



Staff Report for Administrative Approval Hillside Review – Notice of Conditional Approval

Weber County Planning Division

Synopsis

Application Information

Application Request: Consideration and action on a request to approve a Hillside Review for the Mountainside and Parkside Subdivisions in The Bridges PRUD.

Applicant: Bridges Holding Company, LLC

Authorized Representative: Eric Householder

File Number: HSR 2016-04

Property Information

Approximate Address: 4945 E Snowflake Drive

Zoning: FR-3, RE-15

Existing Land Use: Vacant

Proposed Land Use: Multi-phased residential development

Parcel ID: 22-006-0004, 22-006-0033

Township, Range, Section: 7N 1E Sec 15, 16 & 22

Adjacent Land Use

North: Forest	South: Residential
East: Residential	West: Residential

Staff Information

Report Presenter: Ronda Kippen
rkippen@co.weber.ut.us
801-399-8768

Report Reviewer: RG

Applicable Ordinances

- Weber County Land Use Code Title 108 (Standards) Chapter 14 (Hillside Development Review)
- Weber County Land Use Code Title 108 (Standards) Chapter 22 (Natural Hazards Areas)

Background

The subject property has been approved as part of The Bridges at Wolf Creek Resort PRUD located within the approved Wolf Creek Resort Master Development. The application is restricted to the Mountainside and Parkside subdivisions located within The Bridges PRUD. The Parkside and Mountainside subdivisions have been identified as being located within a potential geologic area and potentially having an average slopes in excess of 25%; therefore, a geologic and geotechnical investigation have been included as part of the approved subdivision to ensure the lots are safe for development.

GSH has performed the required geologic and geotechnical investigation, as required in LUC Title 108 Chapter 22, to determine if there is a geologic hazard located on the site and to assess the subsurface soils in order to better design the home for slope stability and safety purposes. Information related to the construction of the subdivisions and the geologic/geotechnical report, have been distributed to the Hillside Review Board for comment. The plans have been reviewed and approved and/or conditionally approved by all applicable review agencies.

Planning Division Review

The Planning Division Staff has determined that the requirements and standards provided by the Hillside Review Chapter have been met for the excavation and construction of the dwelling. The following submittals were required:

1. Subdivision Plats (see Exhibit A)
2. Geotechnical and Geologic Investigation Report (see Exhibit B)

Weber County Hillside Review Board comments

The Weber County Hillside Review Board, on this particular application, made comments related to the following:

Weber County Engineering Division: The Engineering Division granted approval on August 16, 2016. The approval is subject to the applicant following all recommendations found in the applicable Geotechnical and Geological Investigation Reports including the following conditions:

1. Each lot which has any designation of Landslide potential per Figure 19 will need to be addressed with an individual geologic study.
2. Future roadways be addressed per the geologic study or roadways be realigned to avoid the hazard as shown on Figure 19.

Weber Fire District: The Fire district has granted approval on September 14, 2017 subject to the following:

1. Comments from the review dated March 2, 2016 have been addressed and corrected. See response letter from developer dated 6-6-2016.
2. Item #10 in the response letter is a request to have an allowance for Road F to have a 12% slope to minimize cut/fill operations. This is approved. Maximum slope will be allowed to be 12%. This approval is only valid if also approved by County Engineering.

Weber County Planning Division: The Planning Division has granted approval subject to the applicant complying with all Board requirements and conditions. This approval is also subject to the applicant strictly adhering to the recommendations outlined in the geologic and geotechnical investigation report dated July 25, 2016 and amended on August 5, 2016 provided by GSH (Job No. 1661-08N-16). Lots that will be required to have additional geologic and geotechnical investigation prior to submitting a building permit application have been identified with an "N" after the lot number on the recorded subdivision plats.

Planning Division Recommendations

Based on site inspections and review agency comments, the Planning Division Staff has determined that it is necessary to impose additional requirements and conditions as part of approving HSR 2016-04. The recommendation for approval is subject to adherence to all review agencies conditions and based on the following conditions:

1. As a condition it is understood, by the applicant, the geo-technical engineer and engineering geologist that if any geologic hazards are revealed during the excavation and construction phase of the subdivision improvements or during the excavation for the dwelling, work will cease pending the development of appropriate mitigation measures and subsequent approval by the County.

The recommendation is based on the following findings:

1. The application was submitted and with the required conditions, has been deemed complete.
2. The requirements and standards found in the Hillside Development Review Procedures and Standards Chapter have been met or will be met during the excavation and construction phase of the infrastructure and any future dwellings.
3. The Hillside Review Board members reviewed the application individually and have provided their comments.
4. The applicant has met or will meet, as part of the subdivision process and/or during the excavation and construction phase of the improvements and future dwellings, the requirements and conditions set forth by the Hillside Review Board.

Administrative Approval

Administrative approval of the Mountainside and Parkside Subdivisions in The Bridges PRUD (HRS 2016-04) is hereby granted based upon its compliance with the Weber County Land Use Code. This approval is subject to the requirements of applicable review agencies and is based on the recommendations, conditions and findings listed in this staff report.

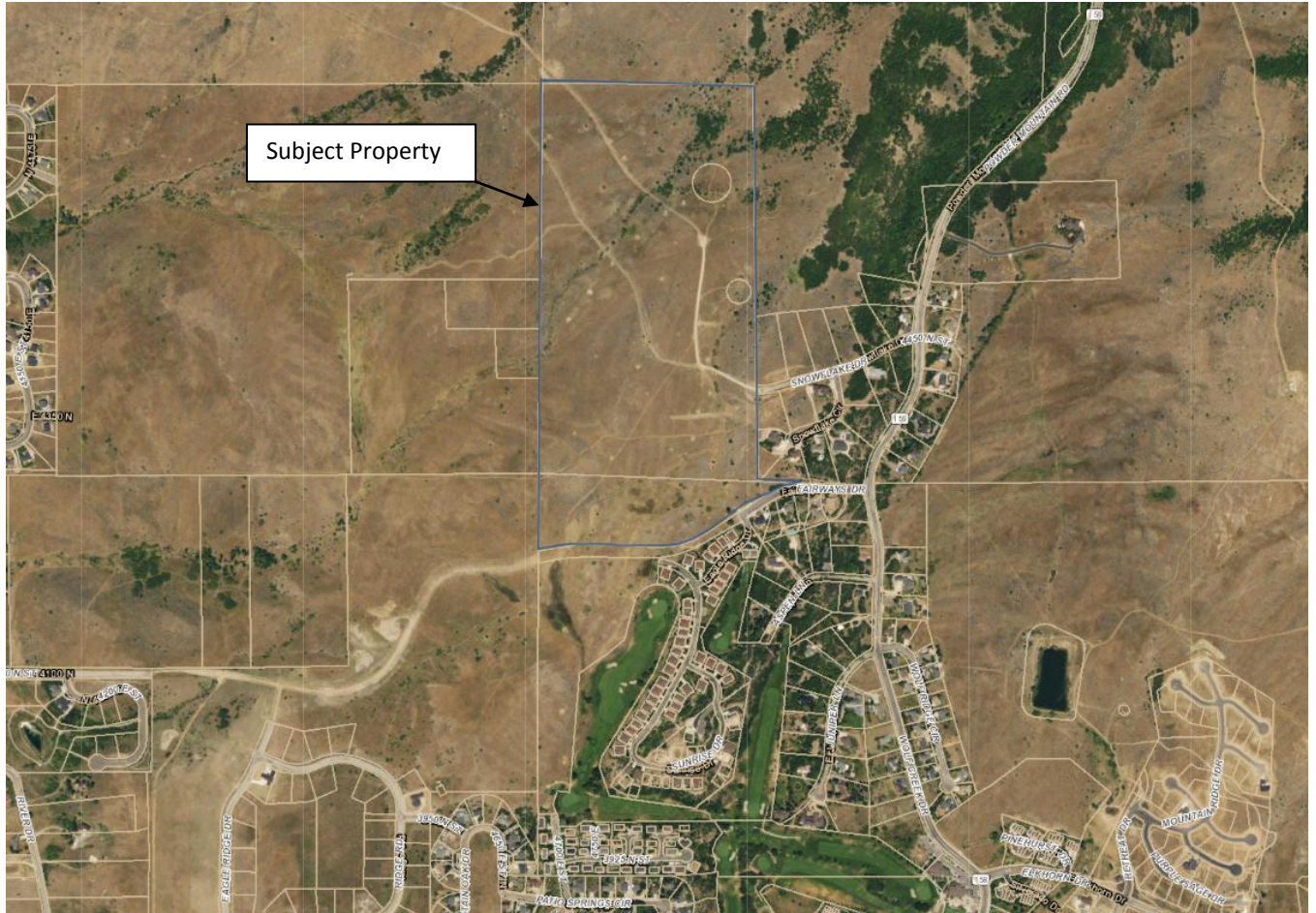
Date of Administrative Approval: _____

Rick Grover
Weber County Planning Director

Exhibits

- A. Subdivision Plats
- B. Geotechnical and Geologic Investigation Report

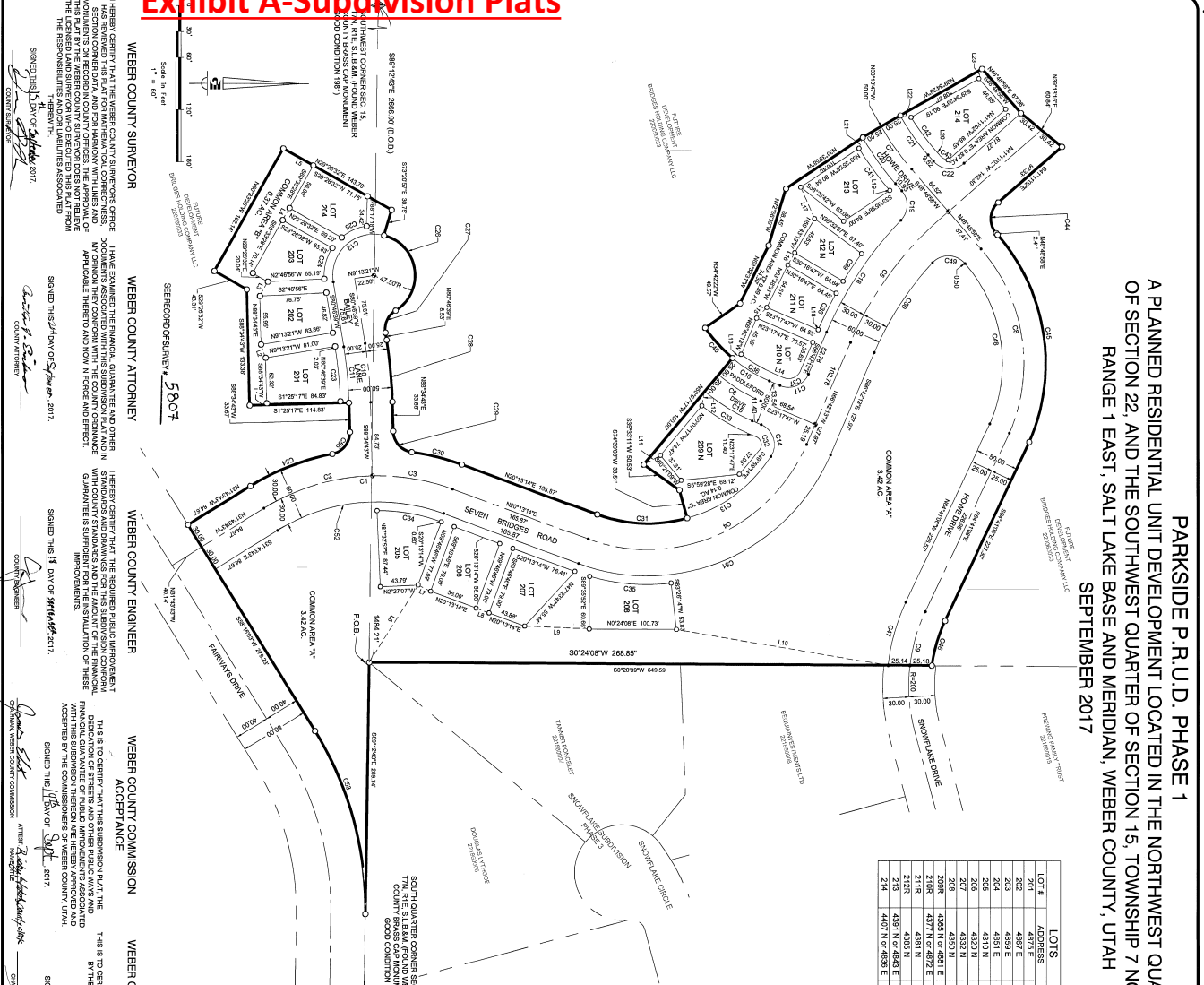
Map 1



0618

R11201 - LEWIS HOMES THE BRIDGES SURVEY WP PARKSIDE PHASE 1 FINAL PLATS DWG

Exhibit A-Subdivision Plats



PARKSIDE P.R.U.D. PHASE 1
A PLANNED RESIDENTIAL UNIT DEVELOPMENT LOCATED IN THE NORTHWEST QUARTER OF SECTION 22, AND THE SOUTHWEST QUARTER OF SECTION 15, TOWNSHIP 7 NORTH, RANGE 1 EAST, SALT LAKE BASE AND MERIDIAN, WEBER COUNTY, UTAH
SEPTEMBER 2017

LOT #	ADDRESS	ACRES
201	4897 E	4.009
202	4897 E	4.016
203	4899 E	4.076
204	4891 E	4.287
205	4903 E	4.332
206	4903 N	4.242
207	4922 N	4.251
208	4932 N	4.253
209	4935 N	4.327
210	4931 N	4.324
211	4851 N	3.245
212	4852 N	3.245
213	4851 N	3.245
214	4851 N	3.245



LEGEND

- WEBER COUNTY MONUMENT AS NOTED
- SET BY HEWITT AND COMPANY ENGINEERING
- SET CENTRAL POINT MONUMENT
- BOUNDARY MONUMENT
- SECTION CORNER
- LOT LINE
- ADJACENT PARCEL
- SECTION LINE
- CONTINGENT SURVEY
- RIGHT-OF-WAY LINE
- THE DATE
- NOTES

- SUBJECT PROPERTY FALLS WITHIN FEMA FLOOD ZONE X- AREA DETERMINED TO BE COVERS THE DATE 2006.
- AND NO OTHER FLOODING INFORMATION WAS PROVIDED TO COMPLETION WITHIN WEBER COUNTY.
- REMARKS SHALL BE SET AT REAR CORNER CURB WALK TO BE SET IN CURB IN FRONT LOT LINE.
- ALL AREAS NOT WITHIN THE BOUNDARIES OF THE EXISTING LOTS IN THE COMMON AREA AND THE COMMON AREA SHALL BE SET AS REAR CORNER CURB WALK TO BE SET IN CURB IN FRONT LOT LINE.
- THE AREAS ARE RECREATIONAL, DESIGNATED FOR THE ENJOYMENT OF RESIDENTS OF THE SECTION AND ARE NOT TO BE USED FOR OTHER PURPOSES.
- NIGHTLY RECREATION ARE ALLOWED.
- HAS BEEN PERMITTED FOR CONSTRUCTION AND TECHNICAL ASSISTANCE TO BE PROVIDED BY THE WEBER COUNTY PLANNING DEPARTMENT.
- THE APPLICANT HAS BEEN ADVISED THAT THE SECTION 15 AND SECTION 22 ARE NOT SUBJECT TO FEDERAL OR STATE WATER RIGHTS.
- SEE PLANS SHEETS FOR FURTHER INFORMATION.
- INTERFERE AND/OR CONTINUE TO BE SET TO ADJACENT LOT MONUMENTS SHALL BE SET BY HEWITT AND COMPANY ENGINEERING.
- DATE: **11/17/2017**
- BY: **David J. Harkness, PLS**

ACKNOWLEDGEMENT

STATE OF UTAH: I, **David J. Harkness, PLS**, do hereby certify that the above and foregoing plat was prepared and filed by me or by the duly authorized agent of the State of Utah, and that the plat is a true and correct copy of the original plat as recorded in the office of the county clerk of Weber County, Utah, and that the plat is a true and correct copy of the original plat as recorded in the office of the county clerk of Weber County, Utah.

ACKNOWLEDGEMENT

STATE OF UTAH: I, **Kurt C. Serrano, PLS**, do hereby certify that the above and foregoing plat was prepared and filed by me or by the duly authorized agent of the State of Utah, and that the plat is a true and correct copy of the original plat as recorded in the office of the county clerk of Weber County, Utah, and that the plat is a true and correct copy of the original plat as recorded in the office of the county clerk of Weber County, Utah.

ACKNOWLEDGEMENT

STATE OF UTAH: I, **David J. Harkness, PLS**, do hereby certify that the above and foregoing plat was prepared and filed by me or by the duly authorized agent of the State of Utah, and that the plat is a true and correct copy of the original plat as recorded in the office of the county clerk of Weber County, Utah, and that the plat is a true and correct copy of the original plat as recorded in the office of the county clerk of Weber County, Utah.

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BOUNDARY DESCRIPTION

A PART OF THE SOUTHWEST QUARTER OF SECTION 15, AND THE NORTHWEST QUARTER OF SECTION 22, DESCRIBED AS FOLLOWS: ... [Detailed boundary description text] ...

OWNERS DEDICATION

THE UNDERSIGNED OWNER OF THE HEREIN DESCRIBED TRACT OF LAND, HEREBY SET ASHIFT AND TRACT: ... [Dedication text] ...

SURVEYORS CERTIFICATE

I, **David J. Harkness, PLS**, a duly Licensed Professional Land Surveyor in the State of Utah, do hereby certify that I have personally examined the above and foregoing plat, and that the same is a true and correct copy of the original plat as recorded in the office of the county clerk of Weber County, Utah, and that the plat is a true and correct copy of the original plat as recorded in the office of the county clerk of Weber County, Utah.

PROFESSIONAL SEAL OF DAVID J. HARKNESS, PLS

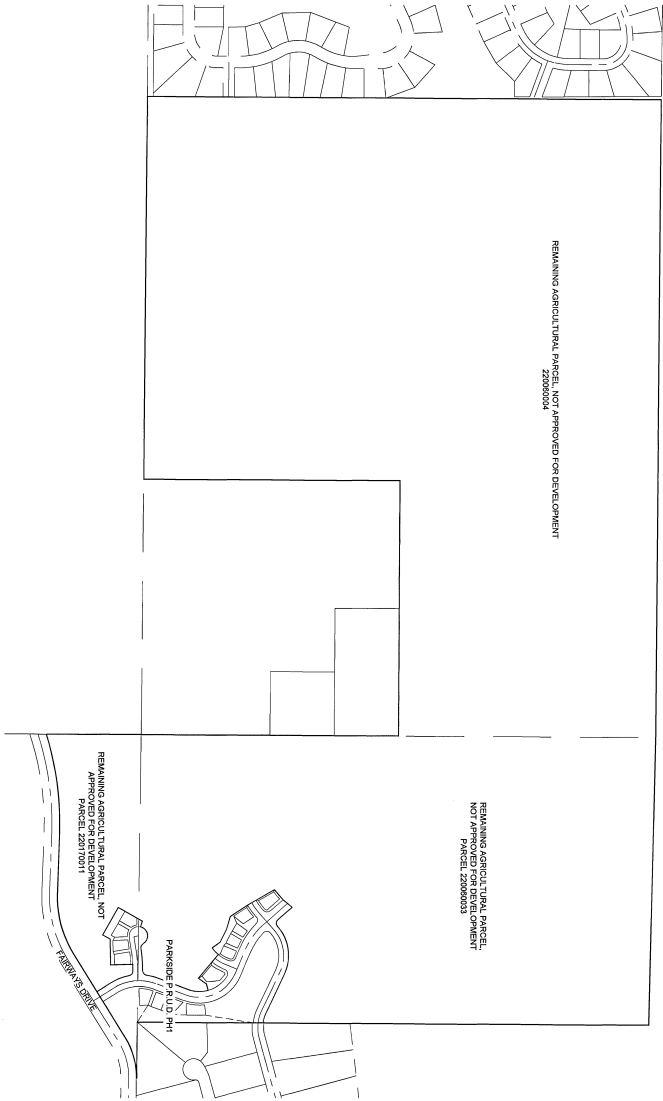
COUNTY RECORDER

GARDNER ENGINEERING
 CIVIL, LAND PLANNING
 LEAN HALLS
 COUNTY RECORDER
 S1 2

Exhibit A-Subdivision Plats

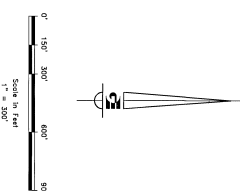
16-18

PARKSIDE P.R.U.D. PHASE 1
 A PLANNED RESIDENTIAL UNIT DEVELOPMENT
 LOCATED IN THE NORTHWEST QUARTER OF SECTION 22,
 AND THE SOUTHWEST QUARTER OF SECTION 15,
 TOWNSHIP 7 NORTH, RANGE 1 EAST, SALT LAKE BASE AND MERIDIAN,
 WEBER COUNTY, UTAH
 SEPTEMBER 2017



CORNER TABLE			CORNER TABLE		
CORNER	LENGTH	BEARING	CORNER	LENGTH	BEARING
C1	2382.67	S26.00	S194°52'37"	N67°42'15"W	118.58
C2	1323.24	S26.00	S071°53'57"	N87°34'30"W	130.70
C3	844.43	S56.00	S128°31'31"	N87°23'58"E	53.87
C4	2032.42	S00.00	S02°52'30"	N20°14'30"W	275.15
C5	1983.21	S00.00	S71°14'44"	N50°04'51"W	168.43
C6	572.88	S00.00	S14°54'50"	S31°33'18"W	57.69
C7	602.53	S00.00	S123°54'50"	S54°33'48"W	60.43
C8	2784.41	S00.00	S42°11'45"	N88°14'52"E	214.25
C9	646.82	S00.00	S194°14'44"	S70°56'57"E	64.84
C10	602.08	S00.00	S00.00	S00.00	60.22
C11	512.24	S25.00	S70°56'57"	N27°22'05"W	51.29
C12	2003.51	S25.00	S42°54'31"	N58°37'52"E	178.84
C13	2228.68	S25.00	S70°56'57"	N10°16'52"W	211.82
C14	432.57	S25.00	S90°51'09"	S70°13'22"W	38.54
C15	643.12	S25.00	S124°54'50"	S31°33'18"W	64.89
C16	504.62	S25.00	S124°54'50"	N31°33'18"E	50.47
C17	382.27	S25.00	S00°00'00"	N17°42'15"W	32.54
C18	158.61	S25.00	S04°44'05"	N80°50'10"W	154.77
C19	371.18	S25.00	S01°24'05"	N88°34'34"W	33.85
C20	643.33	S25.00	S11°10'52"	S54°34'28"W	64.22
C21	552.72	S25.00	S17°53'50"	N46°37'17"E	55.63
C22	392.27	S25.00	S00°00'00"	N47°46'58"E	32.54
C23	612.00	S25.00	S73°44'41"	N66°33'59"E	61.46
C24	512.24	S25.00	S70°56'57"	N27°22'05"W	51.29
C25	1113.35	S25.00	S123°54'50"	N87°17'42"E	87.81
C26	2824.54	S25.00	S74°23'57"	S80°22'02"E	212.83
C28	71.48	S28.00	S74°00'00"	N46°40'41"E	71.43

CORNER TABLE			CORNER TABLE		
CORNER	LENGTH	BEARING	CORNER	LENGTH	BEARING
C27	2824.54	S25.00	S74°23'57"	S80°22'02"E	212.83
C29	331.15	S26.00	S02°52'30"	N20°14'30"W	13.20
C30	584.62	S26.00	S128°31'31"	N87°23'58"E	43.84
C31	1026.53	S26.00	S02°52'30"	N20°14'30"W	87.81
C32	174.43	S26.00	S90°51'09"	S70°13'22"W	13.20
C33	614.46	S26.00	S124°54'50"	S31°33'18"W	61.29
C34	791.10	S26.00	S01°24'05"	S54°34'28"W	74.70
C35	951.10	S26.00	S11°10'52"	S54°34'28"W	91.48
C36	424.49	S26.00	S17°53'50"	N46°37'17"E	42.28
C37	232.88	S26.00	S00°00'00"	S17°42'15"E	21.21
C38	424.49	S26.00	S70°56'57"	S52°42'58"E	42.51
C39	424.49	S26.00	S70°56'57"	S52°42'58"E	42.51
C40	474.68	S26.00	S00°00'00"	N58°37'52"E	47.54
C41	584.62	S26.00	S128°31'31"	N87°23'58"E	58.27
C42	437.02	S26.00	S90°51'09"	S70°13'22"W	43.84
C43	1026.53	S26.00	S02°52'30"	N20°14'30"W	103.20
C44	312.27	S26.00	S00°00'00"	S87°54'42"E	43.84
C45	203.08	S26.00	S44°37'25"	N81°17'42"E	241.64
C46	532.00	S26.00	S73°44'41"	S70°56'57"E	53.89
C47	751.24	S26.00	S17°42'15"	N47°18'28"W	73.89
C48	197.77	S26.00	S44°37'25"	N81°17'42"E	187.41
C49	424.49	S26.00	S90°51'09"	S70°13'22"W	42.28
C50	1344.01	S26.00	S19°21'14"	S57°05'04"E	133.43
C51	348.84	S26.00	S02°52'30"	S14°30"E	318.42
C52	198.27	S26.00	S194°14'44"	S70°56'57"E	198.27
C53	512.24	S26.00	S70°56'57"	N27°22'05"W	51.29
C54	1026.53	S26.00	S02°52'30"	N20°14'30"W	103.20
C55	331.15	S26.00	S02°52'30"	N20°14'30"W	32.53



