TRAFFIC IMPACT STATEMENT

Rolling Plains Construction Inc.
5136 South Desert View Drive
Apache Junction, Arizona

PREPARED FOR
Vista Design Group
2715 East Hermosa Vista Drive
Mesa, Arizona 85213

PREPARED BY

APPROVED BY:

_____ _____
PINAL COUNTY ENGINEER DATE
PINAL COUNTY DEPARTMENT OF PUBLIC WORKS

APPROVAL EXPIRES: DATE

County Case Number: IUP-004-22

TRAFFIC IMPACT STATEMENT

Rolling Plains Construction Inc.
5136 South Desert View Drive
Apache Junction, Arizona

August 15, 2023
Revision #1: December 21, 2023

UCG Project Number: TR23106

PREPARED FOR
Vista Design Group
2715 East Hermosa Vista Drive
Mesa, Arizona 85213

PREPARED BY
United Civil Group
2803 N. 7th Avenue
Phoenix, Arizona 85007
602-265-6155

CONDUCTED BY

Sarah Simpson, PhD, PE
President

TABLE OF CONTENTS

1.0 INTRODUCTION

Vista Design Group retained United Civil Group to perform this Traffic Impact Statement (TS) for Rolling Plains Construction Inc. located at 5136 South Desert View Drive, Apache Junction in Pinal County, Arizona. Rolling Plains Construction Inc. is planning to expand their existing business located at 5136 South Desert View Drive. The expansion is planned to include one new parcel. The new parcel consists of a 5.1-acre laydown yard located north of Guadalupe Road between Pinal Drive and Warner Drive near Apache Junction in Pinal County, Arizona. Figures 1 and 2 present the location of the site in general context with the surrounding area. All figures are attached.

This TS has been performed per the requirements as specified in the Pinal County *Traffic Impact Assessment Guidelines & Procedures* dated January 2007, locally accepted standards, and industry practice. Based on the forecasted traffic generation of the site, fewer than 100 peak hour trips are forecasted for the development; therefore, this Traffic Impact Statement has been conducted instead of a full Traffic Impact Analysis. The purpose of this TS is to forecast the trip generation of the proposed development, evaluate potential impacts the proposed development has on the surrounding roadway network, and evaluate the proposed site access driveways of the development.

2.0 SITE DESCRIPTION

Rolling Plains Construction Inc. is currently located on an approximate 17-acre site located at 5136 South Desert View Drive. The owners of Rolling Plains Construction Inc. purchased one new parcel of land adjacent to their existing site, which is 5.1 acres. Figure 3 illustrates the proposed new site.

As depicted in the site plan, access to the new site will remain as existing. The laydown yard will have two accesses on Warner Drive and one access on Pinal Drive. All accesses are gated. The driveway space between the accesses is approximately 280 feet on Warner Drive.

Figure 3 presents the site driveways in relationship to the existing surrounding driveways near the site.

3.0 EXISTING ROADWAY CONDITIONS

Pinal Drive has a north/south alignment and is a local roadway on the western border of the site. Pinal Drive is a private paved road from Guadalupe Drive to Houston Avenue. The posted speed limit on Pinal Drive is 25 miles per hour.

Warner Drive has a north/south alignment and is a local road on the western border of the site. Adjacent to the site Warner Drive is a private dirt road with no posted speed limit and is assumed to be 25 miles per hour.

4.0 SITE GENERATED TRAFFIC

Estimates of the traffic volumes that will be generated by the Rolling Plains Construction Inc. addition were determined from transportation planning data taken from the Institute of Transportation Engineers (ITE) *Trip Generation Manual, 11th Edition, 2021*. The ITE rates are based on studies that measure trip generation characteristics for various types of land uses. The rates are expressed in terms of trips per unit of land use type.

ITE Land Use Code 140 – Manufacturing was used for the laydown yard.

Table 1 presents the trip generation for the Rolling Plains laydown yard expansion.

TABLE 1: TRIP GENERATION

Land Use	Units	Size	Daily	AM Peak			PM Peak		
				in	out	total	in	out	total
Manufacturing	acres	5.1	202	21	3	24	10	15	25

The proposed addition to Rolling Plains Constriction Inc. is forecasted to generate 202 daily trips with 24 trips occurring in the morning peak hour and 25 trips occurring in the evening peak hour, per the ITE *Trip Generation Manual*.

5.0 SIGHT DISTANCE

Sight triangles shall be provided and maintained at site access points to give drivers exiting the site a clear view of oncoming traffic. The landscape and hardscape within the sight triangles must not obstruct the driver's view of the adjacent travel lanes. After a vehicle has stopped at an intersection, the driver must have sufficient sight distance to make a safe departure through the intersection area.

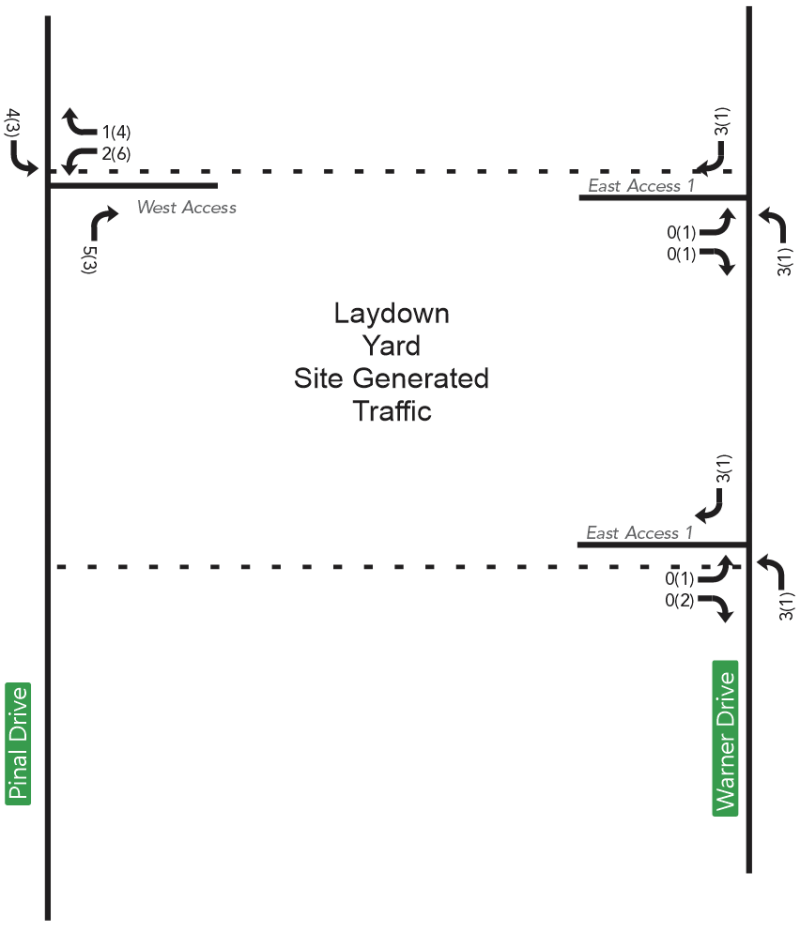
To ensure adequate sight distances and sight distance triangles, AASHTO's *A Policy on Geometric Design of Highways and Streets* manual, 2011, should be followed when designing the accesses and landscaping. Because Pinal Drive and Warner Drive are private roads, eight feet was used as the viewpoint of a driver from the edge of travel way. Based on the speed of 25 mph, the sight distance is 240 feet. A time gap value (t_g) of 6.5 seconds for all maneuvers was used. In addition, the private roadway surface is gravel; to be conservative, 25 mph was assumed for the design speed of the major road (V_{major}).

