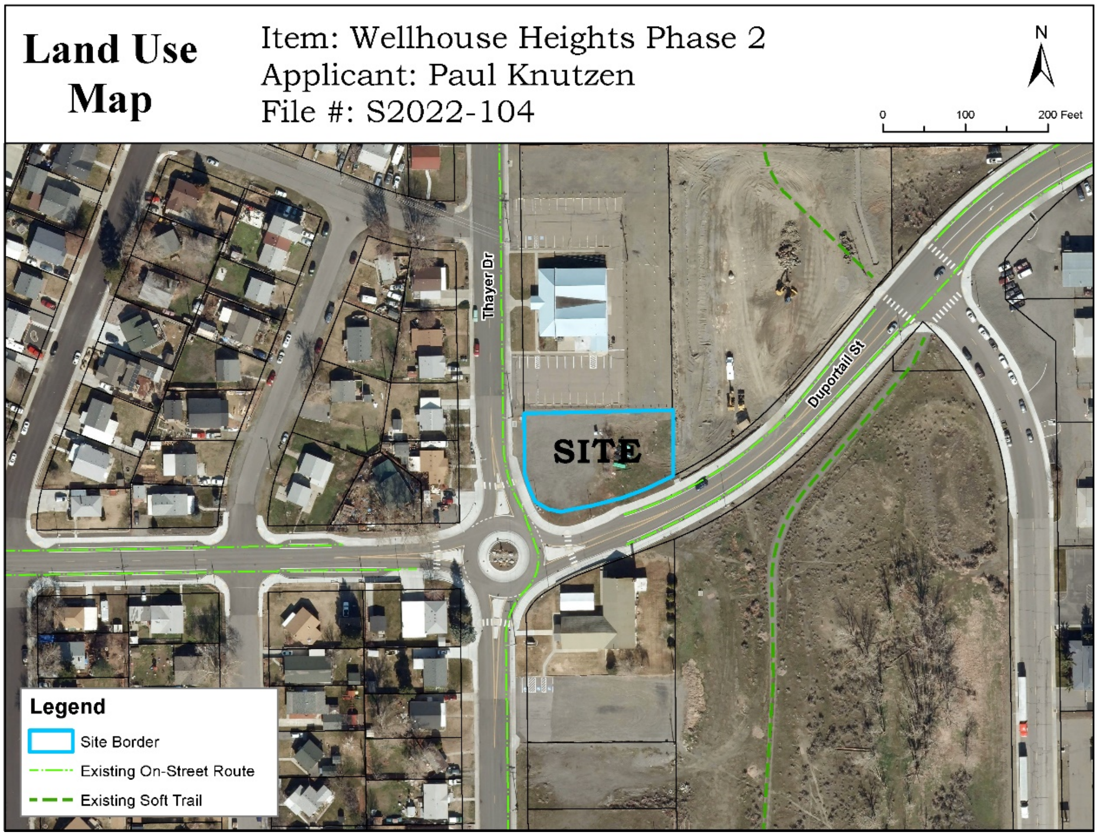
CITY OF RICHLAND
NOTICE OF APPLICATION, PUBLIC HEARING & OPTIONAL DNS (S2022-104 & EA2022-128)

Notice is hereby given that Paul Knutzen has submitted Preliminary Plat Application for the development of an approximately 0.43-acre site, with five (5) residential townhome buildings. The project site is located at property formerly known as 400/404 Thayer Drive (at the NE corner of intersection of Thayer Drive and Duportail Street) and is zoned R-3 (multiple-family residential use district). The property is described as Assessor's Parcel Nos. 115981013704001 located in Section 15, Township 9, North, Range 28 East, W.M., Benton County WA.

A public hearing on the proposed site plan review will be held before the Hearing Examiner on Thursday, October 20, 2022 at 6:00 PM within the City Council Chambers located at 625 Swift Blvd. All interested parties are invited to attend and present testimony at the public hearing or via Zoom by visiting the City's website: www.ci.richland.wa.us.

Environmental Review: The proposal is subject to environmental review. The City of Richland is lead agency for the proposal under the State Environmental Policy Act (SEPA) and has reviewed the proposed project for probable adverse environmental impacts and expects to issue a determination of non-significance (DNS) for this project. The optional DNS process in WAC 197-11-355 is being used. This may be your only opportunity to comment on the environmental impacts of the proposed development. The environmental checklist and related file information are available to the public and can be viewed at www.ci.richland.wa.us.

Any person desiring to express their views or to be notified of any decisions pertaining to this application should notify Matthew Howie, Senior Planner, 625 Swift Boulevard, MS-35, Richland, WA 99352. Comments may emailed to mhowie@ci.richland.wa.us. The deadline for written comments is 6:00 p.m., Wednesday, October 19th. However, written comments must be received no later than 5:00 p.m. on Wednesday, October 12th to be incorporated into the staff report. Comments received after that time will be entered into the record during the hearing.



Please note that pursuant to RMC 23.48.010, the purpose of the site plan approval process is to facilitate project design that is compatible with adjacent land uses and is in keeping with the physical constraints of the project site.* ***The site plan review is not intended to determine whether a particular land use activity is appropriate on a particular site**. Land uses that are otherwise permitted in this title shall not be denied through the site plan review process unless such uses cannot meet the development and/or performance standards required for the use.*

City of Richland
Development Services

625 Swift Blvd. MS-35
Richland, WA 99352
☎ 509-942-7794
🖷 509-942-7764

Preliminary Plat Application

Note: A Pre-Application meeting is required prior to submittal of an application.

PROPERTY OWNER INFORMATION

☐ Contact Person

Owner: Bush Trustees Timothy & Kathryn

Address: 3019 Duportail St #226, Richland, WA 99352

Phone: 509-947-7902	Email: tim@bushdevelopments.com

APPLICANT/CONTRACTOR INFORMATION (if different)

☒ Contact Person

Company: Knutzen Engineering	UBI#: 603-538-277

Contact: Paul Knutzen

Address: 5401 Ridgeline Dr, Suite 160, Kennewick, WA 99338

Phone: 509-222-0959	Email: paul@knutzenengineering.com

SURVEYOR INFORMATION

Contact: Rogers Surveying Inc.

Address: 1455 Columbia Park Trail, Suite 201, Richland, WA 99352

Phone: 509-783-4141	Email: dbaalman@rogerssurveying.com

ENGINEER INFORMATION

Contact: Paul Knutzen

Address: 5401 Ridgeline Dr, Suite 160, Kennewick, WA 99338

Phone: 509-222-0959	Email: paul@knutzenengineering.com

PROJECT DESCRIPTION

5-lot residential development. Each lot will be serviced by City of Richland public utilities. The lots will be accessed off existing public ROW and will not require the construction of new roads.

PROPERTY INFORMATION

Parcel #: 115981013704001	Zoning: R-3

Legal Description: Lot 1, Short plat 3704, recorded in volume 01 of short plats 3704, records of Benton County, WA, AF#2021-037940, 08/12/2021.

Proposed Subdivision Name: Wellhouse Heights

Gross Plat Acreage: 0.43 acres	Number of Lots: 5	Smallest Lot Size: 3,049 sf
Net Lot Area Acreage: 0.43 acres	Avg. Lot Size: 3,768 sf	Largest Lot Size: 5,985 sf

Domestic Water Supply: ☒ City ☐ Private Well	Sewage Disposal: ☒ City ☐ Septic

Irrigation Source: ☒ City ☐ Private Well ☐ Columbia Irrig. District ☐ Kennewick Irrig. District ☐ Other

SEPA Checklist submitted? ☒ Yes ☐ No	Title Report (Subdivision Guarantee) submitted? ☒ Yes ☐ No

APPLICATION MUST INCLUDE

1. Completed application and filing fee
2. 2 – Full-size copies of proposed survey
3. 1 – 11” x 17” copy of proposed survey
4. 1 – PDF file of proposed survey
5. Title Report showing ownership, easements, restrictions and accurate legal description of the property involved
6. SEPA Checklist
7. Other information as determined by the Administrator

I authorize employees and officials of the City of Richland the right to enter and remain on the property in question to determine whether a permit should be issued and whether special conditions should be placed on any issued permit. I have the legal authority to grant such access to the property in question.
I also acknowledge that if a permit is issued for land development activities, no terms of the permit can be violated without further approval by the permitting entity. I understand that the granting of a permit does not authorize anyone to violate in any way any federal, state, or local law/regulation pertaining to development activities associated with a permit.

I hereby certify under penalty of perjury under the laws of the State of Washington that the following is true and correct:

1. I have read and examined this permit application and have documented all applicable requirements on the site plan.
2. The information provided in this application contains no misstatement of fact.
3. I am the owner(s), the authorized agent(s) of the owner(s) of the above referenced property, or I am currently a licensed contractor or specialty contractor under Chapter 18.27 RCW or I am exempt from the requirements of Chapter 18.27 RCW.
4. I understand this permit is subject to all other local, state, and federal regulations.

Note: This application will not be processed unless the above certification is endorsed by an authorized agent of the owner(s) of the property in question and/or the owner(s) themselves. If the City of Richland has reason to believe that erroneous information has been supplied by an authorized agent of the owner(s) of the property in question and/or by the owner(s) themselves, processing of the application may be suspended.

Applicant Printed Name: Paul Knutzen

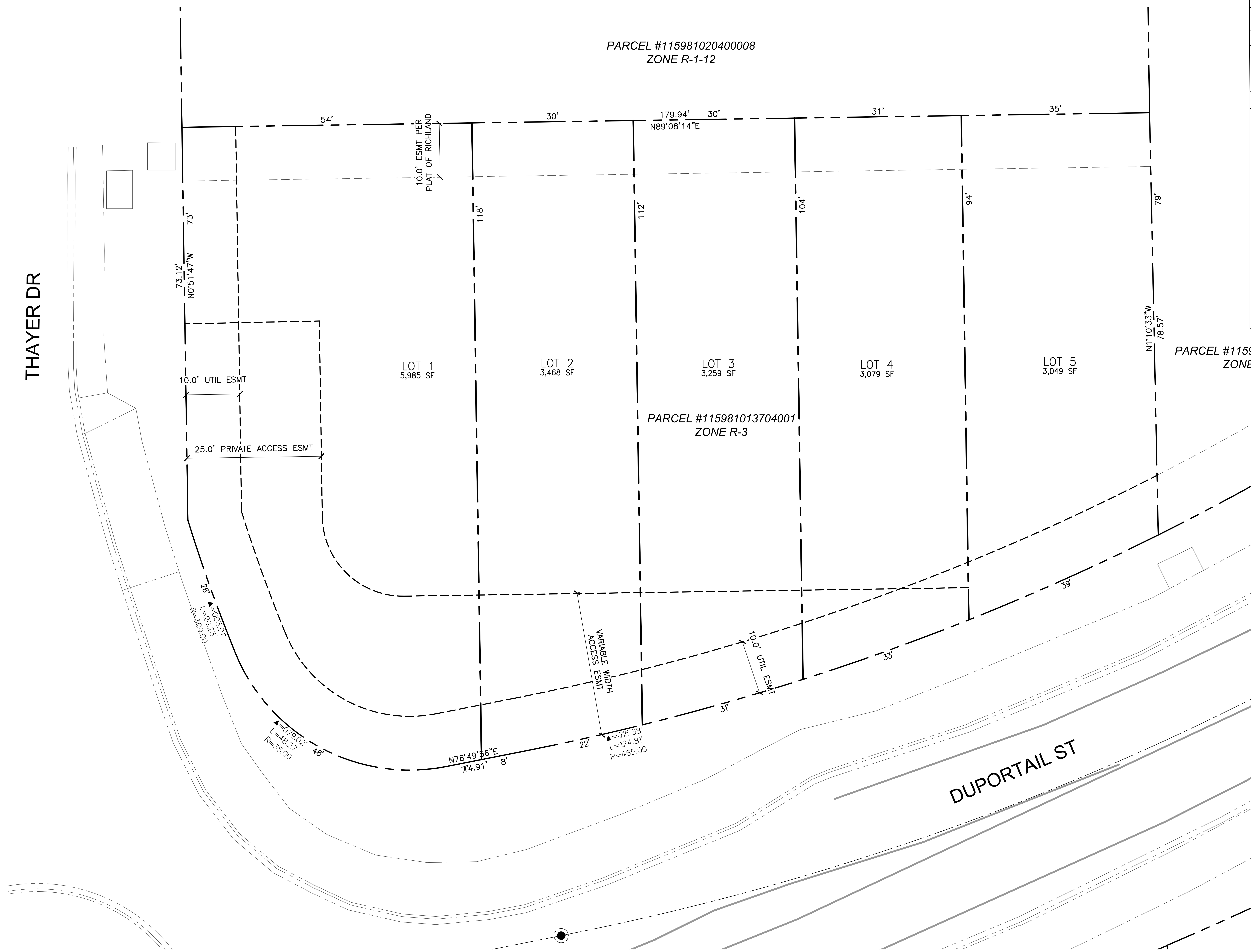
Applicant Signature: Paul Knutzen Date 08/23/2022

WELLHOUSE HEIGHTS PH2

PRELIMINARY PLAT

N.E. 1/4 OF THE N.E. 1/4 OF SEC. 15, T.09N., R.28E, W.M., CITY OF RICHLAND,
BENTON COUNTY, WA

NORTH



CONTACT INFO

ENGINEER:
KNUTZEN ENGINEERING
ATTN: NATHAN MACHIELA
5401 RIDGELINE DRIVE
SUITE 160
KENNEWICK, WA. 99338
PHONE:(509)222–0959

APPLICANT/DEVELOPER:
TIM BUSH
520 W. COLUMBIA DR.
KENNEWICK, WA 99336

SURVEYOR:
RODGERS SURVEYING INC
ATTN:DAVID BAALMAN
1455 COLUMBIA PARK TRAIL
RICHLAND, WA. 99352
PHONE:(509)783–4141

BASIS OF BEARINGS

GRID, US STATE PLAN, NAD 83/2011 WASHINGTON SOUTH ZONE BASED ON GNSS OBSERVATIONS

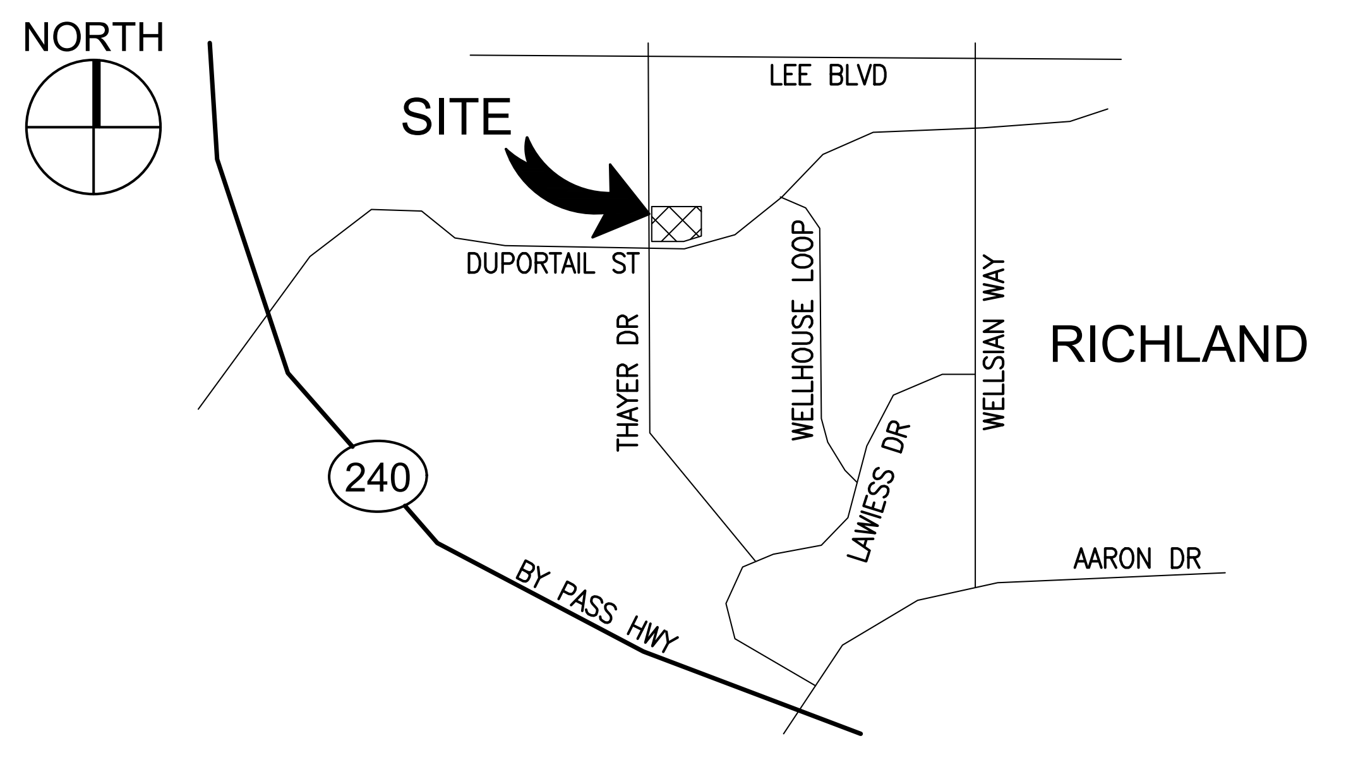
BASIS OF ELEVATION

NAVD 88, BASED ON GNSS OBSERVATIONS PROCESSED BY NGS OPUS & CONFIRMED BY TIES TO CITY OF RICHLAND CONTROL NETWORK.

LEGAL DESCRIPTION

LOT 1, SHORT PLAT 3704, RECORDED IN VOLUME 01 OF SHORT PLATS 3704, RECORDS OF BENTON COUNTY, WASHINGTON. AF#2021–037940, 08/12/2021.

VICINITY MAP



LAND USE SUMMARY

GROSS ACREAGE:	0.43 AC
NET LOT ACREAGE:	0.43 AC
AREA OF PUBLIC ROADS:	0 AC
TOTAL NUMBER OF LOTS:	5 LOTS
AVERAGE LOT SIZE:	3,768 SF
LARGEST LOT AREA:	5,985 SF
SMALLEST LOT AREA:	3,049 SF
AVERAGE DENSITY:	11.6 DU/AC
PRESENT ZONING:	R–3
TYPE OF WATER SERVICE:	CITY
TYPE OF SEWER SERVICE:	CITY

CALL 811
2 BUSINESS DAYS
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0' 5' 10' 20' 30'
1" = 10'

A1 PRELIMINARY PLAT
SCALE: 1" = 10'–0"

KNUTZEN
ENGINEERING
5401 RIDGELINE DR.
SUITE 160
KENNEWICK, WA 99338
1-509-222-0959
www.knutzenengineering.com

No.	REVISIONS	DATE	DESIGN	CHKD	APPD

08/23/22

PRELIMINARY PLAT

BUSH PROPERTIES
WELLHOUSE HEIGHTS PH2
404 THAYER DR, RICHLAND, WA 99352

APPROVAL		
DESIGN	RAM	08/23/22
CHECKED	PTK	08/23/22
APPROVED	PTK	08/23/22

SCALE: AS NOTED
CADFILE: 19023PH2 PP01
JOB No. 19023
REV. 0

DWG. No.
PP01

\2019\19023-Bush Duportail Residential\DWG\Upper Lot Phase 2\19023PH2 PP01.dwg - Aug 23,2022 - 07:01pm - rmc

KNUTZEN
ENGINEERING

Critical Aquifer Recharge Area Report

Wellhouse Heights Ph2

404 Thayer Dr
Richland, WA 99352

Prepared For:

Bush Trustees, Timothy T & Kathryn L
3019 Duportail St, #226
Richland, WA 99352

Prepared By:

Paul Knutzen, PE
Robert McLeod
Project No. 19023

PAUL T. KNUTZEN
44313

Paul Knutzen

9/2/22

Preparation Date:

September 2, 2022

5401 Ridgeline Drive, Suite 160, Kennewick, WA 99338 | 509.222.0959 | knutzenengineering.com

Table of Contents

Appendices

1.0 Project Overview

The Wellhouse Heights Phase 2 project is located at 404 Thayer Dr, Richland, WA 99352. The site encompasses Benton County parcel #115981013704001. The existing 0.43-acre site is undeveloped and zoned R-3, Multiple Family Residential. The property is bordered by R-2 single-family residential housing, Wellhouse Heights Phase 1, religious buildings, and Lawless Park. The project proposes 5 lots intended for single-family townhouse units. The units will access off Duportail St and Thayer Dr via shared private driveways. The project will cover approximately 57% of the site with impervious surfaces. Construction for the proposed improvements is expected to take place in Spring of 2023. Refer to Appendix A for the Vicinity Map and Appendix B for the preliminary plat map.

The site is located completely within an Aquifer Recharge Critical Area, as shown by the City of Richland's online critical area mapping. As identified in the City's Wellhead Protection Program, the site is near the edge of the 1-year time of travel zone for the Wellsian Way Wellfield (SO2). See Appendix C for the map taken from the City's Wellhead Protection Program.

2.0 Site Geology

With previous construction, the existing site was graded relatively flat, approximately level in elevation with Thayer Dr. There is no evidence of storm runoff flowing from the site, or onto the site from an off-site source.

White Shield, Inc. prepared a geotechnical investigation report for the adjacent property for the Wellhouse Heights Phase 1 project, on September 25, 2020. (White Shield Project No. 119-054-01) They performed fifteen exploration test pits and two infiltration test pits on-site. They encountered varying amounts of uncontrolled fill and debris, which was removed with the construction of Phase 1. Underneath the fill, the native soils were predominantly fine to medium sand with occasional thin layers of gravel. No bedrock or groundwater was encountered in any of the test pits. White Shield used air entry permeameter testing and grain size analysis to calculate infiltration rates for the on-site soils. They calculated rates of 6.0 in/hr and 8.0 in/hr for the on-site soils.

3.0 Groundwater

No groundwater was encountered during the test pit explorations. White Shield, Inc. identifies the groundwater depth as approximately 79 feet below the existing surface elevation, based on nearby well logs. The groundwater level is likely to rise and fall with the change of seasons and irrigation.

