

NOTICE OF MEETING
PLANNING COMMISSION
CITY OF ST. GEORGE
WASHINGTON COUNTY, UTAH

Public Notice

Notice is hereby given that the Planning Commission of the City of St. George, Washington County, Utah, will hold a **Planning Commission** meeting in the City Council Chambers, 61 S Main St, St George, Utah, on **Tuesday, October 13, 2026**, commencing at **5:00 p.m.**

The agenda for the meeting is as follows:

Call to Order

Flag Salute

Call for Disclosures

1. **HILLSIDE DEVELOPMENT PERMIT - Desert Haven**

Consider a request for a hillside development permit to allow disturbance of areas in the 20-30%, 30-40%, and 40% and above slope areas, in order to develop single-family homes. The applicant is DSG Engineering, Inc., and the representative is Ken Miller. Case No. 2026-HS-007 (Staff – Brian Dean)

2. **PRELIMINARY PLAT - Desert Haven**

Consider a request for a 29-lot residential preliminary plat called Desert Haven Phase 1. The applicant is DSG Engineering, Inc., and the representative is Ken Miller. Case No. 2026-PP-020 (Staff – Brian Dean)

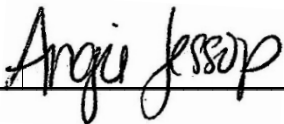
3. **MINUTES**

Consider a request to approve the meeting minutes from the September 22, 2026, meeting.

4. **CITY COUNCIL ACTIONS**

Report on items heard at the October 1, 2026, City Council meeting.

1. 2026-ZC-014 – Horizon Ridge
2. 2026-ZC-015 Strap Tank Restaurant & Brewery
3. 2026-CUP-006 Anthemnet/VZW White Dome
4. 2026-ZC-016 Sullivan Commercial Parcel
5. 2026-ZC-001 RL Wyman 2450 S



Angie Jessop – Community Development Office Supervisor

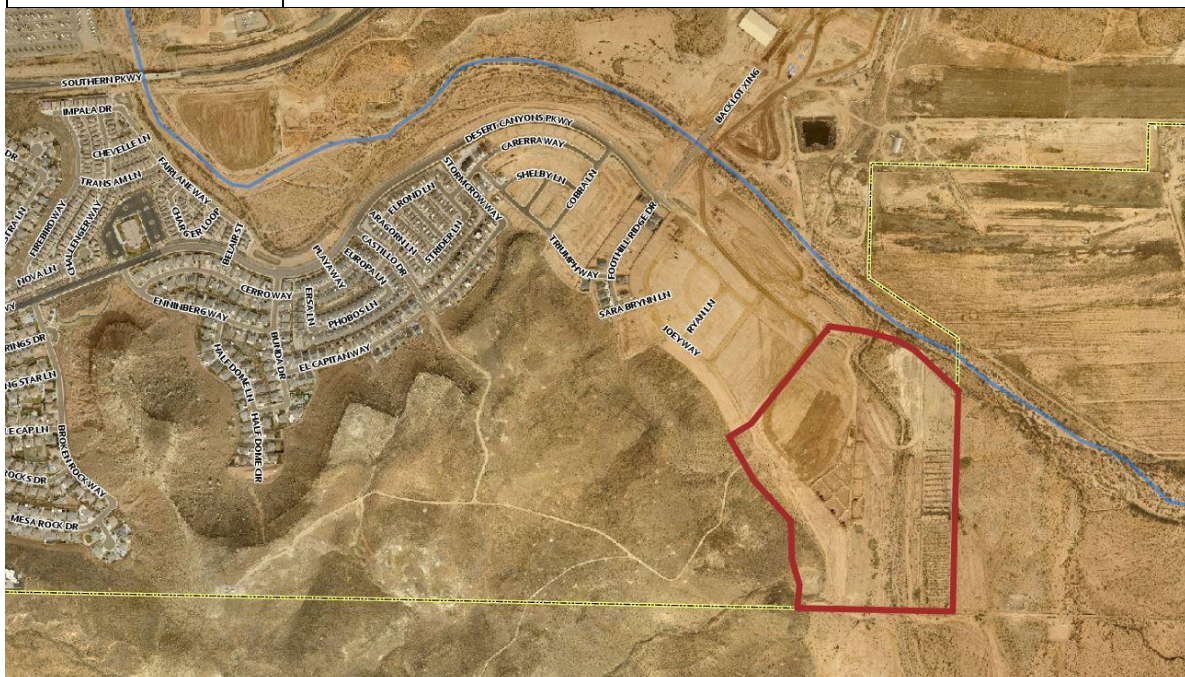
October 9, 2026

Date

Reasonable Accommodation: The City of St. George will make efforts to provide reasonable accommodations to disabled members of the public in accessing City programs. Please contact the City Human Resources Office at (435) 627-4674 at least 24 hours in advance if you have special needs.

HILLSIDE REVIEW BOARD AGENDA REPORT: **08/26/2026**
PLANNING COMMISSION AGENDA REPORT: **09/22/2026**

Desert Haven Hillside Development Permit (Case No. 2026-HS-003)		
Request:	A Hillside Development Permit to allow disturbance of areas in the 20-30%, 30-40%, and 40% and above slope areas. This application is required in order to develop single-family homes.	
Applicant:	DSG Engineering, Inc, Ken Miller	
Location:	Generally located south of the Fort Pierce Wash, along the Utah-Arizona border.	
General Plan:	Medium Density Residential (MDR)	
Existing Zoning:	R-1 (Single-Family no minimum square footage, 40-foot minimum lot width/frontage)	
Surrounding Zoning:	North	A-20 (Agriculture 20-acre minimum lot size)
	South	Arizona
	East	Washington County
	West	PD-R (Planned Development Residential) and A-20 (Agriculture 20-acre minimum lot size)
Land Area:	Approximately 55 acres	



BACKGROUND

This is a request to obtain a hillside permit for the property generally located south of the Fort Pierce Wash, along the Utah-Arizona border. (See Exhibit A, Vicinity Map). This property was included in a 212.679-acre annexation approved by the City on November 7, 2019. On May 7, 2020, the property received an MDR (Medium Density Residential) General Plan land use designation. The City Council recently approved a zone change to an R-1 (Single-Family Residential with no minimum lot size requirement and 40-foot minimum lot width/frontage) zoning district on July 2, 2026. The R-1 zoning district is a recently adopted residential zone that was approved by the City Council on March 25, 2026. The R-1 zone provides flexibility in lot sizes by eliminating lot area requirements. However, the density must still meet the General Plan designation of MDR (Medium Density Residential) and no more than 9 units per acre.

According to the applicant and documents provided, the Desert Haven Subdivision is relatively flat. A small portion of the west side of the project is proposed at the toe of the existing hillside. The applicant is proposing grading that includes cutting into portions of the hillside with existing slopes in the 20% to 30% range. The applicant has provided grading and drainage plans which detail the cut slopes. Located outside of the proposed lot boundaries, cut slopes will include a drainage collection and conveyance swale at the toe of the slope. These drainage swales and cut slopes will be owned and maintained by the HOA.

The applicant has provided a Slope Summary showing the approximate proposed disturbed area for your analysis. This summary shows the following buildable areas:

DESERT HAVEN SLOPE ANALYSIS
Proposed Disturbed Area Only

NUMBER	MINIMUM SLOPE, %	MAXIMUM SLOPE, %	DISTURBED AREA, SF	DISTURBED AREA, AC	PERCENT OF OVERALL HILLSIDE AREA, %	MAXIMUM ALLOWABLE SLOPE DISTURBANCE, %	REMAINING MAXIMUM ALLOWABLE SLOPE DISTURBANCE, AC
1	0	20	69257	1.59	15.09%	NA	NA
2	20	30	38499	0.88	2.08%	30.00%	11.88
3	30	40	407	0.01	0.06%	5.00%	0.83
4	40	100+	0	0.00	0.00%	0.00%	0.00
			108163	2.48	2.32%		

The Hillside Review Board held a public meeting on August 26, 2026, to determine what conditions exist on the ground and if there are any unique features that should be protected. They analyzed proposed concept plans, grading plans, geotechnical reports, and slope maps. During the meeting the applicant made it known that the planned cuts will be mitigated with a rock armoring material of basalt or natural type cobble to mitigate scaring. The Hillside Review Board recommended approval of the application with a 4-0 vote.

APPLICABLE ORDINANCE(S) (*Selected portions*)

10-13A-1: Density and Disturbance Standards

- A. The hillside development overlay zone (HDOZ) limits development densities and provides specific development incentives to transfer underlying zone densities from hillsides (sending areas) to less steep slopes or more safe development areas (receiving areas), within a development.
- B. For those portions of a proposed development with natural slopes twenty percent (20%) or less, development density follows the density and development standards in the underlying zone.
- C. For those portions of a proposed development with natural slopes from twenty-one percent (21%) to thirty percent (30%), development activity shall not disturb more than thirty percent (30%) of the parcel within this slope category.
- D. For those portions of a proposed development with natural slopes from thirty-one percent (31%) to forty percent (40%), development activity shall not disturb more than five percent (5%) of the area within this slope category.
- E. A proposed development may not disturb slopes in excess of forty percent (40%).

10-13A-2: Slope and Slope Areas Determined

- A. Slope shall be determined for each significant portion of development parcel.
- B. *Procedure*: The applicant shall map the location of the natural slope by using the following procedure:
 - 1. *Preparation of Contour Maps*: The applicant shall submit an accurate, current contour map, prepared and certified by a licensed professional engineer or surveyor, which shows all land contours at intervals no greater than five feet (5'), drawn at a one inch equals one hundred feet (1" = 100') scale maximum.
 - 2. *Verification through Field Surveys*: The city engineer or designee may require the applicant to submit a field survey to verify the accuracy of the contour map.
- C. *Determination of Slope Areas*: Using the contour map, natural slopes shall be calculated using points identified as natural slopes of twenty percent (20%), thirty percent (30%), and forty percent (40%), and shall

be located on the contour map and connected by a continuous line. That area bounded by said lines and intersecting property lines shall be used for determining project density. Small washes or outcrops, which have slopes distinctly different from surrounding property, and are not part of the contiguous topography, may be excluded from the slope determination.

EXHIBITS PROVIDED

1. Exhibit A – General Plan Maps
“Exhibit A” in the packet are the maps the applicant supplied showing the existing and proposed General Plan maps. The proposed map will be revised based on HSRB discussion.
2. Exhibit B – Grading and Drainage Plan
“Exhibit B” in the packet is a Grading and Drainage plan.
3. Exhibit C – Slope Map
“Exhibit C” in the packet is a slope summary.
4. Exhibit D – Slope Summary
“Exhibit D” in the packet is a slope summary.
5. Exhibit E – Desert Canyons Geotechnical Study
“Exhibit E” in the packet is the Desert Canyons Geotechnical report by AGEC.
6. Exhibit F – Desert Haven Drainage Study
“Exhibit F” in the packet is the Desert Haven Drainage Study.
7. Exhibit G – Update Letter to Geotechnical Evaluation
“Exhibit G” in the packet is the GES update letter completed in 2024 for this area.

RECOMMENDATION

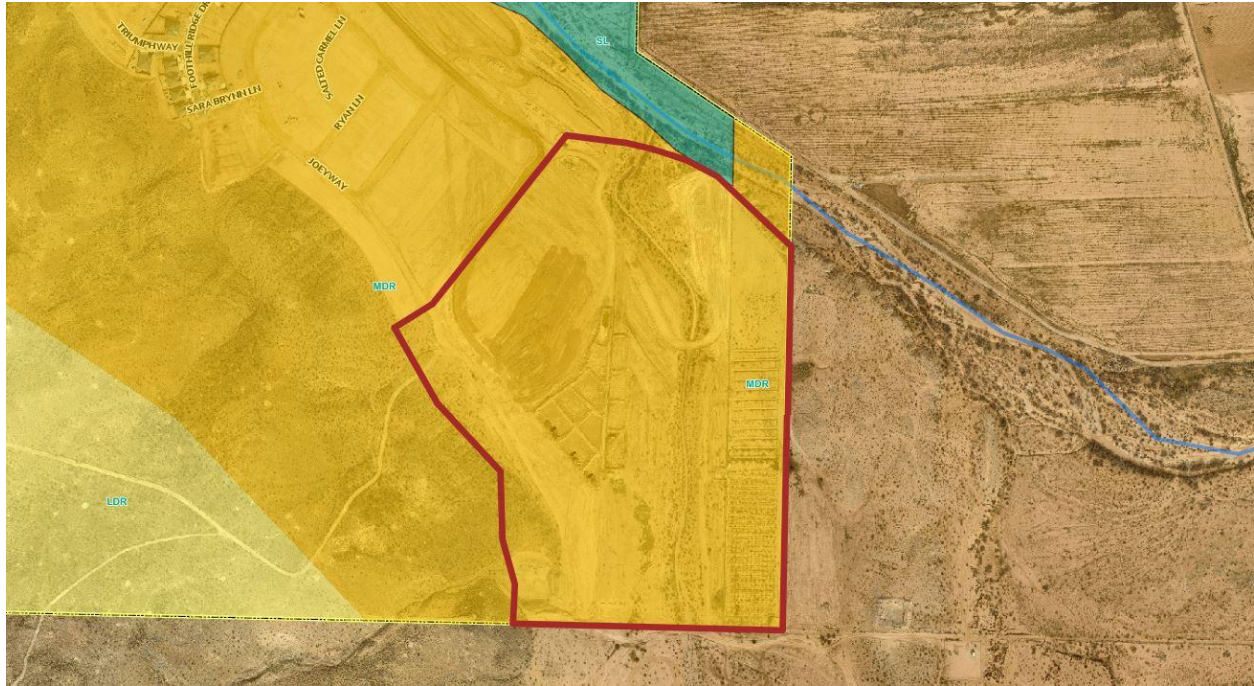
Section 10-13A-8(B)(1) of the “Hillside Review Board Powers and Duties” states that the hillside board can make recommendations to “adopt, modify or reject a proposal” to the Planning Commission (PC).

The Hillside Review Board, at their meeting held August 26, 2026, recommended approval of the application with a 4-0 vote.

FINDINGS

1. The proposed development generally aligns with the intent of the Hillside Development Overlay Zone in that it concentrates density in more buildable areas while limiting disturbance on steeper slopes.
2. Based on the materials provided, including the slope analysis and grading plans, the project appears to stay within the allowable disturbance thresholds for slope between 20% and 40%, and avoids disturbance in areas exceeding 40% slope, consistent with City ordinance requirements.

EXHIBIT A
DESERT HAVEN
General Plan – MDR (Medium Density Residential)



Zoning - R-1

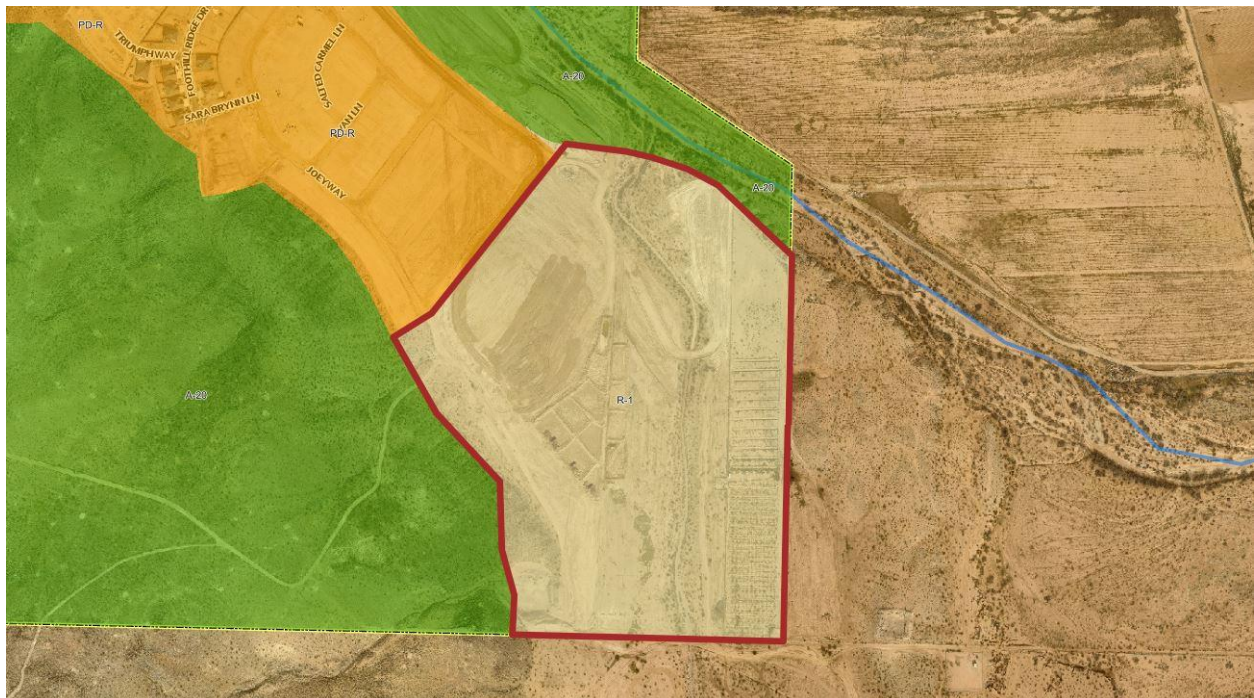
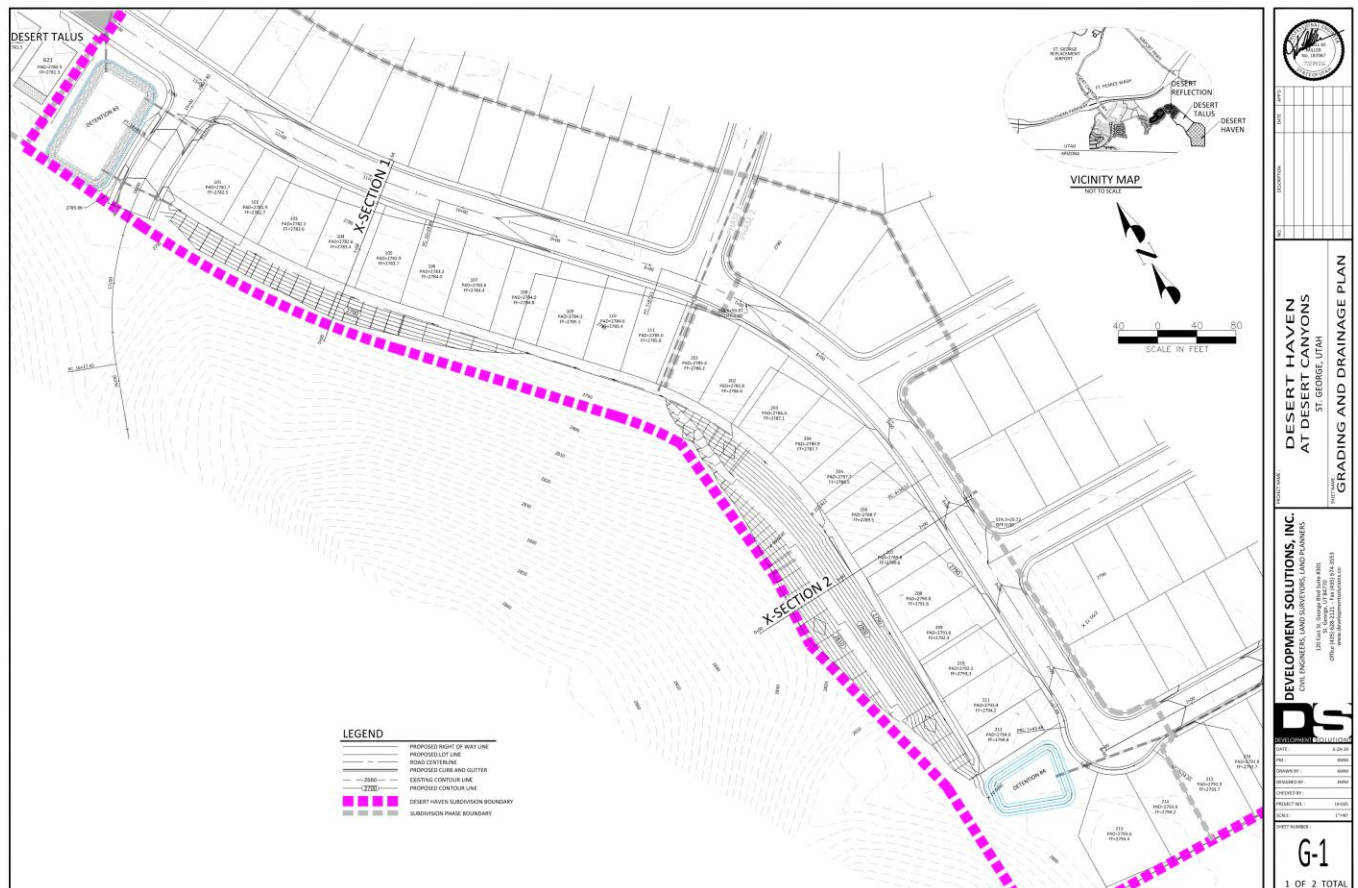
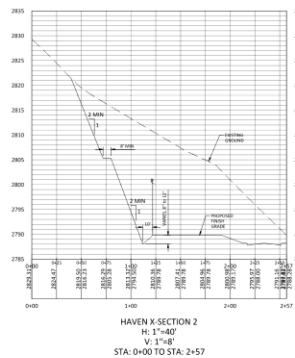
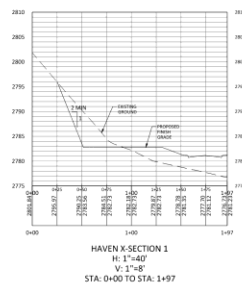


EXHIBIT B
DESERT HAVEN GRADING AND DRAINAGE PLAN AND
CROSS SECTIONS



DESERT TALUS



DESIGNER	
CHECKED BY	
DATE	
DESERT HAVEN AT DESERT CANYONS ST. GEORGE, UTAH	
CROSS SECTIONS	
DEVELOPMENT SOLUTIONS, INC. CIVIL ENGINEERS, LAND SURVEYORS, AND PLANNERS 1234 E. 1000 N., SUITE 200 ST. GEORGE, UT 84770 PHONE: (435) 633-1234 WWW.DSINC.COM	
PROJECT NUMBER: 2026-HS-007	
SHEET NUMBER: G-2	
2 OF 2 TOTAL	

EXHIBIT C

DESERT HAVEN SLOPE MAP

EXHIBIT D DESERT HAVEN SLOPE SUMMARY

DESERT CANYONS SLOPE SUMMARY
CONTIGUOUS HILLSIDE AREA OUTSIDE OF EXISTING AND PROPOSED DEVELOPMENT

NUMBER	MINIMUM SLOPE, %	MAXIMUM SLOPE, %	AREA, SF	AREA, AC	PERCENT OF TOTAL AREA, %
1	0	20	459019	10.54	9.82%
2	20	30	1853289	42.55	39.67%
3	30	40	732458	16.81	15.68%
4	40	100+	1627237	37.36	34.83%
			4672003	107.25	100.00%

DESERT HAVEN SLOPE ANALYSIS
Proposed Disturbed Area Only

NUMBER	MINIMUM SLOPE, %	MAXIMUM SLOPE, %	DISTURBED AREA, SF	DISTURBED AREA, AC	PERCENT OF OVERALL HILLSIDE AREA, %	MAXIMUM ALLOWABLE SLOPE DISTURBANCE, %	REMAINING MAXIMUM ALLOWABLE SLOPE DISTURBANCE, AC
1	0	20	69257	1.59	15.09%	NA	NA
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3	30	40	407	0.01	0.06%	5.00%	0.83
4	40	100+	0	0.00	0.00%	0.00%	0.00
			108163	2.48	2.32%		

EXHIBIT E
DESERT CANYONS GEOTECHNICAL REPORT BY AGE



GEOTECHNICAL INVESTIGATION
DESERT CLIFFS AREA 165 ACRES AT DESERT CANYONS
ST. GEORGE, UTAH

PREPARED FOR:



1472 EAST 3950 SOUTH
ST. GEORGE, UTAH 84790

ATTENTION: CURT GORDON

PROJECT NO. 2200519

MAY 16, 2022

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SUMMARY

1. AGEC conducted a Geotechnical Investigation to define subsurface conditions and to provide geotechnical recommendations for the proposed residential development.
2. The subsurface profile observed within the test pits generally consists of silty sand to sandy silt overlying silty gravel with sand underlain by siltstone, mudstone, and sandstone bedrock. A layer of sandy lean clay was encountered at approximately 12 feet below grade in TP-20. Practical excavator refusal was encountered on sandstone bedrock and dense gravels in test pits TP-2, TP-7, TP-10, TP-11, TP-12, TP-13, TP-14, TP-15, TP-17, TP-18, and TP-20 at depths ranging from approximately 7 to 20 feet below the existing grade.
3. Subsurface water was not encountered within the test pits to the maximum depth investigated, approximately 20 feet. Fluctuations in the groundwater level may occur over time. An evaluation of such fluctuations is beyond the scope of this report.
4. The on-site soils and bedrock in their existing condition are not suitable to support the proposed construction. The site is suitable for the proposed slab-on-grade residences provided recommendations within this report are followed. If basements or pools are proposed, additional subsurface investigation and grading recommendations are required.
5. The upper approximately 0 to 18½ feet of the near surface overburden soil (varies across the site) is loose, dry and potentially collapsible when wetted. Prior to placing fill or concrete, we recommend that the full depth of potentially collapsible soil be removed. The approximate depth of removal is shown on the site plan and test pit logs (Figures 2 and 3).

Alternatively, a soil treatment process known as pre-wetting may be implemented to treat the collapsible soils by adding moisture to the "under-saturated" soils. The building pads may be graded into a series of terraced ponds. The ponds may then be filled with appropriate volume of water to pre-wet the underlying "under-saturated" soils to essentially densify the soils subsequently reducing the collapse potential prior to construction. This process is currently being implemented in the St. George area to treat collapsible soils.

6. The proposed residences may be supported on conventional spread footings bearing on properly compacted structural fill underlain by a properly prepared subgrade. Specifically, the subgrade should be prepared during site grading by overexcavating the building pads to remove unsuitable soils as recommended in the Subgrade Preparation section of this report.

7. The on-site soils, and properly processed siltstone and sandstone bedrock, free of organics and debris are suitable for use as structural fill, site grading fill, wall backfill and utility trench backfill. The bedrock should be processed such that the maximum particle size is 4 inches and at least 50 percent of the material passes the No. 4 sieve. The mudstone bedrock is not suitable for use and should be disposed of off site.
8. Site drainage recommendations should be implemented as recommended in the Site Drainage section of this report.
9. Detailed recommendations for subgrade preparation, materials, foundations, drainage and pavement are included in the report.
10. The information provided in this summary should not be used independent of that provided within the body of this report.

SCOPE

This report presents the results of a geotechnical investigation for the proposed Desert Cliffs Area (165 Acres) at Desert Canyons planned residential area to be located in St. George, Utah, as shown in Figure 1. This report presents the subsurface conditions encountered, laboratory test results, and recommendations for the project. This report was prepared in general accordance with the Geotechnical Engineering Services Agreement dated March 17, 2020 under Project No. 2200519.

Field exploration was conducted to obtain information on the subsurface conditions and to obtain samples. Information obtained from the field was used to define conditions at the site and to develop recommendations for the proposed development.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction are included in the report.

SITE CONDITIONS

The site is located east and southeast of the planned Desert Reflection subdivision. The area to the north, east and south is undeveloped. The project site generally slopes down from the west to the east with a few small washes that traverse the area in a northwest to southeast direction. Vegetation at the site consists generally of desert grass and sage brush.

Grubbing of a portion of the site has been performed. Test pit locations and elevations reflect the pre-grubbed elevations.

FIELD STUDY

On June 23, 24, and 25, 2020 an engineer from AGECEC visited the site and observed the excavation of 20 test pits (planned TP-5 was inaccessible) at the approximate locations shown on the Site Plan, Figure 2. The test pits were excavated with a trackhoe excavator. The subsurface soil profile was logged and soil samples were obtained.

SUBSURFACE SOIL CONDITIONS

The subsurface profile observed within the test pits generally consists of silty sand to sandy silt overlying silty gravel with sand underlain by siltstone, mudstone, and sandstone bedrock. A layer of sandy lean clay was encountered at approximately 12 feet below grade in TP-20. Practical excavator refusal was encountered on sandstone bedrock and dense gravels in test pits TP-2, TP-7, TP-10, TP-11, TP-12, TP-13, TP-14, TP-15, TP-17, TP-18, and TP-20 at depths ranging from approximately 7 to 20 feet below the existing grade.

Laboratory testing and observations of the subsurface soil during our investigation indicate the upper approximately 0 to 18½ feet of the near surface sandy to silty soil is loose, dry and potentially collapsible when wetted.

Detailed descriptions of the soil and bedrock types encountered follow.

Sandy Silt - The sandy silt is medium dense, dry, porous in upper layers, contains roots near the surface, various amounts of sand, and is light brown in color.

Laboratory tests conducted on samples of the sandy silt indicate in-place moisture contents ranging from less than 1 to 7 percent, in-place dry densities ranging from 82 to 95 pounds per cubic foot (pcf) and fines contents (percent passing the No. 200 sieve) ranging from 59 to 96 percent. One dimensional consolidation/collapse tests conducted on samples of the sandy silt material indicate that the material is

moderately moisture sensitive (collapsible) when wetted under a constant pressure of 1,000 pounds per square foot (psf) and slightly compressible under additional loading. Less than 1 percent and 2½ percent collapse potentials were measured during the consolidation/collapse tests.

Sandy Lean Clay - The sandy lean clay is medium dense to dense, dry, low plastic, and is light brown in color.

Laboratory tests conducted on samples of the sandy lean clay indicate an in-place moisture content of 4 percent, an in-place dry density of 101 pcf and a fines content of 76 percent. A one dimensional consolidation/swell test conducted on a sample of the sandy lean clay material indicates that the material is not moisture sensitive (expansive) when wetted under a constant pressure of 1,000 pounds per square foot (psf) and slightly compressible under additional loading.

Silty Sand - The silty sand is loose to dense, dry to moist, contains various amounts of gravel, and is light brown to red in color.

Laboratory tests conducted on samples of the silty sand indicate an in-place moisture content of 2 percent, an in-place dry density of 82 pcf and a fines content of 41 percent.

Silty Gravel with Sand - The silty gravel with sand is medium dense to very dense, dry, contains some cobbles to boulders, and is light grey to light brown in color.

Laboratory tests conducted on samples of the silty gravel with sand indicate an in-place moisture content of 2 percent, a gravel content (percent retained on the No. 4 sieve) of 30 percent and a fines content of 37 percent.

Sandstone Bedrock - The sandstone bedrock is hard, dry, contains some conglomerate layers throughout, and is yellow to green to grey in color.

Mudstone Bedrock - The mudstone bedrock is soft, moist, low to medium plastic, and is green in color.

Laboratory tests conducted on samples of the mudstone bedrock indicate an in-place moisture content of 2 percent, in-place dry densities of 115 and 141 pcf and fines contents of 75 and 98 percent. Atterberg Limits tests indicate liquid limits of 25 and 39 percent and plasticity indexes of 15 and 17 percent. One dimensional consolidation/swell tests conducted on samples of the mudstone bedrock indicate that the material is moderately moisture sensitive (expansive) when wetted under a constant pressure of 1,000 pounds per square foot (psf) and highly compressible under additional loading. Approximately ½ and 3 percent swell potentials were measured during the consolidation/swell tests.

The Logs, Legend and Notes of Test Pits are shown on Figures 3-7. Laboratory test results are also shown on Figures 3-6 and are summarized in the Summary of Laboratory Test Results, Table 1. The One-dimensional Consolidation/Collapse/Swell Test Results are shown graphically on Figures 8-11.

SUBSURFACE WATER

Subsurface water was not encountered within the test pits to the maximum depth investigated, approximately 20 feet. Fluctuations in the groundwater level may occur over time. An evaluation of such fluctuations is beyond the scope of this report.

PROPOSED CONSTRUCTION

The property is proposed to be developed into a residential subdivision. The subdivision will include roadways, site improvements and underground utilities. Additionally, we anticipate building pads will be constructed to support single family, slab-on-grade residences.

Single-family, slab-on-grade residences are proposed for construction and will consist of single and multi-story construction. The residences will be constructed using conventional spread footings with slab-on-grade floors. The residences will likely be constructed with wood framing, stucco or rock veneer, and tile roofs. We do not anticipate the use of basements. If basements or pools are desired, AGECE should evaluate them on an individual case.

For design purposes, we have assumed wall loads of up to 3 kips per linear foot and column loads of up to 25 kips. As part of the development, we understand that roadways, utilities and city improvements will also be included. The roadways will likely include 45 and 50-foot right-of-ways (ROW). For design purposes, we have utilized a Traffic Index (TI) of 5 for 45 and 50-foot ROWs in accordance with the City of St. George standards. When a grading plan is completed it should be shared with AGECE to update the recommendations within this report if needed.

If the proposed construction, building loads or pavement requirements are significantly different from those listed, we should be notified so that we can reevaluate our recommendations.

RECOMMENDATIONS

Based on our experience in the area, the subsurface conditions encountered, laboratory test results, and the proposed construction, the following recommendations are given:

A. Site Grading

1. Subgrade Preparation

General - Prior to placing fill or concrete beneath building areas, pavement/flatwork or site improvements, the site should be grubbed to remove the existing vegetation and soil containing significant roots and organics. Organics and vegetation should be disposed of off-site.

The grubbed soil may be stockpiled for use in landscaped areas. If this soil is placed in landscaped areas, CMU fence footings or other structures/improvements which may be supported in these areas (above the grubbed soil) should be overexcavated to allow for the placement of properly compacted structural fill which extends to the appropriate depth as stated below.

Loose, Dry Collapsible Soil (buildings and structures) - Laboratory testing and observations of the subsurface soil during our investigation indicate the upper approximately 0 to 18 ½ feet of the near surface overburden soil (varies across the site) is loose, dry and potentially collapsible when wetted. Prior to placing fill or concrete, we recommend that the full depth of potentially collapsible soil be removed. The approximate depth of removal is shown on the site plan and test pit logs (Figures 2 and 3). This soil is unsuitable in its existing condition to support the proposed construction.

The limits of overexcavation should extend at least 5 feet beyond the perimeter of the proposed building pads, including patios, porches and porch columns. The lateral extent of the overexcavation should be determined by survey and is the responsibility of the owner/contractor.

Consideration should also be given to extending the overexcavation to include areas which will support flatwork and other improvements such as masonry fences.

Alternative Collapsible Soil (buildings and structures) - As an alternative to removing the full depth of the collapsible soil, a process known as “pre-wetting” may be used to add moisture to the under-saturated soils. This process is intended to improve the support condition of the underlying soils by adding moisture and subsequently reducing the collapse potential prior to construction.

Our experience has shown that when the dry density exceeds on the order of 105 pcf or the fines content (percent silt and clay) is less than on the order of 15 percent, the underlying soils are typically less moisture sensitive regardless of the moisture condition. Laboratory testing performed for this project indicate that the upper sandy silt to silty sand have a density generally less than 105 pcf and fines content greater than 15 percent and therefore are considered to have collapse potential.

The prewetting process can typically be achieved by constructing a series of ponds over the area to be treated. Typically, the pre-wetting ponds should be no larger than 20,000 to 25,000 square feet to ensure a relatively even distribution of water treatment. Based upon previous pre-wetting studies, we estimate a 1 foot high column of water will be necessary to treat every 2 to 3 feet of the underlying potentially collapsible soil and result in an increased saturation (of the soils) which exceeds approximately 50 percent. Pre-wetting near existing homes or site improvements is not recommended and could result in settlement and subsequent distress.

Upon completion of the pre-wetting program, we recommend conducting subsurface investigation to evaluate and verify the pre-wetting process was effective.

Subsequent to pre-wetting and prior refilling ponds or building pads, the bottom of the pre-wetting ponds should be overexcavated to remove loose, soft soils. The overexcavation should extend at least 3 feet below the existing grade or 3 feet below the bottom of footings, whichever is greater. An alternative to overexcavation of the wet soils would be to let the soils dry out prior to mass grading (AGEC should be consulted prior to grading, if this alternative is selected).

The limits of treatment should extend at least 5 feet beyond the perimeter of the proposed building pads, including patios, porches and porch columns. The lateral extent of the overexcavation should be determined by survey and is the responsibility of the owner/contractor.

Potentially Expansive Bedrock - Potentially expansive mudstone bedrock was encountered in test pits TP-4 and TP-12. Based on AGECE's experience in the area, a recommended separation of at least 5 feet above the potentially expansive mudstone should be maintain. Based on the observed depths of the mudstone AGECE does not anticipate the need for overexcavation of mudstone bedrock, however AGECE recommends that additional recommendations be provided once a final grading plan has been provided.

Pavement, Flatwork and Improvements - The pre-wetting method discussed above would be appropriate for these areas. If pre-wetting is not utilized, we recommend at a minimum that the upper 12 inches be scarified, moisture-conditioned, and compacted in areas which will support hard surfaces.

The overexcavation and compaction process is intended to reduce the potential for collapse and also to provide a less permeable, compacted zone of soil beneath the improvements supported above. However, potentially collapsible soils will still remain beneath the overexcavated zone. Settlement could still occur if the remaining collapsible soils are wetted.

The estimated settlement resulting from wetting of the potentially collapsible soils is provided in the following table. If the potential settlement is not acceptable, additional overexcavation or full depth treatment should be conducted. As a minimum, we recommend the exposed subgrade beneath roads and rigid improvements extend at least 5 feet below the existing grade to removed and recompact a portion of the underlying potentially collapsible soils.

Thickness of remaining potential collapsible soil (feet)	Estimated Additional Potential Future Surface Settlement (inches)
10	3 to 3 ½
8	2 to 2 ½
6	1 ½ to 2
4	¾ to 1 ½
2	½ to ¾
0	< ½

2. Excavation

We anticipate that excavation of the overburden soils and soft bedrock at the site can be accomplished with typical excavation equipment. Portions of deeper bedrock may require the use of heavy duty excavation equipment.

3. Grading Slopes and Trenches

The following table provides the maximum recommended slope steepness for a given slope condition. Slopes should include benches in accordance with the 2018 IBC.

Slope Condition	Maximum Slope (Horizontal:Vertical)
Permanent Cut Slopes in Overburden Soils	2:1
Unretained, Properly Compacted Fill	2 ½:1
Permanent Cut Slopes in Moderately Hard Bedrock	½:1
Utility Trenches in On-site Soils and Soft Bedrock (OSHA Soil Class C)	1 ½:1

Fill slopes should be graded by overbuilding and then cutting them back to the desired grade to provide a compacted slope face. Fill placed on existing slopes steeper than 3:1 should be placed using a benching procedure to key the fill into the existing slope. Benches should be of sufficient width to allow adequate area for the compaction equipment.

Steeper trenches may require the use of shoring or a trench box to provide a safe work environment. Safe trench excavation is the responsibility of the contractor.

4. Materials

A. Import Materials:

Import materials should be non-expansive, non-gypsiferous, granular soil. Listed below are the materials recommended for imported fill.

Area	Fill Type	Recommendations
Foundations/slabs	Site grading/ structural fill	-200 < 35%, LL < 30% Maximum size: 4 inches Solubility < 1%
Underslab (upper 4 inches)	Base course	-200 < 12% Maximum size: 1 inch Solubility < 1%

-200 = Percent Passing the No. 200 Sieve

LL = Liquid Limit

B. On-site Materials:

The on-site soils, and properly processed siltstone and sandstone bedrock, free of organics and debris are suitable for use as structural fill, site grading fill, wall backfill and utility trench backfill. The bedrock should be processed such that the maximum particle size is 4 inches and at least 50 percent of the material passes the No. 4 sieve. The mudstone bedrock is not suitable for use and should be disposed of off site.

The potential impact of the collapsible characteristics of the underlying natural silt and sand can be reduced by protecting the collapsible soil from becoming wet. Placement of relatively low permeable fill above the natural soil can help reduce the possibility of water coming in contact with the underlying collapsible soil. The low permeable fill supporting these areas is intended to provide a low permeable zone to reduce the potential for water to infiltrate and wet the underlying subgrade.

Low permeable fill used should meet one of the following set of criteria.

Liquid Limit (%)	Percent Passing the No. 200 Sieve
45 +	15-20
30-45	20-40
0-30	30-100

Laboratory testing indicates the onsite soils would be suitable for use as low permeable fill.

5. Compaction

Compaction of materials placed at the site should equal or exceed the following minimum densities when compared to the maximum dry density as determined by ASTM D-1557:

Area	Percent Compaction
Subgrade	90
Footings/building pad	95
Site grading	95
Utility trenches	95
Wall backfill (as needed)	95

To facilitate the compaction process, the overburden soil and processed, non-expansive bedrock should be moisture conditioned to within 2 percentage points of the optimum moisture content as determined by ASTM D-1557 prior to placement.

Fill should be placed in loose lift thicknesses which do not exceed the capacity of the equipment being utilized. Generally, 6 to 8-inch loose lifts are adequate. Lift thicknesses should be reduced to 4-inches for hand compaction equipment.

6. Shrinkage

We anticipate a significant volume loss of material during the compaction process. Based on our experience, we anticipate on the order of 25 percent loss of the material in the compacted zone. We also anticipate a loss of 2 to 4 inches of surface elevation during the pre-wetting and replacement (loading) and compaction of the materials and the exposed subgrade. These volume losses should be taken into account for material quantity estimates.

7. Surface Drainage

Positive site drainage should be maintained during the course of construction. After construction has been completed, positive drainage of the surface water away from the buildings in each direction must be maintained. To reduce infiltration adjacent to foundations we recommend the following:

- a. A minimum slope of 6 inches in the first 10 feet from the perimeters of the structures should be provided.
- b. Roof gutter systems should be installed around the perimeters of the structures. Roof downspouts should discharge away from the buildings so as to prevent ponding adjacent to foundations. We recommend piping roof gutter downspouts off site directly into the adjacent curb and gutter.
- c. Placement of 3 to 4 foot wide concrete aprons around the perimeters of the structures.
- d. Landscaping requiring water should not be placed adjacent to foundations or within 10 feet of foundations.

- e. Below grade portions of walls/fences which are backfilled with soil should be protected with an impermeable membrane and a subsurface drain on the backfilled side. A gravel covered, perforated PVC pipe should also be placed at the base of the wall to carry water to a discharge point. This is intended to reduce the potential for salt weathering and sulfate attack on concrete/masonry.

B. Foundations

This report does not address support of swimming pools or basements. Support of pools and basements should be addressed with a lot specific subsurface investigation to provide additional support and grading recommendations. Recommendations for design of conventional spread and spot footings are provided below.

1. Bearing Material

The proposed residences may be supported on conventional spread footings bearing on a minimum of 1 foot of properly compacted structural fill underlain by a properly prepared subgrade. Specifically, the subgrade should be prepared during site grading by overexcavating the building pads to remove unsuitable soils as recommended in the Subgrade Preparation section of this report.

2. Bearing Pressures

Footings bearing on properly compacted structural fill may be designed for the following net allowable bearing pressures.

Load Condition	Net Allowable Bearing Pressure (psf)
Walls	2,000
Spots/Columns	2,500

3. Footing Width and Embedment

Footings should have a minimum width of 18 inches and should be embedded at least 12 inches below the lowest adjacent grade.

4. Temporary Loading Conditions

The allowable bearing pressures may be increased by one-half for temporary loading conditions such as wind or seismic loads.

5. Settlement

We estimate that settlement will be approximately 1 inch for footings designed as indicated above due to the load of the structure. Differential settlement is estimated to be approximately $\frac{1}{2}$ inch.

6. Foundation Base

The base of excavations should be cleared of loose or deleterious material prior to placement of fill or concrete.

7. Foundation Setback

Foundations should be set back from the top crest of slopes a horizontal distance equal to or greater than $\frac{1}{3}$ the total slope height.

C. **Concrete Slab-on-Grade**

1. Slab Support

Concrete slabs may be supported on a zone of properly prepared (overexcavated) and compacted fill as stated in the Subgrade Preparation and Materials sections of this report with a minimum thickness of at least 12 inches.

2. Underslab Base Course

A 4-inch layer of properly compacted base course should be placed below slabs to provide a firm and consistent subgrade and promote even curing of the concrete.

3. Vapor Barrier

A vapor barrier should be placed below slabs in areas which will receive sensitive floor coverings or coverings which are impermeable. Vapor barriers also provide protection from salt and sulfate attack.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for spread footings is controlled by sliding resistance developed between the footing and the subgrade soil. An ultimate friction value of 0.40 may be used in design for ultimate lateral resistance of footings bearing on properly compacted on-site soils. The friction value may be increased to 0.45 if the foundations bear on imported, granular structural fill or gravel soils.

2. Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest condition is where the wall does not move. We recommend the basement walls be designed in an at-rest condition.

The values listed below assume a horizontal surface adjacent the top and bottom of the wall.

Description	Active	At-Rest	Passive
Fine/Granular-Grained Backfill - Equivalent Fluid Weight	38 pcf	58 pcf	260 pcf
Fine/Granular-Grained Backfill - Earth Pressure Coefficient	0.33	0.50	-

Care should be taken to prevent percolation of surface water into the backfill material adjacent to the retaining walls. The risk of hydrostatic buildup can be reduced by placing a subdrain behind the walls consisting of free-draining gravel wrapped in a filter fabric.

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be modified as follows according to the Mononobe-Okabe method assuming a level backfill condition:

Lateral Earth Pressure Condition	Seismic Modification (2% PE in 50 yrs)
	Fine/Granular Backfill
Active	9 pcf increase
At-rest	no increase
Passive	22 pcf decrease

The resultant of the seismic increase should be placed up 60 percent of the height of the wall.

4. Safety Factors

The values recommended assume mobilization of the soil to achieve the assumed soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. Seismicity, Liquefaction and Faulting

1. Listed below is a summary of the site parameters as required by the 2018 International Building Code and ASCE 7-16:

Description	Seismic Parameter
	2,500 yr event ($\approx 2\%$ PE in 50 yrs)
2018 IBC	C
PGA	0.26g
S_s (0.2 second period)	0.59g
S_1 (1 second period)	0.19g
F_a	1.26
F_v	1.50
F_{PGA}	1.20

The values provided above were generated using the ASCE 7-16 Seismic Hazard Tool. Based on the observed subsurface conditions, a ground motion hazard analysis (GMHA) as per ASCE 7-16 is not required by the 2018 International Building Code.

2. Liquefaction

Based on subsurface conditions encountered in the test pits, the subsurface soils observed are non-liquefiable to the depths investigated during a seismic event. Liquefiable soils at greater depths are not likely due to the relatively shallow bedrock.

3. Faulting

Based on a review of available geologic literature, there are no mapped faults extending near or through the site.

F. Soil Corrosion

Based on our experience in the area, the on-site soils, bedrock, and many imported sources may contain sulfates in sufficient concentration to be corrosive to concrete. Therefore, we recommend concrete elements that will be exposed to the on-site soils be designed in accordance with provisions provided in the American Concrete Institute Manual of Concrete Practice (ACI) 318-14. Tables 19.3.1.1 and 19.3.2.1 of ACI 318-14 should be referenced for design of concrete elements utilizing a Sulfate Exposure Class of S2.

Consideration should also be given to cathodic protection of buried metal pipes. We recommend utilizing PVC pipes where local building codes allow.

G. Pavement

1. Subgrade Support

We anticipate that the subgrade materials beneath the pavement areas will consist of sandy silt to silty sand. Prior to placement of road base, the subgrade should be prepared as recommended in the subgrade preparation section of this report. A California Bearing Ratio (CBR) of 7 percent was assumed for a properly compacted subgrade for purposes of design.

2. Pavement Thickness

Based on the assumed traffic loadings and St. George City traffic indexes, a 20-year design life, and AASHTO design methods, the following pavement sections are recommended.

Roadway	TI	Asphalt (in.)	Base Course (in.)
45-Foot ROW	5	2½	6
50-Foot ROW	5	2½	6

3. Pavement Materials

The pavement materials should meet City of St. George specifications for gradation and quality. The pavement thicknesses indicated above assume that the base course is a high quality material with a CBR of at least 50 percent and the asphaltic concrete has a minimum Marshall stability of 1,800 pounds. Other materials may be considered for use in the pavement section. The use of other materials may result in other pavement material thicknesses.

4. Drainage

The collection and diversion of drainage away from the pavement surface is extremely important to the satisfactory performance of the pavement section. Proper drainage should be provided.

H. Construction Testing and Observations

We recommend the following testing and observations be done as a minimum as required by the City of St. George.

1. Observe grubbing and verify removal of soil containing roots and organics.
2. Verify that recommended overexcavation depths or subgrade treatment is achieved to appropriate depth in the building pad areas and beneath roadways.
3. Verify that potentially collapsible soils have been overexcavated or prewetted in the outlined area (shown on Figure 2).
4. After mass grading is complete, additional exploration may be necessary in "cut" areas to verify subsurface conditions and the depth to underlying potentially expansive layers of bedrock.