Figure 4 presents the sight distance triangles for the three site accesses.

6.0 AUXILIARY LANES

Due to the low volume of vehicles expected to turn into the driveways, right or left turn deceleration lanes are not considered at the site accesses. If more intense land use is planned, right and left turn deceleration lanes may be required at that time.

The estimated driveway volumes are shown below:



7.0 TRAFFIC ANALYSIS

The intersection of Houston Avenue/Warner Avenue was reviewed for traffic control needs. Because no traffic control exists currently, a stop sign will be installed on the northbound approach to assign the right of way at the intersection with this project.

Per the Pinal County Access Management Manual dated February 2017, Table 1 shows that driveway spacing should be 75 feet or greater. The proposed driveway locations meet the 75-foot spacing for the Rolling Plains Development. Two existing driveways are 40 feet apart on Warner Drive, which does not meet the driveway criteria. However, these driveways are gated and will only be used for millings. Therefore, it is assumed that this driveway be used, minimally. The driveway spacing is shown on Figure 4.

8.0 CONCLUSIONS

The proposed addition to the existing Rolling Plains Construction Inc. site is forecasted to generate an additional 202 daily trips with 24 trips occurring in the morning peak hour and 25 trips occurring in the evening peak hour.

The site accesses are existing and predominately gated. The access spacing for the laydown yard is 265 feet on Warner Drive. The accesses meet the driveway spacing except for one location which is 40 feet. Because the access is used for millings, the driveway will be used minimally, and because Warner Drive is constructed as one lane in each direction, the spacing will not negatively impact the roadway network in the area.

Due to the low forecasted site generated traffic by the proposed addition to Rolling Plains Construction Inc. and sufficient driveway spacing, the proposed development is not anticipated to cause detrimental impacts to the surrounding roadway network.

Proper intersection sight distance and sight triangles shall be provided and maintained at the site accesses of the proposed development. To ensure adequate sight distances and sight distance triangles, AASHTO's *A Policy on Geometric Design of Highways and Streets* should be followed when designing the accesses and landscaping.

The developer will install a stop sign (R1-1 36 inches) on the northbound approach at the intersection of Houston Avenue/Warner Drive. The developer will install a speed limit sign (R2-1 25 MPH 24 x 30 inches) on Warner Drive. The sheeting for the stop sign and speed limit sign shall comply with Pinal County signing standards.

This Traffic Statement is based on a variety of assumptions related to the site plan and land use of the proposed development. If a larger building or alternate land use is ultimately proposed, these trip generation calculations and criteria evaluation should be revised and resubmitted for approval by Pinal County Public Works Department.

9.0 LIMITATIONS

Our professional services have been performed using the degree of skill ordinarily exercised, under similar circumstances, by reputable transportation engineering firms practicing in this locality. No other warranty, expressed or implied, is made.

The contents of this report are intended for the sole use of the addressee and his/her designees. In completing this report, data was obtained from a variety of sources (i.e., City, County, State and Federal sources); United Civil Group has assumed these sources to be reliable and accurate. Should deviations from this report be noted, this firm shall be contacted for review of the area of concern.

A reasonable attempt was made to acquire recent traffic impact studies, traffic projections and/or data that may be helpful in more accurately projecting traffic volumes. United Civil Group is not responsible for incorporating data made available after this document has been finalized.

This report is issued with the understanding that it is the responsibility of the owner to see that its provisions are carried out or brought to the attention of those concerned. If any changes to the proposed project are planned, the conclusions and recommendations contained in this report shall be reviewed and the report shall be modified or supplemented as necessary.

10.0 SOURCES

A Policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials, 2018.

Highway Capacity Manual, HCM, Transportation Research Board, 2010.

Manual on Uniform Traffic Control Devices, Federal Highway Administration, MUTCD 2009.

Pinal County Access Management Manual, February 24, 2017.

Pinal County Regionally Significant Routes for Safety and Mobility Final Report. December 2008.