CE GARDNER ENGINEERING
 CIVIL, LAND PLANNING
 3120 S 2000 W, SUITE 100
 SALT LAKE CITY, UT 84119
 (801) 487-1507

LEWIS HOMES
 801 S 2000 W, SUITE 100
 SALT LAKE CITY, UT 84119
 (801) 487-1507

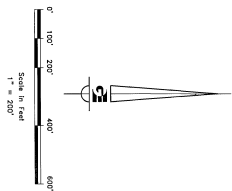
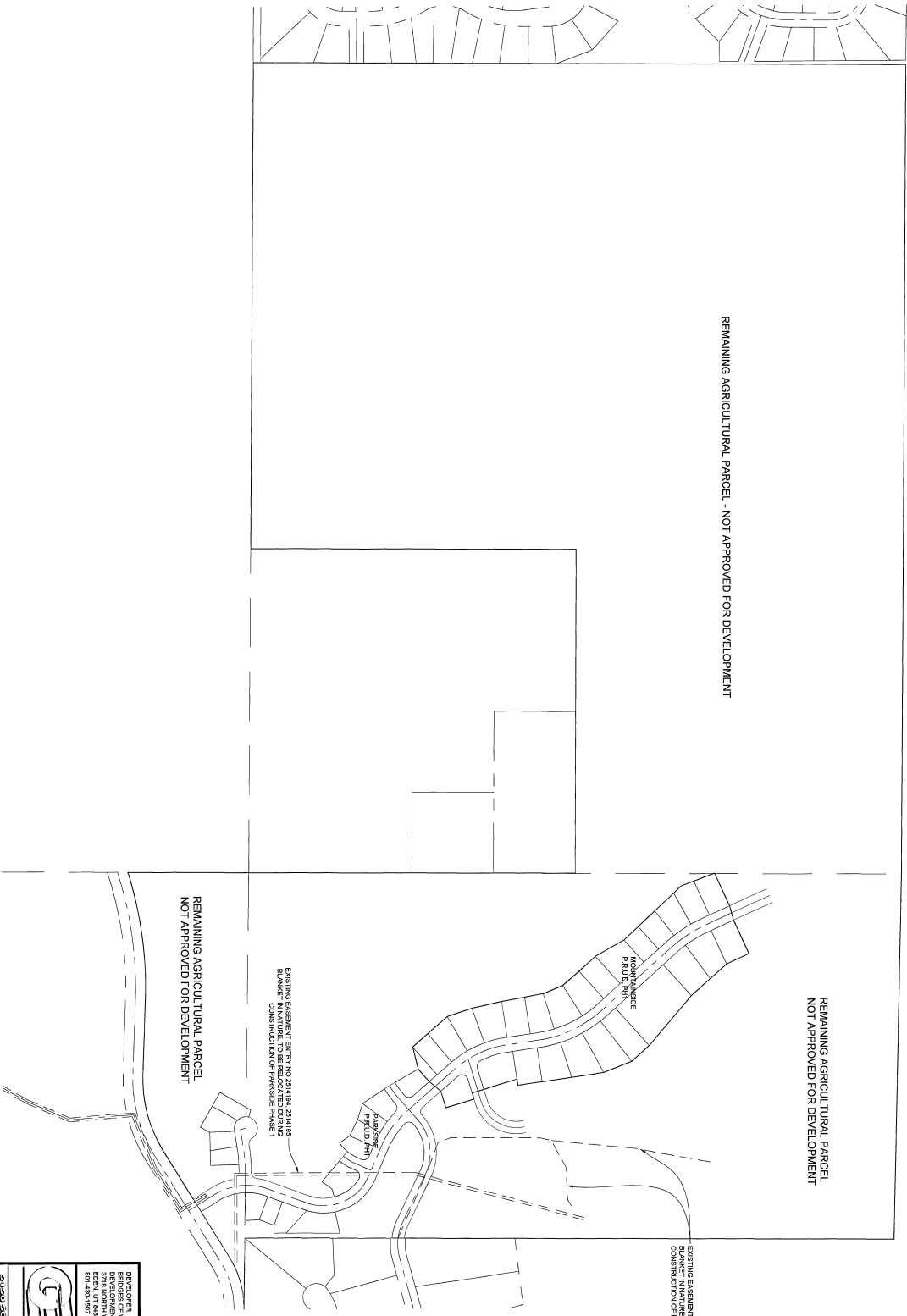
COUNTY RECORDER
 ENTRY NO. 287766 | FEE PAID 2689
 FILED FOR AND RECORDED 25-SEP-2017
 AT 3:12 P.M. IN BOOK 51 OF OFFICIAL RECORDS PAGE 6417
 FOR RELEASER HOLDING
 LE ANI H. KILGIC
 COUNTY RECORDER
 BY: SARA WALKER

81-97

Exhibit A-Subdivision Plats

Tab-1g

MOUNTAINSIDE P.R.U.D. PHASE 1
 A PLANNED RESIDENTIAL UNIT DEVELOPMENT
 LOCATED IN THE SOUTHWEST QUARTER OF SECTION 15 AND THE SOUTHEAST
 QUARTER OF SECTION 16, TOWNSHIP 7 NORTH, RANGE 1 EAST, SALT LAKE BASE AND
 MERIDIAN, WEBER COUNTY, UTAH
 SEPTEMBER 2017



<p>GARDNER ENGINEERING CIVIL, LAND PLANNING 212 W. 1000 S. SUITE 200 SALT LAKE CITY, UT 84119 801-483-1507</p>	<p>S2 2</p>	<p>DEVELOPER: LEWIS HOMES 5718 NORTH MOORE CREEK DRIVE SALT LAKE CITY, UT 84119 801-483-1507</p>
	<p>COUNTY RECORDER ENTRY NO. 2514184, 2514185 FILED FOR AND RECORDED 9/12/17 BY [Signature]</p>	<p>RECORDING FEE \$1.00 OF OFFICIAL FROM [Signature] COUNTY RECORDER BY [Signature]</p>

81-979

August 5, 2016
Job No. 1661-08N-16

Mr. Eric Householder
Lewis Homes
3718 North Wolf Creek Drive
Eden, Utah 84310

**Re: Mountainside Phase 1 (Western Lots 10 through 17)
Addendum to Engineering Geology Study
The Bridges at Wolf Creek East Phase 1
Parts of Sections 15, 16 and 22 Township 7 North, Range 1 East SLBM
Eden area, Ogden Valley Township, Unincorporated Weber County, Utah
(41.3389 N, 111.8323 W)**

Mr. Householder:

As part of our on-going geological and geotechnical studies for the Bridges at Wolf Creek Master Plan area, a July 25, 2016 Engineering Geology Study report was submitted entitled The Bridges at Wolf Creek East Phase 1. This reporting included only the eastern part (third) of the Master Plan Project, an area of approximately 85 acres that includes the Parkside Phases 1, 2 and 3, and the Mountainside Phases 1, 3 and 4, although our on-going studies continue for the overall Master Plan area.

Inadvertently, the very western lots of the Mountainside Phase 1 (Lots 10 through 17) were not shown as part of the July 25, 2016 reporting, although these lots had been studied as part of the on-going Master Plan studies. While the subject lots are not delineated on our mapping figures included in the July 25 reporting, the area of the subject lots are a part of our on-going analysis and appear on the on the mapping figures summarizing our July 25, 2016 analyses. Attached is a revised Figure 19, Geologic/Natural Hazards Exposure.

Through our previous studies referenced below, the area of western lots on the Mountainside Phase 1 (Lot 10-17) are located almost entirely outside delineated hazard areas (Lot 10 is mapped partially within a landslide hazard area).

July 25, 2016

Engineering Geology Study
The Bridges at Wolf Creek East Phase 1
Parts of Sections 15, 16 and 22 Township 7 North, Range 1 East SLBM
Eden area, Ogden Valley Township, Unincorporated Weber County, Utah
(41.3389 N, 111.8323 W)

GSH Geotechnical, Inc.
473 West 4800 South
Salt Lake City, Utah 84123
Tel: 801.685.9190
www.gshgeo.com

GSH Geotechnical, Inc.
1596 West 2650 South, Suite 107
Ogden, Utah 84401
Tel: 801.393.2012

Exhibit B-Geologic and Geotechnical Reports



Lewis Homes
Job No. 1661-08N-16
Addendum Letter – The Bridges at Wolf Creek
August 5, 2016

April 25, 2016
Preliminary Engineering Geology Study
The Bridges at Wolf Creek Master Plan
Parts of Sections 15, 16 and 22 Township 7 North, Range 1 East SLBM
Eden area, Ogden Valley Township, Unincorporated Weber County, Utah
(41.3389 N, 111.8323 W)

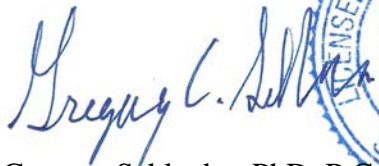
January 21, 2016
Geotechnical Study
The Bridges at Wolf Creek
Northwest of Fairway Drive
Near Eden, Weber County, Utah
(41.3389 N, 111.8323 W)

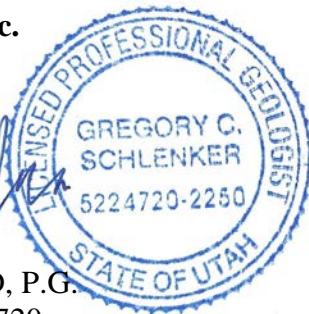
If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 393-2012.


Respectfully submitted,

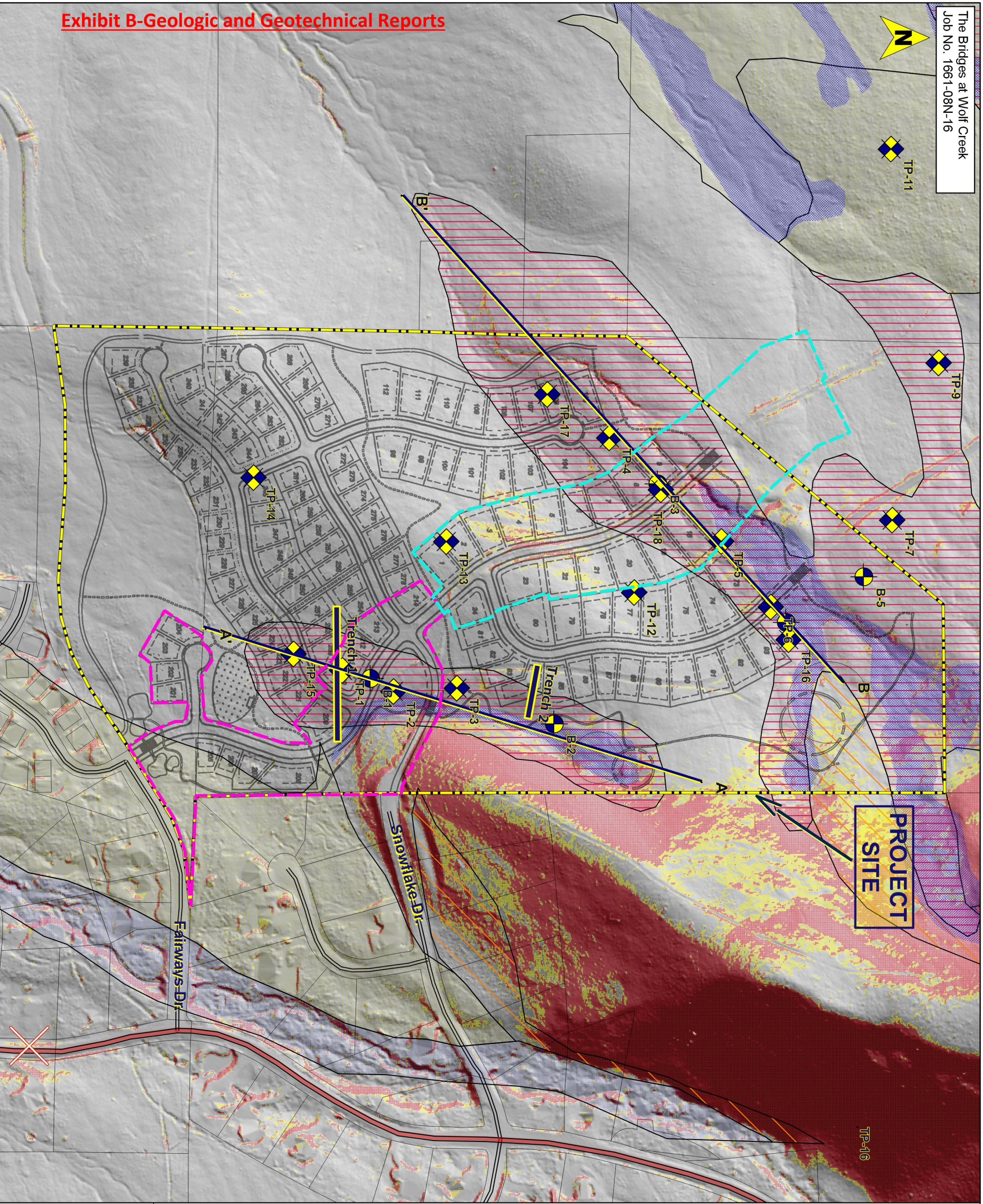
GSH Geotechnical, Inc.

Reviewed by:


Gregory Schlenker PhD, P.G.
State of Utah No. 5224720
Senior Geologist




Andrew M. Harris, P.E.
State of Utah No. 7420456
Senior Geotechnical Engineer



Explanation

- Phase Boundary
- Current Phases 8/3/16
- Mountainside Phase 1
- Parkside Phase 1
- Layout
 - Park Side 1, 2 & 3
 - Mountainside 1, 3, & 4
- SGID10_CADASTRE_Parcels_Weber
- Index contour (10ft)
- Geologic/Natural Hazards**
 - Shallow-Seasonal Groundwater
 - Alluvial Fan - Debris Flow Hazards
 - Landslide - Mass Movement Hazards
 - Alluvial Fan - Debris Flow / Landslide - Mass Movement Hazards (combined)
 - Slope Stability Hazards
 - Flood Zone Hazards
- Steep Slope Areas**
 - 25 to 30 percent
 - 30 percent and greater

Base:
2006 2.0m geoprocessed LIDAR from Utah AGRC;
<http://gis.utah.gov/>

1:3,600



FIGURE 19

**GEOLOGIC/NATURAL
HAZARD EXPOSURE**



**REPORT
ENGINEERING GEOLOGY STUDY
THE BRIDGES AT WOLF CREEK EAST PHASE 1
PARTS OF SECTIONS 15, 16, AND 22 TOWNSHIP 7
NORTH, RANGE 1 EAST SLBM
EDEN, UTAH**

Submitted To:

Lewis Homes
Attention: Mr. Eric Householder
3718 North Wolf Creek Drive
Eden, Utah

Submitted By:

GSH Geotechnical, Inc.
1596 West 2650 South
Ogden, Utah 84401

July 25, 2016

Job No. 1661-08N-16

July 25, 2016
Job No. 1661-08N-16

Mr. Eric Householder
Lewis Homes
3718 North Wolf Creek Drive
Eden, Utah 84310

Re: Engineering Geology Study
The Bridges at Wolf Creek East Phase 1
Parts of Sections 15, 16 and 22 Township 7 North, Range 1 East SLBM
Eden area, Ogden Valley Township, Unincorporated Weber County, Utah
(41.3389 N, 111.8323 W)

1. Introduction

The proposed Bridges at Wolf Creek project (the Project) consists of subdividing and constructing a 357-lot residential subdivision on an approximately 195-acre parcel located northwest of Fairway Drive near Eden, Utah, as shown on Figure 1, Vicinity Map. The present Master Plan concept includes single-family residential lots with utility service and sanitary sewer connections, and associated roadways and pavements. Site development will require a moderate amount of earthwork in the form of site grading. Individual lots will be for single family residences and will be approximately one-quarter acre in size.

A geotechnical engineering study for the Project was completed by GSH Geotechnical Inc., (GSH) on January 21, 2016. The geotechnical study was performed to evaluate the Project site conditions and soils relevant to site development engineering, earthwork and foundation requirements.

During site development review for the Project, Weber County Planning and Engineering staff identified areas of potential geological hazards on the proposed Project area. A meeting was held at the Weber County offices January 29, 2016 to discuss the proposed Project improvements and exposure to potential geological hazards identified during the site development review.

The following individuals were present at the January 29 meeting:

Ronda Kippen (Weber County Planning)
Dana Schuler PE (Weber County Engineering)
Jim Gentry (Weber County Planning)
David Simon PG, (Simon and Associates), Weber County Geological Consultant

GSH Geotechnical, Inc.
473 West 4800 South
Salt Lake City, Utah 84123
Tel: 801.685.9190
www.gshgeo.com

GSH Geotechnical, Inc.
1596 West 2650 South, Suite 107
Ogden, Utah 84401
Tel: 801.393.2012

Lewis Homes
Job No. 1661-08N-16
Geological Report – The Bridges at Wolf Creek
July 25, 2016

Alan Taylor, PE (Taylor Geotechnical) Weber County Geotechnical Engineering Consultant.

Greg Schlenker, PG, (GSH Geotechnical Inc.,) Proponent Geological Consultant.

Andrew Harris, PE, (GSH Geotechnical Inc.,) Proponent Geotechnical Engineering Consultant.

Ryan Christenson, (Gardner Engineering), Proponent Engineering Consultant.

Eric Housholder, (Wolf Creek Bridges Holding Co.) Proponent Project Manager

Because potential geological hazards identified during the development review appeared to impact the proposed Project improvements, and because little is known as to the real potential and severity of the recently identified potential geological hazards, Weber County Staff determined that appropriate studies should be conducted, as stipulated by the requirements of the Weber County Hillside Development Review Procedures and Standards, including Chapter 27, Natural Hazards Overlay District, of the Weber County Zoning Ordinance.

A desktop study including the engineering geology mapping and evaluation for the Project site was conducted by GSH for Lewis Homes on April 22, 2016 (GSH Geotechnical Inc., 2016b). The purpose of the desktop studies was to develop an understanding as to the location, potential and severity of the geological hazards identified on the Project site, and to develop a workable Geologic Hazards scope of work to suffice the Chapter 27, Natural Hazards Overlay District requirements.

On the basis of the findings of the Desktop Studies the following scope of work for this present study was developed for implementation during the Spring of 2016. The desktop studies were conducted for the entirety of the 195-acre area Wolf Creek Master Plan area, however the present Scope of Work and reporting includes only the eastern part (third) of the Project, an area of approximately 85 acres that includes the Parkside Phases 1, 2 and 3, and the Mountainside Phases 1, 3 and 4. The generalized location of these proposed East Phase improvements are shown on Figure 2, Site Plan and Proposed Layout. The Site Plan and Proposed Layout shown on Figure 2 were drawn from a Langvart Design Group drawing titled "Phasing Plan" dated May 31, 2016.

1.1 Scope of Work

The Scope of Work presented for this evaluation includes eastern part of the Project, an area of approximately 85 acres that includes the Parkside Phases 1, 2 and 3, and the Mountainside Phases 1, 3 and 4 (East Phase), as it pertains to the Weber County Chapter 27 Natural Hazards Overlay District Code. Based on the Chapter 27 requirements, GSH has performed the following scope of work for this engineering geology study:

1. **Literature Review:** *A preliminary study and review of published and unpublished geologic and geotechnical information pertinent to the site (both regional and site specific);*

2. **Technical Analysis:** *A review and interpretation of available stereoscopic and oblique aerial photographs, DEMs, LiDAR and GIS data;*
3. **Field Reconnaissance:** *A field reconnaissance study including the geologic/geotechnical logging and geotechnical sampling of two walk-in exploration trenches approximately 420 feet and 143 feet in length and as much as 10 feet in depth, and the geotechnical logging and sampling of 17 walk-in test pits to a depth of as much as 19 feet, and five geotechnical hollow-stem auger borings to 30 to 50 feet in depth (or auger refusal). The locations of our subsurface excavations and borings are shown on Figure 3, Site Evaluation and Engineering Geology;*
4. **Geologic Mapping:** *Site specific geological mapping and classification to identify critical geological units and exposure to proposed site improvements;*
5. **Surface Analysis:** *Surface and slope analysis from LiDAR DEM geoprocessing identifying critical areas 25-percent or greater across the site and/or surficial features potentially affecting the proposed site improvements, and to develop geologic cross sections for our slope stability analysis;*
6. **Soils Laboratory Program:** *A laboratory geotechnical soils testing program of samples recovered from the trenches, test pits and borings for typical and critical geological units explored and identified in our subsurface evaluation. The laboratory testing program to include but not be limited to the moisture, density, gradation, Atterberg limits, consolidation, vane shear, and direct shear tests of representative soil sample; and*
7. **Summary Report:** *Preparation of summary report presenting results of our analysis and findings, and in conjunction with this reporting a concurrent geotechnical slope stability study will be prepared for the subject property based on the findings and analysis of this geologic study.*

2. Site Engineering Geology Analysis

2.1 Literature Review

As part of these preliminary studies existing previous reports and geological literature sources were reviewed. Specific to the site and immediate surrounding area, geotechnical reporting and mapping by our staff GSH Geotechnical Inc. (2016a), and an untitled and undated Site Concept Plan provided by Lewis Homes were reviewed. The 2016 geotechnical study was performed to evaluate the Project site conditions and soils relevant to site development engineering, earthwork and foundation requirements. As part of the 2016 study 33 test pits were excavated and sampled. Geologic mapping and studies pertaining the Project and Ogden Valley area in general, included USGS geological mapping by Sorensen and Crittenden (1979), UGS geological and groundwater reporting by Avery (1994), in-progress UGS mapping by King and McDonald (2014), and recently published mapping by Coogan and King (2016).

2.2 GIS Data Integration and Analysis

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Our GIS data integration effort included reviews of previous mapping and literature pertaining to site geology including Sorensen and Crittenden (1979), in-progress UGS mapping by King and McDonald (2014), and recently published mapping by Coogan and King (2016); an analysis of vertical and stereoscopic aerial photography for the site including a 1946 1:20,000 stereoscopic sequence, a 2014 1.0 meter digital NAIP coverage, and a 2012 5.0 inch digital HRO coverage of the site; and a GIS analysis using the QGIS[®] GIS platform to geoprocess and analyze 2006 2.0 meter LiDAR digital elevation data made available for the site by the Utah Automated Geographic Reference Center (AGRC). The GIS analysis included using the QGIS[®] platform Geospatial Data Abstraction Library (GDAL, 2013) Contour; the GRASS[®] (Geographic Resources Analysis Support System, 2013) r.slope and r.shaded.relief modules.

The following GIS layers have been developed or processed for this analysis:

1. Engineering Geology; vector file developed and modified from geological mapping of King and McDonald, 2014, and reviewed from aerial imagery.
2. Cienega Areas; vector file of groundwater effluent zones identified from referenced aerial imagery.
3. Contour Elevations (2 foot); vector file of elevation contours processed from 2006 2.0 meter LiDAR data.
4. Shaded Relief; raster file of surface relief shading processed from 2006 2.0 meter LiDAR data.
5. Slope Gradient; raster file of surface slope gradients processed from 2006 2.0 meter LiDAR data.
6. Geological/Natural Hazards; vector file of data integrated from the above listed layers and reference data classified according the following areal categories;
 - a. shallow-seasonal groundwater,
 - b. alluvial fan-debris flow hazards,
 - c. landslide-mass movement hazards,
 - d. alluvial fan-debris flow hazards/landslide-mass movement hazards (combined area),
 - e. slope stability hazards,
 - f. flood hazards, and
 - g. steep slopes.