5. Verify that recommended structural fill depths are provided below foundations and slabs.
6. Conduct compaction testing on fill placed below foundations and in building pads. We recommend testing each foot of fill placed.
7. Conduct construction materials testing on city improvements at a frequency which meets or exceeds St. George City requirements.

I. Geotechnical Recommendation Review

The client should familiarize themselves with the information contained in this report. If specific questions arise or if the client does not fully understand the conclusions/recommendations provided, AGECH should be contacted to provide clarification.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the excavated test pits, the data obtained from laboratory testing and our experience in the area. Variations in the subsurface conditions may not become evident until excavation is conducted. If the subsurface conditions or groundwater level are found to be significantly different from those described above, we should be notified to reevaluate our recommendations.

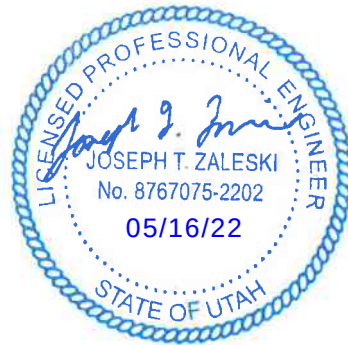
If you have any questions or if we can be of further service please call.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Joseph T. Zaleski, P.E.

Reviewed by: Jake Erickson, P.E.

P:\2020 Project Files\2200500\2200519 - Desert Cliffs Area 165 Acres\desert cliffs area 11



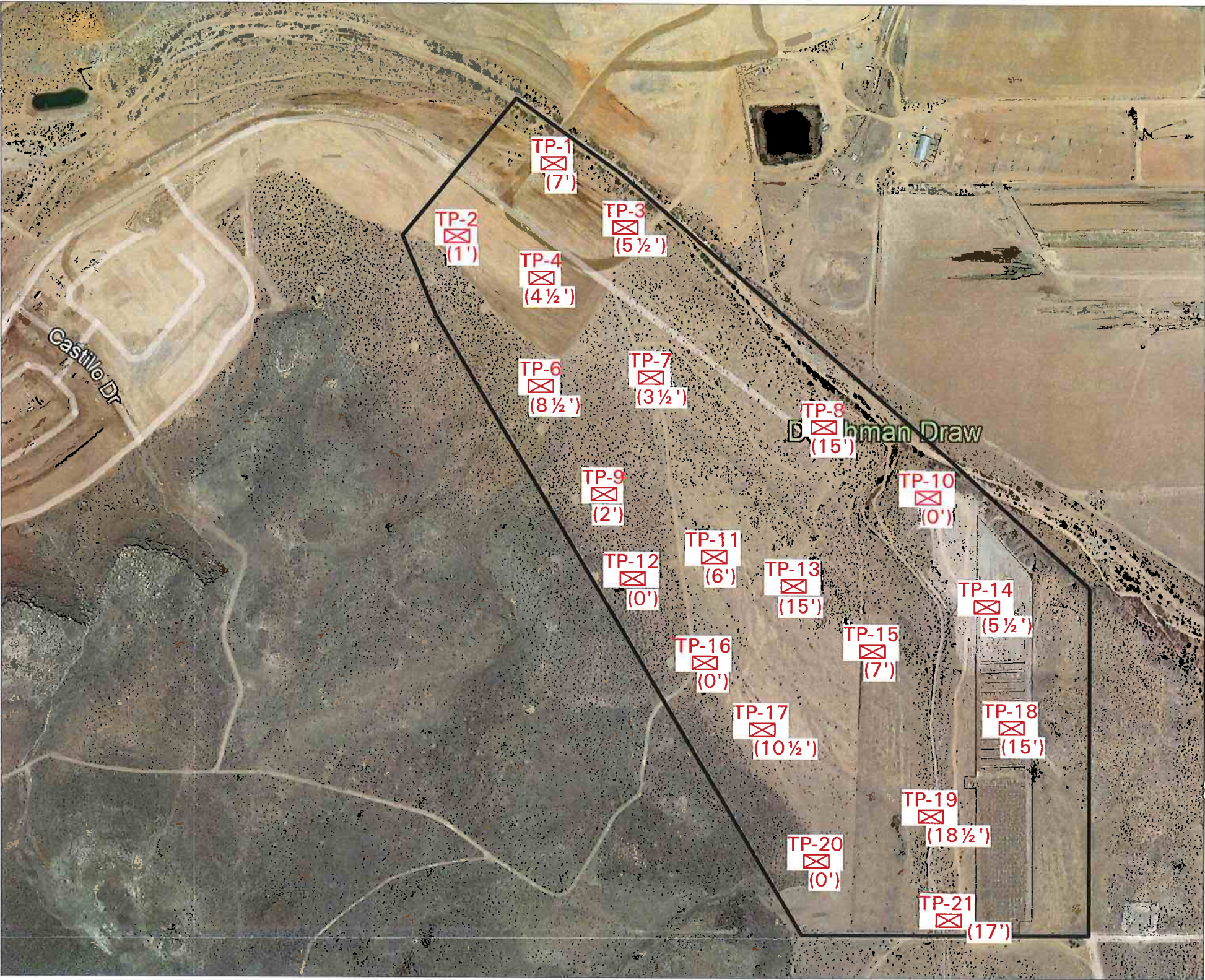
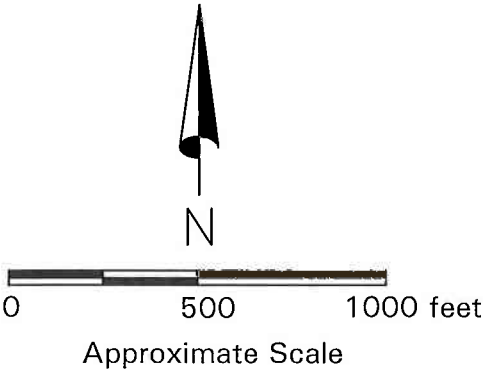


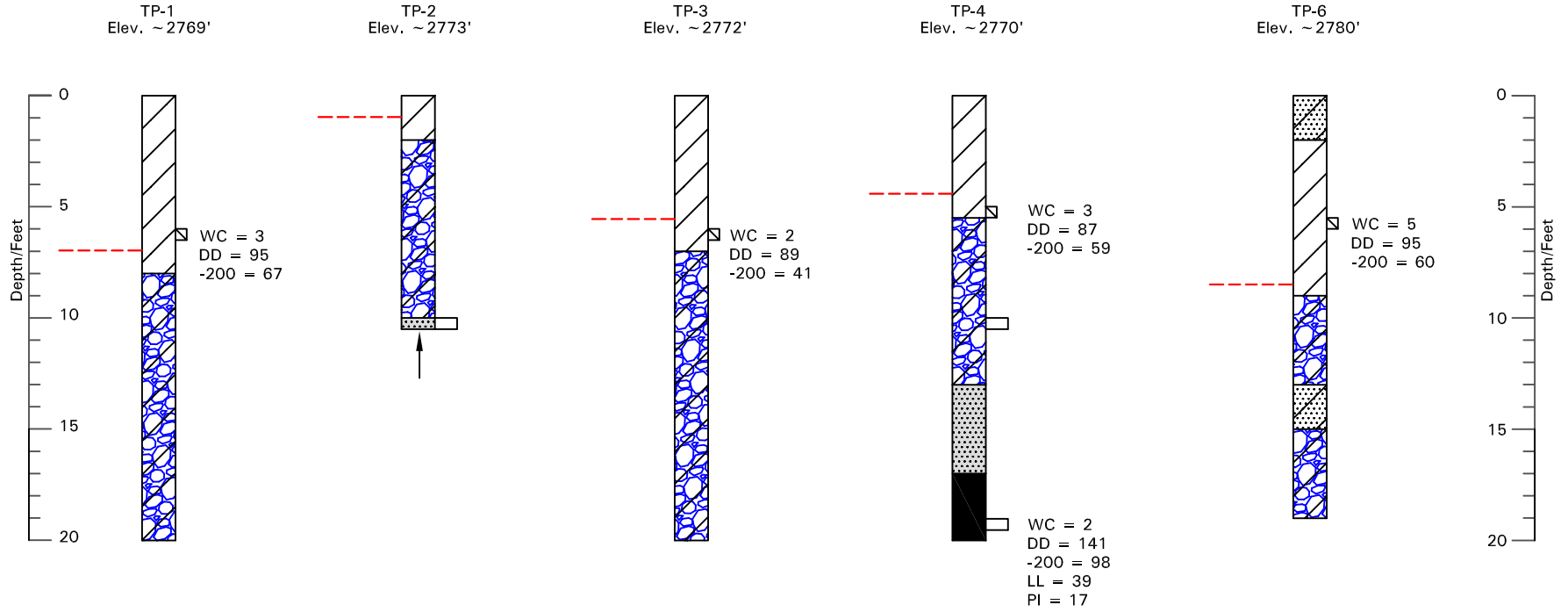
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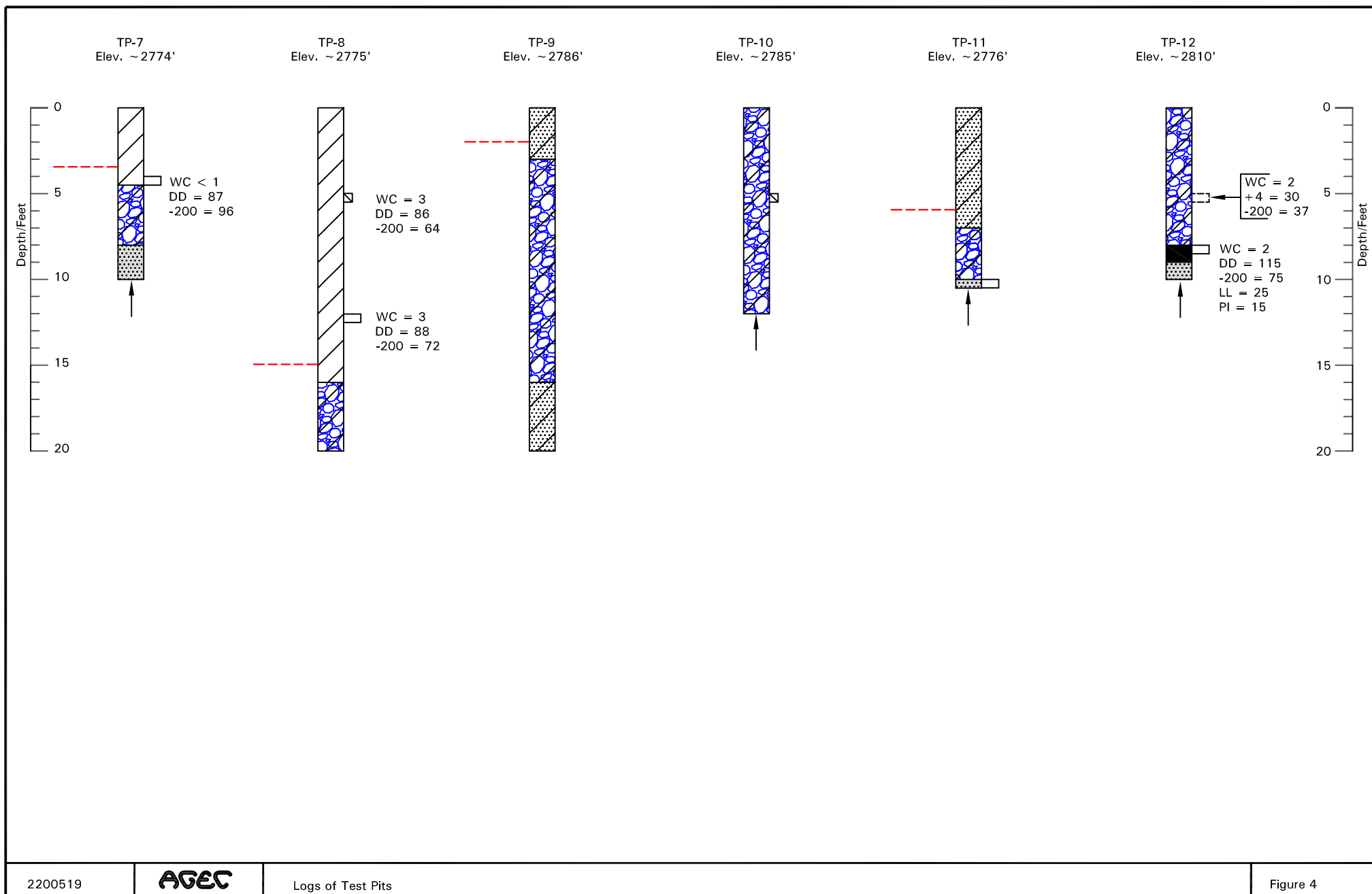
DESERT CLIFFS AREA
165 ACRES AT DESERT CANYONS
ST. GEORGE, UTAH

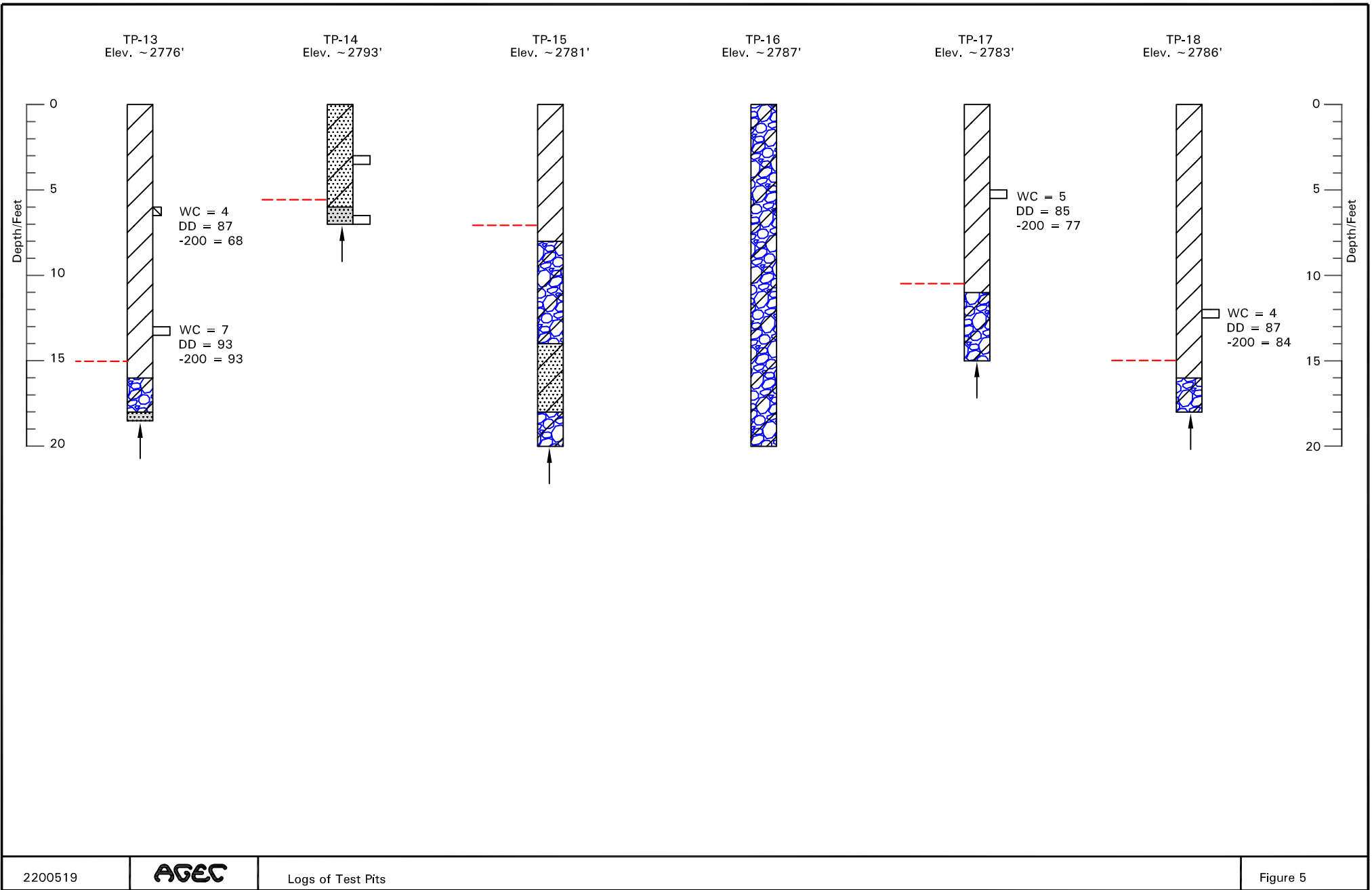
DESERT CLIFFS AREA
165 ACRES AT DESERT CANYONS
ST. GEORGE, UTAH

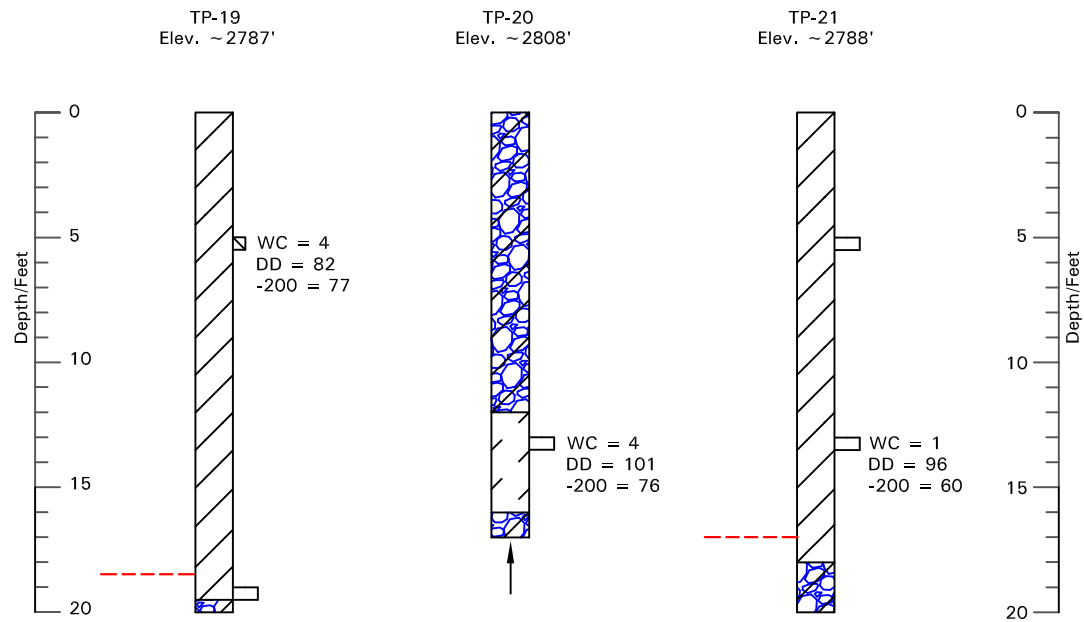
- ⊠ Approximate test pit location
- (#') Approximate depth of overexcavation











LEGEND:



Sandy Silt (ML); medium dense, dry, porous, roots near surface, various amounts of sand, and is light brown in color.



Sandy Lean Clay (CL); medium dense to dense, dry, low plastic, and is light brown in color.



Silty Sand (SM); loose to dense, dry to moist, various amounts of gravel, and is light brown to red in color.



Silty Gravel with Sand (GM); medium dense to very dense, dry, some cobbles to boulders, and is light grey to light brown in color.



Sandstone Bedrock; hard, dry, some conglomerate layers, and is yellow/green/grey in color.



Mudstone Bedrock; soft, moist, low to medium plastic, and is green in color.



Indicates relatively undisturbed hand drive sample taken.



Indicates relatively undisturbed block sample taken.



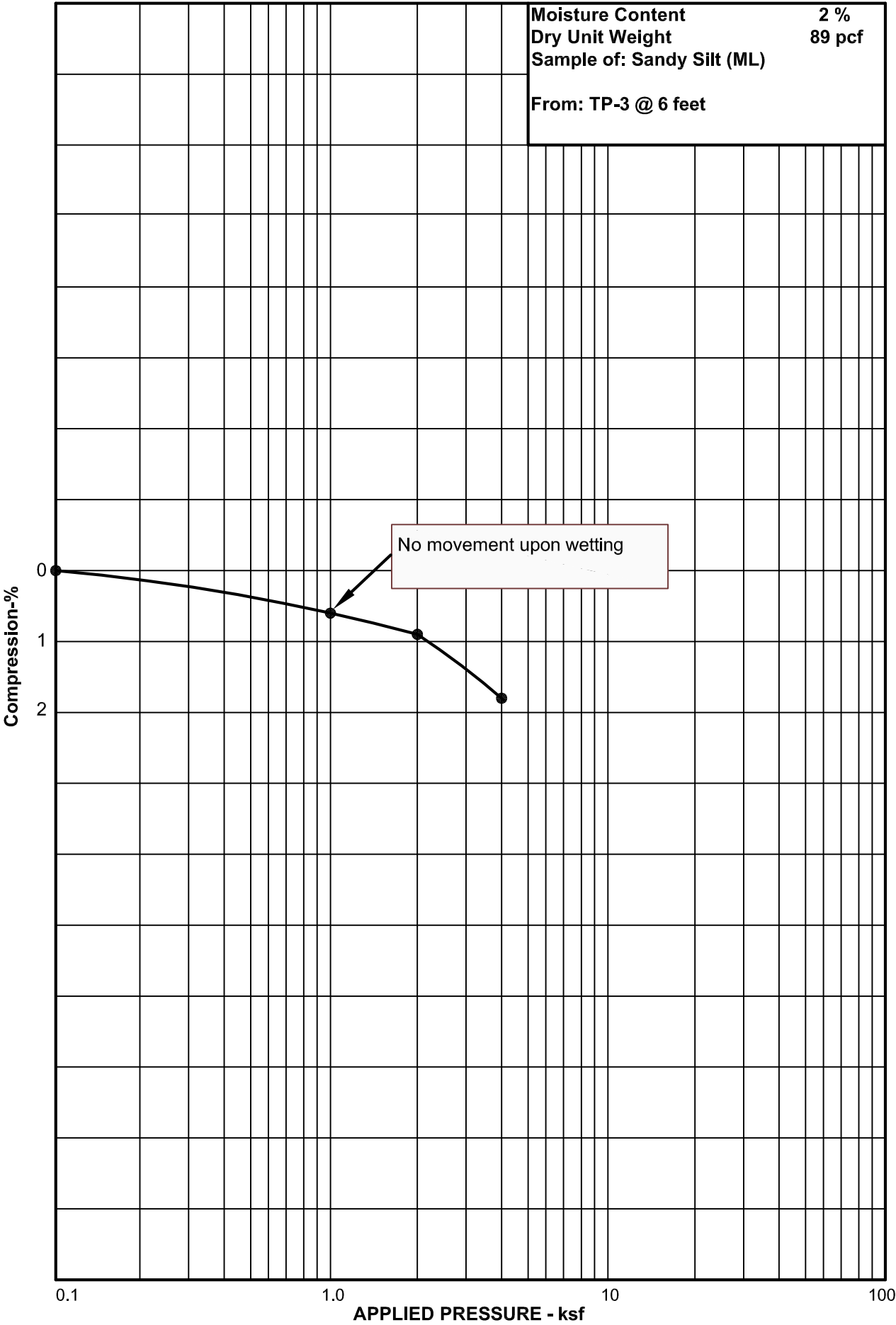
Indicates disturbed sample taken.

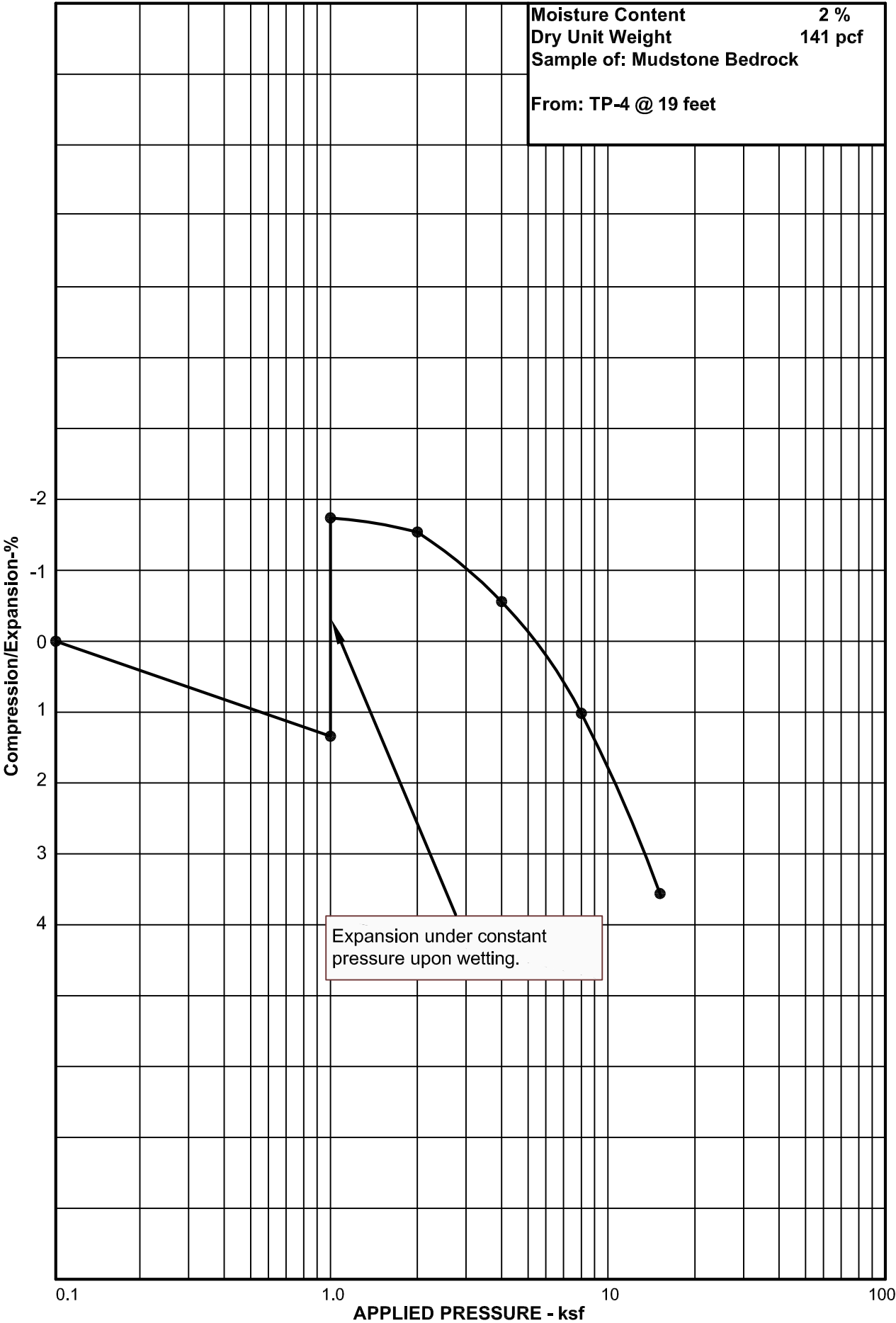


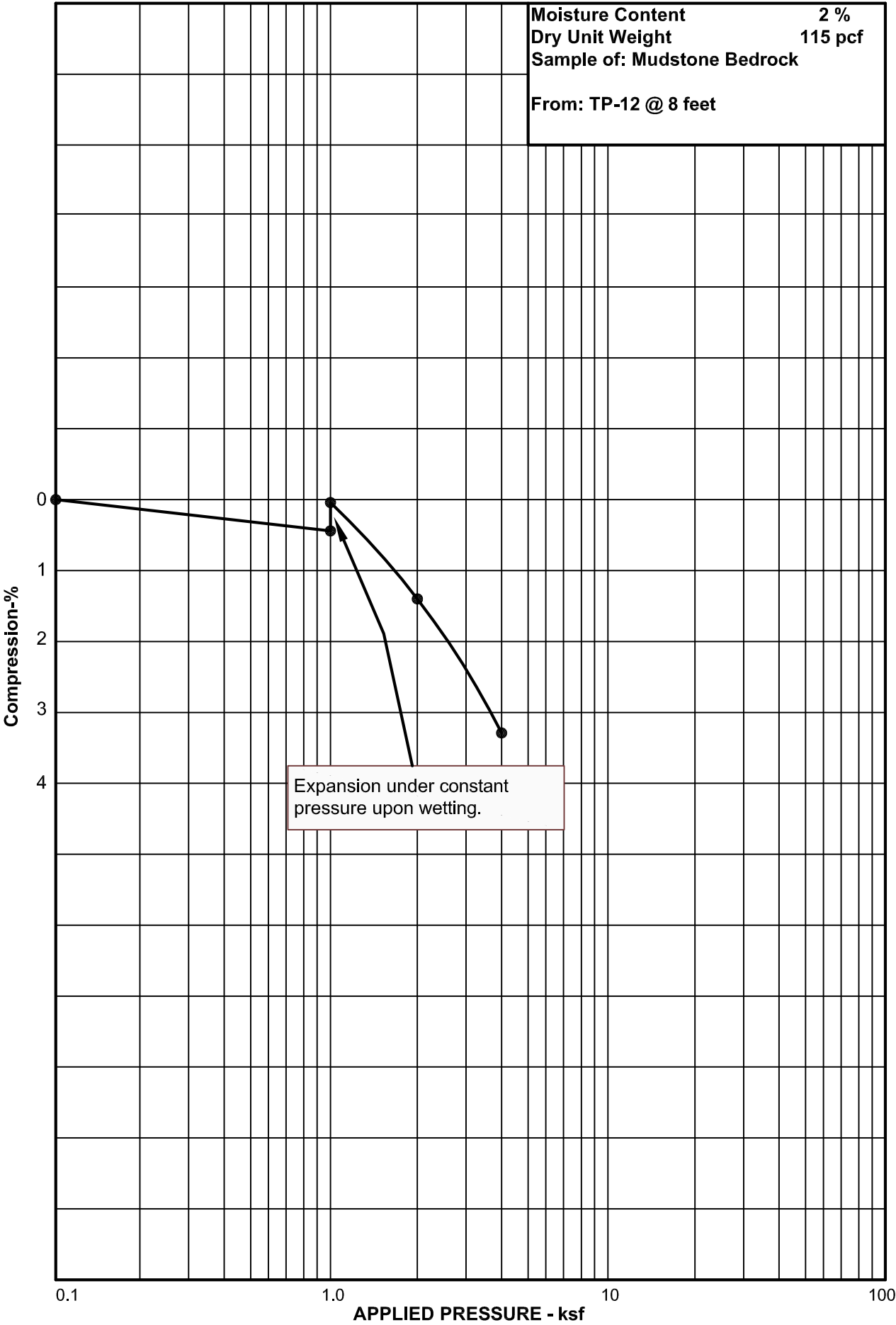
Indicates practical backhoe refusal on boulders, sandstone bedrock, or limestone bedrock.

NOTES:

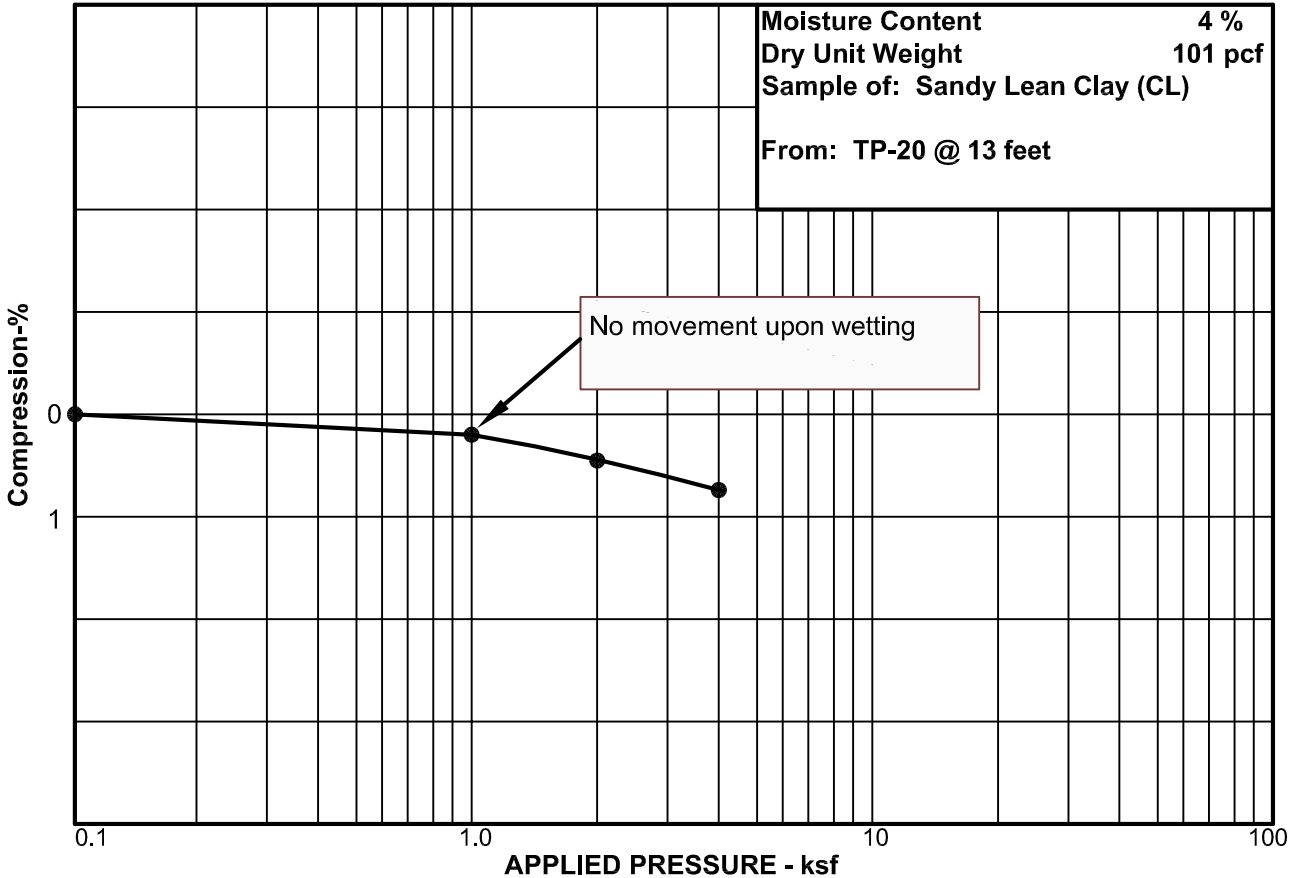
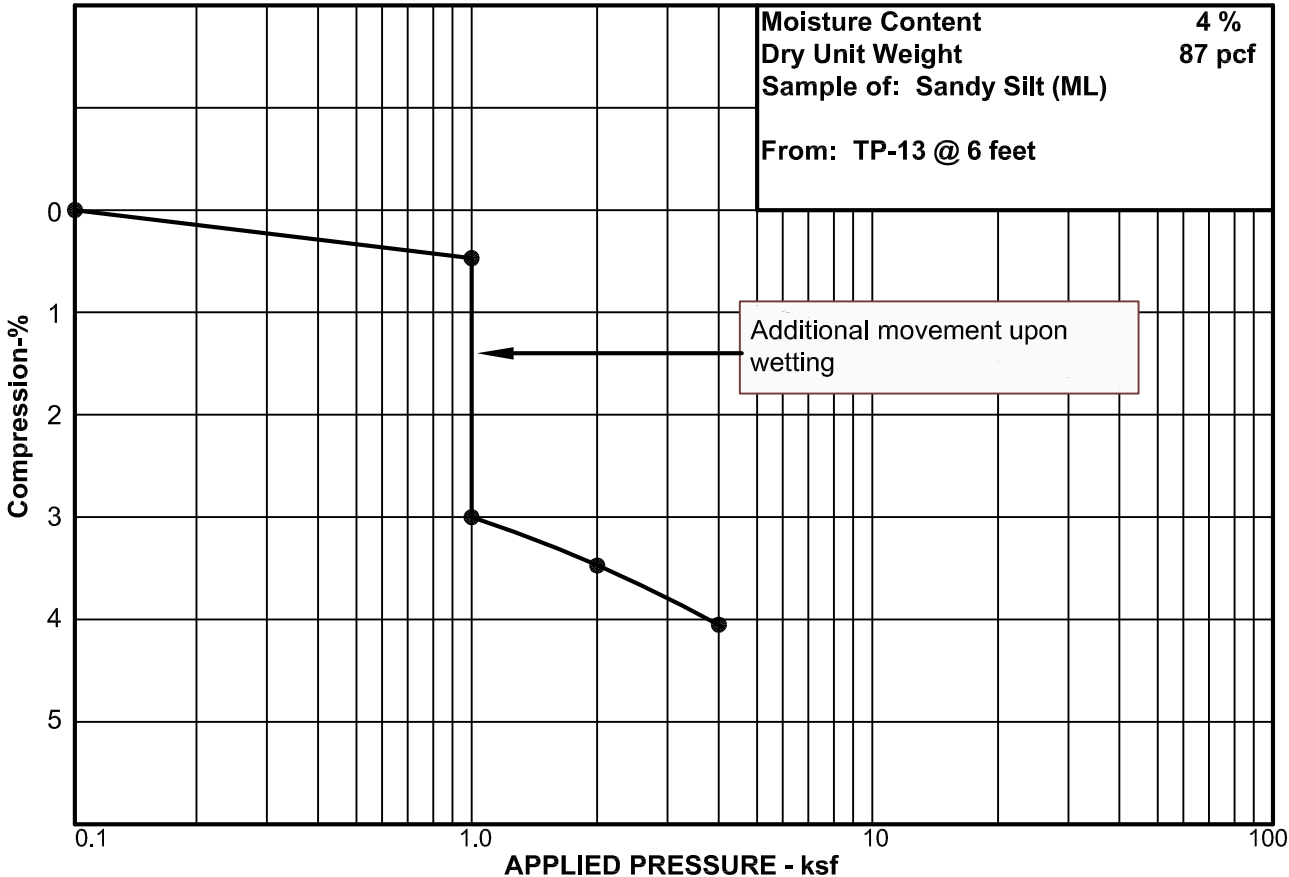
1. The test pits were excavated on June 23, 24, and 25, 2020 with a trackhoe.
2. The locations of the test pits were measured by pacing from property corners.
3. The elevations of the test pits were estimated from the Google Earth elevations.
4. The test pit locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the test pit logs represent the approximate boundaries between material types and the transitions may be gradual.
6. Free water was not encountered in the borings at the time of drilling.
7. WC = water content (%);
DD = dry density (pcf);
+ 4 = percent retained on the No. 4 sieve;
-200 = percent passing No. 200 sieve;
PI = plasticity index (%);
NP = non-plastic;







Applied Geotechnical Engineering Consultants, Inc.



APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I SUMMARY OF LABORATORY TEST RESULTS

Desert Cliff Area

Project Number 2200519

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Sample Classification
Test Pit No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)	
TP-1	6	3	95			67			Sandy Silt (ML)
TP-3	6	2	89			41			Silty Sand (SM)
TP-4	5	3	87			59			Sandy Silt (ML)
TP-4	19	2	141			98	39	17	Mudstone Bedrock
TP-6	5½	5	95			60			Sandy Silt (ML)
TP-7	4	< 1	87			96			Silt (ML)
TP-8	5	3	86			64			Sandy Silt (ML)
TP-8	12	3	88			72			Silt with Sand (ML)
TP-12	5	2		30	33	37			Silty Gravel with Sand (GM)
TP-12	8	2	115			75	25	15	Mudstone Bedrock
TP-13	6	4	87			68			Sandy Silt (ML)
TP-13	13	7	93			93			Silt (ML)
TP-17	5	5	85			77			Silt with Sand (ML)
TP-18	12	4	87			84			Silt with Sand (ML)
TP-19	5	4	82			77			Silt with Sand (ML)
TP-20	13	4	101			76			Sandy Lean Clay (CL)
TP-21	13	1	96			60			Sandy Silt (ML)

EXHIBIT F
DESERT HAVEN DRAINAGE STUDY

DESERT HAVEN SUBDIVISION, OFFSITE ONLY

Preliminary Drainage Study



Prepared By:



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St. George, Utah 84770
(435) 628-2121

July, 2026

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APPENDIX

1.0 INTRODUCTION

This Drainage Study addresses the hydrologic impacts of offsite runoff on the proposed Desert Haven subdivision, located in the Desert Canyons Master Planned Development in St. George, Utah. The objective of this study is to analyze the off-site hydrology under current conditions, and to analyze the impact of runoff on the proposed development located within the Hillside Overlay Zone. Flow patterns, points of discharge, and peak runoff are evaluated and compared to determine compliance with City of St. George drainage requirements. A plan was developed for the conveyance of storm flows through and around the site, establishment of flow rates for use as the basis of design for permanent and temporary flood protection facilities, and for the determination of potential impacts to adjacent properties and facilities.

2.0 PROJECT DESCRIPTION

2.1 Location

The project site is in the southern portion of St. George City, within portions of Sections 35, and 36, Township 43 South, Range 15 West, Salt Lake Base and Meridian. The proposed Desert Haven development is located immediately south of the Desert Talus residential subdivision. Desert abuts the Utah/Arizona state line on the south. A map illustrating the location of the project in relation to St. George and the surrounding area is presented in Figure 1 of the Appendix.

2.2 Project Description

The proposed Desert Haven residential subdivision project consists of R-1 zoned, single-family detached units to be constructed on approximately 55 acres. The undeveloped project site is in an upland terrace area. Properties surrounding the project site are undeveloped and consist primarily of sparsely vegetated desert habitat. The project site is bounded on the northeast by the Ft. Pearce Wash floodplain. A portion of the site is encroached by the current floodplain.

2.3 Soils

Soils information was referenced from the USDA Web Soil Survey. A copy of the soil map is included in the Appendix. Soils found within onsite sub-basins consist primarily of the Junction fine sandy loam (hydrologic group "A"), and Hobcan fine sandy loam (hydrologic group "B"), respectively. Soils found within offsite sub-basins consist primarily of the Hobcan fine sandy loam (hydrologic group "B"), and minor outcropping of Stony colluvial land are found in the offsite steep hillside area (estimated hydrologic group "D"), and Junction fine sandy loam (hydrologic group "A"). Composite SCS Curve number calculations based upon soil types and land uses are included in the Appendix.

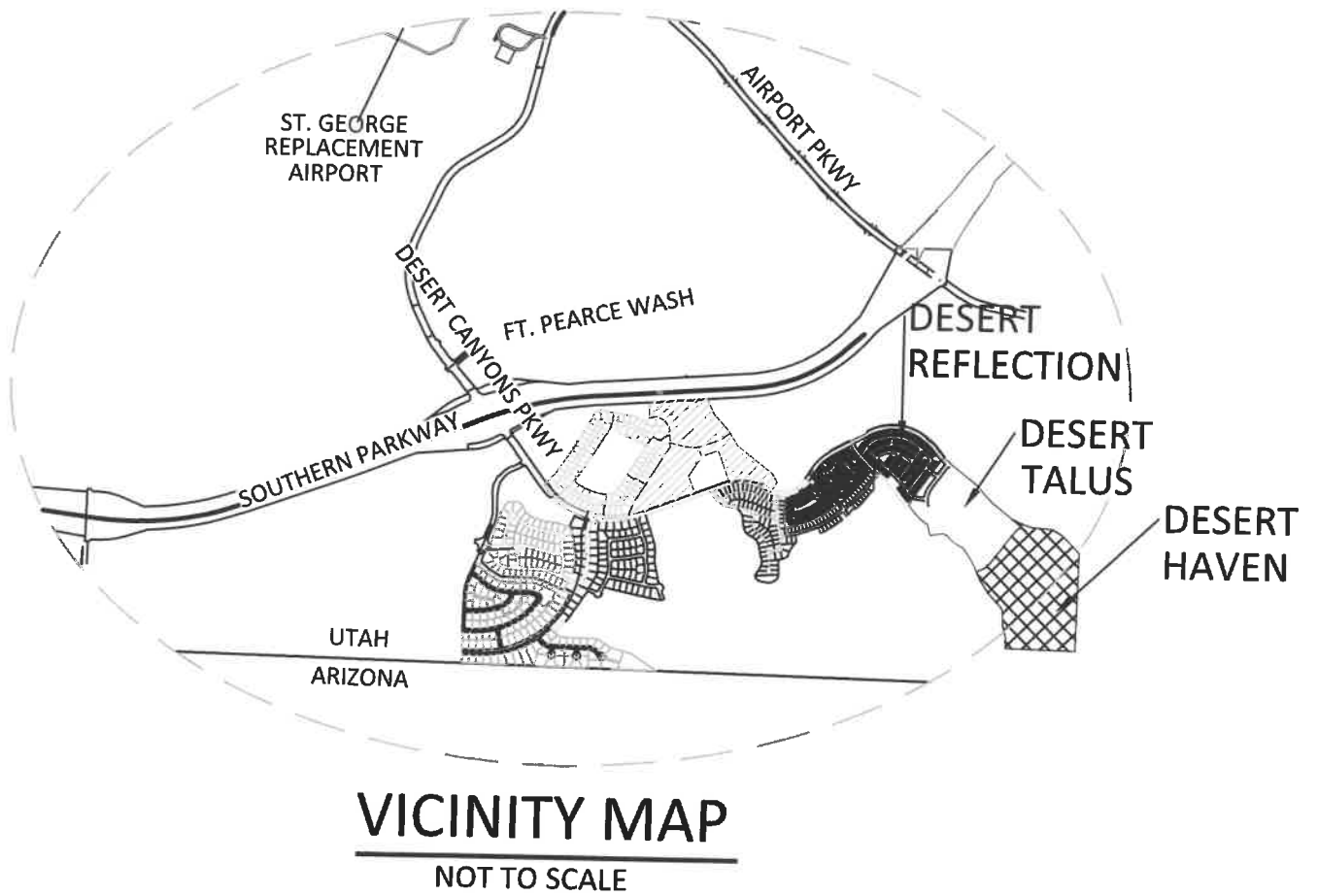


FIGURE 1

3.0 DRAINAGE BASINS

3.1 FEMA Floodplain

Based upon the current Flood Insurance Rate Map (FIRM), a portion of the site (Phases 1-2) lie entirely within an area designated as Zone "X", defined by FEMA as an area outside the 100-year floodplain. Other proposed phases lie within area designated as zone AE, as shown on FEMA map ID 49053C1063G, effective 4/2/2009, and LOMR 22-08-0356P, effective 5/2/2023.

3.2 Master Plan Drainage Facilities

No master planned drainage facilities are addressed in the St. George City Master Drainage Study within the project boundaries.

3.3 Existing Drainage Conditions

The existing hydrologic conditions consist of flat to moderately steep upland areas. The site is rough graded and drains to the northeast to the Ft Pearce wash. Offsite drainage consists of runoff from undeveloped subbasins located west of the project site which drain to the westerly project boundary (Subbasins OFF8, OFF9, and OFF10). Existing offsite hydrologic conditions are illustrated on Figure 2.

3.4 Developed Drainage Conditions

The proposed Desert Haven development will consist of R-1 zoned single-family detached units with appurtenant improved public streets, detention/retention facilities, and storm drain facilities. Runoff generated offsite will be conveyed within natural and graded swale to the proposed onsite detention basin facilities. Additional storage and orifice-controlled outlet structures provide additional detention volume, thus reducing the overall peak runoff rates to a pre-development condition, or less.