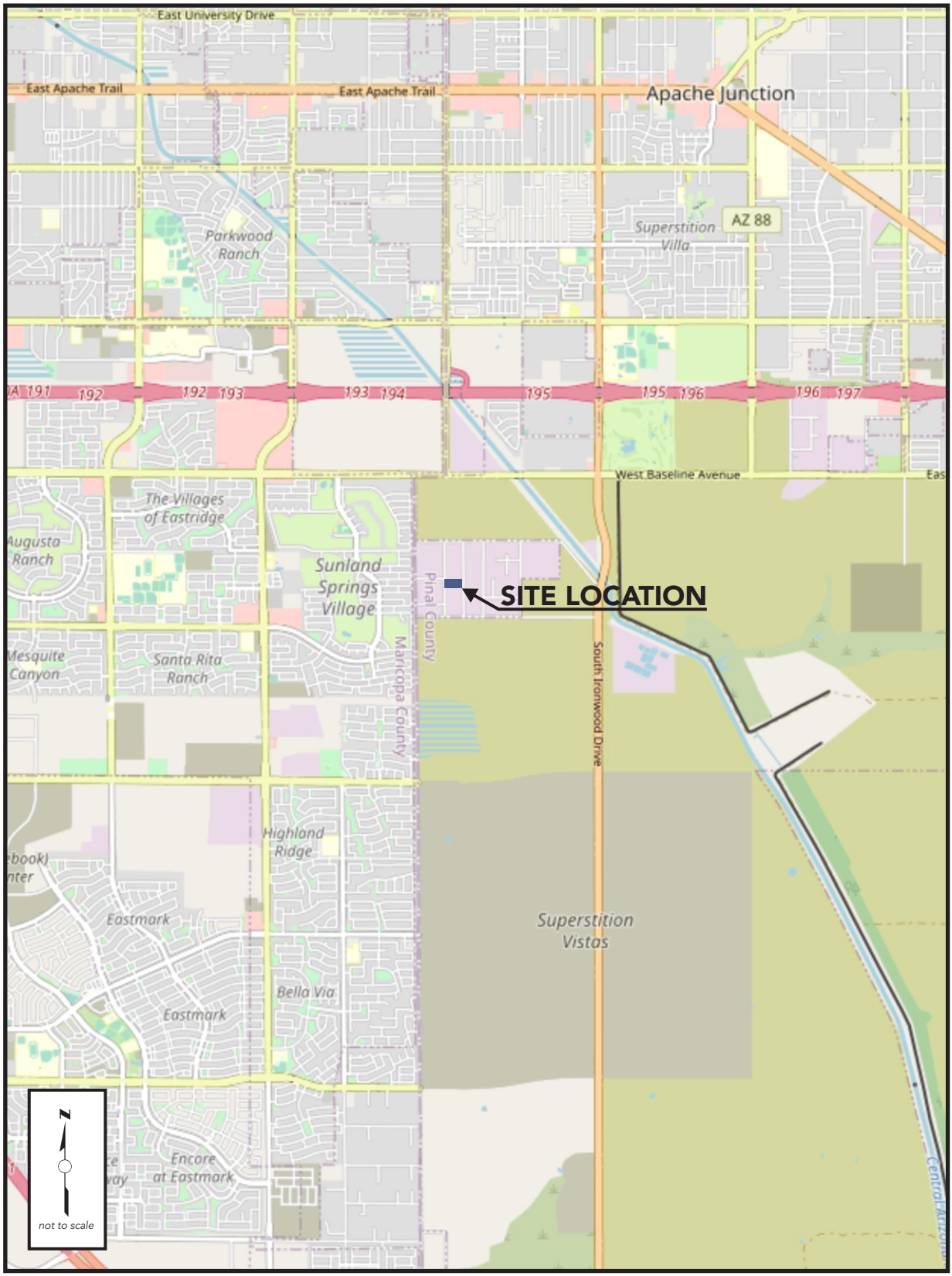
Pinal County Small Area Transportation Study Final Report, August 2006.

Pinal County Subdivision & Infrastructure Design Manual.

Pinal County Traffic Assessment Guidelines & Procedures, January 2007.

Trip Generation, 11th Edition, Institute of Transportation Engineers, 2021.