2.3 Field Program

The field program involved the excavation and geological logging of two exploration trenches and 17 test pits and the advancement of five drilled boreholes on the locations shown on Figure 3. GSH conducted preliminary field operations at the site on the dates of March 16 and 17, 2016 completing Test Pits 1 through 11 (no Test Pit 8 was excavated). The primary phase of our field program was conducted from May 6 through May 19, 2016, during which Trenches 1 and 2, Test Pits 12 to 18, and Borings 1 to 5 were completed. The excavations and borings were logged to observe and characterize site subsurface/geologic and groundwater conditions for the site and the proposed

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residential development improvements. Trenches and test pits were located to evaluate the conditions for each of the proposed areas of improvement, and borings were placed on slope locations in order to evaluate geologic subsurface conditions relative to slope stability conditions for the East Phase. The locations of our trenches, test pits and borings are included on Figure 3. The trenches were from 420 and 143 feet in length and extended as deep as 10.0 feet, and the test pits consisted of walk-in excavations, 15.0 to 25.0 feet in length and extended as deep as 19.0 feet. The trenches and test pits were logged so as to illustrate the vertical and lateral characteristics and variations of soil and rock conditions comprising the subsurface across the site. The trenches and test pits were excavated using a 20-ton class excavator with a 36-inch bucket and was refused at depth in many of the excavations as indicated on our field logs. In addition to the observations in the trenches and test pits, the general surface of the site and surrounding area was reconnoitered to assess geological and slope conditions. Feature locations and elevation data were recorded using a hand-held GPS receiver device.

Our field program was conducted by Senior Engineering Geologist Dr. Greg Schlenker, PG of our geotechnical staff. Mr. Amos Allard, Staff Geologist also of our geotechnical staff visited the site to assist Dr. Schlenker and to collect soil samples from the trenches test pits for laboratory geotechnical testing. Mr. Allard also supervised drilling operations for the Geotechnical Borings.

The soils and geology in the trenches, test pits and borings were classified in the field based upon visual and textural examination, and interpretation of geologic site formation processes. These classifications have been supplemented by subsequent inspection and testing in our laboratory, and the results are included in our geotechnical study. Detailed graphical representations of the subsurface conditions encountered are presented on Figure 4 through Figure 8, Log of Trenches, Figure 9 through Figure 17, Log of Test Pits, and our Boring Logs of the five borings are included in the Appendix A of this report. It should be noted that no Log for Test Pit 8 is presented as this location was eliminated at the time of our preliminary field program. The soil and rock units observed in the trenches and test pits were classified in accordance with the Unified Soil Classification System (USCS), and were further classified on the basis of geological site formation processes.

Bulk and thin wall samples of representative soil layers encountered in the trenches and test pits were obtained and placed in sealable bags and/or were recovered undisturbed using driven sample tubes. The locations of the sample recovery locations are included on our trench and test pit logs. The results of our laboratory analysis and testing of the soils recovered from the test pits are included in our accompanying geotechnical report. Groundwater was observed and recorded in several of the excavations or test pits during the dates of our field program. Piezometers were placed in all the test pits and borings except Test Pit 10 and 12.

The logs of the five borings shown at the locations on Figure 3, are include in Appendix A of this report. These borings were made as part of our concurrent geotechnical study

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and included in this reporting, were supplemental for the development of our Geologic Slope Cross Sections *A-A'* and *B-B'* on Figures 20 and 21. The borings were completed using a CME 55 truck-mounted drill rig using hollow-stem auger/rotary wash equipment and methods. Soil and rock samples were recovered at 2.5-foot intervals using driven 2.42-inch inside diameter drive Dames & Moore sampler. The borings were also logged in accordance with the Unified Soil Classification System (USCS).

2.3 LiDAR - Slope Analysis

To assess slope conditions, interpret terrain, and develop site specific geologic cross sections for the site, a LiDAR-Slope Analysis was performed for the site. Elevation data consisting of 2.0 meter LiDAR digital elevation data (DEM) for the site was obtained from Utah Automated Geographic Reference Center (AGRC). These data were geoprocessed using the QGIS® GIS platform. Using the *r.slope*, *r.shaded.relief* and *r.contour.level* GRASS® (Geographic Resources Analysis Support System) modules, slope percentages, relief renderings and elevation contours for the site area were processed.

Figure 18, LiDAR-Slope Analysis, presents the results of our slope analysis efforts. Shown on Figure 18, is the 25-percent, and greater than 30-percent slope gradients across the site. The shaded relief rendering on Figure 18 also provides a visual basis for landform interpretation, and the contour elevation data shown on Figure 18 is used to develop the cross sections shown on Figures 20 and 21, Geologic Slope Cross Sections *A-A'* and *B-B'*. The critical gradient for slope development considerations according to the Weber County Section 108-14-3, 108-14-7, 108-14-8, and 108-14-12 includes slopes greater than 25-percent (Weber County Code, 2016). The Geologic Slope Cross Sections shown on Figure 20 and 21 will be used for modeling slope stability analysis in our geotechnical reporting.

3. SITE CONDITIONS

The site conditions and site engineering geology were interpreted through an integrated compilation of data including a review of literature and mapping from previous studies conducted in the area (Sorensen and Crittenden, 1979; Currey and Oviatt, 1985; Bryant, 1988; Coogan and King, 2001; King and McDonald, 2014; and Coogan and King, 2016), photogeologic analyses of 2012 and 2014 imagery shown on Figure 2, and historical stereoscopic imagery flown in 1946. GIS analyses of elevation and geoprocessed DEM terrain data as discussed in the previous section and shown on Figure 18. Seismic hazards information was developed from United States Geologic Survey (USGS) databases (Peterson, et al., 2008).

3.3 Surface

A surface reconnaissance of the site was conducted on March 16 and 17 and May 6 through May 19 of this year. As shown on Figure 1 and Figure 2, the East Phase consists of an area of approximately 85 acres that is currently vacant and undeveloped. Surface

vegetation consists of open areas of grasses, weeds and sage brush, with wooded cover of scrub oak, alder and maple trees occupying slopes on the south side of the site, and cottonwood and willows occupying the riparian zones of the site. The topography of the site consists of a "piedmont" (valley-margin) slope, which is an intermediate slope surface between the mountains and the valley bottom. The elevation of the site is between 5,296 feet on the very southwest of the property and 5,700 feet on the northeast of the property. This piedmont slope is located at the base of 7,000 foot high ridgelines that buttress James Peak which rises to 9,424 feet, approximately 4 miles northeast of the site. The floodplain of the North Fork of the Ogden River forms the lowest elevations in the site vicinity with elevations on the order of 5,060 feet to 5,100 feet along the grade of the river approximately 1/3-mile west of the site. Wolf Creek is a through-flowing perennial stream that drains from the James Peak area on the north, and passes the site near the eastern boundary. Two unnamed, apparently ephemeral, drainages cross the site from northeast to southwest. An array of cienegas occurs along the piedmont slope surface where emergent groundwater appears to intercept the ground surface along the mountain front. A sewer line for the service of Powder Mountain Resort, located approximately 3.5 miles northeast of the site, crosses the northeast corner of the Project and terminates at a lagoon system approximately 4500 feet northwest of the East Phase site. The East Phase site, as shown on Figure 2, is bordered on the south and west by vacant and residential land uses, and on the north and east by steeply sloped unimproved ground. State Road SR-158, locally known as Powder Mountain Road, passes the East Phase site on the east along Wolf Creek.

3.4 Geologic Setting

The site is located in Ogden Valley on the southwestern flank of James Peak. The valley is a northwest trending fault bounded graben structure, with the Wasatch Range comprising the western flank of the valley and the Bear River Range the eastern flank (Avery, 1995). The western boundary of the Wasatch Range (Wasatch Front) is marked by the Wasatch fault, approximately 5.5 miles west of the site, and provides the basis of division between the Middle Rocky Mountain Physiographic Province on the east and the Basin and Range Physiographic Province on the west. The Basin and Range Physiographic Province is characterized by approximately north-south trending valleys and mountain ranges that have been formed by extensional tectonics and displacement along normal faults, and extends from the Wasatch Range on the east to the Sierra Nevada Range on the west (Hunt, 1967).

The Middle Rocky Mountain province covers parts of Utah, Colorado, Wyoming, Idaho, and Montana. The geology of the province is an assemblage of sedimentary, igneous, and metamorphic rocks that have been folded, faulted, and uplifted. Mountain building (tectonic) activity commenced about 30 million years ago (Cretaceous time) and continues to the present. The province is characterized by mountainous terrain with deep canyons and broad intervening basins, with temperate semi-arid to mesic climatic conditions (Hunt, 1967).

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The surficial geology of the site vicinity is the result of the uplift and exposure of older pre-Cambrian rocks which forms the crests of Lewis Peak (8,031 feet) west of the valley and James Peak on the east. This exposure was the result of movement along locally high-angle faults during late Tertiary and Quaternary age (Bryant, 1988). The older Precambrian rocks that underlie the site are parts of eastward thrust plates including the Willard thrust sheet, which is believed to have moved onto the vicinity during the Cretaceous Sevier orogeny, approximately 140 million years ago. The older Precambrian rocks have since been exposed by uplift along the valley bounding faults that has been occurring over the past 10 million years.

During the most recent stage of geologic time, the Quaternary Period, including the past one million years, permanent (year-round) ice and glaciers have periodically occupied the higher elevation summits surrounding the site, and waters of Lake Bonneville have risen to within a few feet of the site approximately 15,000 years ago (Currey and Oviatt, 1985).

The site location occupies a piedmont surface that is believed to be largely underlain by eroded Precambrian rocks (Sorensen and Crittenden, 1979), Quaternary age valley-fill sediments (Avery, 1994), and mantled on the surface with Quaternary age soils placed by alluvial and mass movement processes and modified by erosion and soil development processes (King and McDonald, 2014; Coogan and King, 2016).

3.5 Site Engineering Geology

The previous existing 1:24,000 scale mapping of the site was prepared by US Geological Survey geologist in 1979 (Sorensen and Crittenden, 1979), wherein the 1979 mapping focused on the distribution of bedrock formation contacts and geologic structure of the area. More recent mapping efforts by Utah Geological Survey (UGS) geologist, Coogan and King, (2001, 2016), and King and McDonald (2014) has included mapping that is more inclusive of the surficial Quaternary soils that are more indicative of engineering geology conditions and hazard processes. The King and McDonald (2014) mapping is a 1:24,000 scale U.S. Geological Survey quadrangle based effort that is currently distributed as an "In-Progress Document" subject to review and revision.

Our interpretation of the site engineering geology is presented on Figure 3 Site Evaluation and Engineering Geology. The engineering geologic mapping shown on Figure 4 is largely based on previous mapping prepared by King and McDonald (2014), with amendments to the mapping drawn herein on the basis of the findings of this study. A summary of the mapping units identified on/or in the vicinity of the East Phase are listed below in relative or inferred age sequence (youngest-top to oldest bottom):

- Af1** - Alluvial-fan deposits, younger-active (Holocene)
- Qaf?** - Alluvial-fan deposits, undivided (Holocene and Pleistocene)
- Qafy** - Younger alluvial-fan deposits (Holocene and uppermost Pleistocene)
- Qaf2, Qafp?, Qafb?, Qafo?** - Older alluvial-fan deposits (upper and middle (?) Pleistocene)

- Qafoe?** - Eroded old alluvial-fan deposits (middle and lower Pleistocene)
- Qac** - Alluvium and colluvium (Holocene and Pleistocene)
- Qacg, Qacg?** - Gravelly alluvium and colluvium deposits (Holocene and Pleistocene)
- Qc** - Colluvium (Holocene and Pleistocene)
- Qcg** - Gravelly colluvial deposits (Holocene and Pleistocene)
- Qms** - Landslide and slump deposits (Holocene and Pleistocene)
- Qmc** - Landslide and slump, and colluvial deposits, undivided (Holocene and Pleistocene)
- Qmdfp?** - Debris- and mud-flow deposits (Holocene and Pleistocene)
- Zkc** - Kelly Canyon Formation, Siltstone-quartzite
- Zmcc** - Maple Canyon Formation; **Zmcc1** - lower conglomerate member; **Zmcc2** - argillite; **Zmcc3?** - quartzite conglomerate.

The engineering geology mapping included the delineation of **Cienega Areas** on the site. The significance of the cienega areas is that these are areas of groundwater emergence, with affect of shallow groundwater limiting site development, and the affect of groundwater reducing soil strength of the site slopes.

Site slopes and terrain conditions are presented on Figure 18, LiDAR-Slope Analysis. The elevation contours and site slope gradients on Figure 18 were developed from our LiDAR analysis. Surface gradients were found to range from level to over 65-percent as shown on Figure 18. For the site area, the slope gradient averaged 15.6-percent, with areas both above and below the average as shown on Figure 18. As previously mentioned in Section 2.3 of this report, the critical slope gradient for site development considerations according to the Weber County Code is 25-percent or greater. The terrain features illustrated by the relief shading on Figure 18, assisted in the interpretation and/or confirmation of the engineering geology units presented in Figure 3.

3.6 Subsurface Observations Trenches and Test Pits

The soils encountered in the trenches consisted of a complex sequence of clays (CL) silty clays (CL), clayey silts (ML), silts (ML), and sandy silts (ML) , with varying percentages of matrix-supported sub-angular and angular cobble and boulder (oversized) clast. Bedrock was not encountered in any of the trenches or test pits excavated on the East Phase site. Bedrock was however is believed to have been encountered by auger refusal at depth in Boring 1 at 45 feet and Boring 2 at 33 feet. The soils encountered in the trenches and test pits included residual and colluvial deposits, landslide and slope creep deposits, debris flow deposits, and overbank flood deposits.

The soils interpreted to have undergone landslide movement showed soft to medium-stiff consistencies, with rotated over sized clasts, and coloration from oxidation (Fe-iron staining) and reduction (gleization) oxides, and/or mottled coloration from both processes. Higher moisture conditions were generally found in the landslide soil deposits. Landslide and slope creep deposit soils were observed in Trench 1 and 2, Test Pits 1, 2, 3, 4, 5, 6, 7, 9, 15, 16, 17 and 18, and Borings 1 through 5.

The residual and colluvial soil deposits encountered on the site were observed in similar context with the landslide deposits except that these deposits were stiff to very stiff in consistency, and not as strongly colored in response to oxidation and reduction processes. The residual and colluvial deposit soils were observed in Trench 1 and 2, and Test Pits 2, 3, 12, 13, 14 and 15.

The debris flow deposits consisted of sandy clays (CL), and clayey gravels (GC) with clast supported matrices, and significantly higher percentages of sand. Diagnostic pin-hole structures were observed in the sandy clay soils (CL) classified as debris flow deposits. Debris flow deposit soils were observed in Trench 1, Test Pits 10 and 11.

The silty clay (CL) alluvial overbank deposits consisted of massive medium-stiff clay deposits. The Alluvial overbank deposit soils were observed in the west part of Trench 1

Topsoil A horizons observed on the surface of the borings, trenches, and test pits consisted of clayey silts, silts and sandy silts (ML), dark brown in color with herb roots extending 6-inches to a foot below the surface.

3.7 Subsurface Observations Borings

As part of our exploration program five soil borings were drilled on the site at the locations shown on Figure 3. Borings were located in conjunction with proposed site improvements and mapped landslide locations. The borings were drilled between May 4 and May 20 of this year. The borings were completed using a CME 55 drill rig using hollow-stem auger and rotary wash equipment and methods. Soil samples were recovered at 2.5-foot intervals using driven 2.42-inch inside diameter drive Dames & Moore sampler. Recovered samples were returned to our laboratory for testing, and the results of these tests will be included in our concurrent geotechnical report.

The conditions encountered in borings consisted of stiff, very stiff, and hard clays (CL) with traces to some fine and coarse gravels, cobbles, and boulders. Layers of clayey gravels (GC) were encountered between 10 and 17 feet in depth in Boring 4, and 25 and 27 feet in depth in Boring 5. Boring 1 was refused at 45.0 feet, Boring 2 was refused at 33.0 feet, Boring 3 was refused at 41.5 feet, Boring 3 was refused at 36.5 feet, and Boring 5 was refused at 41.5 feet. Each of the borings were completed with slotted PVC to the depths penetrated and backfilled with auger cuttings. Groundwater was encountered about 5.0 to 10.0 feet within the borings at the time of drilling.

3.7 Groundwater

Soil groundwater conditions were recorded in the excavations at the time of our field programs in March and May of 2016. Slotted PVC piezometers were placed in most of the Test Pits and Trench 2, and all of the borings.

Exhibit B-Geologic and Geotechnical Reports

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Stabilized water levels were measured within the installed piezometers on July 1, 2016 and are summarized on the following page.

Location	Level Below Surface (ft) on 5/4/16 to 5/9/16	Level Below Surface (ft) on 7/1/16	Comments
Test Pit 1	1.0	5.6	Piezometer
Test Pit 2	2.5	7.7	Piezometer
Test Pit 3	0.0	0.0	Piezometer...water at surface
Test Pit 4	4.0	Pipe Damaged	Piezometer
Test Pit 5	Not encountered	Not encountered	Piezometer...dry to 14.0 feet
Test Pit 6	3.0	4.7	Piezometer
Test Pit 7		Not encountered	Piezometer...dry to 12.5 feet
Test Pit 9	3.0	7.6	Piezometer
Test Pit 11	Not encountered	Not encountered	Piezometer...dry to 9.0 feet
Test Pit 13	Not encountered	Not encountered	Piezometer... dry to 11.7 feet
Test Pit 14	10.0	5/9/16	Vadose water entering test pit
Test Pit 15	Not encountered	Not encountered	Piezometer... dry to 9.5 feet
Test Pit 16	Not encountered	7.5	Piezometer
Test Pit 17	Not encountered	Pipe Damaged	Piezometer
Test Pit 18	Not encountered	8.0	Piezometer
Trench 2 STA 05	5.0	Not encountered	Observed in trench
Boring 1	5.0	5.6	Encountered during drilling
Boring 2	5.0	3.2	Encountered during drilling

Boring 3	5.0	5.5	Encountered during drilling
Boring 4	7.5	7.3	Encountered during drilling
Boring 5	5.0	10.5	Encountered during drilling

4. DISCUSSIONS AND RECOMMENDATIONS

4.1. Site Specific Geologic/Natural Hazards

On the basis of our literature reviews, site engineering geology mapping, subsurface exploration and slope and terrain mapping we have prepared a Geologic/Natural Hazards Exposure map for the East Phase site, as shown on Figure 19, Geologic/Natural Hazard Exposure. This map has been classified for the delineation of potential geologic or natural hazards impacting the site, including; a) shallow-seasonal groundwater, b) alluvial fan-debris flow hazards, c) landslide-mass movement hazards, d) alluvial fan-debris flow hazards/landslide-mass movement hazards (combined area), e) slope stability hazards, f) flood hazards, and g) steep slopes.

4.1.1 Shallow-Seasonal Groundwater, Hazards or conditions include the mapped Cienega Areas as shown on Figure 3, where groundwater emerges to the surface. These areas were identified through the aerial photography analysis and site reconnaissance. The affect of shallow groundwater presents limitations for site development, and will also affect the soil strength and mass of site slopes, and can negatively affect slope stability.

4.1.2 Alluvial Fan-Debris Flow Hazards, Hazards or conditions include debris flows and clear-water flooding that are systemic processes that occur on active alluvial fan surfaces. Debris-flow hazards involve the rapid downslope movement of hyper-concentrated sediments in response to intense rainfall and/or snowmelt events. The debris-flow sediments typically originate in steep drainage basins, and move downslope as a concentrated and confined flow. After the flow passes through the originating canyon mouth, beyond the steep and confining limits of the drainage basin onto an open valley floor, the flow will slow and come to a rest, forming an alluvial fan deposit (Giraud, 2005). Over time successive debris-flow and/or alluvial fan events will construct significantly large alluvial fan systems at the mouths of the contributing canyons or drainage basins.

Clear-water flood, without debris, can also occur on alluvial fan surfaces in response to meteorological/snowmelt events.

Alluvial Fan-Debris Flow Hazard areas shown on Figure 19 include engineering geology units mapped as **Af1, Qaf?, and Qafy** on Figure 3. Older alluvial fan deposits mapped as **Qaf2, Qafp?, Qafb?, Qafo?, and Qafoe?** on Figure 3, are believed to have been formed by alluvial fan debris-flow processes, but are believed to not presently be subject to those process activities.

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4.1.3 Landslide-Mass Movement Hazards, are the downslope movement of a mass of soil, surficial deposits or bedrock, that includes a continuum of processes between landslides, earth-flows, debris flows and debris avalanches, and rock falls. Landslide hazards are identified where terrain features such as; head scarps (main scarps), minor scarps, transverse cracks and ridges, hummocky surfaces and toe development are observed (Varnes, 1978).

The Landslide-Mass Movement Hazard areas shown on Figure 19 include engineering geology units mapped as **Qms** on Figure 3. The locations of the landslide deposits on the East Phase area appear to correlate to areas downslope of Maple Canyon Formation argillite beds mapped as **Zmcc2** on Figure 3.

For the East Phase site the areas of landsliding include two areas, an eastern slide area near the eastern boundary of the site where Snowflake drive accesses the site, and a northwestern slide area clustered along the axis of the unnamed northeast to southwest drainage that emerges from the Cienega on the northeast corner of the site. Both of these landslide areas display complex combined earth-flow/soil creep morphology (Varnes, 1978), that has occurred on relatively low gradient slopes. These landslide deposits appear to be relatively shallow (extending about 30 to 45 feet below existing site grades) in context to the areal distribution of the deposits.

4.1.4 Alluvial Fan-Debris Flow Hazards/Landslide-Mass Movement Hazards (combined area) shown on Figure 19, include areas on Figure 3 where both these hazard conditions are present.

4.1.5 Slope Stability Hazards Although evidence of active landslide movement is not apparent, areas on the site covered with soils that are inherently weak and/or expansive, or consisting of older landslide deposits, may become unstable upon implementation of site grading and/or improvements. The areas classified on Figure 19 as Slope Stability Hazards, and include areas mapped on Figure 3 as **Qmc** and **Qmso**.

4.1.6 Flood Hazards shown on Figure 19 include areas on or near the East Phase where alluvial stream deposition along Wolf Creek has occurred in response to overbank stream flows. These include areas mapped as **Qac** on Figure 3.

The FEMA 100-year flood hazard zone as delimited by recent FEMA studies conducted in the Ogden Valley and Wolf Creek area fall within the **Qac** unit shown on Figure 3 (FEMA 2015). On the basis of the FEMA determination *...mandatory flood insurance purchase requirements and floodplain management standards apply...* for improvements made in the 100-year flood hazard zone, however the entirety of the East Phase site is **Qac** area shown on Figure 19.

4.1.7 Steep Slopes Steep slope conditions present difficulty in maintaining and controlling slope stability and runoff when improvements such as grading are made in these areas. By rule Weber County limits site development improvements on slopes 25-

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percent grade or steeper. Rules or limits that apply to improvements are included Weber County code Sections 108-14-3, 108-14-7, 108-14-8 , and 108-14-12 (Weber County Code, 2016). The areas shown on Figure 19 as Steep Slopes, include slopes identified through our LiDAR analysis and shown on Figure18.

4.1.8 Geoseismic Setting: Utah municipalities have adopted the International Building Code (IBC) 2012. The IBC 2012 code determines the seismic hazard for a site based upon 2008 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class (Peterson, et al., 2008). The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

Based on probabilistic estimates (Peterson, et al., 2008) queried for the site , the expected peak horizontal ground acceleration on rock from a large earthquake with a ten-percent probability of exceedance in 50 years is as high as 0.17g, and for a two-percent probability of exceedance in 50 years is as high as 0.37g for the site. Ground accelerations greater than these are possible but will have a lower probability of occurrence.

4.1.9 Active Earthquake Faults: Based upon our review of available literature, no active faults are known to pass through or immediately adjacent to the site. The nearest active (Holocene) fault is the Weber Segment of the Wasatch fault, located 5.5 miles west of the site (Black et al., 2004). The Wasatch Fault Zone is considered capable of generating earthquakes as large as magnitude 7.3 (Arabasz, et al., 1992). An older Quaternary aged fault, the Ogden Valley northeastern margin fault ends approximately 0.7 miles east of the site (Black et al., 2004). This older fault is not expected to move during the design life of the project.

4.1.10 Liquefaction Potential Hazards: In conjunction with the ground shaking potential of large magnitude seismic events as discussed previously, certain soil units may also possess a potential for liquefaction during a large magnitude event. Liquefaction is a phenomenon whereby loose, saturated, granular soil units lose a significant portion of their shear strength due to excess pore water pressure buildup resulting from dynamic loading, such as that caused by an earthquake. Among other effects, liquefaction can result in densification of such deposits causing settlements of overlying layers after an earthquake as excess pore water pressures are dissipated. Horizontally continuous liquefied layers may also have a potential to spread laterally where sufficient slope or free-face conditions exist. The primary factors affecting liquefaction potential of a soil deposit are: (1) magnitude and duration of seismic ground motions; (2) soil type and consistency; and (3) occurrence and depth to groundwater.

No area-wide liquefaction potential studies have been conducted for the Ogden Valley area, thus this potential hazard has not been mapped in the East Phase vicinity. Because liquefaction commonly occurs in saturated non-cohesive soils such as alluvium, areas of the East Phase vicinity mapped as **Qac** should be considered susceptible to liquefaction processes.

4.1.11 Rockfall and Avalanche Hazards: Rockfall and avalanche hazards were not identified on the East Phase during this desk top study. The East Phase boundary appears to be located an adequate distance from the steep slope areas northeast of the site where such hazards may originate.