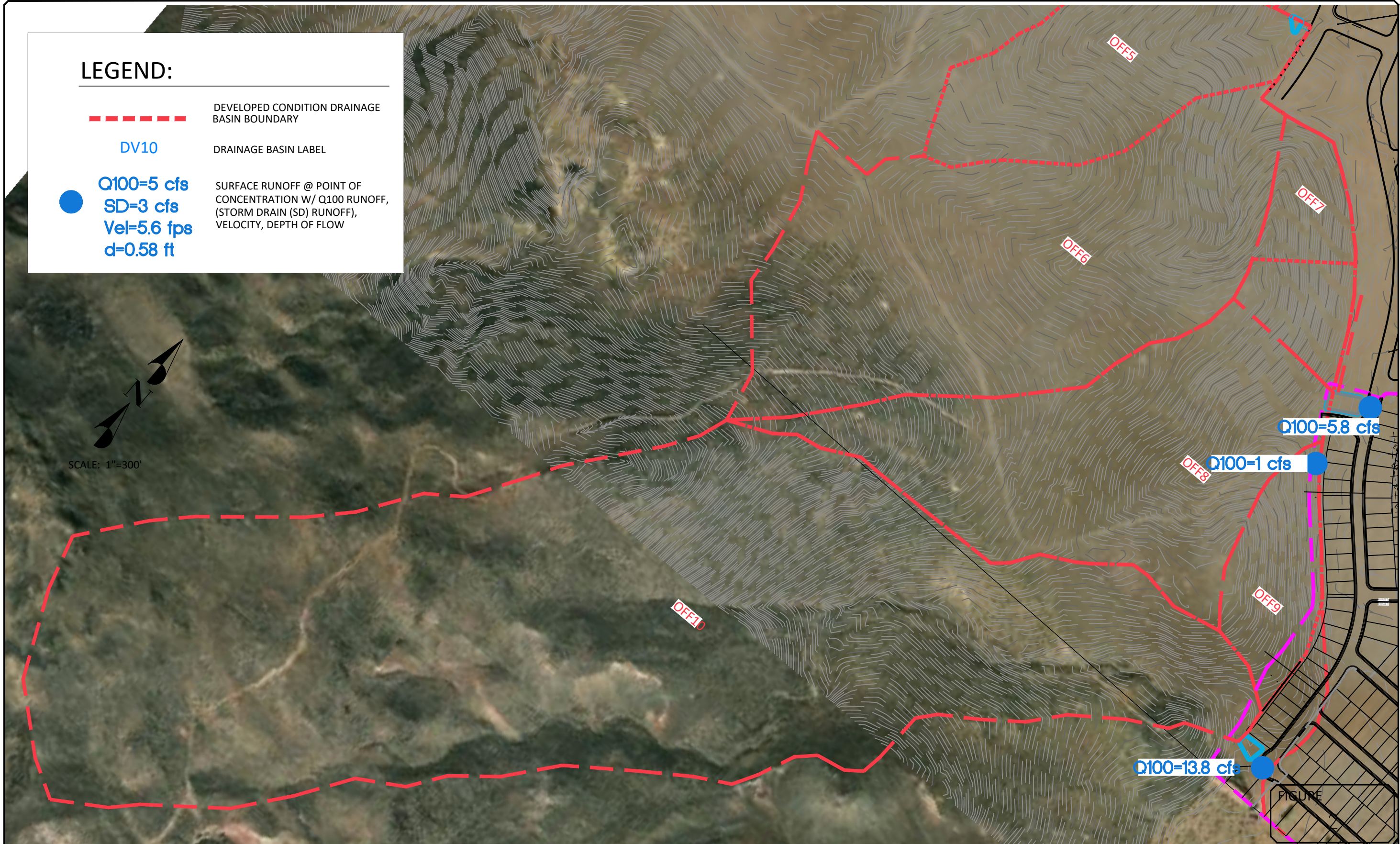
LEGEND:

- DV10

Q100=5 cfs
SD=3 cfs
Vel=5.6 fps
d=0.58 ft
- DEVELOPED CONDITION DRAINAGE
BASIN BOUNDARY

DRAINAGE BASIN LABEL

SURFACE RUNOFF @ POINT OF
CONCENTRATION W/ Q100 RUNOFF,
(STORM DRAIN (SD) RUNOFF),
VELOCITY, DEPTH OF FLOW



EXISTING OFFSITE CONDITIONS
DESERT HAVEN
@ DESERT CANYONS



4.0 HYDROLOGICAL DESIGN METHODS

4.1 Rainfall Methodology

The rainfall and runoff data developed for this hydrologic analysis was prepared for use with the Army Corp of Engineering's program HEC-HMS in accordance with the City of St. George Drainage Design Manual. HEC-HMS input data was generated using the St. George Drainage Manual. Runoff modeling was performed for the 10-year and 100-year storm frequencies.

A 100-year, 3-hour point rainfall depth of 1.64 inches was utilized in the HEC-HMS portion of this hydrology analysis to size the detention basin and calculate street flows. A 10-year, 3-hour point rainfall depth of 1.00 inch was utilized to size the storm drain system. Point rainfall depths for the 24-hour storm of 1.68 inches and 2.51 inches were assumed for the 10-year and 100-year rainfall events, respectively. No area reduction was utilized in the point rainfall determinations.

4.2 Runoff Methodology

The SCS Curve number method was used for the loss calculations in all scenarios. The curve numbers for the water sheds were determined using a weighted average based on soil type, vegetation and land use. The lag time for each basin was calculated using both the travel time component method and the SCS empirical method. The shortest lag time was then used in the transform analysis. The time of concentration was calculated as follows:

$$T_c = T_i + T_t$$

where:

T_c = Time of concentration

T_i = Initial, inlet or sheet flow travel time

T_t = Travel time for shallow concentrated flow

Initial flow time was calculated as follows:

$$T_i = 0.007(nL)^{0.8}/(P_2)^{0.5}s^{0.4}$$

where:

T_i = Initial overland travel time (minutes)

n = manning's number

L = sheet flow length (typically less than 300 feet)

P_2 = 2-yr 24-hr precipitation (inches)

s = slope (ft/ft)

Shallow concentrated flow travel time was calculated as follows:

$$T_t = L/3600V$$

Where:

T_t = travel time for shallow concentrated flow

L = flow length (feet)

V = average velocity (ft/s)

The lag time was calculated as follows: $T_{lag} = 0.6T_c$ (hours)

5.0 RESULTS OF ANALYSIS

5.1 Peak Runoff

Historical, existing on-site, and developed on-site calculated peak runoff at critical points of discharge for the site are indicated on Figure 3, and in Table 1 below.

Table 1.
Calculated Runoff

Hydrologic Condition/Basin	3-hr FF		24-hour
	Q10 (cfs)	Q100 (cfs)	Q10 (cfs)
Existing Conditions			
OFF8	1	10	2.9
OFF9	<1	2.1	<1
OFF10	3.3	29.7	10.9
Reservoir 3 discharge	<1	5.8	2.4
Reservoir 4 discharge	1.6	13.8	6.7

*Includes onsite routing and detention.

5.2 Stormwater Runoff Detention

Sufficient stormwater detention is proposed to mitigate excess developed condition runoff. The two on-site detention basins include at least 6" of sediment capture, as well as detention of the offsite runoff prior to discharge to the proposed onsite storm drain system. Maximum pool detention volumes of 0.75 and 1.2 acre feet for detention basins 3 and 4, respectively, are sufficient to reduce peak offsite flow rates to levels sufficient for future downstream conveyance capacities.

6.0 CONCLUSIONS

Street and storm drain improvements are designed to convey the calculated 100-yr and 10-yr storm event runoff within the limits established by the City of St. George. Existing condition peak stormwater runoff rates will not be exceeded after the proposed project is constructed.

APPENDIX

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

TIME OF CONCENTRATION

PROJECT: DESERT HAVEN

Run: Final

FILE : SF4

CALCULATED BY: kmm

DATE : 7/28/2026

Sub-Basin Data					Initial/Overland Time (Ti)			Travel Time (Tt)				Tc	Tc Check (Urbanized Basins)		Final Tc	Tlag	Remarks
DESIG (1)	CN (2)	K (3)	AREA (acres) (4)	AREA (mi^2) (5)	LENGTH (ft) (6)	SLOPE (%) (7)	Ti (min) (8)	LENGTH (ft) (9)	SLOPE (%) (10)	VELOCITY (fps) (11)	Tt (min) (12)	Tc=Ti+Tt (min) (13)	TOTAL (ft) (14)	Tc (min) (15)	(min) (16)	Tlag (min) (17)	
OFFSITE BASINS - EXISTING CONDITIONS																	
OFF8	78	0.640	20.20	0.0316	300	24.00	5.0	832	10.00	4.1	3.4	8.4	1132.0	NA	8.4	5	
OFF9	78	0.640	4.30	0.0067	280	25.00	4.7	325	1.00	2.5	2.2	6.9	605.0	NA	6.9	4	
OFF10	78	0.640	75.00	0.1172	300	25.00	4.9	3500	6.00	3.8	15.4	20.3	3800.0	NA	20.3	12	use 5 min

$$Ti = (1.8(1.1 - K)L^{1/2}) / (S^{1/3})$$

$$Tc = Ti + Tt$$

$$K = 0.0132(CN)^{-0.39}$$

$$Tlag = 6Tc$$

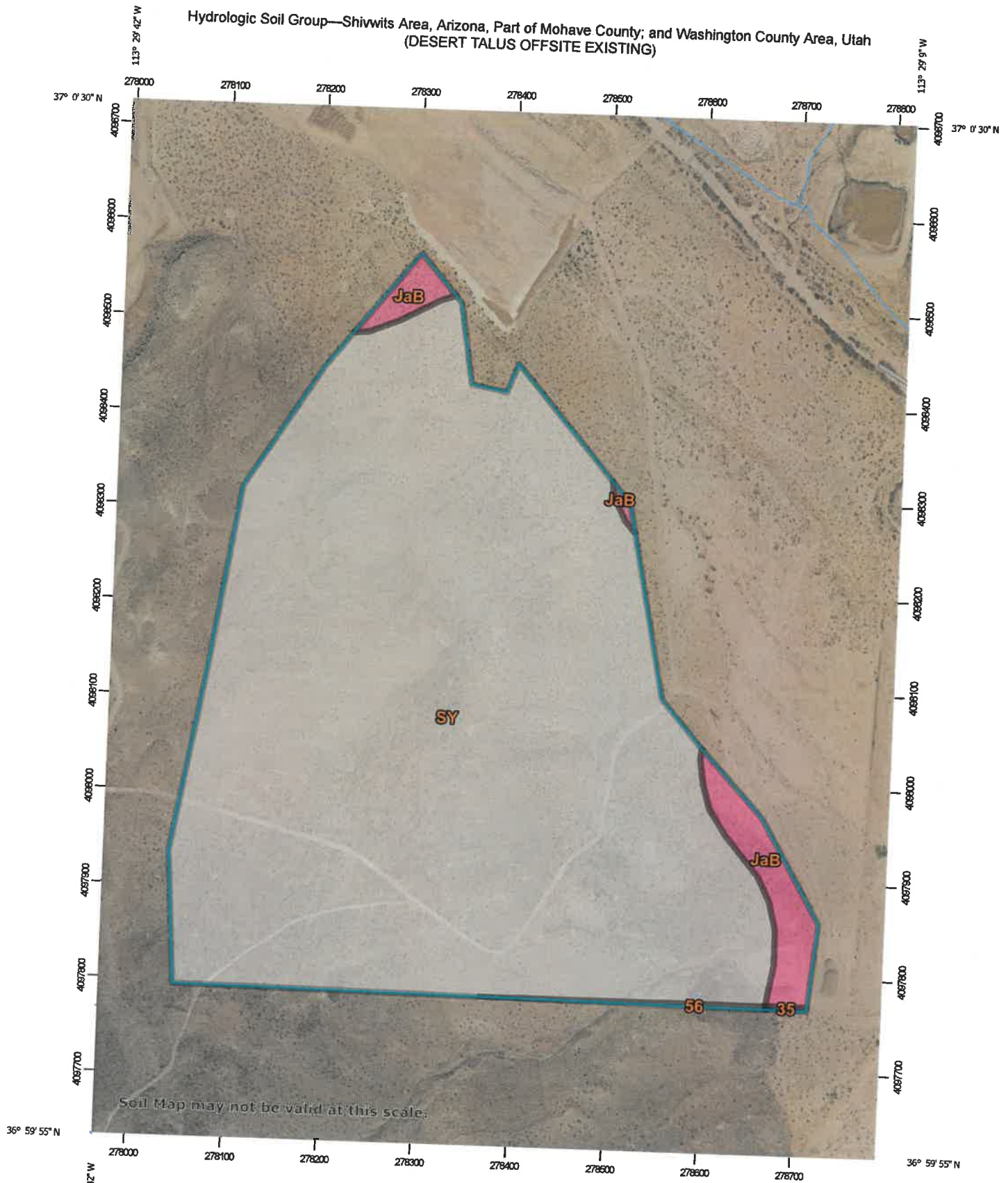
* Soil is Type 'C'.

REFERENCE:

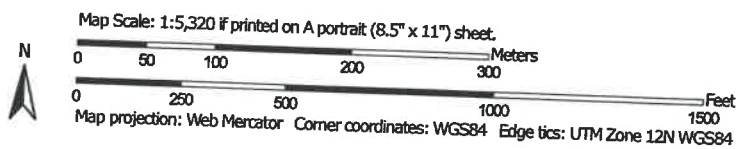
STANDARD FORM 4

Hydrologic Criteria

Hydrologic Soil Group—Shivwits Area, Arizona, Part of Mohave County; and Washington County Area, Utah
(DESERT TALUS OFFSITE EXISTING)



Soil Map may not be valid at this scale.



Natural Resources
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National Cooperative Soil Survey

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Hydrologic Soil Group—Shivwits Area, Arizona, Part of Mohave County; and Washington County Area, Utah
(DESERT TALUS OFFSITE EXISTING)

MAP LEGEND

Area of Interest (AOI)			C
	Area of Interest (AOI)		C/D
Soils			D
Soil Rating Polygons			Not rated or not available
	A	Water Features	
	A/D		Streams and Canals
	B	Transportation	
	B/D		Rails
	C		Interstate Highways
	C/D		US Routes
	D		Major Roads
	Not rated or not available		Local Roads
Soil Rating Lines		Background	
	A		Aerial Photography
	A/D		
	B		
	B/D		
	C		
	C/D		
	D		
	Not rated or not available		
Soil Rating Points			
	A		
	A/D		
	B		
	B/D		

MAP INFORMATION

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

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Shivwits Area, Arizona, Part of Mohave County

Survey Area Data: Version 21, Aug 29, 2024

Soil Survey Area: Washington County Area, Utah

Survey Area Data: Version 18, Aug 28, 2024

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Sep 8, 2022—Sep 29, 2022

Hydrologic Soil Group—Shivwits Area, Arizona, Part of Mohave County; and Washington County Area, Utah
(DESERT TALUS OFFSITE EXISTING)

MAP LEGEND

MAP INFORMATION

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



Natural Resources
Conservation Service

Web Soil Survey
National Cooperative Soil Survey

12/3/2024
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Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
35	Hobcan fine sandy loam, 1 to 5 percent slopes	B	0.0	0.1%
56	Nikey family-Ruesh family-Rock outcrop complex, 10 to 40 percent slopes		0.1	0.2%
Subtotals for Soil Survey Area			0.2	0.2%
Totals for Area of Interest			84.4	100.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
JaB	Junction fine sandy loam, 1 to 2 percent slopes	A	3.6	4.3%
SY	Stony colluvial land		80.6	95.5%
Subtotals for Soil Survey Area			84.2	99.8%
Totals for Area of Interest			84.4	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

**HEC-RAS Output Summaries
Desert Haven Subdivision
Offsite Runoff
Existing and Developed Conditions
100-Yr., 10-Yr. Storm Events**

Simulation End: 1 January 2024, 24:00

Executed: 29 July 2026, 18:37

Downstream	
Element Name	Downstream
Reach - 2	Junction - 2
Reach - 1	Reservoir - 3
Reach - 3	Junction - 3

Route: Muskingum Cunge												
Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Diameter	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - 2	Muskingum Cunge	Circular	300	0.01	0.01	2	Combined Inflow	Automatic DX and DT	Index Flow	2	20	30
Reach - 1	Muskingum Cunge	Circular	100	0.01	0.01	1.5	Combined Inflow	Automatic DX and DT	Index Flow	2	20	30
Reach - 3	Muskingum Cunge	Circular	300	0.01	0.01	1.5	Combined Inflow	Automatic DX and DT	Index Flow	2	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Off10	0.12	10.88	01Jan2024, 12:30	0.31
Reservoir - 4	0.12	6.76	01Jan2024, 13:00	0.31
Reach - 2	0.12	6.72	01Jan2024, 13:00	0.31
Junction - 2	0.12	6.72	01Jan2024, 13:00	0.31
Off8	0.03	2.93	01Jan2024, 12:30	0.31
Off9	0.01	0.62	01Jan2024, 12:30	0.31
Junction - 1	0.01	0.62	01Jan2024, 12:30	0.31
Reach - 1	0.01	0.62	01Jan2024, 12:30	0.31
Reservoir - 3	0.04	2.42	01Jan2024, 13:00	0.31
Reach - 3	0.04	2.4	01Jan2024, 13:00	0.31
Junction - 3	0.04	2.4	01Jan2024, 13:00	0.31

Subbasin: OFF10

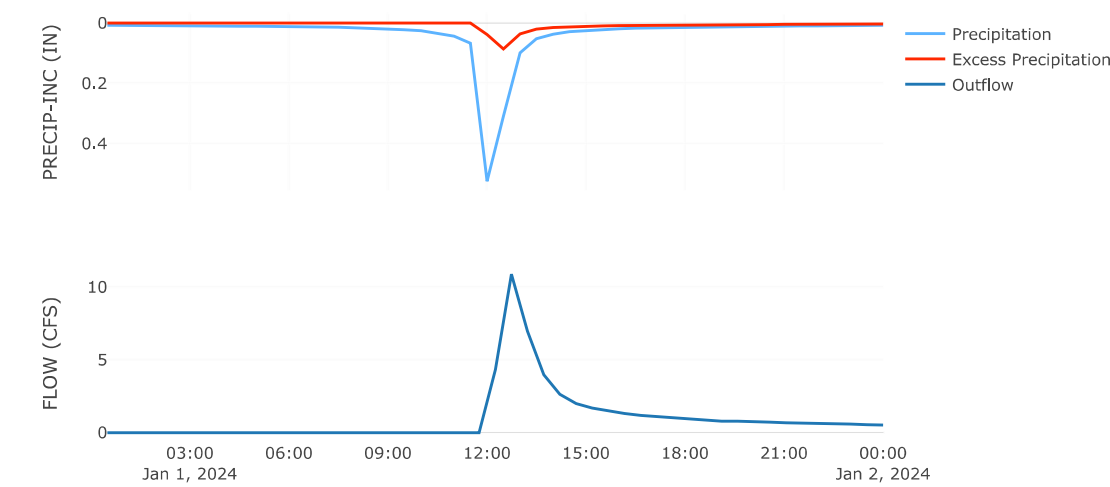
Area (MI²): 0.12
Downstream : Reservoir - 4

Loss Rate: SCS	
Percent Impervious Area	0
Curve Number	78

Transform: SCS	
Lag	12
Unitgraph Type	Standard

Results: OFF10	
Peak Discharge (CFS)	10.88
Time of Peak Discharge	01Jan2024, 12:30
Volume (IN)	0.31
Precipitation Volume (AC - FT)	10.48
Loss Volume (AC - FT)	8.51
Excess Volume (AC - FT)	1.97
Direct Runoff Volume (AC - FT)	1.95
Baseflow Volume (AC - FT)	0

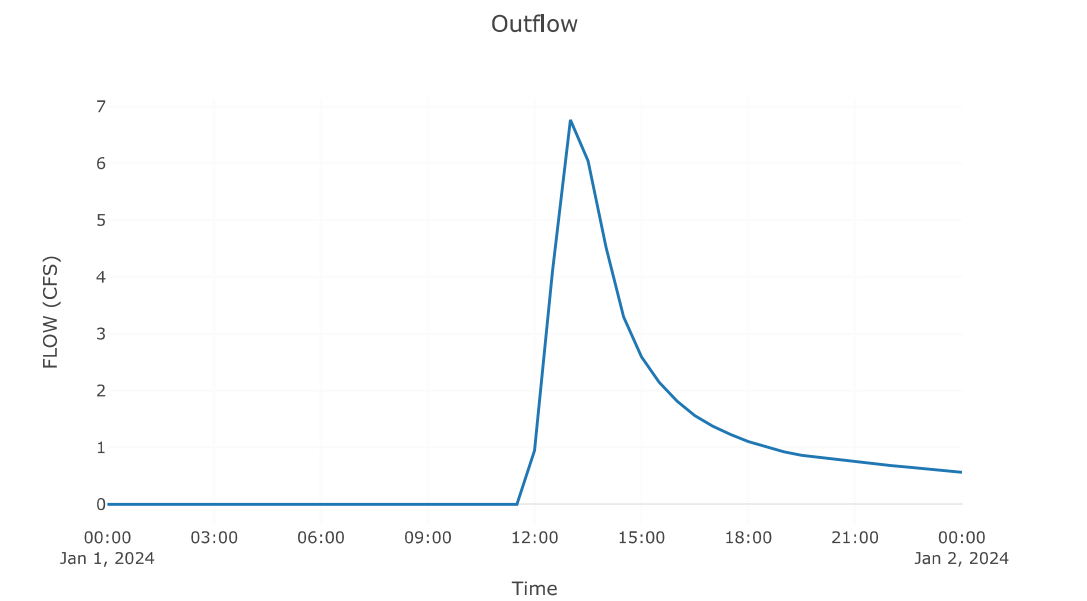
Precipitation and Outflow



Reservoir: Reservoir-4

Downstream : Reach - 2

Results: Reservoir-4	
Peak Discharge (CFS)	6.76
Time of Peak Discharge	01Jan2024, 13:00
Volume (IN)	0.31
Peak Inflow (CFS)	10.88
Time of Peak Inflow	01Jan2024, 12:30
Inflow Volume (AC - FT)	1.95
Maximum Storage (AC - FT)	0.62
Peak Elevation (FT)	2792.75
Discharge Volume (AC - FT)	1.91

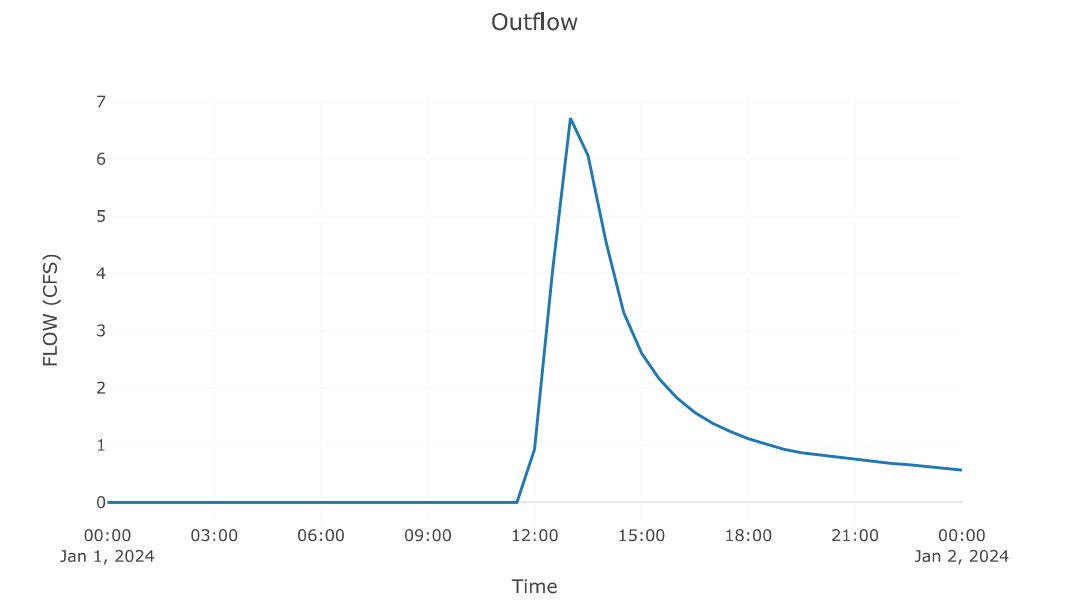


Reach: Reach-2

Downstream : Junction - 2

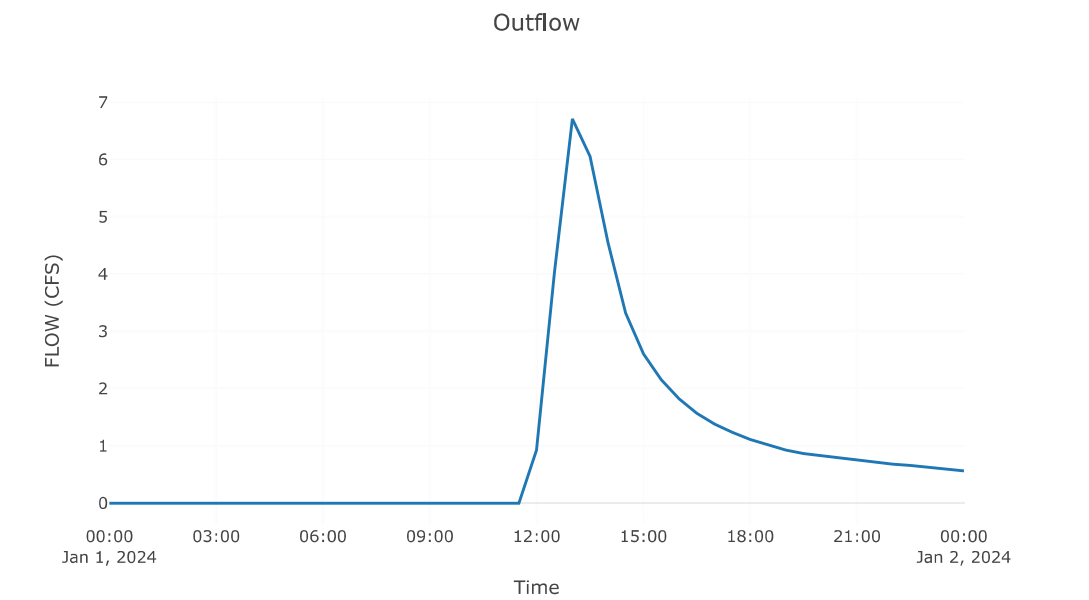
Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Circular
Length (FT)	300
Energy Slope (FT/FT)	0.01
Mannings n	0.01
Diameter	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	2
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-2	
Peak Discharge (CFS)	6.72
Time of Peak Discharge	01Jan2024, 13:00
Volume (IN)	0.31
Peak Inflow (CFS)	6.76
Inflow Volume (AC - FT)	1.91



Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	6.72
Time of Peak Discharge	01-Jan-2024, 13:00
Volume (IN)	0.31



Subbasin: OFF8

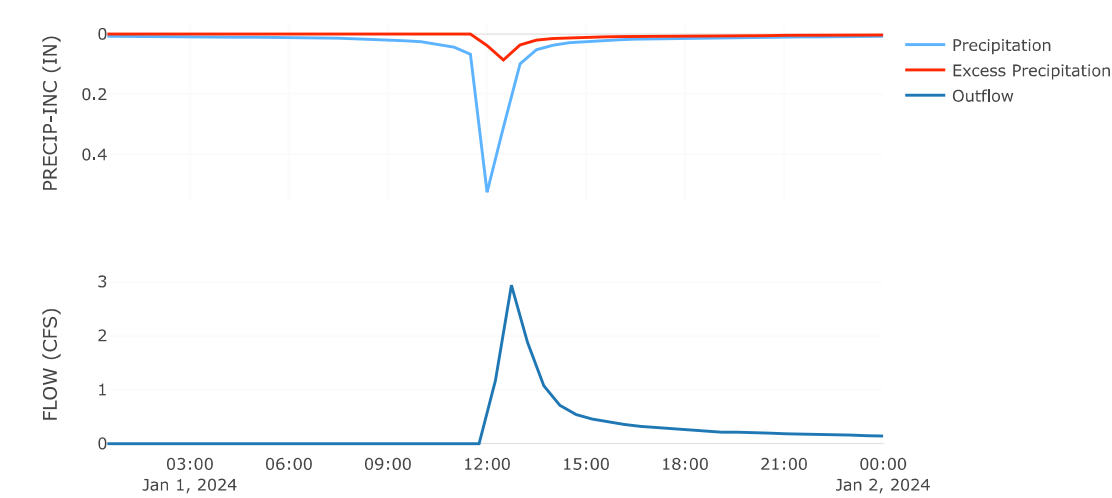
Area (MI²): 0.03
Downstream : Reservoir - 3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	78

Transform: Scs	
Lag	5
Unitgraph Type	Standard

Results: OFF8	
Peak Discharge (CFS)	2.93
Time of Peak Discharge	01Jan2024, 12:30
Volume (IN)	0.31
Precipitation Volume (AC - FT)	2.83
Loss Volume (AC - FT)	2.3
Excess Volume (AC - FT)	0.53
Direct Runoff Volume (AC - FT)	0.53
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Subbasin: OFF9

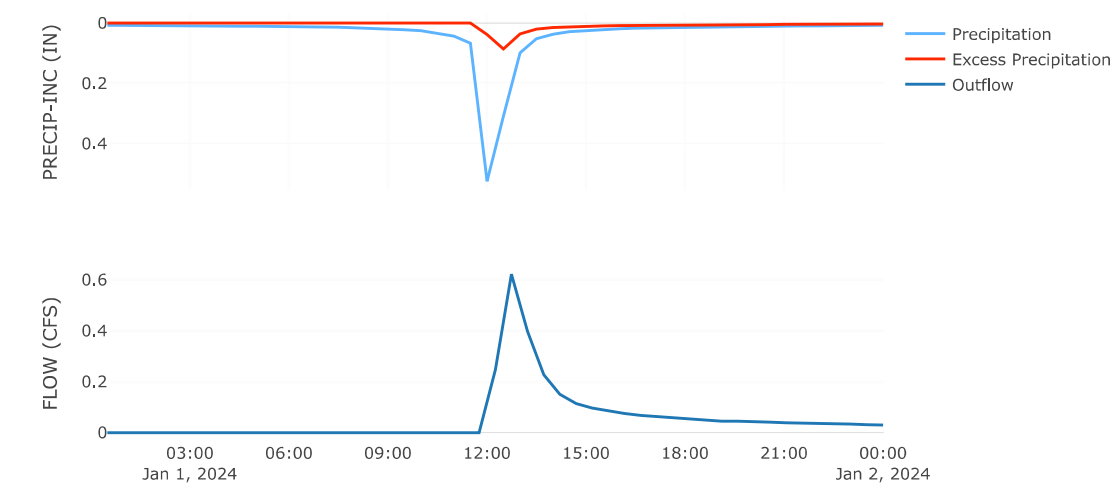
Area (MI2) : 0.01
Downstream : Junction - 1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	78

Transform: Scs	
Lag	5
Unitgraph Type	Standard

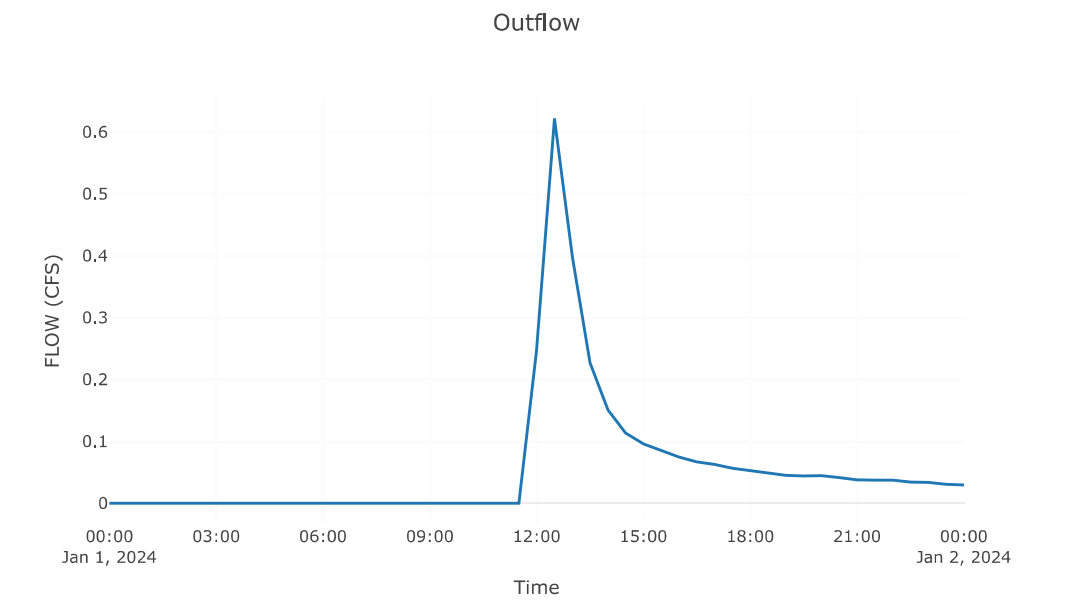
Results: OFF9	
Peak Discharge (CFS)	0.62
Time of Peak Discharge	01Jan2024, 12:30
Volume (IN)	0.31
Precipitation Volume (AC - FT)	0.6
Loss Volume (AC - FT)	0.49
Excess Volume (AC - FT)	0.11
Direct Runoff Volume (AC - FT)	0.11
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	0.62
Time of Peak Discharge	01Jan2024, 12:30
Volume (IN)	0.31

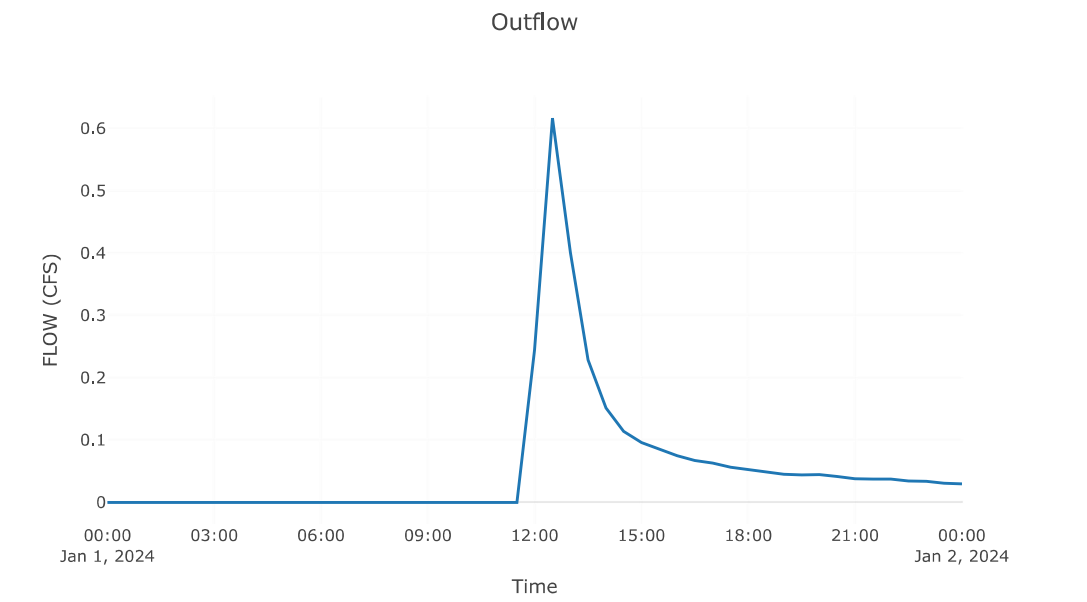


Reach: Reach-1

Downstream : Reservoir - 3

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Circular
Length (FT)	100
Energy Slope (FT/FT)	0.01
Mannings n	0.01
Diameter	1.5
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	2
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

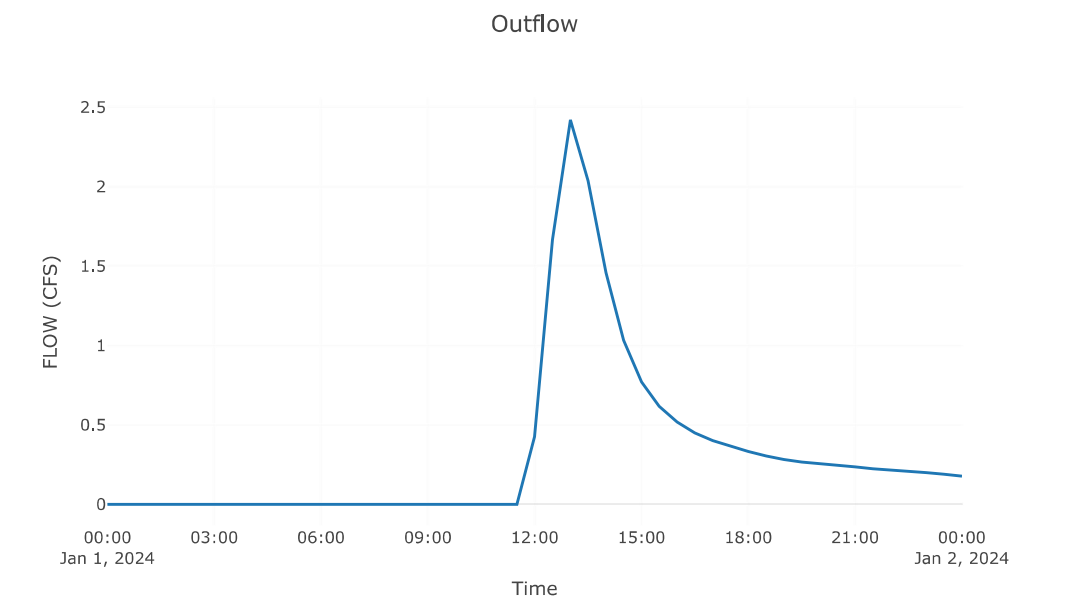
Results: Reach-1	
Peak Discharge (CFS)	0.62
Time of Peak Discharge	01Jan2024, 12:30
Volume (IN)	0.31
Peak Inflow (CFS)	0.62
Inflow Volume (AC - FT)	0.11



Reservoir: Reservoir-3

Downstream : Reach - 3

Results: Reservoir-3	
Peak Discharge (CFS)	2.42
Time of Peak Discharge	01Jan2024, 13:00
Volume (IN)	0.31
Peak Inflow (CFS)	3.55
Time of Peak Inflow	01Jan2024, 12:30
Inflow Volume (AC - FT)	0.64
Maximum Storage (AC - FT)	0.24
Peak Elevation (FT)	2776.81
Discharge Volume (AC - FT)	0.63

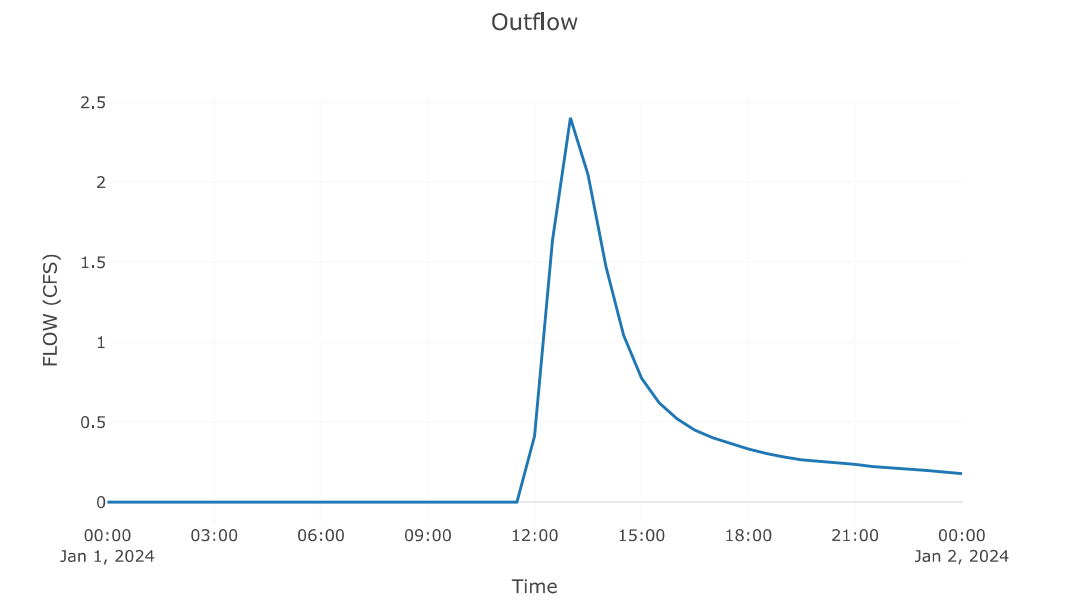


Reach: Reach-3

Downstream : Junction - 3

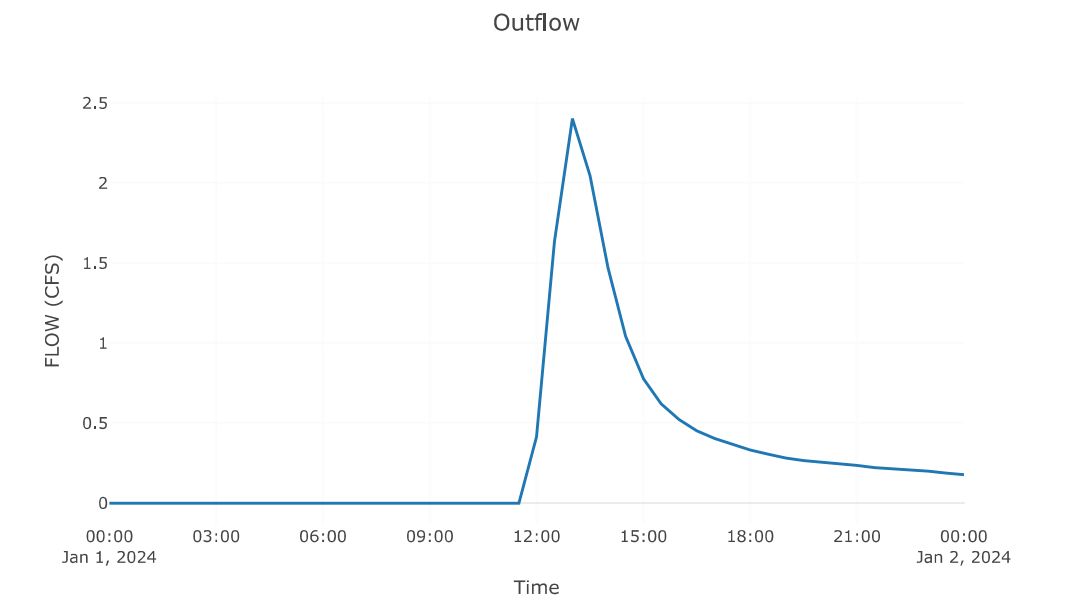
Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Circular
Length (FT)	300
Energy Slope (FT/FT)	0.01
Mannings n	0.01
Diameter	1.5
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	2
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-3	
Peak Discharge (CFS)	2.4
Time of Peak Discharge	01Jan2024, 13:00
Volume (IN)	0.31
Peak Inflow (CFS)	2.42
Inflow Volume (AC - FT)	0.63



Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	2.4
Time of Peak Discharge	01Jan2024, 13:00
Volume (IN)	0.31



Simulation End: 1 January 2023, 03:00

Executed: 29 July 2026, 18:36

Downstream	
Element Name	Downstream
Reach - 2	Junction - 2
Reach - 1	Reservoir - 3
Reach - 3	Junction - 3

Route: Muskingum Cunge												
Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Diameter	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - 2	Muskingum Cunge	Circular	300	0.01	0.01	2	Combined Inflow	Automatic DX and DT	Index Flow	2	20	30
Reach - 1	Muskingum Cunge	Circular	100	0.01	0.01	1.5	Combined Inflow	Automatic DX and DT	Index Flow	2	20	30
Reach - 3	Muskingum Cunge	Circular	300	0.01	0.01	1.5	Combined Inflow	Automatic DX and DT	Index Flow	2	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Off10	0.12	3.3	01Jan2023, 01:10	0.05
Reservoir - 4	0.12	1.56	01Jan2023, 01:50	0.04
Reach - 2	0.12	1.56	01Jan2023, 01:50	0.04
Junction - 2	0.12	1.56	01Jan2023, 01:50	0.04
Off8	0.03	1.03	01Jan2023, 01:00	0.06
Off9	0.01	0.22	01Jan2023, 01:00	0.06
Junction - 1	0.01	0.22	01Jan2023, 01:00	0.06
Reach - 1	0.01	0.22	01Jan2023, 01:05	0.06
Reservoir - 3	0.04	0.66	01Jan2023, 01:30	0.04
Reach - 3	0.04	0.65	01Jan2023, 01:30	0.04
Junction - 3	0.04	0.65	01Jan2023, 01:30	0.04

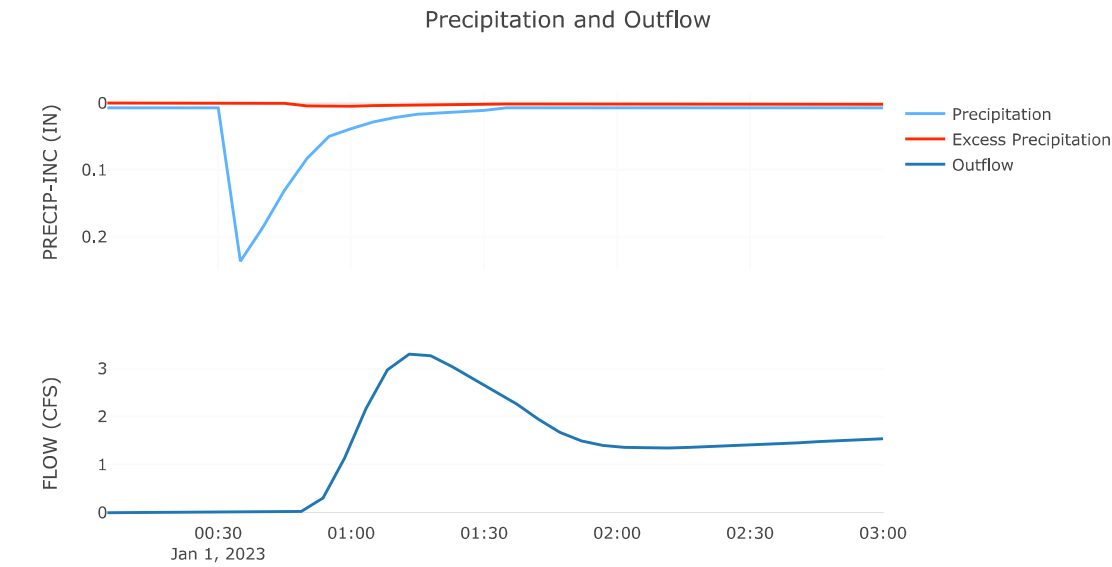
Subbasin: OFF10

Area (MI²): 0.12
Downstream : Reservoir - 4

Loss Rate: SCS	
Percent Impervious Area	0
Curve Number	78

Transform: SCS	
Lag	12
Unitgraph Type	Standard

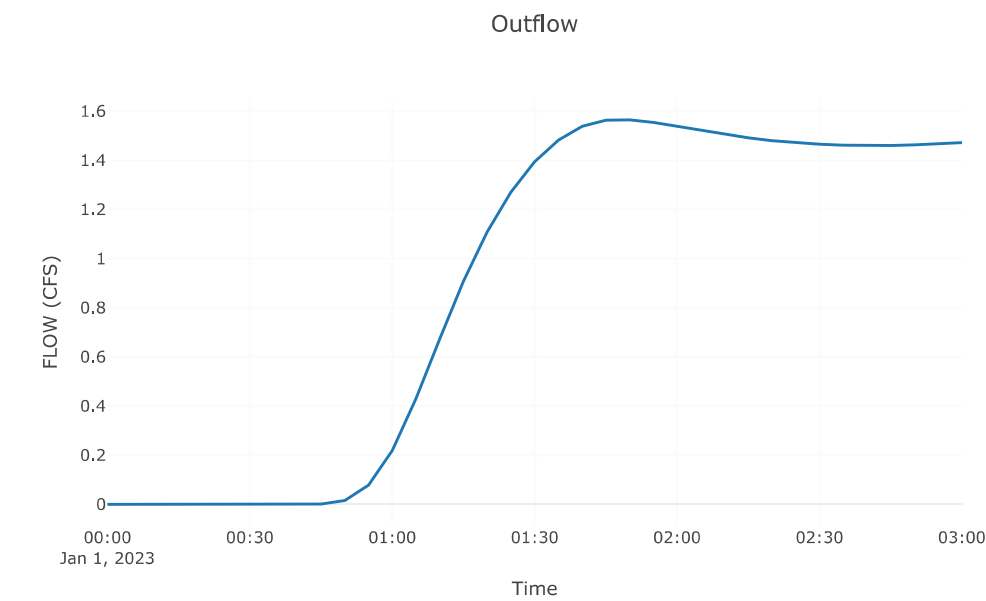
Results: OFF10	
Peak Discharge (CFS)	3.3
Time of Peak Discharge	01Jan2023, 01:10
Volume (IN)	0.05
Precipitation Volume (AC - FT)	6.25
Loss Volume (AC - FT)	5.89
Excess Volume (AC - FT)	0.37
Direct Runoff Volume (AC - FT)	0.33
Baseflow Volume (AC - FT)	0



Reservoir: Reservoir-4

Downstream : Reach - 2

Results: Reservoir-4	
Peak Discharge (CFS)	1.56
Time of Peak Discharge	01Jan2023, 01:50
Volume (IN)	0.04
Peak Inflow (CFS)	3.3
Time of Peak Inflow	01Jan2023, 01:10
Inflow Volume (AC - FT)	0.33
Maximum Storage (AC - FT)	0.31
Peak Elevation (FT)	2791.52
Discharge Volume (AC - FT)	0.22