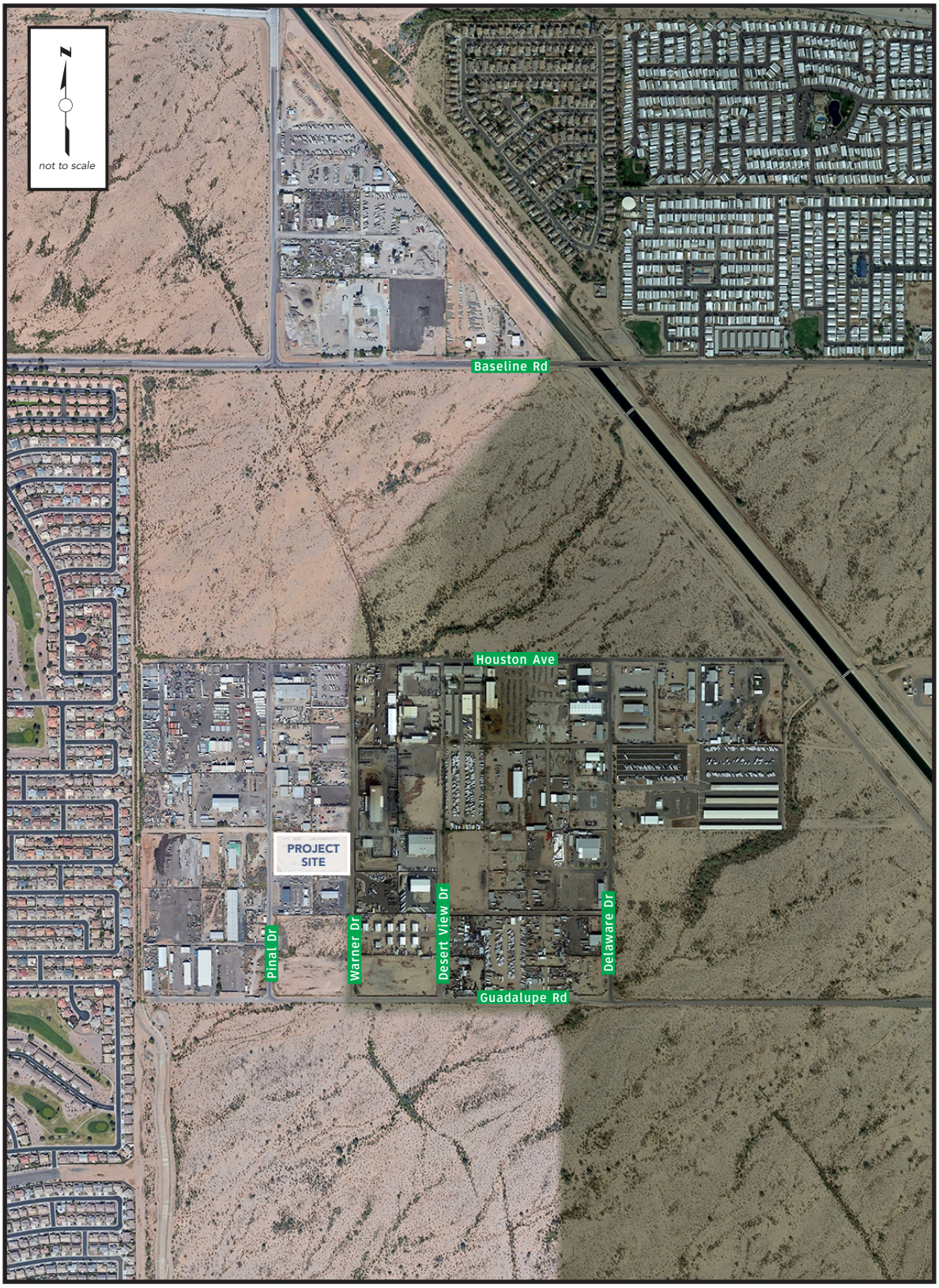
Appendix A



ArcGIS - 2023

Figure 1: Vicinity Map

United Civil Group



Permission for commercial use granted by Google Earth

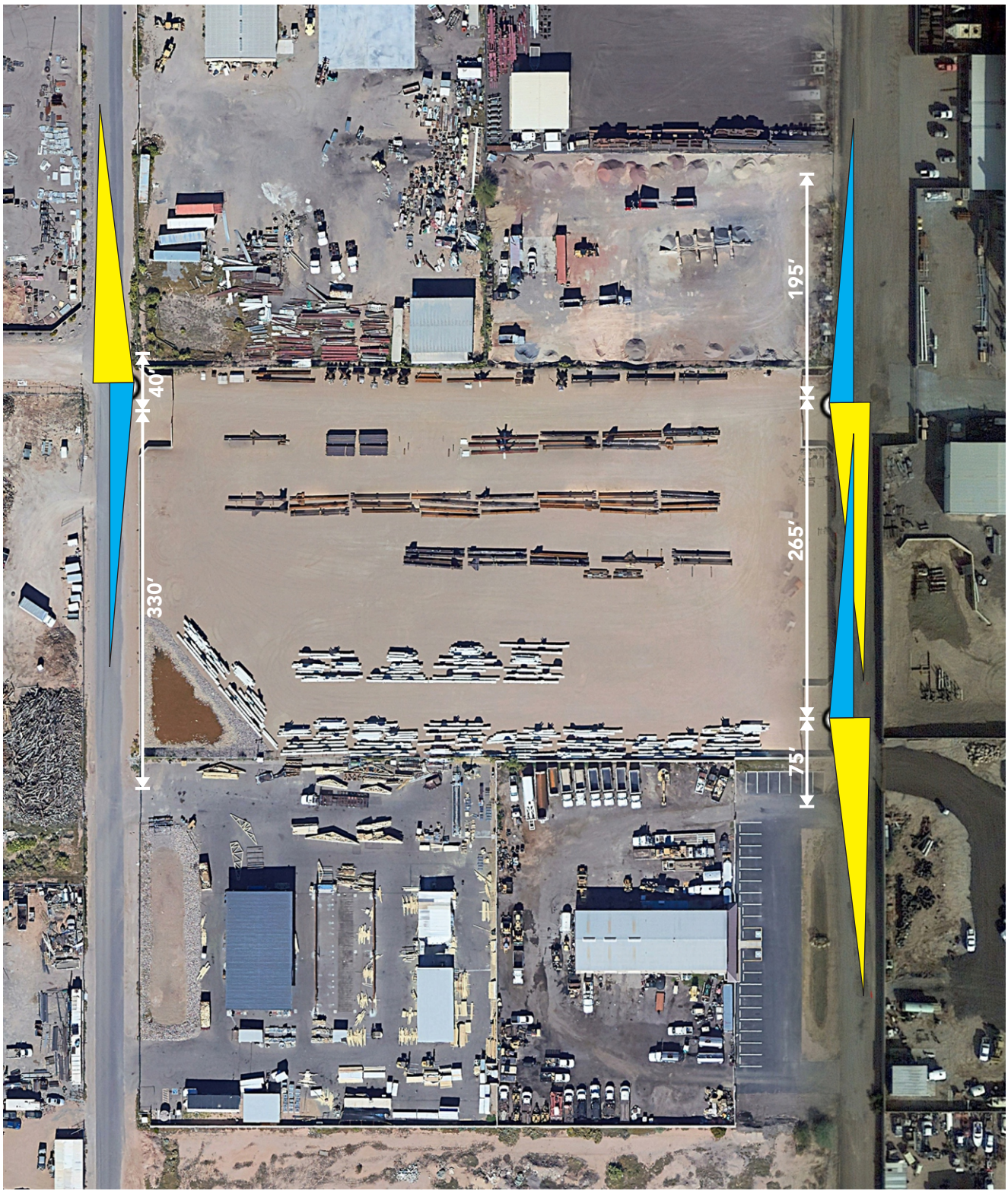
Figure 2: Aerial View

United Civil Group

not to scale

UCG
United Civil Group

Figure 3: Site Plan



not to scale

UCG
United Civil Group

Figure 4: Sight Distance and Driveway Spacing

Appendix B

Leo Lew
County Manager

Joe Ortiz
Public Works Director

Christopher Wanamaker
County Engineer

PINAL COUNTY
WIDE OPEN OPPORTUNITY

Public Works Traffic Engineering Review Comment Letter

Project Name:		Rolling Plains Const. 5136 S. Desert View Dr., Apache Junction, Az			
Engineering Firm:		UCG		Reviewed by:	John Kraft
Engineer:		Sarah Simpson, P.E. , sealed 8/16/23			
Case #:	IUP-004-22	Review Status:	1st Review	Date:	8/17/2023
		RESPOND TO ALL COMMENTS AND REDLINES:			
Sheet #	Comment #				
Cover Sheet	1	Please add IUP-004-22 as County Case Number.			
Page 3	2	Please clarify statement "The expansion is planned to include three new parcels." There are 4 parcels shown below this statement.			
Page 3	3	Referencing second paragraph, please note Peterson Dr. is shown on Site Plan.			
Page 3	4	Where is Laydown Yard? Please reference on Site Plan.			
Page 3	5	"The driveway space between the accesses is approximately 280 feet on Warner Drive." Please show the 280 ft on site plan with accesses shown.			
Page 4	6	Referencing 2nd Paragraph, Please plan to post 25 mph R2-1 on Warner Drive.			
Page 4	7	Referencing 3rd paragraph, Please plan to post 36in R1-1 with Diamond Grade Sheeting and 2 in Perforated Square Tube Post on Warner Drive.			
Page 4	8	Referencing 4th paragraph, Is pavement at each T intersection approach have appropriate pavement marking with arrows to show left-through-right lanes? Please reference photos of existing conditions.			
Page 4	9	Referencing Table 1, Please provide more information to show how the numbers in the Table were arrived at.			
Page 5	10	Referencing "clear view" IN 1ST paragraph, Please show sight lines for each access on Site Plan.			
Page 5	11	Referencing "low Volume of vehicles", Please provide diagram for each access showing volumes.			
Page 5	12	Referencing "should" in 2nd to last paragraph, Please commit to installing R1-1 by developer.			
Page 5	13	Referencing "40 feet apart" in last paragraph, Please show dimensions on Site Plan.			
Page 5	14	Referencing 4th paragraph, "shall be provided" Please show sight lines or triangles on Site Plan or other diagrams in this report.			
Page 5	15	Referencing 5th paragraph, "A Stop sign should be" change to "Will be installed with this project".			
Page 5	16	Referencing 6th paragraph, "evaluation may not remain valid" change to read "evaluation should be revised and resubmitted for approval by Pinal Public Works Department."			
General	17	This TIS report is not approved and the comments above should be addressed by the Engineer and report to be resubmitted for a 2nd Review. Pinal Public Works Dept. reserves the right to make new comments on the 2nd submittal if necessary.			