A report provided by USGS identifies the general hydraulic gradient in the area as towards the northeast. See Appendix E for exhibits showing shallow water table level contours, Saddle Mountain basalt water level contours and Wanapum basalt contours.

4.0 Project Impact and Mitigation Plan

It is possible that stormwater produced by the site's impervious surfaces could enter the belowground aquifer. It is unlikely that pollutants in the stormwater could enter the belowground aquifer due to the significant depth of the groundwater. The large barrier, comprised of native soils in the vadose zone, provides natural filtration, preventing pollutants from entering groundwaters. Furthermore, no storage or usage of chemicals are proposed on-site. The principal component of the site's mitigation plan is ensuring pollutants do not enter groundwater through the stormwater management plan and pretreatment practices.

The stormwater management plan for the site will collect and infiltrate all stormwater runoff through conveyance systems and underground infiltration facilities. The plan compliant with the Stormwater Management Manual for Eastern Washington. The site is classified as a low pollutant loading site, per table 5.22 of the SMMEW. Based on the soil type and the infiltration rate provided by White Shield, on-site soils are classified as low treatment capacity soils, per table 5.21 of the SMMEW. The Wellhouse Heights construction drawings will instruct the contractor to install 18” of high treatment capacity soil around all underground infiltration facilities, per table 5.21. Therefore, per table 5.23 of the SMMEW, the required pre-treatment is a two-stage drywell. Catch basins with inverted tees are proposed at the entrances of the underground infiltration facilities, satisfying the requirement of a two-stage drywell.

Proper stormwater facility maintenance instructions are provided on the corresponding construction drawings for the project. Based on the site conditions found and the proposed pre-treatment facilities, the proposed project should have no significant impact to the Critical Aquifer Recharge Area. No additional plans are proposed to limit the impact on the aquifer at this time.

APPENDIX A

Vicinity Map

Wellhouse Heights Ph2
Project Site
404 Thayer Dr
Richland, WA 99352
Redeemer Lutheran Church
Americar
Donor Cent
Fries St
Fries St
Thayer Dr
Thayer Dr
Thayer Dr
Rossell Ave
Rossell Ave
Robert Ave
Robert Ave
Duportail St
Duportail St
Duportail St
AUTO EXPERTS
The Foldec
Temp
Wellhouse Loop
Wellhouse Loop
New Heights Church
CAN Do Kids, Pediatric
Therapy Services
Wine Boss
Ros

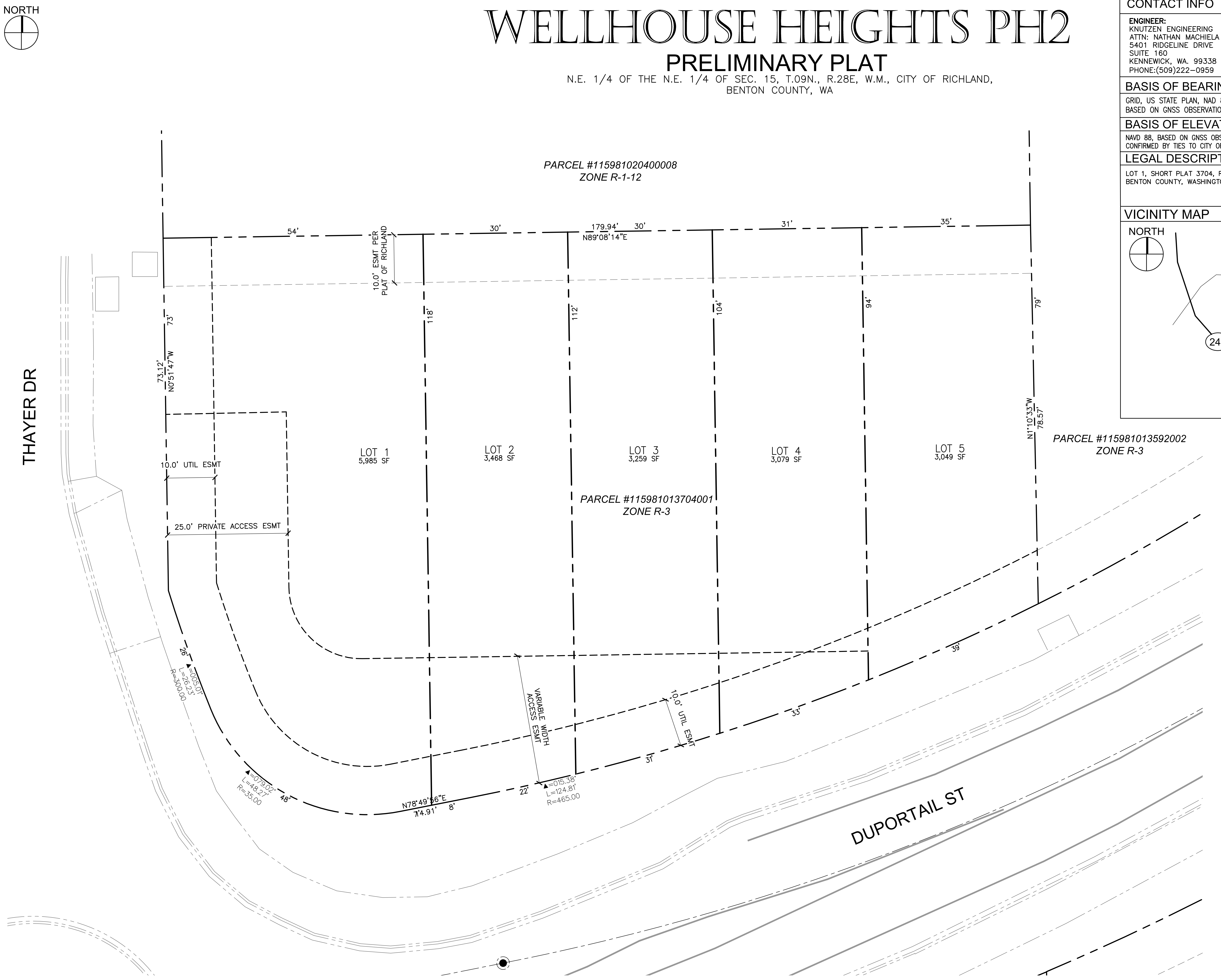
APPENDIX B

Preliminary Plat

WELLHOUSE HEIGHTS PH2

PRELIMINARY PLAT

N.E. 1/4 OF THE N.E. 1/4 OF SEC. 15, T.09N., R.28E, W.M., CITY OF RICHLAND,
BENTON COUNTY, WA



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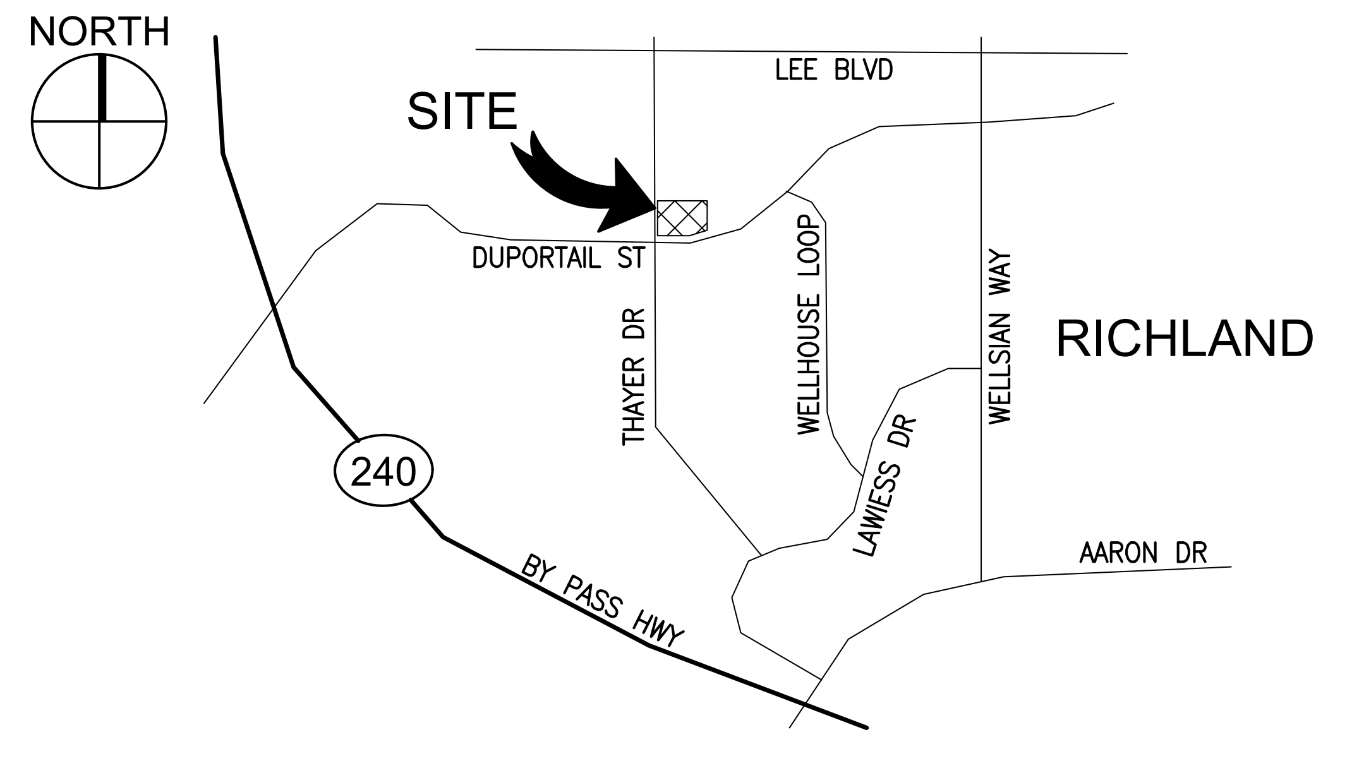

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No.	REVISIONS	DATE	DESIGN	CHKD	APPD

08/23/22

PRELIMINARY PLAT

BUSH PROPERTIES
WELLHOUSE HEIGHTS PH2
404 THAYER DR, RICHLAND, WA 99352

APPROVAL		
DESIGN	RAM	08/23/22
CHECKED	PTK	08/23/22
APPROVED	PTK	08/23/22

SCALE: AS NOTED
CADFILE: 19023PH2 PP01

JOB No.	REV.
19023	0

DWG. No.
PP01

A1 PRELIMINARY PLAT
SCALE: 1" = 10'–0"

\2019\19023-Bush Duportail Residential\DWG\Upper Lot Phase 2\19023PH2 PP01.dwg - Aug 23,2022 - 07:01pm - rmc

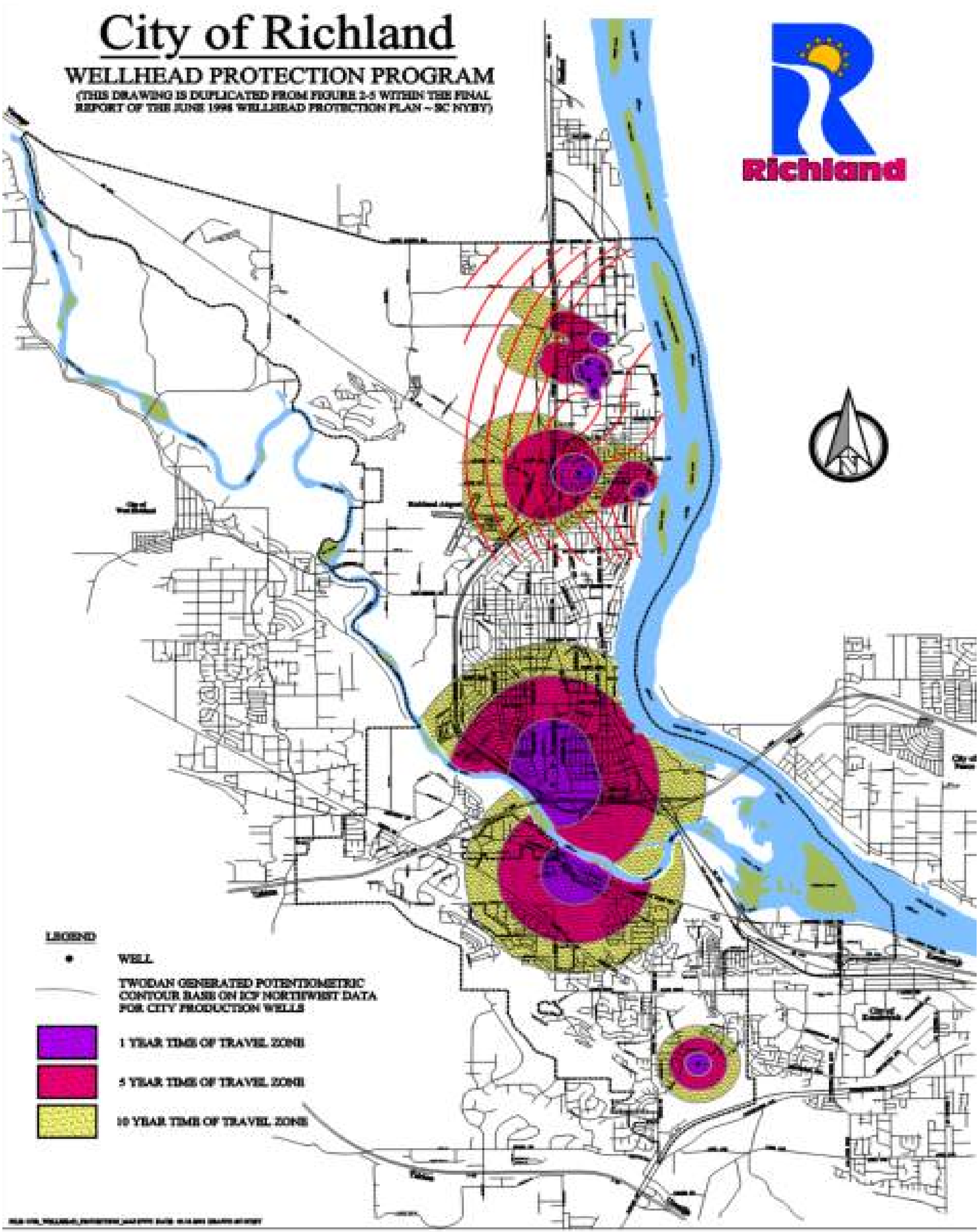
APPENDIX C

Wellhead Map

City of Richland

WELLHEAD PROTECTION PROGRAM

(THIS DRAWING IS DUPLICATED FROM FIGURE 2-5 WITHIN THE FINAL
REPORT OF THE JUNE 1998 WELLHEAD PROTECTION PLAN ~ SC NYBY)



APPENDIX D

Geotechnical Report

Geotechnical Investigation Report
Bush Townhome Development
1380 Duportail Street
Richland, WA

September 25, 2020

Submitted To:

Tim Bush
520 W Columbia Drive
Kennewick, WA 99336

Prepared By:

White Shield, Inc.
320 North 20th Avenue
Pasco, WA 99301
509-547-0100 office
509-547-8292 fax
Email: Info@whiteshield.com
http://www.whiteshield.com

White Shield, Inc. Project No. 119-054-01

TABLE OF CONTENTS

FIGURES

APPENDIX A

APPENDIX B

CERTIFICATE OF ENGINEER

Geotechnical Investigation Report
Bush Townhomes
Richland, Washington

The technical information and data contained in this report were prepared by, or under the direction and supervision of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

Prepared by:

Benjamin P. Staehr, PE
Senior Geotechnical Engineer

BENJAMIN P STAEHR
53247

1.0 INTRODUCTION

1.1 Project Description and Background Information

White Shield, Inc. (WSI) is pleased to present this Geotechnical Investigation Report for the construction of proposed townhomes at 1380 Duportail Street in Richland, WA. The location of the site is shown in Figure 1, Vicinity Map and preliminary site plan is provided on Figure 2, Exploration Site Plan. This area will include 8 townhome buildings consisting of 19 units with associated parking, utilities, and stormwater infiltration.

The site slopes moderately to the east and is bordered to the west by the Masonic Lodge, the southeast by Duportail Street, the north by undeveloped land and soccer fields, and to the east by a City of Richland storm pond.

This report presents the results of our geotechnical investigation of this site. It includes a review of the site geology, a description of site soils and subsurface profile, and geotechnical recommendations and specifications for site grading and construction of home foundations consistent with International Residential Code requirements.

1.2 Scope of Services

Our scope of services for this project included the following:

- **Geologic Literature Review:** Relevant, readily-available geologic information on the site and surrounding area was reviewed for information regarding geologic conditions at or near the site.
- **Site Exploration:** Sixteen exploration test pits were excavated at the site to assess the soil conditions and to obtain representative soil samples for laboratory testing.
- **Laboratory Testing:** Soil testing included index properties testing, and sieve analyses, as required.
- **Geotechnical Engineering Analysis:** Data collected during the site exploration, literature research, and laboratory testing were analyzed to develop project-specific geotechnical design and construction recommendations for the project.
- **Report Preparation:** This geotechnical report contains the results of our work including information as it relates to the following:
    - Site exploration and laboratory test results
    - Soil/rock conditions and subsurface profile
    - Earthwork and site preparation recommendations
    - Site grading and soil placement recommendations
    - Slope design and construction recommendations
    - Foundation subgrade soil preparation recommendations
    - Allowable soil bearing capacities and maximum foundation bearing pressures
    - Foundation wall design parameters and design earth pressures
    - Pavement and slab-on-grade recommendations
    - International Residential Code (IRC) 2015 seismic design parameters
    - General site grading and drainage control requirements

- **Geotechnical Construction Observation:** This report includes the outline of basic geotechnical requirements for construction observation and documentation to be performed during the construction process.

2.0 SITE INVESTIGATION

2.1 Literature Review

Information about the basic geology of the Pasco Basin was obtained from Lindsey (1996) and a discussion of the underlying Miocene-age basalt bedrock structure was provided from Reidel (et al., 1994). Information about the geologic setting of the site comes from many years of exploration work throughout Richland, West Richland, and Kennewick and from correlating the site data with regional geologic conditions.

2.2 Field Investigation

The subsurface investigation of this site included excavation of fifteen exploration test pits and two infiltration test pits at locations shown on Figure 2.

The test pits were excavated with a tracked excavator. In general, test pits 1-9 encountered varying amounts of concrete and asphalt debris up to 13 feet in depth. Test pit 11 encountered 4 feet of loose gravelly fill soils. Beneath any fill encountered, the site soils are predominantly fine to medium sands with occasional thin layers of gravel, generally at the top of the native soil deposits

INF TP-1 encountered 3.2 feet of fill soils, with fine to medium sands to a depth of 10 feet. INF TP-2 encountered 1 foot of fill soils with fine to medium sands to a depth of 11 feet. Hydrogeologic testing was performed and can be seen in section 6.0 Site Drainage and Infiltration Analysis.

The test pit logs, provided in Appendix A (TP-1 through TP-15 and INF TP-1 through INF TP-2), include detailed descriptions of the subsurface soil types and condition.

2.3 Laboratory Testing and Analysis

All soil samples were classified under the Unified Soil Classification System (USCS). The soil descriptions were prepared according to the Burmister Classification System. All soils were easily classified using visual manual procedures. Laboratory gradation analysis of soils from the infiltration test pits were conducted to aid in the hydrogeologic analysis and are attached to the associated memorandum in Appendix B. Further lab testing will likely be required for soil classification and proctor analysis for use during construction observations.

3.0 SITE CONDITIONS

3.1 Surface Conditions and Lot Slopes

The property is moderately sloping down to the east. The bulk of the site is ungraded native soil deposits. There are some amount of dumped fill soils located along the upper western portion of the site, and just below in the central portion of the site. We discussed these garbage fill areas with Knutzen Engineering and they have incorporated them into their grading plan for removal. Surface or subsurface water was not encountered during our explorations.

3.2 Site Soils

The local soils exposed during our explorations are generally upper outburst flood gravel deposits of the Missoula floods.

3.3 Regional and Local Geology

We reviewed the WADNR Geologic map of the Richland 1:100,000 Quadrangle (Riedel, et al.), 1994. The site is classified as outburst flood deposits of Glacial Lake Missoula, gravels (Qfg_4).

The Qfg deposits are generally described as gravels, grain size ranges from sand to boulders, size generally decreases away from major Pleistocene outburst flood channels. The Qfg_4 are the youngest of such flood deposits.

Based on our explorations we believe that the majority of the site consists of sand size particles that are consistent with the upper portion of the outburst flood gravel deposits.

4.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

4.1 Foundation Configuration

Building foundations should be extended through any fill soils on site and founded on native site soils below or be placed on properly prepared structural fill.

4.2 Site Preparation

Clear and grub all cut and fill areas of all surface vegetation and either use as landscape fill or haul offsite. All dumped garbage fill containing concrete and asphalt debris should be hauled off site. Remove all roots and organic material, loose or soft soil, and old topsoil from all areas to receive fill soil, retaining walls, pavement, foundations, driveways, etc. Positive drainage away from structures and pavement subgrade areas should be constructed and maintained throughout the project.

4.3 Earthwork

4.3.1 Excavations

Excavation of the surface fine sand and silt soil can be accomplished with a backhoe with a smooth bucket to prevent disturbance of subgrades or through mass grading equipment such as scrapers or dozers.

A maximum slope of 1V:1.5H (vertical to horizontal) is recommended for all unsupported excavation sidewalls in the silty sand soils at the site. Any trenching or excavation over 4.0 feet bgs requires either the previously-mentioned side slopes or shoring and bracing of the excavation.

This information on slope protection is based on Occupational Safety and Health Administration (OSHA) regulations and is provided entirely as a service to our Client. Under no circumstances should the Client or their contractors or subcontractors interpret this information to mean, or otherwise imply, that White Shield, Inc. (WSI) assumes responsibility for construction site safety and/or temporary slope stability, or the contractor activities. Such responsibility is not implied and should not be inferred.

4.3.2 Site Grading

All excavated materials will be kept on site and used as backfill around foundation walls and structures and for grading around the homes. All soil fill placed on this property during construction is considered to be structural fill that must be placed and compacted to the specifications listed in the following section 4.4.4 Structural Fill.