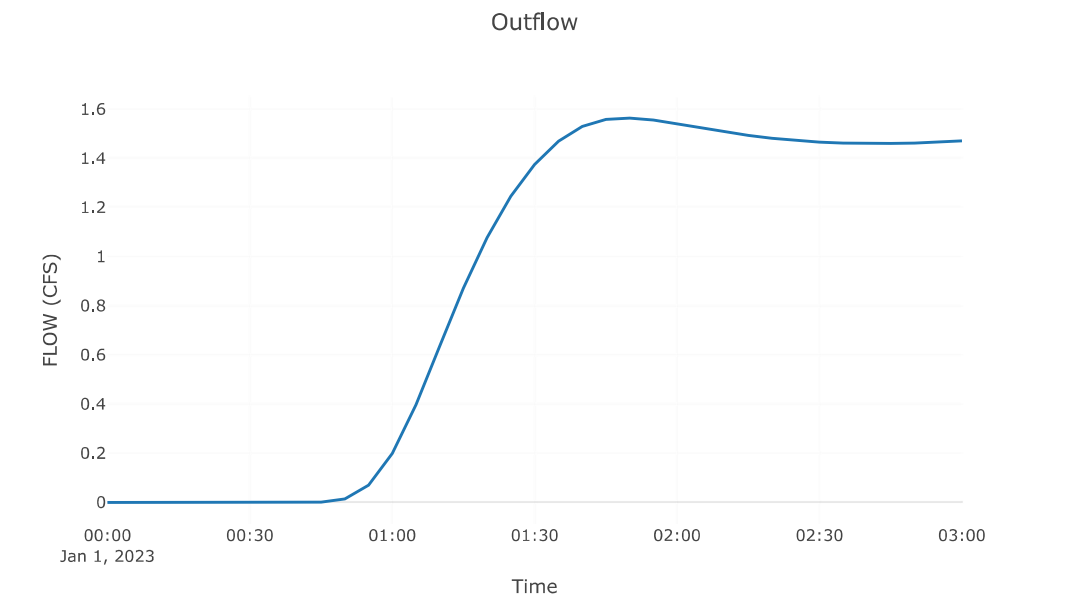


Reach: Reach-2

Downstream : Junction - 2

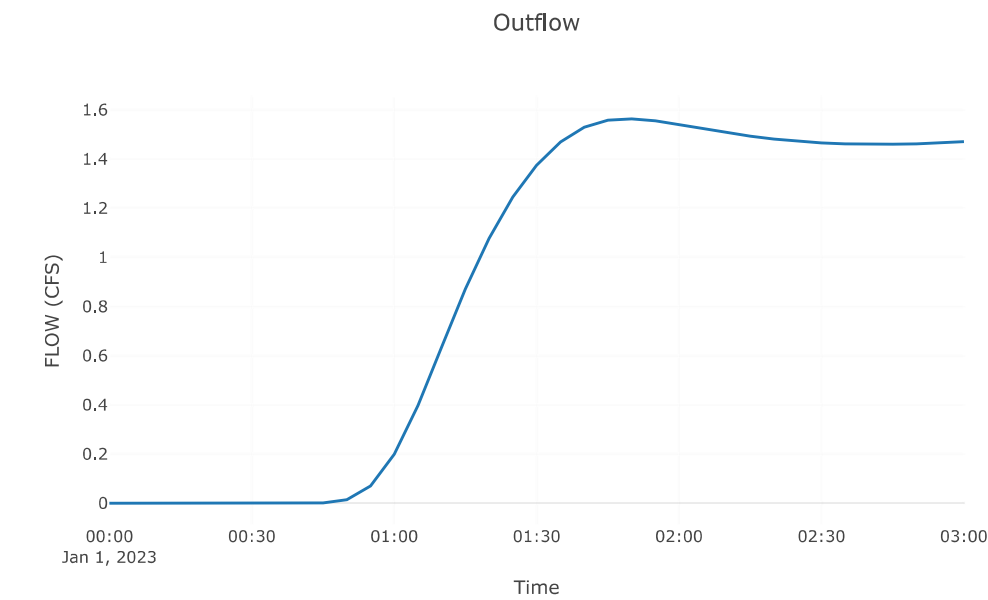
Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Circular
Length (FT)	300
Energy Slope (FT/FT)	0.01
Mannings n	0.01
Diameter	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	2
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-2	
Peak Discharge (CFS)	1.56
Time of Peak Discharge	01Jan2023, 01:50
Volume (IN)	0.04
Peak Inflow (CFS)	1.56
Inflow Volume (AC - FT)	0.22



Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	1.56
Time of Peak Discharge	01Jan2023, 01:50
Volume (IN)	0.04



Subbasin: OFF8

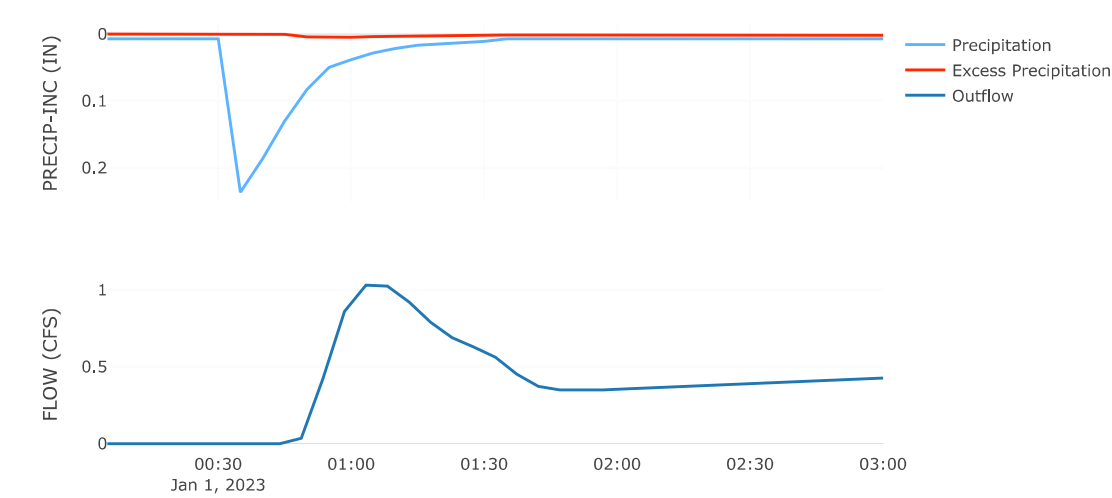
Area (MI²): 0.03
Downstream : Reservoir - 3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	78

Transform: Scs	
Lag	5
Unitgraph Type	Standard

Results: OFF8	
Peak Discharge (CFS)	1.03
Time of Peak Discharge	01Jan2023, 01:00
Volume (IN)	0.06
Precipitation Volume (AC - FT)	1.69
Loss Volume (AC - FT)	1.59
Excess Volume (AC - FT)	0.1
Direct Runoff Volume (AC - FT)	0.09
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Subbasin: OFF9

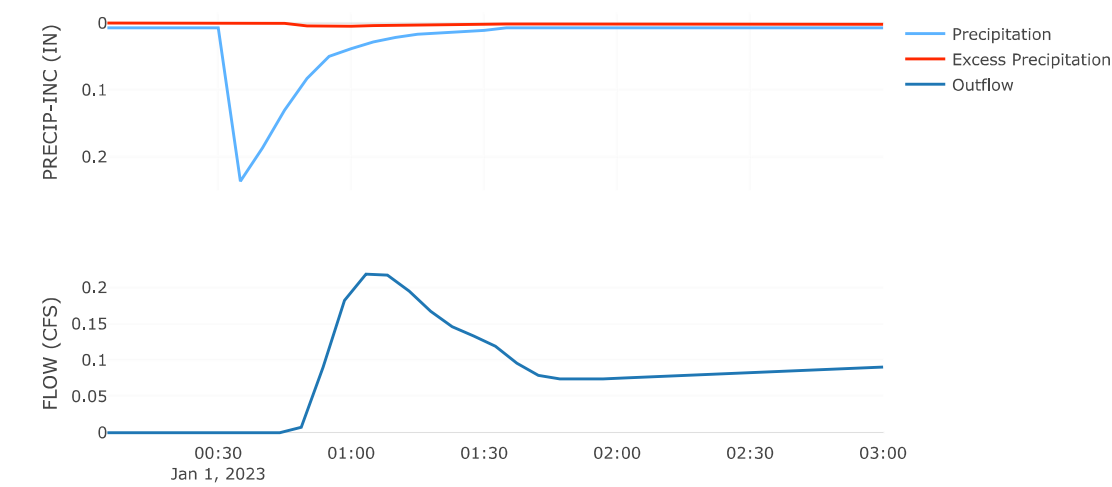
Area (MI²): 0.01
Downstream : Junction - 1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	78

Transform: Scs	
Lag	5
Unitgraph Type	Standard

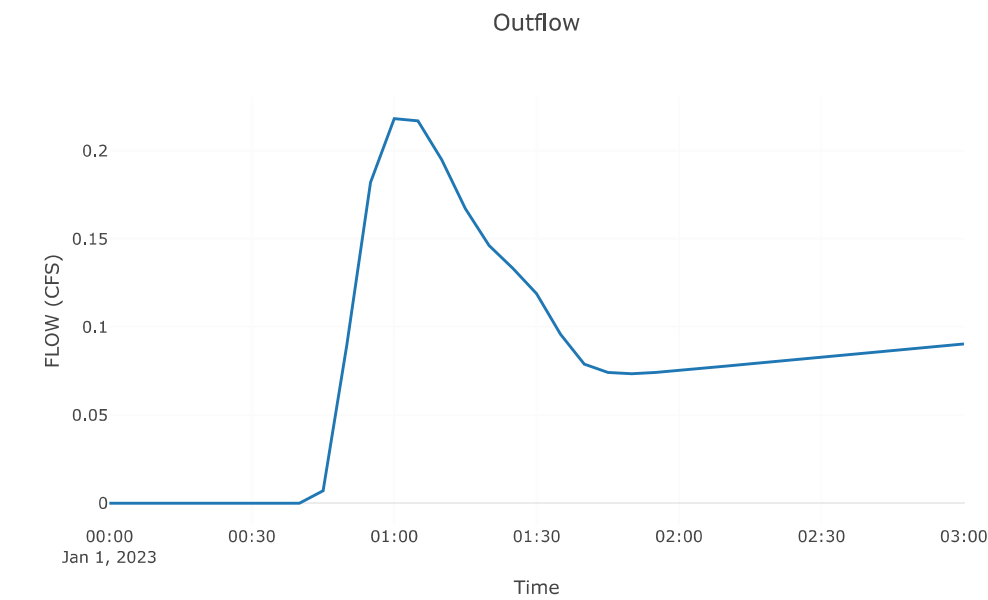
Results: OFF9	
Peak Discharge (CFS)	0.22
Time of Peak Discharge	01Jan2023, 01:00
Volume (IN)	0.06
Precipitation Volume (AC - FT)	0.36
Loss Volume (AC - FT)	0.34
Excess Volume (AC - FT)	0.02
Direct Runoff Volume (AC - FT)	0.02
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	0.22
Time of Peak Discharge	01Jan2023, 01:00
Volume (IN)	0.06

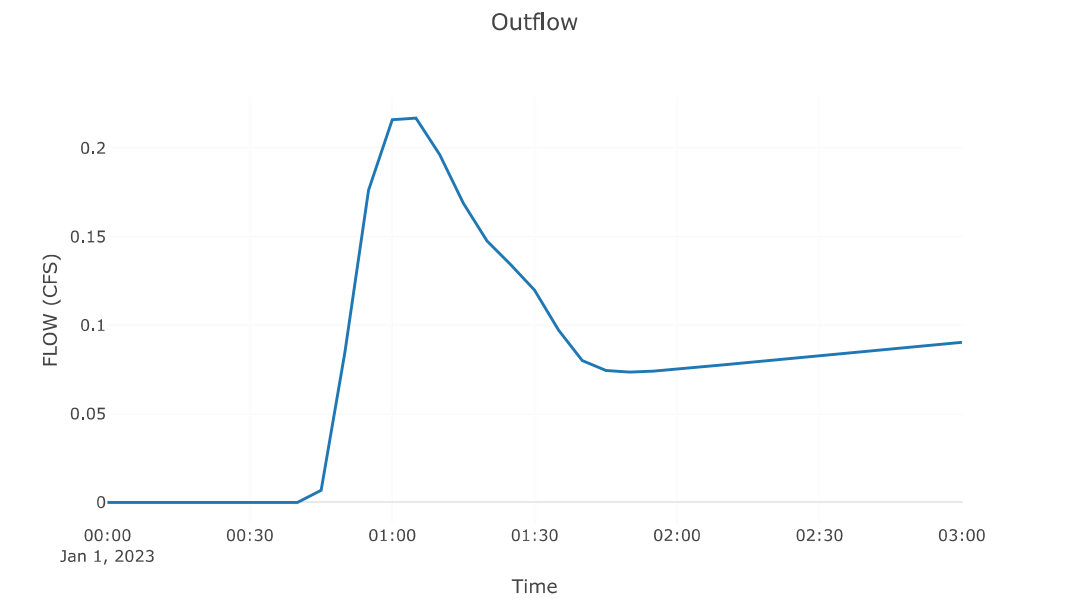


Reach: Reach-1

Downstream : Reservoir - 3

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Circular
Length (FT)	100
Energy Slope (FT/FT)	0.01
Mannings n	0.01
Diameter	1.5
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	2
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

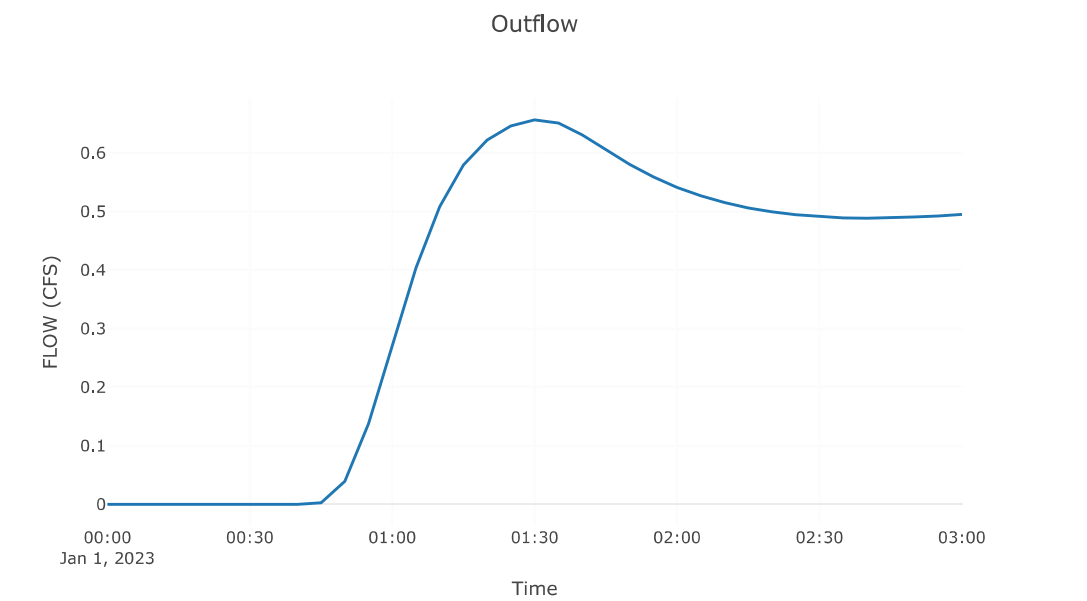
Results: Reach-1	
Peak Discharge (CFS)	0.22
Time of Peak Discharge	01Jan2023, 01:05
Volume (IN)	0.06
Peak Inflow (CFS)	0.22
Inflow Volume (AC - FT)	0.02



Reservoir: Reservoir-3

Downstream : Reach - 3

Results: Reservoir-3	
Peak Discharge (CFS)	0.66
Time of Peak Discharge	01Jan2023, 01:30
Volume (IN)	0.04
Peak Inflow (CFS)	1.25
Time of Peak Inflow	01Jan2023, 01:00
Inflow Volume (AC - FT)	0.11
Maximum Storage (AC - FT)	0.15
Peak Elevation (FT)	2776.22
Discharge Volume (AC - FT)	0.09

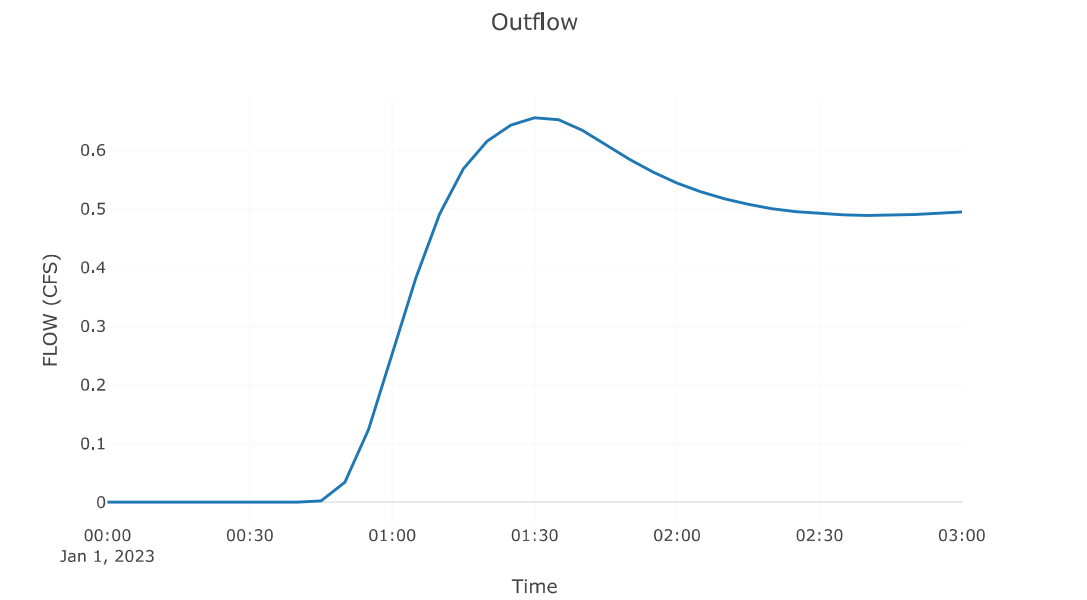


Reach: Reach-3

Downstream : Junction - 3

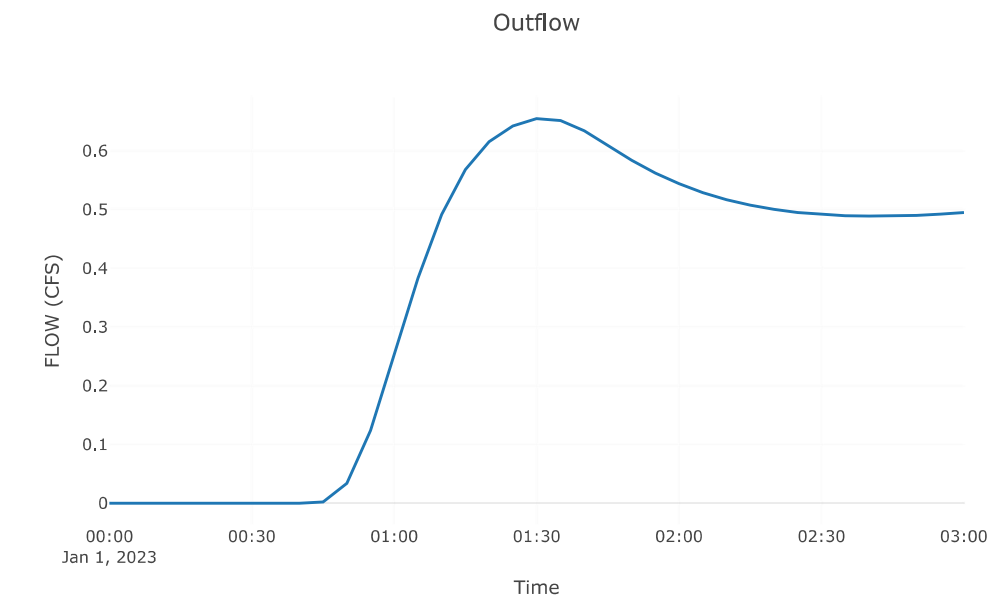
Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Circular
Length (FT)	300
Energy Slope (FT/FT)	0.01
Mannings n	0.01
Diameter	1.5
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	2
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-3	
Peak Discharge (CFS)	0.65
Time of Peak Discharge	01Jan2023, 01:30
Volume (IN)	0.04
Peak Inflow (CFS)	0.66
Inflow Volume (AC - FT)	0.09



Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	0.65
Time of Peak Discharge	01Jan2023, 01:30
Volume (IN)	0.04



Simulation End: 1 January 2023, 03:00

Executed: 29 July 2026, 18:32

Downstream	
Element Name	Downstream
Reach - 2	Junction - 2
Reach - 1	Reservoir - 3
Reach - 3	Junction - 3

Route: Muskingum Cunge												
Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Diameter	Initial Variable	Space - Time Method	Index Parameter Type	Index Flow	Maximum Depth Iterations	Maximum Route Step Iterations
Reach - 2	Muskingum Cunge	Circular	300	0.01	0.01	2	Combined Inflow	Automatic DX and DT	Index Flow	2	20	30
Reach - 1	Muskingum Cunge	Circular	100	0.01	0.01	1.5	Combined Inflow	Automatic DX and DT	Index Flow	2	20	30
Reach - 3	Muskingum Cunge	Circular	300	0.01	0.01	1.5	Combined Inflow	Automatic DX and DT	Index Flow	2	20	30

Global Results Summary

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Off10	0.12	29.68	01Jan2023, 01:05	0.29
Reservoir - 4	0.12	13.78	01Jan2023, 01:35	0.24
Reach - 2	0.12	13.77	01Jan2023, 01:35	0.24
Junction - 2	0.12	13.77	01Jan2023, 01:35	0.24
Off8	0.03	10	01Jan2023, 00:55	0.29
Off9	0.01	2.12	01Jan2023, 00:55	0.29
Junction - 1	0.01	2.12	01Jan2023, 00:55	0.29
Reach - 1	0.01	2.08	01Jan2023, 00:55	0.29
Reservoir - 3	0.04	5.81	01Jan2023, 01:15	0.27
Reach - 3	0.04	5.78	01Jan2023, 01:15	0.27
Junction - 3	0.04	5.78	01Jan2023, 01:15	0.27

Subbasin: OFF10

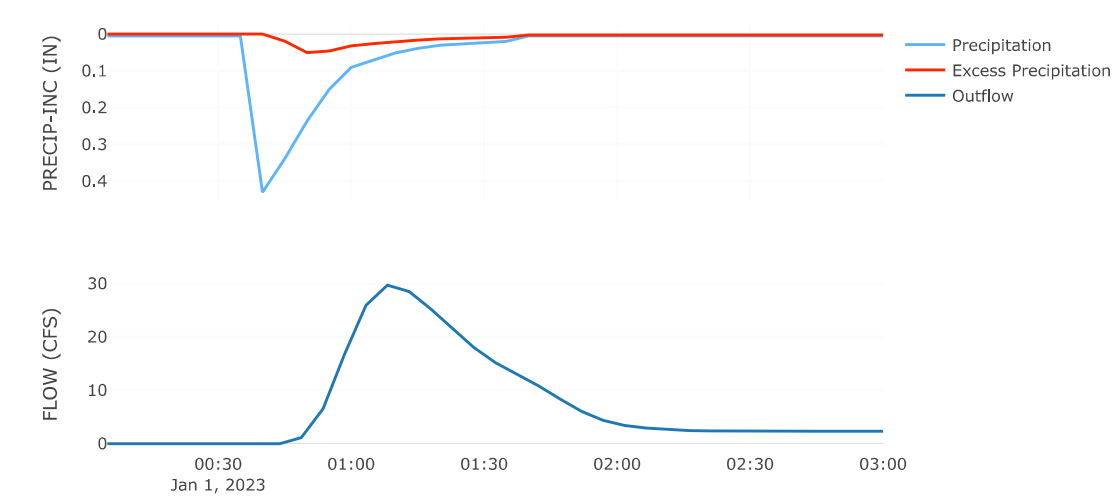
Area (MI²): 0.12
Downstream : Reservoir - 4

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	78

Transform: Scs	
Lag	12
Unitgraph Type	Standard

Results: OFF10	
Peak Discharge (CFS)	29.68
Time of Peak Discharge	01Jan2023, 01:05
Volume (IN)	0.29
Precipitation Volume (AC - FT)	10.25
Loss Volume (AC - FT)	8.39
Excess Volume (AC - FT)	1.86
Direct Runoff Volume (AC - FT)	1.8
Baseflow Volume (AC - FT)	0

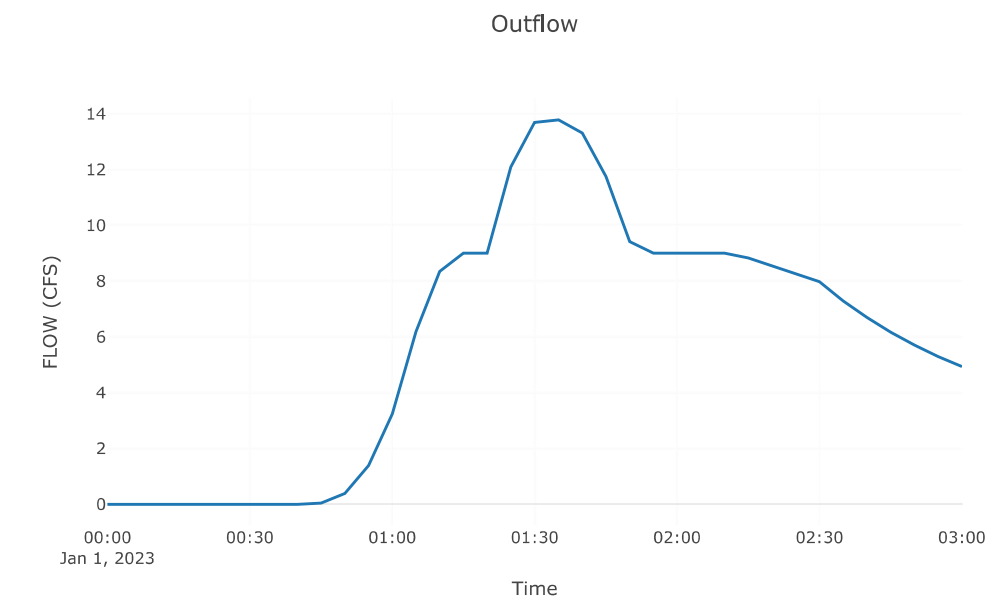
Precipitation and Outflow



Reservoir: Reservoir-4

Downstream : Reach - 2

Results: Reservoir-4	
Peak Discharge (CFS)	13.78
Time of Peak Discharge	01Jan2023, 01:35
Volume (IN)	0.24
Peak Inflow (CFS)	29.68
Time of Peak Inflow	01Jan2023, 01:05
Inflow Volume (AC - FT)	1.8
Maximum Storage (AC - FT)	1.06
Peak Elevation (FT)	2794.12
Discharge Volume (AC - FT)	1.48

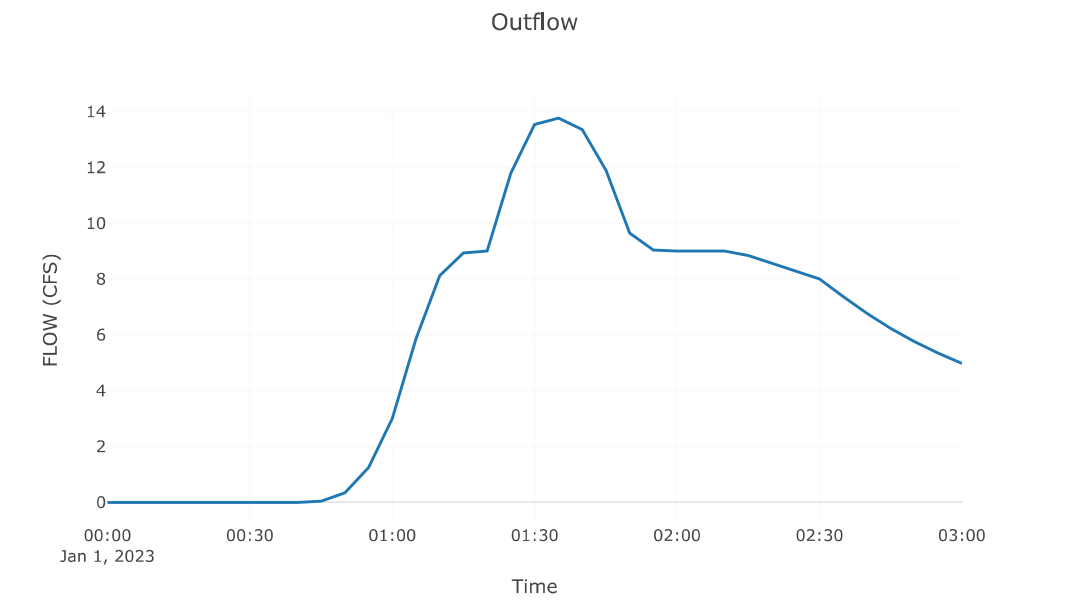


Reach: Reach-2

Downstream : Junction - 2

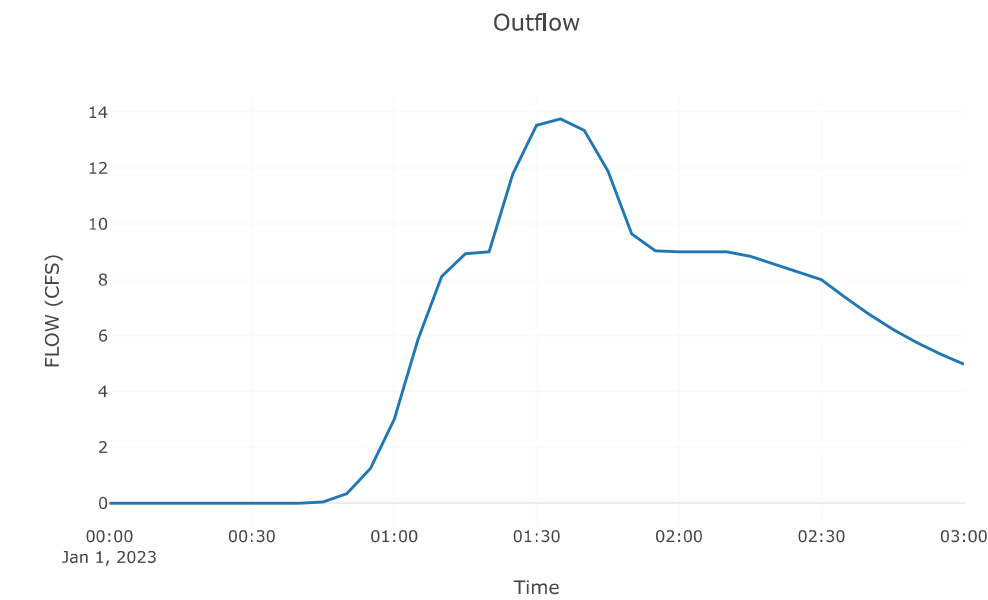
Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Circular
Length (FT)	300
Energy Slope (FT/FT)	0.01
Mannings n	0.01
Diameter	2
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	2
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-2	
Peak Discharge (CFS)	13.77
Time of Peak Discharge	01Jan2023, 01:35
Volume (IN)	0.24
Peak Inflow (CFS)	13.78
Inflow Volume (AC - FT)	1.48



Junction: Junction-2

Results: Junction-2	
Peak Discharge (CFS)	13.77
Time of Peak Discharge	01Jan2023, 01:35
Volume (IN)	0.24



Subbasin: OFF8

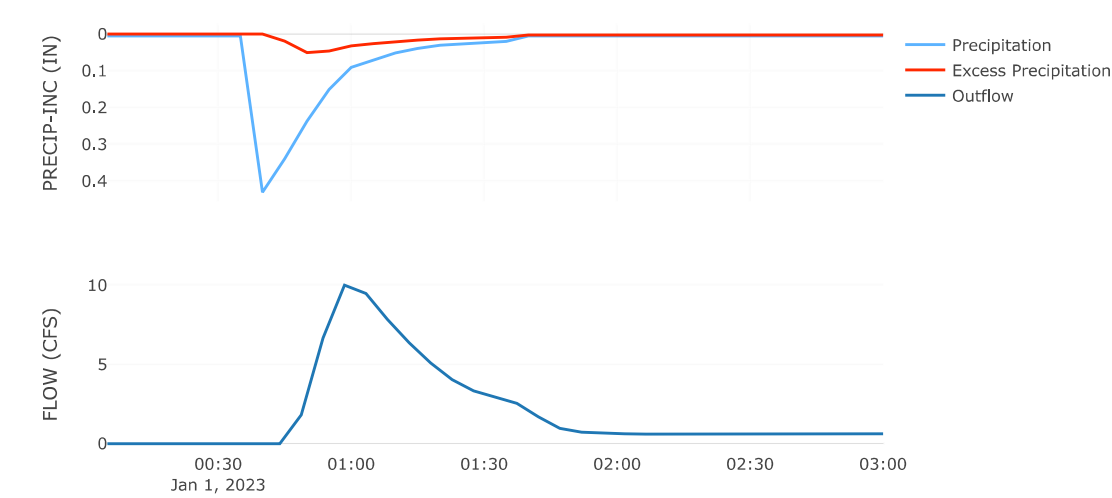
Area (MI²): 0.03
Downstream : Reservoir - 3

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	78

Transform: Scs	
Lag	5
Unitgraph Type	Standard

Results: OFF8	
Peak Discharge (CFS)	10
Time of Peak Discharge	01Jan2023, 00:55
Volume (IN)	0.29
Precipitation Volume (AC - FT)	2.76
Loss Volume (AC - FT)	2.26
Excess Volume (AC - FT)	0.5
Direct Runoff Volume (AC - FT)	0.49
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Subbasin: OFF9

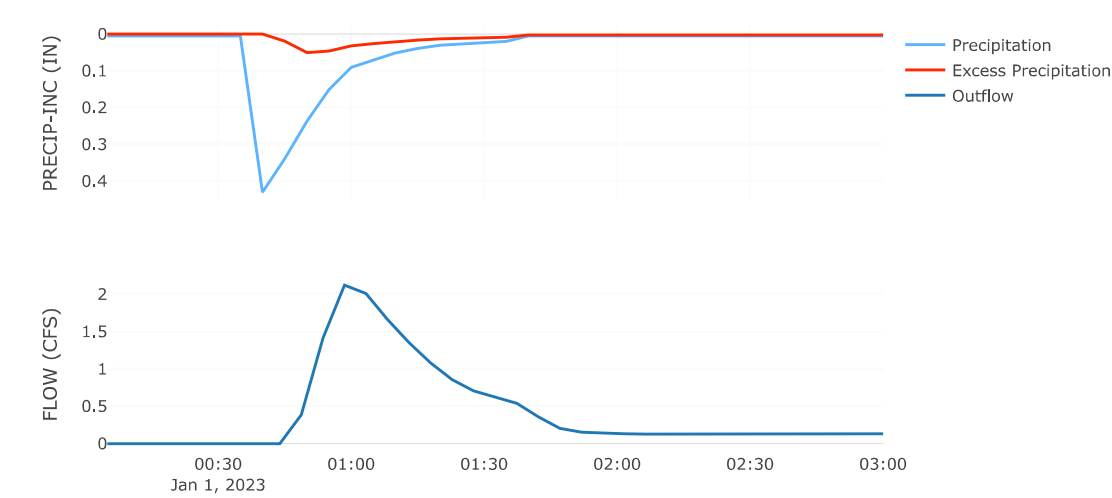
Area (MI2) : 0.01
Downstream : Junction - 1

Loss Rate: Scs	
Percent Impervious Area	0
Curve Number	78

Transform: Scs	
Lag	5
Unitgraph Type	Standard

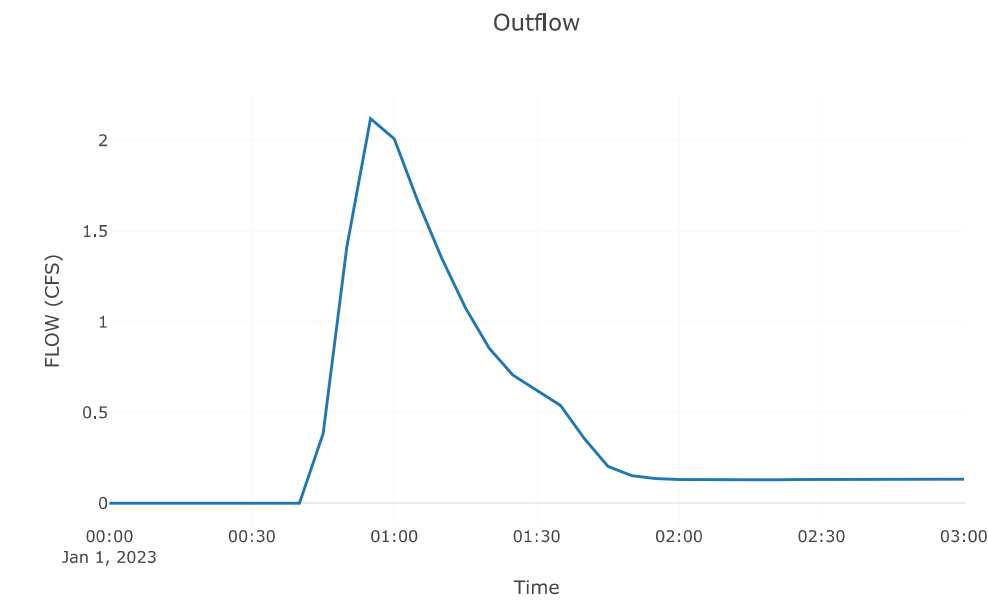
Results: OFF9	
Peak Discharge (CFS)	2.12
Time of Peak Discharge	01Jan2023, 00:55
Volume (IN)	0.29
Precipitation Volume (AC - FT)	0.59
Loss Volume (AC - FT)	0.48
Excess Volume (AC - FT)	0.11
Direct Runoff Volume (AC - FT)	0.1
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Junction: Junction-1

Results: Junction-1	
Peak Discharge (CFS)	2.12
Time of Peak Discharge	01Jan2023, 00:55
Volume (IN)	0.29

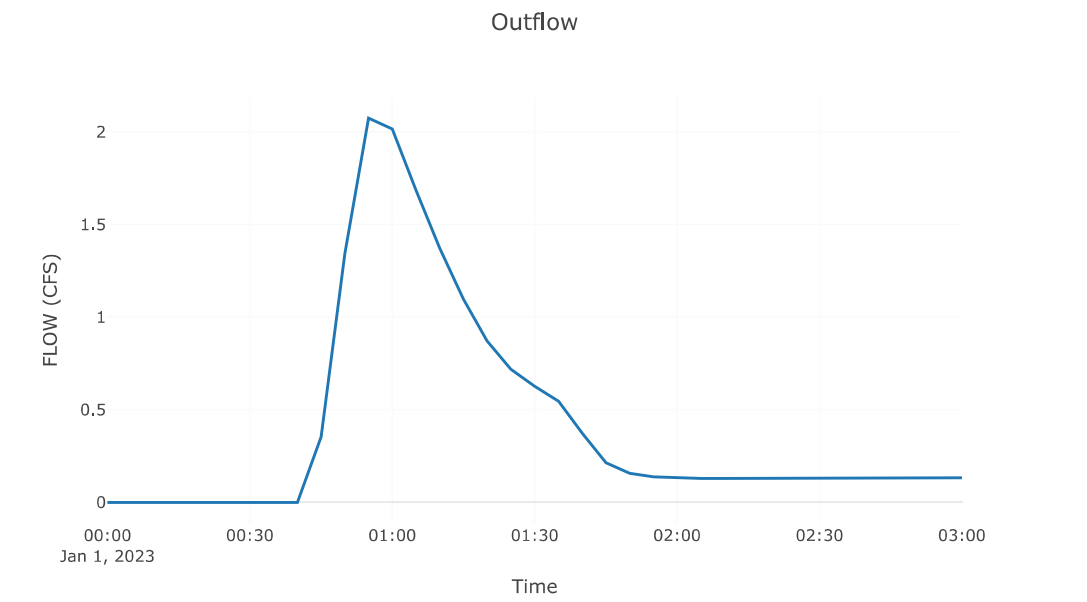


Reach: Reach-1

Downstream : Reservoir - 3

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Circular
Length (FT)	100
Energy Slope (FT/FT)	0.01
Mannings n	0.01
Diameter	1.5
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	2
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

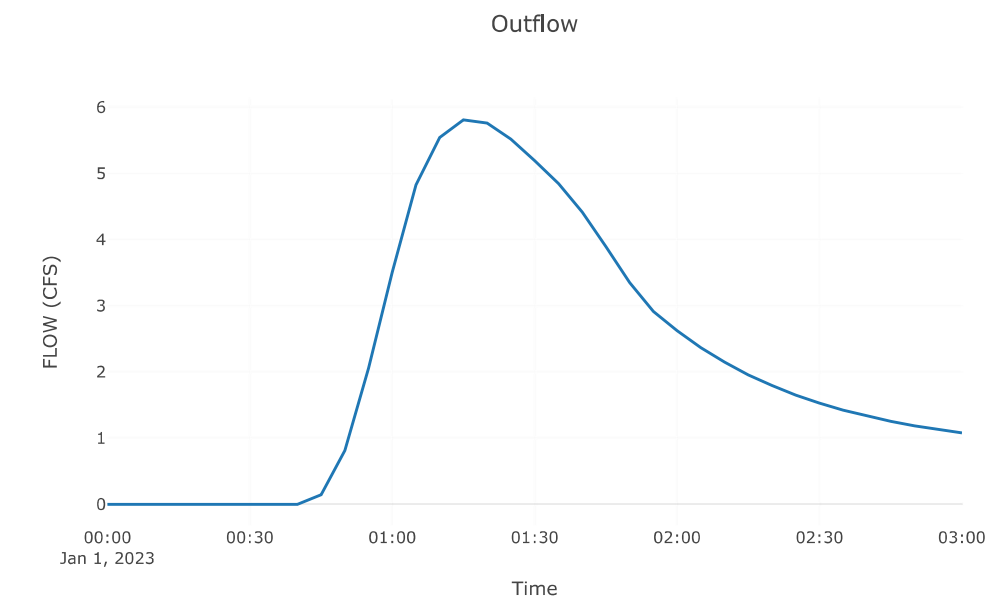
Results: Reach-1	
Peak Discharge (CFS)	2.08
Time of Peak Discharge	01Jan2023, 00:55
Volume (IN)	0.29
Peak Inflow (CFS)	2.12
Inflow Volume (AC - FT)	0.1



Reservoir: Reservoir-3

Downstream : Reach - 3

Results: Reservoir-3	
Peak Discharge (CFS)	5.81
Time of Peak Discharge	01Jan2023, 01:15
Volume (IN)	0.27
Peak Inflow (CFS)	12.08
Time of Peak Inflow	01Jan2023, 00:55
Inflow Volume (AC - FT)	0.6
Maximum Storage (AC - FT)	0.36
Peak Elevation (FT)	2777.56
Discharge Volume (AC - FT)	0.55

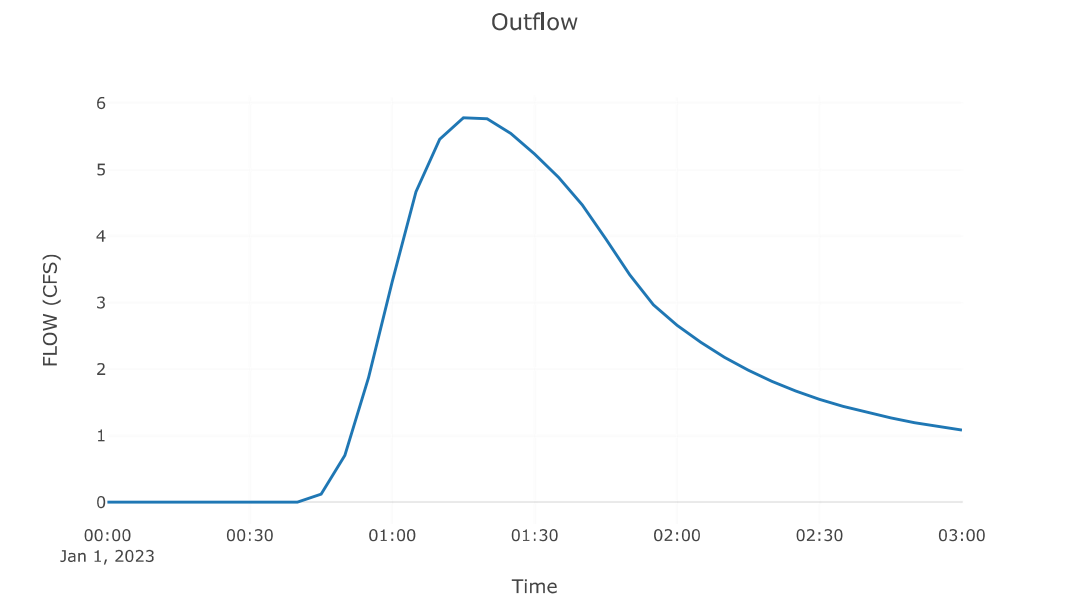


Reach: Reach-3

Downstream : Junction - 3

Route: Muskingum Cunge	
Method	Muskingum Cunge
Channel	Circular
Length (FT)	300
Energy Slope (FT/FT)	0.01
Mannings n	0.01
Diameter	1.5
Initial Variable	Combined Inflow
Space - Time Method	Automatic DX and DT
Index Parameter Type	Index Flow
Index Flow	2
Maximum Depth Iterations	20
Maximum Route Step Iterations	30

Results: Reach-3	
Peak Discharge (CFS)	5.78
Time of Peak Discharge	01Jan2023, 01:15
Volume (IN)	0.27
Peak Inflow (CFS)	5.81
Inflow Volume (AC - FT)	0.55



Junction: Junction-3

Results: Junction-3	
Peak Discharge (CFS)	5.78
Time of Peak Discharge	01Jan2023, 01:15
Volume (IN)	0.27

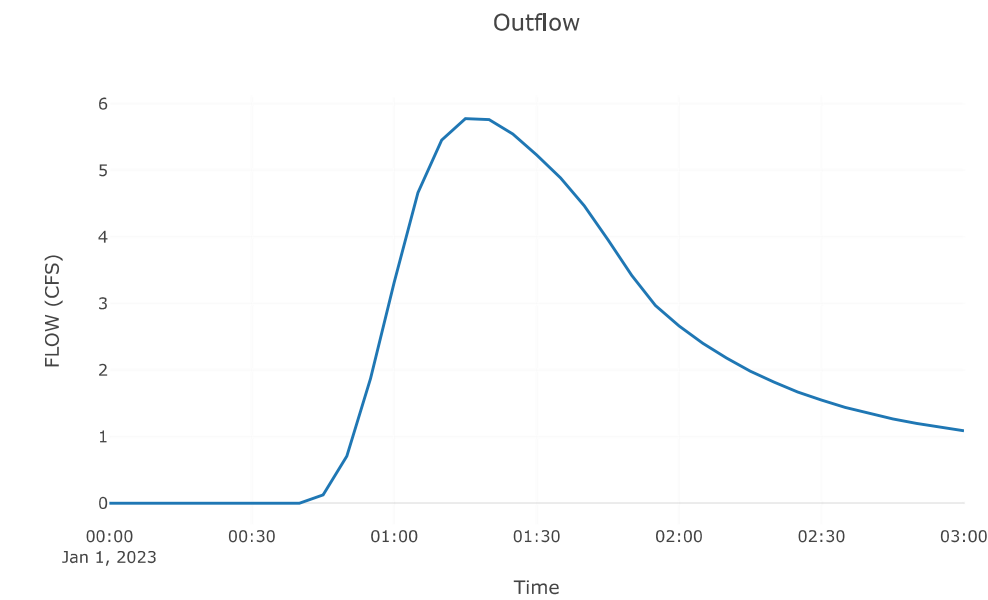


EXHIBIT G
UPDATE LETTER TO GEOTECHNICAL EVALUATION



December 6, 2024
Project No. G20247223E1

Mr. Mike Bracken
Quality Excavation
1472 East 3950 South
St. George, Utah 84790

**RE: Update Letter to Geotechnical Evaluation
Desert Talus, Phases I through IV
Southwest of Desert Canyons Parkway and Airport Parkway
(Geotechnical Investigation Report, prepared by AGECE Inc., Project No. 2200519,
Dated May 16, 2022)**

Dear Mr. Bracken,

- **Geotechnical Engineering**
- **Construction Materials Testing & Inspections**
- **Environmental Services**
- **AASHTO Accredited Testing Laboratories**
- **IAS Accredited**

Applied Geotechnical Engineering Consultants, Inc. (AGECE), has previously prepared a Geotechnical Investigation report dated May 16, 2022, Project No. 2200519, for the above referenced project. The purpose of this update is to assess the current condition of the subject site and to incorporate any applicable changes based on the 2021 International Building Code (IBC) and local amendments.