December 21, 2023

Project:	**TS for Rolling Plains Construction Inc**
UCG Project Number:	TR23106 – August 15, 2023
Reviewing Agency:	Pinal County
Revision:	1st Review Comments
Date Reviewed:	August 17, 2023
Case #	IUP-004-22

Sheet No	Comment	Response
Cover Sheet	1	Added IUP-004-22 to cover
3	2	The expansion solely includes one parcel as shown on the site plan.
3	3	Removed from description because the parcel is between Warner Drive and Pinal Drive.
3	4	**Laydown yard is now shown as the only parcel for the development in Figure 2 and within this report.**
3	5	Driveway spacing is shown on Figure 4.
4	6	Recommended adding speed limit sign R2-1 on Warner Drive
4	7	Recommended adding R1-1 for the northbound approach on Warner Drive at Houston Avenue
4	8	Arrows are not required for local streets
4	9	The Trip Generation Manual was used for Manufacturing (140) for the laydown yard.
5	10	Sight lines shown on Figure 4.
5	11	Diagram provided showing trips into and out of laydown yard
5	12	Agree. Developer to install R1-1
5	13	Driveway dimensions shown on aerial view, Figure 4
5	14	Sight triangles shown on Figure 4.
5	15	Changed to will be installed for this project
5	16	Revised to read "**… criteria evaluation should be revised and resubmitted for approval by Pinal County Public Works Department.**"
General	17	Agree.

Rolling Plains Construction Site Plan

Drainage Memo

June 20, 2023

5136 S. Desert View Drive
Apache Junction, Arizona 85120
Township 1 South, Range 8 East
Pinal County Assessor's Parcel Numbers: 10463009M, 10463009N, 10463009NP, 10463009Q, 10463012W, 10463012S, 10463005J

Exp. 9/30/2023

Prepared for:

Rolling Plains Construction, Inc.
5136 S. Desert View Drive
Apache Junction, Arizona 85120
Contact: Chris Henderson, PH 480-895-8813

Prepared by:

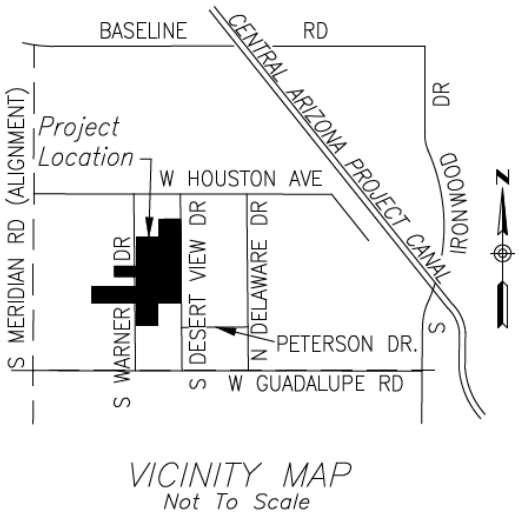
VISTA DESIGN GROUP

2715 E. Hermosa Vista Drive
Mesa, AZ 85213
Jared Cox, P.E.

VDG Project No. 19010

Table of Contents

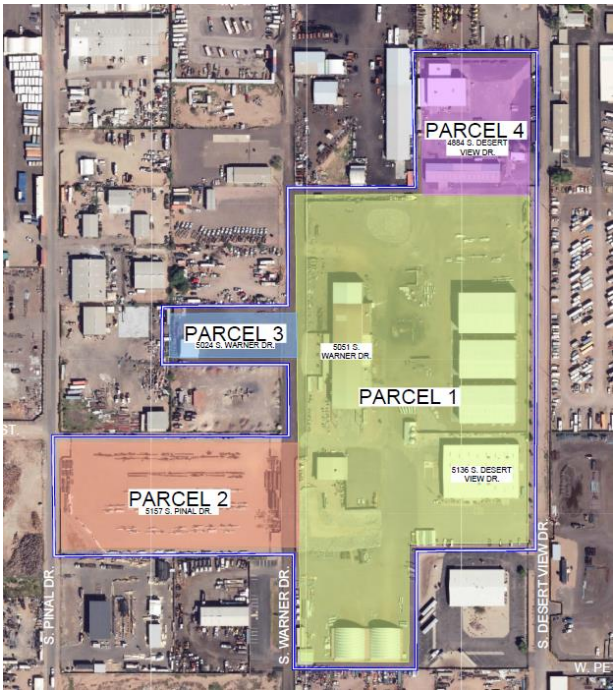
1.0 INTRODUCTION



VICINITY MAP
Not To Scale

The subject property is located in unincorporated Pinal County, in Apache Junction, Arizona. The site is located in Section 6, Township 1 South, Range 8 East, northwest of Guadalupe Drive and Ironwood Dr. The existing property has an address of 5136 S. Desert View Drive, Apache Junction, AZ 85120. The owner is Rolling Plains Construction that owns over 26.1 contiguous acres (made up of 4 parcels) between Pinal Drive on the west and Desert View Drive on the east. The vicinity map to the right shows the location of the 26.1 acres that will now all be part of the Rolling Plains Industrial Use Permit. As part of this development, approximately 5 acres is being used as a laydown yard for the growing needs of the Rolling Plains business. These 5 acres are identified as "Parcel 2" (see Appendix A). The remainder of the properties are not being redeveloped or changed in use. Appendix A shows an overall boundary of the land and parcels being incorporated into Industrial Use Permit. Throughout this report, the four areas will be referred to as Parcel 1, Parcel 2, Parcel 3 and Parcel 4 as identified in Appendix A.

Parcel 1: 17.0 acres, apn: 10463009N, 10463009M, 10463009P, 10463009Q
Parcel 2: 5.1 acres, apn: 10463012W
Parcel 3: 1.2 acres, apn: 10463012S
Parcel 4: 2.8 acres, apn: 10463005J



1.1 Project Description

The project includes a change of use of Parcel 2 to be used as a Laydown yard in support of the Rolling Plains fire proofing work that is performed on Parcel 1. The County requested that an Industrial Use Permit be processed across all of the contiguous properties owned and operated by Rolling Plains Construction. The project does not include any changes to the existing grading or drainage of the 26.1 acres. Parcel 1 has an approved drainage report dated 5/5/2021 that was part of a separate Site Plan Approval (SPR-032-20 approved 5/12/2023). A copy of the approved drainage report is included in the Appendix.

1.2 Project Location

The subject property is approximately 1 mile south of US-60 Freeway, ¾ mile south of Baseline Road, and ¼ mile north of Guadalupe Road, approximately ½ mile east of the Meridian Road alignment, and ½ mile west of Ironwood Drive. (see Vicinity Map Page 3)

1.3 Existing On-Site Conditions

The overall property slopes moderately in a general direction from northeast to southwest (less than 1% in most areas).