4.3.3 Cut and Fill Slopes

All finish slopes shall be graded to a maximum slope of 1V:2H. All fill slopes shall be constructed from the base upward by compacting the soil in layers, overbuilding the slope, and then finish grading to a maximum slope of 1V:2H. Temporary soil cuts should not exceed four feet unless approved by the geotechnical engineer and plans are made for providing immediate permanent structural support.

4.3.4 Structural Fill

For structural fill, use existing onsite soil or imported granular soil. The onsite soil can be used as structural fill provided it is free of organics, it is installed in maximum 8-inch-loose lifts and it is compacted in place. Structural fill soil shall not contain boulders exceeding 6 inches in diameter. Backfill soil next to building foundations shall be classified as primarily sand and gravel with no boulders or clasts exceeding 3 inches in diameter.

Imported fill should be well graded between coarse and fine with a maximum particle size of 1 inch and contain no deleterious materials. Imported fill should have a less than 20 percent by weight passing the No. 200 sieve. Imported soil fill shall be approved for use by a geotechnical engineer and soil compaction criteria shall be established for the specific material.

Knutzen Engineering requested that we analyze site soils from 1383 Lawless Drive in Richland for suitability of these soils for use as import fill. We performed 3 hand auger borings within the site to depths based upon a grading plan provided by Knutzen. We found the soils are similar to those found within the building site and consist mainly of fine to medium sands. These soils should be acceptable for use as import structural fill, however we will need to occasionally observe the soils for continued use as structural fill during construction.

All structural fill shall be installed in 8-inch, maximum loose lifts, it shall be moisture conditioned to optimum moisture content and it shall be compacted to a dry density of at least 95 percent of its maximum dry density as determined by the modified proctor test using ASTM International (ASTM) D1557 or per onsite specification and approval by the geotechnical engineer.

Vibratory roller compactors or wheel roller compaction equipment will produce the best soil compaction results at this site. For backfilling next to the foundation walls, we recommend using a hand-operated jumping jack.

4.4 Foundations

4.4.1 Design

The proposed buildings can be supported on conventional spread footings. All footings should be supported on properly prepared subgrade in native soils or on structural fill as discussed in the previous paragraphs. If we are retained to monitor mass grading, there is no need for further geotechnical evaluation of individual lots.

The minimum widths of the continuous wall footings shall be consistent with current IRC standards. The bottom exterior of all footings shall be at least 24 inches below the lowest adjacent exterior grade for frost protection.

Per IRC code, all buildings should be set back a minimum of H/3 from the edge of any descending slopes, where H is the overall height of the slope. According to the proposed grading plan, this will be required for buildings 6-8.

WSI recommends using a maximum soil bearing pressure of 2,000 pounds per square foot (lb/ft^2) for all footings that bear on the near-surface, or sandy soils consistent with current IRC standards. Please note that this allowable soil bearing pressure assumes a minimum confinement depth, or depth of burial, of 2.0 feet bgs. For interior footings placed directly on the prepared subgrade and not backfilled, reduce the allowable bearing pressure to 1,000 psf.

An assessment of loading on the foundation system by the home designer, architect, or structural engineer is required to verify that the footing sizes comply with the previously-mentioned requirements and the footings are correctly proportioned for the specified bearing capacity.

For consideration of short period seismic and wind pressures, the allowable footing bearing pressure values provided in this section may be increased by one-third. Use a dynamic bearing capacity of 2,000 lb/ft^2 when sizing footings for transient forces. For lateral forces, use a friction coefficient of 0.4 between the base of the footings and the underlying subgrade soil.

4.4.2 Settlement

WSI estimates a maximum total settlement of less than 0.5 inch and a maximum differential settlement on the order of 30 percent of the maximum settlement over 50 feet. Our settlement estimate assumes that no disturbance of the foundation soil would be permitted during excavation and construction and the footings are prepared as described previously.

4.4.3 Foundation Backfill

The clear space around the exterior of all foundations and between the stem walls and footing trenches shall be backfilled in lifts and compacted to a minimum of 90 percent of maximum dry density per ASTM D1557, or per onsite inspection and approval by the geotechnical engineer. Care must be taken with the backfilling operation to provide foundation subgrade soil confinement pressure and to help limit infiltration and future settlement around the foundation. At this site, careful backfilling behind the basement walls is critical for preventing any storm drainage inflow into the foundation area.

4.4.4 Foundation Walls and Lateral Earth Pressure

For the design of elevated stem walls and garage foundation walls, use the data in the following Table 1:

Table 1: Native Soil Design Parameters

Assumed Soil Density		=	120 lb/ft^3
Assumed Soil Internal Friction Angle		=	32 degrees
Coefficient of At-Rest Earth Pressure,	K_o	=	0.47
At-Rest Earth Pressure Equivalent Fluid Density		=	56 lb/ft^3
Coefficient of Active Earth Pressure,	K_a	=	0.31
Active Earth Pressure Equivalent Fluid Density		=	37 lb/ft^3
Coefficient of Passive Earth Pressure,	K_p	=	3.25
Passive Earth Pressure Equivalent Fluid Density		=	390 lb/ft^3

Basement foundation walls should generally be designed using the at-rest lateral earth pressure value.

All foundation walls must be backfilled with compacted soil to fully mobilize the passive earth resistance. Backfill placed within 3 feet of foundation walls should be placed in maximum 12-inch, loose lifts and compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557.

4.4.5 Seismic Design Criteria

The soil profile at the site consists of silty sand surface soil underlain by dense fine to medium sand followed by dense sandy gravels. This soil profile conforms to a seismic design “Site Class C”, very dense soil and soft rock. For this site, use the following seismic design parameters found in the following Table 2:

Table 2: 2015 IBC Seismic Design Parameters

	Short Period	1 sec
Maximum Credible Earthquake Acceleration	$S_s = 0.412$	$S_1 = 0.159$
Site Class	C	
Site Coefficient	$F_a = 1.200$	$F_v = 1.641$
Adjusted Spectral Acceleration	$S_{MS} = 0.495$	$S_{M1} = 0.261$
Design Response Acceleration	$S_{DS} = 0.330$	$S_{D1} = 0.174$
Design Peak Ground Acceleration	0.175 g	

Based on the design response acceleration (S_{DS}=0.330) the buildings on this site are assigned a Seismic Design Category C consistent with IRC Table R301.2.2.1.1

Additionally, due to a lack of near surface water, the potential for liquefaction of site soils under seismic loading is considered very low to low for this site.

4.5 Slabs on Grade

Slabs-on-grade should be supported on subgrade soils prepared as described in **Section 4.3.2 Site Grading** subsection of this report. Clean crushed rock, at least 6 inches thick and compacted into place should be placed throughout the planned slab areas and over the exposed native soils We recommend that all floor slabs be underlain by at least four inches of free-draining gravel with less than three percent by weight of the material passing Sieve No. 200 for use as a capillary break. A suitable vapor barrier, such as heavy plastic sheeting (6-mil minimum), should be placed over the capillary break material. An additional 2-inch thick moist sand layer may be used to cover the vapor barrier. This sand layer is optional and is intended to protect the vapor barrier membrane during construction.

4.6 Pavements

Pavement subgrade preparation, and structural filling where required, should be completed as recommended in the **4.3.2 Site Grading** and **4.3.4 Structural Fill** subsections of this report. The pavement subgrade should be proof-rolled with a heavy, rubber-tired piece of equipment to identify soft or yielding areas that require repair. We anticipate the areas needed for repair can be removed and replaced with clean crushed rock, compacted into place. We should be retained to observe the proof rolling and recommend repairs prior to placement of the asphalt or hard surfaces. WSI should approve all pavement subgrades.

Pavement sections should include a minimum of 6 inches of crushed surfacing base course (CSBC) and 2 inches of hot mix asphalt (HMA). Any paving that will experience heavy loading such as for garbage trucks, should consist of 8 inches of CSBC and 3 inches of HMA placed in 2 lifts.

5.0 FINAL SITE GRADING AND EROSION CONTROL

The ground surface adjacent to the building shall slope away from the slab, stem walls, or foundation walls at 5 percent for a minimum distance of 10 feet from the structure per the requirements of the IRC, or an alternative drainage method shall be designed into the site drainage plan. Landscaping and lot grading should consider drainage requirements of the building and prevent ponding of water near the structures or in landscaped areas. All impervious surfaces shall be sloped to drain into an approved catch basin and piped to an appropriate infiltration system on-site.

All final slope surfaces should be moisture conditioned and compacted with a track dozer or some other compaction method that will work on the slope to achieve a smooth slope with a maximum slope angle of 1V:2H. A maximum slope of 1V:3H should be used if the slope will be maintained in grass and mowed. Finish soil slopes that are steeper than 1V:3H require some form of erosion protection to prevent water erosion at the surface in the event of an irrigation or domestic water line break. Erosion protection of these slopes should be designed into the final landscaping plan for the lot. Several options exist for slope protection and erosion control including but not limited to the following:

- The slope can be planted with drought-resistant plants (desert landscape) and watered with drip irrigation systems or light hand watering.

- Erosion control blankets or geotextile can be utilized along with sparsely-placed suitable vegetation. The erosion control blanket provides more immediate slope protection with the vegetation and will aid in long-term stability.
- The slope can be covered with a landscape fabric and then covered with decorative gravel, cobble, or rock.

Existing slopes that are undisturbed and covered with native desert vegetation are all less than 1V:3H and do not require any form of erosion control.

6.0 SITE DRAINAGE AND STORMWATER INFILTRATION

We conducted two on-site infiltration test pits within the proposed stormwater infiltration locations during our site visit. The on-site tests were conducted in INFTP-1 and INFTP-2 at 6.0 feet below grade.

As an alternative to recommendations in the WSDOE Stormwater Manual for Eastern Washington (2019), we performed air entry permeameter testing within the upper soil horizon in both test holes. We further collected samples of each different soil horizon encountered to a depth of 5 feet below the bottom of the proposed infiltration locations. We used the grain size analysis to estimate the saturated hydraulic conductivity of the soils, and used this value to calculate an approximate infiltration rate for both locations. This method exceeds the requirements of the WSDOE for infiltration testing.

The results of our testing can be found in detail in Appendix B: Stormwater Memorandum. Based on our analysis, an infiltration rate of **6.0 inches/hour for INF TP-1** and **8.0 inches/hour for INF TP-2** should be used for design of infiltration systems. These rates are design rates, however do not account for the possibility of silting in of the systems, and thus an appropriate correction factor should be used when designing the stormwater system.

We reviewed nearby well logs in the area and found that the approximate depth to static groundwater is approximately 79 feet below grade in this area. We would anticipate basalt formations to be shallower than this, and based on nearby well logs approximately 68 feet below grade.

The recommended infiltration rates are based on our interpretation of the on-site testing. Soil conditions may vary in different locations and depths. WSI should be retained to evaluate the soils exposed in the bottom of the infiltration system excavations during construction.

7.0 CONSTRUCTION OBSERVATION AND ENGINEERING INSPECTIONS

Geotechnical engineering construction observation is required during construction of both homes to monitor earthwork, soil, and groundwater conditions and to document the geotechnical aspects of constructing the townhomes. Construction observation will allow us to identify unexpected soil or groundwater conditions that were not identified in our site explorations and will allow us to adjust our geotechnical recommendations as required.

This project will require several onsite inspection visits by the geotechnical engineer to observe field conditions and verify the following items:

- Geotechnical engineering review of the building construction plans.

- Geotechnical engineering observation and approval of site grading, soil placement, and compaction.
- Geotechnical engineering inspection, testing, and approval of the building foundation subgrade soil conditions.
- Geotechnical engineering inspection and documentation of the backfill around foundation and stem walls.
- Geotechnical engineering inspection and documentation of the stormwater collection and infiltration system.
- Geotechnical engineering approval of final site grading.

8.0 REFERENCES

Lindsey, K.A. (1996). *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-Central Washington and North-Central Oregon.* Washington Department of Natural Resources, Division of Geology and Earth Resources, Open-File Report 96-8, 45 p., 4 Appendices.

Reidel, S.P., N.P., Campbell, K.R. Fecht, and K.A. Lindsey (1994). *Late Cenozoic Structure and Stratigraphy of South-Central Washington.* Bulletin 80, Washington Division of Geology and Earth Resources, Washington Department of Natural Resources

FIGURES

VICINITY MAP

NOT TO SCALE

Project Number

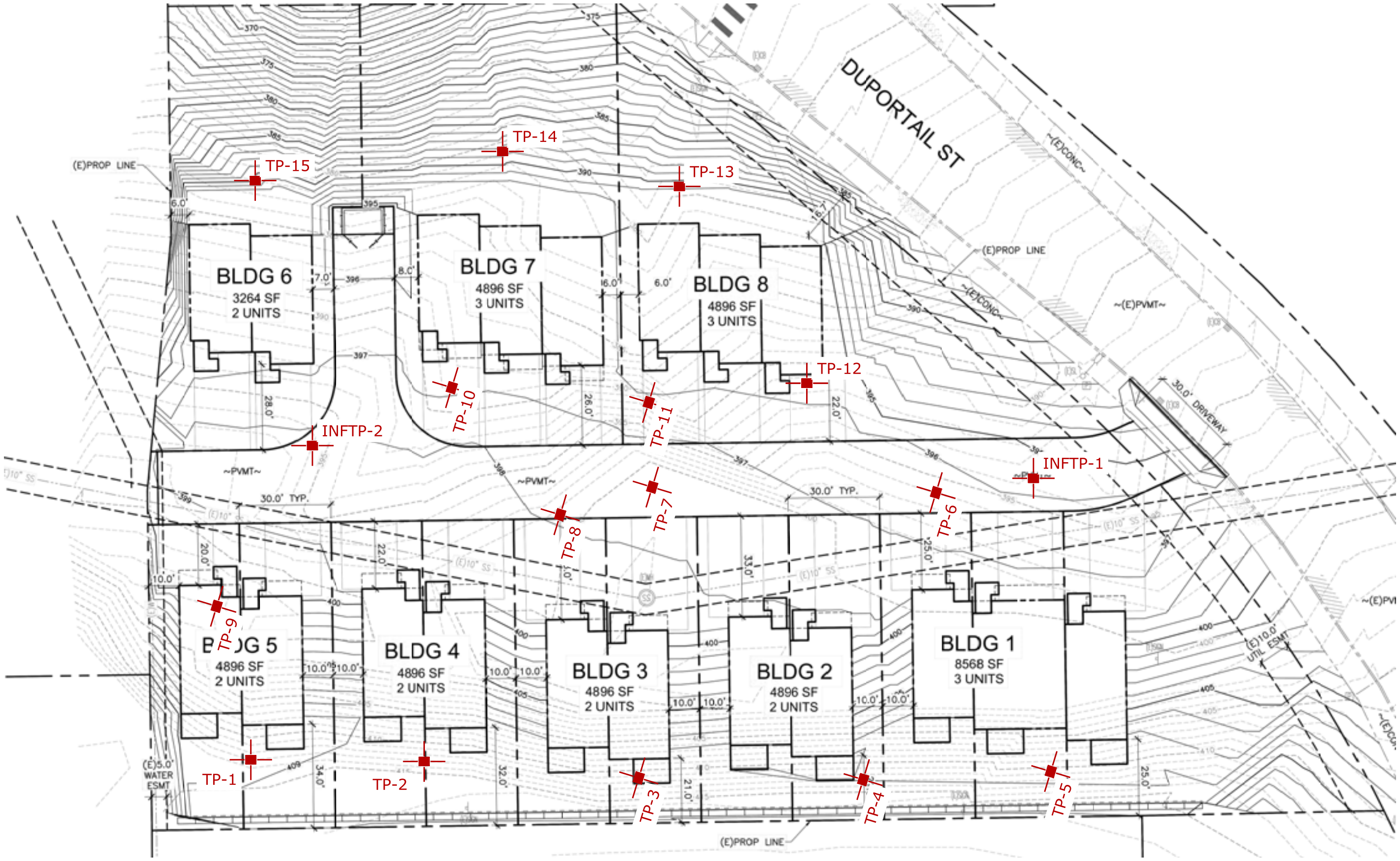
120-054-01

Figure 1

TIM BUSH
1380 DUPORTAIL
RICHLAND, WA
VICINITY MAP

WHITE SHIELD, INC
LAND SURVEYING
ENVIRONMENTAL
ENGINEERING
SERVICES
320 N. 20TH AVENUE
PASCO, WA 99301
PHONE 509.547.0100
FAX 509.547.8292

No.	Date	Revision	By	CK
1	9/11/20	Original	CH	BPS



PRELIMINARY SITE PLAN

LEGEND

TP-1	Number and approximate location of test pit
INF TP-1	Number and approximate location of infiltration test pit

SCALE

20 0 20 40 80

(FEET)

1 INCH = 40 FEET

NOTE- SITE PLAN FROM "SITE PLAN - BUSH PROPERTIES - DUPORTAIL MULTI-FAMILY" PROVIDED BY KNUTZEN ENGINEERING - 8/4/20.

No.	Date	Revision	By	CK
1	9/11/20	Original	CH	BPS

WHITE SHIELD, INC
LAND SURVEYING
ENVIRONMENTAL
ENGINEERING
SERVICES
320 N. 20TH AVENUE
PASCO, WA 99301
PHONE 509.547.0100
FAX 509.547.8292

TIM BUSH
1380 DUPORTAIL ST
RICHLAND, WA
PRELIMINARY SITE PLAN

Project Number
120-054-01

FIGURE 2

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE - GRAINED SOILS MORE THAN 50 % RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE - GRAINED SOILS MORE THAN 50 % PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50 %	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 % OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-93.

2) Soil classification using laboratory tests is based on ASTM D 2488-93.

3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Damp - No visible water, leaves hand dry.

Moist - Leaves water or mud on hand.

Wet - Visible free water or saturated, usually soil is obtained from below water table

Project Number

120-054-01

Figure 3

TIM BUSH
1380 DUPORTAIL ST
RICHLAND, WA
SOIL CLASSIFICATION

WHITE SHIELD, INC
LAND SURVEYING
ENVIRONMENTAL
ENGINEERING
SERVICES

320 N. 20TH AVENUE
PASCO, WA 99301
PHONE 509.547.0100
FAX 509.547.8292

No.	Date	Revision	By	CK
1	9/11/20	Original	CH	BPS

APPENDIX A

Test Pits TP-1 through TP-15 and INF TP-1 through INF TP-2

TEST PIT TP- 1

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhome
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 15 FT

COORDINATES 46.270535 , -119.289124
COORD SYS GPS
SURFACE ELEVATION 407 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
1 2 3 4 5 6 7 8 9 10 11 12	Garbage, concrete asphalt	■	04			
13 14	Medium dense, 5 YR (2.5/1) black, damp medium SAND	▨	SP			
15						
16	Boring terminated at 15 ft on 9/1/20.		Boring terminat at 15			

TEST PIT TP- 2

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Bush
ADDRESS XXXX Richland, WA

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 11 FT

COORDINATES 46.270338 , -119.289137
COORD SYS GPS
SURFACE ELEVATION 407 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
	Garbage					
1						
2						
3						
4	Medium dense, 7.5 YR (2.5/2) brown-blackish, dry Fine-medium SAND, little fine gravel, layered black SAND.	░	SW			
5		░				
6		░				
7		░				
8		░				
9		░				
10		░				
11						
12						
13						
14						
15	Boring terminated at 11 ft on 9/1/20.		Boring terminat at 11			

TEST PIT TP- 3

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 12 FT

COORDINATES 46.270230 , -119.289181
COORD SYS GPS
SURFACE ELEVATION 409 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	**Material Description**	**Graphic Log**	**USCS**	**Blow Count**	**Samples**	**Penetration Resistance**
	Garbage					
9	Medium dense, 7.5 YR (2.5/2) brown blackish, dry Fine-medium SAND, little fine gravel, layered black SAND.	░	SW			
12						
15	Boring terminated at 12 ft on 9/1/20.		Boring terminat at 12			

TEST PIT TP- 4

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 14.5 FT

COORDINATES 46.270030 , -119.289184
COORD SYS GPS
SURFACE ELEVATION 411 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
1 2 3 4 5 6 7 8 9	Garbage					
10	Medium dense, 7.5 YR (5/3) brown, dry Fine-medium GRAVEL, and Fine-medium SAND.		GW			
11	Medium dense, 2.5 Y (5/2) brown grayish, damp Fine-medium SAND.		SW			
12 13 14	Medium dense, 2.5 Y (2.5/1) black, damp medium SAND, little Medium-coarse GRAVEL.		SP			
15						
16	Boring terminated at 14.5 ft on 9/1/20.		Boring terminat at			

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TEST PIT TP- 5

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 10 FT

COORDINATES 46.270338 , -119.289137
COORD SYS GPS
SURFACE ELEVATION 406 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	**Material Description**	**Graphic Log**	**USCS**	**Blow Count**	**Samples**	**Penetration Resistance**
1 2 3	Garbage - Asphalt	■	04			
4 5 6	Medium dense, 10 YR (4/3) brown, damp Fine-medium SAND.	░	SW			
7 8 9	Medium dense, 10 YR (2/1) black, damp medium SAND layered.	░	SW			
10 11 12 13 14						
15	Boring terminated at 10 ft on 9/1/20.		Boring terminat at 10			

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TEST PIT TP- 6

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 7.0 FT

COORDINATES 46.269967 , -119.288982
COORD SYS GPS
SURFACE ELEVATION 401 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
	Fill - roots and trash					
1						
2						
3						
4	Medium dense, 10 YR (6/1) gray, damp Coarse-fine GRAVEL (rounded-elong), some medium black SAND.		GP			
5	Medium dense , 10 YR (5/3) brown, damp Fine-medium SAND.		SW			
6						
7						
8						
9						
10						
11						
12						
13						
14						
15	Boring terminated at 7.0 ft on 9/1/20.		Boring terminat at 7.0			

White Shield
Progressive Solutions, Traditional Values

TEST PIT TP- 7

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 8.7 FT

COORDINATES 46.270114 , -119.288965
COORD SYS GPS
SURFACE ELEVATION 401 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
1 2 3 4 5 6	Garbage - Concrete - Asphalt	■	04			
7	Medium dense, 2.5 Y (5/1) gray, dry Medium-fine GRAVEL(rounded), some fine SAND.	○	GM			
8	Medium dense, 7.5 YR (6/3) light brown, dry Fine-medium SAND.	⠿	SW			
9 10 11 12 13 14 15						
	Boring terminated at 8.7 ft on 9/1/20.		Boring terminat at 8.7			