We understand that the nature of the development as described in the referenced report has not changed from the time of the original evaluation, which will consist of a single-family residential subdivision with roadways, site improvements, and underground utilities. We assume the proposed structures will be constructed with wood framing, stucco or rock veneer, and tile roofs. We assume wall loads of up to 3 kips per linear feet and column loads of up to 25 kips, supported on conventional spread footings with slab-on-grade floors. Basements are not anticipated on any of the structures.

GES evaluated the subsurface conditions at the site on November 20, 2024, by excavating fifteen (15) additional test pits to depths of up to approximately 9 feet below the existing ground surface, using a trackhoe excavator using a 3-foot wide bucket with teeth. The enclosed Figure A-1 presents a site plan showing the approximate test pit locations within the subject site.

A qualified GES representative directed and supervised the subsurface explorations while visually observing the site, maintained detailed logs of the subsurface conditions and observed and visually classified the soils encountered. A Key to Symbols and Terms utilized on the exploration logs is presented on Figure A-2. The soils encountered were visually classified in the field in general accordance with the American Society of Testing and Materials (ASTM) Standard D 2488.

In preparation of this update, GES reviewed the following documents:

- Geotechnical Investigation Report – Desert Cliffs Area 165 Acres at Desert Canyons – St. George, Utah, Prepared by AGECE Inc, Project No. 2200519, Dated May 16, 2022.

Las Vegas
7150 Placid Street
Las Vegas, NV 89119 •
702.365.1001

Mesquite
530 Commerce Circle
Mesquite, NV 89027 •
702.346.4489

Reno
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Suite 116 Reno, NV 89511 •
775.622.3844

St. George
705 S. 5300 W., Suite 5
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On the basis of our review of the referenced documents and exploration, it is our opinion that the conclusions and recommendations presented in the referenced Geotechnical Investigation Report remain applicable to the proposed improvements referenced above, with the following clarifications:

- We understand that the site will be mass graded prior to construction of structures and site improvements. Based on the soil conditions, we recommend that the on-site soils be overexcavated down to within 1 foot of the gravel layer, fragmented rock layer, slightly cemented, or dense sand layer, whichever is encountered first. Based on our observations the depth of native soil removal from current grade is generally between 2 to 5 feet. The Test Pit logs can be referenced to estimate depth to approximate competent layer. A GES representative should observe the exposed subgrade after overexcavation and prior to placing structural fill. The exposed subgrade should be scarified to a depth of at least 6 inches, moisture conditioned and compacted to a firm unyielding condition. Soil probing of the subgrade is acceptable with less than 1-inch of penetration. At least 1 foot of structural fill should be placed below foundations and concrete slabs.
- The geotechnical consultant during construction should observe exposed materials after needed removals of unsuitable materials to evaluate whether additional removal down to competent materials is needed. The soil preparation area should extend laterally a minimum of 5 feet beyond the edges of buildings and exterior foundations, where practical. For exterior concrete flatwork, the soil preparation area should extend laterally at least 2 feet beyond the edges. The vertical and lateral extent of the recommended excavations should be evaluated under the direction of the geotechnical consultant.
- All existing uncontrolled fill, deleterious material, loose or disturbed native soils should be removed from improvement areas, and either removed from the site or processed to comply with the recommendations outlined below:

Imported and/or On-site Structural Fill Recommendations

Description*	Recommendation
4-inch Sieve Gradation**	50 Percent Passing
No. 200 Sieve Gradation**	<75 Percent Passing
Liquid Limit	<30
Dry Weight Soluble Solids	<1.0% as determined by American Water Works Association (AWWA) Standard Method (SM) 2540 C
Dry Weight Soluble Sulfate	<1.0 percent by dry weight soluble sulfate as determined by AWWA SM 4500 SO4 E
Soluble Soil Chloride Content	<500 ppm as determined by AWWA SM 4500-CL B unless appropriate corrosion protection is utilized in the design of proposed structures

* Imported fill materials and excavated on-site material should be free of debris, organic materials, and other deleterious materials.

**Materials used as retaining wall backfill, which should have 15 percent, or less, of material passing the No. 200 sieve and 100 percent passing the 4-inch sieve.

- Structural fill should be uniformly moisture conditioned to near optimum moisture content, placed in horizontal, loose lifts up to 12 inches thick, and compacted to 95 percent of the maximum dry density, or more, as determined by ASTM D1557. The optimal lift thickness of fill will depend on the type of soil and compaction equipment used but should generally not exceed approximately 12 inches in loose thickness.
- If fill material is placed where the existing ground surface is steeper than 5:1 (horizontal to vertical), the surface on which fill is to be placed should be benched. We recommend that benches be 8 feet or wider or be of sufficient width to permit operation by compaction equipment. Benches should include approximately 2-foot high vertical or near-vertical intervening steps, cut to expose suitable soil as evaluated in the field by the geotechnical consultant during earthwork operations. Preparation of the benching surface in areas to receive fill should include scarification and moisture-conditioning to a depth of approximately 6-inches, and compaction to a relatively non yielding condition, prior to placement of fill.
- As a minimum, conventionally reinforced slabs-on-grade should be 4 inches thick, or more, and the reinforcing should be designed by an experienced Structural Engineer based on the anticipated loading conditions. Aggregate base course or similar granular materials beneath the floor slab-on-grade should be 4-inches thick, or more, and should consist of Type II Aggregate Base materials, be uniformly placed and compacted to 95 percent, or more, of the maximum dry density per ASTM D1557. The conventionally-reinforced slab-on-grade foundation supported on Type II Aggregate Base may be designed using an average vertical modulus of subgrade reaction (kv) of 150 pounds per cubic inch for a 1-foot square area. This value should be reduced based on the actual area of the slab.
- Where moisture-sensitive floor coverings are anticipated, a vapor retarder is recommended beneath slabs-on-grade and should consist of 10-mil minimum sheet plastic overlain by at least 4 inches of a coarse, clean sand, Type II Aggregate Base, or other similar material approved by the Geotechnical Engineer. The vapor retarder should comply with the Class A rating as set forth in ASTM E1745. Installation of the vapor retarder should be performed in accordance with ASTM E1643. The base materials should be uniformly moisture conditioned and compacted to at least 90 percent of the maximum dry density.
- Based on the limited data available to evaluate the seismic site class for the project site, the default value for Seismic Site Class (Site Class D) may be used for design.
- As appropriate, the following seismic design parameters based on the 2021 IBC for a default Seismic Site Class D may be utilized using representative site coordinates of 37.005373 degrees latitude and -113.489054 degrees longitude with an assumed Risk Category of II and may be utilized for design of project structures.

Spectral Response Accelerations and Site Coefficients – Site Class D

Spectral Response Acceleration at Short Periods, S_s	Spectral Response Acceleration at 1-Second Period, S_1	Spectral Response Coefficient at Short Periods, SD_s	Spectral Response Coefficient at 1-Second Period, SD_1	Site Modified Peak Ground Acceleration PGA_M
0.594g	0.192g	0.525g	0.284g	0.345

- Lateral active earth pressures induced by adjacent uniform surface surcharge loads should be estimated as a uniformly distributed lateral load with a magnitude equal to the magnitude of the surface surcharge load multiplied by an appropriate earth pressure coefficient. GES is presenting earth pressure coefficients for “active” and “at-rest” wall conditions. In the “active” condition the wall can deflect such that stresses from the retained soils are lessened. The “at rest” condition considers the walls to be rigid, or restrained, such that the walls do not deflect to lessen stresses from retained soils. Retaining walls with level backfill should be designed to resist the lateral earth pressures for the appropriate conditions presented in Figure B-1.
- The values presented in Figure B-1 assume that the build-up of hydrostatic pressure will be prevented. To reduce the build-up of hydrostatic pressure, a wall drainage system, including weep-holes or a footing drainage system, day lighting to an appropriate outlet should be installed behind retaining walls. The wall drainage system should consist of Mirafi 140N (or equivalent) geotextile wrapped around drain rock, or a DrainStar Drain Board (or equivalent). The drain board should be used in conjunction with DrainStar Stripdrain by Tremco Barrier Solutions, Inc., or equivalent. The Stripdrain should be a minimum of 12 inches in height and placed continuously along the bottom of the retaining wall.
- Resistance to lateral loads may be estimated using both passive lateral earth support and friction developing between the wall footing and underlying soil. Passive resistance may be used if foundation backfill soils in front of the wall are compacted to 95 percent, or more, of the maximum laboratory dry density (ASTM D1557). The upper 12 inches below the ground surface should be neglected if passive resistance is used. The passive lateral earth support for subsurface walls may be estimated based on an un-factored equivalent fluid density of 380 pcf up to a maximum passive lateral pressure of 2,500 psf. A coefficient of friction of 0.39 may be used for the interface between the wall footing and underlying properly compacted structural fill. The values for the equivalent fluid density and coefficient of friction presented above do not include a specific factor of safety. The structural engineer should utilize appropriate factors of safety during design.
- Backfill placed behind retaining walls or subsurface walls should consist of structural fill meeting the criteria presented in this report. Backfill placed behind retaining walls should be placed in 8-inch maximum vertical lifts and should be compacted to 95 percent, or more, of the maximum laboratory dry density as determined per ASTM D1557. Over-compaction adjacent to retaining walls or subsurface walls should be avoided. The lateral earth pressures shown on Figure B-1 assume that compaction behind retaining walls or subsurface walls will be accomplished with relatively light compaction equipment.
- Based on our experience with other projects in the vicinity, we recommend, in accordance with Table 19.3.2.1 of ACI 318-14 (ACI, 2014) concrete in contact with on-site soils along with subsurface walls up to 12 inches above finished grade should be designed for a sulfate exposure class S2 with Type V cement and have a minimum design compressive strength of 4,500 pounds per square inch (psi) and a maximum water to cement ratio of 0.45.
- The table below shows the nearest faults nearby the project site. Based on the results of our review of available literature and the distance to mapped faults and fissures, it is our opinion that the potential for fault-related surface rupture at the site is low.

Nearby Faults and Earth Fissures

Fault		Distance from Project Vicinity (miles)	Direction
Quaternary-Age Tectonic Faults	Washington Fault Zone	$\frac{3}{4}$	East
	Dutchman Draw Fault	$4\frac{3}{4}$	Southeast
	Hurricane Fault Zone	$8\frac{3}{4}$	East

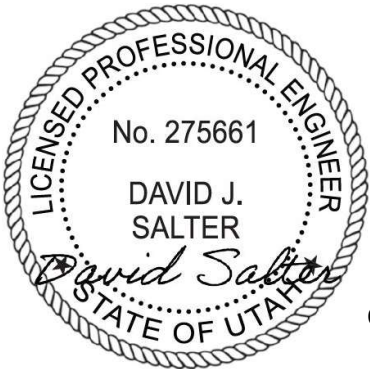
- When finished, project grading and foundation plans, at the option of the Building Official, should be reviewed by the geotechnical consultant to evaluate whether the project grading and foundation plans are consistent with the geotechnical design criteria presented in the referenced report.

Our services were performed using that degree of care and skill ordinarily exercised under similar circumstances by reputable engineering firms in this or similar localities. No other warranty, either expressed or implied, is included or intended in this letter.

We appreciate the opportunity to assist you in this matter. Please contact our office if you have any questions or comments regarding this information.

Sincerely,

Geotechnical & Environmental Services, Inc.



exp. 3-31-25

Thessa Fernando
Digitally signed by Thessa Fernando
DN: C=US, E=thessa.fernando@gesnevada.com,
O=Geotechnical and Environmental Services,
OU=Geotechnical and Environmental Services,
CN=Thessa Fernando
Date: 2024.12.06 10:55:49 -08'00'

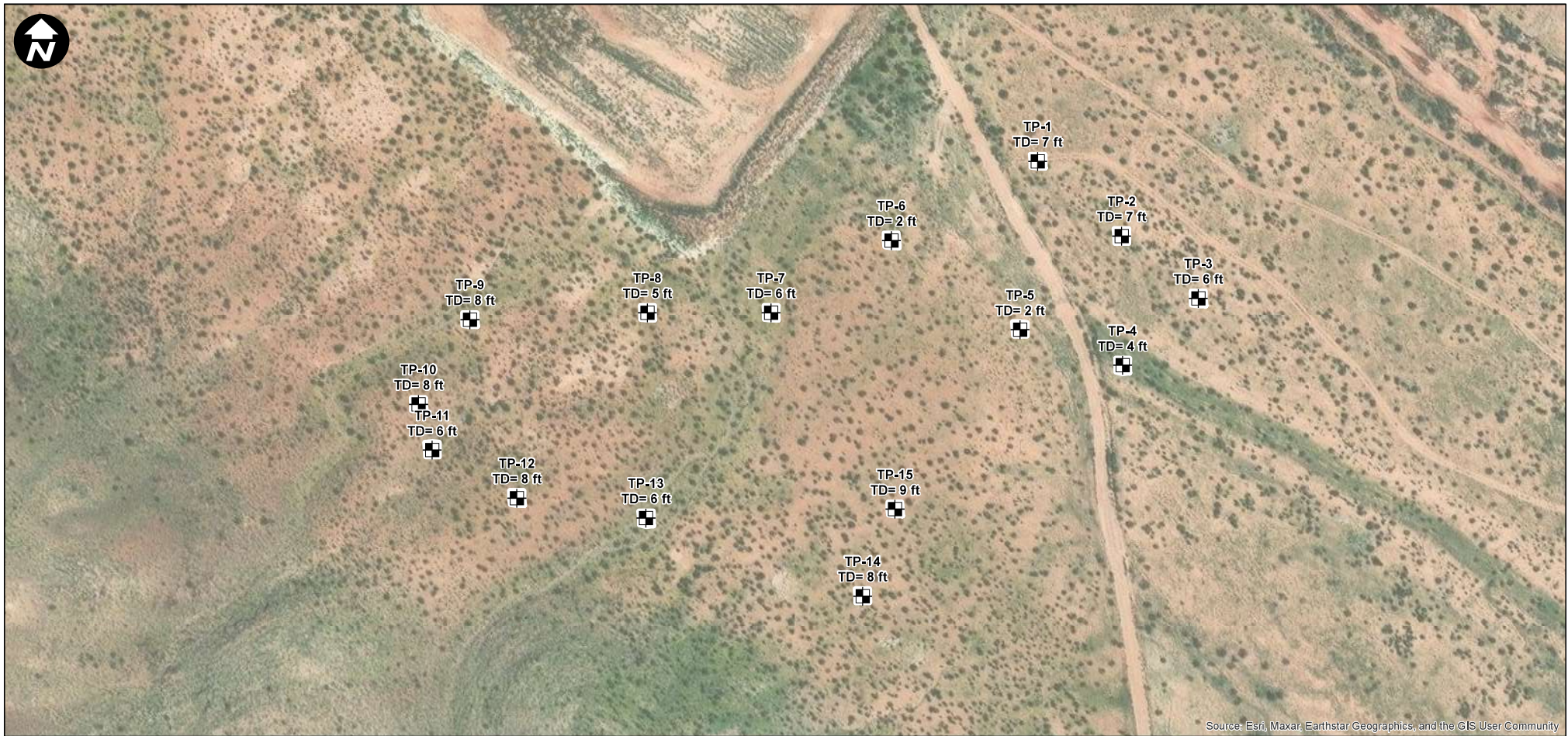
Thessa Fernando
Engineering Assistant

TF:DJS:vs

David Salter
Digitally signed by David Salter
Date: 2024.12.06
10:45:04 -08'00'
David J. Salter, P.E.
Geotechnical Practice Leader

Encl: Figure A-1: through A-17: Test Pit Location Map and Test Pit Logs
Figure No. B-1: Lateral Earth Pressure Diagram
Geotechnical Investigation, Dated May 16, 2022, Project No. 2200519

Dist: PDF copy e-mail to addressee at mike@qualityexcavation.net
Copy to project file



Legend

• <all other values>

Approximate Test Pit Location (GES Project G20247223E1)

0 125 250 500 750 1,000 Feet



EXPLORATION LOCATION MAP - SURVEYED LOCATIONS DESERT TALUS ROUGH GRADING PASES 1-4 ST. GEORGE, UTAH

Drawn By: JJB

Date Drawn: 12/4/2024

GES Project No. G20247223E1

Figure No. 1

\\B011\Company\GES\Clients\In-State Region\St. George Office\Projects\2024\20247223 - Desert Talus\Map\ArcMap\G20247223E1 Explorations.mxd

KEY TO SYMBOLS AND TERMS

Terms used according to the Unified Soil Classification System

Consistency or Condition of Soils

Fine-Grained Soils (Silt and Clay): Major portion passing #200 sieve

California Sampler* (blows/foot)	SPT** (blows/foot)	Relative Consistency	Unconfined Compressive Strength (tsf)	Manual Manipulation
< 2	< 2	Very Soft	< 0.25	Thumb will penetrate soil more than 1 in.
2-5	2-4	Soft	0.25-0.50	Thumb will penetrate soil about 1 in.
5-10	4-8	Firm	0.50-1.00	Thumb will penetrate soil about 1/4 in.
10-20	8-15	Stiff	1.00-2.00	Thumb will not indent soil but readily indented with thumbnail.
20-40	15-30	Very Stiff	>2.00	Thumbnail will not indent soil.
>40	>30	Hard	>2.00	Thumbnail will not indent soil.

*ASTM D3550 using a 140-pound hammer falling 30 inches.

**ASTM D1586-18

Coarse-Grained Soils (Sand and Gravel): Major portion retained on #200 sieve

California Sampler* (blows/foot)	SPT** (blows/foot)	Relative Density	Behavior of 1/2-inch Diameter Probe Rod
0-7	0-4	Very Loose	Easily penetrated when pushed by hand.
7-18	4-10	Loose	Firmly penetrated when pushed by hand.
18-50	10-30	Medium Dense	Easily penetrated when driven by 1 lb. hammer.
50-70	30-50	Dense	Penetrated less than 1 inch when driven with a 1 lb. hammer.
>70	>50	Very Dense	Penetrated less than 1/4 inch when driven with a 1 lb. hammer.

*ASTM D3550 using a 140-pound hammer falling 30 inches.

**ASTM D1586-18

Cementation	Characteristic
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

Hardness	Characteristic
Moderately Hard	Can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and scratch is readily visible after the powder has been blown away.
Hard	Can be scratched with difficulty; scratch produces little powder and is often faintly visible; traces of the knife steel may be visible.
Very Hard	Cannot be scratched with pocket knife. Leave knife steel marks on surface.

Laboratory Testing Acronyms & Abbreviations

AL = Atterberg Limits
Consol = Consolidation
CBR = California Bearing Ratio

Corr = Corrosion Suite
DS = Direct Shear
MC = Moisture Content

MD = Moisture Content/ Dry Density
OC = Organic Content
PROC = Proctor

R-Val = R-Value
SA = Sieve Analysis
SPG = Specific Gravity

UU = Unconsolidated Undrained Triaxial Test

Misc. Symbols

	Exploration continues
	Initial groundwater depth
	Measured groundwater depth (after 24 hours or more)

Constituent Percentages

Trace - < 5%
Few - 5 to 10%
Little - 15-25%
Some - 30-45%
Mostly - 50-100%

Moisture Condition

Dry - Visible absence of moisture, dusty, dry to the touch
Moist - Damp but no visible water
Wet - Visible free water, usually soil is below water table

Notes

1. Subsurface explorations were performed using the equipment listed on the exploration logs.
2. Subsurface explorations were performed on the date(s) shown on the exploration logs.
3. Soil sampler(s) were driven with a 140 pound hammer falling 30 inches (unless otherwise noted in the text of this report).
4. The transitions between soil types shown on the exploration logs as occurring abruptly at particular depths in actuality may be a gradual progression from one soil type to the next.
5. Exploration logs are subject to the limitations, conclusions, and recommendations presented in this report.
6. DR = Drilling Rate (min/ft)

Strata Group Symbols

	AC - Asphalt Concrete
	PCC - Portland Cement Concrete
	CL - Low plasticity clay
	CH - High plasticity clay
	CL-ML - Silty low plasticity clay
	ML - Silt
	MH - Elastic silt
	SC - Clayey sand
	SM - Silty sand
	SP - Poorly graded sand
	SW - Well - graded sand
	GC - Clayey Gravel
	GM - Silty gravel
	GP - Poorly graded gravel
	GW - Well - graded gravel
	CSG - Cemented sand and gravel
	CALI - Caliche

Soil Sampler Symbols

	Air Knife
	Bulk Sample
	California Sampler
	Standard Penetration Test
	Core Barrel
	Shelby Tube



Disclaimer

This Key to Symbols and Terms is part of a report prepared by Geotechnical & Environmental Services, Inc. and should be used with the report. The descriptions on the exploration logs apply only at the specific exploration locations and at the time the explorations were made. They are not warranted to be representative of subsurface conditions at other locations or times.

Figure No. A-2



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2765.91 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.0068 LONG. -113.48921 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			
			Brown sandy SILT, roots, blocky structure, light weight, frequent pin holes, dry and firm.
2.5	ML		
			... firm to stiff.
5.0			
5.5			2760.4
	GP- GM		Gray poorly graded GRAVEL with silt and sand, gravel rounded, dry and dense.
7.0			2758.9

Bottom of test pit at 7.0 feet.



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2766.91 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00648 LONG. -113.48885 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			
2.5	ML		Brown sandy SILT, some structure, less pin holes, dry and firm.
5.0			
5.0			
5.0	GP- GM		Gray poorly graded GRAVEL with silt and sand, dry and medium dense to dense.
7.0			
7.0			

Bottom of test pit at 7.0 feet.



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2768.44 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00621 LONG. -113.48853 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0			Brown sandy SILT, some structure, less pin holes, dry and firm.	
2.5	ML			
4.5				2763.9
5.0	GP- GM		Gray Poorly graded GRAVEL with silt and sand, dry and medium dense to dense.	
6.0				2762.4

Bottom of test pit at 6.0 feet.



TEST PIT NUMBER TP-4

PAGE 1 OF 1

PROJECT NAME Desert Talus

CLIENT Quality Excavation

PROJECT NUMBER G20247223E1

PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy

DATE STARTED 11/20/24

COMPLETED 11/20/24

GROUND ELEVATION 2768.43 ft

TEST PIT SIZE 2' X 10' feet

EXCAVATION CONTRACTOR Quality Excavation

GROUND WATER LEVELS:

EXCAVATION METHOD Track Excavator

AT TIME OF EXCAVATION Not Encountered

LOGGED BY D. Salter

DRILLER Client

AT END OF EXCAVATION N/A

LAT. 37.00593

LONG. -113.48885

AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			
	ML		Brown sandy SILT, less structure, no pin holes observed, dry and firm.
2.5			
	GP-GM		Gray poorly graded GRAVEL with silt and sand, dry and medium dense to dense.
4.0			
			2765.4
			2764.4

Bottom of test pit at 4.0 feet.

Soils were classified in general accordance with ASTM D2488

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

Figure No. A-6

GENERAL BH/TPWELL - GES - GES - GEOTECHNICAL STD.GDT - 12/5/24 21:56 - J:\GES\CLIENTS\TRI-STATE REGION\ST. GEORGE OFFICE\PROJECTS\2024\IG20247223 - DESERT TALUS\IG20247223E1.GPJ



PROJECT NAME	Desert Talus	CLIENT	Quality Excavation
PROJECT NUMBER	G20247223E1	PROJECT LOCATION	SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED	11/20/24	COMPLETED	11/20/24
GROUND ELEVATION	2768.52 ft	TEST PIT SIZE	2' X 10' feet
EXCAVATION CONTRACTOR	Quality Excavation	GROUND WATER LEVELS:	
EXCAVATION METHOD	Track Excavator	AT TIME OF EXCAVATION	Not Encountered
LOGGED BY	D. Salter	DRILLER	Client
AT END OF EXCAVATION	N/A	AFTER EXCAVATION	N/A
LAT.	37.00608	LONG.	-113.48929

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0				
	ML		Brown sandy SILT, less structure, no pin holes observed, dry and firm.	
1.0				2767.5
	GP- GM		Gray poorly graded GRAVEL with silt and sand, cobbles, dry and medium dense to dense.	
2.0				2766.5

Bottom of test pit at 2.0 feet.

GENERAL BH/TP/WELL - GES - GES - GEOTECHNICAL - STD.GDT - 12/5/24 21:56 - J:\GES\CLIENTS\TRI-STATE REGIONIST. GEORGE OFFICE\PROJECTS\2024\G20247223 - DESERT TALUS\G20247223E1.GPJ

Soils were classified in general accordance with ASTM D2488
The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made.
It is not intended to be representative of subsurface conditions at other locations or times.

Figure No. A-7



PROJECT NAME	Desert Talus	CLIENT	Quality Excavation
PROJECT NUMBER	G20247223E1	PROJECT LOCATION	SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED	11/20/24	COMPLETED	11/20/24
GROUND ELEVATION	2766.31 ft	TEST PIT SIZE	2' X 10' feet
EXCAVATION CONTRACTOR	Quality Excavation	GROUND WATER LEVELS:	
EXCAVATION METHOD	Track Excavator	AT TIME OF EXCAVATION	Not Encountered
LOGGED BY	D. Salter	DRILLER	Client
AT END OF EXCAVATION	N/A	AFTER EXCAVATION	N/A
LAT.	37.00646	LONG.	-113.48983

DEPTH (ft)	U.S.C.S. GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0			
	ML	Brown sandy SILT with 3-inch thick crystal gypsum layer, dry and firm.	
1.0			2765.3
	GP- GM	Gray poorly graded GRAVEL with silt and sand, cobbles, dry and medium dense to dense.	
2.0			2764.3

Bottom of test pit at 2.0 feet.

GENERAL BH/TP/WELL - GES - GES - GEOTECHNICAL - STD.GDT - 12/5/24 2:15:56 - J:\GES\CLIENTS\TRI-STATE REGIONIST. GEORGE OFFICE\PROJECTS\2024\G20247223 - DESERT TALUS\G20247223E1.GPJ



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2769.49 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00615 LONG. -113.49035 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0			Brown sandy SILT, dry and firm.	
2.5	ML		... siltstone fragments.	
5.0				2764.5
	GP- GM		Gray poorly graded GRAVEL with silt and sand, siltstone fragments, dry and medium dense to dense.	
				2763.5

Bottom of test pit at 6.0 feet.



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2770.41 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00615 LONG. -113.49088 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0			Brown sandy SILT, roots, blocky structure, light weight, frequent pin holes, dry and firm.	
2.5	ML		... mostly gypsum.	
3.5				2766.9
5.0	GP- GM		Gray poorly graded GRAVEL with silt and sand, cobbles, dry and medium dense to dense.	
5.0				2765.4

Bottom of test pit at 5.0 feet.



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2774.49 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00612 LONG. -113.49163 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			Brown sandy SILT, frequent gypsum in crystal form, dry and firm.
2.5	ML		... with shale pieces.
5.0			
6.0			Gray silty SAND, frequent gypsum blocky with clay stone, dry and medium dense.
7.5	SM		
8.0			

Bottom of test pit at 8.0 feet.



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2789.12 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00576 LONG. -113.49185 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0			Brown sandy SILT, trace gravel and siltstone pieces, roots, blocky structure, light weight, frequent pin holes, firm and dry.	
2.5	ML			
5.0				
6.0			Brown silty SAND, dry, slightly cemented and very dense.	2783.1
7.5	SM			
8.0				2781.1

Bottom of test pit at 8.0 feet.



PROJECT NAME	Desert Talus	CLIENT	Quality Excavation
PROJECT NUMBER	G20247223E1	PROJECT LOCATION	SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED	11/20/24	COMPLETED	11/20/24
GROUND ELEVATION	2784.44 ft	TEST PIT SIZE	2' X 10' feet
EXCAVATION CONTRACTOR	Quality Excavation	GROUND WATER LEVELS:	
EXCAVATION METHOD	Track Excavator	AT TIME OF EXCAVATION	Not Encountered
LOGGED BY	D. Salter	DRILLER	Client
AT END OF EXCAVATION	N/A	AFTER EXCAVATION	N/A
LAT.	37.00556	LONG.	-113.4918

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			
2.5			
5.0			
6.0			

Brown sandy SILT with gravel and siltstone fragments, frequent gypsum white crystals, no structure or pinholes observed, dry and firm.

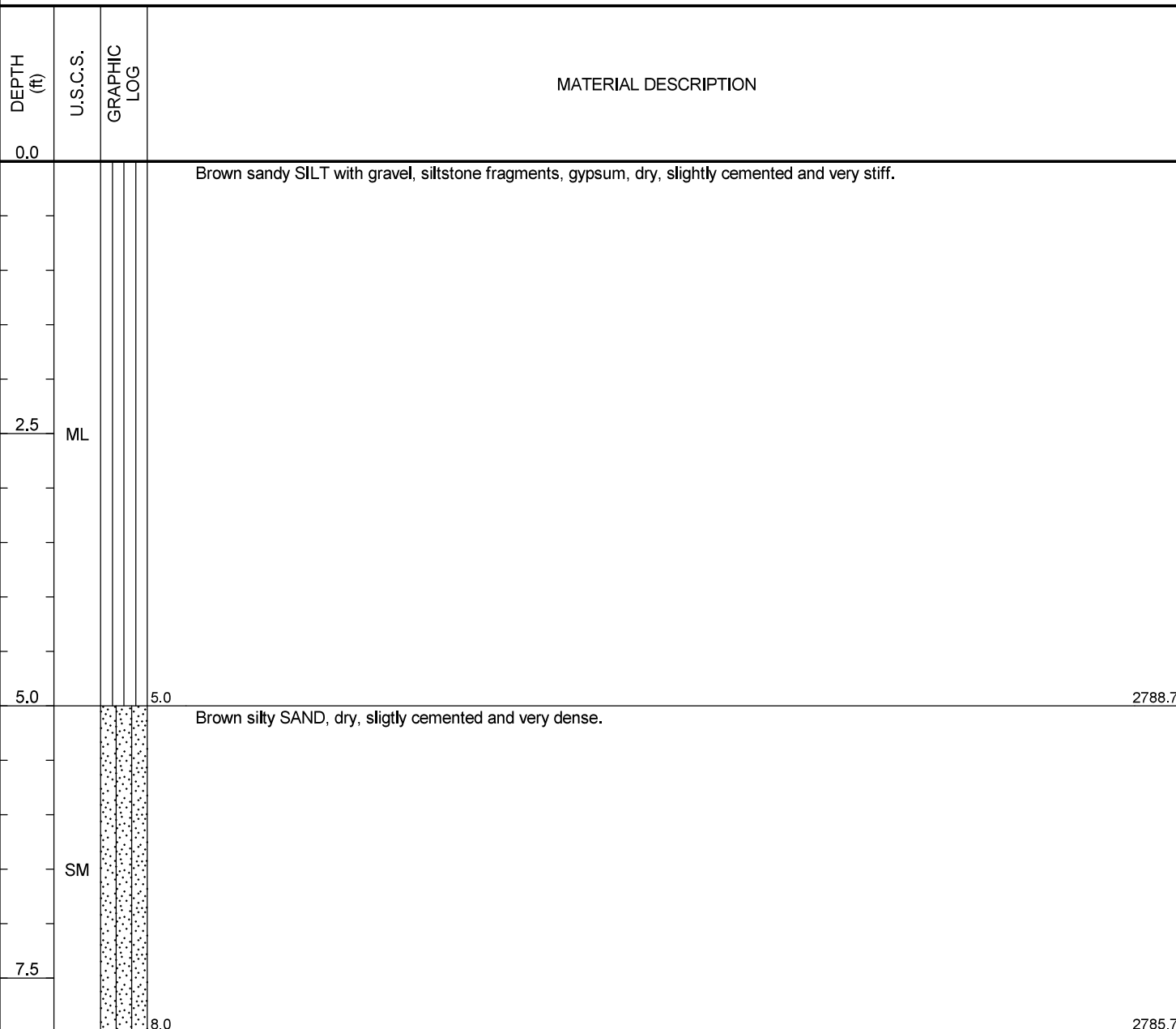
... slightly cemented.

Bottom of test pit at 6.0 feet.

2778.4



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2793.7 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00536 LONG. -113.49143 AFTER EXCAVATION N/A



Bottom of test pit at 8.0 feet.



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2781.81 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00527 LONG. -113.49088 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0			Brown sandy SILT with frequent gravel, cobbles, sandstone, no structure or pinholes observed, dry and firm.	
2.5	ML			
3.0				2778.8
			Brown poorly graded GRAVEL with silt and sand, dry and medium dense to dense.	
5.0	GP- GM			
6.0				2775.8

Bottom of test pit at 6.0 feet.



PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2778.46 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00494 LONG. -113.48996 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			
2.5	ML		Brown sandy SILT, little to no gravel fragment, trace gypsum powder, no structure or pinholes observed, dry and firm.
5.0			
6.0			2772.5
			Brown silty SAND, dry, slightly cemented and very dense.
7.5	SM		
8.0			2770.5

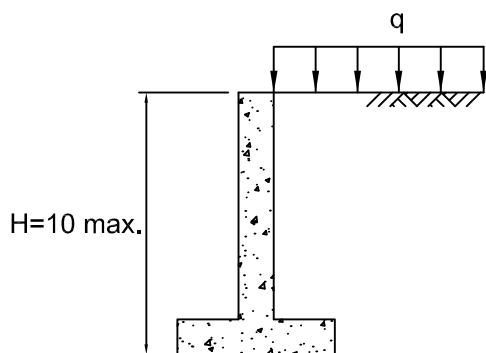
Bottom of test pit at 8.0 feet.



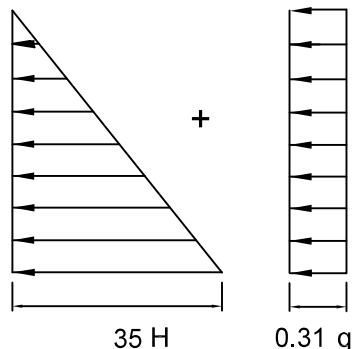
PROJECT NAME Desert Talus CLIENT Quality Excavation
PROJECT NUMBER G20247223E1 PROJECT LOCATION SW of Desert Canyons Pkwy and Airport Pkwy
DATE STARTED 11/20/24 COMPLETED 11/20/24 GROUND ELEVATION 2774.02 ft TEST PIT SIZE 2' X 10' feet
EXCAVATION CONTRACTOR Quality Excavation GROUND WATER LEVELS:
EXCAVATION METHOD Track Excavator AT TIME OF EXCAVATION Not Encountered
LOGGED BY D. Salter DRILLER Client AT END OF EXCAVATION N/A
LAT. 37.00531 LONG. -113.48982 AFTER EXCAVATION N/A

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			
2.5			
5.0	ML		Brown sandy SILT with trace gravel, no structure or pinholes observed, dry and firm. ... slightly cemented.
7.5			
8.0			2766.0
	GP- GM		Gray poorly graded GRAVEL with silt and sand, dry and medium dense.
9.0			2765.0

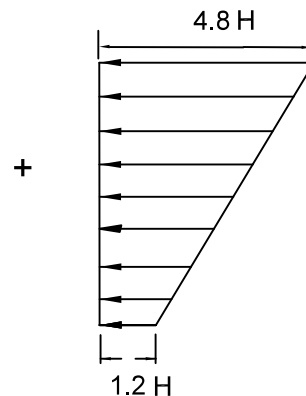
Bottom of test pit at 9.0 feet.



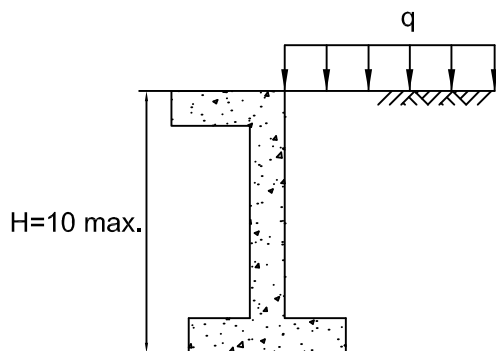
Static Earth Pressure



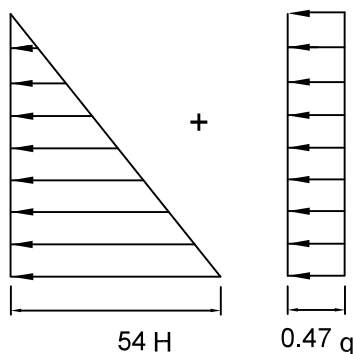
Seismic Earth Pressure



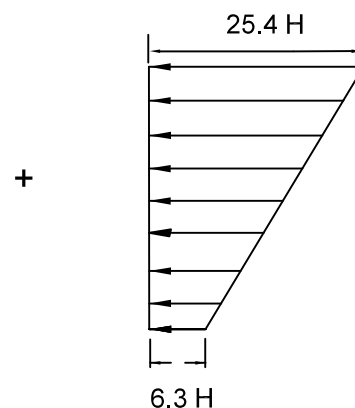
Active Condition



Static Earth Pressure



Seismic Earth Pressure



At-Rest Condition

Notes:

H is height of wall in feet.

q is magnitude of uniform surcharge load in pounds per square foot (psf).

Earth pressures are in psf.

Earth pressures shown assume that no hydrostatic pressure is exerted on the wall.

NOT TO SCALE



**GEOTECHNICAL &
ENVIRONMENTAL
SERVICES, INC.**
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7150 Placid Street
Las Vegas, NV 89119
www.gesnevada.com

LATERAL EARTH PRESSURE DIAGRAM

DESERT TALUS
SW OF DESERT CANYON PKWY & AIRPORT PKWY
ST. GEORGE, UTAH

DRAWN BY:

TF

REVIEWED BY:

DJS

DATE DRAWN:

12/3/2024

PROJECT NO.

G20247223E1

FIGURE NO.

B-1



GEOTECHNICAL INVESTIGATION
DESERT CLIFFS AREA 165 ACRES AT DESERT CANYONS
ST. GEORGE, UTAH

PREPARED FOR:



1472 EAST 3950 SOUTH
ST. GEORGE, UTAH 84790

ATTENTION: CURT GORDON

PROJECT NO. 2200519

MAY 16, 2022

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SUMMARY

1. AGEC conducted a Geotechnical Investigation to define subsurface conditions and to provide geotechnical recommendations for the proposed residential development.
2. The subsurface profile observed within the test pits generally consists of silty sand to sandy silt overlying silty gravel with sand underlain by siltstone, mudstone, and sandstone bedrock. A layer of sandy lean clay was encountered at approximately 12 feet below grade in TP-20. Practical excavator refusal was encountered on sandstone bedrock and dense gravels in test pits TP-2, TP-7, TP-10, TP-11, TP-12, TP-13, TP-14, TP-15, TP-17, TP-18, and TP-20 at depths ranging from approximately 7 to 20 feet below the existing grade.
3. Subsurface water was not encountered within the test pits to the maximum depth investigated, approximately 20 feet. Fluctuations in the groundwater level may occur over time. An evaluation of such fluctuations is beyond the scope of this report.
4. The on-site soils and bedrock in their existing condition are not suitable to support the proposed construction. The site is suitable for the proposed slab-on-grade residences provided recommendations within this report are followed. If basements or pools are proposed, additional subsurface investigation and grading recommendations are required.
5. The upper approximately 0 to 18½ feet of the near surface overburden soil (varies across the site) is loose, dry and potentially collapsible when wetted. Prior to placing fill or concrete, we recommend that the full depth of potentially collapsible soil be removed. The approximate depth of removal is shown on the site plan and test pit logs (Figures 2 and 3).

Alternatively, a soil treatment process known as pre-wetting may be implemented to treat the collapsible soils by adding moisture to the "under-saturated" soils. The building pads may be graded into a series of terraced ponds. The ponds may then be filled with appropriate volume of water to pre-wet the underlying "under-saturated" soils to essentially densify the soils subsequently reducing the collapse potential prior to construction. This process is currently being implemented in the St. George area to treat collapsible soils.

6. The proposed residences may be supported on conventional spread footings bearing on properly compacted structural fill underlain by a properly prepared subgrade. Specifically, the subgrade should be prepared during site grading by overexcavating the building pads to remove unsuitable soils as recommended in the Subgrade Preparation section of this report.

7. The on-site soils, and properly processed siltstone and sandstone bedrock, free of organics and debris are suitable for use as structural fill, site grading fill, wall backfill and utility trench backfill. The bedrock should be processed such that the maximum particle size is 4 inches and at least 50 percent of the material passes the No. 4 sieve. The mudstone bedrock is not suitable for use and should be disposed of off site.
8. Site drainage recommendations should be implemented as recommended in the Site Drainage section of this report.
9. Detailed recommendations for subgrade preparation, materials, foundations, drainage and pavement are included in the report.
10. The information provided in this summary should not be used independent of that provided within the body of this report.

SCOPE

This report presents the results of a geotechnical investigation for the proposed Desert Cliffs Area (165 Acres) at Desert Canyons planned residential area to be located in St. George, Utah, as shown in Figure 1. This report presents the subsurface conditions encountered, laboratory test results, and recommendations for the project. This report was prepared in general accordance with the Geotechnical Engineering Services Agreement dated March 17, 2020 under Project No. 2200519.

Field exploration was conducted to obtain information on the subsurface conditions and to obtain samples. Information obtained from the field was used to define conditions at the site and to develop recommendations for the proposed development.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction are included in the report.

SITE CONDITIONS

The site is located east and southeast of the planned Desert Reflection subdivision. The area to the north, east and south is undeveloped. The project site generally slopes down from the west to the east with a few small washes that traverse the area in a northwest to southeast direction. Vegetation at the site consists generally of desert grass and sage brush.

Grubbing of a portion of the site has been performed. Test pit locations and elevations reflect the pre-grubbed elevations.

FIELD STUDY

On June 23, 24, and 25, 2020 an engineer from AGECEC visited the site and observed the excavation of 20 test pits (planned TP-5 was inaccessible) at the approximate locations shown on the Site Plan, Figure 2. The test pits were excavated with a trackhoe excavator. The subsurface soil profile was logged and soil samples were obtained.

SUBSURFACE SOIL CONDITIONS

The subsurface profile observed within the test pits generally consists of silty sand to sandy silt overlying silty gravel with sand underlain by siltstone, mudstone, and sandstone bedrock. A layer of sandy lean clay was encountered at approximately 12 feet below grade in TP-20. Practical excavator refusal was encountered on sandstone bedrock and dense gravels in test pits TP-2, TP-7, TP-10, TP-11, TP-12, TP-13, TP-14, TP-15, TP-17, TP-18, and TP-20 at depths ranging from approximately 7 to 20 feet below the existing grade.

Laboratory testing and observations of the subsurface soil during our investigation indicate the upper approximately 0 to 18½ feet of the near surface sandy to silty soil is loose, dry and potentially collapsible when wetted.

Detailed descriptions of the soil and bedrock types encountered follow.

Sandy Silt - The sandy silt is medium dense, dry, porous in upper layers, contains roots near the surface, various amounts of sand, and is light brown in color.

Laboratory tests conducted on samples of the sandy silt indicate in-place moisture contents ranging from less than 1 to 7 percent, in-place dry densities ranging from 82 to 95 pounds per cubic foot (pcf) and fines contents (percent passing the No. 200 sieve) ranging from 59 to 96 percent. One dimensional consolidation/collapse tests conducted on samples of the sandy silt material indicate that the material is

moderately moisture sensitive (collapsible) when wetted under a constant pressure of 1,000 pounds per square foot (psf) and slightly compressible under additional loading. Less than 1 percent and 2½ percent collapse potentials were measured during the consolidation/collapse tests.

Sandy Lean Clay - The sandy lean clay is medium dense to dense, dry, low plastic, and is light brown in color.

Laboratory tests conducted on samples of the sandy lean clay indicate an in-place moisture content of 4 percent, an in-place dry density of 101 pcf and a fines content of 76 percent. A one dimensional consolidation/swell test conducted on a sample of the sandy lean clay material indicates that the material is not moisture sensitive (expansive) when wetted under a constant pressure of 1,000 pounds per square foot (psf) and slightly compressible under additional loading.

Silty Sand - The silty sand is loose to dense, dry to moist, contains various amounts of gravel, and is light brown to red in color.

Laboratory tests conducted on samples of the silty sand indicate an in-place moisture content of 2 percent, an in-place dry density of 82 pcf and a fines content of 41 percent.

Silty Gravel with Sand - The silty gravel with sand is medium dense to very dense, dry, contains some cobbles to boulders, and is light grey to light brown in color.

Laboratory tests conducted on samples of the silty gravel with sand indicate an in-place moisture content of 2 percent, a gravel content (percent retained on the No. 4 sieve) of 30 percent and a fines content of 37 percent.

Sandstone Bedrock - The sandstone bedrock is hard, dry, contains some conglomerate layers throughout, and is yellow to green to grey in color.

Mudstone Bedrock - The mudstone bedrock is soft, moist, low to medium plastic, and is green in color.

Laboratory tests conducted on samples of the mudstone bedrock indicate an in-place moisture content of 2 percent, in-place dry densities of 115 and 141 pcf and fines contents of 75 and 98 percent. Atterberg Limits tests indicate liquid limits of 25 and 39 percent and plasticity indexes of 15 and 17 percent. One dimensional consolidation/swell tests conducted on samples of the mudstone bedrock indicate that the material is moderately moisture sensitive (expansive) when wetted under a constant pressure of 1,000 pounds per square foot (psf) and highly compressible under additional loading. Approximately ½ and 3 percent swell potentials were measured during the consolidation/swell tests.

The Logs, Legend and Notes of Test Pits are shown on Figures 3-7. Laboratory test results are also shown on Figures 3-6 and are summarized in the Summary of Laboratory Test Results, Table 1. The One-dimensional Consolidation/Collapse/Swell Test Results are shown graphically on Figures 8-11.

SUBSURFACE WATER

Subsurface water was not encountered within the test pits to the maximum depth investigated, approximately 20 feet. Fluctuations in the groundwater level may occur over time. An evaluation of such fluctuations is beyond the scope of this report.

PROPOSED CONSTRUCTION

The property is proposed to be developed into a residential subdivision. The subdivision will include roadways, site improvements and underground utilities. Additionally, we anticipate building pads will be constructed to support single family, slab-on-grade residences.

Single-family, slab-on-grade residences are proposed for construction and will consist of single and multi-story construction. The residences will be constructed using conventional spread footings with slab-on-grade floors. The residences will likely be constructed with wood framing, stucco or rock veneer, and tile roofs. We do not anticipate the use of basements. If basements or pools are desired, AGECE should evaluate them on an individual case.

For design purposes, we have assumed wall loads of up to 3 kips per linear foot and column loads of up to 25 kips. As part of the development, we understand that roadways, utilities and city improvements will also be included. The roadways will likely include 45 and 50-foot right-of-ways (ROW). For design purposes, we have utilized a Traffic Index (TI) of 5 for 45 and 50-foot ROWs in accordance with the City of St. George standards. When a grading plan is completed it should be shared with AGECE to update the recommendations within this report if needed.

If the proposed construction, building loads or pavement requirements are significantly different from those listed, we should be notified so that we can reevaluate our recommendations.

RECOMMENDATIONS

Based on our experience in the area, the subsurface conditions encountered, laboratory test results, and the proposed construction, the following recommendations are given:

A. Site Grading

1. Subgrade Preparation

General - Prior to placing fill or concrete beneath building areas, pavement/flatwork or site improvements, the site should be grubbed to remove the existing vegetation and soil containing significant roots and organics. Organics and vegetation should be disposed of off-site.

The grubbed soil may be stockpiled for use in landscaped areas. If this soil is placed in landscaped areas, CMU fence footings or other structures/improvements which may be supported in these areas (above the grubbed soil) should be overexcavated to allow for the placement of properly compacted structural fill which extends to the appropriate depth as stated below.

Loose, Dry Collapsible Soil (buildings and structures) - Laboratory testing and observations of the subsurface soil during our investigation indicate the upper approximately 0 to 18 ½ feet of the near surface overburden soil (varies across the site) is loose, dry and potentially collapsible when wetted. Prior to placing fill or concrete, we recommend that the full depth of potentially collapsible soil be removed. The approximate depth of removal is shown on the site plan and test pit logs (Figures 2 and 3). This soil is unsuitable in its existing condition to support the proposed construction.

The limits of overexcavation should extend at least 5 feet beyond the perimeter of the proposed building pads, including patios, porches and porch columns. The lateral extent of the overexcavation should be determined by survey and is the responsibility of the owner/contractor.

Consideration should also be given to extending the overexcavation to include areas which will support flatwork and other improvements such as masonry fences.

Alternative Collapsible Soil (buildings and structures) - As an alternative to removing the full depth of the collapsible soil, a process known as “pre-wetting” may be used to add moisture to the under-saturated soils. This process is intended to improve the support condition of the underlying soils by adding moisture and subsequently reducing the collapse potential prior to construction.