4.1.12 Radon Exposure: Radon is a naturally occurring radioactive gas that has no smell, taste, or color, and comes from the natural decay of uranium that is found in nearly all rock and soil. Radon has been found occur in the Ogden Valley area, and can be a hazard in buildings because the gas collects in enclosed spaces. Indoor testing following construction to detect and determine radon hazard exposure should be conducted to determine if radon reduction measures are necessary for new construction. The radon-hazard potential is mapped as "Moderate" for parts of the East Phase site included in studies by the UGS (Solomon, 1996). For new structures radon-resistant construction techniques as provided by the EPA (EPA 2016) should be considered.

5. Hazard Exposure and Mitigation

Hazards exposure for the East Phase of the Bridges at Wolf Creek is shown on Figure 19, and includes Shallow-Seasonal Groundwater areas (**Cienega**), Landslide-Mass Movement Hazard areas (**Qms**), and Alluvial Fan - Debris Flow Hazard areas (**Qafy**).

The two landslide areas described herein are complex combined earth-flow/soil creep features that have occurred on relatively low gradient slopes, and appear to be relatively shallow in thickness. Apparent from the mapping on Figure 19, is the areal relationship between Shallow-Seasonal Groundwater areas Landslide-Mass Movement Hazard areas. The location of the Shallow-Seasonal Groundwater areas over Landslide-Mass Movement Hazard areas indicates a systemic relationship between these two phenomena. As previously mentioned, the Landslide-Mass Movement Hazard areas appear to correlate to areas downslope of Maple Canyon Formation argillite beds mapped as **Zmcc2** on Figure 3. The emergence of the ground water on the surface on the same areas suggest the argillite beds may also controlling factor for the location of the groundwater emergence. The occurrence of the Shallow-Seasonal Groundwater on the Landslide-Mass Movement Hazard areas is believed to have a negative effect on the soil strength and stability of these soils, thus the removal of the water in these areas is believed to be a possible strategic measure for attaining stability in these areas.

The Weber County Natural Hazards Overlay Sec. 104-27-2 - Potential hazards section, provides the following guidance for landslide hazard reduction:

Many methods have been developed for reducing landslide hazards. Proper planning and avoidance is the least expensive measure, if landslide-prone areas

are identified early in the planning and development process. Care in site grading with proper compaction of fills and engineering of cut slopes is a necessary follow-up to good land use planning. Where avoidance is not feasible, various engineering techniques are available to stabilize slopes, including de-watering (draining), retaining structures, piles, bridging, weighting or buttressing slopes with compacted earth fills and drainage diversion. Since every landslide and unstable slope has differing characteristics, any development proposed within a designated landslide hazard area...shall require the submittal, review and approval by the planning commission, of specific site studies, including grading plans, cut/fill, and plans produced by a qualified engineering geologist and a Utah licensed geotechnical engineer. The site specific study shall address slope stability (including natural or proposed cut slopes), evaluate slope-failure potential, effects of development and recommendations for mitigative measures. Slope stability analysis shall include potential for movement under static, development-induced and earthquake-induced conditions as well as likely groundwater conditions.

These guidelines should be considered a basis for landslide hazards reductions where proposed improvements are exposed to landslide hazards as shown on Figure 19.

Debris Flow Hazard areas (Qafy) are shown on Figure 19 to occur on the very southeast side of the East Phase site. These Younger Alluvial Fan Deposits (Holocene and Pleistocene) (**Qafy**), occur adjacent to the active floodplain deposits along the Wolf Creek channel. The Debris Flow Hazard area defined by the **Qafy** deposits is potentially exposed to both debris flows and clear-water flooding should Wolf Creek avulse during a future flood event. It is our understanding that no flood control or significant diversion structures on Wolf Creek exist upstream from the East Phase site, thus these hazards exist under the present conditions.

The area exposed to the debris flow hazards includes four residential development lots on the very southeast side of the East Phase, however the source of the hazard (Wolf Creek) is located off site, and is thus not feasible for hazard modification remediation. Therefore modifying what is at risk may be the only feasible approach to protect the improvements proposed for this area. Risk modification may include disclosure that exposed properties are subject to the potential debris-flow/flood hazards, and prescribed site specific grading and structural measures taken to reduce the potential impact of the hazards to the proposed improvements, which may include building setbacks, deflection berms, minimum finished floor elevations, limits to basement locations, and/or limits to door/window openings in basements.

6. CONCLUSIONS

The East Phase site is located on a piedmont surface that is essentially the transition zone between the mountains and the valley bottom, where exposure to potential geologic and natural hazards may exist. Based upon our geological studies herein, we believe that the

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July 25, 2016



proposed Bridges at Wolf Creek East Phase site is suitable for development. This conclusion assumes that remedial measures will be made for improvements that may be exposed to the hazard areas identified on Figure 19 and discussed in Section 4.1 of this report.

Remedial hazard risk reduction measures will need to be implemented where improvements will be exposed or potentially exposed to the hazard processes. These areas are shown on Figure 19, however more detailed and specific studies in-grading circumstances may find conditions different than presented on Figure 19. Hazard reduction measures may include site engineering measures to contain, deflect, drain or stabilize these processes, and/or include site development planning to avoid exposure to the hazards.

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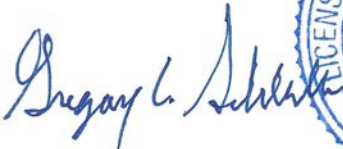
CLOSURE

If you have any questions or would like to discuss the results of this study further, please feel free to contact us at (801) 393 2012..


Respectfully submitted,

GSH Geotechnical, Inc.

Reviewed by:



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- Encl. Figure 1, Site Vicinity Map
 - Figure 2, Site Plan and Proposed Layout
 - Figure 3, Site Evaluation and Engineering Geology
 - Figure 4, Trench 1 STA 00 to 140 West
 - Figure 5, Trench 1 STA 140 to 280 West
 - Figure 6, Trench 1 STA 280 to 420 West
 - Figure 7, Trench 2 STA 00 to 70 West
 - Figure 8, Trench 2 STA 70 to 143 West
 - Figure 9, Log of Test Pit 1 and Test Pit 2
 - Figure 10, Log of Test Pit 3 and Test Pit 4
 - Figure 11, Log of Test Pit 5 and Test Pit 6
 - Figure 12, Log of Test Pit 7 and Test Pit 9
 - Figure 13, Log of Test Pit 10 and Test Pit 11
 - Figure 14, Log of Test Pit 12 and Test Pit 13
 - Figure 15, Log of Test Pit 14 and Test Pit 15
 - Figure 16, Log of Test Pit 16 and Test Pit 17
 - Figure 17, Log of Test Pit 18
 - Figure 18, LiDAR-Slope Analysis
 - Figure 19, Geologic/Natural Hazard Exposure
 - Figure 20, Geologic Cross Section A-A'
 - Figure 21, Geologic Cross Section B-B'
- Appendix A Boring Logs
Key to Boring Logs

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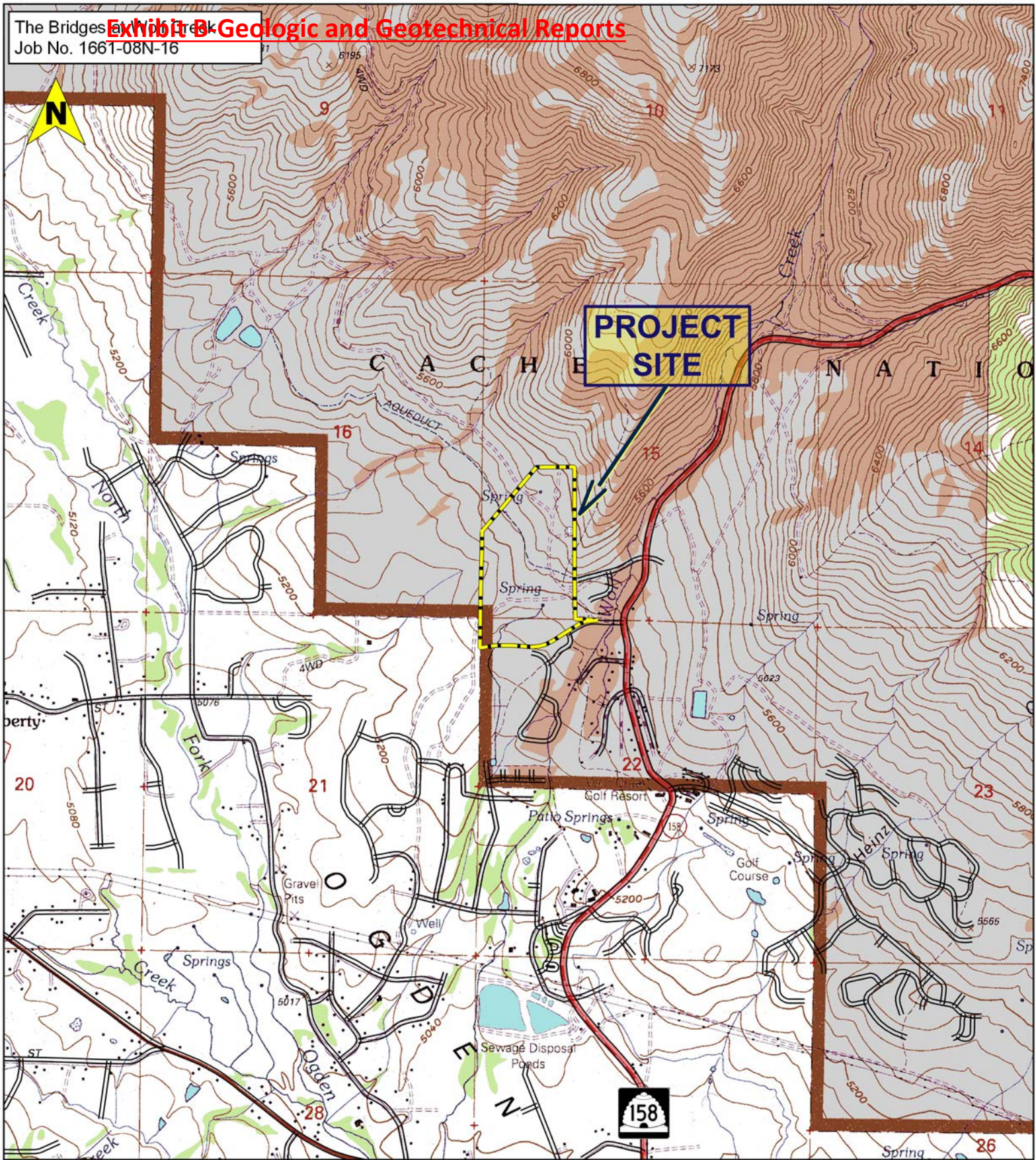
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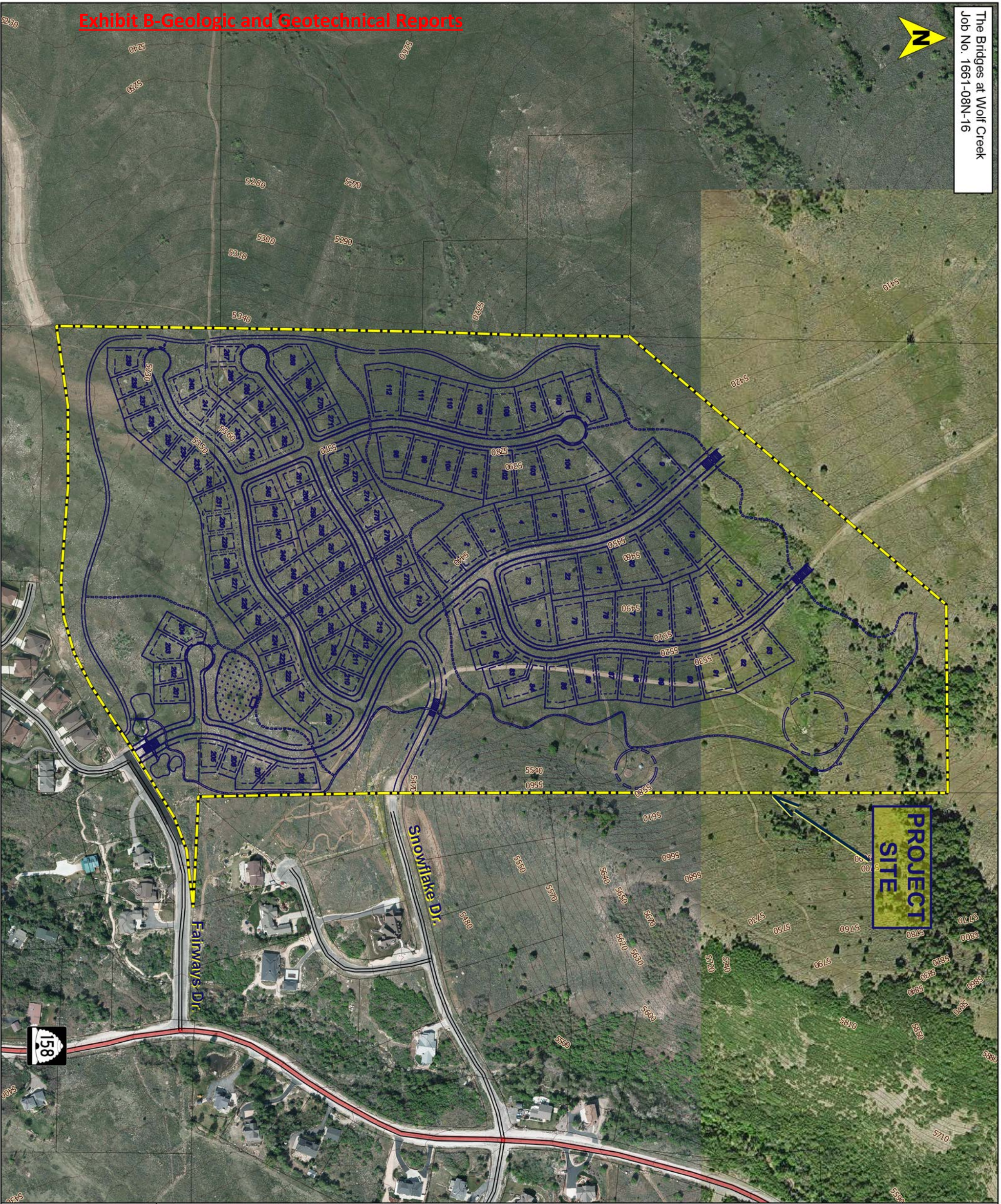
Base: 1998 7.5 Minute USGS Topographic Map
Titled Huntsville, Utah.

**FIGURE 1
VICINITY MAP**









1:24,000





PROJECT SITE

Explanation

-  Phase Boundary
-  Layout
-  Park Side 1, 2 & 3
-  Mountainside 1, 3, & 4
-  Index Contour (10ft)
-  SGID10_CADASTRE_Parcels_Weber

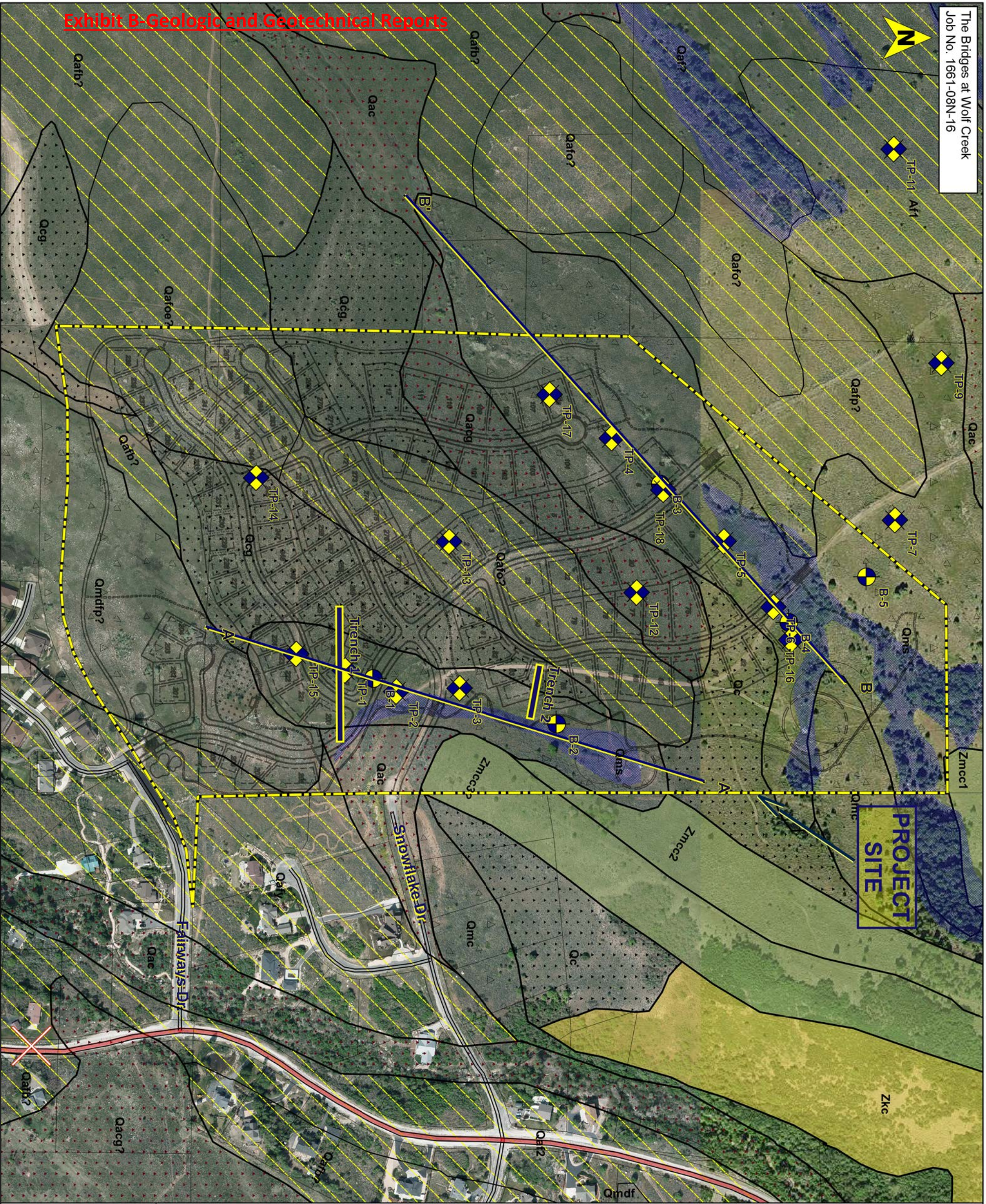
1:3,600

Base:
2012 5.0 inch Color HRO Orthoimagery, and 2014 1.0 m
NAIP Orthoimagery, from Utah AGRC; <http://gis.utah.gov/>

FIGURE 2

**SITE PLAN AND
PROPOSED LAYOUT**





PROJECT SITE

Explanation

- Phase Boundary
- Test Pit Locations
- Boring Locations
- Trench Locations
- Slope Cross Section Locations
- Cienega Areas
- Engineering Geology
- (modified from Coogan and King 2016; King and McDonald, 2014; and Sorensen and Crittenden, 1979)
- Af1 - Alluvial-fan deposits, younger-active (Holocene)
- Qaf? - Alluvial-fan deposits, undivided (Holocene and Pleistocene)
- Qafy - Younger alluvial-fan deposits (Holocene and uppermost Pleistocene)
- Qaf2, Qaf3, Qaf4, Qaf5, Qaf6, Qaf7, Qaf8, Qaf9, Qaf10, Qaf11, Qaf12, Qaf13, Qaf14, Qaf15, Qaf16, Qaf17, Qaf18, Qaf19, Qaf20, Qaf21, Qaf22, Qaf23, Qaf24, Qaf25, Qaf26, Qaf27, Qaf28, Qaf29, Qaf30, Qaf31, Qaf32, Qaf33, Qaf34, Qaf35, Qaf36, Qaf37, Qaf38, Qaf39, Qaf40, Qaf41, Qaf42, Qaf43, Qaf44, Qaf45, Qaf46, Qaf47, Qaf48, Qaf49, Qaf50, Qaf51, Qaf52, Qaf53, Qaf54, Qaf55, Qaf56, Qaf57, Qaf58, Qaf59, Qaf60, Qaf61, Qaf62, Qaf63, Qaf64, Qaf65, Qaf66, Qaf67, Qaf68, Qaf69, Qaf70, Qaf71, Qaf72, Qaf73, Qaf74, Qaf75, Qaf76, Qaf77, Qaf78, Qaf79, Qaf80, Qaf81, Qaf82, Qaf83, Qaf84, Qaf85, Qaf86, Qaf87, Qaf88, Qaf89, Qaf90, Qaf91, Qaf92, Qaf93, Qaf94, Qaf95, Qaf96, Qaf97, Qaf98, Qaf99, Qaf100 - Older alluvial-fan deposits (upper and middle(?) Pleistocene)
- Qaf0e? - Eroded old alluvial-fan deposits (middle and lower Pleistocene)
- Qac - Alluvium and colluvium (Holocene and Pleistocene)
- Qacg, Qacg? - Gravely alluvium and colluvium deposits (Holocene and Pleistocene)
- Qc - Colluvium (Holocene and Pleistocene)
- Qcg - Gravely colluvial deposits (Holocene and Pleistocene)
- Qms - Landslide and slump deposits (Holocene and Pleistocene)
- Qmc - Landslide and slump, and colluvial deposits, undivided (Holocene and Pleistocene)
- Qmddf? - Debris- and mud-flow deposits (Holocene and Pleistocene)
- Zkc - Kelly Canyon Formation, siltstone-quartzite conglomerate member; Zmcc1 - lower member; Zmcc2 - argillite; Zmcc3? - quartzite-conglomerate



1:3,600

Base:
2012 5.0 inch Color HRO Orthomagey, and 2014 1.0 m NALP Orthomagey, from Utah AGRC; <http://gis.utah.gov/>

FIGURE 3

SITE EVALUATION AND ENGINEERING GEOLOGY



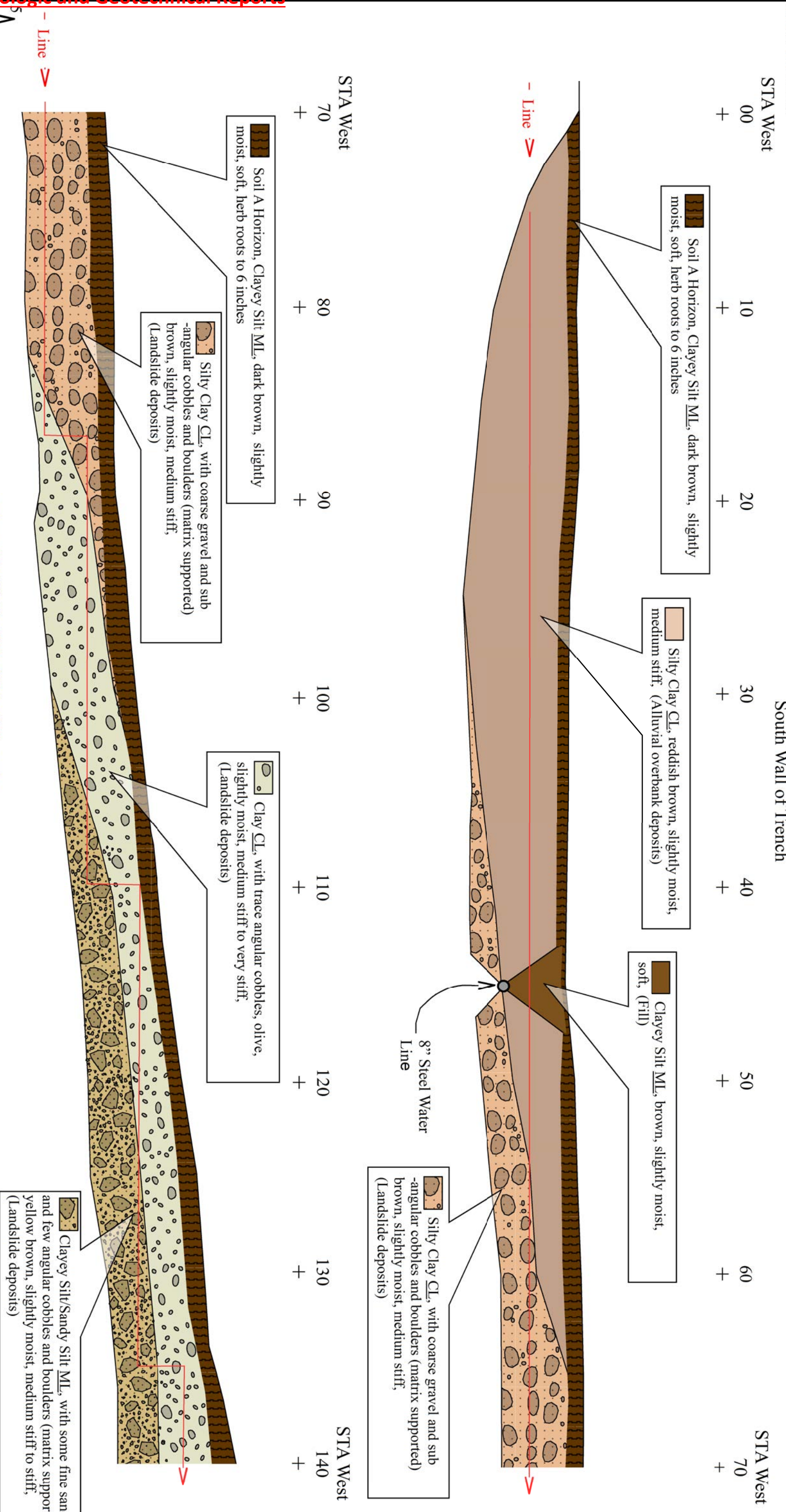


FIGURE 4

LOG OF TRENCH 1
STA 00 TO 140 WEST

Sample Locations
(see geotechnical report for sample data)