TEST PIT TP- 8

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 7.5 FT

COORDINATES 46.270448 , -119.288917
COORD SYS GPS
SURFACE ELEVATION 400 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
	Garbage - Concrete - Asphalt.	■	04			
1		■				
2		■				
3		■				
4		■				
	Medium dense, 7.5 YR (5/2) brown, dry Medium-fine GRAVEL(rounded), some Fine-medium SAND.	○	GW			
5	Medium dense, 7.5 YR (5/2) brown, dry Fine-medium SAND(bedded).	⁘	SW			
6		⁘				
7		⁘				
8						
9						
10						
11						
12						
13						
14						
15	Boring terminated at 7.5 ft on 9/1/20.		Boring terminat at 7.5			

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TEST PIT TP- 9

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 8.0 FT

COORDINATES 46.270589 , -119.288981
COORD SYS GPS
SURFACE ELEVATION 403 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
	Garbage - Concrete					
5	Medium dense, 10 YR (2/2) brown blackish, dry Fine-medium SAND, layered black SAND.	░	SW			
8						
15	Boring terminated at 8.0 ft on 9/1/20.		Boring terminat at 8.0			

TEST PIT TP- 10

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 7.0 FT

COORDINATES 46.270374 , -119.288640
COORD SYS GPS
SURFACE ELEVATION 392 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
1 2	Medium dense, 7.5 YR (6/3) light brow, dry Fine-medium SAND, some Fine-medium GRAVEL.		SP			
3 4 5 6 7	Medium dense, 10 YR (5/2) brown grayish, dry Fine-medium SAND, BEDDED.		SW			
8 9 10 11 12 13 14 15						
	Boring terminated at 7.0 ft on 9/1/20.		Boring terminat at 7.0			

TEST PIT TP- 11

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 9.0 FT

COORDINATES 46.270079 , -119.288775
COORD SYS GPS
SURFACE ELEVATION 392 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
1 2 3	Loose, 7.5 YR (6/3) light brown, dry Fine-coarse GRAVEL and Fine-medium SAND(FILL).		GW			
4 5 6 7 8	Medium dense, 7.5 YR (4/3) brown, dry Fine - medium SAND, BEDDED.		SW			
9 10 11 12 13 14						
15	Boring terminated at 9.0 ft on 9/1/20.		Boring terminat at 9.0			

TEST PIT TP- 12

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 7.0 FT

COORDINATES 46.269956 , -119.288737
COORD SYS GPS
SURFACE ELEVATION 392 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
1	Loose, 7.5 YR (5/2) brown, dry Fine-medium SAND (FILL).	⁙	SW			
2 3 4 5 6	Medium dense, 7.5 (5/2) brown, damp Fine-medium SAND.	⁙	SW			
7 8 9 10 11 12 13 14						
15			Boring terminat at 7.0			

White Shield
Progressive Solutions, Traditional Values

TEST PIT TP- 13

PROJECT NUMBER 120-054-01
PROJECT NAME Bush- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 4.0 FT

COORDINATES 46.270119 , -119.288546
COORD SYS GPS
SURFACE ELEVATION 385 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
	Medium dense, 7.5 YR (2.5/2) brown blackish, dry Fine-medium BEDDED SAND.	▨	SP			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15	Boring terminated at 4.0 ft on 9/1/20		Boring terminat at 4.0			

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TEST PIT TP- 14

PROJECT NUMBER 120-054-01
PROJECT NAME Bush - Richland Townhomes
CLIENT TIM Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 6.0 FT

COORDINATES 46.270395 , -119.288396
COORD SYS GPS
SURFACE ELEVATION 379 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
1 2 3 4 5 6	Medium dense, 7.5 YR (4/3) brown, dry Fine-medium BEDDED SAND.		SP			
7 8 9 10 11 12 13 14						
15	Boring terminated at 6.0 ft on 9/1/20		Boring terminat at 6.0			

TEST PIT TP- 15

PROJECT NUMBER 120-054-01
PROJECT NAME Bush - Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 8.0 FT

COORDINATES 46.270562 , -119.288486
COORD SYS GPS
SURFACE ELEVATION 387 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
1 2 3	Loose, tan, dry Fine SAND, little silt.		SP			
4 5 6 7	Medium dense, 7.5 YR (5/4) brown, dry Fine-medium SAND.		SW			
8 9 10 11 12 13 14						
15	Boring terminated at 8.0 ft on 9/1/20		Boring terminat at 8.0			

INFILTRATION TEST INFTP- 1

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 10 FT

COORDINATES 46.269810 , -119.288857
COORD SYS GPS
SURFACE ELEVATION 395 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance
	Loose, 10 YR (5/2) brown grayish, dry Coarse-fine GRAVEL, some fine SAND.		GP			
1 2 3	Loose, 10 YR (4/3) brown, dry Fine-medium SAND(FILL).		SP			
4 5 6 7	Medium dense, 10 YR (5/2) brown grayish, damp Fine-medium SAND, trace black SAND.		SW		Sample collected	
8	Medium dense, 10 YR (5/2) brown gray, damp Fine-medium SAND, trace black SAND.		SM		Sample collected	
9	Medium dense, 10YR(5/2) brow grayish, damp Fine-medium SAND, trace black SAND.		SW		Sample collected	
10 11 12 13 14 15						
16	Boring terminated at 10 ft on 9/1/20. 2-3 feet : Ash layer in Sand end of the test pit		Boring terminat at 10			

INFILTRATION INFTP- 2

PROJECT NUMBER 120-054-01
PROJECT NAME BUSH- Richland Townhomes
CLIENT Tim Bush
ADDRESS 1380 DUPORTAIL RICHLAND, WA 99352

DRILLING DATE 9/1/20
DRILLING METHOD Excavator
TOTAL DEPTH 7.0 FT

COORDINATES 46.270404 , -119.288705
COORD SYS GPS
SURFACE ELEVATION 399 FT
LOGGED BY CH
CHECKED BY BPS

COMMENTS

Depth (ft)	Material Description	Graphic Log	USCS	Blow Count	Samples	Penetration Resistance 0 60
0–1	Loose, 7.5 YR (5/3) brown, dry Fine-medium SAND (FILL)		SW			
1	Medium dense, 7.5 YR (6/4) light brown, dry Fine-medium SAND.		SW			
2						
3					Sample collected Sample collected	
4						
5						
6						
7						
8	Medium dense, 10 YR (5/2) brown grayish, damp Medium-fine SAND.		SW			
9					Sample collected	
10						
11						
12						
13						
14						
15						
16	Boring terminated at 11 ft on 9/1/20.		Boring terminat at 11			

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APPENDIX B

Stormwater Memorandum

WHITE SHIELD, INC.

Memo

MICHAEL THOMAS BLACK
0019810
9/19/20

To: Ben Staehr, P.E.

From: Michael Black, P.E.

cc: Callixte Hirwa

Date: 9/19/20

Re: Bush Geohydrology for Stormwater Design

This memo report provides the results of my analysis for infiltration rates for the Bush Site, 1380 Dupertail, Richland, WA.

Some common definitions as follows:

- *Vadose Zone-* geologic media between the land surface and the regional water table. In the case of this project, all considerations are within the vadose zone.
- *Saturated Hydraulic conductivity-* The ease with which a fluid travels through a given soil (saturated porous medium).
- *Unsaturated hydraulic conductivity-* The ease with which a fluid travels through a given soil at different soil moistures (i.e. different matric pressures or capillary pressures).
- *Infiltration-* The movement of water into the soil column based on the following:
  a. The depth to groundwater or a restrictive layer.
  b. The physical dimensions of the application source.
  c. The pressure head (depth) and the application time.
  d. The saturated and unsaturated hydraulic conductivity.
  e. The initial and full soil saturation values.

Per your direction, I did not consider groundwater or a restrictive layer as your field investigation determined it was at a substantial depth. You also provided guidance that exfiltration trenches were to be used for this site. The design trench depth is 3 ft. for the Test Pit 1 area and 5 ft. for the Test Pit No. 2 area.

INFILTRATION RATE METHODOLOGY

The salient issue for this evaluation is the infiltration rate as previously defined for the proposed stormwater management device (infiltration trench). While a large number of methods exist to estimate the saturated hydraulic conductivity (K_s) there are few recognized by the engineering/geohydrology practice as follows:

1. Performing air-entry permeameter tests in each soil layer accompanied by a field constant head permeameter (K_{sv}) and and Well Pump-In Technique (Ksh), which both are recommended by the ASTM. This is a very expensive protocol.

2. Collecting in-situ, un-disturbed samples, oriented in the vertical and horizontal position for either a falling- or constant head permeameter test. This is a very expensive protocol as well.

3. Collecting samples, at-depth, for Grain Size Analysis (GSD). GSD analysis uses research derived empirical formulas to determine the K_s. Over the years, the engineering professional has lagged well behind the soil science technical community with respect to water flow in soils. The National Resource Conservation Service (NCRS) has sponsored large research efforts and enjoy a database with over 30,000 soil types. Most of these formulas developed by engineers were developed for sand. While the WSDOE uses a much more simplified technique for estimation, we used the Soil Water Characteristic Curve (NCRS) data for our work. Furthermore, we have found the NCRS methods much more accurate when compared to actual field tests.

We used the Saxton[1] method for application to our models. This method includes the soil texture, approximate density, organic content, and salinity. It also provides the hydraulic conductivity at a range of matrix soil suction, both osmotic and capillary.

<u>Vadose zone flow</u>

We used the Green-Ampt Explicit Model to determine the infiltration rate. This model considers the level of ponding (3 ft. and 5 ft.) Using the saturated hydraulic conductivity (K_{SAT}) the model determines the changes to infiltration, over time, based on overcoming the matric suction.

---

[1] Saxton, K.E., Rawls, W.J., *Soil Water Characteristic Estimates by Texture and Organic Matter for Hydrologic Solutions.* Soil Science Society of America Journal, 70:1569-1578, 2006

ANALYSIS

Using the hydrometer data (see Appendix), we calculated the following key information for each soil layer:

- Saturated hydraulic conductivity (K_{sat})
- Soil Saturation (% by volume).
- Various other data included in the Excel Sheets in the Appendix.

Once this data was determined, we calculated the Brooks-Corey Grain Size Distribution and the infiltration rate for each trench area using the Green-Ampt Explicit Model. We used the lowest calculated K_{SAT} is it would provide the controlling layer.

For the Test Pit No. 1 area (3 ft. deep trench), the infiltration rate with start at 15.38 cm/hr (6.1 in/hr) and rise to 70.45 cm/hr (27.7 in/hr) after 1.5 hrs. This assumes a constant 3 ft. head.

For the Test Pit No. 2 area (5 ft. deep trench), the infiltration rate with start at 20.24 cm/hr (8.0 in/hr) and rise to 90.72 in/hr (35.7 in/hr) after 1.5 hours. This assumes a constant 5 ft. head.

CONCLUSIONS AND RECOMMENDATIONS

Depending on the maintenance of the trenches, silt build up over time will decrease the exfiltration capacity. The recommended infiltration rate does not include consideration of silting in. We recommend the following infiltration values:

- Test Pit No. 1 Area; **6.0 inches/hr**
- Test Pit No. 2 Area; **8.0 inches/hr**

Michael Black, P.E.

BROOKS-COREY GRAIN SIZE DISTRIBUTION, TP-1; BUSH, RICHLAND

~~JULY 2020~~
9/18/20

The pore size distribution is used in many infiltration models. The Brooks-Corey parameter is most commonly used and is calculated here. The variables include the following:

- C= percent clay (5<%<60)
- S= percent sand (5<%<70)
- ϕ= porosity (volume fraction)

INPUT VARIABLES

$C := 0.024$

$S := 84$

$\phi := 0.402$

$$\lambda := \exp\begin{bmatrix} -0.7842831 + 0.0177544\cdot S - 1.062498\cdot\phi - 0.00005304\cdot S^2 - 0.00273493\cdot C^2 \ldots \\ + 1.1113496\cdot\phi^2 - 0.03088295\cdot S\cdot\phi + 0.00026587\cdot S^2\cdot\phi^2 - 0.00610522\cdot C^2\cdot\phi^2 \ldots \\ + \left(-0.00000235\cdot S^2\cdot C\right) + 0.00798746\cdot C^2\cdot\phi - 0.00674491\cdot\phi^2\cdot C \end{bmatrix} = 0.52$$

Green-Ampt Explicit Model (GAEXP)

A. Description

The Green-Ampt model is the first physically-based equation describing the infiltration of water into a soil. It has been the subject of considerable developments in soil physics and hydrology owing to its simplicity and satisfactory performance for a great variety of water infiltration problems. This model yields cumulative infiltration and infiltration rate as implicit functions of time, *i.e.*, given a value of time, *t*, *q* and *I* cannot be obtained by direct substitution. The equations have to be solved in an iterative manner to obtain these quantities. Therefore, the required functions are *q(t)* and *I(t)* instead of *t(q)* and *t(I)*. The Green Ampt explicit model (GAEXP) for *q(t)* and *I(t)*, developed by Salvucci and Entekhabi (1994), facilitated a straight forward and accurate estimation of infiltration for any given time. This model supposedly yield less than 2% error at all times when compared to the exact values from the implicit Green-Ampt model. A scenario was chosen to simulate the water infiltration into a sandy soil under ponding conditions by using the GAEXP model. A ponding depth of 1 cm was applied at the soil surface. Input parameters and simulation results were given below.

B. Definition of Variables

$h_e := -82$	**Air entry head from test (cm)**
$\lambda := 0.52$	**The exponent of the Brooks-Corey water retention model**
$\theta_s := 0.402$	**Saturated volumetric water content (cm³/cm³)**
$\theta_0 := 0.04$	**Initial volumetric water content (cm³/cm³)**
$K_s := 14.0$	**Saturated hydraulic conductivity (cm/h)**
$h_s := 91.4$	**Ponding depth or capillary pressure head at the surface (cm)**
$t := 0.1, 0.2 .. 1.5$	**Duration of infiltration (h)**

Values given above were obtained from Carsel and Parrish (1988) for a sandy soil.

C. Equations

$$\eta := (2 + 3\cdot\lambda) \qquad \textbf{(1)}$$

$$h_f := \frac{\eta}{(\eta - 1)}\cdot h_e \qquad \textbf{(2)}$$

Capillary pressure head at the wetting front

$$\chi := \frac{\left(h_s - h_f\right)\cdot\left(\theta_s - \theta_0\right)}{K_s} \qquad \textbf{(3)}$$

$$\tau(t) := \frac{t}{(t + \chi)} \qquad \textbf{(4)}$$

$$q(t) := \left[\left(\frac{\sqrt{2}}{2}\right)\cdot\tau(t)^{\left(-\frac{1}{2}\right)} + \left(\frac{2}{3}\right) - \left(\frac{\sqrt{2}}{6}\right)\cdot\tau(t)^{\frac{1}{2}} + \left(\frac{1-\sqrt{2}}{3}\right)\cdot\tau(t)\right]\cdot K_s \qquad \textbf{(5)}$$

Infiltration rate

$$I(t) := \left[\left(1 - \frac{\sqrt{2}}{3}\right)\cdot t + \frac{\sqrt{2}}{3}\cdot\sqrt{\chi\cdot t + t^2} + \left(\frac{\sqrt{2}-1}{3}\right)\cdot\chi\cdot(\ln(t+\chi) - \ln(\chi)) + \frac{\sqrt{2}}{3}\cdot\chi\cdot\left(\ln\left(t + \frac{\chi}{2} + \sqrt{\chi\cdot t + t^2}\right) - \ln\left(\frac{\chi}{2}\right)\right)\right]\cdot K_s \qquad \textbf{(6)}$$

D. Results

t =	q(t) =	I(t) =
0.1	81.68	15.38
0.2	60.6	22.31
0.3	51.28	27.86
0.4	45.73	32.69
0.5	41.95	37.06
0.6	39.16	41.11
0.7	36.99	44.91
0.8	35.25	48.52
0.9	33.8	51.97
1	32.58	55.29
1.1	31.54	58.5
1.2	30.62	61.6
1.3	29.82	64.62
1.4	29.1	67.57
1.5	28.46	70.45

Cumulative infiltration

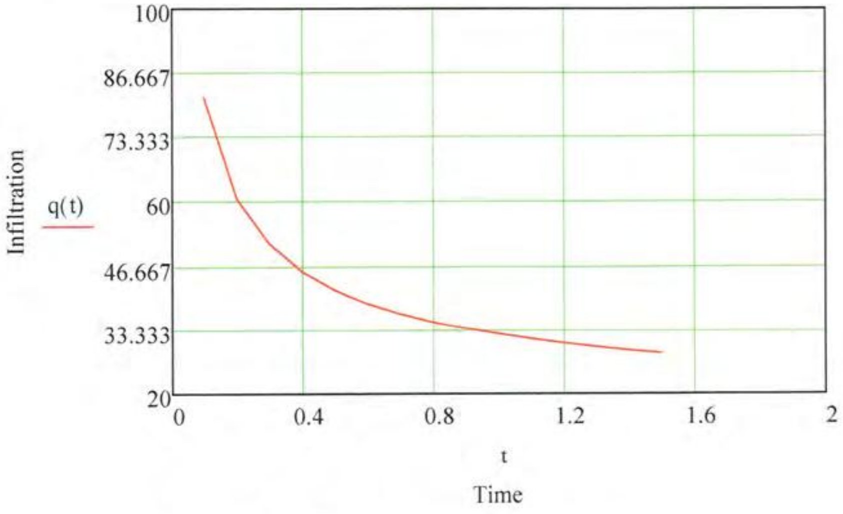


Figure 1. Soil infiltration as a function of time.

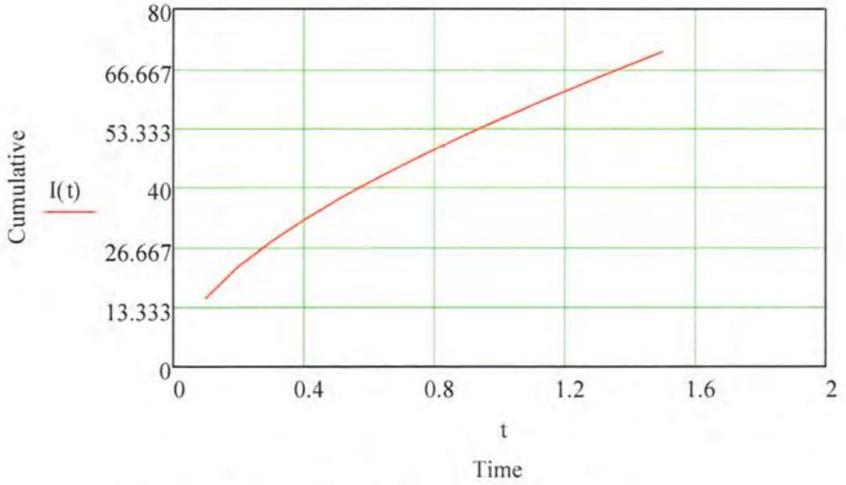


Figure 2. Cumulative Infiltration as a function of time.

E. Discussion

Figures 1 and 2 show the soil water infiltration rate and cumulative infiltration as a function of time, respectively. A rapid decrease in water infiltration rate was observed within the first hour.

F. Sensitivity Analysis of Infiltration Rate to Saturated hydraulic Conductivity

This section shows the sensitivity coefficient (S_s) and the relative sensitivity (S_r) of the surface infiltration rate, q, to the saturated hydraulic conductivity (K_s) at the time of 1 hours. The expressions were obtained by applying Equations 3 and 4 in Section B2 (PHILIP2T model) to Equation 5 in this section.

F.1. Input Data

$K_s := 7.5, 7.6 .. 8.9$ $t := 5$

F.2. Sensitivity Calculation Equations

$$\chi(K_s) := \frac{(h_s - h_f)\cdot(\theta_s - \theta_0)}{K_s} \quad (7)$$

$$\tau(K_s) := \frac{t}{(t + \chi(K_s))} \quad (8)$$

$$q(K_s) := \left[\left(\frac{\sqrt{2}}{2}\right)\cdot\tau(K_s)^{\left(-\frac{1}{2}\right)} + \left(\frac{2}{3}\right) - \left(\frac{\sqrt{2}}{6}\right)\cdot\tau(K_s)^{\frac{1}{2}} + \left(\frac{1-\sqrt{2}}{3}\right)\cdot\tau(K_s)\right]\cdot K_s \qquad (9)$$

$$S_s(K_s) := \frac{d}{dK_s}q(K_s) \qquad (10)$$

Sensitivity

$$S_r(K_s) := \left(\frac{d}{dK_s}q(K_s)\right)\cdot\left(\frac{K_s}{q(K_s)}\right) \qquad (11)$$

Relative Sensitivity

F.3.Results

$K_s =$	$q(K_s) =$	$S_s(K_s) =$	$S_r(K_s) =$
7.5	12.79	1.22	0.72
7.6	12.91	1.22	0.72
7.7	13.03	1.22	0.72
7.8	13.15	1.21	0.72
7.9	13.28	1.21	0.72
8	13.4	1.21	0.72
8.1	13.52	1.21	0.72
8.2	13.64	1.2	0.72
8.3	13.76	1.2	0.72
8.4	13.88	1.2	0.73
8.5	14	1.2	0.73
8.6	14.12	1.19	0.73

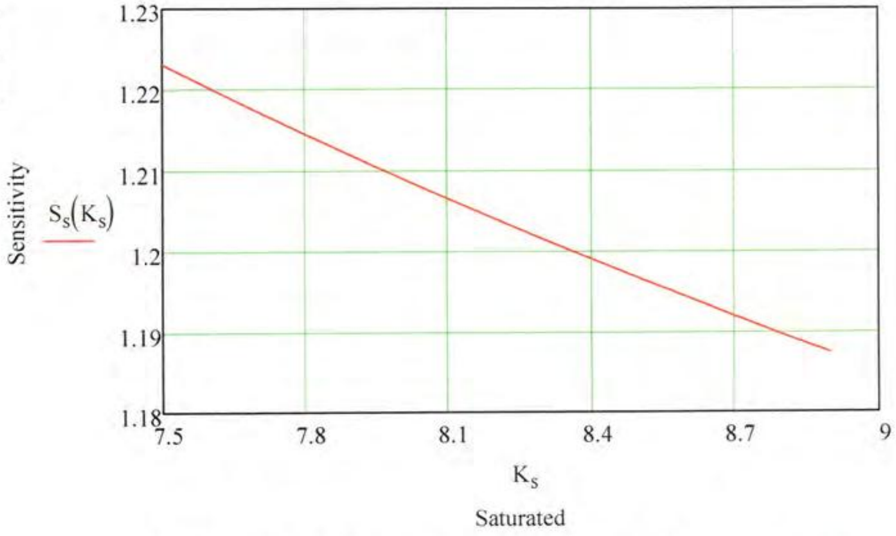


Figure 3. Sensitivity of infiltration rate for different values of saturated hydraulic conductivity at t = 5 hours.