Our experience has shown that when the dry density exceeds on the order of 105 pcf or the fines content (percent silt and clay) is less than on the order of 15 percent, the underlying soils are typically less moisture sensitive regardless of the moisture condition. Laboratory testing performed for this project indicate that the upper sandy silt to silty sand have a density generally less than 105 pcf and fines content greater than 15 percent and therefore are considered to have collapse potential.

The prewetting process can typically be achieved by constructing a series of ponds over the area to be treated. Typically, the pre-wetting ponds should be no larger than 20,000 to 25,000 square feet to ensure a relatively even distribution of water treatment. Based upon previous pre-wetting studies, we estimate a 1 foot high column of water will be necessary to treat every 2 to 3 feet of the underlying potentially collapsible soil and result in an increased saturation (of the soils) which exceeds approximately 50 percent. Pre-wetting near existing homes or site improvements is not recommended and could result in settlement and subsequent distress.

Upon completion of the pre-wetting program, we recommend conducting subsurface investigation to evaluate and verify the pre-wetting process was effective.

Subsequent to pre-wetting and prior refilling ponds or building pads, the bottom of the pre-wetting ponds should be overexcavated to remove loose, soft soils. The overexcavation should extend at least 3 feet below the existing grade or 3 feet below the bottom of footings, whichever is greater. An alternative to overexcavation of the wet soils would be to let the soils dry out prior to mass grading (AGEC should be consulted prior to grading, if this alternative is selected).

The limits of treatment should extend at least 5 feet beyond the perimeter of the proposed building pads, including patios, porches and porch columns. The lateral extent of the overexcavation should be determined by survey and is the responsibility of the owner/contractor.

Potentially Expansive Bedrock - Potentially expansive mudstone bedrock was encountered in test pits TP-4 and TP-12. Based on AGECE's experience in the area, a recommended separation of at least 5 feet above the potentially expansive mudstone should be maintain. Based on the observed depths of the mudstone AGECE does not anticipate the need for overexcavation of mudstone bedrock, however AGECE recommends that additional recommendations be provided once a final grading plan has been provided.

Pavement, Flatwork and Improvements - The pre-wetting method discussed above would be appropriate for these areas. If pre-wetting is not utilized, we recommend at a minimum that the upper 12 inches be scarified, moisture-conditioned, and compacted in areas which will support hard surfaces.

The overexcavation and compaction process is intended to reduce the potential for collapse and also to provide a less permeable, compacted zone of soil beneath the improvements supported above. However, potentially collapsible soils will still remain beneath the overexcavated zone. Settlement could still occur if the remaining collapsible soils are wetted.

The estimated settlement resulting from wetting of the potentially collapsible soils is provided in the following table. If the potential settlement is not acceptable, additional overexcavation or full depth treatment should be conducted. As a minimum, we recommend the exposed subgrade beneath roads and rigid improvements extend at least 5 feet below the existing grade to removed and recompact a portion of the underlying potentially collapsible soils.

Thickness of remaining potential collapsible soil (feet)	Estimated Additional Potential Future Surface Settlement (inches)
10	3 to 3 ½
8	2 to 2 ½
6	1 ½ to 2
4	¾ to 1 ½
2	½ to ¾
0	< ½

2. Excavation

We anticipate that excavation of the overburden soils and soft bedrock at the site can be accomplished with typical excavation equipment. Portions of deeper bedrock may require the use of heavy duty excavation equipment.

3. Grading Slopes and Trenches

The following table provides the maximum recommended slope steepness for a given slope condition. Slopes should include benches in accordance with the 2018 IBC.

Slope Condition	Maximum Slope (Horizontal:Vertical)
Permanent Cut Slopes in Overburden Soils	2:1
Unretained, Properly Compacted Fill	2 ½:1
Permanent Cut Slopes in Moderately Hard Bedrock	½:1
Utility Trenches in On-site Soils and Soft Bedrock (OSHA Soil Class C)	1 ½:1

Fill slopes should be graded by overbuilding and then cutting them back to the desired grade to provide a compacted slope face. Fill placed on existing slopes steeper than 3:1 should be placed using a benching procedure to key the fill into the existing slope. Benches should be of sufficient width to allow adequate area for the compaction equipment.

Steeper trenches may require the use of shoring or a trench box to provide a safe work environment. Safe trench excavation is the responsibility of the contractor.

4. Materials

A. Import Materials:

Import materials should be non-expansive, non-gypsiferous, granular soil. Listed below are the materials recommended for imported fill.

Area	Fill Type	Recommendations
Foundations/slabs	Site grading/ structural fill	-200 < 35%, LL < 30% Maximum size: 4 inches Solubility < 1%
Underslab (upper 4 inches)	Base course	-200 < 12% Maximum size: 1 inch Solubility < 1%

-200 = Percent Passing the No. 200 Sieve

LL = Liquid Limit

B. On-site Materials:

The on-site soils, and properly processed siltstone and sandstone bedrock, free of organics and debris are suitable for use as structural fill, site grading fill, wall backfill and utility trench backfill. The bedrock should be processed such that the maximum particle size is 4 inches and at least 50 percent of the material passes the No. 4 sieve. The mudstone bedrock is not suitable for use and should be disposed of off site.

The potential impact of the collapsible characteristics of the underlying natural silt and sand can be reduced by protecting the collapsible soil from becoming wet. Placement of relatively low permeable fill above the natural soil can help reduce the possibility of water coming in contact with the underlying collapsible soil. The low permeable fill supporting these areas is intended to provide a low permeable zone to reduce the potential for water to infiltrate and wet the underlying subgrade.

Low permeable fill used should meet one of the following set of criteria.

Liquid Limit (%)	Percent Passing the No. 200 Sieve
45 +	15-20
30-45	20-40
0-30	30-100

Laboratory testing indicates the onsite soils would be suitable for use as low permeable fill.

5. Compaction

Compaction of materials placed at the site should equal or exceed the following minimum densities when compared to the maximum dry density as determined by ASTM D-1557:

Area	Percent Compaction
Subgrade	90
Footings/building pad	95
Site grading	95
Utility trenches	95
Wall backfill (as needed)	95

To facilitate the compaction process, the overburden soil and processed, non-expansive bedrock should be moisture conditioned to within 2 percentage points of the optimum moisture content as determined by ASTM D-1557 prior to placement.

Fill should be placed in loose lift thicknesses which do not exceed the capacity of the equipment being utilized. Generally, 6 to 8-inch loose lifts are adequate. Lift thicknesses should be reduced to 4-inches for hand compaction equipment.

6. Shrinkage

We anticipate a significant volume loss of material during the compaction process. Based on our experience, we anticipate on the order of 25 percent loss of the material in the compacted zone. We also anticipate a loss of 2 to 4 inches of surface elevation during the pre-wetting and replacement (loading) and compaction of the materials and the exposed subgrade. These volume losses should be taken into account for material quantity estimates.

7. Surface Drainage

Positive site drainage should be maintained during the course of construction. After construction has been completed, positive drainage of the surface water away from the buildings in each direction must be maintained. To reduce infiltration adjacent to foundations we recommend the following:

- a. A minimum slope of 6 inches in the first 10 feet from the perimeters of the structures should be provided.
- b. Roof gutter systems should be installed around the perimeters of the structures. Roof downspouts should discharge away from the buildings so as to prevent ponding adjacent to foundations. We recommend piping roof gutter downspouts off site directly into the adjacent curb and gutter.
- c. Placement of 3 to 4 foot wide concrete aprons around the perimeters of the structures.
- d. Landscaping requiring water should not be placed adjacent to foundations or within 10 feet of foundations.

- e. Below grade portions of walls/fences which are backfilled with soil should be protected with an impermeable membrane and a subsurface drain on the backfilled side. A gravel covered, perforated PVC pipe should also be placed at the base of the wall to carry water to a discharge point. This is intended to reduce the potential for salt weathering and sulfate attack on concrete/masonry.

B. Foundations

This report does not address support of swimming pools or basements. Support of pools and basements should be addressed with a lot specific subsurface investigation to provide additional support and grading recommendations. Recommendations for design of conventional spread and spot footings are provided below.

1. Bearing Material

The proposed residences may be supported on conventional spread footings bearing on a minimum of 1 foot of properly compacted structural fill underlain by a properly prepared subgrade. Specifically, the subgrade should be prepared during site grading by overexcavating the building pads to remove unsuitable soils as recommended in the Subgrade Preparation section of this report.

2. Bearing Pressures

Footings bearing on properly compacted structural fill may be designed for the following net allowable bearing pressures.

Load Condition	Net Allowable Bearing Pressure (psf)
Walls	2,000
Spots/Columns	2,500

3. Footing Width and Embedment

Footings should have a minimum width of 18 inches and should be embedded at least 12 inches below the lowest adjacent grade.

4. Temporary Loading Conditions

The allowable bearing pressures may be increased by one-half for temporary loading conditions such as wind or seismic loads.

5. Settlement

We estimate that settlement will be approximately 1 inch for footings designed as indicated above due to the load of the structure. Differential settlement is estimated to be approximately $\frac{1}{2}$ inch.

6. Foundation Base

The base of excavations should be cleared of loose or deleterious material prior to placement of fill or concrete.

7. Foundation Setback

Foundations should be set back from the top crest of slopes a horizontal distance equal to or greater than $\frac{1}{3}$ the total slope height.

C. **Concrete Slab-on-Grade**

1. Slab Support

Concrete slabs may be supported on a zone of properly prepared (overexcavated) and compacted fill as stated in the Subgrade Preparation and Materials sections of this report with a minimum thickness of at least 12 inches.

2. Underslab Base Course

A 4-inch layer of properly compacted base course should be placed below slabs to provide a firm and consistent subgrade and promote even curing of the concrete.

3. Vapor Barrier

A vapor barrier should be placed below slabs in areas which will receive sensitive floor coverings or coverings which are impermeable. Vapor barriers also provide protection from salt and sulfate attack.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for spread footings is controlled by sliding resistance developed between the footing and the subgrade soil. An ultimate friction value of 0.40 may be used in design for ultimate lateral resistance of footings bearing on properly compacted on-site soils. The friction value may be increased to 0.45 if the foundations bear on imported, granular structural fill or gravel soils.

2. Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest condition is where the wall does not move. We recommend the basement walls be designed in an at-rest condition.

The values listed below assume a horizontal surface adjacent the top and bottom of the wall.

Description	Active	At-Rest	Passive
Fine/Granular-Grained Backfill - Equivalent Fluid Weight	38 pcf	58 pcf	260 pcf
Fine/Granular-Grained Backfill - Earth Pressure Coefficient	0.33	0.50	-

Care should be taken to prevent percolation of surface water into the backfill material adjacent to the retaining walls. The risk of hydrostatic buildup can be reduced by placing a subdrain behind the walls consisting of free-draining gravel wrapped in a filter fabric.

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be modified as follows according to the Mononobe-Okabe method assuming a level backfill condition:

Lateral Earth Pressure Condition	Seismic Modification (2% PE in 50 yrs)
	Fine/Granular Backfill
Active	9 pcf increase
At-rest	no increase
Passive	22 pcf decrease

The resultant of the seismic increase should be placed up 60 percent of the height of the wall.

4. Safety Factors

The values recommended assume mobilization of the soil to achieve the assumed soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. Seismicity, Liquefaction and Faulting

1. Listed below is a summary of the site parameters as required by the 2018 International Building Code and ASCE 7-16:

Description	Seismic Parameter
	2,500 yr event ($\approx 2\%$ PE in 50 yrs)
2018 IBC	C
PGA	0.26g
S_s (0.2 second period)	0.59g
S_1 (1 second period)	0.19g
F_a	1.26
F_v	1.50
F_{PGA}	1.20

The values provided above were generated using the ASCE 7-16 Seismic Hazard Tool. Based on the observed subsurface conditions, a ground motion hazard analysis (GMHA) as per ASCE 7-16 is not required by the 2018 International Building Code.

2. Liquefaction

Based on subsurface conditions encountered in the test pits, the subsurface soils observed are non-liquefiable to the depths investigated during a seismic event. Liquefiable soils at greater depths are not likely due to the relatively shallow bedrock.

3. Faulting

Based on a review of available geologic literature, there are no mapped faults extending near or through the site.

F. Soil Corrosion

Based on our experience in the area, the on-site soils, bedrock, and many imported sources may contain sulfates in sufficient concentration to be corrosive to concrete. Therefore, we recommend concrete elements that will be exposed to the on-site soils be designed in accordance with provisions provided in the American Concrete Institute Manual of Concrete Practice (ACI) 318-14. Tables 19.3.1.1 and 19.3.2.1 of ACI 318-14 should be referenced for design of concrete elements utilizing a Sulfate Exposure Class of S2.

Consideration should also be given to cathodic protection of buried metal pipes. We recommend utilizing PVC pipes where local building codes allow.

G. Pavement

1. Subgrade Support

We anticipate that the subgrade materials beneath the pavement areas will consist of sandy silt to silty sand. Prior to placement of road base, the subgrade should be prepared as recommended in the subgrade preparation section of this report. A California Bearing Ratio (CBR) of 7 percent was assumed for a properly compacted subgrade for purposes of design.

2. Pavement Thickness

Based on the assumed traffic loadings and St. George City traffic indexes, a 20-year design life, and AASHTO design methods, the following pavement sections are recommended.

Roadway	TI	Asphalt (in.)	Base Course (in.)
45-Foot ROW	5	2½	6
50-Foot ROW	5	2½	6

3. Pavement Materials

The pavement materials should meet City of St. George specifications for gradation and quality. The pavement thicknesses indicated above assume that the base course is a high quality material with a CBR of at least 50 percent and the asphaltic concrete has a minimum Marshall stability of 1,800 pounds. Other materials may be considered for use in the pavement section. The use of other materials may result in other pavement material thicknesses.

4. Drainage

The collection and diversion of drainage away from the pavement surface is extremely important to the satisfactory performance of the pavement section. Proper drainage should be provided.

H. Construction Testing and Observations

We recommend the following testing and observations be done as a minimum as required by the City of St. George.

1. Observe grubbing and verify removal of soil containing roots and organics.
2. Verify that recommended overexcavation depths or subgrade treatment is achieved to appropriate depth in the building pad areas and beneath roadways.
3. Verify that potentially collapsible soils have been overexcavated or prewetted in the outlined area (shown on Figure 2).
4. After mass grading is complete, additional exploration may be necessary in "cut" areas to verify subsurface conditions and the depth to underlying potentially expansive layers of bedrock.

5. Verify that recommended structural fill depths are provided below foundations and slabs.
6. Conduct compaction testing on fill placed below foundations and in building pads. We recommend testing each foot of fill placed.
7. Conduct construction materials testing on city improvements at a frequency which meets or exceeds St. George City requirements.

I. Geotechnical Recommendation Review

The client should familiarize themselves with the information contained in this report. If specific questions arise or if the client does not fully understand the conclusions/recommendations provided, AGECC should be contacted to provide clarification.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the excavated test pits, the data obtained from laboratory testing and our experience in the area. Variations in the subsurface conditions may not become evident until excavation is conducted. If the subsurface conditions or groundwater level are found to be significantly different from those described above, we should be notified to reevaluate our recommendations.

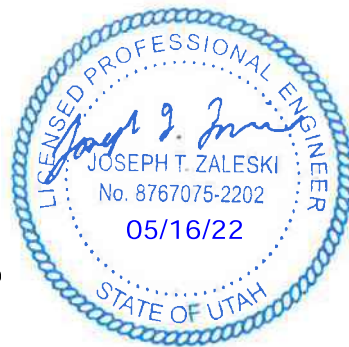
If you have any questions or if we can be of further service please call.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Joseph T. Zaleski, P.E.

Reviewed by: Jake Erickson, P.E.

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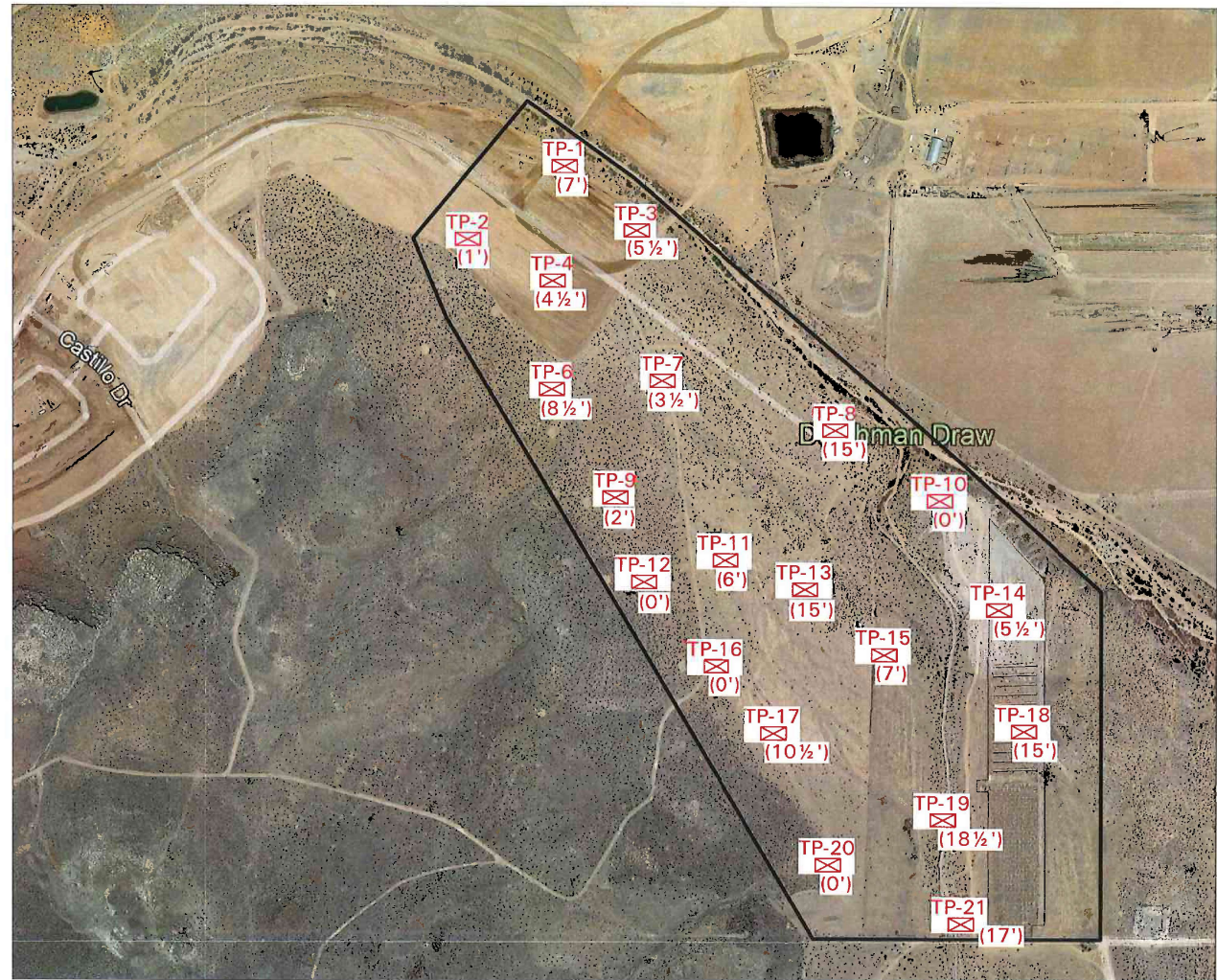
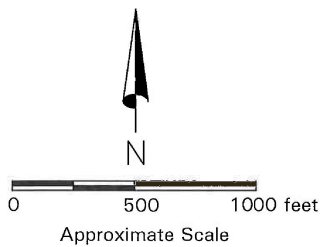


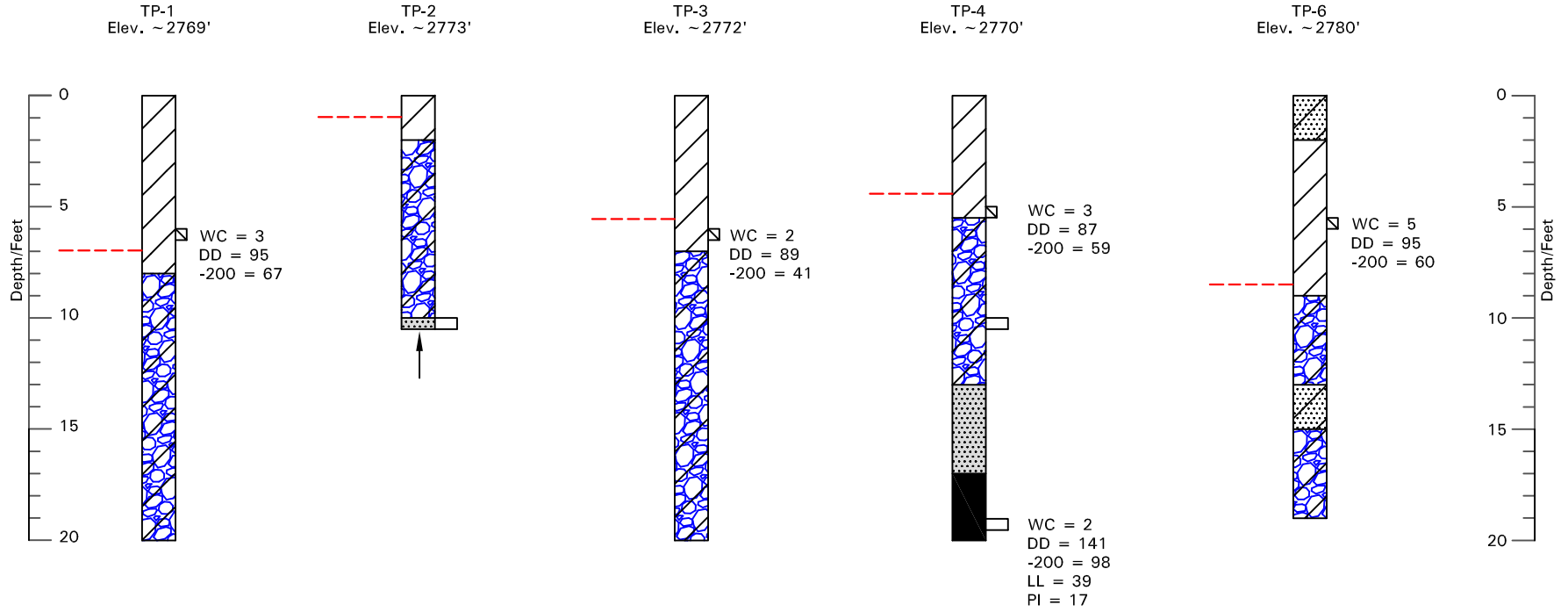
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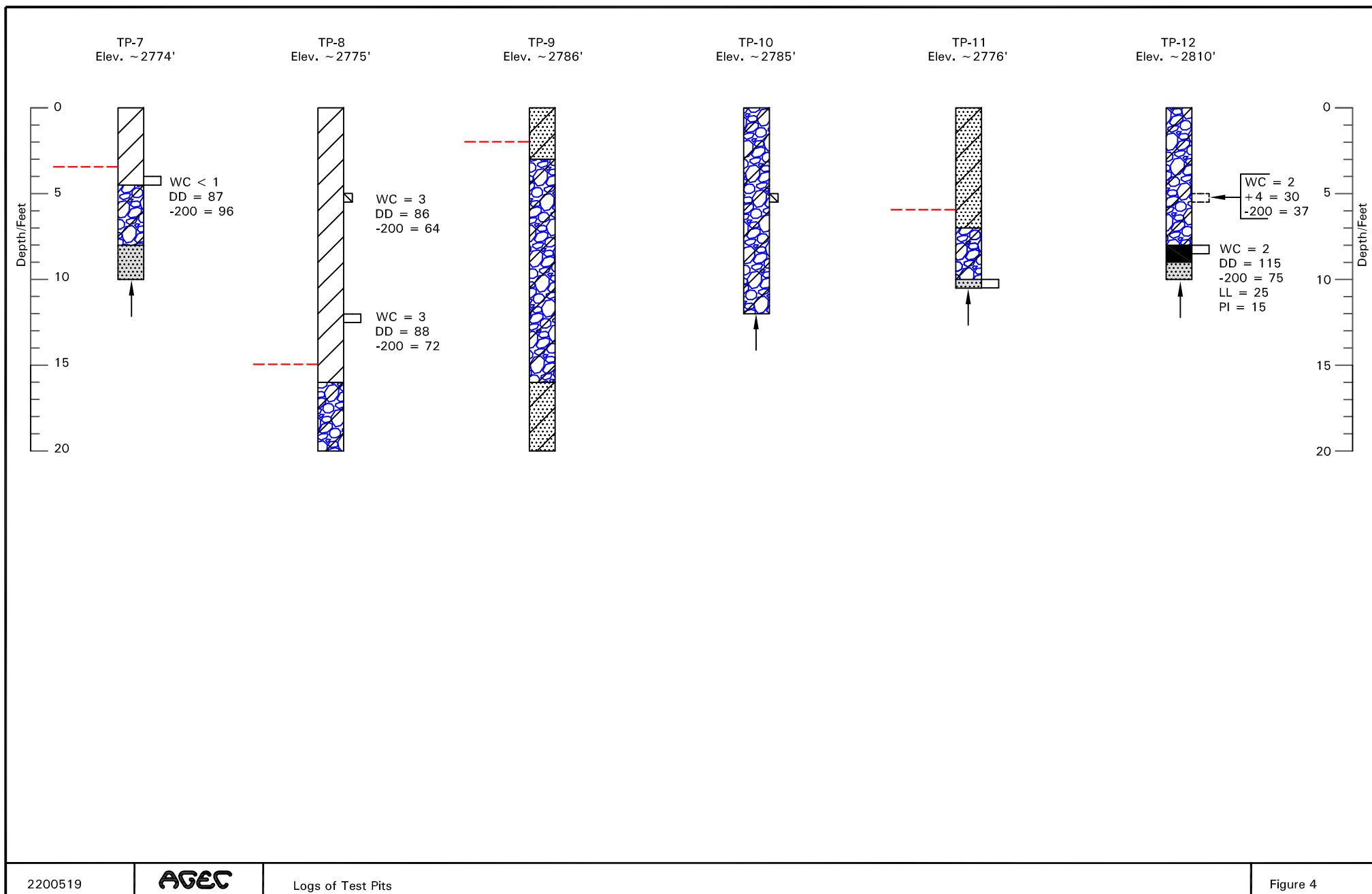
DESERT CLIFFS AREA
165 ACRES AT DESERT CANYONS
ST. GEORGE, UTAH

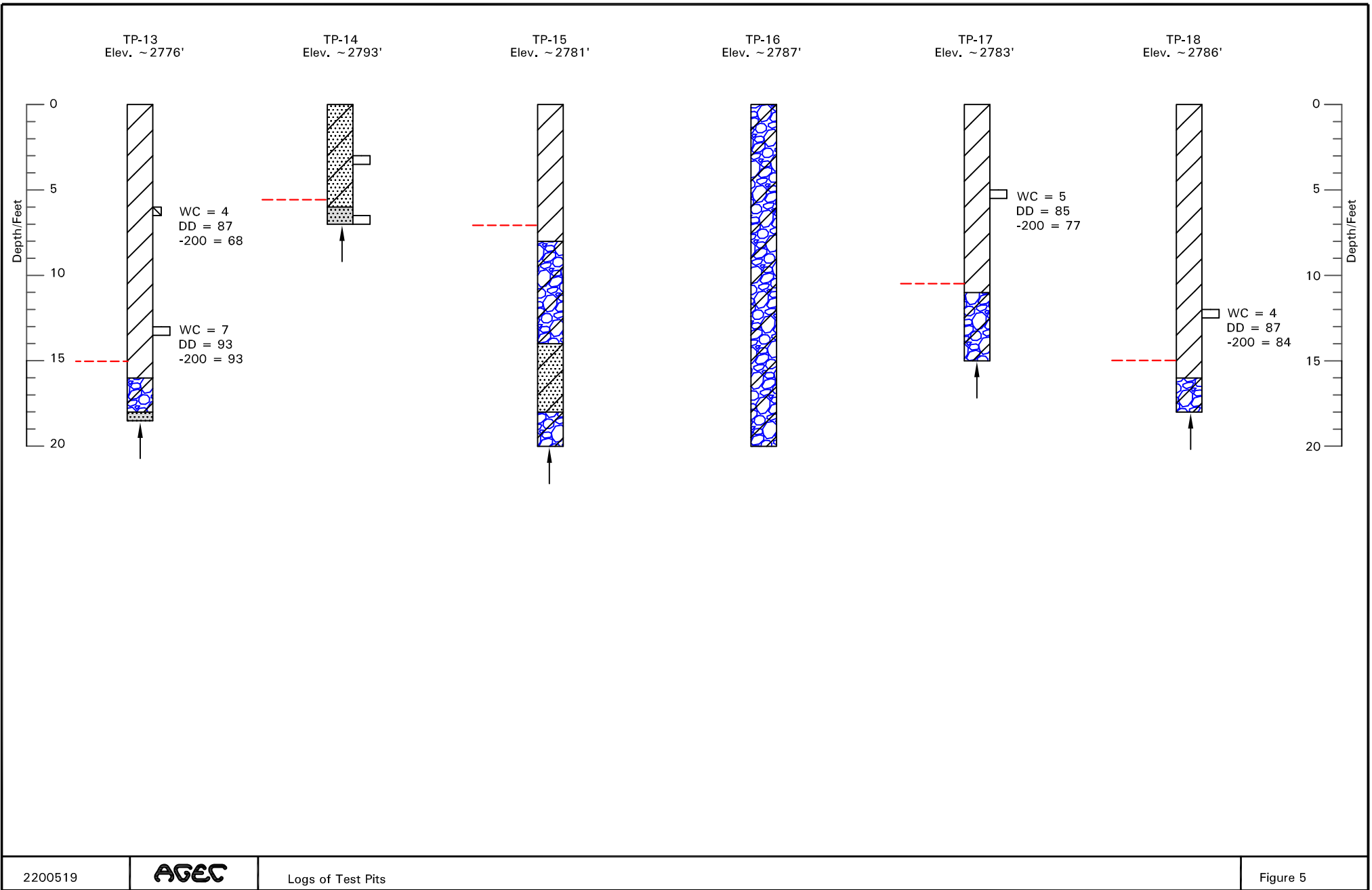
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165 ACRES AT DESERT CANYONS
ST. GEORGE, UTAH

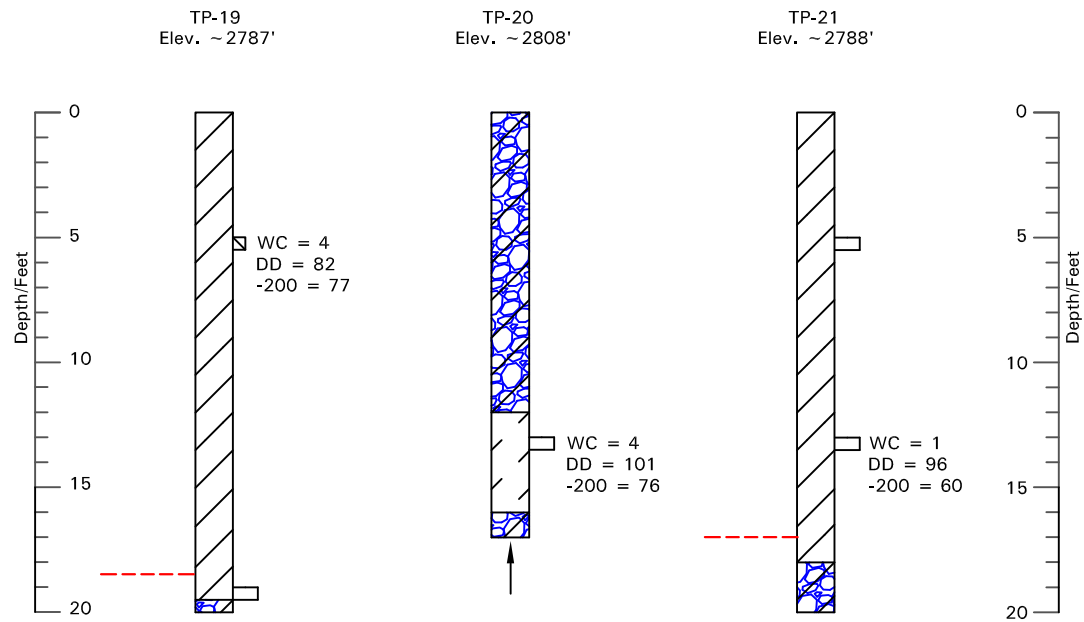
- ⊠ Approximate test pit location
- (#') Approximate depth of overexcavation











LEGEND:



Sandy Silt (ML); medium dense, dry, porous, roots near surface, various amounts of sand, and is light brown in color.



Sandy Lean Clay (CL); medium dense to dense, dry, low plastic, and is light brown in color.



Silty Sand (SM); loose to dense, dry to moist, various amounts of gravel, and is light brown to red in color.



Silty Gravel with Sand (GM); medium dense to very dense, dry, some cobbles to boulders, and is light grey to light brown in color.



Sandstone Bedrock; hard, dry, some conglomerate layers, and is yellow/green/grey in color.



Mudstone Bedrock; soft, moist, low to medium plastic, and is green in color.



Indicates relatively undisturbed hand drive sample taken.



Indicates relatively undisturbed block sample taken.



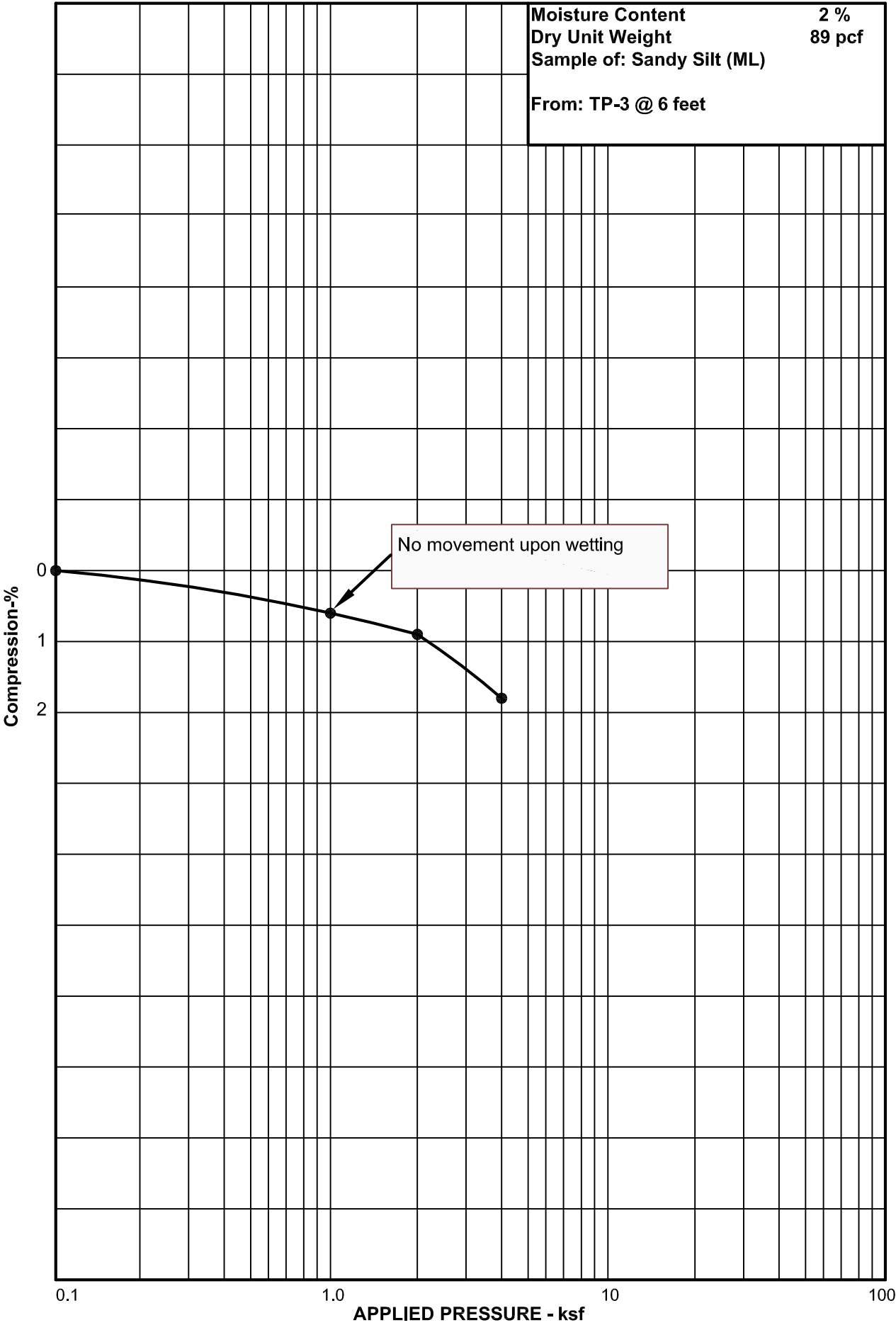
Indicates disturbed sample taken.



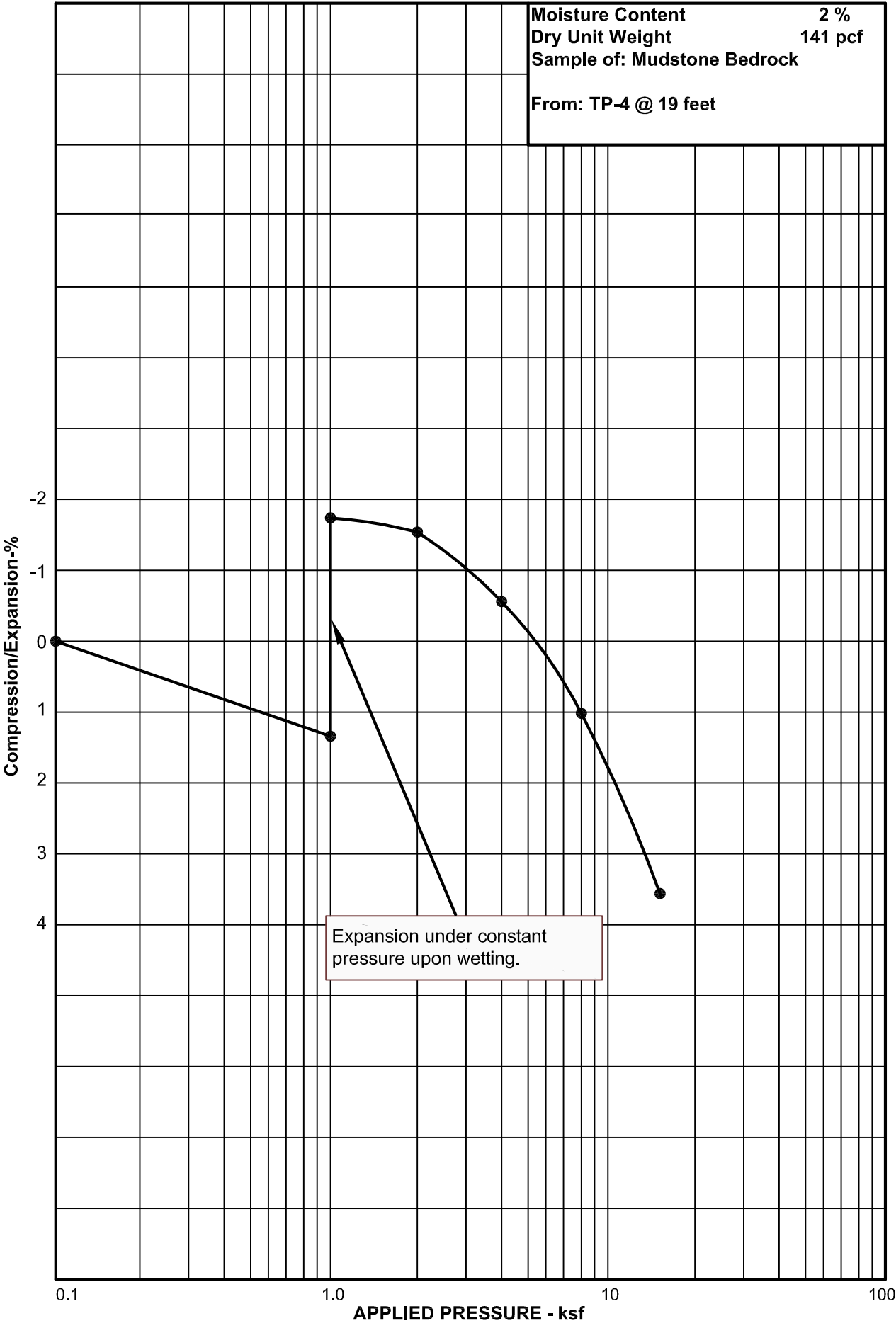
Indicates practical backhoe refusal on boulders, sandstone bedrock, or limestone bedrock.

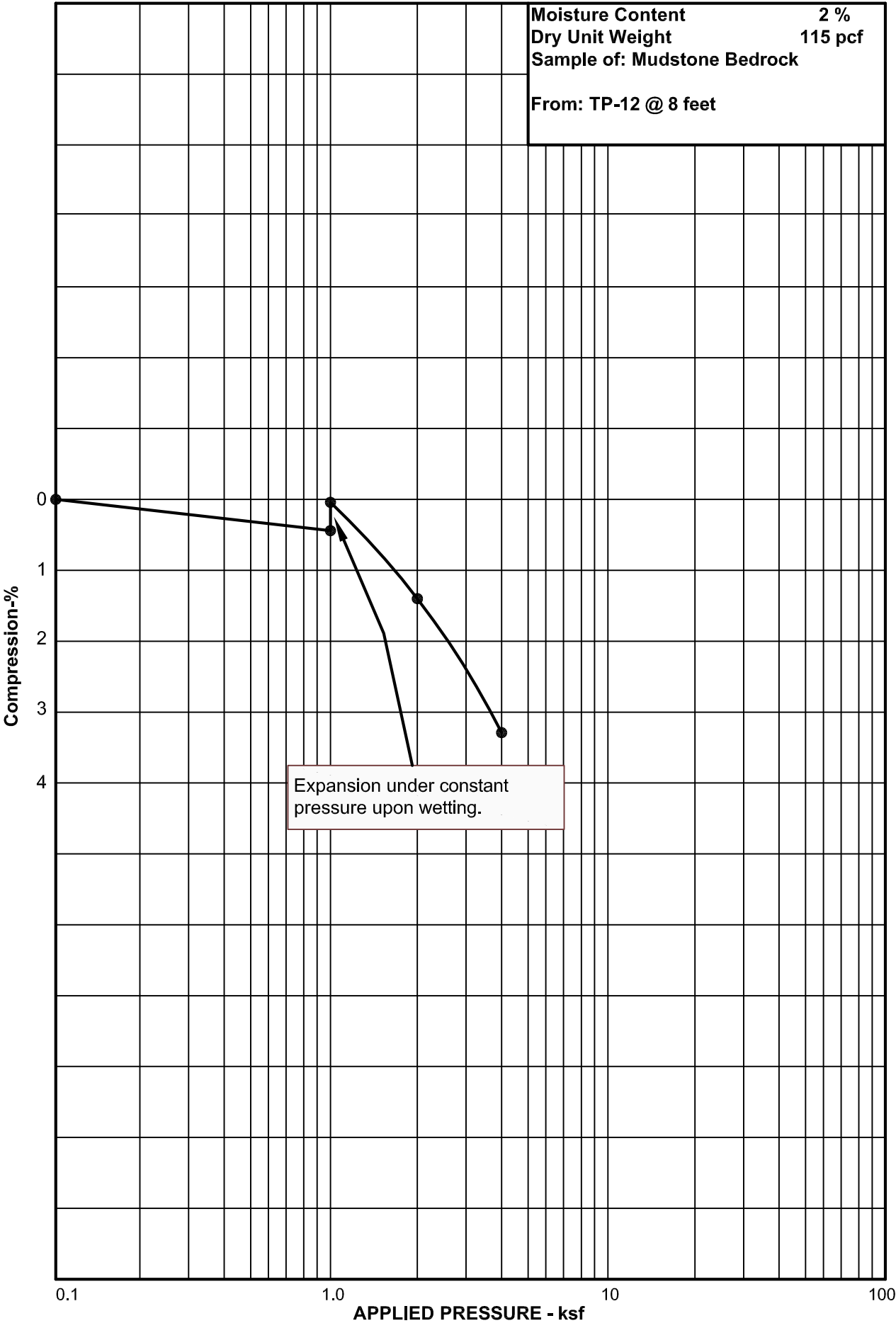
NOTES:

1. The test pits were excavated on June 23, 24, and 25, 2020 with a trackhoe.
2. The locations of the test pits were measured by pacing from property corners.
3. The elevations of the test pits were estimated from the Google Earth elevations.
4. The test pit locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the test pit logs represent the approximate boundaries between material types and the transitions may be gradual.
6. Free water was not encountered in the borings at the time of drilling.
7. WC = water content (%);
DD = dry density (pcf);
+ 4 = percent retained on the No. 4 sieve;
-200 = percent passing No. 200 sieve;
PI = plasticity index (%);
NP = non-plastic;

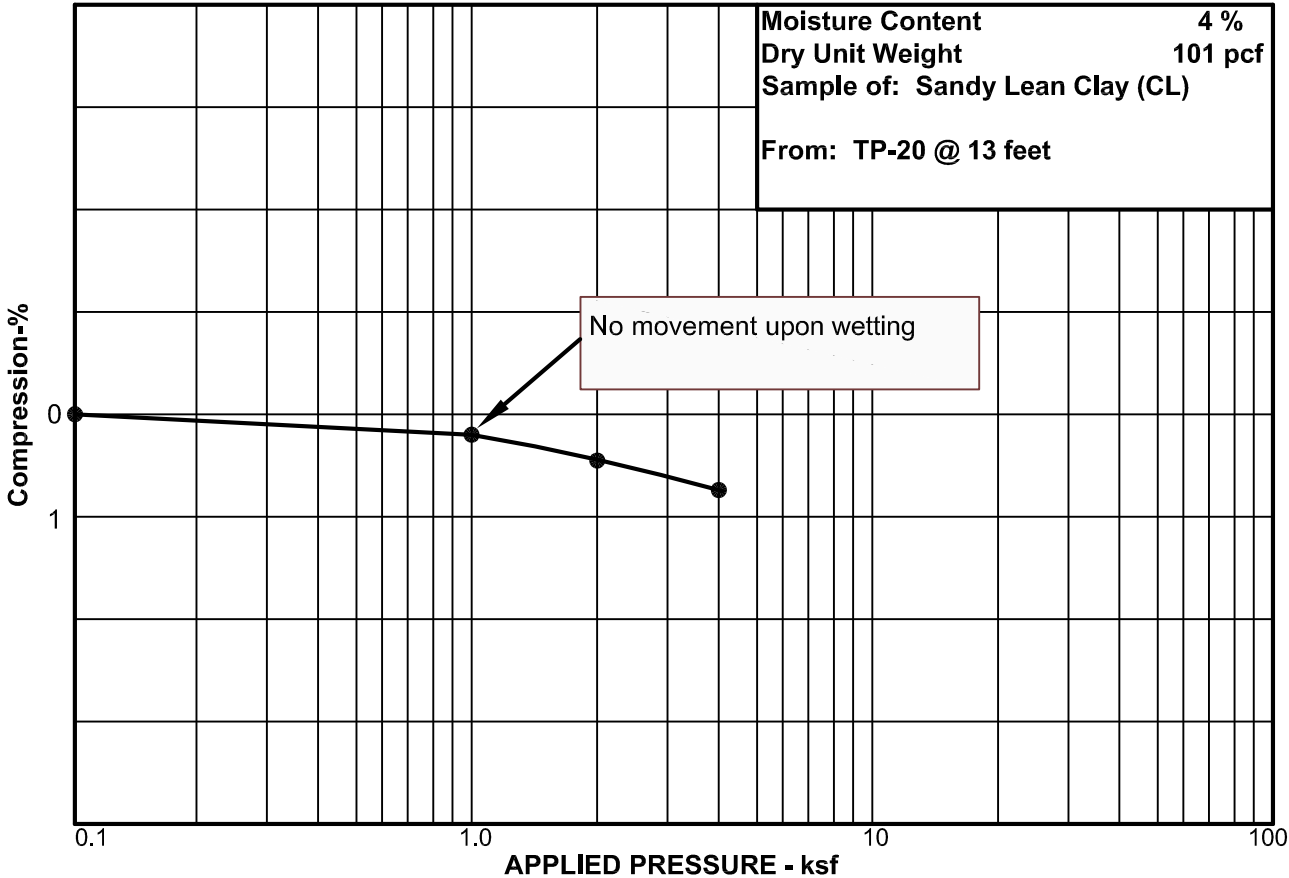
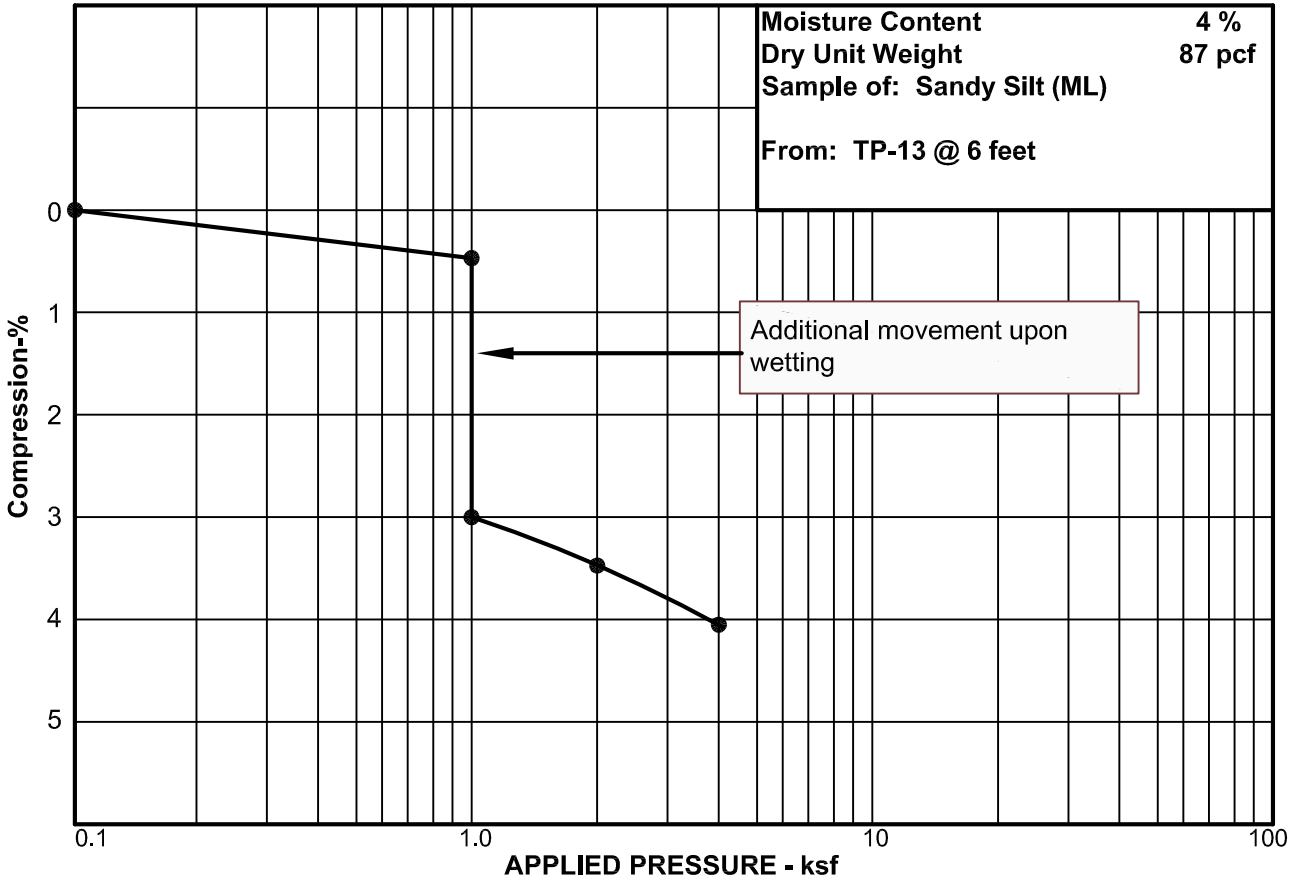


Moisture Content 2 %
Dry Unit Weight 89 pcf
Sample of: Sandy Silt (ML)
From: TP-3 @ 6 feet





Applied Geotechnical Engineering Consultants, Inc.



APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Desert Cliff Area

Project Number 2200519

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Sample Classification
Test Pit No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)	
TP-1	6	3	95			67			Sandy Silt (ML)
TP-3	6	2	89			41			Silty Sand (SM)
TP-4	5	3	87			59			Sandy Silt (ML)
TP-4	19	2	141			98	39	17	Mudstone Bedrock
TP-6	5½	5	95			60			Sandy Silt (ML)
TP-7	4	< 1	87			96			Silt (ML)
TP-8	5	3	86			64			Sandy Silt (ML)
TP-8	12	3	88			72			Silt with Sand (ML)
TP-12	5	2		30	33	37			Silty Gravel with Sand (GM)
TP-12	8	2	115			75	25	15	Mudstone Bedrock
TP-13	6	4	87			68			Sandy Silt (ML)
TP-13	13	7	93			93			Silt (ML)
TP-17	5	5	85			77			Silt with Sand (ML)
TP-18	12	4	87			84			Silt with Sand (ML)
TP-19	5	4	82			77			Silt with Sand (ML)
TP-20	13	4	101			76			Sandy Lean Clay (CL)
TP-21	13	1	96			60			Sandy Silt (ML)

EXHIBIT H

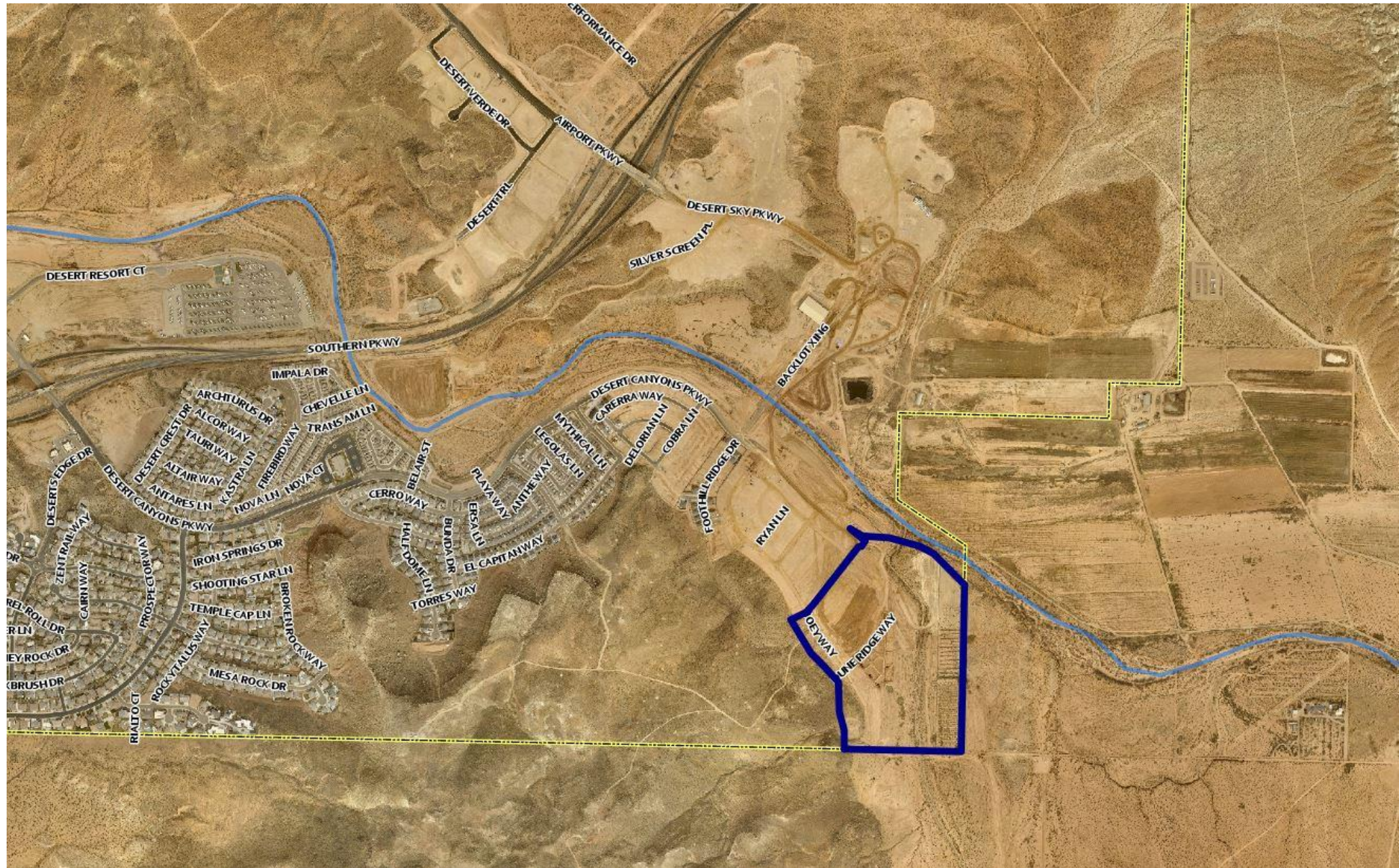
POWERPOINT PRESENTATION



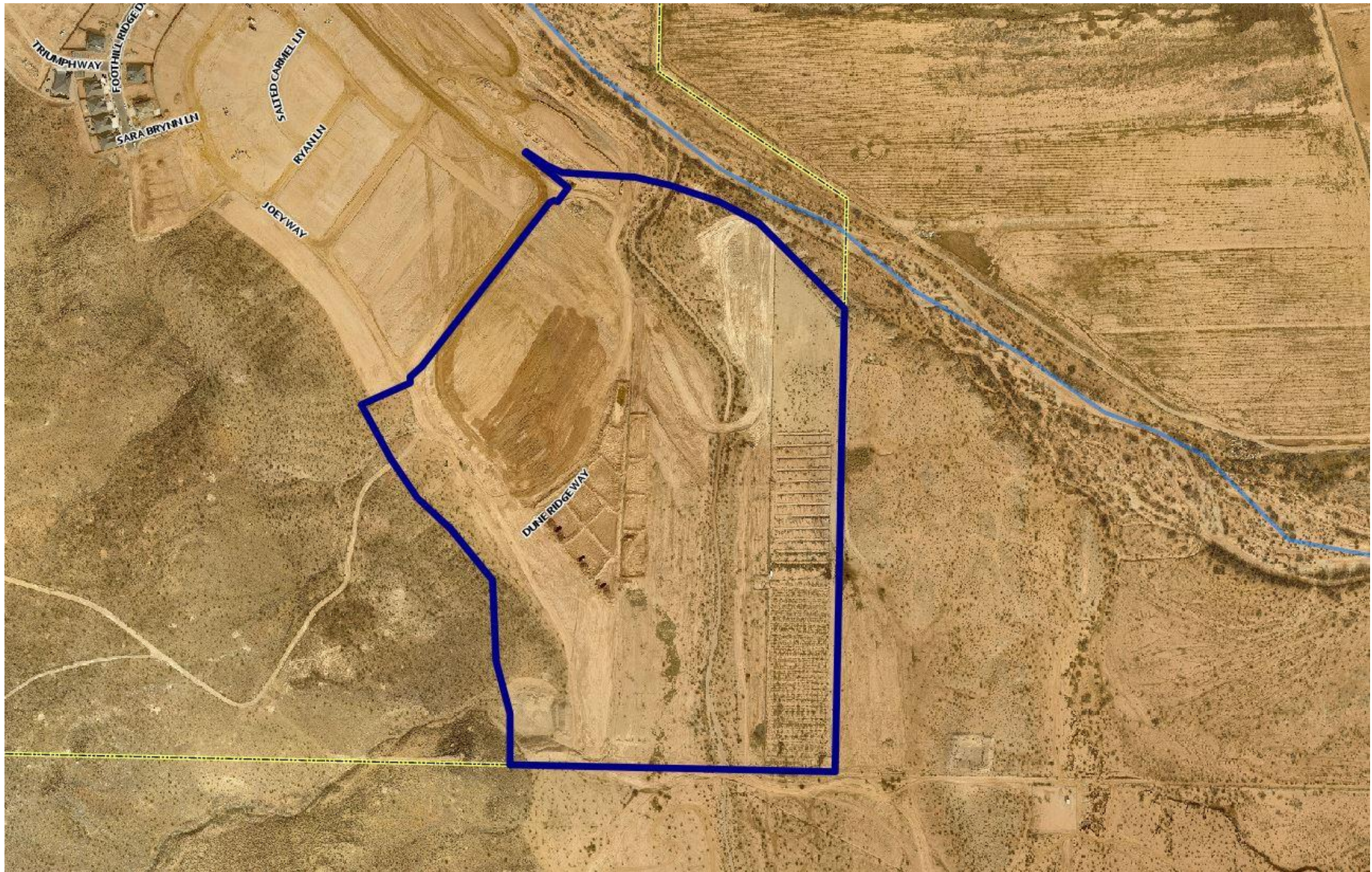
Desert Haven
Hillside

2026-PP-020

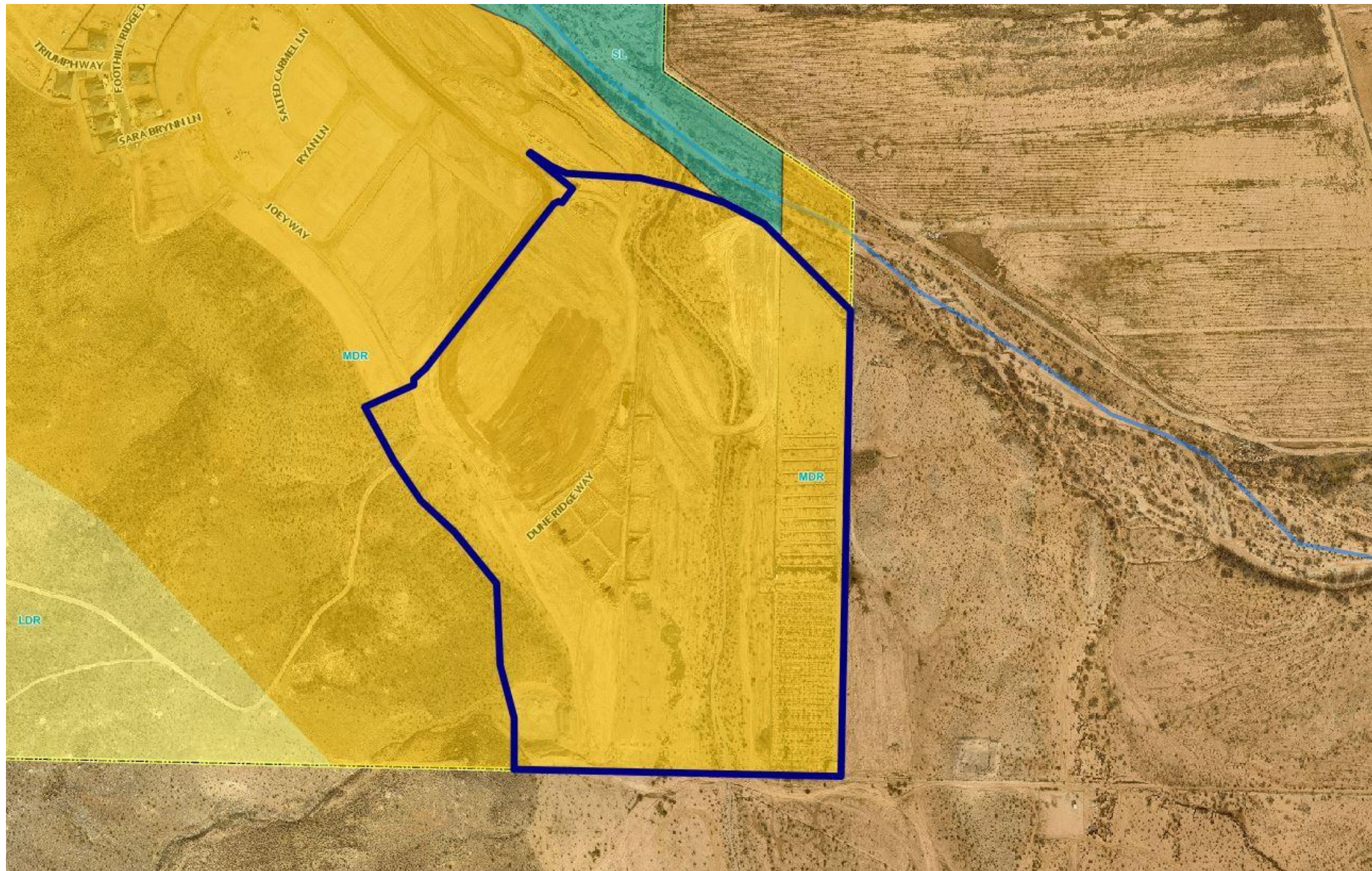
Vicinity Map



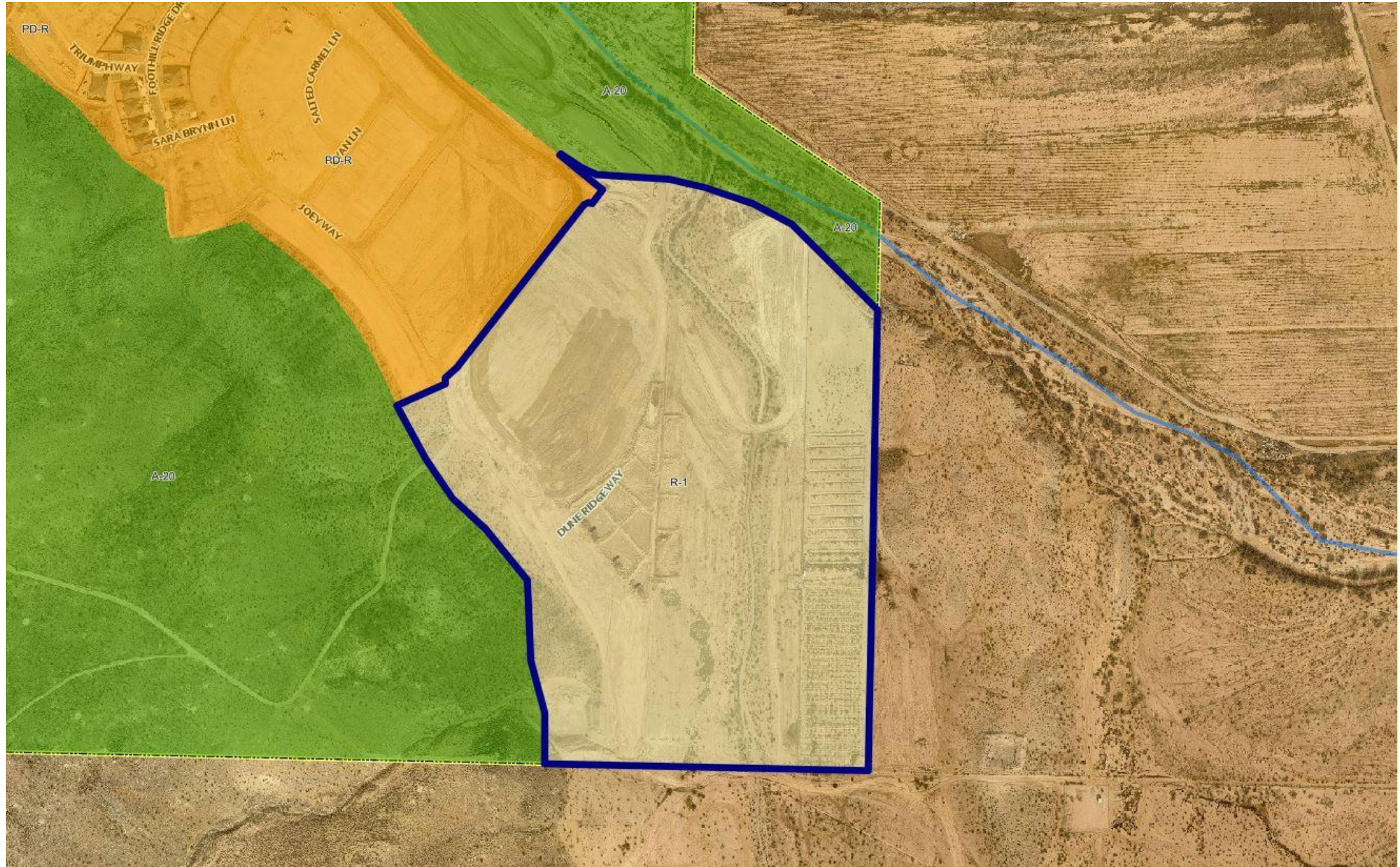
Aerial Map



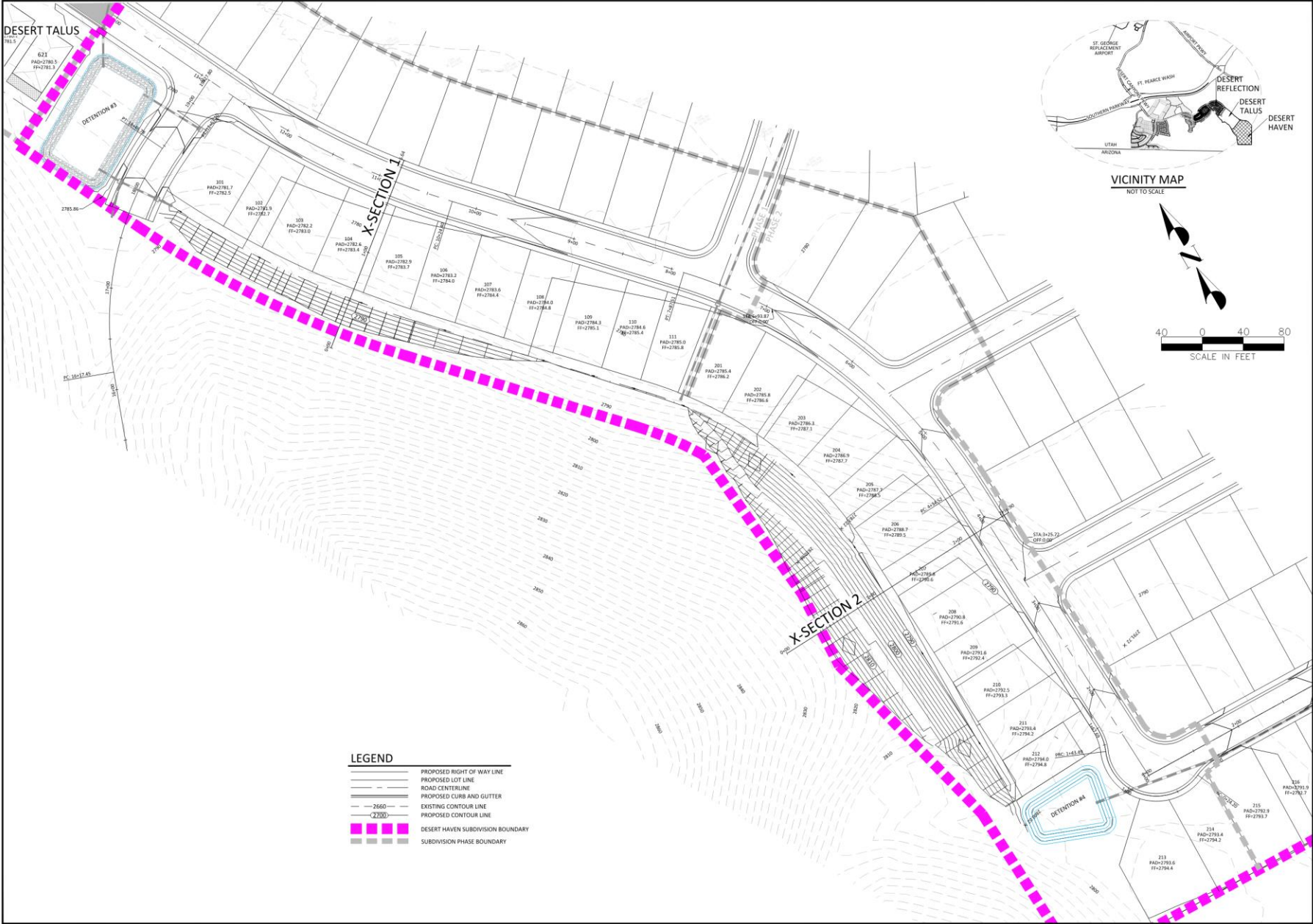
Land Use Map



Zoning Map



Proposed Grading and Drainage Plan



DATE	
DESCRIPTION	
NO.	

**DESERT HAVEN
AT DESERT CANYONS
ST. GEORGE, UTAH**

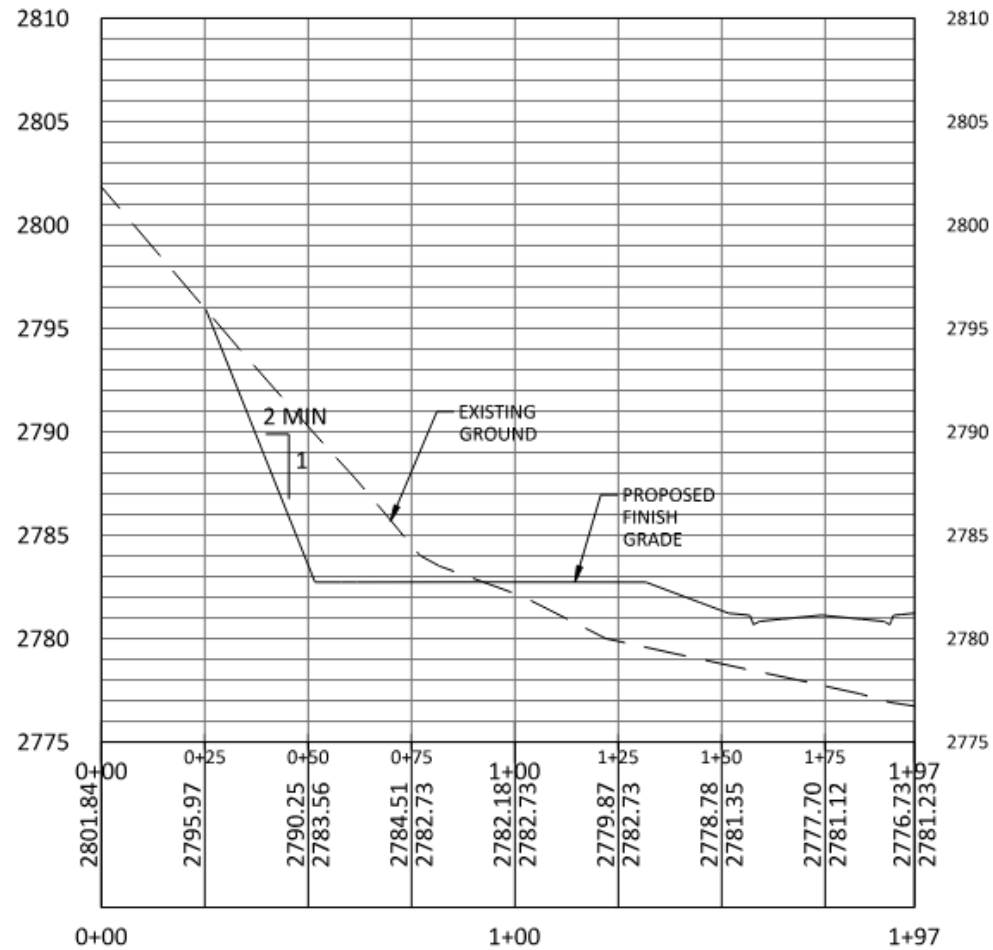
GRADING AND DRAINAGE PLAN

DEVELOPMENT SOLUTIONS, INC.
CIVIL ENGINEERS, LAND SURVEYORS, LAND PLANNERS
120 East St. George Blvd Suite #101
St. George, UT 84770
Office (435) 628-2212 • Fax (435) 628-3553
www.developmentsolutions.com

DATE: 6-24-24
PM: KMM
DRAWN BY: KMM
DESIGNED BY: KMM
CHECKED BY: KMM
PROJECT NO.: 19-015
SCALE: 1"=40'

SHEET NUMBER:
G-1
1 OF 2 TOTAL

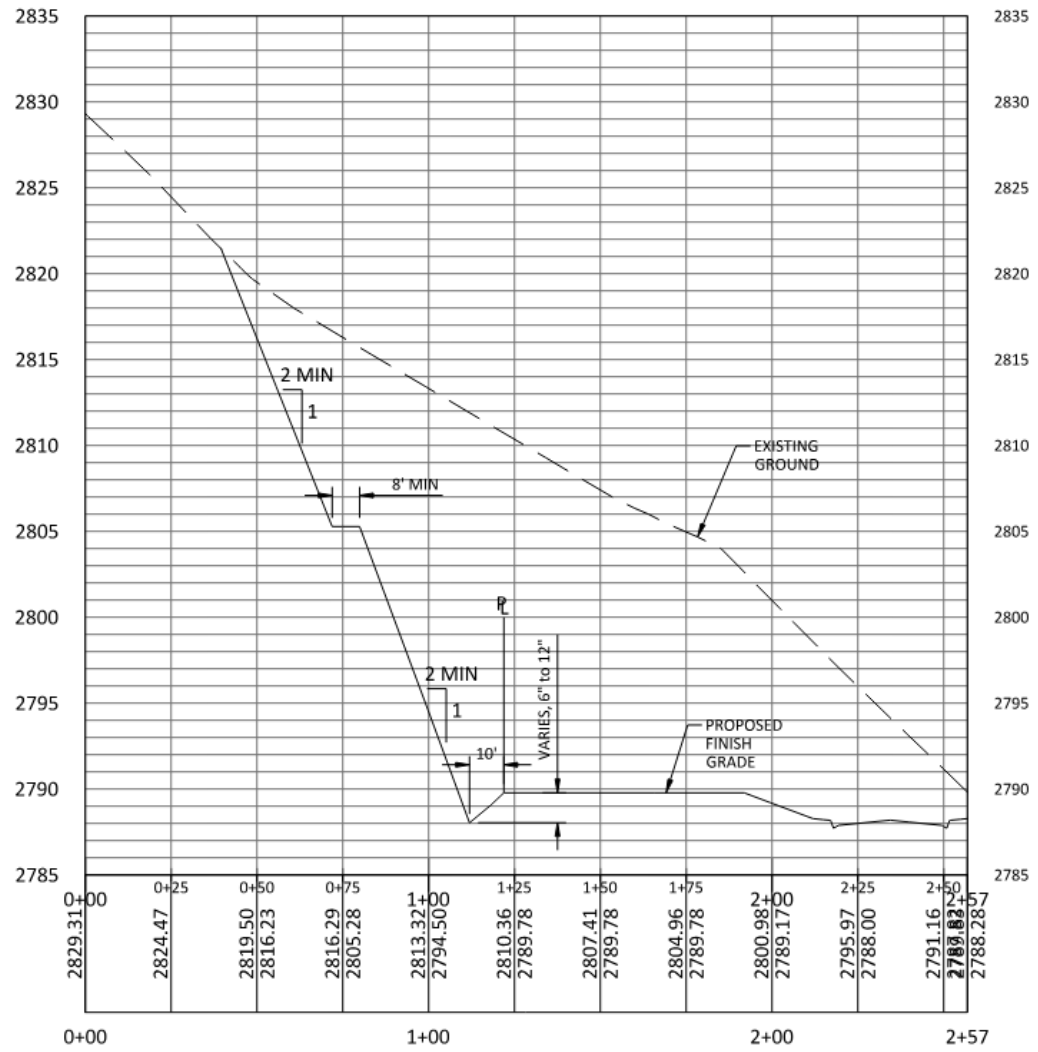
Proposed Cross Section 1



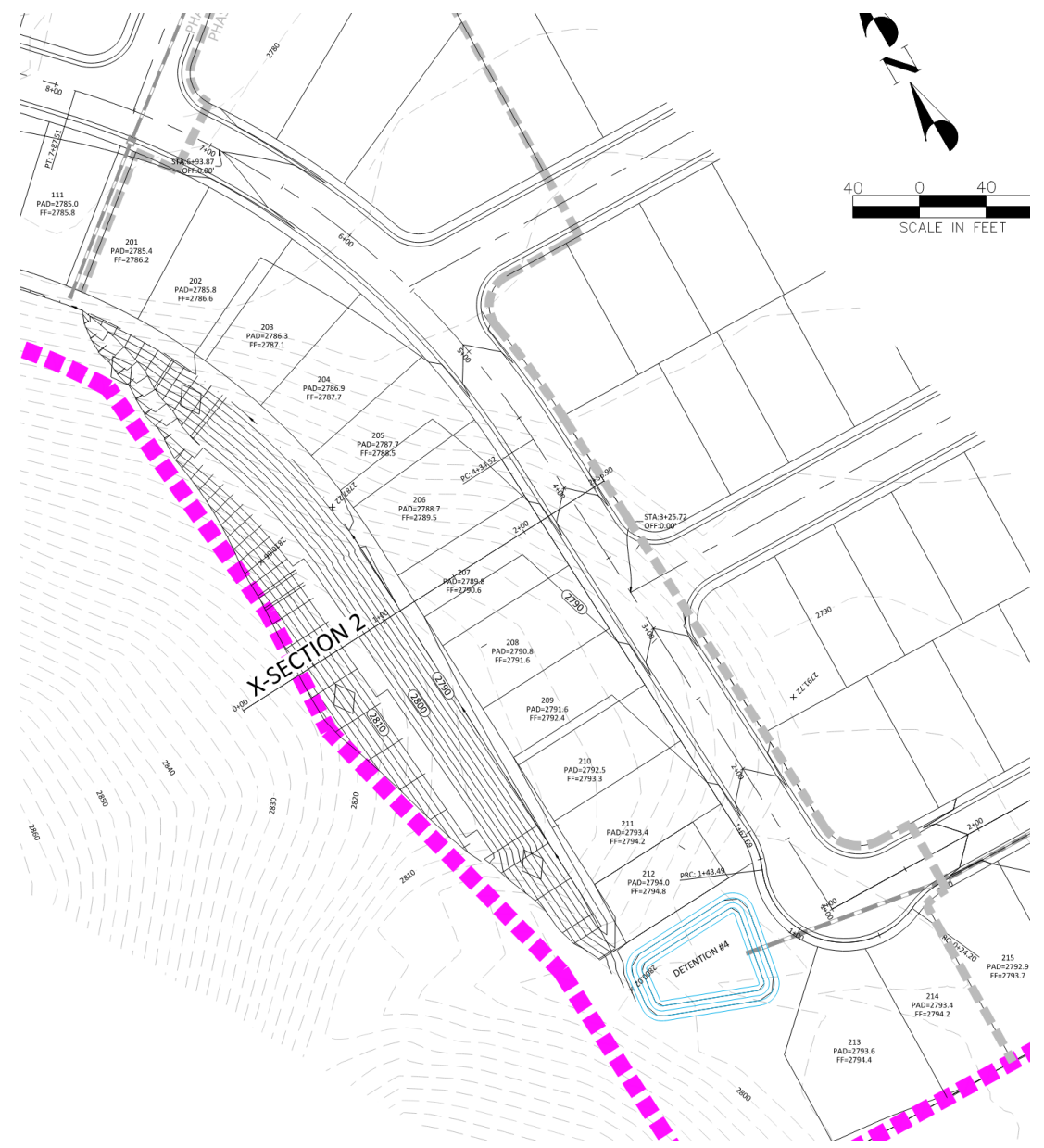
HAVEN X-SECTION 1
H: 1"=40'
V: 1"=8'
STA: 0+00 TO STA: 1+97



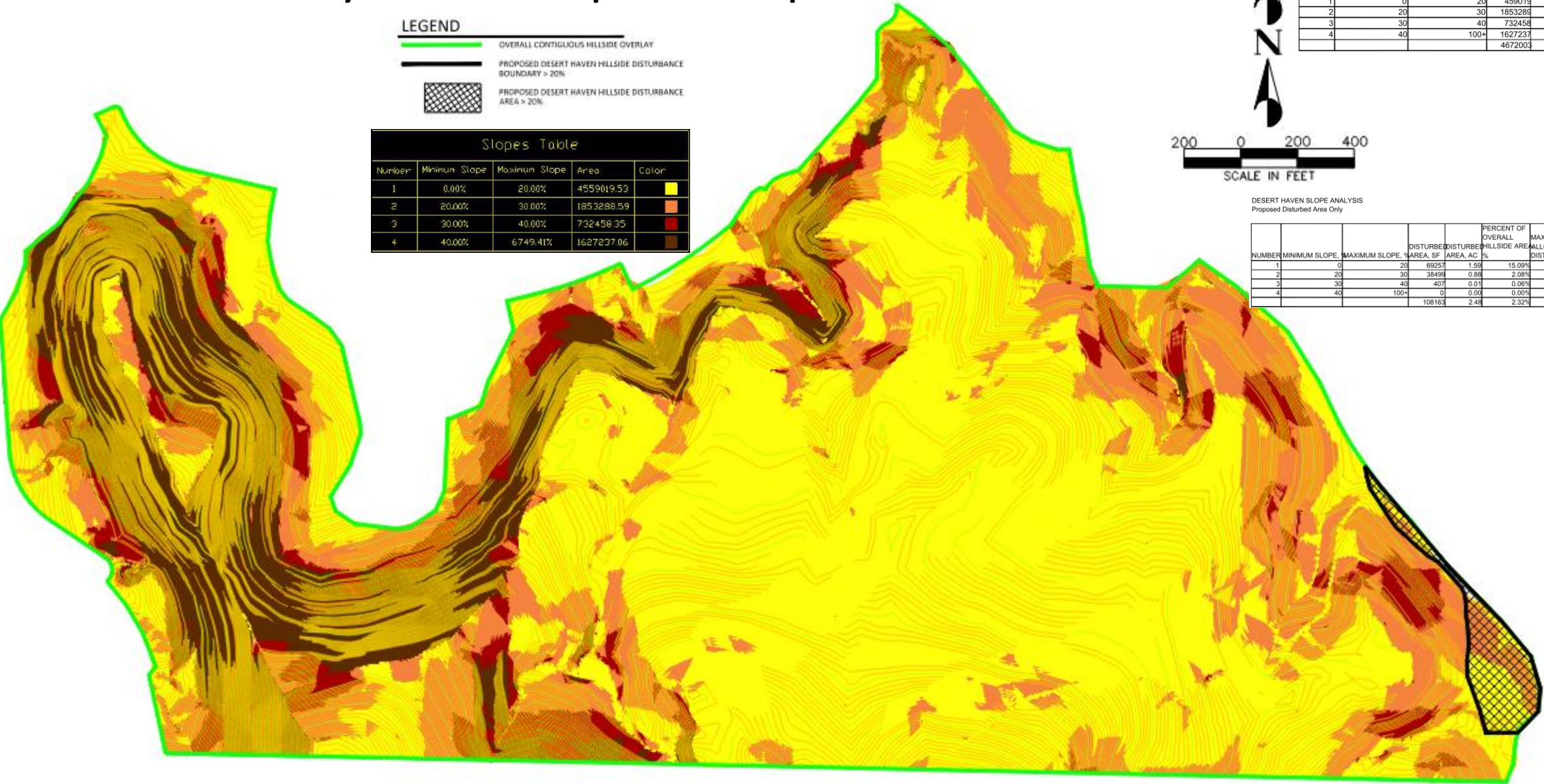
Proposed Cross Section 2



HAVEN X-SECTION 2
H: 1"=40'
V: 1"=8'
STA: 0+00 TO STA: 2+57



Desert Canyons Slope Map



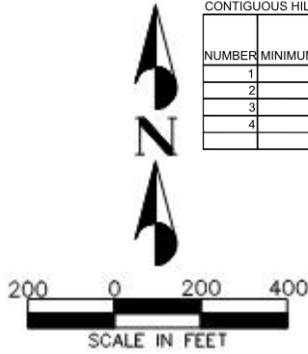
LEGEND

- OVERALL CONTIGUOUS HILLSIDE OVERLAY
- PROPOSED DESERT HAVEN HILLSIDE DISTURBANCE BOUNDARY > 20%
- PROPOSED DESERT HAVEN HILLSIDE DISTURBANCE AREA > 20%

Slopes Table				
Number	Minimum Slope	Maximum Slope	Area	Color
1	0.00%	20.00%	4559019.53	
2	20.00%	30.00%	1853288.59	
3	30.00%	40.00%	732458.35	
4	40.00%	6749.41%	1627237.06	

DESERT CANYONS SLOPE SUMMARY
CONTIGUOUS HILLSIDE AREA OUTSIDE OF EXISTING AND PROPOSED DEVELOPMENT

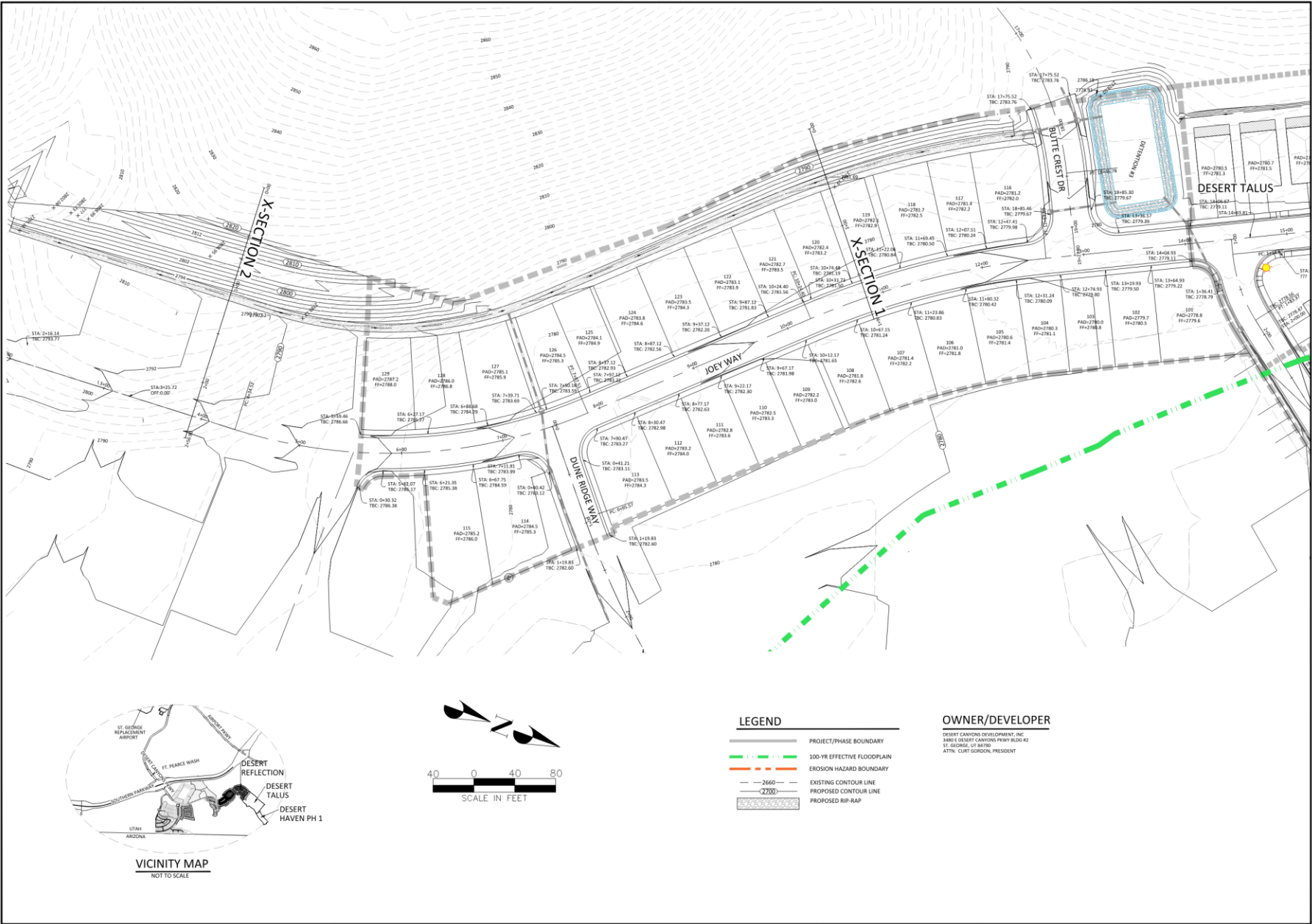
NUMBER	MINIMUM SLOPE	MAXIMUM SLOPE	AREA, SF	AREA, AC	PERCENT OF TOTAL AREA, %
1	0	20	459019	10.54	9.82%
2	20	30	1853288	42.55	39.67%
3	30	40	732458	16.81	15.68%
4	40	100+	1627237	37.36	34.83%
			4672003	107.25	100.00%



DESERT HAVEN SLOPE ANALYSIS
Proposed Disturbed Area Only

NUMBER	MINIMUM SLOPE	MAXIMUM SLOPE	DISTURBED AREA, SF	DISTURBED AREA, AC	PERCENT OF OVERALL HILLSIDE AREA, %	MAXIMUM ALLOWABLE SLOPE DISTURBANCE, %	REMAINING MAXIMUM ALLOWABLE SLOPE DISTURBANCE, AC
1	0	20	69257	1.59	15.09%	NA	NA
2	20	30	38498	0.88	2.08%	30.00%	11.68
3	30	40	407	0.01	0.06%	5.00%	0.83
4	40	100+	0	0.00	0.00%	0.00%	0.00
			108163	2.48	2.32%		

Proposed Grading Plan





DATE	BY
9/1/26	KMM
DRAWN BY:	KMM
DESIGNED BY:	KMM
CHECKED BY:	
PROJECT NO.:	25-003
SCALE:	1"=40'
SHEET NUMBER:	PP-2

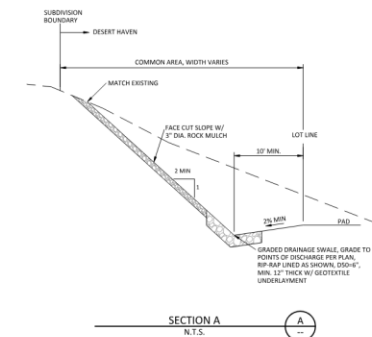
DESERT HAVEN PHASE 1
AT DESERT CANYONS
ST. GEORGE, UTAH

PRELIMINARY PLAT

DEVELOPMENT SOLUTIONS, INC.
CIVIL ENGINEERS, LAND SURVEYORS, AND PLANNERS
120 West St. George, Utah 84770
St. George, UT 84770
Office (435) 633-2222 • Fax (435) 674-5553
www.developmentsolutions.com

PP-2
2 OF 3 TOTAL

DSG ENGINEERING, INC. LAND PLANNERS, LAND SURVEYORS, CIVIL ENGINEERS			
PP-3 3 OF 3 TOTAL		PROJECT NAME: DESERT HAVEN PHASE 1 AT DESERT CANYONS PRELIMINARY PLAT	
SHEET NUMBER: PP-3		SHEET NAME: SECTIONS AND DETAILS	
DATE : 9-1-26 DRAWN BY : KRM DESIGNED BY : KRM CHECKED BY : KRM PROJECT NO. : 25-002 SCALE : N.T.S. SHEET NUMBER :		181 EAST 100 NORTH AVE #2 S.E. Gresham, UT 84770 Office (435) 628-2121	



Recommendation

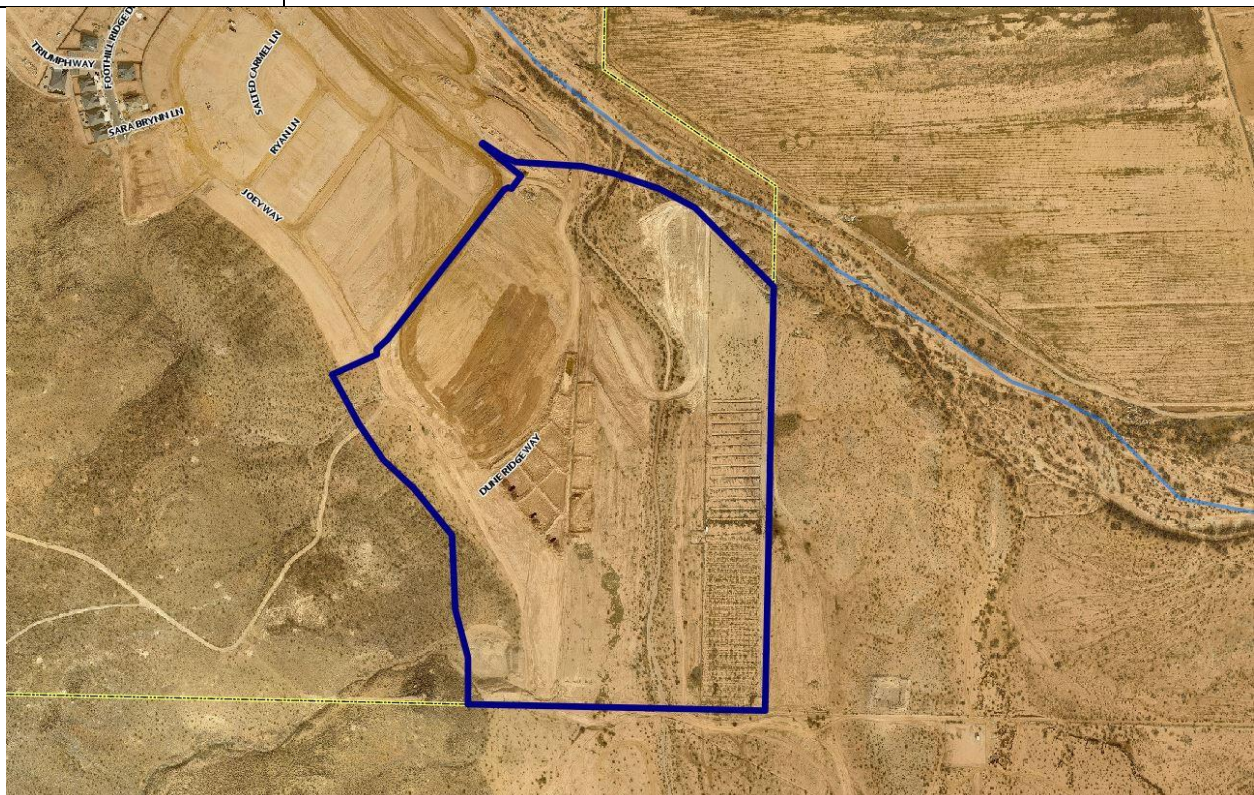
The Hillside Review Board, at their meeting held August 26, 2026, recommended approval of the application with a 4-0 vote.