Parcel 1: The parcel has been covered with ground asphalt millings for dust control measures along with an asphalt parking lot for the office buildings. This parcel has a large existing retention basin on-site that has a depth of 6.5 feet. Parcel 1 drains to the existing retention basin. This parcel has multiple buildings as approved on the site plan SPR 032-20.

Parcel 2: This parcel does not have any structures on it. The ground is covered with ground asphalt millings. The parcel has a 2' deep retention basin located in the southwest corner of the property.

Parcel 3: drains slightly to the west, southwest. The site is surrounded by a chainlink fence that does not impede offsite drainage flows. The parcel has an existing 50'x50' metal canopy in the southwest corner. The property is covered by ground asphalt millings for dust control.

Parcel 4: is an existing site with 4 separate buildings, pavement and a small retention basin near the southwest corner. The parcel drains to the west through a chainlink fence

1.4 Purpose

This drainage report is to report on the existing drainage condition of the 4 subject parcels that make up the Industrial Use Permit. As mentioned, no new structures are proposed and no grading is proposed. The only proposed improvement is on Parcel 2 which was cleared of all junk and is being used as an open laydown yard to support the work of Rolling Plains Construction. .

1.5 Existing Drainage Studies

A number of previous drainage studies have been prepared in this Industrial area. See Appendix C for a copy of the recently approved drainage study for Parcel 1.

1.6 Site Location Relative to Known FEMA Flood Hazard Zones

This site is not located in a known FEMA Flood Hazard Zone. The floodplain designation for the project is Zone X as found on Panel 0200 of 2575, Community – Panel Number 04021C0200E, dated December 4, 2007.

Zone X is defined by the Federal Emergency Management Agency as: "Areas determined to be outside the 0.2% annual chance floodplain."

See Appendix B for the Firmette copy of the above referenced FEMA Flood Insurance Rate Map.

1.7 Geotechnical Investigation

A Geotechnical Investigation was performed by ATEK ENGINEERING CONSULTANTS on 9/13/2019 as ATEK Project # 190070. The report in it's entirety is included in the approved drainage report for Parcel 1. The study included a percolation test in the existing retention basin area for Parcel 1 as well as multiple soil borings on Parcel 1. The resulting data is referenced in the respective locations of the approved drainage report for Parcel 1.

1.8 Fissure Investigation and Report

A land subsidence and earth fissure evaluation of the property was performed by Kenneth Euge of Geological Consultants, Inc. The final reports were completed 11/27/2019 and copies of these reports are included with as Appendix C. The study identified potential fissure locations in Task 1 and then in Task 2 the fissure locations were further verified on Parcel 1. It is important to note that after extensive field investigations, no fissures were identified on Parcel 1.

2.0 DRAINAGE ANALYSIS / NARRATIVE

The following section outlines the existing hydrologic conditions affecting the site as well as the hydrology for the project.

Parcel 1 drainage has been approved and is reported in the Appendix. Please see the detailed drainage report for information regarding the onsite and offsite drainage affecting Parcel 1.

Parcel 2 is a vacant property that has a gradual grade to the southwest corner of the site. Although the site is being used as a Laydown yard for large structural steel members, the drainage runoff coefficient will not be changed or impacted. There is an existing retention basin in the southwest corner within the walls of the property. There are drainage blocks located in the existing wall at the outfall of the property in the southwest corner and a chainlink fence along the low portion of the south property wall. Storm water surface drains across the dirt lot and is retained within the small detention basin. The detention basin is dewatered via natural percolation and evaporation. The property owner reports that the water drains within 24 hours of any storm event.

Parcel 3 is a vacant property with a 50'x50' open metal canopy located in the southwest corner. The property is relatively flat and drains to the west/southwest. The property is surrounded by chain link fences on all sides and allows for drainage to flow in its historic pattern. There are no drainage channels, drainage basins, or any drainage structures on the parcel.

Parcel 4 is an existing site that has 4 buildings. The site has an asphalt drive and working area, a paved parking lot, and ground asphalt millings for dust control in other areas. The site also has a small detention basin located in the southwest corner of the property.

3.0 DRAINAGE INFRASTRUCTURE

The following section provides an overview of the storm water drainage system that will be on the lot to convey runoff generated during the 100-yr peak storm event.

3.1 Proposed Drainage Plan

There are no proposed drainage improvements for the existing parcels. The existing drainage condition is not being impacted by the implementation of the Industrial Use Permit. The existing drainage will remain untouched. The Runoff Coefficient will remain the same.

3.2 Onsite Basin Dewatering Requirements

Parcel 1 retention basins drain via percolation and two drywells (see approved drainage report)

Parcel 2 drains via natural percolation.

Parcel 3 does not have any retention basins.

Parcel 4 retention basin drains via percolation.

4.0 SPECIAL ISSUES OR CONSIDERATIONS

The following section outlines any issues of significance that may govern the site.

4.1 401/404 Permit

No 401/404 Permits through the United States Army Corp of Engineers will be required for this project.

4.2 Floodplain Use Permit through FCDPC

No Floodplain use permits through the Flood Control District of Pinal County will be required for this project.

4.3 NPDES Permit

No area is being disturbed on any parcel and there is no need for a NPDES permit. There are no distressed bodies of water within the vicinity of the project.

4.4 Phasing

There is no construction activity and therefore no phasing.

5.0 SUMMARY AND CONCLUSIONS

The existing parcels that are made up of the Industrial Use Permit are all existing and will not be changed. As such, the existing drainage will remain the same. Drainage on each parcel will not be changed. There are no adverse drainage effects of the proposed Industrial Use Permit.

Appendix A : SITE PARCEL MAP EXHIBIT

INDUSTRIAL USE PERMIT
SITE PLAN EXHIBIT
ROLLING PLAINS CONSTRUCTION
5136 S. DESERT VIEW DR.