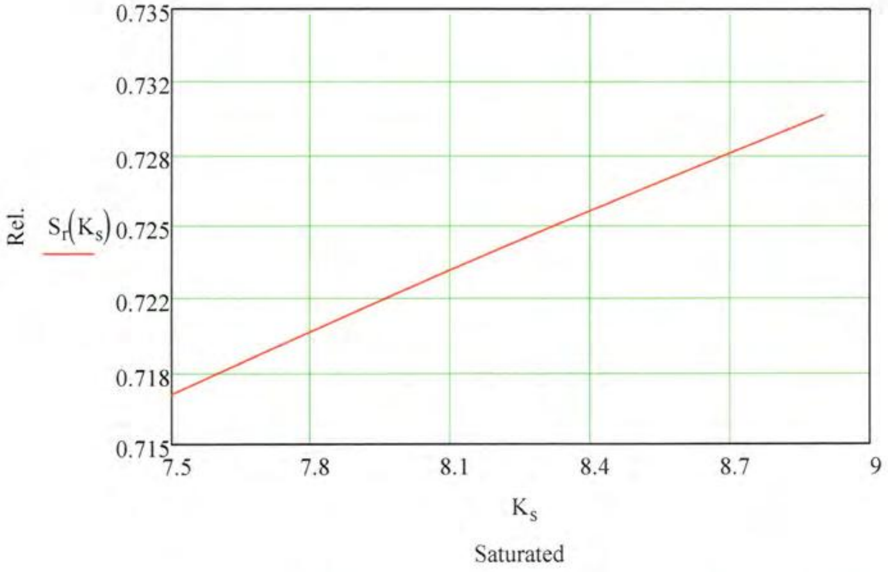


Figure 4. Relative sensitivity of infiltration rate for different values of saturated hydraulic conductivity at t = 5 hours.

F.4. Discussion

Figure 3 shows a sensitivity of the infiltration rate for different values of saturated hydraulic conductivity. The sensitivity decreased as the saturated hydraulic conductivity increased. Figure 4 shows the relative sensitivity of the infiltration rate for different values of saturated hydraulic conductivity. The relative sensitivity increased as the saturated hydraulic conductivity increased.

Soil Sample Analysis Input:

Project: Bush		Sample ID: INFTP-1		Depth: 4.0 - 4.5 ft			
SAND %	CLAY %	SILT %	Saturation % (vol.)	Bulk Density (lb/ft^3)	Effective Porosity % (vol.)	Saturated Hydraulic Conductivity K_s (in/hr)	In-Situ Soil Moisture %
87.6	2.4	10.0	41.4	96.86	5.2	7.31	2.82

Moisture Calculation:

Water %	Matric Potential (bars)	Matic Potential (ft)	K (in/hr)
0.4	13.56	453.67	9.57E-12
3.0	0.73	24.42	1.38E-06
6.0	0.33	11.04	8.22E-05
9.0	0.30	10.04	8.98E-04
12.0	0.27	9.03	4.90E-03
15.0	0.24	8.03	1.82E-02
18.0	0.22	7.36	5.35E-02
21.0	0.19	6.36	1.33E-01
24.0	0.16	5.35	2.92E-01
27.0	0.13	4.35	5.84E-01
30.0	0.11	3.68	1.09E+00
33.0	0.08	2.68	1.91E+00
36.0	0.05	1.67	3.18E+00
41.0	0.01	0.33	6.85E+00

Figure-1:

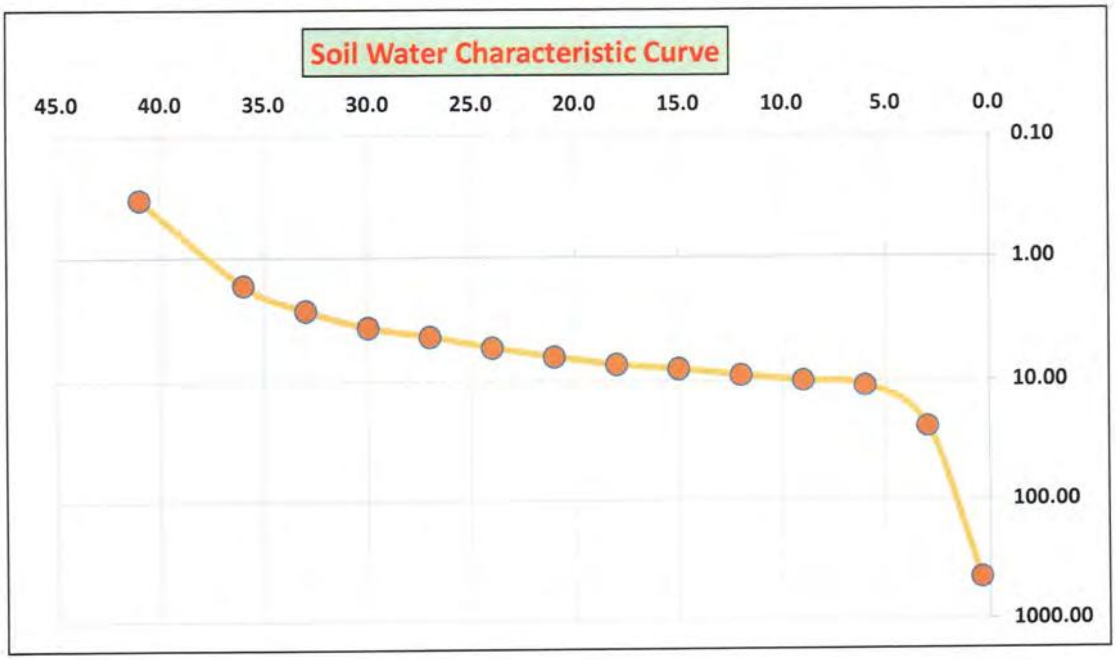
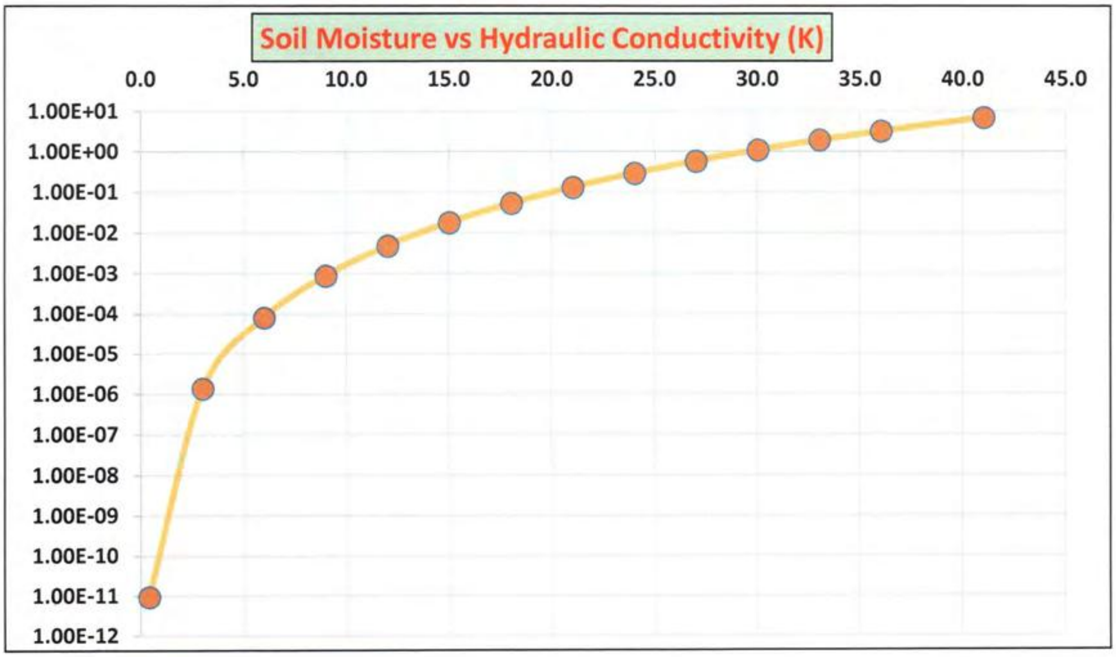


Figure-2:


Soil Moisture vs Hydraulic Conductivity (K)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
1.00E+01
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1.00E-10
1.00E-11
1.00E-12

Soil Sample Analysis Input:

Project: Bush		Sample ID: INFTP-1		Depth: 8.0 - 8.5 ft			
SAND %	CLAY %	SILT %	Saturation % (vol.)	Bulk Density (lb/ft^3)	Effective Porosity % (vol.)	Saturated Hydraulic Conductivity K_s (in/hr)	In-Situ Soil Moisture %
77.6	2.4	20.0	40.2	98.91	7.3	5.53	3.48

Moisture Calculation:

Water %	Matric Potential (bars)	Matic Potential (ft)	K (in/hr)
0.6	14.68	491.14	5.78E-11
3.0	1.33	44.50	7.23E-07
6.0	0.45	15.06	4.98E-05
9.0	0.32	10.71	5.93E-04
12.0	0.29	9.70	3.43E-03
15.0	0.26	8.70	1.34E-02
18.0	0.23	7.69	4.09E-02
21.0	0.20	6.69	1.05E-01
24.0	0.17	5.69	2.37E-01
27.0	0.14	4.68	4.86E-01
30.0	0.11	3.68	9.25E-01
33.0	0.08	2.68	1.65E+00
36.0	0.05	1.67	2.82E+00
40.1	0.01	0.33	5.44E+00

Figure-1:

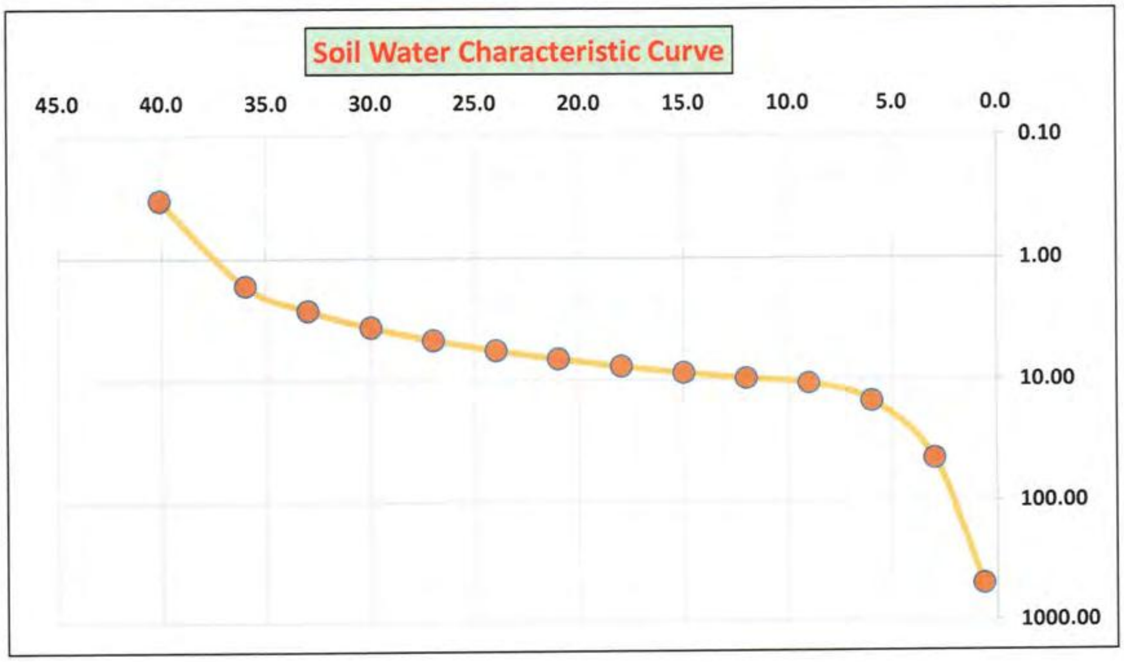
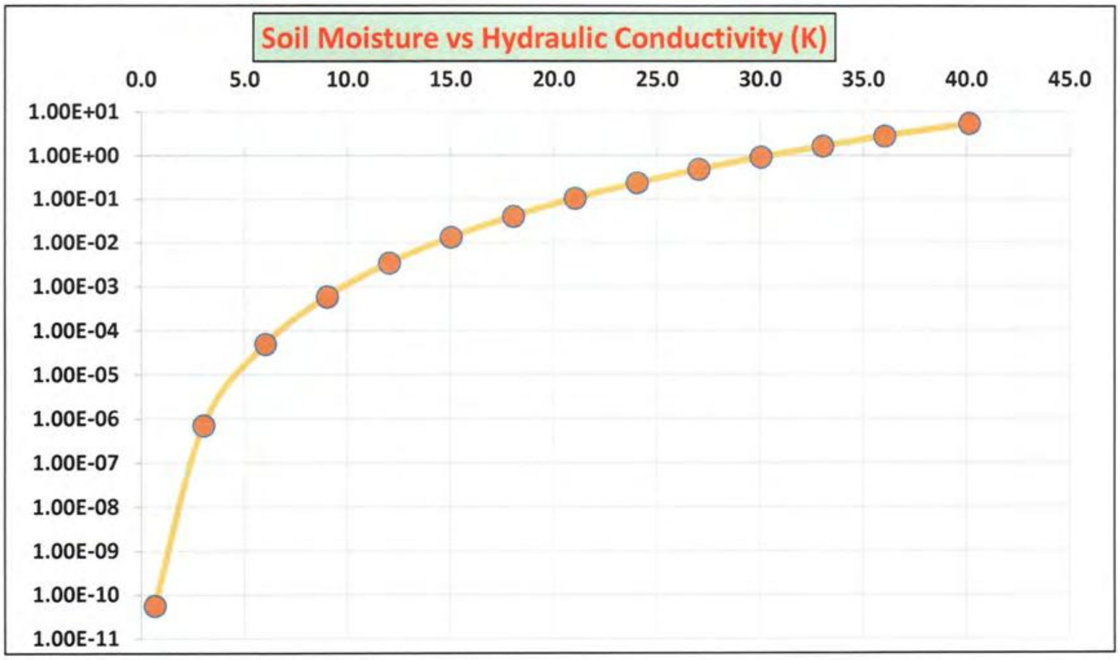


Figure-2:


Soil Moisture vs Hydraulic Conductivity (K)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
1.00E+01
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1.00E-10
1.00E-11

Soil Sample Analysis Input:

Project: Bush		Sample ID: INFTP-1		Depth: 9.0 - 9.5 ft			
SAND %	CLAY %	SILT %	Saturation % (vol.)	Bulk Density (lb/ft^3)	Effective Porosity % (vol.)	Saturated Hydraulic Conductivity K_s (in/hr)	In-Situ Soil Moisture %
89.6	2.4	8.0	41.7	96.42	4.8	7.76	2.86

Moisture Calculation:

Water %	Matric Potential (bars)	Matic Potential (ft)	K (in/hr)
0.3	14.46	483.78	4.43E-12
3.0	0.64	21.41	1.70E-06
6.0	0.32	10.71	9.64E-05
9.0	0.30	10.04	1.02E-03
12.0	0.27	9.03	5.47E-03
15.0	0.24	8.03	2.01E-02
18.0	0.21	7.03	5.80E-02
21.0	0.19	6.36	1.42E-01
24.0	0.16	5.35	3.10E-01
27.0	0.13	4.35	6.16E-01
30.0	0.11	3.68	1.14E+00
33.0	0.08	2.68	1.98E+00
36.0	0.05	1.67	3.29E+00
41.2	0.01	0.33	7.22E+00

Figure-1:

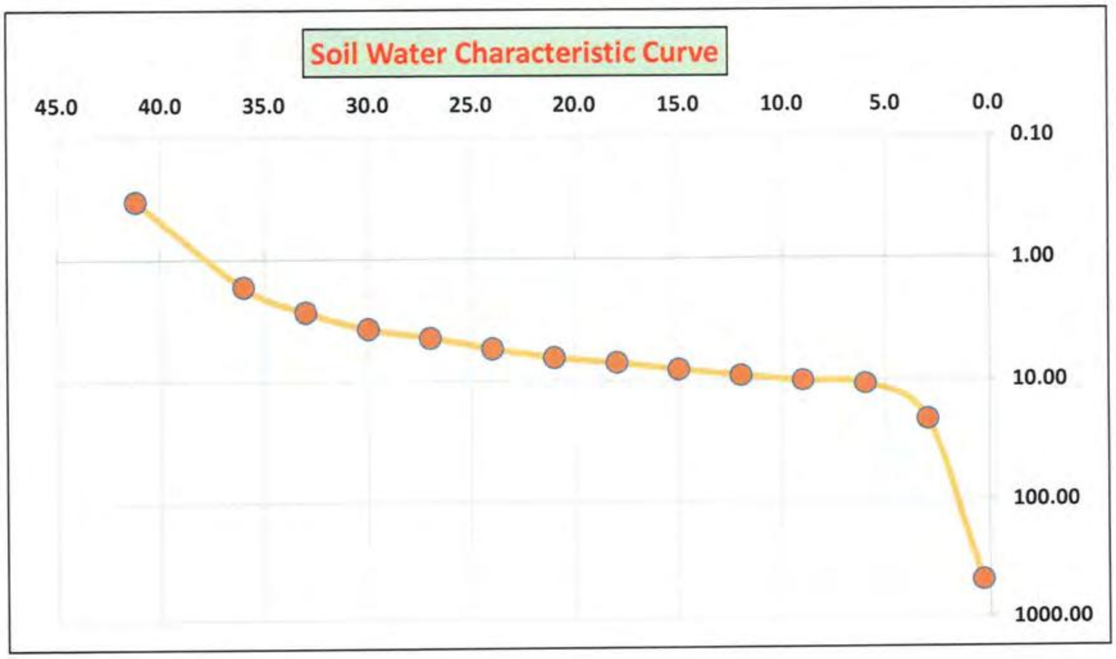
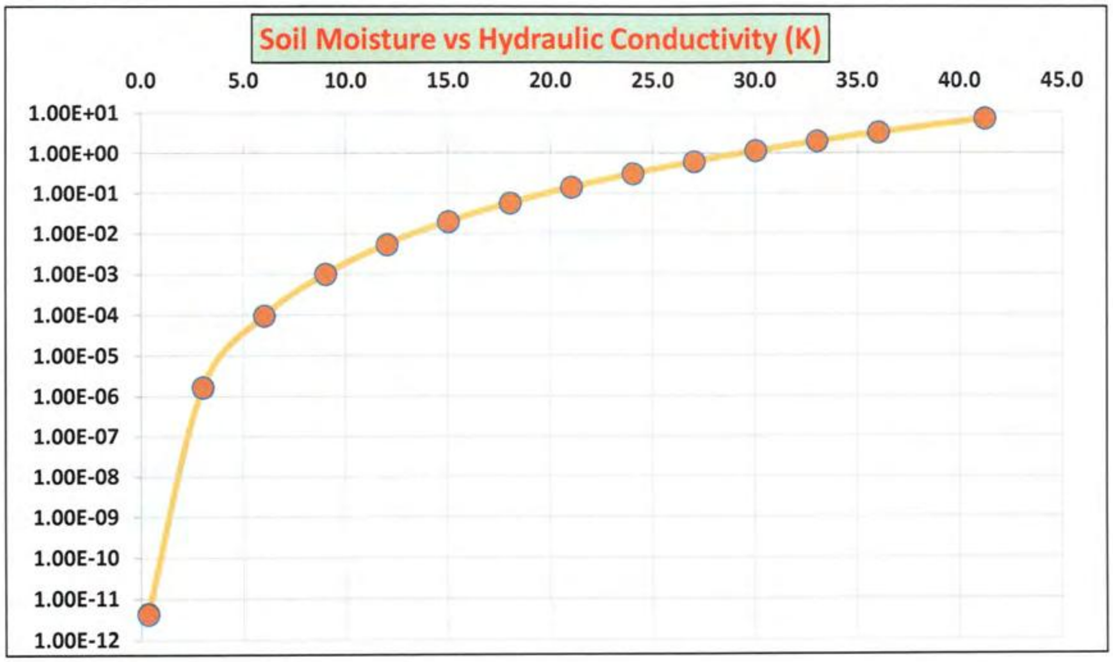


Figure-2:


Soil Moisture vs Hydraulic Conductivity (K)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
1.00E+01
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1.00E-10
1.00E-11
1.00E-12

The pore size distribution is used in many infiltration models. The Brooks-Corey parameter is most commonly used and is calculated here. The variables include the following:

- C= percent clay (5<%<60)
- S= percent sand (5<%<70)
- ϕ= porosity (volume fraction)

INPUT VARIABLES

$C := 0.24$

$S := 90.6$

$\phi := 0.418$

$$\lambda := \exp\left[\begin{array}{l} -0.7842831 + 0.0177544\cdot S - 1.062498\cdot\phi - 0.00005304\cdot S^{2} - 0.00273493\cdot C^{2} \ldots \\ + 1.1113496\cdot\phi^{2} - 0.03088295\cdot S\cdot\phi + 0.00026587\cdot S^{2}\cdot\phi^{2} - 0.00610522\cdot C^{2}\cdot\phi^{2} \ldots \\ + \left(-0.00000235\cdot S^{2}\cdot C\right) + 0.00798746\cdot C^{2}\cdot\phi - 0.00674491\cdot\phi^{2}\cdot C \end{array}\right] = 0.52$$

Green-Ampt Explicit Model (GAEXP)

A. Description

The Green-Ampt model is the first physically-based equation describing the infiltration of water into a soil. It has been the subject of considerable developments in soil physics and hydrology owing to its simplicity and satisfactory performance for a great variety of water infiltration problems. This model yields cumulative infiltration and infiltration rate as implicit functions of time, *i.e.*, given a value of time, *t*, *q* and *I* cannot be obtained by direct substitution. The equations have to be solved in an iterative manner to obtain these quantities. Therefore, the required functions are *q(t)* and *I(t)* instead of *t(q)* and *t(I)*. The Green Ampt explicit model (GAEXP) for *q(t)* and *I(t)*, developed by Salvucci and Entekhabi (1994), facilitated a straight forward and accurate estimation of infiltration for any given time. This model supposedly yield less than 2% error at all times when compared to the exact values from the implicit Green-Ampt model. A scenario was chosen to simulate the water infiltration into a sandy soil under ponding conditions by using the GAEXP model. A ponding depth of 1 cm was applied at the soil surface. Input parameters and simulation results were given below.