TW Thin Wall Sample
B Bulk Sample



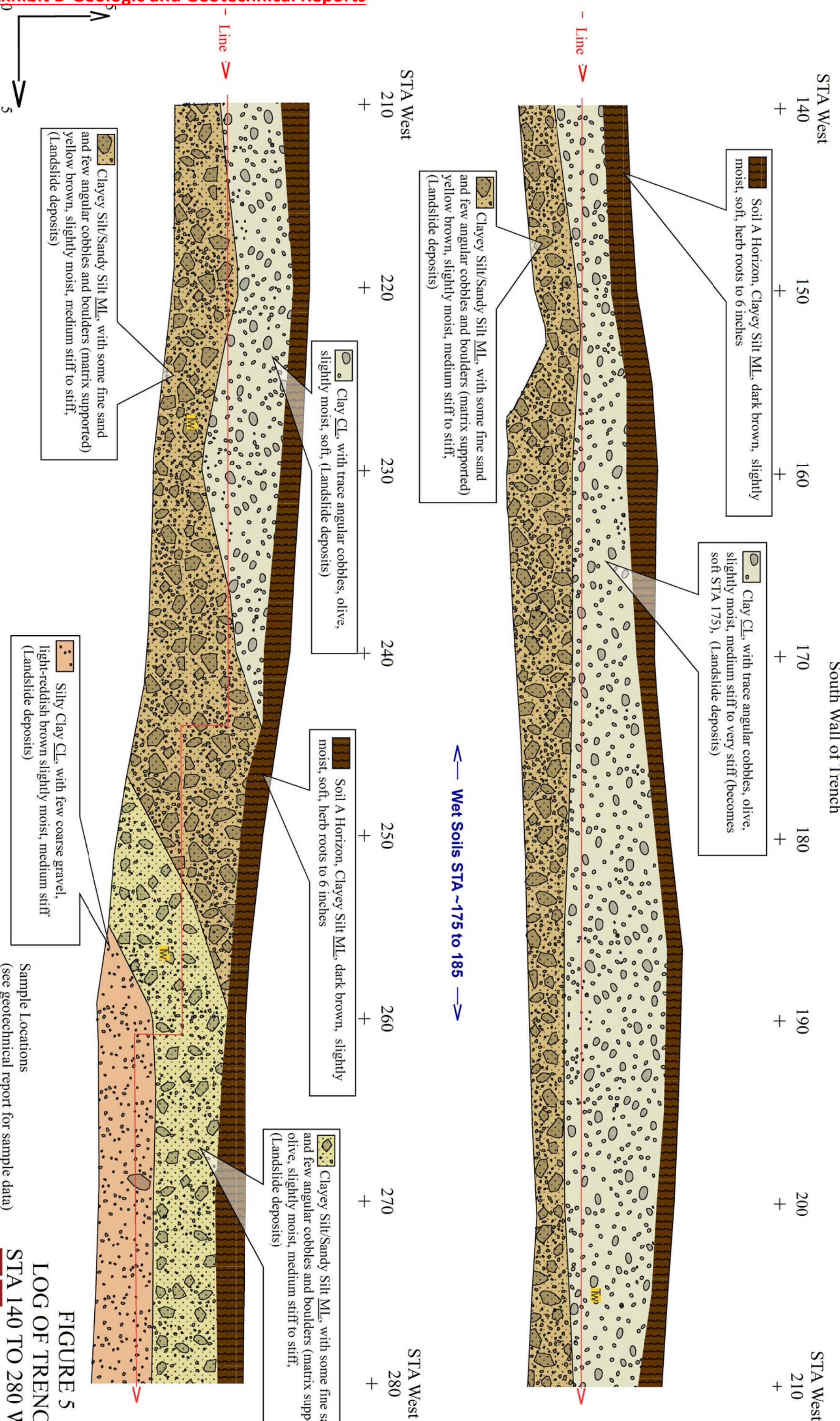


FIGURE 5
LOG OF TRENCH 1
STA 140 TO 280 WEST



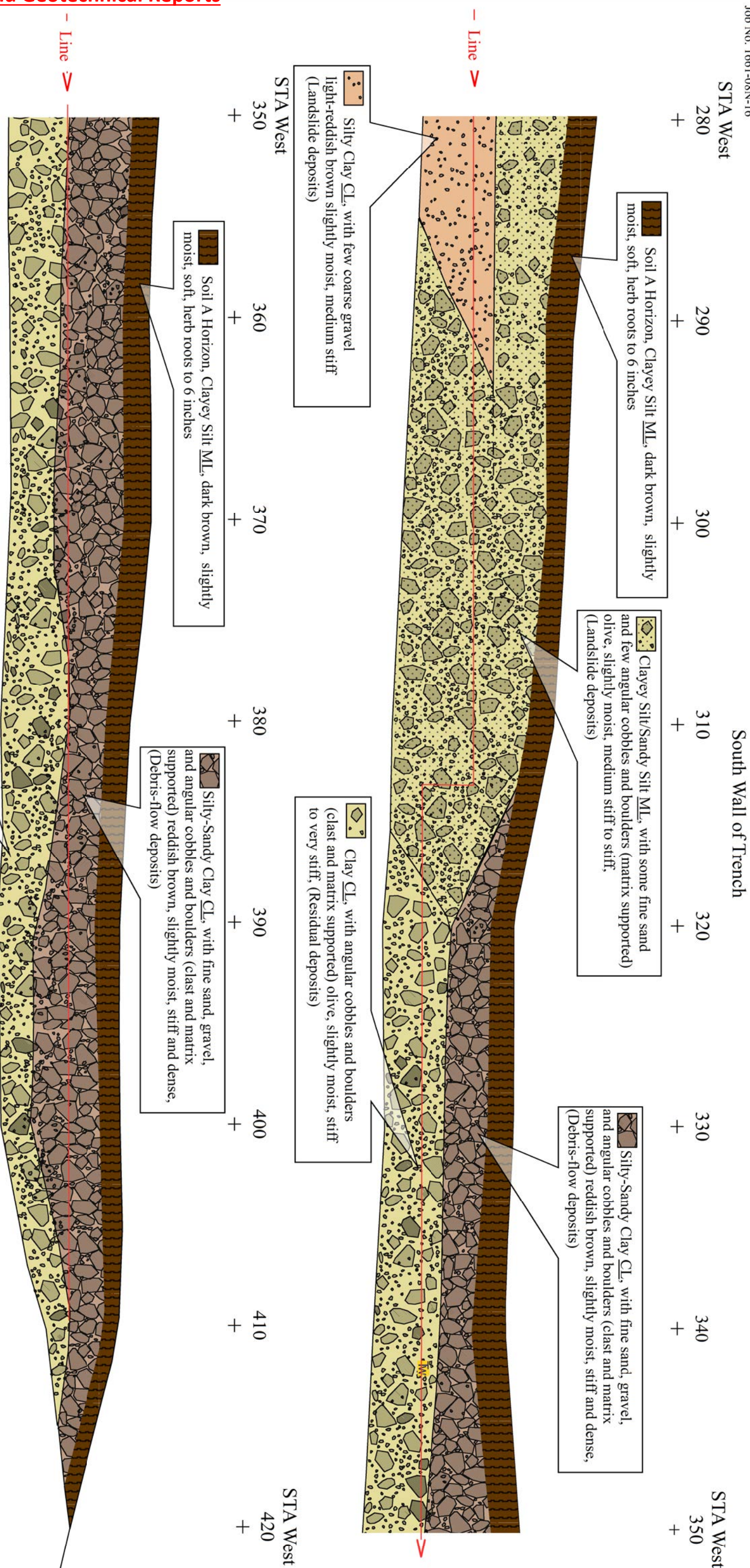
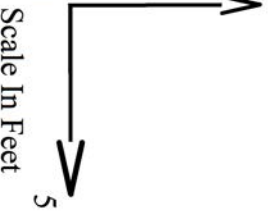


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Sample Locations
(see geotechnical report for sample data)

mw Thin Wall Sample

B Bulk Sample

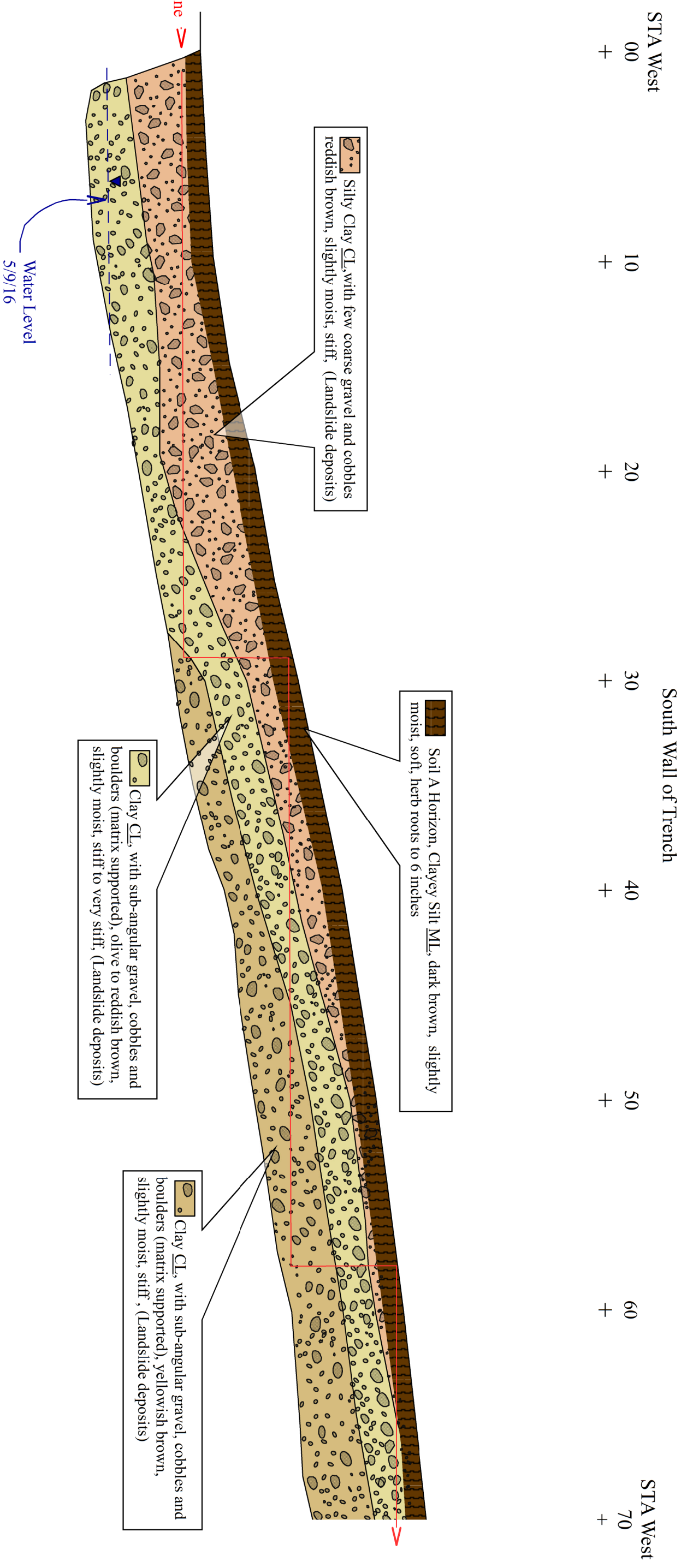


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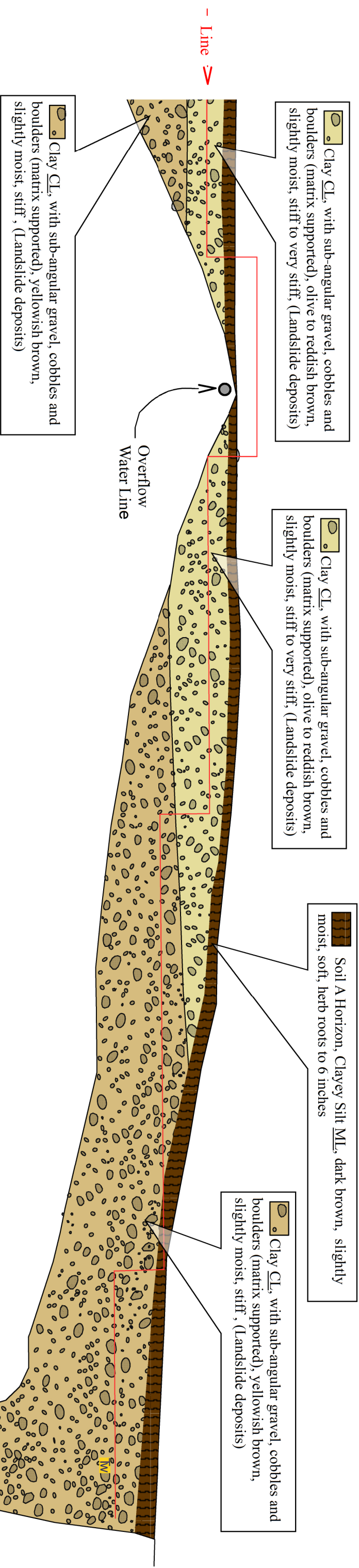
ANALYSIS BY: GCS | CHECKED BY RAG | DATE 7/19/16

Sample Locations
(see geotechnical report for sample data)

TM Thin Wall Sample
B Bulk Sample

FIGURE 7
LOG OF TRENCH 2
STA 00 TO 70 WEST

STA West	South Wall of Trench	STA West
70		140
+		+
80		
+		
90		
+		
100		
+		
110		
+		
120		
+		
130		
+		
		140
		+



Excavation Refused at 11'
No GW Encountered
1.5" Slotted PVC Installed to 11'

FIGURE 8

LOG OF TRENCH 2
STA 70 TO 143 WEST

Sample Locations
(see geotechnical report for sample data)

TW Thin Wall Sample

B Bulk Sample

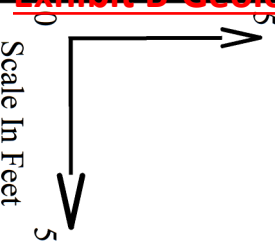


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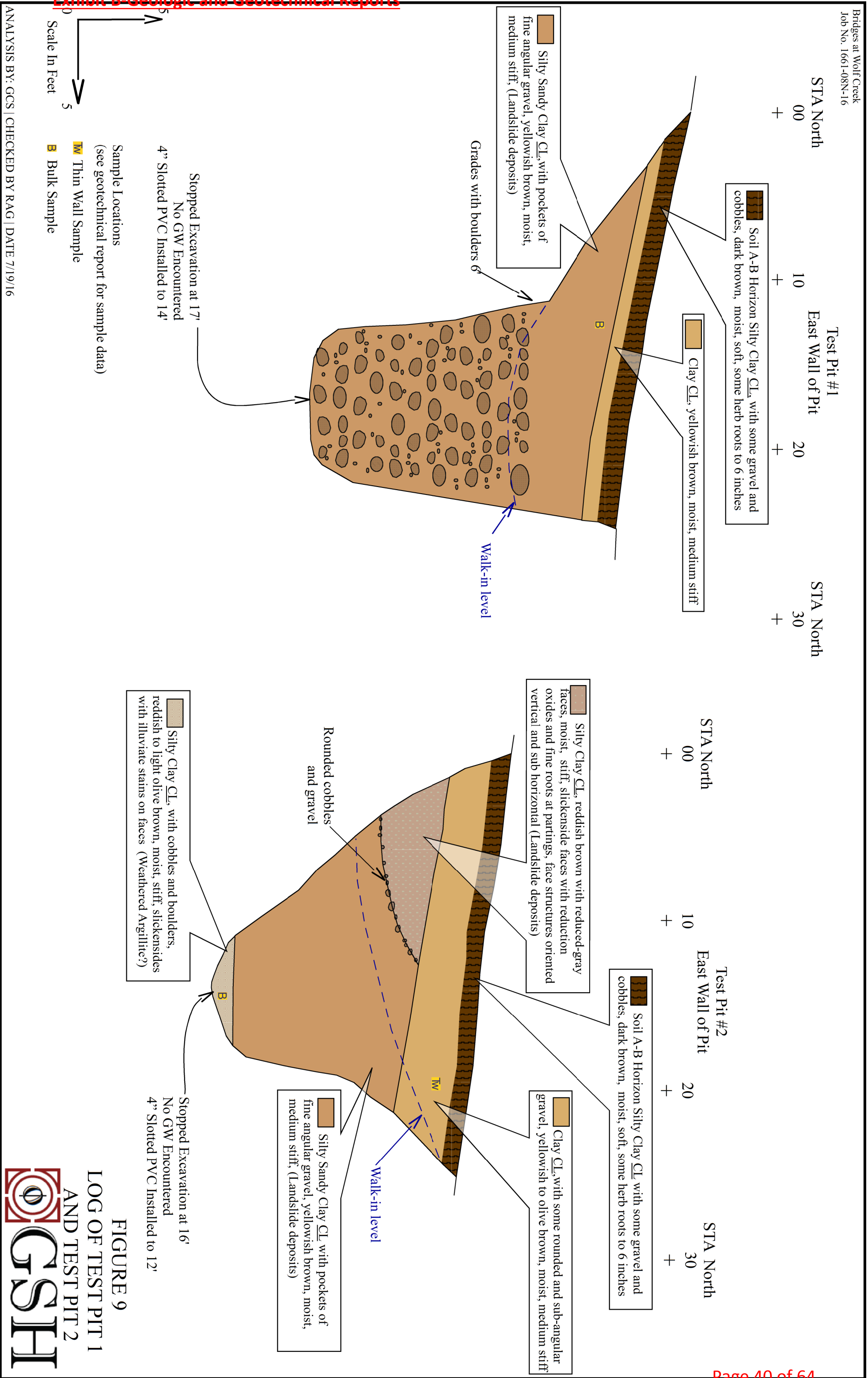


FIGURE 9
LOG OF TEST PIT 1
AND TEST PIT 2



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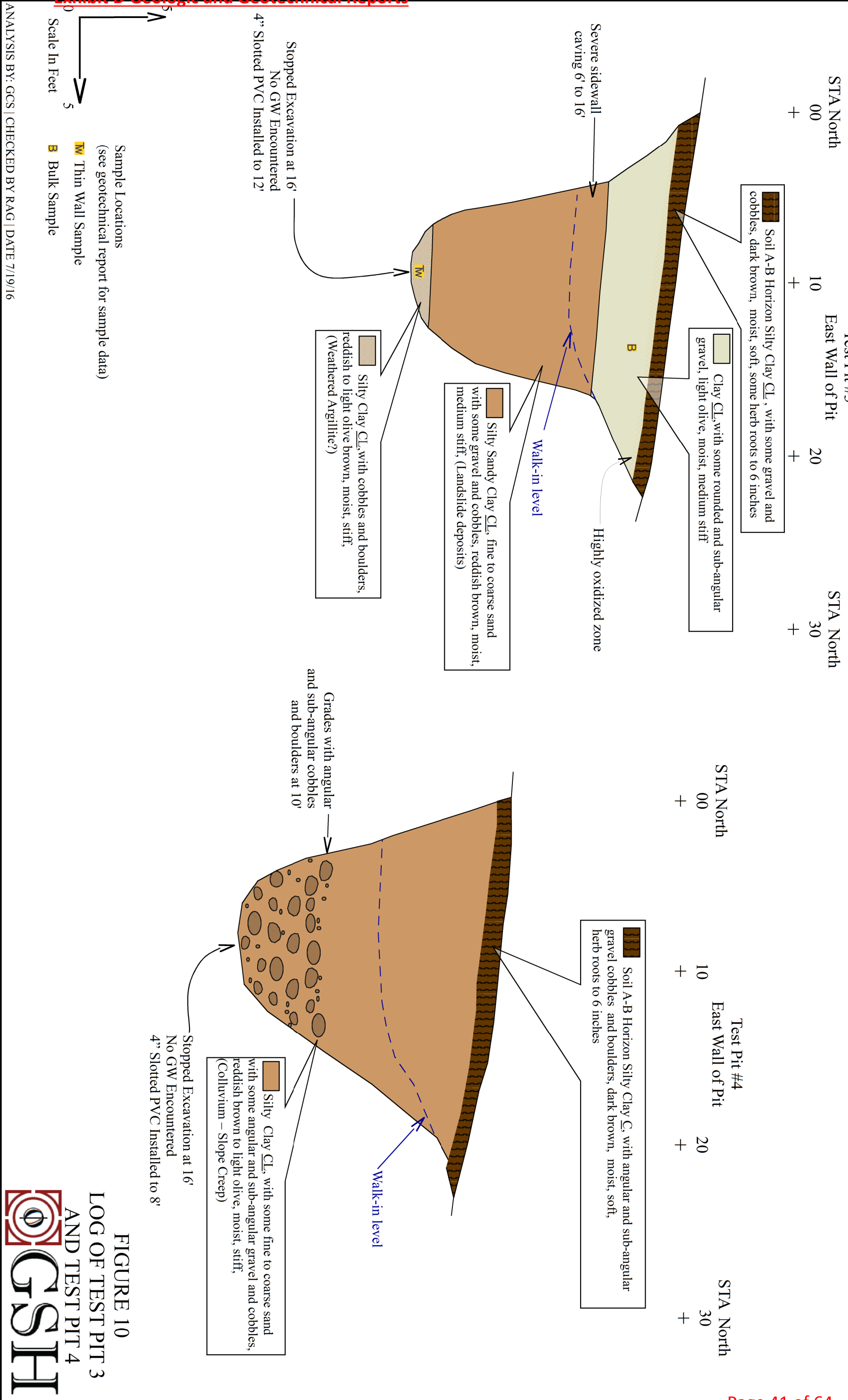