PARCEL 1
AREA: 17.0 AC
USE: CORPORATE OFFICES
STEEL SURFACE PREP
STEEL FIRE PROOF COATING

PARCEL 2
AREA: 5.1 AC
USE: LAYDOWN YARD
STORAGE
MATERIAL DROP-OFF / STAGING

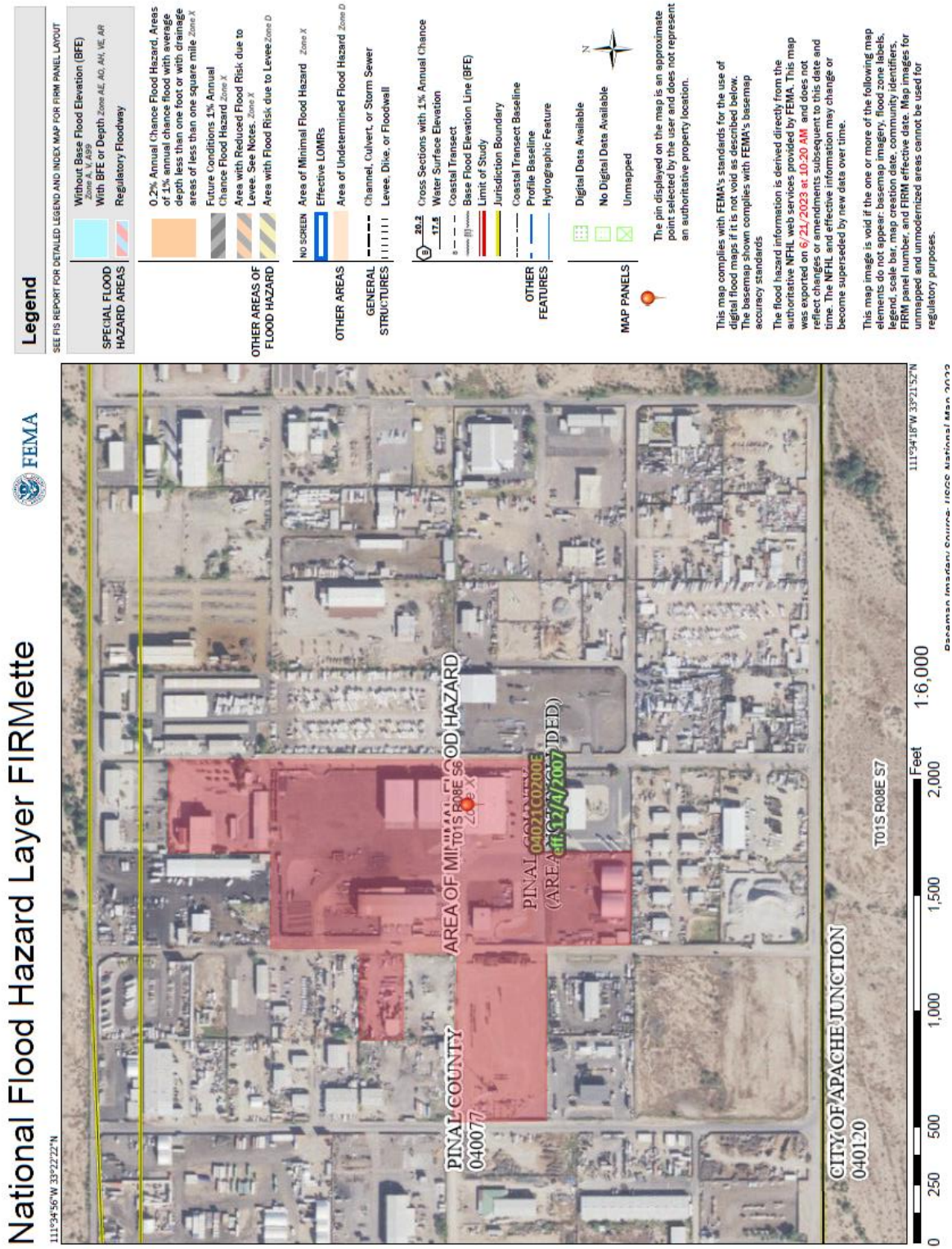
PARCEL 3
AREA: 1.2 AC
USE: STORAGE

PARCEL 4
AREA: 2.8 AC
USE: OFFICES
STORAGE
WAREHOUSING

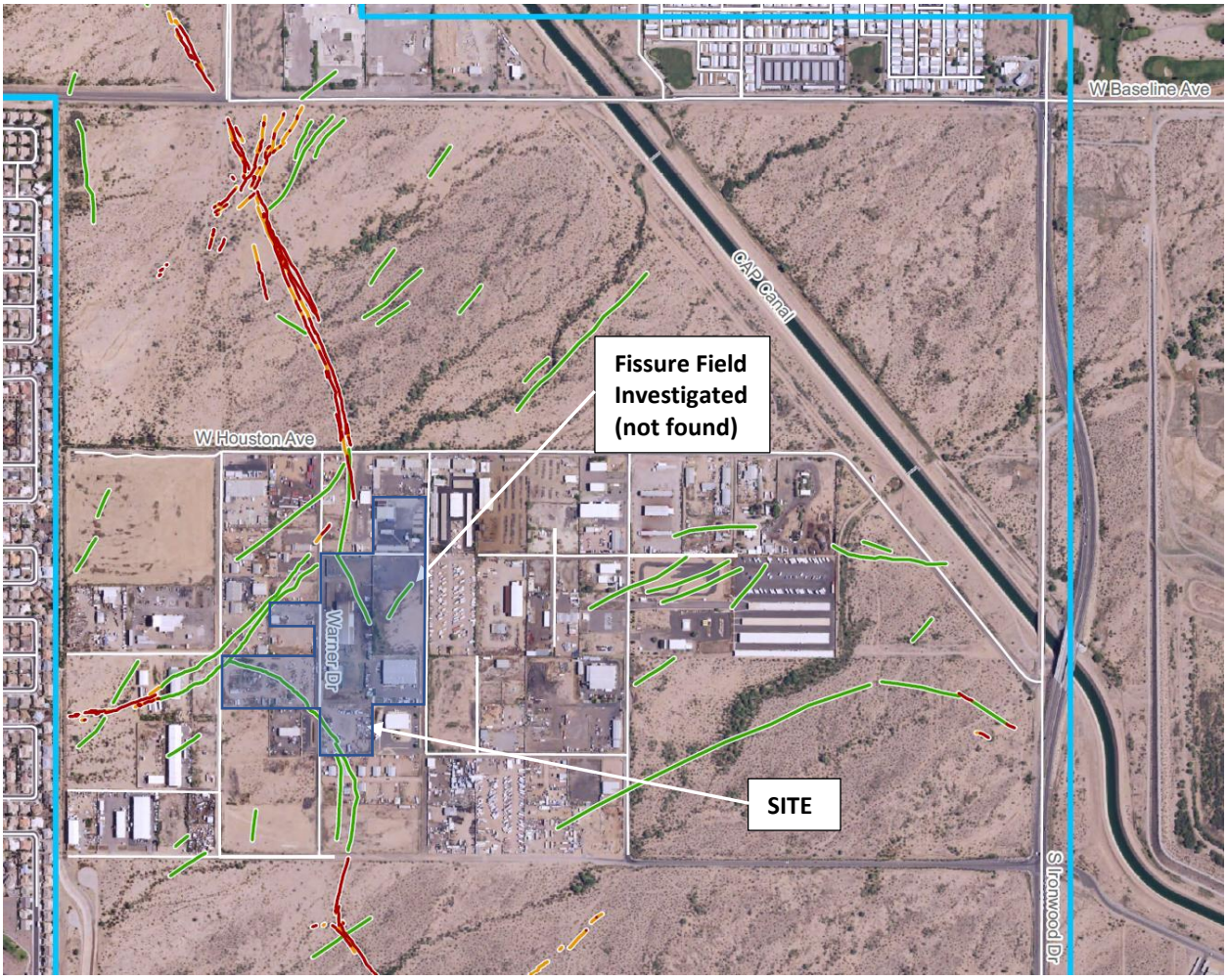
N

0 100 200
50
SCALE:
Horz.: 1" = 100'