B. Definition of Variables

$h_e := -104$	**Air entry head from test (cm)**
$\lambda := 0.51$	**The exponent of the Brooks-Corey water retention model**
$\theta_s := 0.418$	**Saturated volumetric water content (cm³/cm³)**
$\theta_0 := 0.029$	**Initial volumetric water content (cm³/cm³)**
$K_s := 15.9$	**Saturated hydraulic conductivity (cm/h)**
$h_s := 152$	**Ponding depth or capillary pressure head at the surface (cm)**
$t := 0.1, 0.2 .. 1.5$	**Duration of infiltration (h)**

Values given above were obtained from Carsel and Parrish (1988) for a sandy soil.

C. Equations

$$\eta := (2 + 3\cdot\lambda) \qquad (1)$$

$$h_f := \frac{\eta}{(\eta - 1)}\cdot h_e \qquad (2)$$

Capillary pressure head at the wetting front

$$\chi := \frac{(h_s - h_f)\cdot(\theta_s - \theta_0)}{K_s} \qquad (3)$$

$$\tau(t) := \frac{t}{(t + \chi)} \qquad (4)$$

$$q(t) := \left[\left(\frac{\sqrt{2}}{2}\right)\cdot\tau(t)^{\left(-\frac{1}{2}\right)} + \left(\frac{2}{3}\right) - \left(\frac{\sqrt{2}}{6}\right)\cdot\tau(t)^{\frac{1}{2}} + \left(\frac{1-\sqrt{2}}{3}\right)\cdot\tau(t)\right]\cdot K_s \qquad (5)$$

Infiltration rate

$$I(t) := \left[\left(1 - \frac{\sqrt{2}}{3}\right)\cdot t + \frac{\sqrt{2}}{3}\cdot\sqrt{\chi\cdot t + t^2} + \left(\frac{\sqrt{2}-1}{3}\right)\cdot\chi\cdot(\ln(t+\chi) - \ln(\chi)) + \frac{\sqrt{2}}{3}\cdot\chi\cdot\left(\ln\left(t + \frac{\chi}{2} + \sqrt{\chi\cdot t + t^2}\right) - \ln\left(\frac{\chi}{2}\right)\right)\right]\cdot K_s \qquad \textbf{(6)}$$

D. Results

t =	q(t) =	I(t) =
0.1	$1.07\cdot10^2$	20.24
0.2	78.63	29.27
0.3	66.24	36.45
0.4	58.86	42.68
0.5	53.83	48.3
0.6	50.11	53.49
0.7	47.23	58.35
0.8	44.91	62.95
0.9	42.99	67.34
1	41.36	71.56
1.1	39.96	75.62
1.2	38.75	79.56
1.3	37.67	83.38
1.4	36.72	87.09
1.5	35.86	90.72

Cumulative infiltration

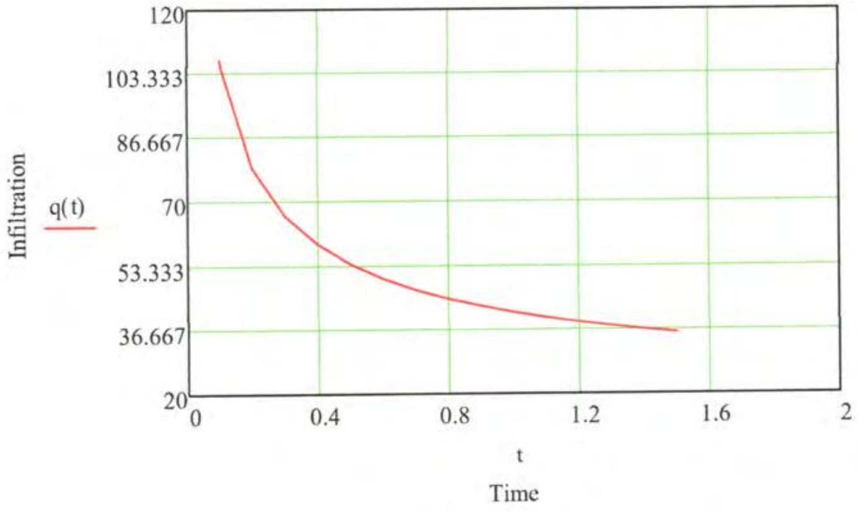


Figure 1. Soil infiltration as a function of time.

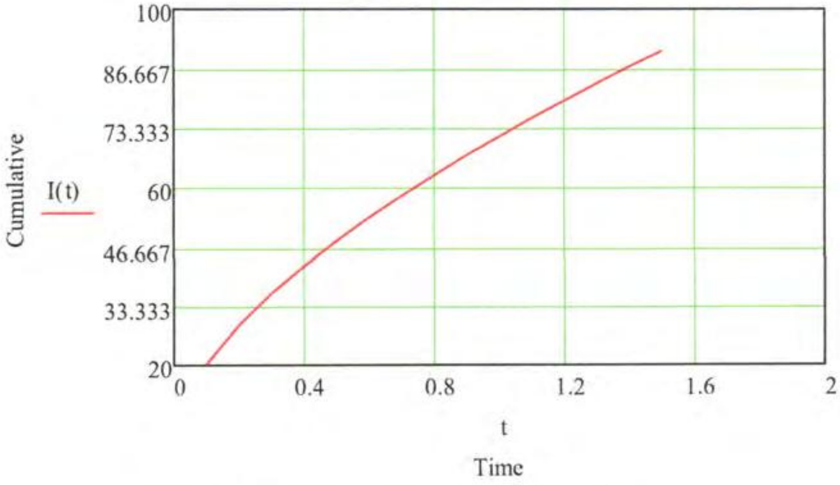


Figure 2. Cumulative Infiltration as a function of time.

E. Discussion

Figures 1 and 2 show the soil water infiltration rate and cumulative infiltration as a function of time, respectively. A rapid decrease in water infiltration rate was observed within the first hour.

F. Sensitivity Analysis of Infiltration Rate to Saturated hydraulic Conductivity

This section shows the sensitivity coefficient (S_s) and the relative sensitivity (S_r) of the surface infiltration rate, q, to the saturated hydraulic conductivity (K_s) at the time of 1 hours. The expressions were obtained by applying Equations 3 and 4 in Section B2 (PHILIP2T model) to Equation 5 in this section.

F.1. Input Data

$K_s := 7.5, 7.6 .. 8.9$ $\qquad$ $t := 5$

F.2. Sensitivity Calculation Equations

$$\chi(K_s) := \frac{(h_s - h_f)\cdot(\theta_s - \theta_0)}{K_s} \qquad \textbf{(7)}$$

$$\tau(K_s) := \frac{t}{(t + \chi(K_s))} \qquad \textbf{(8)}$$

$$q(K_s) := \left[\left(\frac{\sqrt{2}}{2}\right)\cdot\tau(K_s)^{\left(-\frac{1}{2}\right)} + \left(\frac{2}{3}\right) - \left(\frac{\sqrt{2}}{6}\right)\cdot\tau(K_s)^{\frac{1}{2}} + \left(\frac{1-\sqrt{2}}{3}\right)\cdot\tau(K_s)\right]\cdot K_s \qquad (9)$$

$$S_s(K_s) := \frac{d}{dK_s}q(K_s)$$ **Sensitivity** **(10)**

$$S_r(K_s) := \left(\frac{d}{dK_s}q(K_s)\right)\cdot\left(\frac{K_s}{q(K_s)}\right)$$ **Relative Sensitivity** **(11)**

F.3.Results

$K_s =$	$q(K_s) =$	$S_s(K_s) =$	$S_r(K_s) =$
7.5	14.59	1.34	0.69
7.6	14.72	1.33	0.69
7.7	14.85	1.33	0.69
7.8	14.99	1.32	0.69
7.9	15.12	1.32	0.69
8	15.25	1.32	0.69
8.1	15.38	1.31	0.69
8.2	15.51	1.31	0.69
8.3	15.64	1.31	0.69
8.4	15.77	1.3	0.69
8.5	15.9	1.3	0.7

8.6	16.03	1.3	0.7

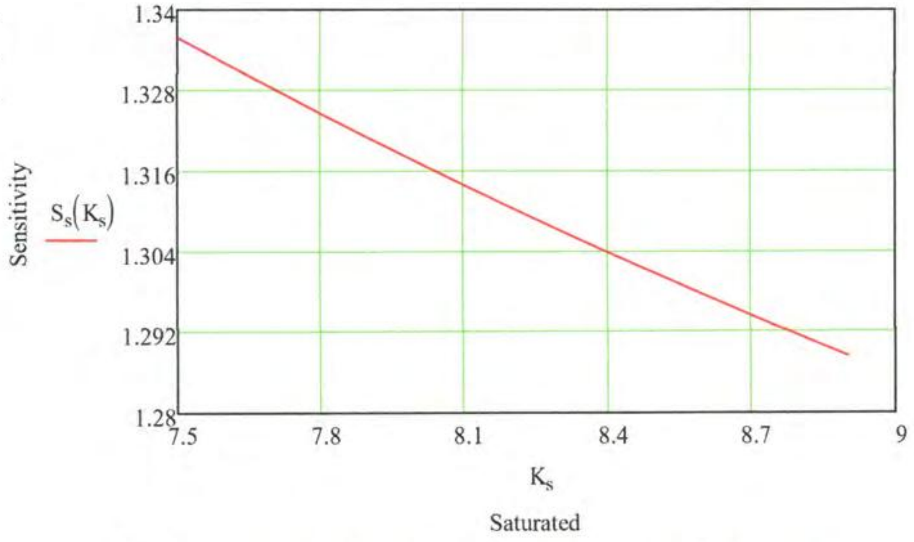


Figure 3. Sensitivity of infiltration rate for different values of saturated hydraulic conductivity at t = 5 hours.

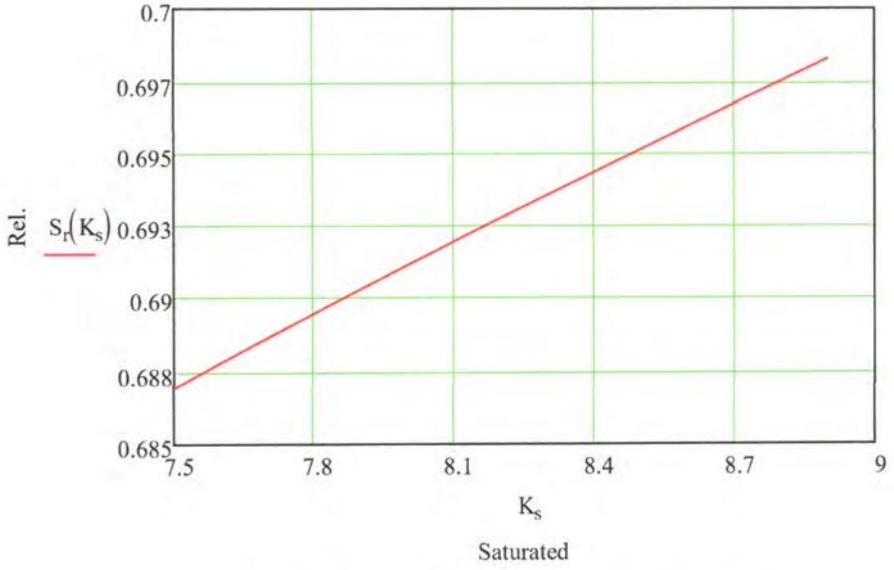


Figure 4. Relative sensitivity of infiltration rate for different values of saturated hydraulic conductivity at t = 5 hours.

F.4. Discussion

Figure 3 shows a sensitivity of the infiltration rate for different values of saturated hydraulic

conductivity. The sensitivity decreased as the saturated hydraulic conductivity increased. Figure 4 shows the relative sensitivity of the infiltration rate for different values of saturated hydraulic conductivity. The relative sensitivity increased as the saturated hydraulic conductivity increased.

Soil Sample Analysis Input:

Project: Bush		Sample ID: INFTP-2		Depth: 2.5 - 3.0 ft			
SAND %	**CLAY %**	**SILT %**	**Saturation % (vol.)**	**Bulk Density (lb/ft^3)**	**Effective Porosity % (vol.)**	**Saturated Hydraulic Conductivity K_s (in/hr)**	**In-Situ Soil Moisture %**
90.6	2.4	7.0	41.8	96.20	4.6	8.01	2.90

Moisture Calculation:

Water %	Matric Potential (bars)	Matic Potential (ft)	K (in/hr)
0.3	14.70	491.81	3.16E-12
3.0	0.60	20.07	1.92E-06
6.0	0.32	10.71	1.06E-04
9.0	0.29	9.70	1.10E-03
12.0	0.27	9.03	5.83E-03
15.0	0.24	8.03	2.12E-02
18.0	0.21	7.03	6.08E-02
21.0	0.19	6.36	1.48E-01
24.0	0.16	5.35	3.21E-01
27.0	0.13	4.35	6.35E-01
30.0	0.11	3.68	1.17E+00
33.0	0.08	2.68	2.03E+00
36.0	0.05	1.67	3.35E+00
41.4	0.01	0.33	7.52E+00

Figure-1:

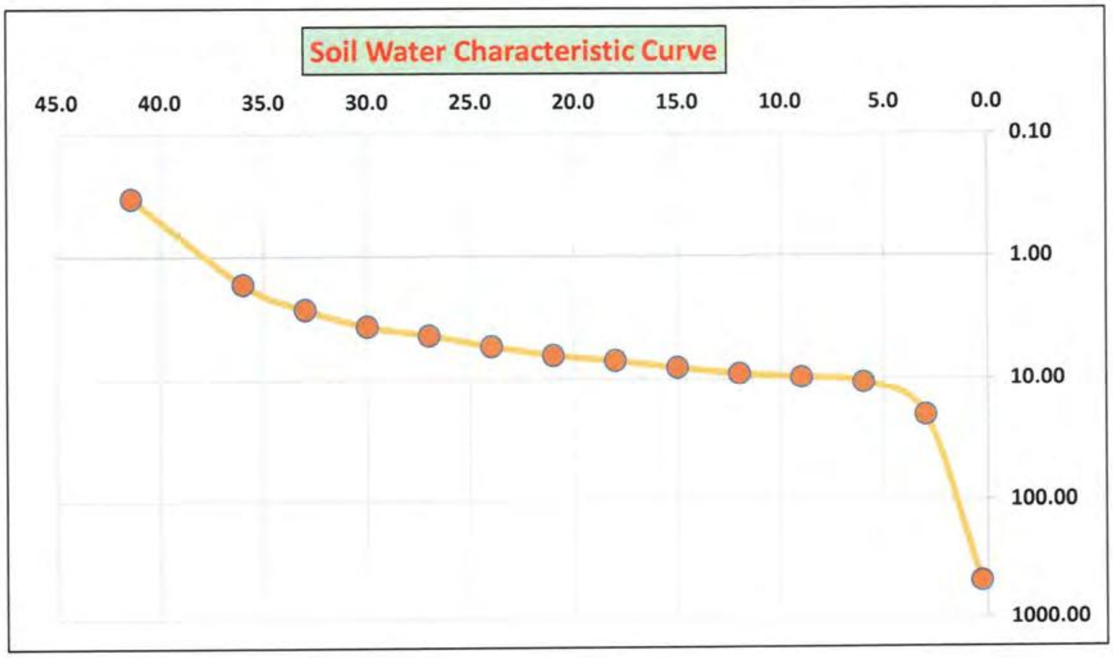
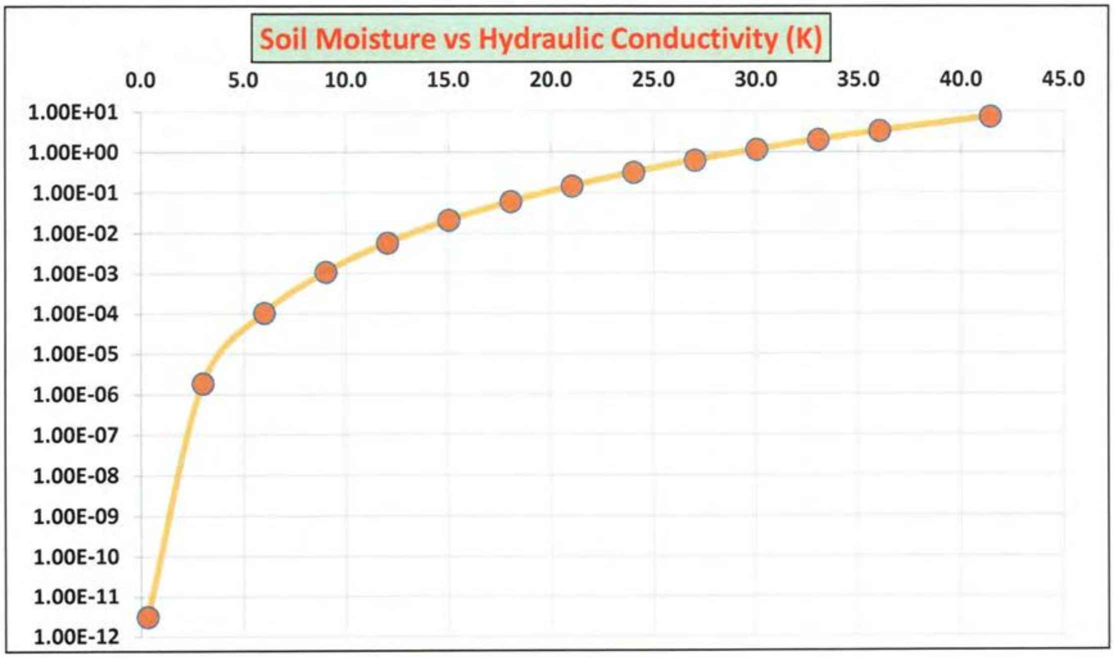


Figure-2:


Soil Moisture vs Hydraulic Conductivity (K)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
1.00E+01
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1.00E-10
1.00E-11
1.00E-12

Soil Sample Analysis Input:

Project: Bush		Sample ID: INFTP-15		Depth: 3.0 - 3.5 ft			
SAND %	**CLAY %**	**SILT %**	**Saturation % (vol.)**	**Bulk Density (lb/ft^3)**	**Effective Porosity % (vol.)**	**Saturated Hydraulic Conductivity K_s (in/hr)**	**In-Situ Soil Moisture %**
95.6	2.4	2.0	42.5	95.05	3.6	9.61	2.93

Moisture Calculation:

Water %	Matric Potential (bars)	Matic Potential (ft)	K (in/hr)
0.2	11.96	400.14	1.62E-12
3.0	0.41	13.72	4.61E-06
6.0	0.31	10.37	2.07E-04
9.0	0.29	9.70	1.91E-03
12.0	0.26	8.70	9.26E-03
15.0	0.24	8.03	3.15E-02
18.0	0.21	7.03	8.57E-02
21.0	0.18	6.02	2.00E-01
24.0	0.16	5.35	4.15E-01
27.0	0.13	4.35	7.92E-01
30.0	0.11	3.68	1.41E+00
33.0	0.08	2.68	2.38E+00
36.0	0.06	2.01	3.84E+00
39.0	0.03	1.00	5.96E+00
42.0	0.01	0.33	8.95E+00

Figure-1:

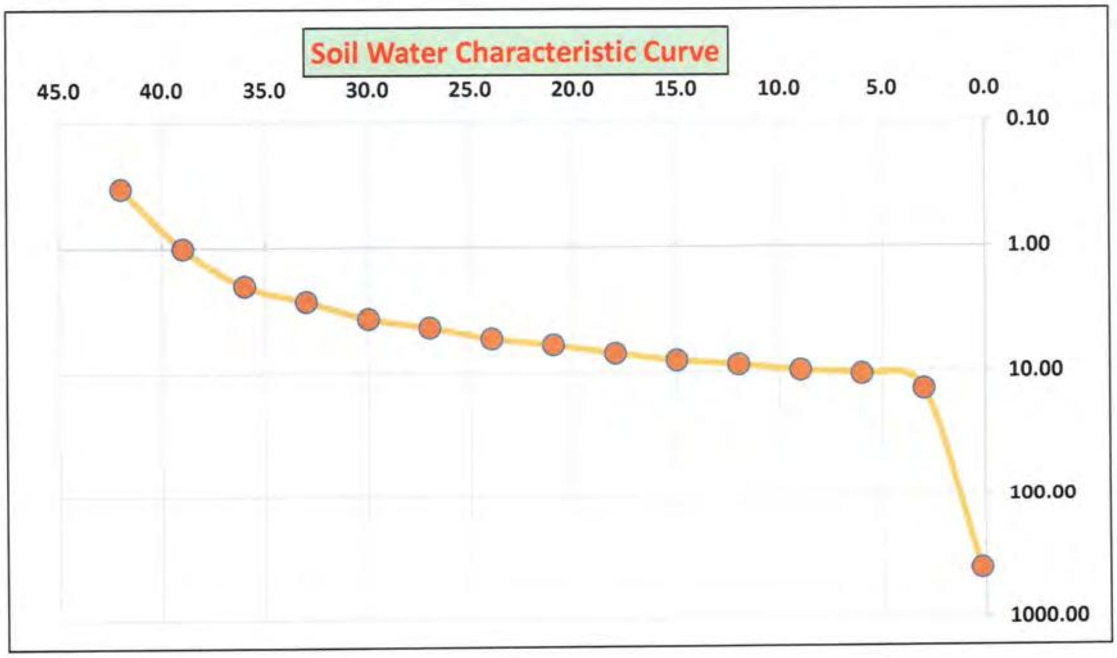
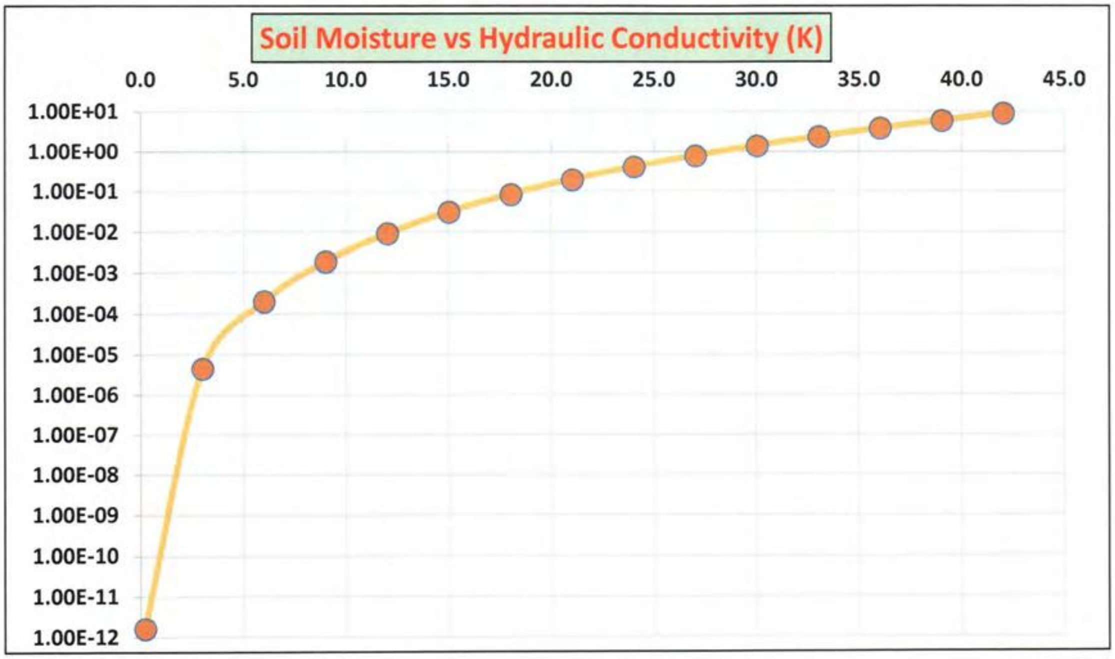


Figure-2:


Soil Moisture vs Hydraulic Conductivity (K)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
1.00E+01
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1.00E-10
1.00E-11
1.00E-12

Soil Sample Analysis Input:

Project: Bush		**Sample ID: INFTP-2**		**Depth: 9.0 - 9.5 ft**			
SAND %	**CLAY %**	**SILT %**	**Saturation % (vol.)**	**Bulk Density (lb/ft^3)**	**Effective Porosity % (vol.)**	**Saturated Hydraulic Conductivity K_s (in/hr)**	**In-Situ Soil Moisture %**
95.6	3.4	1.0	42.1	95.84	4.3	6.25	2.82

Moisture Calculation:

Water %	**Matric Potential (bars)**	**Matic Potential (ft)**	**K (in/hr)**
0.8	15.00	501.84	5.92E-13
3.0	0.75	25.09	1.15E-08
6.0	0.32	10.71	2.25E-06
9.0	0.29	9.70	4.94E-05
12.0	0.27	9.03	4.42E-04
15.0	0.24	8.03	2.42E-03
18.0	0.21	7.03	9.71E-03
21.0	0.19	6.36	3.14E-02
24.0	0.16	5.35	8.69E-02
27.0	0.13	4.35	2.13E-01
30.0	0.11	3.68	4.76E-01
33.0	0.08	2.68	9.84E-01
36.0	0.05	1.67	1.91E+00
39.0	0.03	1.00	3.51E+00
40.6	0.01	0.33	3.80E+00

Figure-1:

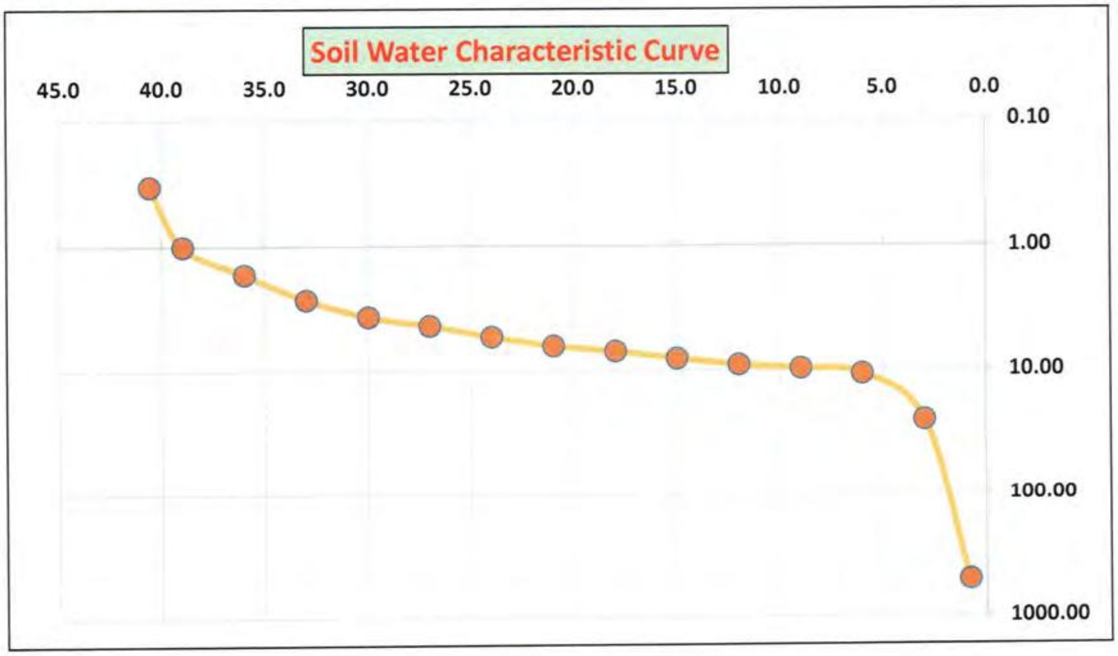
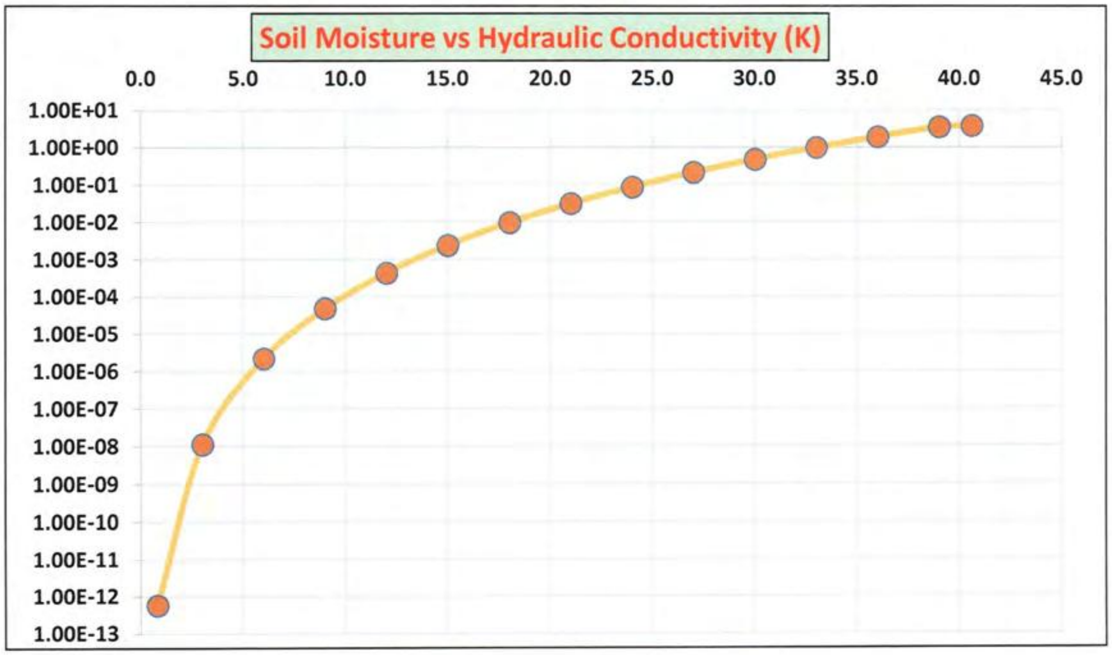


Figure-2:


Soil Moisture vs Hydraulic Conductivity (K)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
1.00E+01
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1.00E-10
1.00E-11
1.00E-12
1.00E-13

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✉ info@kuotestinglabs.com

Sample Analysis Report

Date: September 4, 2020

Report No: 64818

Grower: **Bush**

Client: **White Shield, Inc.**

Sampler: **Michael Black**

Sample Date: 9/1/2020

Sample ID: **INFTP-1 4-4.5ft**

Sample Type:

Lab No: 370122

Depth: 48-54

Analysis	Unit	Result
Clay	%	**2.4**
Moisture-Soil	%	**2.82**
Sand	%	**87.6**
Silt	%	**10**
Texture		**Sand**

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Sample Analysis Report

Date: September 4, 2020
Report No: 64818
Grower: **Bush**
Client: **White Shield, Inc.**
Sampler: **Michael Black**

Sample Date: 9/1/2020
Sample ID: **INFTP-1 8-8.5ft**
Sample Type:
Lab No: 370123
Depth: 96-102

Analysis	Unit	Result
Clay	%	**2.4**
Moisture-Soil	%	**3.48**
Sand	%	**77.6**
Silt	%	**20**
Texture		**Loamy Sand**

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✉ info@kuotestinglabs.com

Sample Analysis Report

Date: September 4, 2020
Report No: 64818
Grower: **Bush**
Client: **White Shield, Inc.**
Sampler: **Michael Black**

Sample Date: 9/1/2020
Sample ID: **INFTP-1 9-9.5ft**
Sample Type:
Lab No: 370124
Depth: 108-114

Analysis	Unit	Result
Clay	%	**2.4**
Moisture-Soil	%	**2.86**
Sand	%	**89.6**
Silt	%	**8**
Texture		**Sand**

KTL
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Sample Analysis Report

Date: September 4, 2020

Report No: 64818

Grower: **Bush**

Client: **White Shield, Inc.**

Sampler: **Michael Black**

Sample Date: 9/1/2020

Sample ID: **INFTP-2 2.5-3ft**

Sample Type:

Lab No: 370125

Depth: 30-36

Analysis	Unit	Result
Clay	%	**2.4**
Moisture-Soil	%	**2.9**
Sand	%	**90.6**
Silt	%	**7**
Texture		**Sand**

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Sample Analysis Report

Date: September 4, 2020
Report No: 64818
Grower: Bush
Client: White Shield, Inc.
Sampler: Michael Black
Sample Date: 9/1/2020
Sample ID: INFTP-2 9-9.5ft
Sample Type:
Lab No: 370126
Depth: 108-114

Analysis	Unit	Result
Clay	%	**3.4**
Moisture-Soil	%	**2.82**
Sand	%	**95.6**
Silt	%	**1**
Texture		**Sand**

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Pasco Office: 1320 E Spokane St., Pasco, WA 99301
☎ (509) 488-0112 ✉ info@kuotestinglabs.com

Sample Analysis Report

Date: September 4, 2020
Report No: 64818
Grower: **Bush**
Client: **White Shield, Inc.**
Sampler: **Michael Black**
Sample Date: 9/1/2020
Sample ID: **INFTP-15 3-3.5ft**
Sample Type:
Lab No: 370127
Depth: 36-42

Analysis	Unit	Result
Clay	%	**2.4**
Moisture-Soil	%	**2.93**
Sand	%	**95.6**
Silt	%	**2**
Texture		**Sand**

Project : **Air Entry Permeameter Test**

Client : **BUSH**

Date : 9/1/2020

INFTP-1

Pmin= 7.70 in H20 (0.64 ft)
Hr = 1.77 ft
G = 1.01 ft
Lf = 1.03 ft
Pa = Pmin + G + Lf
Pa = 0.64 ft +1.01 ft +1.03 = **2.68 ft**

Time (in Min)	Level of reservoir(Drop)
0:00	0.50 ft
0:30	0.47 ft
1:00	0.44 ft
1:30	0.42 ft
2:00	0.40 ft

Permeameter = 2.68 ft (Expressed in negative water-pressure head)
82cm ~~81cm~~ 82cm

Vertical Hydraulic Conductivity (K)

K = (Lf(dHr/dt)(rr/rc)^2)/(Hr+Lf-0.5Pa)

K = [(1.03 ft)((0.03 ft/30 sec)(3600 sec/1hr))((0.5 ft)/(1.0 ft))^2]/{(1.77 ft + 1.03 ft-0.5(2.68ft)} =0.635 ft/hr = 7.62in/hr

Vertical Hydraulic Conductivity = 0.635 ft/hr = 7.62 in/hr

INFTP-2

Pmin= 11.40 in H20 (0.95 ft)
Hr = 1.81 ft
G = 1.02 ft
Lf = 1.45ft
Pa = Pmin + G + Lf
Pa = 0.95 ft +1.02 ft +1.45 ft = **3.42 ft**

Time (in Min)	**Level of reservoir(Dro**
0:00	0.49 ft
0:30	0.39 ft
1:00	0.31 ft
1:30	0.23 ft
2:00	0.15 ft

Permeameter = 3.42 ft(expressed in negative water-pressure head)
104 cm

Vertical Hydraulic Conductivity (K)

K = (Lf(dHr/dt)(rr/rc)^2)/(Hr+Lf-0.5Pa)

K = [(1.45 ft)((0.08ft/30 sec)(3600 sec/1hr))((0.5 ft)/(1.0 ft))^2]/{(1.81 ft +1.45 ft-0.5(3.24ft)} = 2.12 ft/hr = 25.44 in/hr

Vertical Hydraulic Conductivity = 2.12 ft/hr = 25.44 in/hr

APPENDIX E

USGS Maps

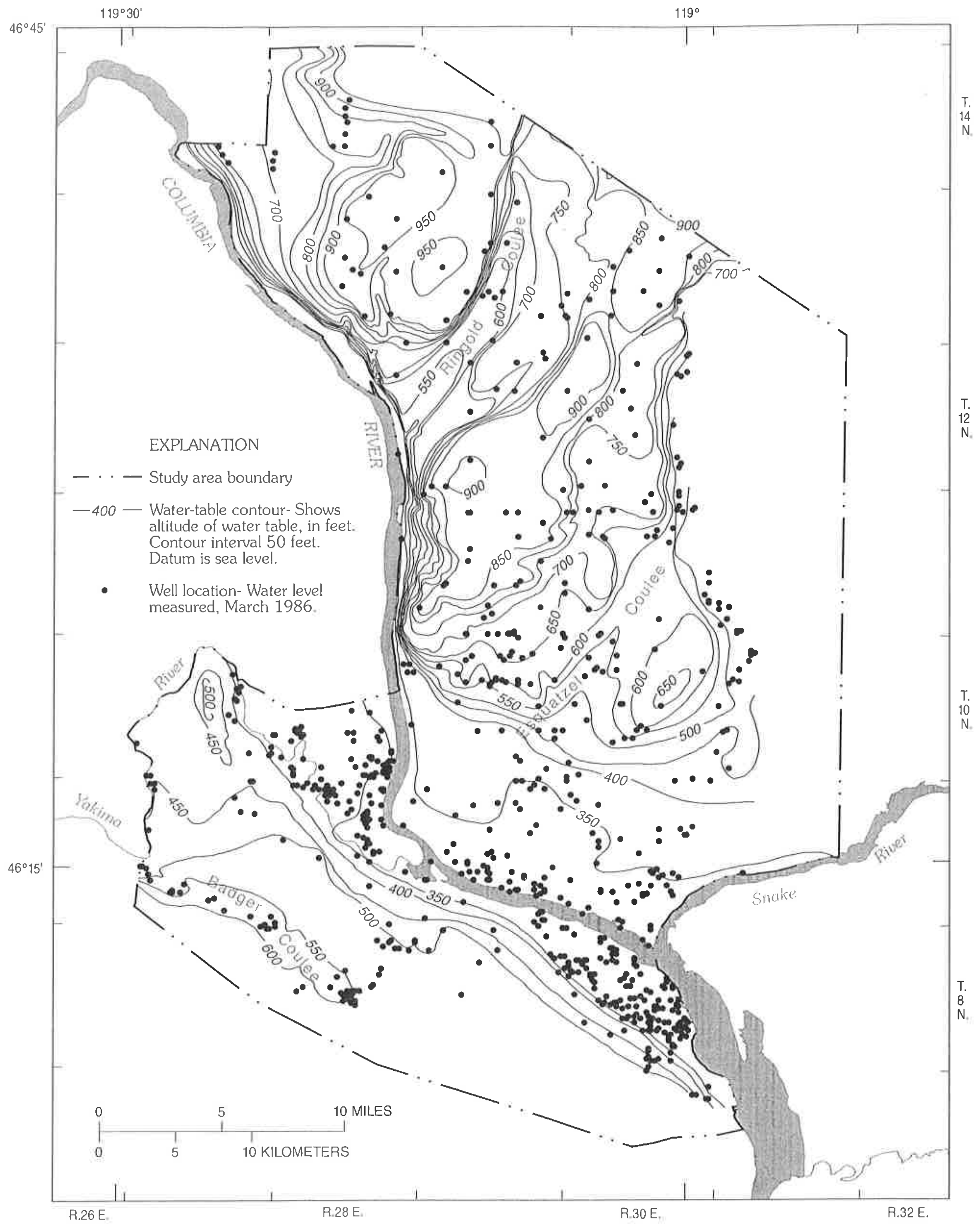

Figure 26.--Water-table altitude, March 1986.

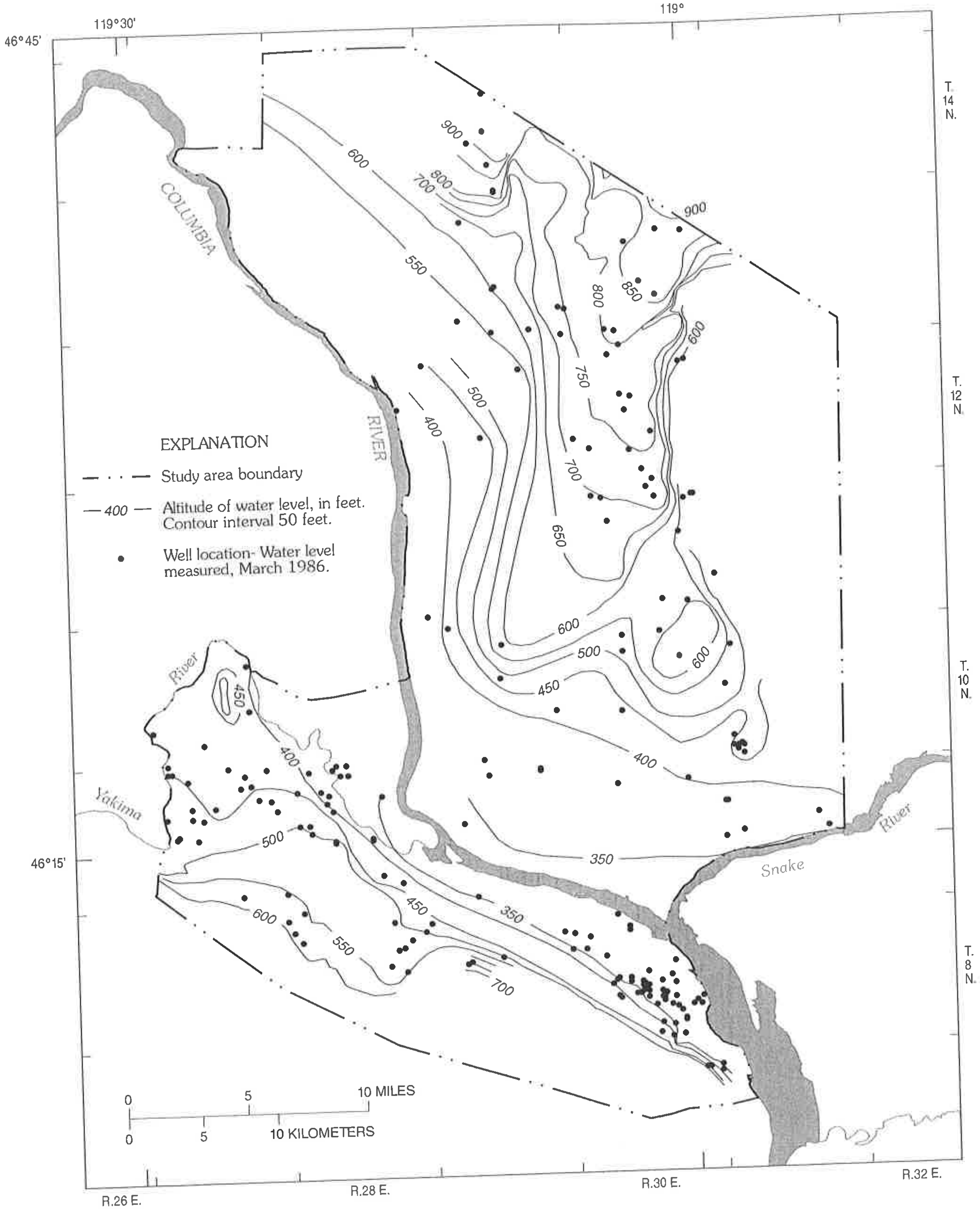

Figure 27.--Water-level altitudes in the Saddle Mountains Basalt, March 1986.