FIGURE 10
LOG OF TEST PIT 3
AND TEST PIT 4



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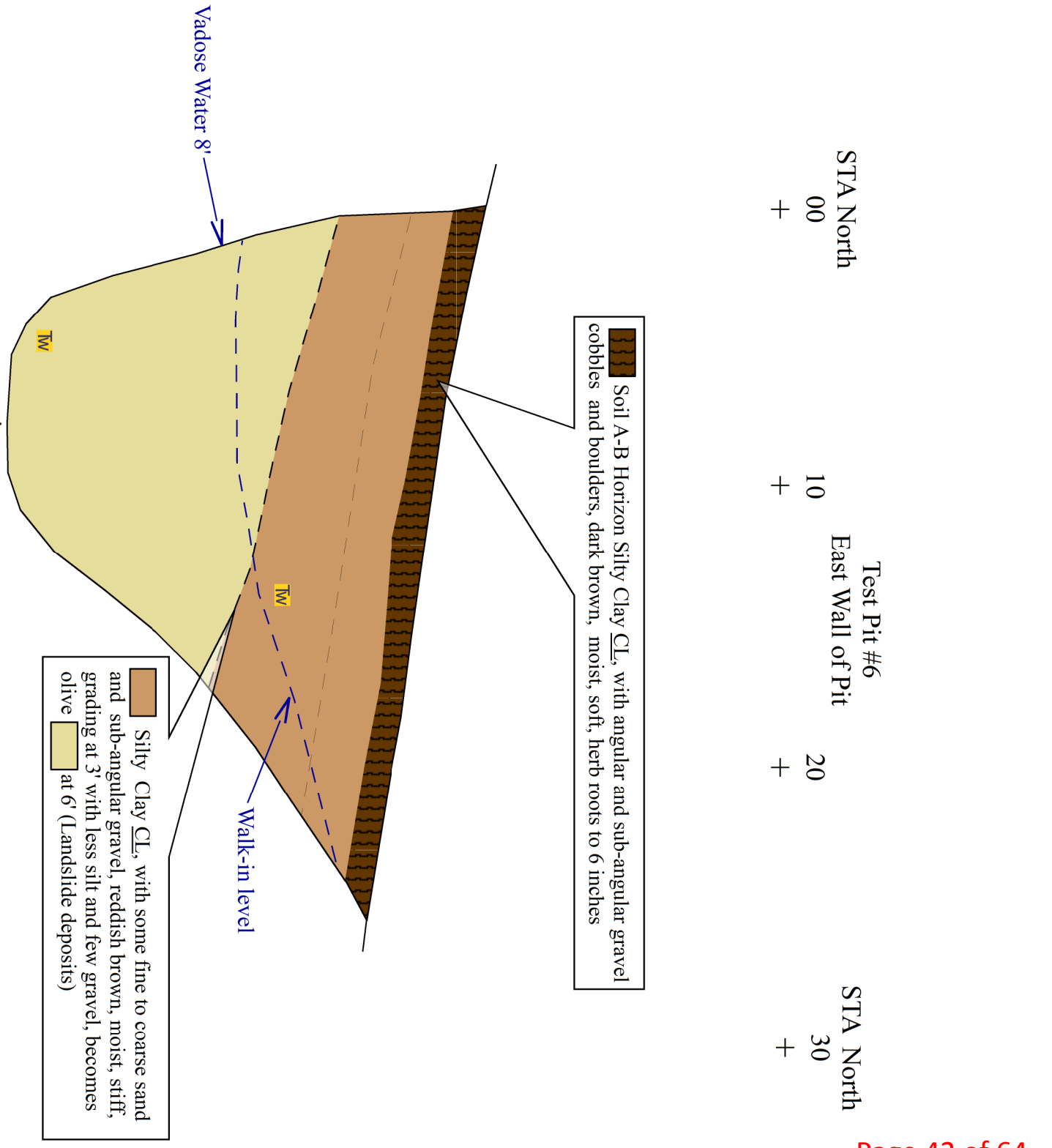
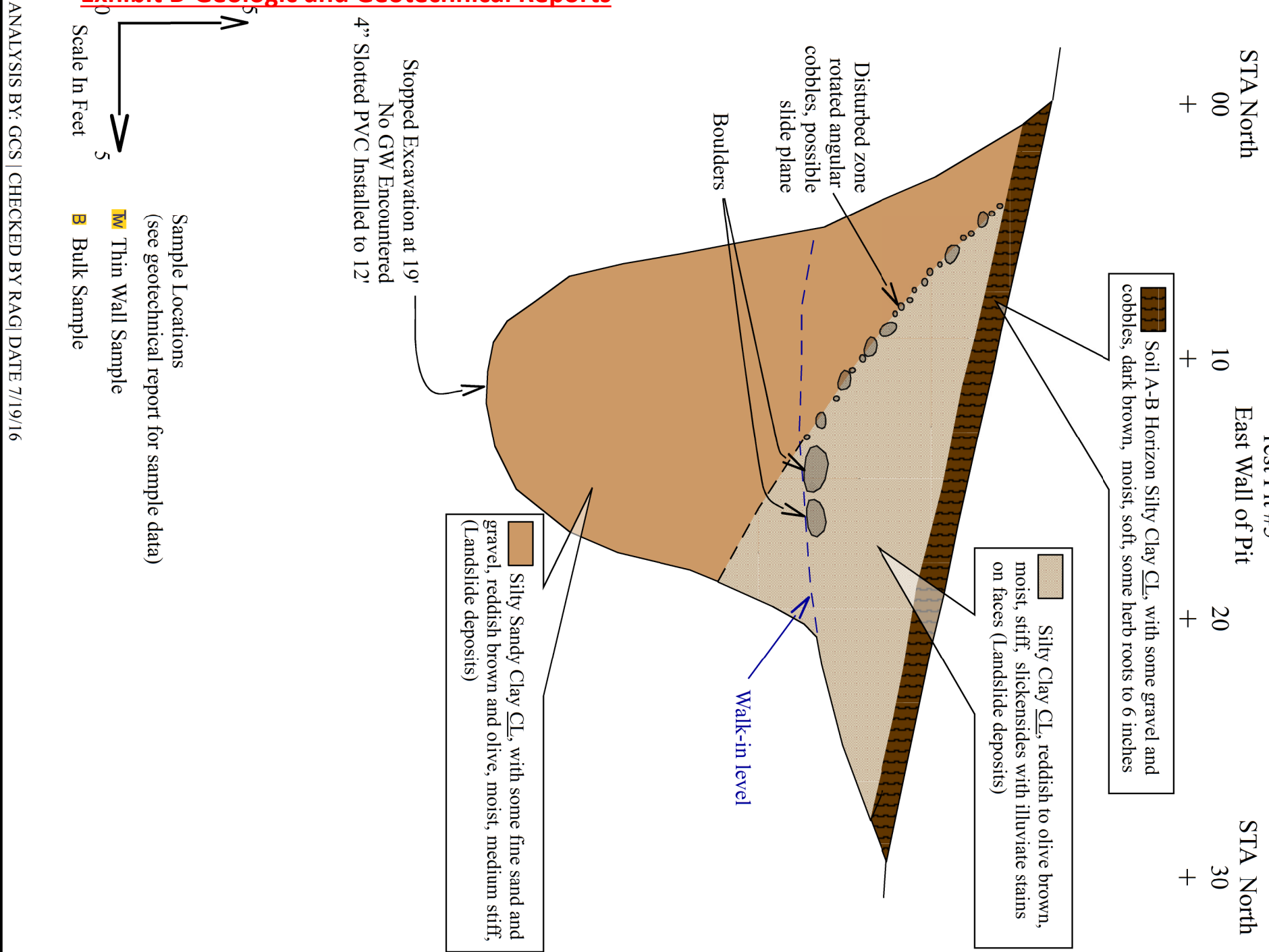


FIGURE 11
LOG OF TEST PIT 5
AND TEST PIT 6



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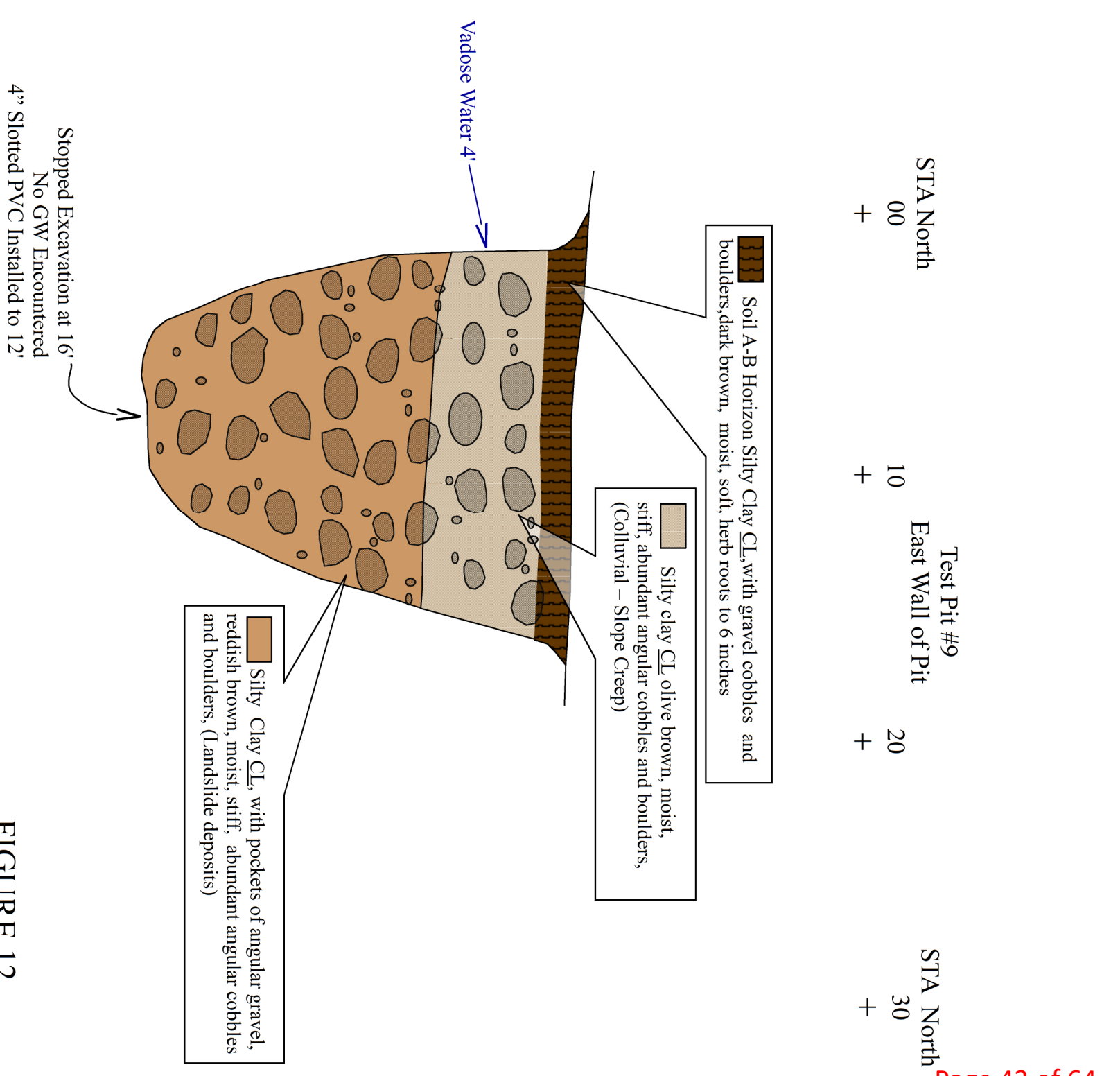
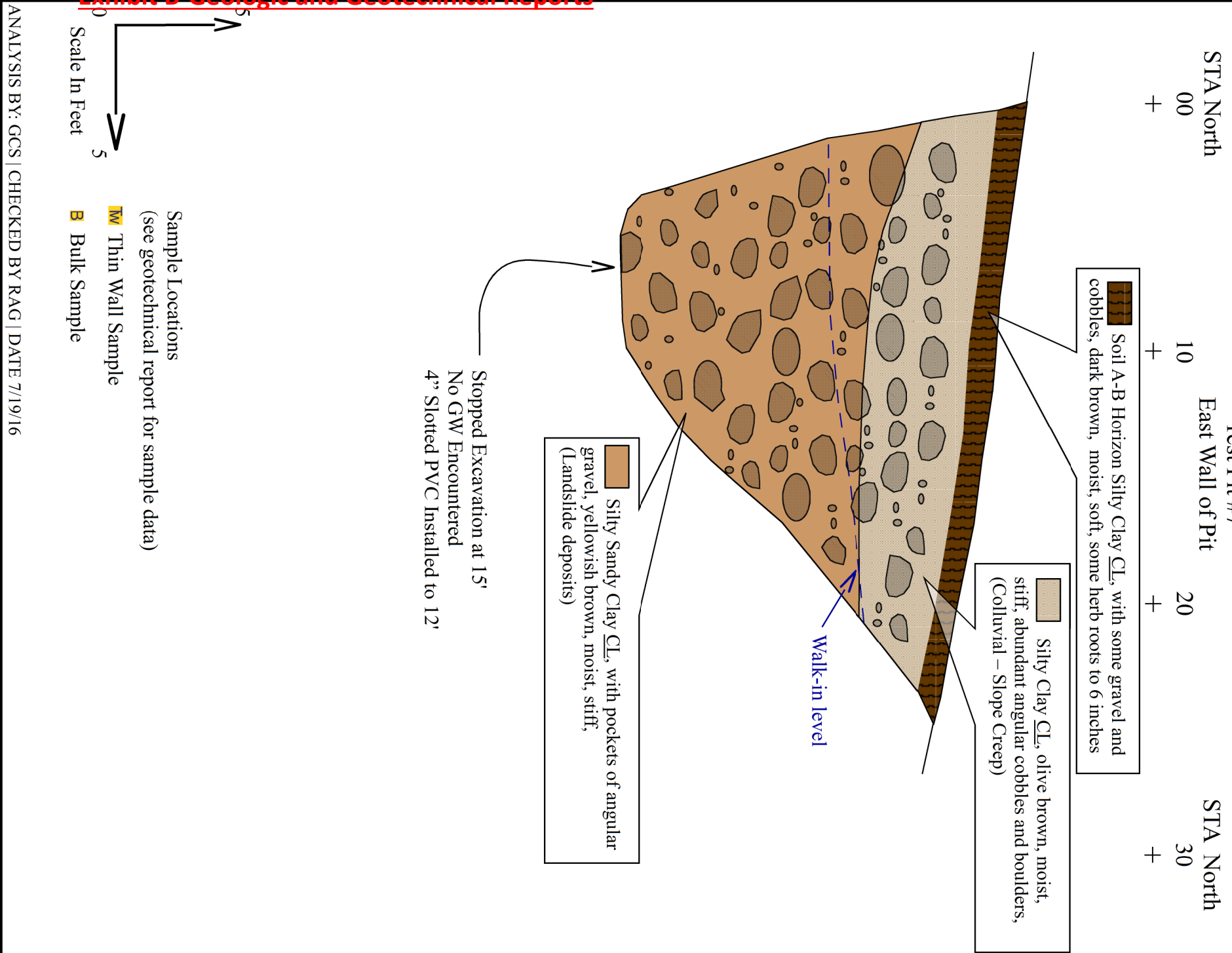
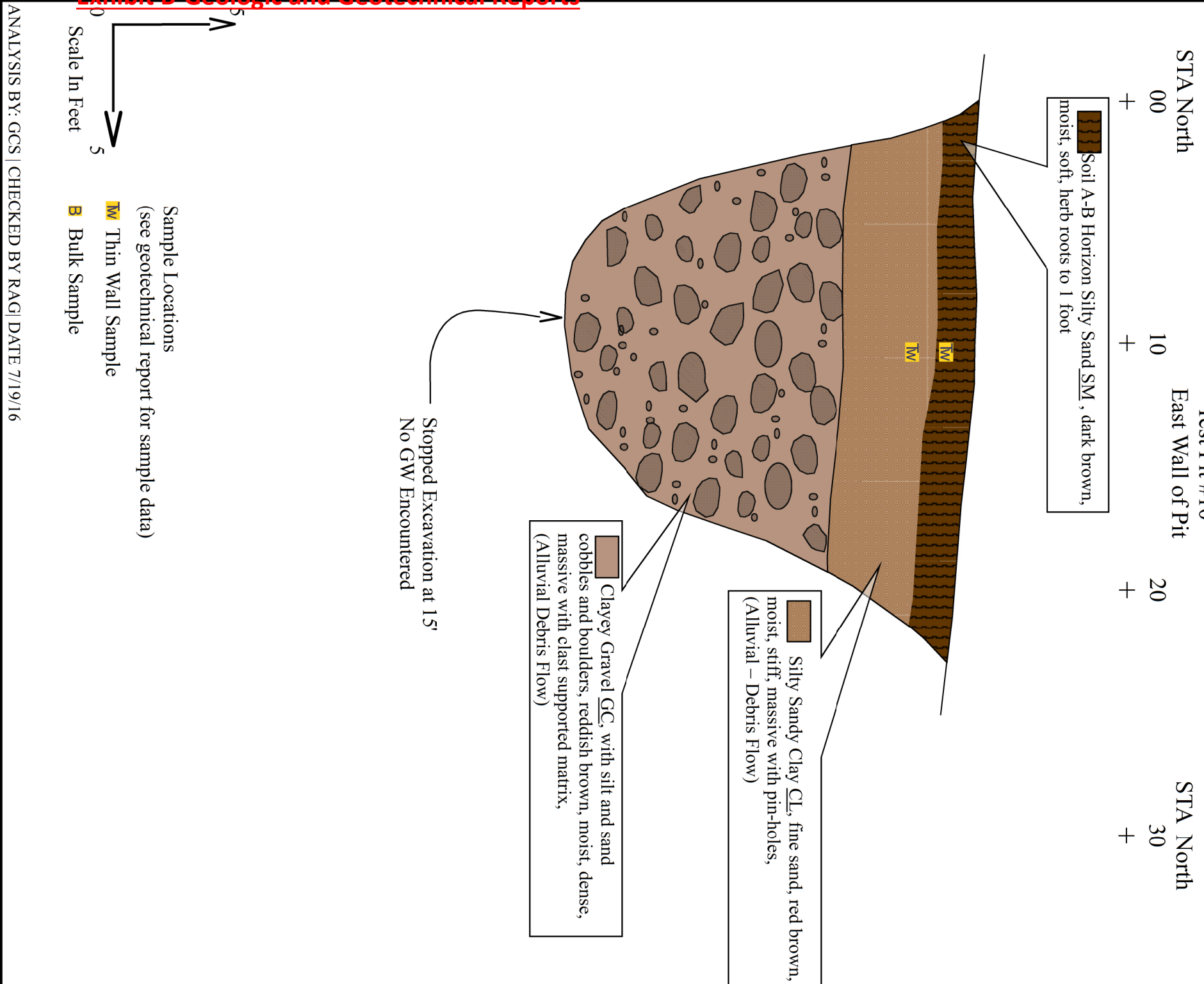


FIGURE 12
 LOG OF TEST PIT 7
 AND TEST PIT 9*

* Proposed Test Pit 8 not excavated



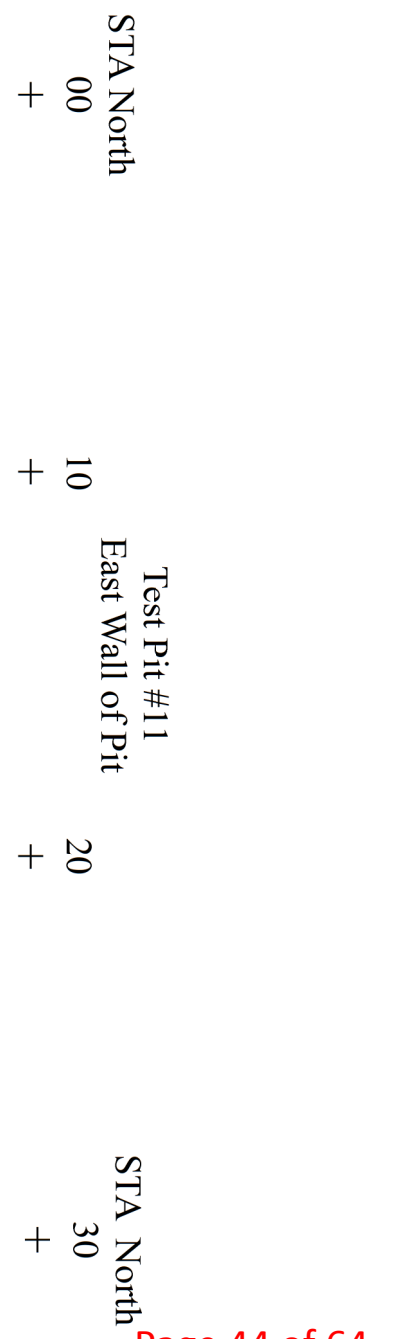
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Sample Locations
(see geotechnical report for sample data)

- TW Thin Wall Sample
- B Bulk Sample

ANALYSIS BY: GCS | CHECKED BY RAGI DATE 7/19/16



Stopped Excavation at 15'
No GW Encountered

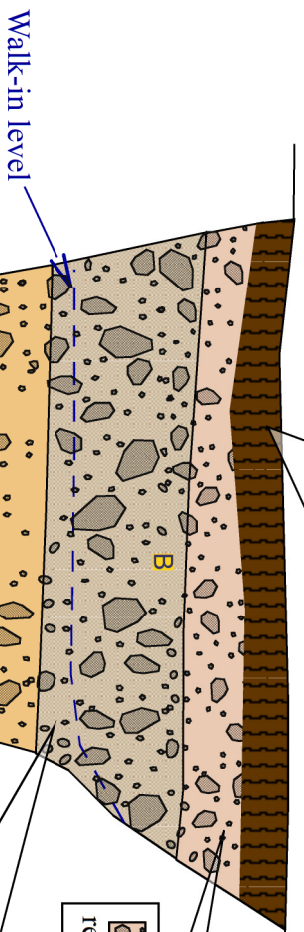
FIGURE 13

**LOG OF TEST PIT 10
AND TEST PIT 11**



STA North 00 + 10 + 20 + 30
 Test Pit #12
 East Wall of Pit

Soil A Horizon, Clayey Silt ML, dark brown, slightly moist, soft, herb roots to 6 inches



Silty Clay CL, with few coarse gravel and cobbles reddish brown, slightly moist, stiff, (Colluvium – Slope Creep)

Clay CL, with sub-angular gravel, cobbles and boulders, olive to reddish brown, slightly moist, stiff, (Colluvium)

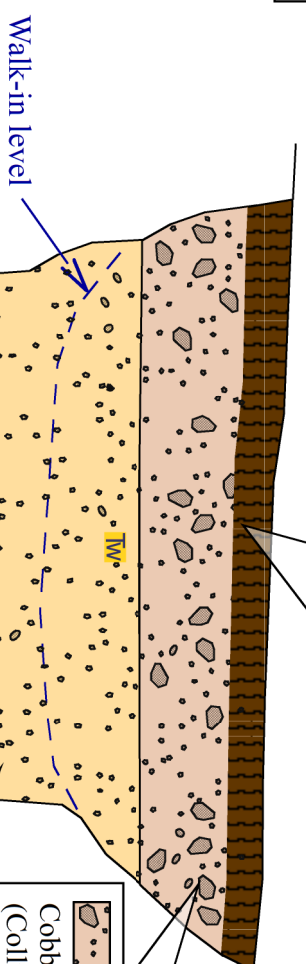
Silty Clay CL, with some sub-angular gravel, cobbles and boulders, yellowish brown, slightly moist, stiff, (Colluvium)

Stopped Excavation at 12.5'
No GW Encountered

STA North 30 +

STA North 00 + 10 + 20 + 30
 Test Pit #13
 East Wall of Pit

Soil A Horizon, Clayey Silt ML, dark brown, slightly moist, soft, herb roots to 6 inches



Silty Clay CL, with few coarse gravel and cobbles reddish brown, slightly moist, stiff, (Colluvium – Slope Creep)

Clay CL, with some fine and coarse gravel, yellowish brown, slightly moist, stiff (Alluvium)

Clay CL, with sub-angular gravel, cobbles and boulders (matrix supported), yellowish brown, slightly moist, stiff, (Colluvium-Alluvium)

Excavation Refused at 16.5'
No GW Encountered
1.5" Slotted PVC Installed to 16.5'

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Scale In Feet
 Sample Locations
 (see geotechnical report for sample data)
 TW Thin Wall Sample
 B Bulk Sample