Possible Motion

“I move that we recommend approval to the City Council for the Desert Haven Hillside Development Permit request, Case No. 2026-HS-007, based on the findings noted in the staff report.”

PLANNING COMMISSION AGENDA REPORT: 10/13/2026

Desert Haven Phase 1 Preliminary Plat (Case No. 2026-PP-020)	
Request:	Consider a request for a preliminary plat for a 29-lot residential preliminary plat called Desert Haven Phase 1.
Applicant:	DSG Engineering – Ken Miller
Location:	Generally located south of the Fort Pierce Wash. Along the Utah-Arizona border.
General Plan:	MDR (Medium Density Residential)
Existing Zoning:	R-1 (Single-family no minimum square footage, 40-foot minimum lot width/frontage)
Surrounding Zoning:	North A-20 (Agriculture 20-acre minimum lot size)
	South Arizona
	East Washington County
	West PD-R (Planned Development Residential) and A-20 (Agriculture 20-acre minimum lot size)
Land Area:	Approximately 5.04 acres



BACKGROUND & ANALYSIS:

The subject property was included in a 212.679-acre annexation approved by the City on November 7, 2019. On May 7, 2020, the property received an MDR (Medium Density Residential) General Plan land use designation. The City Council approved a zone change to an R-1 (Single-Family Residential with no minimum lot size requirement and 40-foot minimum lot width/frontage) zoning district on July 2, 2026.

As a reminder, the R-1 zoning district is a recently adopted residential zone that was approved by the City Council on March 25, 2026. The R-1 zone provides flexibility in lot sizes by eliminating a minimum lot area requirement. However, because of the property's underlying General Plan land use designation is MDR (Medium Density Residential), development within this R-1 zone is subject to a minimum lot frontage of 40 feet and a maximum residential density of nine dwelling units per acre.

With those factors in mind the applicant is asking for approval of a 29-lot Phase 1 Preliminary Plat on the subject property. Lot sizes range from 3,600 ft² on the smaller end to 7,679 ft² on the larger end. All frontage requirements are being met, and the density is approximately 5.8 units per acre.

RECOMMENDATION:

Staff recommends approval of this preliminary plat with the following conditions:

1. That the final plat shall be recorded prior to the issuance of any building permits.
2. That the Hillside application associated with this plat is approved, if not this plat will be null and void.

ALTERNATIVES:

1. Approve as presented.
2. Approve with no conditions.
3. Deny the application.
4. Continue the proposed preliminary plat to a later date.

POSSIBLE MOTION:

"I move that we approve the Desert Haven Phase 1 Preliminary Plat request, application number 2026-PP-020, based on the findings and subject to the conditions noted in the staff report."

FINDINGS FOR APPROVAL:

1. The plat complies with the development standards of the R-1 zone, including the applicable density and frontage requirements established by the underlying MDR (Medium Density Residential) General Plan designation.
2. The plat connects to existing and planned streets within adjacent developments, allowing for logical circulation and integration with the surrounding neighborhood.
3. The proposed Preliminary Plat supports goal 2.3 of the General Plan by increasing and diversifying housing supply across the city.
4. Approval of the Preliminary Plat will not negatively impact the health, stability, and/or formation of families within the city.

PC 2026-PP-020
Desert Haven Phase 1
Preliminary Plat

EXHIBIT A

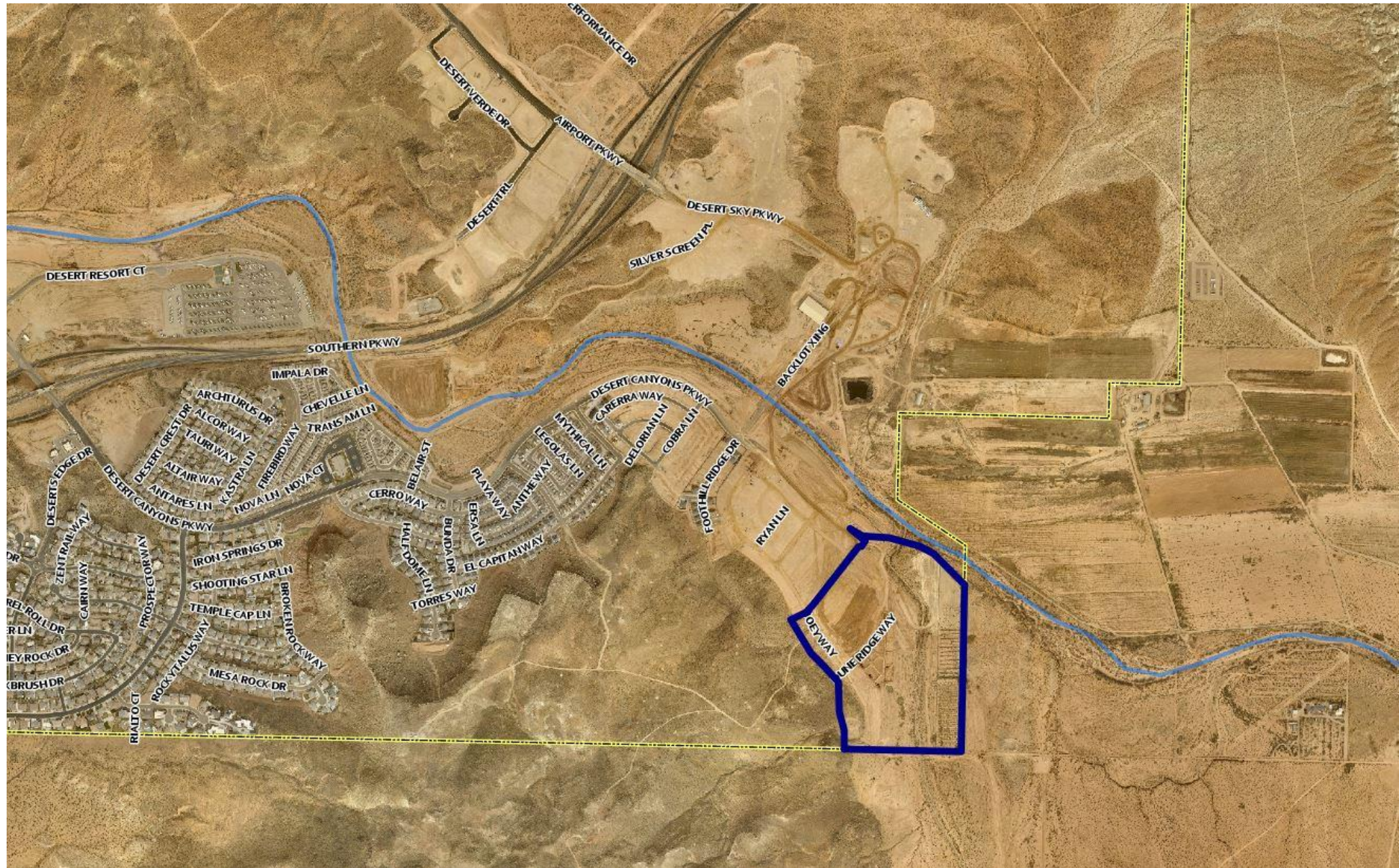
POWERPOINT PRESENTATION



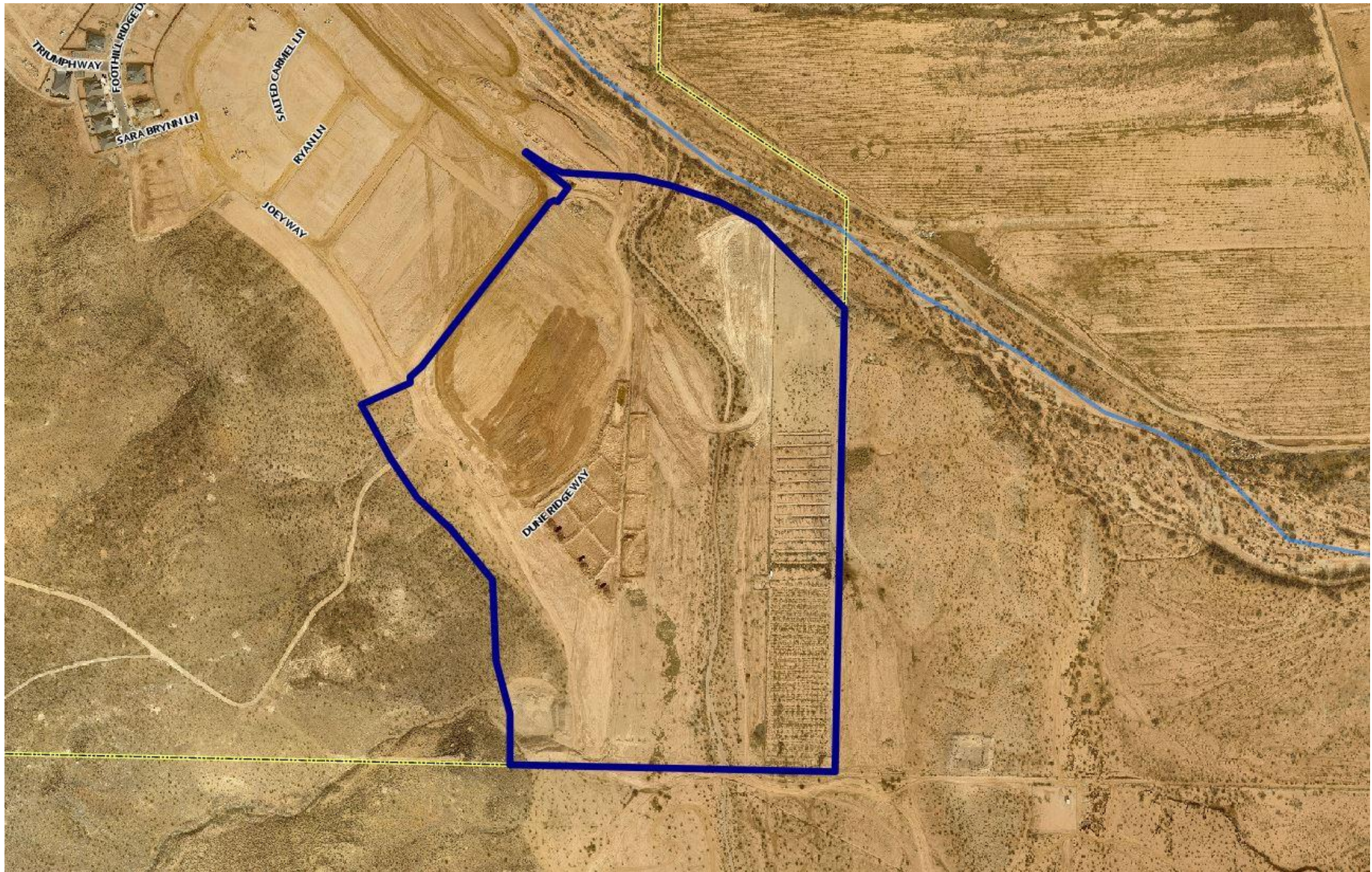
Desert Haven Phases 1
Preliminary Plat

2026-PP-020

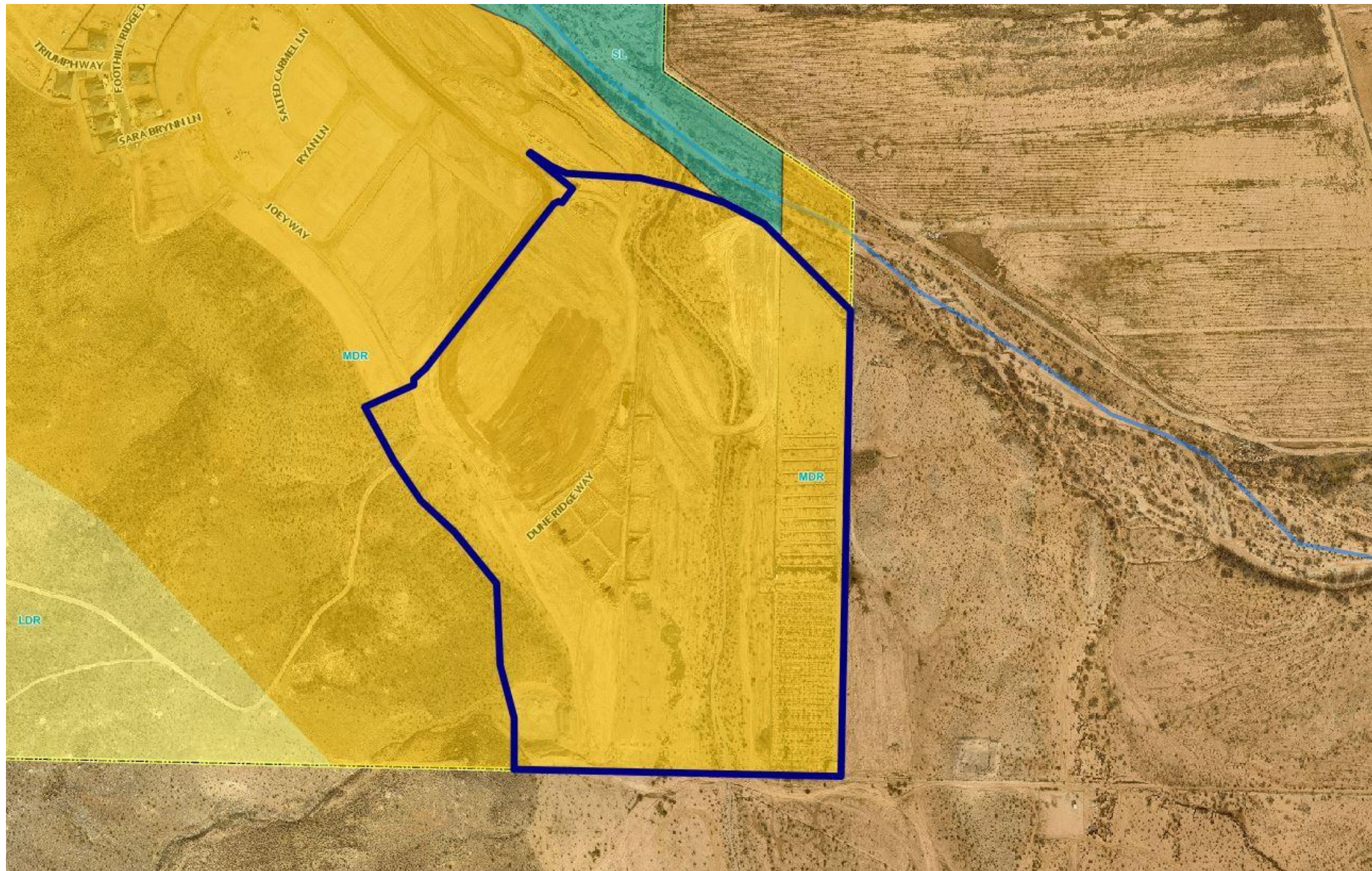
Vicinity Map



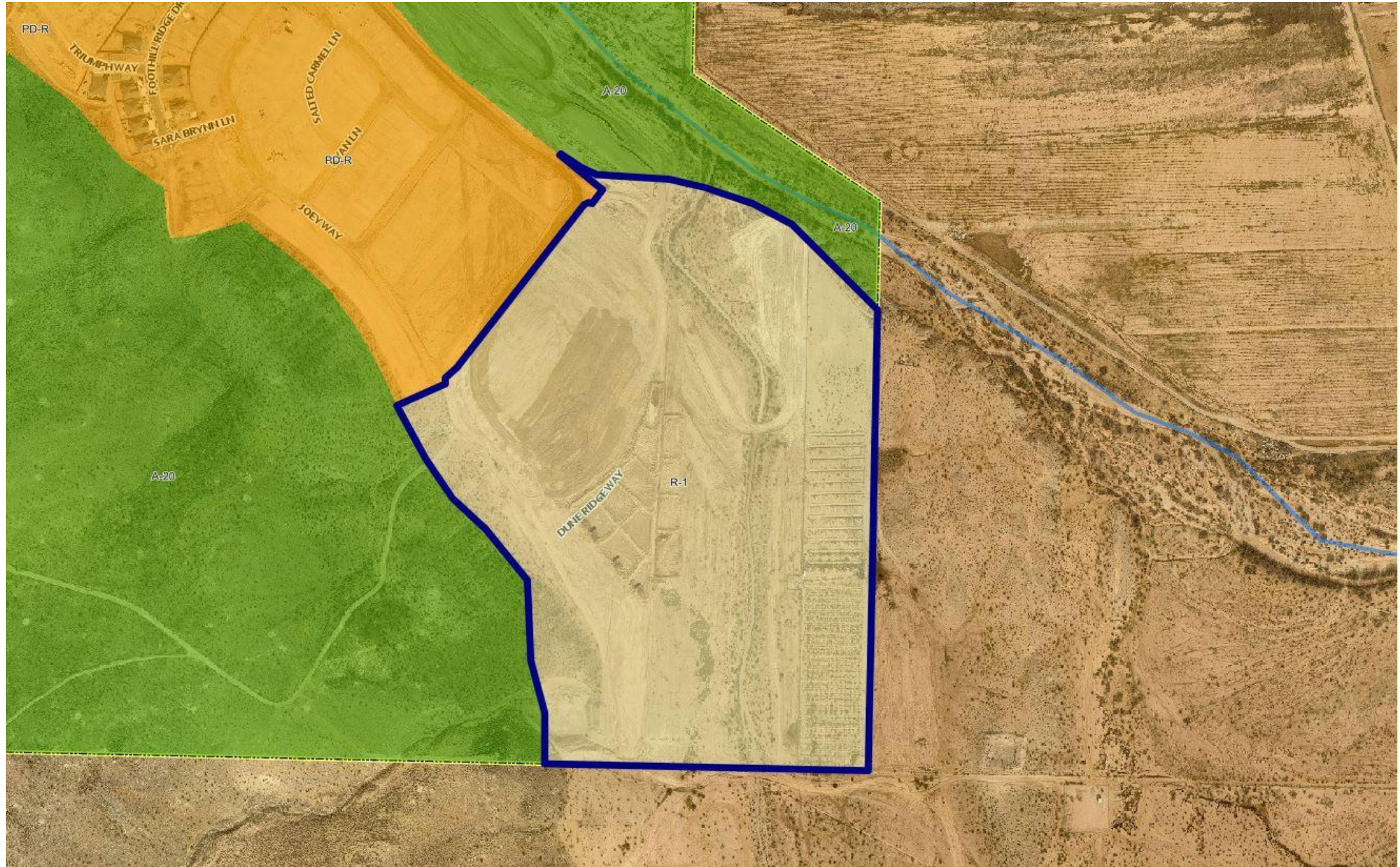
Aerial Map



Land Use Map



Zoning Map



SITE DATA:

ZONING: R-1
SITE AREA: 5.04
LOTS: 29
DENSITY: 5.8 DU/AC

OWNER/DEVELOPER

DESERT CANYONS LAND, LLC/DESERT CANYONS DEVELOPMENT, INC.
3480 E. DESERT CANYONS PKWY
ST. GEORGE, UTAH 84790

LEGEND

- ROADWAY CENTERLINE
- LOT LINE
- PROJECT/PHASE BOUNDARY
- EXISTING SANITARY SEWER MAIN
- EXISTING CULINARY WATER MAIN
- EXISTING IRRIGATION MAIN
- PROPOSED SANITARY SEWER MAIN
- PROPOSED CULINARY WATER MAIN
- PROPOSED IRRIGATION
- PROPOSED FIRE HYDRANT

VICINITY MAP

NOT TO SCALE

DESERT HAVEN PHASE 1 AT DESERT CANYONS ST. GEORGE, UTAH PRELIMINARY PLAT

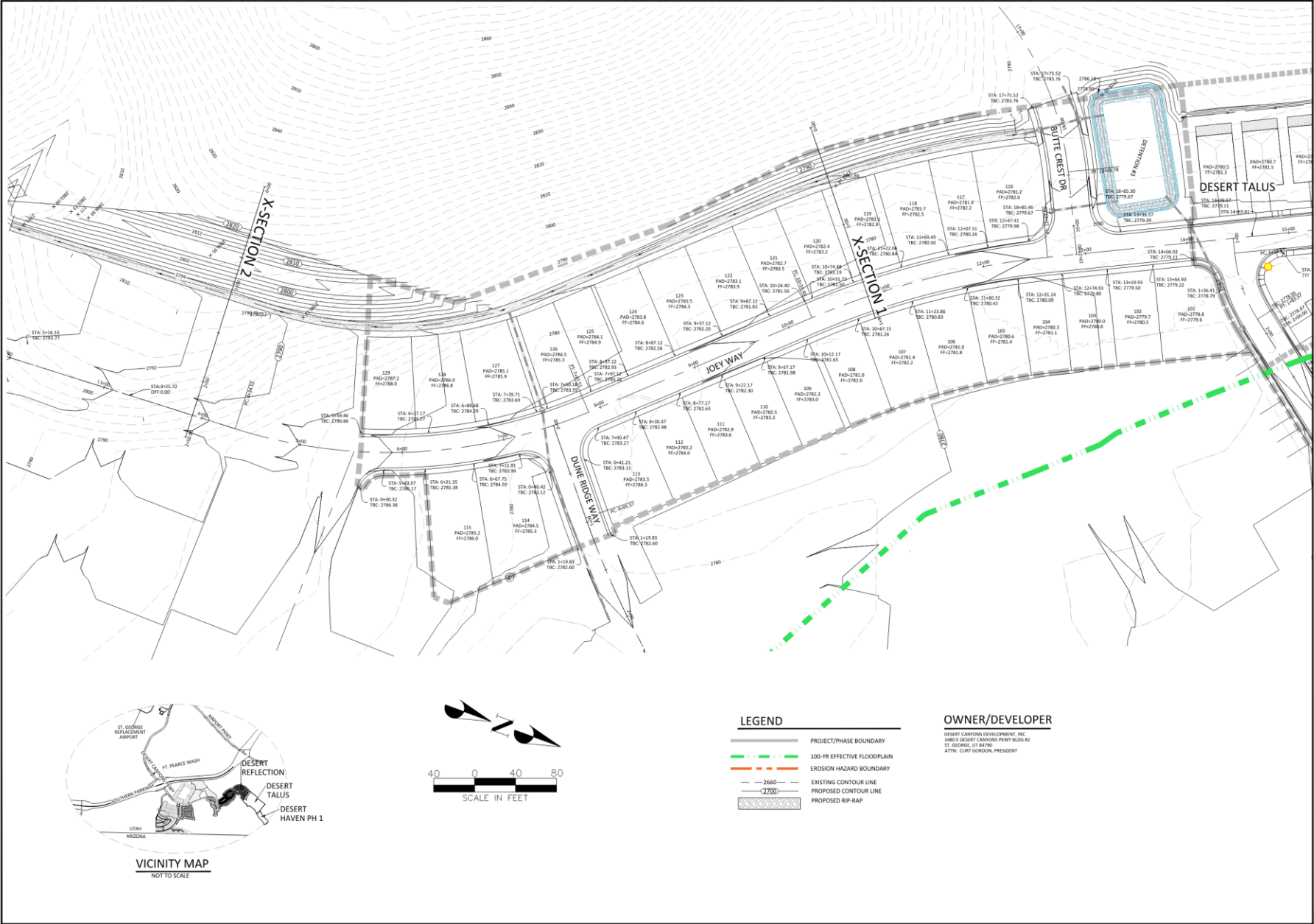
DEVELOPMENT SOLUTIONS, INC.
CIVIL ENGINEERS, LAND SURVEYORS, AND PLANNERS
120 East St. George Blvd Suite #901
Office (801) 528-2211 • Fax (801) 744-3553
www.developmentsolutions.co

PP-1

1 OF 3 TOTAL

Proposed Preliminary Plat

Proposed Grading Plan





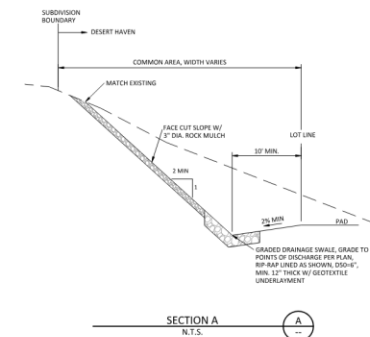
DATE	BY
9/1/26	KMM
DRAWN BY:	KMM
DESIGNED BY:	KMM
CHECKED BY:	
PROJECT NO.:	25-003
SCALE:	1"=40'
SHEET NUMBER:	PP-2

2 OF 3 TOTAL

DESERT HAVEN PHASE 1
AT DESERT CANYONS
ST. GEORGE, UTAH

PRELIMINARY PLAT

DEVELOPMENT SOLUTIONS, INC.
CIVIL ENGINEERS, LAND SURVEYORS, AND PLANNERS
120 West St. George, Utah 84770
ST. GEORGE, UT 84770
OFFICE (435) 633-2222 • FAX (435) 674-5553
www.developmentsolutions.com

[illegible]

Recommendation

Staff recommends approval with the following conditions:

1. That the final plat is recorded prior to the issuance of any building permits.
2. That the Hillside application associated with this plat is approved, if not this plat will be null and void.

Possible Motion

“I move that we approve the Desert Haven Phase 1 Preliminary Plat request, Case No. 2026-PP-020, based on the findings and conditions noted in the staff report.”

1 **ST. GEORGE PLANNING COMMISSION MINUTES**
2 **September 22, 2026, 5:00 P.M.**
3 **CITY COUNCIL CHAMBERS**

4
5 **PRESENT:**

6 **Planning Commission Chair Ben Rogers**
7 **Planning Commission Member Brandon Anderson**
8 **Planning Commission Member Kelly Taysom**
9 **Planning Commission Member Terri Draper (absent items 4 & 5)**
10 **Planning Commission Member Lori Chapman**
11 **Planning Commission Member Nathan Fisher**
12 **Planning Commission Member Kelly Casey**

13
14 **EXCUSED:**

15
16 **STAFF MEMBERS PRESENT:**

17 **Assistant City Attorney Daniel Baldwin**
18 **Community Development Director Carol Winner**
19 **Public Works Engineering Manager Director Cathy Hasfurther**
20 **Planner Lonnie Olson**
21 **Planner Dan Boles**
22 **Planner Brian Dean**
23 **Development Office Supervisor Angie Jessop**

24
25 **OTHERS PRESENT:**

26 **Applicant Logan Blake**
27 **Applicant Stacy Young**
28 **Applicant Zack Graham**
29 **Applicant Greg Goffin**
30 **Applicant Curt Gordon**

31
32
33 **CALL TO ORDER:**

34 Planning Commission Chair Rogers called the meeting to order and welcomed all in
35 attendance. The Pledge of Allegiance to the Flag was led by Commission Member
36 Chapman.

37
38 Link to call to order and flag salute: [00:00:07](#)

39
40 Link to call for disclosures [00:00:40](#)

41
42
43 **ITEM 1**

44 **PLANNED DEVELOPMENT AMENDMENT Ledges St George – PUBLIC HEARING**

45 Consider a request to amend the Ledges of St. George zone plan. This PD
46 amendment would reallocate the unit counts within areas of the project and the total
47 unit count for the planned development would remain the same on 1,108 acres. The
48 site is located on the west and east side of Highway 18. The applicant is DSG
49 Engineering, and the representative is Logan Blake. The project will be known as
50 Ledges St George. Case No. 2026-PDA-019 (Staff – Lonnie Olson)

51
52 [Agenda Packet \[Page 3\]](#)
53

Link to Presentation by Lonnie Olson [00:01:00](#)

Link to public hearing [00:05:54](#)

Link to comment by Matt Ence [00:06:11](#)

Link to comment by Lynn Howell [00:10:42](#)

Link to comment by Russell John Mauer [00:12:06](#)

Link to comment by Dan Brown [00:13:47](#)

Link to comment by Tim Reed [00:14:40](#)

Public Hearing Closed

Link to comment by applicant Stacy Young [00:16:18](#)

Link to question by Commission Member Draper for Mr. Young [00:18:25](#)

Link to discussion by Commission Members [00:19:25](#)

Link to question by Commission Chair Rogers and discussion with Mr. Olson
[00:22:32](#)

Link to motion [00:23:26](#)

MOTION:

A motion was made by Planning Commission Member Fisher to recommend approval to City Council, this Planned Development Amendment for the Ledges, based on the findings in the staff report.

SECOND:

The motion was seconded by Planning Commission Member Casey.

VOTE:

Commission Chair Rogers called for a vote, as follows:

Planning Commission Chair Rogers – aye
Planning Commission Member Anderson –absent
Planning Commission Member Fisher – aye
Planning Commission Member Casey – aye
Planning Commission Member Chapman – aye
Planning Commission Member Taysom –aye
Planning Commission Member Draper –aye

The vote was unanimous. Motion carries.

ITEM 2**PLANNED DEVELOPMENT AMENDMENT Les Schwab Tire Center – PUBLIC HEARING**

Consider a request to amend the Lin's Market River Road PD-C (Planned Development Commercial) zone to allow construction of an 8,208 ft² Les Schwab Tire Shop which is an allowed use in the zone. The property is located north of the intersection of River Road and Quarry Ridge Drive. The applicant is Graham Engineering, and the representative is Zack Graham. The project will be known as Les Schwab Tire Center. Case No. 2026-PDA-018 (Staff – Dan Boles)

[Agenda Packet \[Page 30\]](#)

Link to Presentation by Dan Boles [00:24:38](#)

Link to clarification by Mr. Boles and Assistant City Attorney Daniel Baldwin with Commission Members [00:32:16](#)

Link to question by Commission Member Chapman and discussion with Mr. Boles [00:35:29](#)

Link to public hearing [00:36:40](#)

Link to comment by Dennis Gray [00:36:50](#)
Exhibit A (see below)

Link to comment by Rick Meyer [00:41:26](#)

Public Hearing Closed

Link to comment by applicant Zack Graham [00:42:08](#)

Link to question by Commission Chair Rogers and discussion with Mr. Graham [00:44:20](#)

Link to question by Commission Member Fisher and discussion with Mr. Graham [00:45:35](#)
Exhibit B (see below)

Link to question by Commission Member Draper and discussion with Mr. Graham [00:48:10](#)

Link to discussion by Commission Members [00:50:55](#)

Link to motion [00:51:24](#)

MOTION:

A motion was made by Planning Commission Member Draper to continue this item.

SECOND:

The motion was seconded by Planning Commission Member Chapman

VOTE:

Commission Chair Rogers called for a vote, as follows:

Planning Commission Chair Rogers – aye
Planning Commission Member Anderson –absent
Planning Commission Member Fisher – aye
Planning Commission Member Casey – aye
Planning Commission Member Chapman – aye
Planning Commission Member Taysom –aye
Planning Commission Member Draper –aye

The vote was unanimous. Motion carries.

Link to comment by Commission Member Fisher [00:51:45](#)

ITEM 3**PLANNED DEVELOPMENT AMENDMENT Plastics Clinic – PUBLIC HEARING**

Consider a request to amend the Fields at Mall Drive Phase 2, Planned Development Commercial (PD-C) zone. The applicant is seeking approval of the design and site plan for a professional and medical office building of approximately 45,000 square feet. The property is generally located north of Mall Drive and west of 2780 E, in St. George, Utah. The applicant is The Plastics Clinic, and the representative is Greg Goffin. The proposed project will be known as The Plastics Clinic.
Case No. 2026-PDA-021. (Staff – Brian Dean)

[Agenda Packet \[Page 64\]](#)

Link to Presentation by Brian Dean [00:52:14](#)

Link to public hearing [00:58:06](#)

Link to comment by Paul Broadhead [00:58:23](#)

Public Hearing Closed

Link to comment by applicant Gregg Goffin [01:02:56](#)

Link to question by Commission Member Draper for Mr. Goffin [01:03:03](#)

Link to comment by City Engineer Cathy Hasfurther and discussion with Commission Members [01:04:00](#)

Link to question by Commission Member Fisher for Mr. Dean and Ms. Hasfurther [01:07:36](#)

Link to question by Commission Member Chapman and Commission Member Casey for Ms. Hasfurther [01:09:48](#)

Link to question by Commission Member Fisher and discussion with Ms. Hasfurther [01:13:33](#)

Link to discussion by Commission Members [01:14:30](#)

Link to discussion by Commission Members and Mr. Dean [01:19:30](#)

Link to comment by Ms. Hasfurther and discussion with Commission Members
[01:22:31](#)

Exhibit C (see below)

Link to motion [01:28:54](#)

MOTION:

A motion was made by Planning Commission Member Draper to forward a positive recommendation to the City Council for this item, with concerns about whether there is any way to make the traffic better, that better minds than our, go for it. Including the findings and conditions presented.

SECOND:

The motion was seconded by Planning Commission Member Fisher.

VOTE:

Commission Chair Rogers called for a vote, as follows:

Planning Commission Chair Rogers – aye
Planning Commission Member Anderson –absent
Planning Commission Member Fisher – aye
Planning Commission Member Casey – aye
Planning Commission Member Chapman – aye
Planning Commission Member Taysom –aye
Planning Commission Member Draper –aye

The vote was unanimous. Motion carries.

ITEM 4

PLANNED DEVELOPMENT AMENDMENT Rusty Cliffs South – PUBLIC HEARING

Consider a request to amend the approved zone plan for the Rusty Cliff South development. The change would reduce the number of homes from 380 to 294, along with a few other minor updates. The overall layout stays mostly the same, with a focus on single-family homes and affects the entire 49-acres. The property is located on the east side of Highway 18, between 4100 North and 4400 North. The applicant is DSG Engineering, and the representatives are Logan Blake and Stacy Young.

Case No. 2026-PDA-020 (Staff – Dan Boles)

[Agenda Packet \[Page 97\]](#)

Link to Presentation by Dan Boles [01:30:00](#)

Link to public hearing [01:37:00](#)

Link to comment by Gai Bowler Cannon [01:37:16](#)

Public Hearing Closed

Link to comment by applicant Stacy Young [01:39:22](#)

Link to discussion by Commission Members [01:42:24](#)

Link to motion [01:43:00](#)

MOTION:

A motion was made by Planning Commission Member Fisher to recommend approval to City Council, this Planned Development Amendment for Rusty Cliffs, adopting the findings and recommendations and conditions in staff report.

SECOND:

The motion was seconded by Planning Commission Member Casey.

VOTE:

Commission Chair Rogers called for a vote, as follows:

Planning Commission Chair Rogers – aye
Planning Commission Member Anderson –absent
Planning Commission Member Fisher – aye
Planning Commission Member Casey – aye
Planning Commission Member Chapman – aye
Planning Commission Member Taysom –aye
Planning Commission Member Draper –absent

The vote was unanimous. Motion carries.

ITEM 5

PRELIMINARY PLAT Desert Sky Phase 1

Consider a request for a 70-lot preliminary plat for a residential subdivision in the Desert Canyons development area. The applicant is DSG Engineering, and the representative is Ken Miller.
Case No. 2026-PP-019(Staff – Brian Dean)

[Agenda Packet \[Page 148\]](#)

Link to Presentation by Brian Dean [01:43:38](#)

Link to question by Commission Member Fisher for Mr. Dean [01:46:03](#)

Link to comment by applicant Curt Gordon [01:46:55](#)

Link to motion [01:47:42](#)

MOTION:

A motion was made by Planning Commission Member Chapman to approve the Desert Sky Phase 1-3 Preliminary Plat request, based on the findings and on the conditions noted in the staff report.

SECOND:

The motion was seconded by Planning Commission Member Taysom.

VOTE:

Commission Chair Rogers called for a vote, as follows:

Planning Commission Chair Rogers – aye
Planning Commission Member Anderson –absent
Planning Commission Member Fisher – aye
Planning Commission Member Casey – aye
Planning Commission Member Chapman – aye
Planning Commission Member Taysom –aye
Planning Commission Member Draper –absent

The vote was unanimous. Motion carries.

APPROVAL OF MINUTES:

Consider a request to approve the meeting minutes from the September 8, 2026, meeting.

[Agenda Packet \[Page 162\]](#)

Link to motion [01:48:20](#)

MOTION:

A motion was made by Planning Commission Member Fisher to approve minutes of September 8, 2026, meeting.

SECOND:

The motion was seconded by Planning Commission Member Taysom.

VOTE:

Commission Chair Rogers called for a vote, as follows:

Planning Commission Chair Rogers – aye
Planning Commission Member Anderson -absent
Planning Commission Member Fisher – aye
Planning Commission Member Casey – aye
Planning Commission Vice Chair Chapman –aye
Planning Commission Member Taysom – aye
Planning Commission Member Draper- absent

The vote was unanimous and the motion carried.

CITY COUNCIL ITEMS:

There has not been a City Council Meeting held since last Planning Commission meeting.

ADJOURN:

Link to motion: [01:48:47](#)

MOTION:

A motion was made by Planning Commission Member Fisher to adjourn.

SECOND:

The motion was seconded by Planning Commission Member Taysom.

VOTE:

Commission Chair Rogers called for a vote, as follows:

Planning Commission Chair Rogers – aye
Planning Commission Member Anderson –absent
Planning Commission Member Fisher – aye
Planning Commission Member Casey –aye
Planning Commission Member Chapman –aye
Planning Commission Member Taysom –aye
Planning Commission Member Draper – absent

The vote was unanimous, and the motion carries.

/s/
Angie Jessop, Development Services

1 **Exhibit A**



2
3

DRAFT

1
2
3
4

Exhibit B



EXTERIOR PERSPECTIVE - MASONRY - B

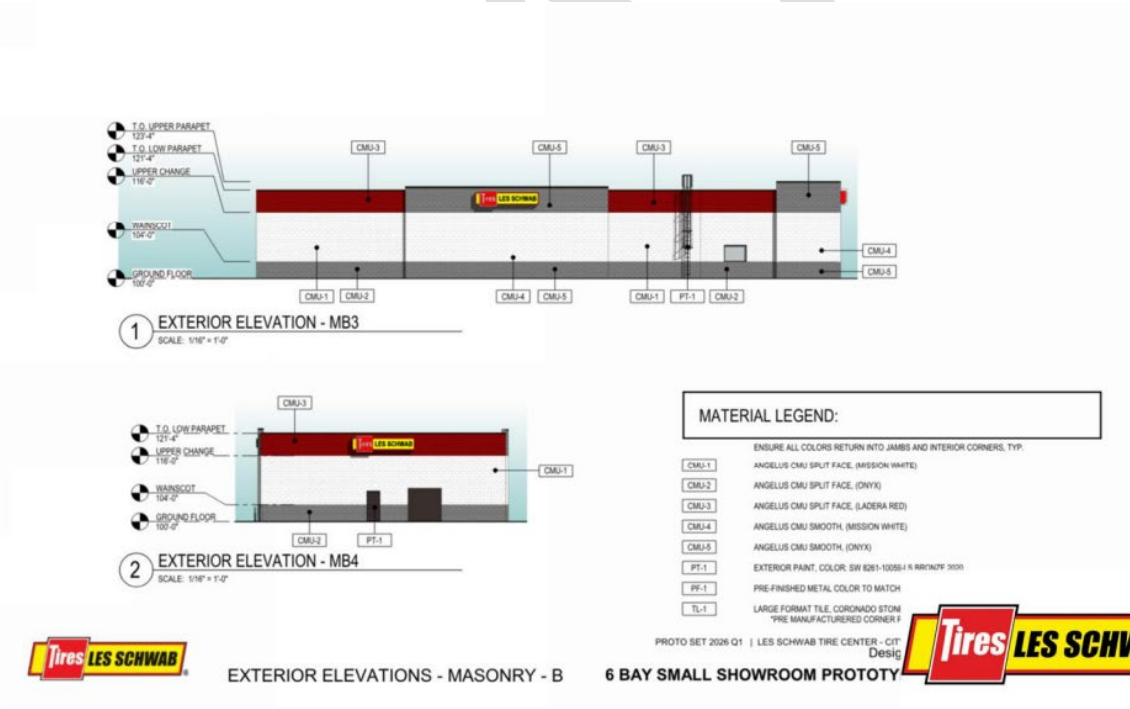
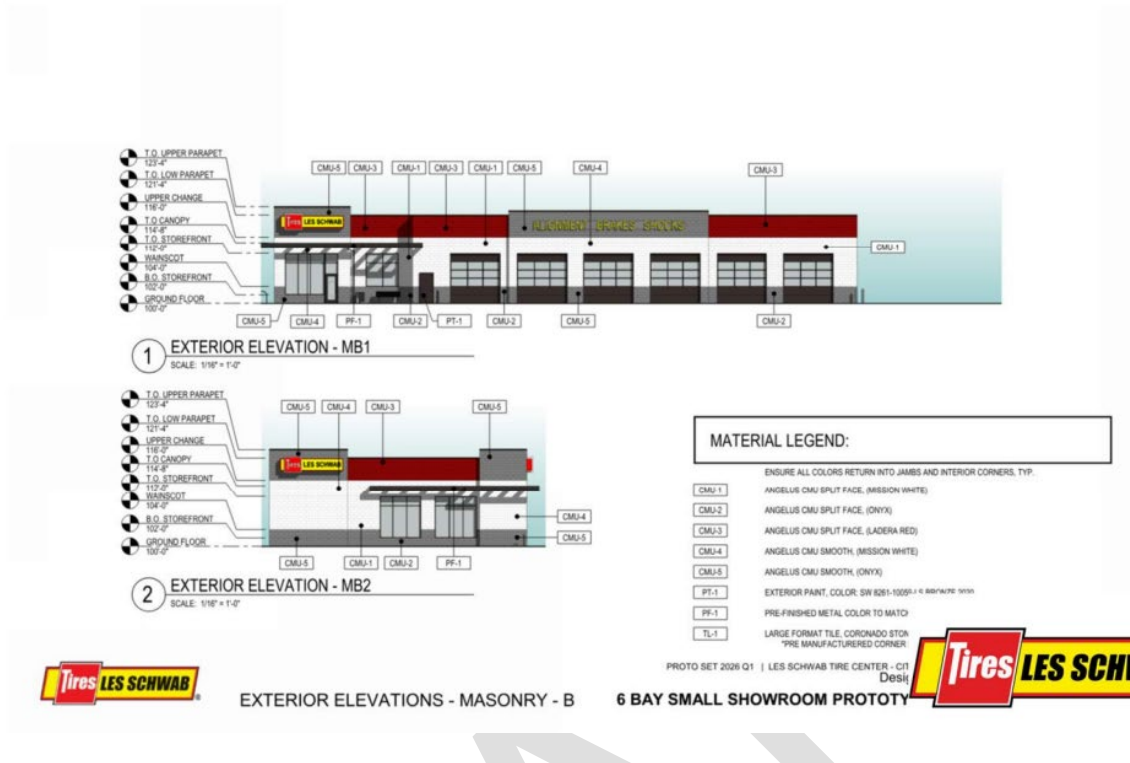
PROTO SET 2026 Q1 | LES SCHWAB TIRE CENTER - CIT
Desig

6 BAY SMALL SHOWROOM PROTOTY



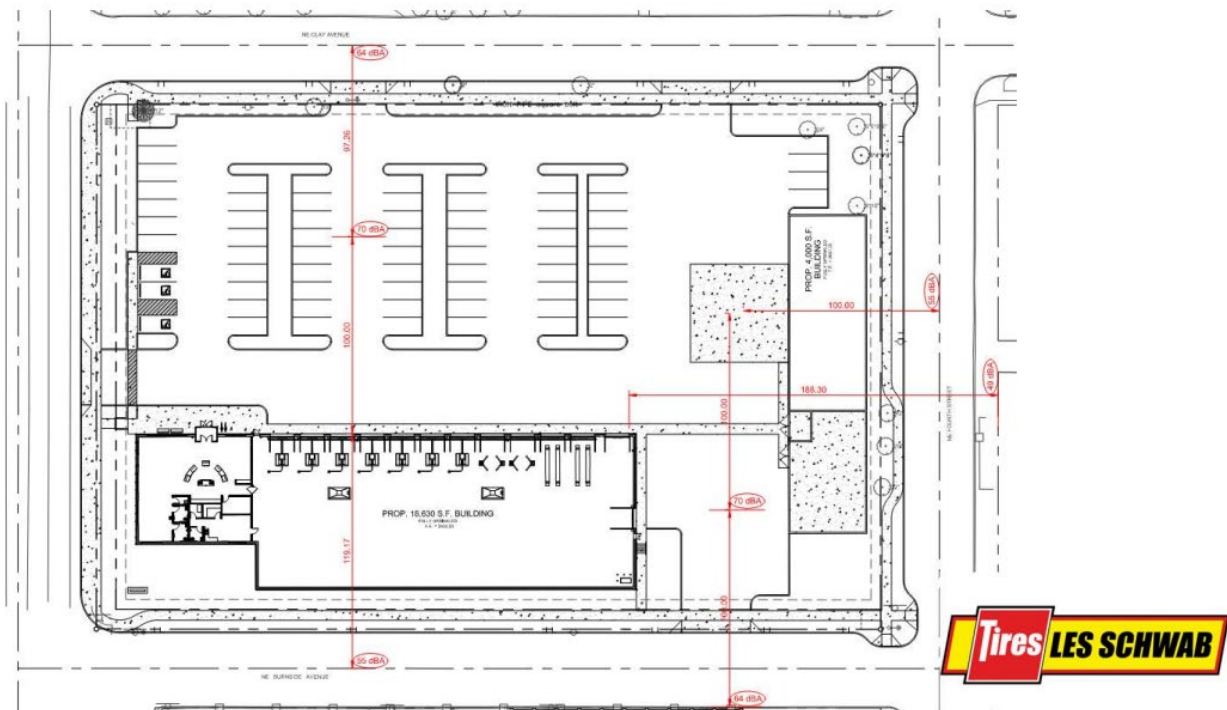
5

OK

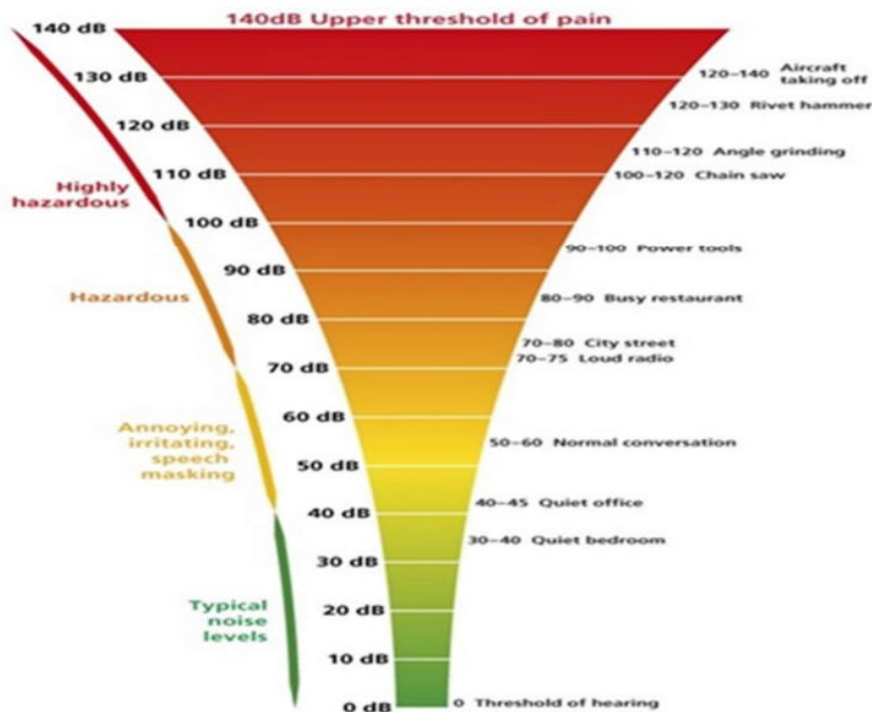


1
2

3



1



2



1



2
3