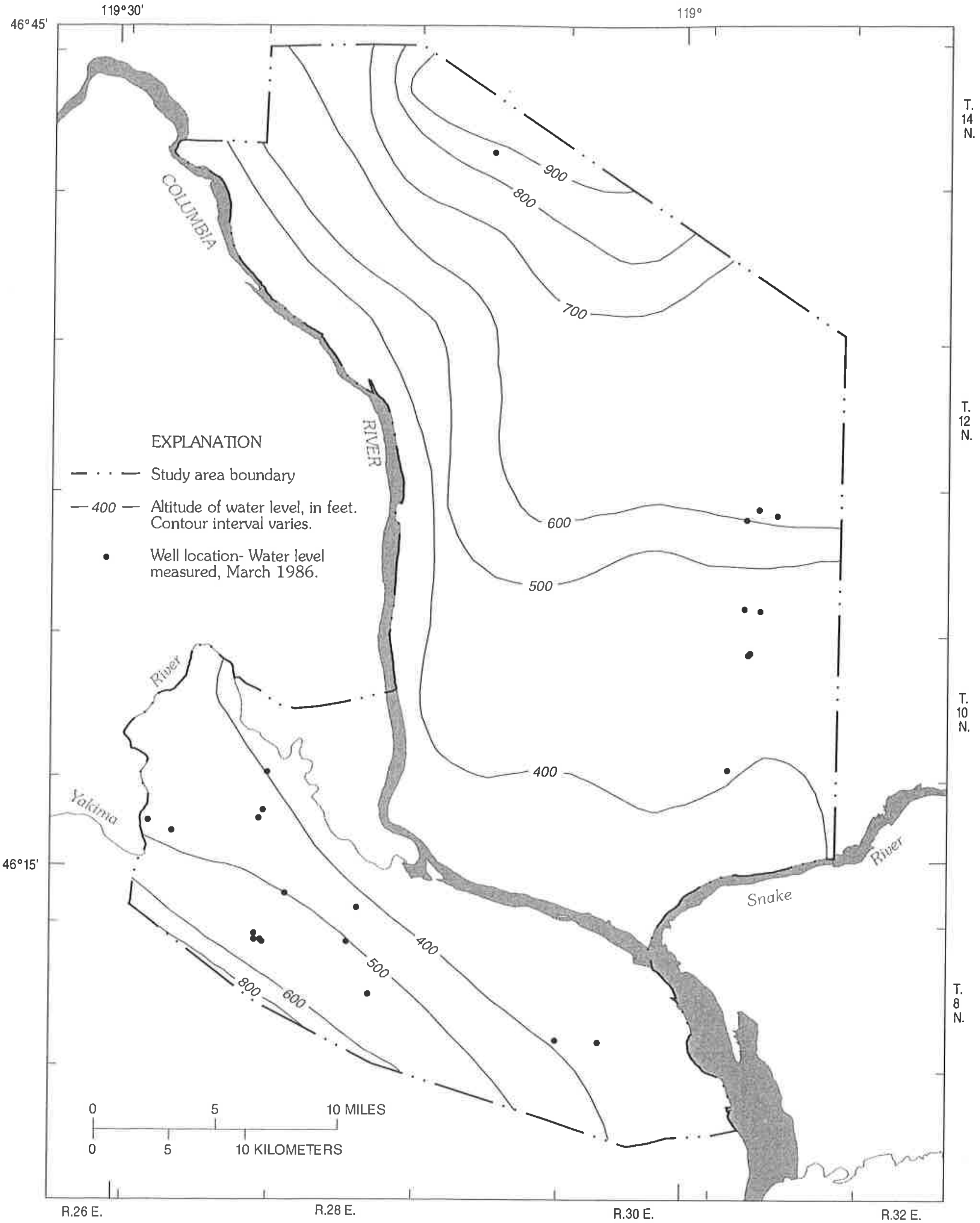

Figure 28.--Water-level altitudes in the Wanapum Basalt, March 1986 (Modified from Bauer, Vaccaro, and Lane, 1985).

SUBDIVISION

Guarantee/Certificate Number:

62242202083

Issued By:

CHICAGO TITLE INSURANCE COMPANY

CHICAGO TITLE INSURANCE COMPANY

a corporation, herein called the Company

GUARANTEES

Knutzen Engineering

herein called the Assured, against actual loss not exceeding the liability amount stated in Schedule A which the Assured shall sustain by reason of any incorrectness in the assurances set forth in Schedule A.

LIABILITY EXCLUSIONS AND LIMITATIONS

1. No guarantee is given nor liability assumed with respect to the identity of any party named or referred to in Schedule A or with respect to the validity, legal effect or priority of any matter shown therein.
2. The Company's liability hereunder shall be limited to the amount of actual loss sustained by the Assured because of reliance upon the assurance herein set forth, but in no event shall the Company's liability exceed the liability amount set forth in Schedule A.

Please note carefully the liability exclusions and limitations and the specific assurances afforded by this guarantee. If you wish additional liability, or assurances other than as contained herein, please contact the Company for further information as to the availability and cost.

Chicago Title Insurance Company

By:

Michael J. Nolan, President

Attest:

Marjorie Nemzura

Marjorie Nemzura, Secretary

Chicago Title Company of Washington
6416 W. Okanogan Avenue
Kennewick, WA 99336

Countersigned By:

Gary Duncan
Authorized Officer or Agent

ISSUING OFFICE:
Title Officer: Christopher Hull Chicago Title Company of Washington 6416 W. Okanogan Avenue Kennewick, WA 99336 Phone: (509)735-1575 Fax: (509)735-0707 Main Phone: (509)735-1575 Email: Christopher.Hull@ctt.com

SCHEDULE A

Liability	Premium	Tax
$1,000.00	$350.00	$30.45

Effective Date: August 22, 2022 at 08:00 AM

The assurances referred to on the face page are:

That, according to those public records which, under the recording laws, impart constructive notice of matter relative to the following described property:

SEE EXHIBIT "A" ATTACHED HERETO AND MADE A PART HEREOF

Title to said real property is vested in:

Timothy T. Bush and Kathryn L. Bush, Trustees under the Bush Living Trust dated August 19, 1999

subject to the matters shown below under Exceptions, which Exceptions are not necessarily shown in the order of their priority.

END OF SCHEDULE A

EXHIBIT "A"

Legal Description

For APN/Parcel ID(s): 115981013704001

Lot 1, Short Plat 3704, according to the plat thereof recorded in Volume 1 of Plats, Page 3704, recorded under Auditor's File No. 2021-37940, records of Benton County, Washington.

SCHEDULE B

1. General and special taxes and charges, payable February 15, delinquent if first half unpaid on May 1, second half delinquent if unpaid on November 1 of the tax year (amounts do not include interest and penalties):

Year:	2022
Tax Account No.:	115981013704001
Levy Code:	R1
Assessed Value-Land:	$70,000.00
Assessed Value-Improvements:	$0.00

General and Special Taxes:

Billed:	$790.32
Paid:	$790.32
Unpaid:	$0.00

2. Easements and limitations as established in the dedication of "plat of richland" or as delineated on the map thereof.

3. Reservations and Easement contained in Quit Claim Deed from the United States of America recorded October, 1959 under Auditor's File No. 425136.

4. Covenants, conditions, restrictions, recitals, reservations, easements, easement provisions, encroachments, dedications, building setback lines, notes, statements, and other matters, if any, but omitting any covenants or restrictions, if any, including but not limited to those based upon race, color, religion, sex, sexual orientation, familial status, marital status, disability, handicap, national origin, ancestry, or source of income, as set forth in applicable state or federal laws, except to the extent that said covenant or restriction is permitted by applicable law, as set forth on Short Plat 3704:

   Recording No: 2021-37940

END OF SCHEDULE B

SEPA ENVIRONMENTAL CHECKLIST

Purpose of checklist:

Governmental agencies use this checklist to help determine whether the environmental impacts of your proposal are significant. This information is also helpful to determine if available avoidance, minimization or compensatory mitigation measures will address the probable significant impacts or if an environmental impact statement will be prepared to further analyze the proposal.

Instructions for applicants:

This environmental checklist asks you to describe some basic information about your proposal. Please answer each question accurately and carefully, to the best of your knowledge. You may need to consult with an agency specialist or private consultant for some questions. You may use “not applicable” or "does not apply" only when you can explain why it does not apply and not when the answer is unknown. You may also attach or incorporate by reference additional studies reports. Complete and accurate answers to these questions often avoid delays with the SEPA process as well as later in the decision-making process.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Instructions for Lead Agencies:

Please adjust the format of this template as needed. Additional information may be necessary to evaluate the existing environment, all interrelated aspects of the proposal and an analysis of adverse impacts. The checklist is considered the first but not necessarily the only source of information needed to make an adequate threshold determination. Once a threshold determination is made, the lead agency is responsible for the completeness and accuracy of the checklist and other supporting documents.

Use of checklist for nonproject proposals:

For nonproject proposals (such as ordinances, regulations, plans and programs), complete the applicable parts of sections A and B plus the SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS (part D). Please completely answer all questions that apply and note that the words "project," "applicant," and "property or site" should be read as "proposal," "proponent," and "affected geographic area," respectively. The lead agency may exclude (for non-projects) questions in Part B - Environmental Elements –that do not contribute meaningfully to the analysis of the proposal.

A. Background [HELP]

1. Name of proposed project, if applicable:

   Wellhouse Heights Phase 2

2. Name of applicant:
   Robert McLeod (Knutzen Engineering)

3. Address and phone number of applicant and contact person:
Robert McLeod (Knutzen Engineering)
5401 Ridgeline Dr, Suite 160, Kennewick, WA 99338
509-222-0959

4. Date checklist prepared:
August 23, 2022

5. Agency requesting checklist:
City of Richland

6. Proposed timing or schedule (including phasing, if applicable):
The preliminary plat will be presented at a public hearing and will then be presented to the City of Richland's planning commission. Assuming approval of the plat is received, construction of necessary improvements will begin approximately 3-months later. The project will be completed in a single phase.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.
Lots created by the proposed plat will be developed with townhouses. There are no other future plans related to the project at this time.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.
A geotechnical report and critical aquifer recharge area report have been prepared for the property adjacent to the proposed subdivision, in association with the Wellhouse Heights Ph1 project.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.
None known of.

10. List any government approvals or permits that will be needed for your proposal, if known.
City of Richland Planning Commission Approval
City of Richland ROW & Grading Permits.
Erosivity Waiver through the Department of Environmental Quality (DEQ)

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)
The project site covers 0.43-acres, which will be divided into 5 lots compliant with R-3 zoning standards. City of Richland utilities will be extended to each lot. It is expected that each lot will be developed with residential townhomes, some of which will be duplex units. Paved driveways will be constructed for each lot, accessible from existing public ROWs; Duportail St and Thayer Dr. No construction of new public roads is necessary.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

404 Thayer Dr, Richland, WA 99352
Benton County Parcel #115981013704001
(NE corner of Thayer Dr and Duportail St.)

Lot 1 of Shot Plat 3704, recorded in volume 01 of short plats 3704, records of Benton County, Washington. AF#2021-037940, 08/12/2021.

B. Environmental Elements [HELP]

1. Earth [help]

a. General description of the site:

(circle one): [✓ **Flat**], rolling, hilly, steep slopes, mountainous, other ______________

b. What is the steepest slope on the site (approximate percent slope)?
Approximately 15%.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.
A layer of gravel covers a large portion of the site. A geotechnical report prepared for the neighboring property found layers of medium dense sand and gravel. (White Shield Project No. 119-054-01) Unpermitted garbage fill was also found underground. Per the Geotech's recommendations, all uncontrolled fill and garbage will be removed from the site and disposed of properly.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

None known.

e. Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.
The site would be graded to establish building pads and engineered slopes for stormwater drainage. The site appears to have been graded in the past in association with a previous project, minimal grading is expected to be necessary. The site is expected to balance on-site without the import or export of fill. Approximately 200 cy of soil is expected to be affected throughout the project.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.
Erosion could occur during construction activities but will be minimized through implementation of BMPs, including silt fencing, use of a construction entrance, site watering for dust control and catch basin inserts. All stormwater runoff will be contained and managed on-site.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?
Approximately 55% of the site.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:
Standard erosion control methods will be used, including catch basin inserts, silt fencing and stabilized construction entrances. Dust during construction will be controlled by the use of a water truck as necessary.

2. *Air* [help]

a. What types of emissions to the air would result from the proposal during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities if known.

During construction, minor amounts of dust and exhaust from equipment activity may occur. The completed project will not affect air quality.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.
None known.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:
Dust control measures will be implemented per recommendations by the Department of Ecology and the Benton County Clean Air Authority. Measures include, but are not limited to site watering, lowering vehicle speeds, limit of construction vehicles and reducing the number of dust-generating activities on windy days.

3. *Water* [help]

a. Surface Water: [help]

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

The Yakima River is approximately 0.5 miles SW of the site. The Columbia River is approximately 1.0 miles E of the site.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.
No.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.
Not applicable.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.
No.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

No.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.
No.

b. Ground Water: [help]

1) Will groundwater be withdrawn from a well for drinking water or other purposes? If so, give a general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.

No.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals: agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.
No waste materials will be discharged into the ground.

c. Water runoff (including stormwater):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Proposed impervious surfaces will generate stormwater runoff. A stormwater management system will be designed by a licensed engineer to contain and infiltrate all stormwater runoff on-site in accordance with the Stormwater Management Manual for Eastern Washington.

2) Could waste materials enter ground or surface waters? If so, generally describe.
Pretreatment will be proposed in accordance with the Stormwater Management Manual for Eastern Washington (SMMEW) to limit the amount of pollutant entering infiltration facilities.

3) Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? If so, describe.

No, all runoff will be contained and infiltrated on-site. There are no known off-site runoff sources flowing to the site.

d. Proposed measures to reduce or control surface, ground, and runoff water, and drainage pattern impacts, if any:

Stormwater runoff generated from impervious surfaces will be collected and conveyed to infiltration systems on-site, per City of Richland standards.

4. ***Plants*** [help]

a. Check the types of vegetation found on the site:

____deciduous tree: alder, maple, aspen, other
____evergreen tree: fir, cedar, pine, other
____shrubs
_X__grass
____pasture
____crop or grain
_____Orchards, vineyards or other permanent crops.
_____wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other
____water plants: water lily, eelgrass, milfoil, other
____other types of vegetation

b. What kind and amount of vegetation will be removed or altered?
There is an insignificant amount of weeds and grasses on-site, which will be removed during grading activities.

c. List threatened and endangered species known to be on or near the site.
None, per the Washington Department of Fish and Wildlife.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:
Street frontage will be landscaped per City of Richland standards.

e. List all noxious weeds and invasive species known to be on or near the site.

None, per the Washington State Noxious Weed Data Viewer.

5. ***Animals*** [help]

a. List any birds and other animals which have been observed on or near the site or are known to be on or near the site.

Examples include:

birds: hawk, heron, eagle, songbirds, other:
mammals: deer, bear, elk, beaver, other:
fish: bass, salmon, trout, herring, shellfish, other _________

b. List any threatened and endangered species known to be on or near the site.
None, per the Washington Department of Fish and Wildlife.

c. Is the site part of a migration route? If so, explain.
Yes, the Columbia Basin is part of a migration route for several species of fowl.

d. Proposed measures to preserve or enhance wildlife, if any:
None currently.

e. List any invasive animal species known to be on or near the site.
None known.

6. *Energy and Natural Resources* [help]

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Electricity and natural gas will be used to meet the project's lighting and heating needs.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.
No.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:
Proposed buildings will comply with Building Energy Codes, per the 2018 IBC.

7. *Environmental Health* [help]

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.
None known.

1) Describe any known or possible contamination at the site from present or past uses.
None known.

2) Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity.
None known.

3) Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project.
Gas may be stored on-site during construction activities. The completed development will not store any hazardous chemicals on-site.

4) Describe special emergency services that might be required.
The project will utilize typical emergency services provided by the City of Richland.

5) Proposed measures to reduce or control environmental health hazards, if any:
None currently.

b. *Noise*

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

   The major source of noise in the area is from traffic on Duportail St and Thayer Dr.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

   Short term: Construction Noise
   Long term: Traffic associated with the new housing.

3) Proposed measures to reduce or control noise impacts, if any:

   Noise volumes will comply with Benton County noise policies. Construction will be limited to designated working hours of the day.

8. *Land and Shoreline Use* [help]

a. What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.

The site is currently undeveloped land. Adjacent land uses are single-family residential housing, the Richland Masonic Temple, and the New Heights Church. The project will not affect land uses on nearby or adjacent properties.

b. Has the project site been used as working farmlands or working forest lands? If so, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses as a result of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or nonforest use?
No.

1) Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides, tilling, and harvesting? If so, how:
   No.

c. Describe any structures on the site.
There are no existing structures on-site.

d. Will any structures be demolished? If so, what?
Not applicable.

e. What is the current zoning classification of the site?
R-3 (Multiple-Family Residential Use District)

f. What is the current comprehensive plan designation of the site?
HDR (High Density Residential)

g. If applicable, what is the current shoreline master program designation of the site?
Not applicable.

h. Has any part of the site been classified as a critical area by the city or county? If so, specify.
Yes, the site is within a Critical Aquifer Recharge Area, as designated by the City of Richland.

i. Approximately how many people would reside or work in the completed project?
Approximately 8 people would reside in the completed housing.

j. Approximately how many people would the completed project displace?
None.

k. Proposed measures to avoid or reduce displacement impacts, if any:
Not applicable.

L. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The project will be permitted through the City of Richland, in accordance with all applicable zoning ordinances.

l. Proposed measures to reduce or control impacts to agricultural and forest lands of long-term commercial significance, if any:
Not applicable.

9. ***Housing*** [help]

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

5 single-family townhome units considered medium to high income housing.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.
No units will be eliminated.

c. Proposed measures to reduce or control housing impacts, if any:
Impact fees will be paid to the City of Richland as required. The new housing will generate additional tax revenue for the City of Richland.

10. ***Aesthetics*** [help]

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?
Approximately 37-feet.

b. What views in the immediate vicinity would be altered or obstructed?
None.

c. Proposed measures to reduce or control aesthetic impacts, if any:
Homes will complete with City of Richland building material requirements, and will match the design and materials of the adjacent property (Wellhouse Heights Ph1).

11. *Light and Glare* [help]

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

Outdoor building lighting would be active during late evening hours.

b. Could light or glare from the finished project be a safety hazard or interfere with views?
No, the proposed lighting will be minimal. Lights will be shielded downwards to prevent glare.

c. What existing off-site sources of light or glare may affect your proposal?
None known.

d. Proposed measures to reduce or control light and glare impacts, if any:
All lighting will follow City of Richland requirements and will be properly shielded downwards to prevent glare.

12. *Recreation* [help]

a. What designated and informal recreational opportunities are in the immediate vicinity?
Lawless Park is located approximately 400-feet from the project site, which features a frisbee golf course. The Goethals Park Natural Playground is approximately 0.25 E of the site. Richland High School's outdoor soccer fields are located approximately 500-feet NE of the site.

b. Would the proposed project displace any existing recreational uses? If so, describe.
No.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:
None currently.

13. *Historic and cultural preservation* [help]

a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers ? If so, specifically describe.

No.

b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts, or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources.
None known. No evidence was found on the adjacent property (Wellhouse Heights Ph1) during construction. The DAHP's WISAARD mapping identifies the site as High Risk for environmental factors with archaeological resources.

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc.
Internet search for project site. Washington State Department of Archeology and History Preservation, National Register of Historic Places in Benton County.

d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required.
Upon any discover of potential or known archaeological resources at the project site, prior to or during construction, the contractor and/or any other parties involved in construction shall immediately cease all on-site construction, shall act to protect the known historical and cultural resources area from outside intrusion, and shall notify, within a maximum period of twenty-four hours from the time of discovery, City of Richland officials of said discovery.

14. *Transportation* [help]

a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on site plans, if any.

The site can be accessed from Duportail St and Thayer Dr.

b. Is the site or affected geographic area currently served by public transit? If so, generally describe. If not, what is the approximate distance to the nearest transit stop?
The nearest Ben-Franklin Transit bus stop is located 725-feet N of the site on Thayer Dr. Bus Stop ID RC433.

c. How many additional parking spaces would the completed project or non-project proposal have? How many would the project or proposal eliminate?
The project will propose a private driveway and garage for each residential unit.

d. Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle or state transportation facilities, not including driveways? If so, generally describe (indicate whether public or private).

The project will not require the construction of new roads or sidewalks. Improvements will be made to existing roads & streets as required by the City of Richland.

e. Will the project or proposal use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.
No.

f. How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and nonpassenger vehicles). What data or transportation models were used to make these estimates?
The project will generate approximately 16 vehicular trips on a typical weekday. (Per Land Use Code 230 of the Trip Generation Manual of the ITE.) Peak traffic volumes are expected to occur between 4pm and 6pm.

g. Will the proposal interfere with, affect or be affected by the movement of agricultural and forest products on roads or streets in the area? If so, generally describe.
No.

h. Proposed measures to reduce or control transportation impacts, if any:
Traffic impact fees will be paid to the City of Richland as required. The new housing will generate additional tax revenue for the City of Richland.

15. *Public Services* [help]

a. Would the project result in an increased need for public services (for example: fire protection, police protection, public transit, health care, schools, other)? If so, generally describe.

The new housing will use public services provided by the City of Richland, including fire protection, police protection, public transit, health care and schools.

b. Proposed measures to reduce or control direct impacts on public services, if any.
Impact fees will be paid to the City of Richland as required. The new housing will generate additional tax revenue for the City of Richland.

16. *Utilities* [help]

a. Circle utilities currently available at the site:
[✓ electricity], [✓ natural gas], [✓ water], [✓ refuse service], [✓ telephone], [✓ sanitary sewer], septic system, other ____________

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

Water – City of Richland

Sewer – City of Richland

Internet – Ziply / Charter

Natural Gas – Cascade Natural Gas Company

C. Signature [HELP]

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature:____

Name of signee Robert McLeod

Position and Agency/Organization Junior Engineer / Knutzen Engineering

Date Submitted: 08/23/2022