ANALYSIS BY: GCS | CHECKED BY RAG | DATE 7/19/16

FIGURE 14
 LOG OF TEST PIT 12
 AND TEST PIT 13



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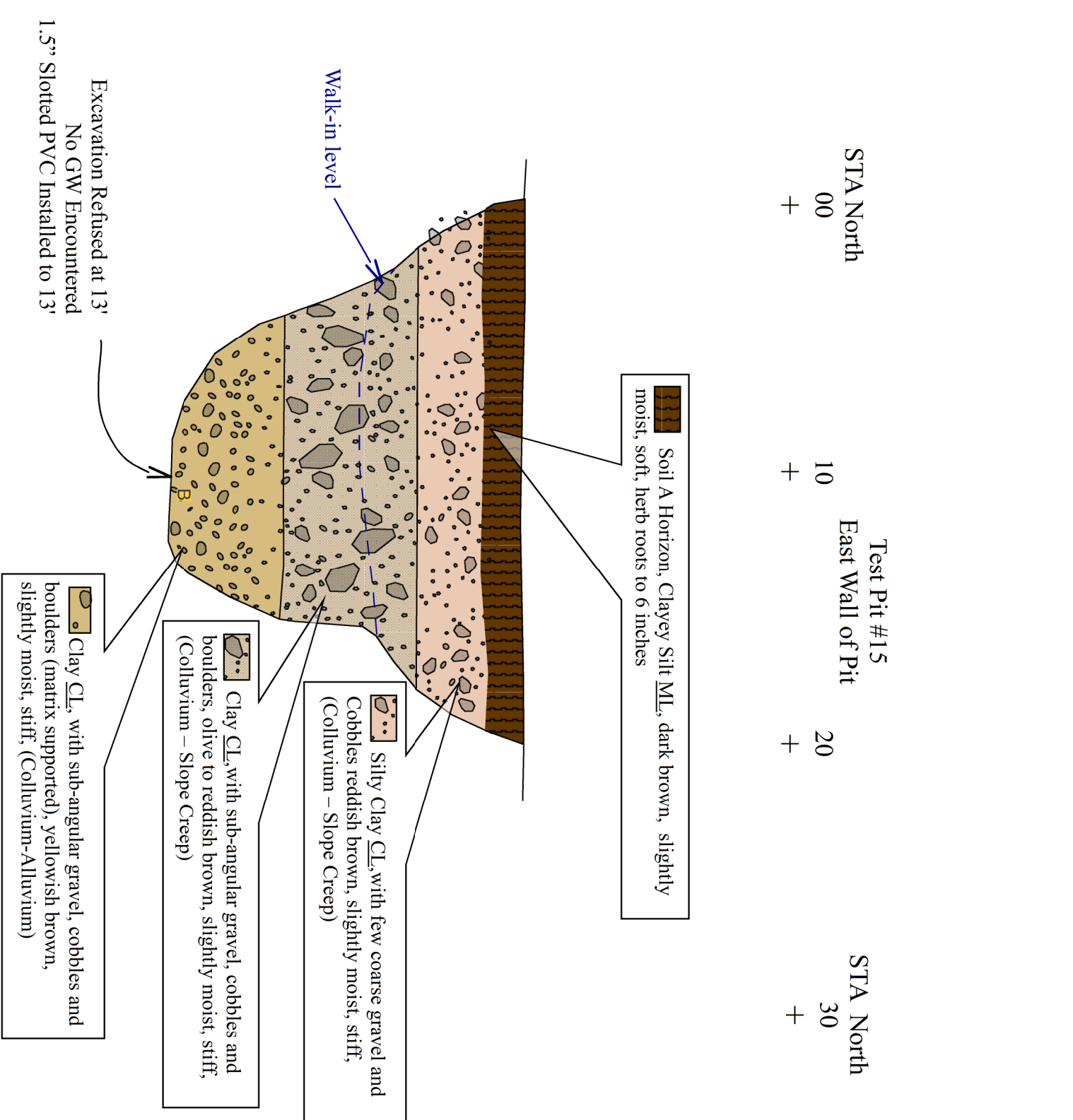
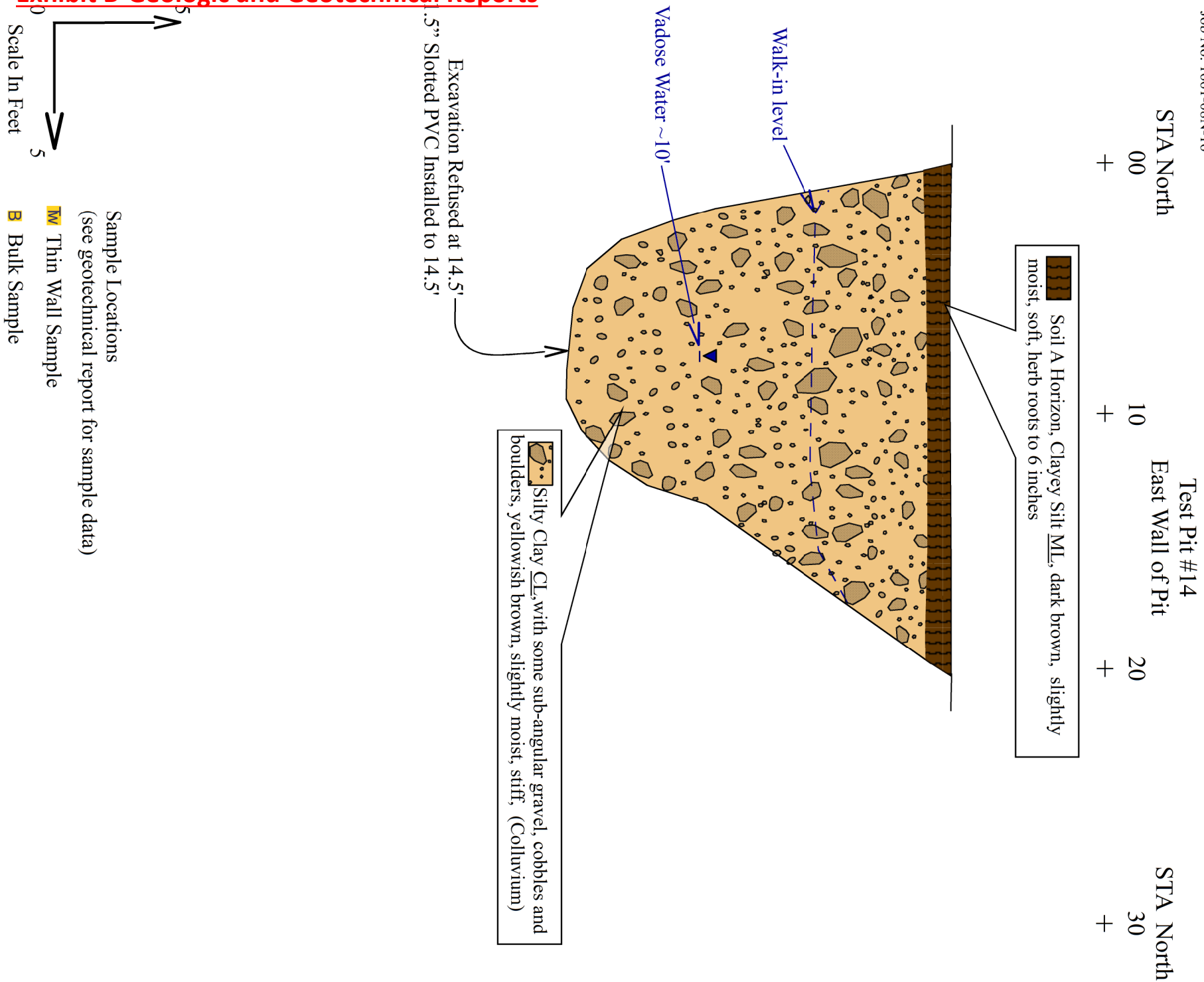
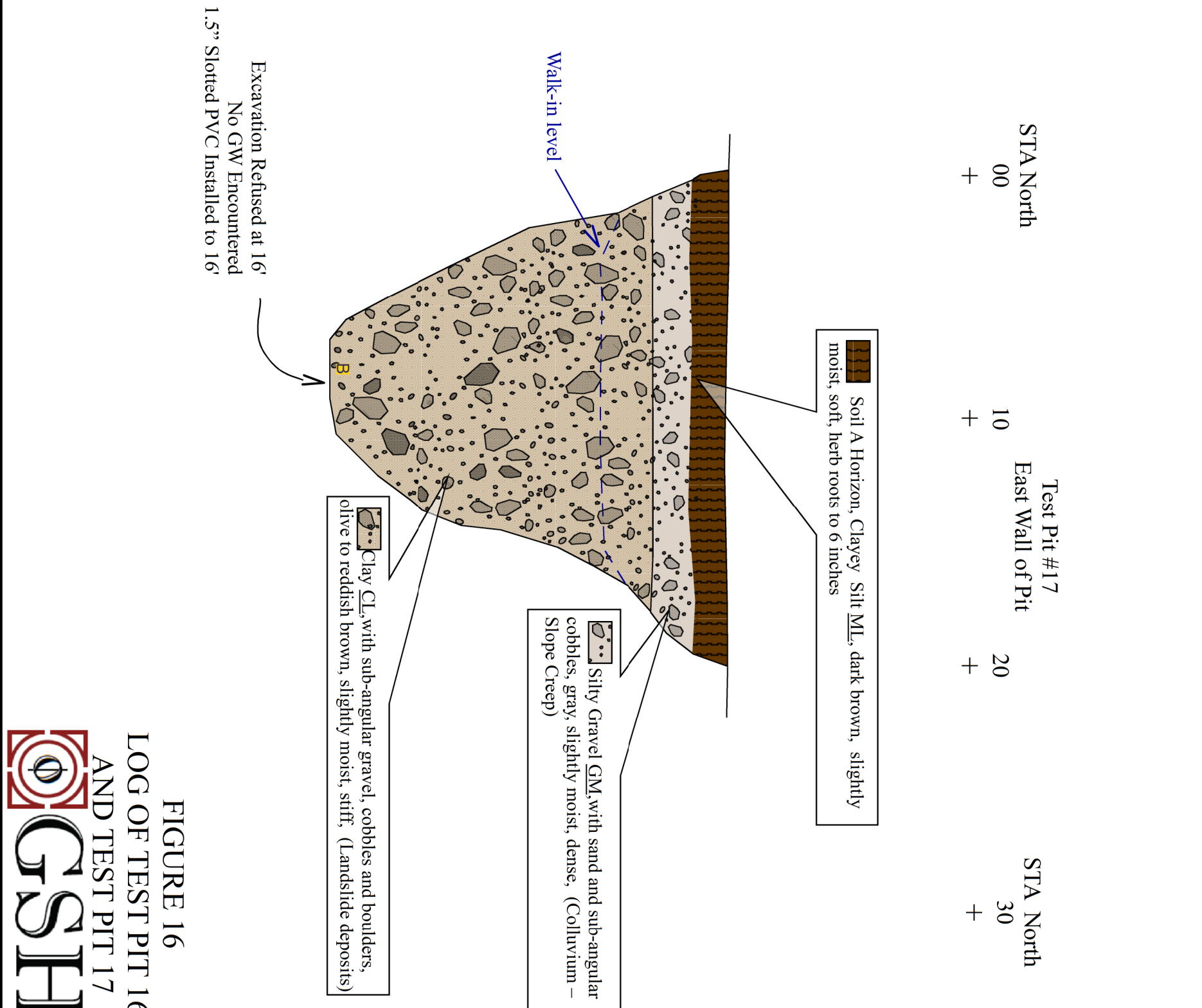
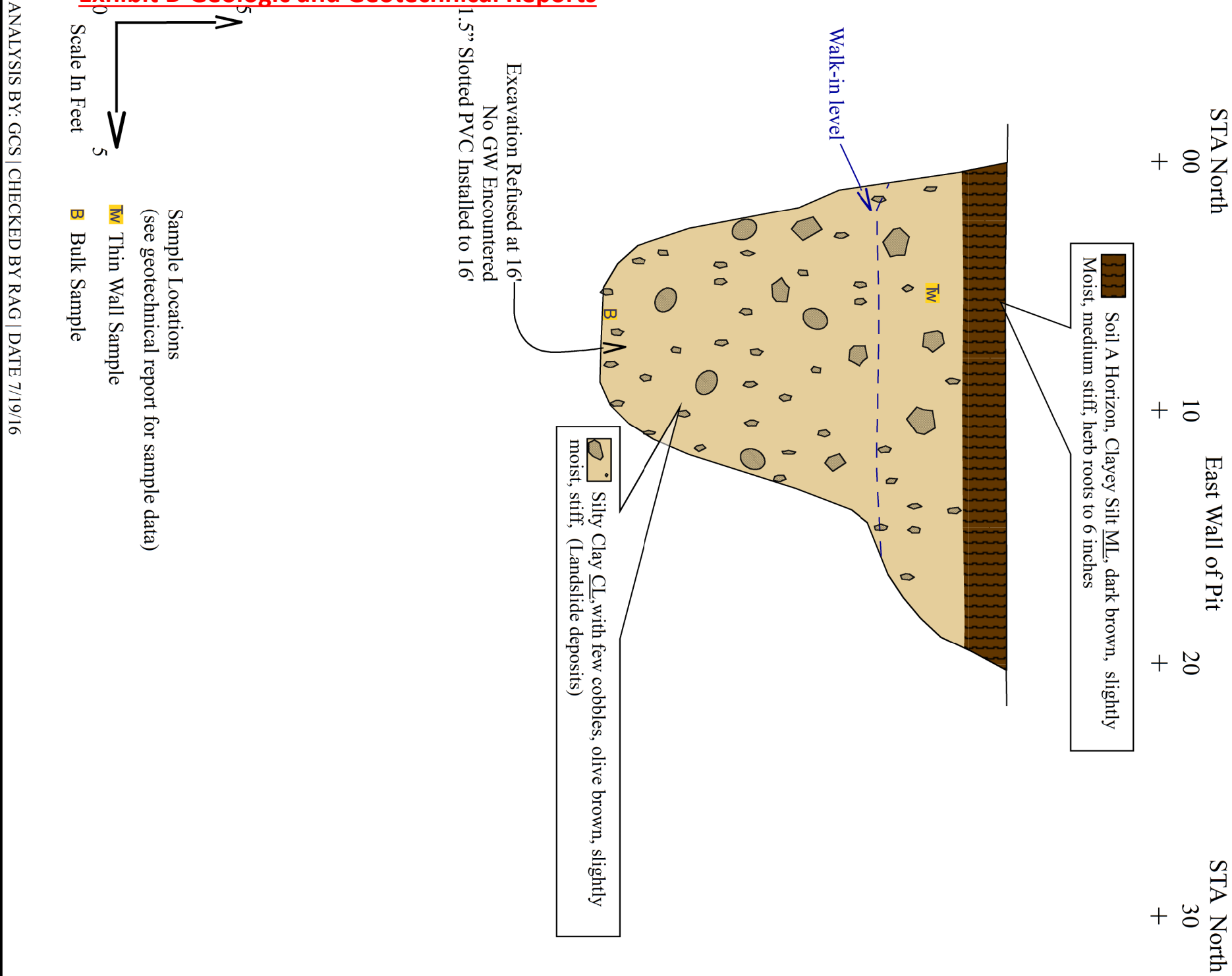


FIGURE 15
LOG OF TEST PIT 14
AND TEST PIT 15



Exhibit B-Geologic and Geotechnical Reports



Sample Locations
(see geotechnical report for sample data)

TW Thin Wall Sample
B Bulk Sample

Scale In Feet
0 5

FIGURE 16

**LOG OF TEST PIT 16
AND TEST PIT 17**



ANALYSIS BY: GCS | CHECKED BY RAG | DATE 7/19/16

Exhibit B-Geologic and Geotechnical Reports

Bridges at Wolf Creek
Job No. 1661-08N-16

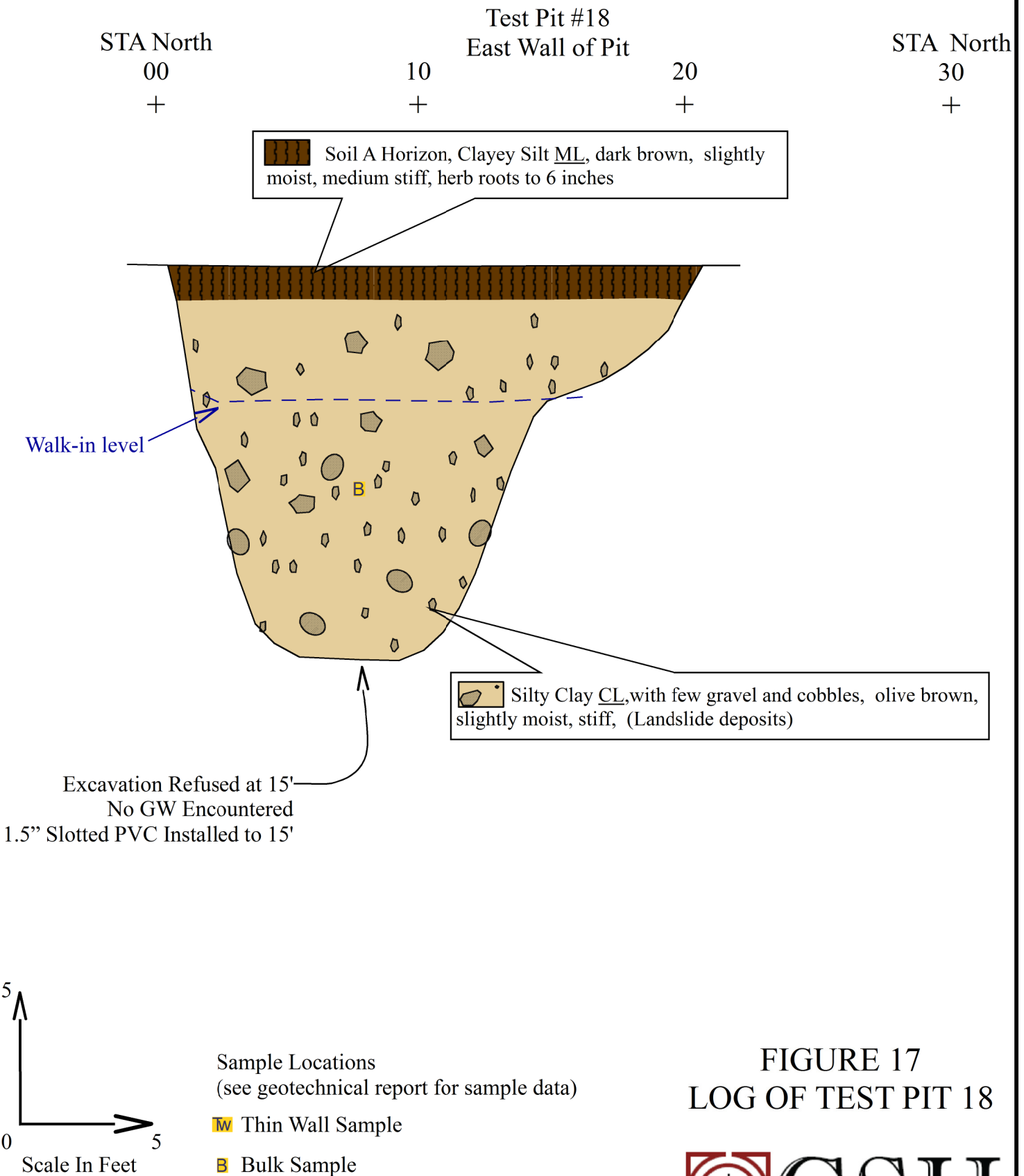
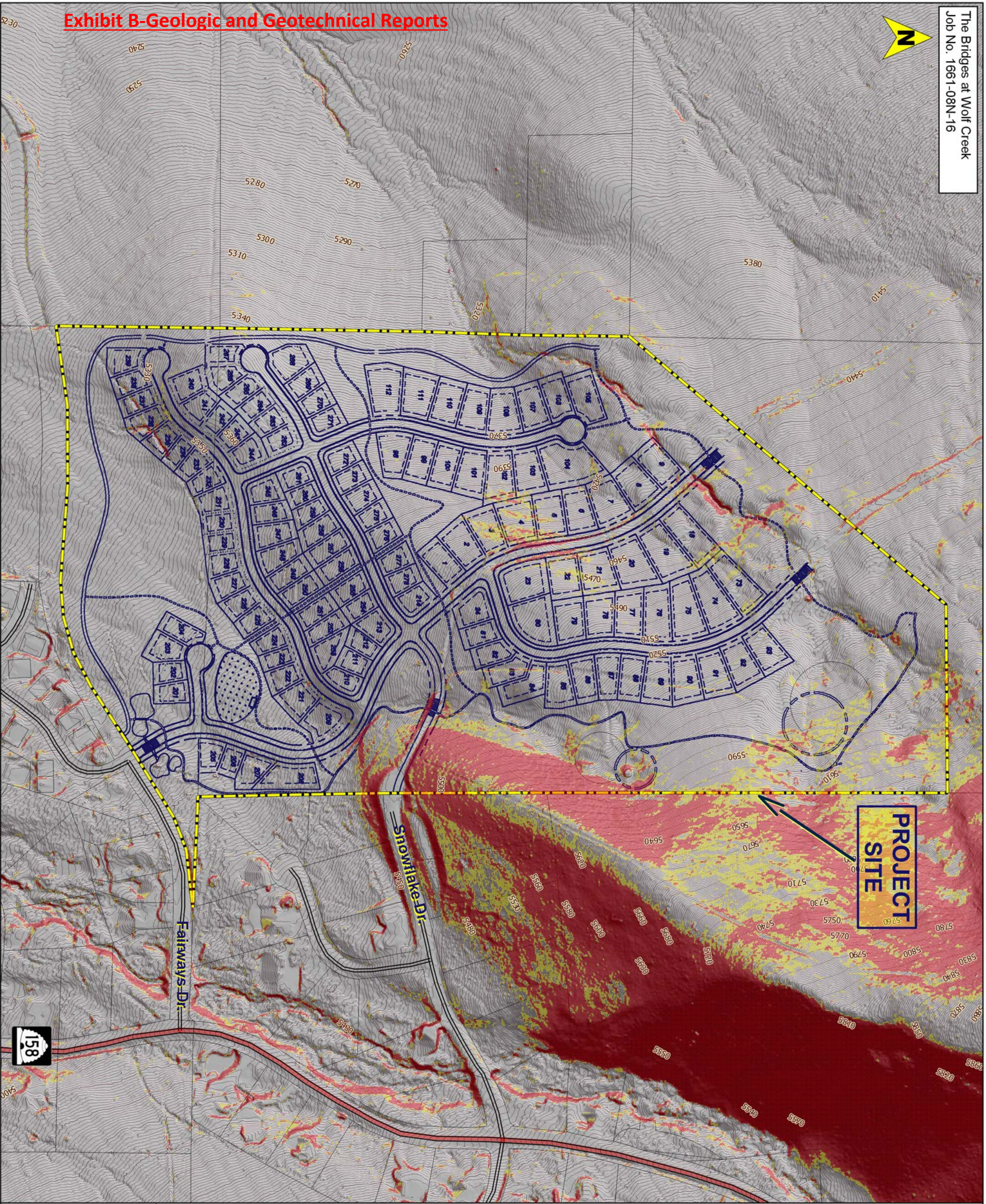










FIGURE 17
LOG OF TEST PIT 18





Explanation

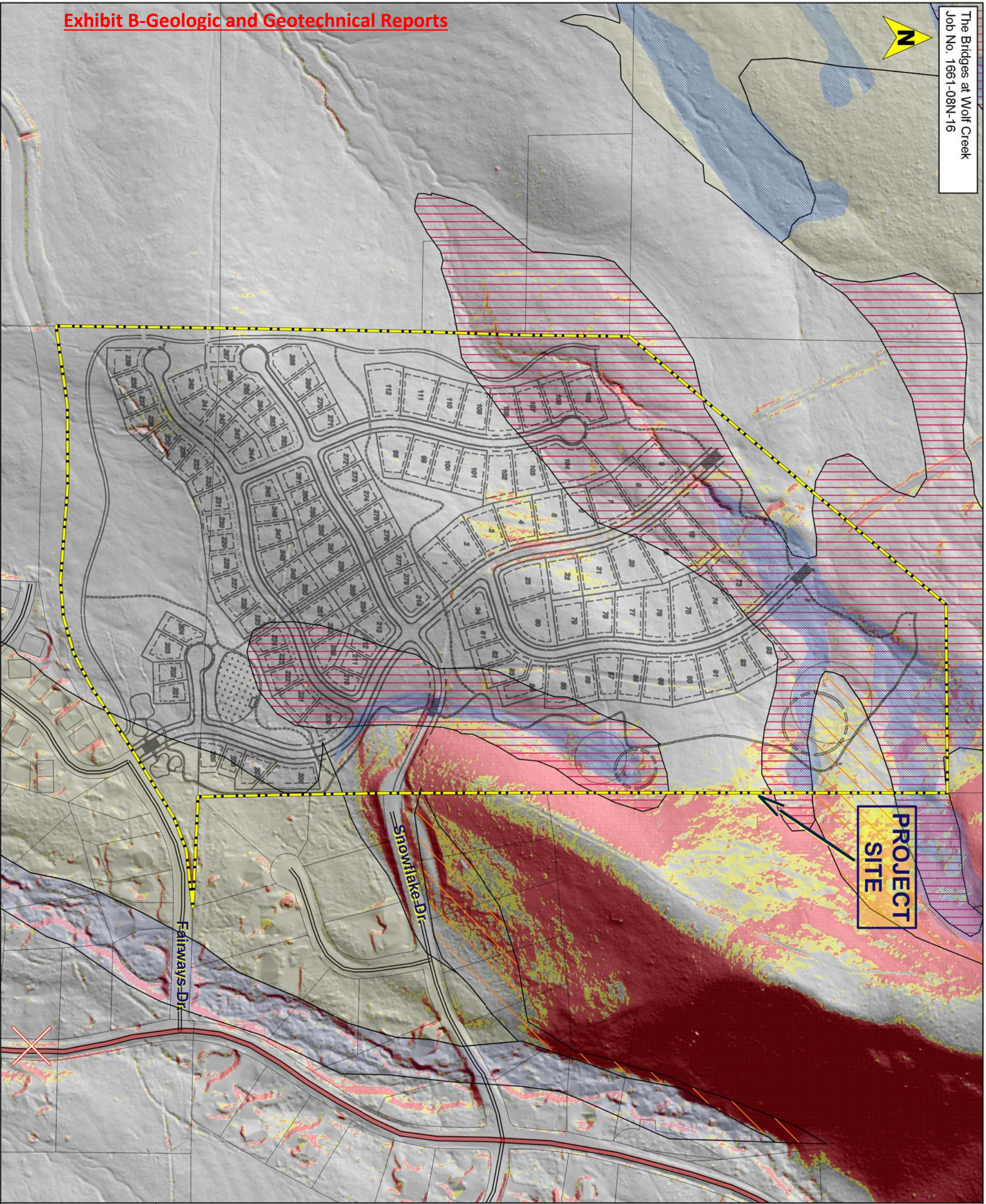
-  Phase Boundary
-  Layout
-  Park Side 1, 2 & 3
-  Mountainside 1, 3, & 4
-  SGID10_CADASTRE_Parcels_Weber
- Slope Percentage Classification**
-  25 to 30 percent
-  30 percent and greater
-  Index contour (10ft)



Base:
2006 2.0m geoprocessed LIDAR from Utah AGRC;
<http://gis.utah.gov/>

FIGURE 18
LIDAR-SLOPE ANALYSIS





Explanation

- Phase Boundary
- Layout
 - Park Side 1, 2 & 3
 - Mountainside 1, 3, & 4
- SGID10_CADASTRE_Parcel_s_Weber
- Index contour (10ft)
- Geologic/Natural Hazards**
 - Shallow-Seasonal Groundwater
 - Alluvial Fan - Debris Flow Hazards
 - Landslide - Mass Movement Hazards
 - Alluvial Fan - Debris Flow / Landslide - Mass Movement Hazards (combined)
 - Slope Stability Hazards
 - Flood Zone Hazards
- Steep Slope Areas**
 - 25 to 30 percent
 - 30 percent and greater



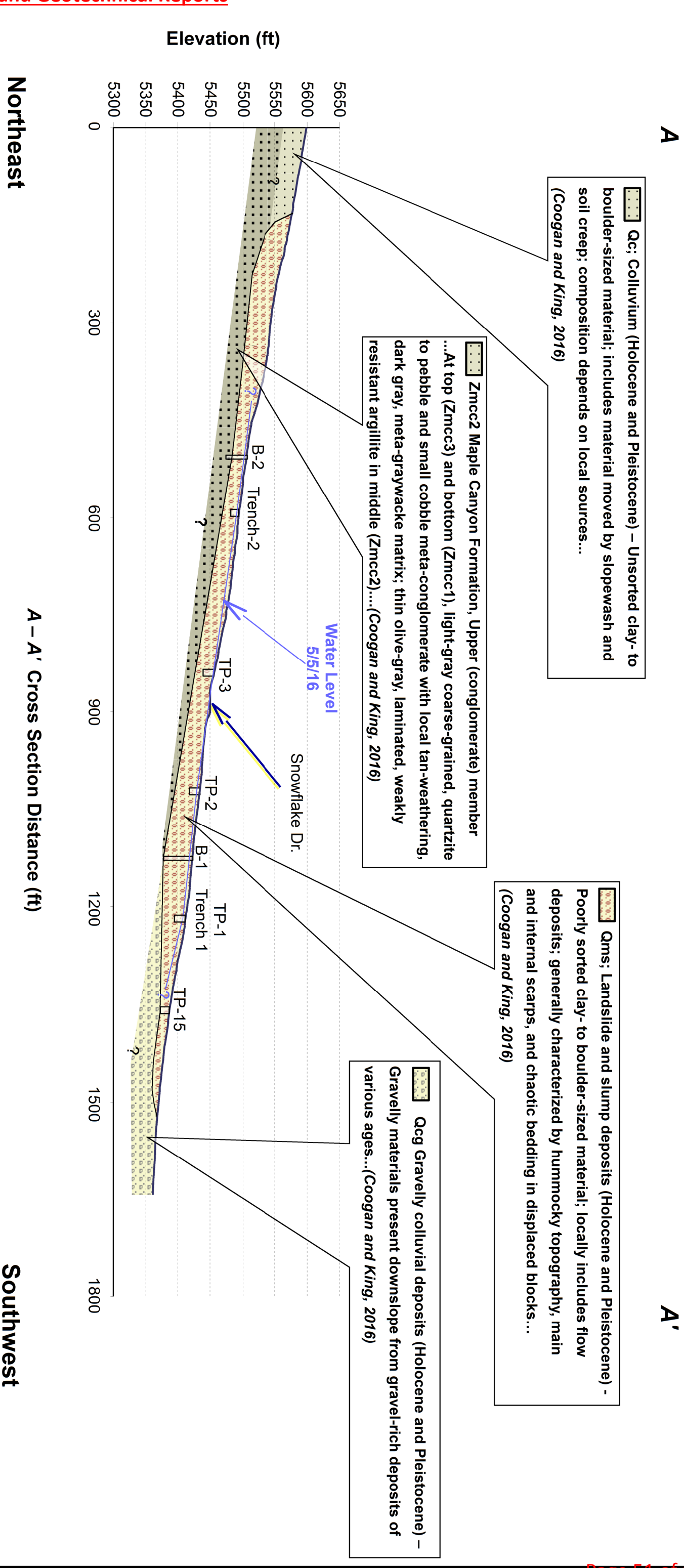
1:3,600

Base:
2006 2.0m geoprocessed LIDAR from Utah AGRC;
<http://gis.utah.gov/>

FIGURE 19

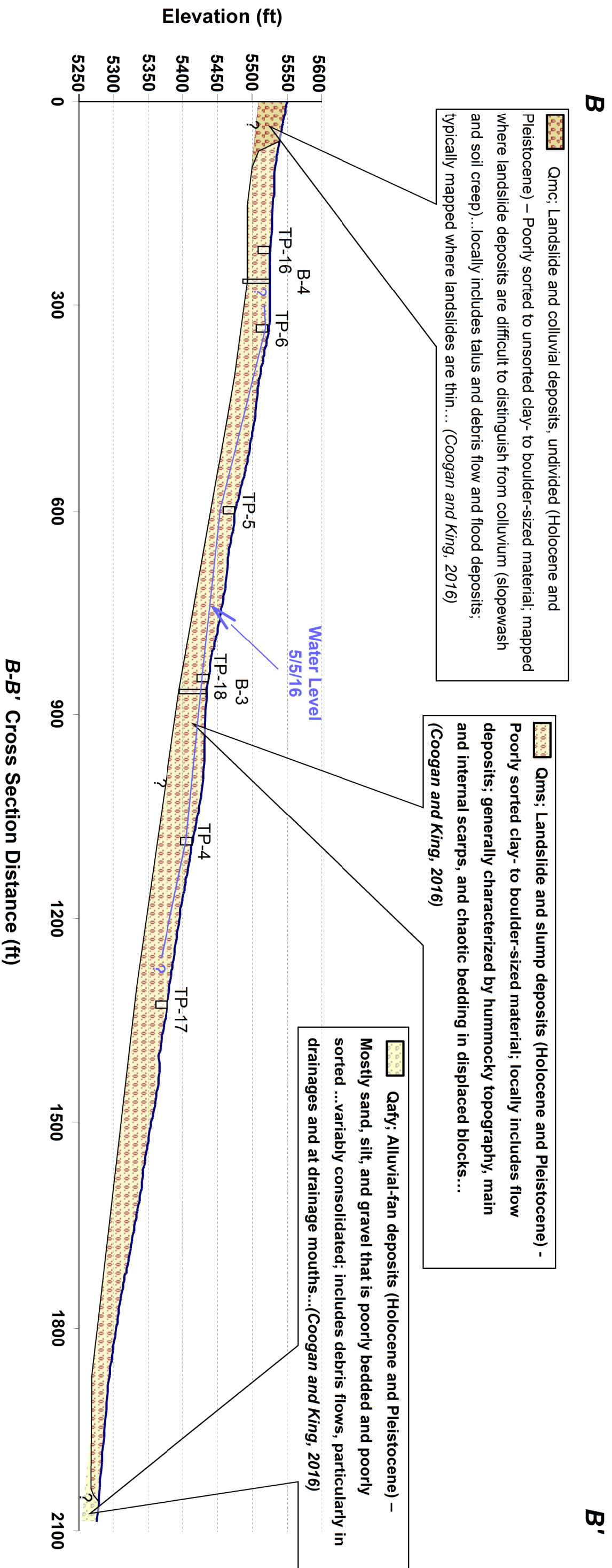
**GEOLOGIC/NATURAL
HAZARD EXPOSURE**





ANALYSIS BY: GCS | CHECKED BY AH | DATE 06/24/16

* From Section Line Shown On Figure 3





APPENDIX

Exhibit B-Geologic and Geotechnical Reports

GSH		BORING LOG				BORING: B-1					
		Page: 1 of 2									
CLIENT: Lewis Homes		PROJECT NUMBER: 1661-08N-16									
PROJECT: The Bridges at Wolf Creek Phase I		DATE STARTED: 5/4/16				DATE FINISHED: 5/4/16					
LOCATION: Northwest of Fairway Drive, near Eden, Weber County, Utah		GSH FIELD REP.: AA									
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger		HAMMER: Automatic		WEIGHT: 140 lbs		DROP: 30"					
GROUNDWATER DEPTH: 5.0' (5/4/16), 5.6' (7/1/16)		ELEVATION: ---									
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								slightly moist hard
▼	CL	SILTY CLAY with some fine and coarse gravel; some fine to coarse sand; trace large to small cobbles; small boulders; trace organics; major roots (topsoil) to 3"; light reddish-brown		71	X						
			5	50+	X						saturated
				50+	X						
	CL	FINE TO COARSE SANDY CLAY with some fine and coarse gravel; small to large cobbles; boulders; trace organics; light reddish-brown	10	50+	X						saturated hard
				46	X						
			15	45	X						
	CL/ CH	SILTY CLAY with trace fine and coarse gravel; some fine to coarse sand; trace organics; light reddish-brown		57	X	31	87	61	55	33	saturated hard
			20	20	X						
		grades with trace fine to coarse sand		18	X	29	93	66	45	28	very stiff
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3A

Exhibit B-Geologic and Geotechnical Reports

GSH		BORING LOG					BORING: B-1				
		Page: 2 of 2									
CLIENT: Lewis Homes		PROJECT NUMBER: 1661-08N-16									
PROJECT: The Bridges at Wolf Creek Phase I		DATE STARTED: 5/4/16				DATE FINISHED: 5/4/16					
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
			25								
				18	X						
											hard
				66	X						
			30								very stiff
				31	X	29	97	55	59	33	
											hard
				66	X						
			35								
				50+	X						
											very stiff
				41	X						
			40								hard
				48	X						
				50+	X						
			45								
				55	X						
		End of Exploration at 45.0' due to auger refusal Installed 1.25" diameter slotted PVC pipe to 45.0'									
			50								

See Subsurface Conditions section in the report for additional information.

FIGURE 3A
(continued)


Exhibit B-Geologic and Geotechnical Reports

GSH		BORING LOG				BORING: B-2					
		Page: 1 of 2									
CLIENT: Lewis Homes		PROJECT NUMBER: 1661-08N-16									
PROJECT: The Bridges at Wolf Creek Phase I		DATE STARTED: 5/5/16				DATE FINISHED: 5/6/16					
LOCATION: Northwest of Fairway Drive, near Eden, Weber County, Utah		GSH FIELD REP.: AA									
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger		HAMMER: Automatic		WEIGHT: 140 lbs		DROP: 30"					
GROUNDWATER DEPTH: 5.0' (5/5/16), 3.2' (7/1/16)		ELEVATION: ---									
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	CL	SILTY CLAY with some fine to coarse sand; cobbles and boulders; trace organics; major roots (topsoil) to 3"; brown		50+	X						
▼			5	29	X	21	99				saturated very stiff
		grades light reddish-brown		58	X						hard
			10	50+	X						
				50+	X						
		grades with some fine and coarse gravel	15	50+	X						
				25	X	30	92				very stiff
			20	17	X	29	89	44	22		stiff
				50+	X						
	BR	BEDROCK	25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3B



Exhibit B-Geologic and Geotechnical Reports

 GSH		BORING LOG Page: 2 of 2					BORING: B-2				
CLIENT: Lewis Homes			PROJECT NUMBER: 1661-08N-16								
PROJECT: The Bridges at Wolf Creek Phase I			DATE STARTED: 5/5/16				DATE FINISHED: 5/6/16				
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
	BR	BEDROCK brown	25								
		End of Exploration at 33.0' due to auger refusal Installed 1.25" diameter slotted PVC pipe to 33.0'	30								
			35								
			40								
			45								
			50								

See Subsurface Conditions section in the report for additional information.

FIGURE 3B
(continued)

Exhibit B-Geologic and Geotechnical Reports

		<h2 style="margin: 0;">BORING LOG</h2> <p style="margin: 0;">Page: 1 of 2</p>			<h2 style="margin: 0;">BORING: B-3</h2>							
CLIENT: Lewis Homes					PROJECT NUMBER: 1661-08N-16							
PROJECT: The Bridges at Wolf Creek Phase I					DATE STARTED: 5/24/16		DATE FINISHED: 5/24/16					
LOCATION: Northwest of Fairway Drive, near Eden, Weber County, Utah					GSH FIELD REP.: JM							
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger					HAMMER: Automatic		WEIGHT: 140 lbs		DROP: 30"			
GROUNDWATER DEPTH: 5.0' (5/24/16), 5.5' (7/1/16)					ELEVATION: ---							
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS	
	CL	Ground Surface	0								moist very stiff	
		with trace fine and coarse gravel; trace fine to coarse sand; large cobbles; trace organics; brown										
		grades light brown	5	31	X							saturated
		grades reddish-brown	10	36	X							
		grades gray	15	27	X							
		grades light brown	20	65	X							stiff
		grades reddish-brown	25	36	X							hard
		grades gray	30	36	X							very stiff
		grades light brown	35	36	X							
		grades reddish-brown	40	36	X							

See Subsurface Conditions section in the report for additional information.

FIGURE 3C

Exhibit B-Geologic and Geotechnical Reports

GSH		BORING LOG				BORING: B-3					
		Page: 2 of 2									
CLIENT: Lewis Homes		PROJECT NUMBER: 1661-08N-16									
PROJECT: The Bridges at Wolf Creek Phase I		DATE STARTED: 5/24/16				DATE FINISHED: 5/24/16					
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		grades whitish-gray	25		X						
			30		X						
			28		X						
			30		X						
			22		X						
			43		X						
		grades reddish-brown	35		X						hard
			46		X						
			85		X						
			40		X						
		End of Exploration at 41.5' due to auger refusal Installed 1.25" diameter slotted PVC pipe to 40.0'	80		X						
			45								
			50								

See Subsurface Conditions section in the report for additional information.

FIGURE 3C
(continued)

Exhibit B-Geologic and Geotechnical Reports

GSH		BORING LOG				BORING: B-4					
		Page: 1 of 2									
CLIENT: Lewis Homes		PROJECT NUMBER: 1661-08N-16									
PROJECT: The Bridges at Wolf Creek Phase I		DATE STARTED: 5/19/16		DATE FINISHED: 5/19/16							
LOCATION: Northwest of Fairway Drive, near Eden, Weber County, Utah		GSH FIELD REP.: AA/JM									
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger		HAMMER: Automatic		WEIGHT: 140 lbs		DROP: 30"					
GROUNDWATER DEPTH: 7.5' (5/19/16), 7.3' (7/1/16)		ELEVATION: ---									
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								moist very stiff
	CL	SILTY CLAY with trace fine and coarse gravel; trace fine to coarse sand; trace organics; major roots (topsoil) to 2"; brown		21	X						
		grades brownish-gray	5	23	X						
				12	X						saturated
	GC	CLAYEY GRAVEL with trace fine to coarse sand; trace organics; brown to grayish-green	10	50+	X						saturated hard
				35	X			47	31		very stiff
			15	34	X						
	CL	SANDY CLAY with trace fine and coarse gravel; whitish-gray		7	X						saturated stiff
			20	12	X						
		grades with trace fine to coarse sand; reddish-brown		31	X						very stiff
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3D

Exhibit B-Geologic and Geotechnical Reports

GSH		BORING LOG				BORING: B-4					
		Page: 2 of 2									
CLIENT: Lewis Homes		PROJECT NUMBER: 1661-08N-16									
PROJECT: The Bridges at Wolf Creek Phase I		DATE STARTED: 5/19/16				DATE FINISHED: 5/19/16					
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
			25		X						hard
				35	X						
				55	X	25	96				
			30		X						
				53	X	21	100				
				94	X						
			35		X						
		End of Exploration at 36.5' Installed 1.25" diameter slotted PVC pipe to 36.0'		65	X						
			40								
			45								
			50								

See Subsurface Conditions section in the report for additional information.

FIGURE 3D
(continued)

Exhibit B-Geologic and Geotechnical Reports

GSH		BORING LOG				BORING: B-5						
		Page: 1 of 2										
CLIENT: Lewis Homes		PROJECT NUMBER: 1661-08N-16										
PROJECT: The Bridges at Wolf Creek Phase I		DATE STARTED: 5/20/16				DATE FINISHED: 5/20/16						
LOCATION: Northwest of Fairway Drive, near Eden, Weber County, Utah		GSH FIELD REP.: JM										
DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger		HAMMER: Automatic		WEIGHT: 140 lbs		DROP: 30"						
GROUNDWATER DEPTH: 5.0' (5/20/16), 10.5' (7/1/16)		ELEVATION: ---										
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS	
		Ground Surface	0								moist very stiff	
	CL	SILTY CLAY with trace fine and coarse gravel; trace fine to coarse sand; trace organics; brown grades light gray to white		37	X							
▼			5	69	X							saturated hard
			10	69	X							
			10	28	X	31		75				very stiff
			15	40	X							
			15	35	X							
			20	43	X							hard
			20	37	X							very stiff
			25	56	X							hard
	GC		CLAYEY GRAVEL	25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3E

Exhibit B-Geologic and Geotechnical Reports

GSH		BORING LOG				BORING: B-5					
		Page: 2 of 2									
CLIENT: Lewis Homes		PROJECT NUMBER: 1661-08N-16									
PROJECT: The Bridges at Wolf Creek Phase I		DATE STARTED: 5/20/16				DATE FINISHED: 5/20/16					
WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		GC CLAYEY GRAVEL with trace fine to coarse sand; gray	25	38	X						moist very stiff
		CL/CH SILTY CLAY with trace fine and coarse gravel; trace fine to coarse sand; brownish-gray		53	X						moist hard
				30	63	X					
					42	X					very stiff
				35	50+	X					hard
					57	X	22		71	59	35
			40	50+	X						
		End of Exploration at 41.5' due to auger refusal Installed 1.25" diameter slotted PVC pipe to 40.0'									
			45								
			50								

See Subsurface Conditions section in the report for additional information.

FIGURE 3E
(continued)

Exhibit B-Geologic and Geotechnical Reports

CLIENT: Lewis Homes
 PROJECT: The Bridges at Wolf Creek Phase I
 PROJECT NUMBER: 1661-08N-16

KEY TO BORING LOG

WATER LEVEL	U S C S	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
-------------	------------------	-------------	-------------	------------	---------------	--------------	-------------------	---------------	------------------	------------------	---------

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫

COLUMN DESCRIPTIONS

<p>① Water Level: Depth to measured groundwater table. See symbol below.</p> <p>② USCS: (Unified Soil Classification System) Description of soils encountered; typical symbols are explained below.</p> <p>③ Description: Description of material encountered; may include color, moisture, grain size, density/consistency,</p> <p>④ Depth (ft.): Depth in feet below the ground surface.</p> <p>⑤ Blow Count: Number of blows to advance sampler 12" beyond first 6", using a 140-lb hammer with 30" drop.</p> <p>⑥ Sample Symbol: Type of soil sample collected at depth interval shown; sampler symbols are explained below.</p> <p>⑦ Moisture (%): Water content of soil sample measured in laboratory; expressed as percentage of dryweight of</p> <p>⑧ Dry Density (pcf): The density of a soil measured in laboratory; expressed in pounds per cubic foot.</p> <p>⑨ % Passing 200: Fines content of soils sample passing a No. 200 sieve; expressed as a percentage.</p>	<p>⑩ Liquid Limit (%): Water content at which a soil changes from plastic to liquid behavior.</p> <p>⑪ Plasticity Index (%): Range of water content at which a soil exhibits plastic properties.</p> <p>⑫ Remarks: Comments and observations regarding drilling or sampling made by driller or field personnel. May include other field and laboratory test results using the following abbreviations:</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; border: 1px solid black; padding: 2px;"> <p>Weakly: Crumbles or breaks with handling or slight finger pressure.</p> <p>Moderately: Crumbles or breaks with considerable finger pressure.</p> <p>Strongly: Will not crumble or break with finger pressure.</p> </td> <td style="width: 33%; border: 1px solid black; padding: 2px;"> <p>Trace <5%</p> <p>Some 5-12%</p> <p>With > 12%</p> </td> <td style="width: 33%; border: 1px solid black; padding: 2px;"> <p>Dry: Absence of moisture, dusty, dry to the touch.</p> <p>Moist: Damp but no visible water.</p> <p>Saturated: Visible water, usually soil below water table.</p> </td> </tr> </table>	<p>Weakly: Crumbles or breaks with handling or slight finger pressure.</p> <p>Moderately: Crumbles or breaks with considerable finger pressure.</p> <p>Strongly: Will not crumble or break with finger pressure.</p>	<p>Trace <5%</p> <p>Some 5-12%</p> <p>With > 12%</p>	<p>Dry: Absence of moisture, dusty, dry to the touch.</p> <p>Moist: Damp but no visible water.</p> <p>Saturated: Visible water, usually soil below water table.</p>
<p>Weakly: Crumbles or breaks with handling or slight finger pressure.</p> <p>Moderately: Crumbles or breaks with considerable finger pressure.</p> <p>Strongly: Will not crumble or break with finger pressure.</p>	<p>Trace <5%</p> <p>Some 5-12%</p> <p>With > 12%</p>	<p>Dry: Absence of moisture, dusty, dry to the touch.</p> <p>Moist: Damp but no visible water.</p> <p>Saturated: Visible water, usually soil below water table.</p>		

CEMENTATION: MODIFIERS: MOISTURE CONTENT (FIELD TEST):

Descriptions and stratum lines are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on the logs apply only at the specific boring locations and at the time the borings were advanced; they are not warranted to be representative of subsurface conditions at other locations or times.

MAJOR DIVISIONS	USCS SYMBOLS	TYPICAL DESCRIPTIONS											
COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	GRAVELS More than 50% of coarse fraction retained on No. 4 sieve.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">CLEAN GRAVELS (little or no fines)</td> <td style="width: 10%; text-align: center;">GW</td> <td>Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines</td> </tr> <tr> <td>GRAVELS WITH FINES (appreciable amount of fines)</td> <td style="text-align: center;">GP</td> <td>Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines</td> </tr> <tr> <td rowspan="2">CLEAN SANDS (little or no fines)</td> <td style="text-align: center;">GM</td> <td>Silty Gravels, Gravel-Sand-Silt Mixtures</td> </tr> <tr> <td style="text-align: center;">GC</td> <td>Clayey Gravels, Gravel-Sand-Clay Mixtures</td> </tr> </table>	CLEAN GRAVELS (little or no fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines	GRAVELS WITH FINES (appreciable amount of fines)	GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines	CLEAN SANDS (little or no fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures	GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	CLEAN GRAVELS (little or no fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines										
	GRAVELS WITH FINES (appreciable amount of fines)	GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines										
	CLEAN SANDS (little or no fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures										
GC		Clayey Gravels, Gravel-Sand-Clay Mixtures											
SANDS More than 50% of coarse fraction passing through No. 4 sieve.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">CLEAN SANDS (little or no fines)</td> <td style="width: 10%; text-align: center;">SW</td> <td>Well-Graded Sands, Gravelly Sands, Little or No Fines</td> </tr> <tr> <td rowspan="2">SANDS WITH FINES (appreciable amount of fines)</td> <td style="text-align: center;">SP</td> <td>Poorly-Graded Sands, Gravelly Sands, Little or No Fines</td> </tr> <tr> <td style="text-align: center;">SM</td> <td>Silty Sands, Sand-Silt Mixtures</td> </tr> <tr> <td style="text-align: center;">SC</td> <td>Clayey Sands, Sand-Clay Mixtures</td> </tr> </table>	CLEAN SANDS (little or no fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines	SANDS WITH FINES (appreciable amount of fines)	SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines	SM	Silty Sands, Sand-Silt Mixtures	SC	Clayey Sands, Sand-Clay Mixtures		
CLEAN SANDS (little or no fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines											
SANDS WITH FINES (appreciable amount of fines)	SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines											
	SM	Silty Sands, Sand-Silt Mixtures											
SC	Clayey Sands, Sand-Clay Mixtures												
FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size.	SILTS AND CLAYS Liquid Limit less than 50%	ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity										
		CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays										
	SILTS AND CLAYS Liquid Limit greater than 50%	OL	Organic Silts and Organic Silty Clays of Low Plasticity										
		MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils										
CH	Inorganic Clays of High Plasticity, Fat Clays												
OH	Organic Silts and Organic Clays of Medium to High Plasticity												
HIGHLY ORGANIC SOILS	PT	Peat, Humus, Swamp Soils with High Organic Contents											

STRATIFICATION:

DESCRIPTION	THICKNESS
Seam	up to 1/8"
Layer	1/8" to 12"

Occasional:
One or less per 6" of thickness

Numerous:
More than one per 6" of thickness

TYPICAL SAMPLER GRAPHIC SYMBOLS

	Bulk/Bag Sample
	Standard Penetration Split Spoon Sampler
	Rock Core
	No Recovery
	3.25" OD, 2.42" ID D&M Sampler
	3.0" OD, 2.42" ID D&M Sampler
	California Sampler
	Thin Wall

WATER SYMBOL

Water Level

Note: Dual Symbols are used to indicate borderline soil classifications.

FIGURE 5

GSH
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