Appendix B – – FLOOD INSURANCE RATE MAP (FIRM)



Appendix C – FISSURE MAP



MAP EXPLANATION

Red lines represent the location of continuous earth fissures manifested as open cracks or gullies.

Orange lines represent the location of discontinuous earth fissures manifested as elongated to circular depressions or as abbreviated or irregular linear depressions. These discontinuous surface features frequently represent an incipient surface expression of an earth fissure.

Yellow lines represent the location of fissures confirmed by non-AZGS personnel or clear evidence of earth fissures on aerial imagery. Traditional field investigation of these features by AZGS was hindered by agricultural or urban modification of the land surface.

Green lines represent the approximate locations of unconfirmed earth fissures, defined as fissures which could not be confirmed by surface investigations by AZGS geologists, but which have been previously reported by Professional Geologists in published documents or maps.

The outline of the Study Area is shown in blue. The limits of the study area are based on interpretation of modern and recent ground subsidence data provided by the Arizona Department of Water Resources. Historical and modern aerial photos taken within this area were searched for anomalous lineaments. These lineaments were then investigated in the field to determine if there was any evidence of earth fissures.

Appendix D – EXISTING DRAINAGE REPORT FOR PARCEL 1

APROVED 5/5/2021

Rolling Plains Construction Site Plan

Drainage Report

July 2020

March 2021 Revised

5050 S. Desert View Drive
Apache Junction, Arizona 85120
Township 1 South, Range 8 East
Pinal County Assessor's Parcel Numbers: 104-63-0100, 009H, 009J (to be combined)

Exp. 9/30/2023

Prepared for:

Rolling Plains Construction, Inc.
5136 S. Desert View Drive
Apache Junction, Arizona 85120
Contact: Chris Henderson, PH 480-895-8813

Prepared by:

VISTA DESIGN GROUP

2715 E. Hermosa Vista Drive
Mesa, AZ 85213
Jared Cox, P.E.

VDG Project No. 19010

DRAINAGE
CLEARANCE
1998 DRAINAGE ORDINANCE

COUNTY ENGINEER

05/05/2021
DATE

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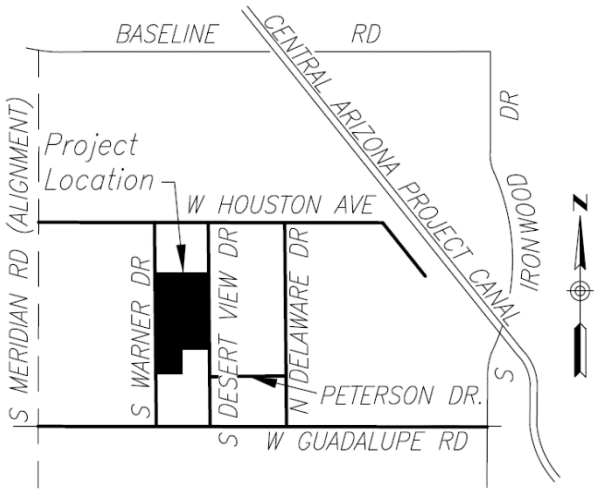
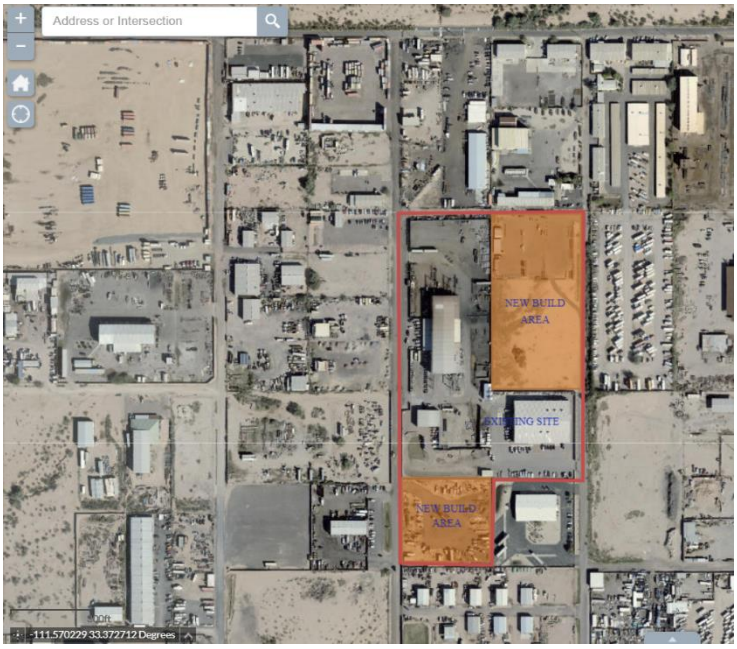
1.0 INTRODUCTION



The subject property is located in unincorporated Pinal County, in Apache Junction, Arizona. The site is located in Section 6, Township 1 South, Range 8 East, northwest of Guadalupe Drive and Ironwood Dr. The existing property has an address of 5050 S. Desert View Drive, Apache Junction, AZ 85120. The owner is Rolling Plains Construction that owns over 17 contiguous acres between Warner Drive on the west and Desert View Drive on the east. The vicinity map to the right shows the location of the 17 acres that will now all be part of the Rolling Plains Site plan. As part of this development, approximately 7 acres is being re-developed for the growing needs of the Rolling Plains business. These 7 acres is being incorporated into the existing 10 acre site plan which is remaining in place. Throughout this report, the three areas will be referred to as the 5-acre redevelopment area to the northeast, the 2-acre redevelopment area to the southwest, and the 10-acre existing site. The APNs are 104630100, 10463009H, and 10463009J. These parcels are in the process of being combined.

1.1 Project Description

The project will involve the installation of two new 15,000 SF pre-engineered metal buildings on the northeast 5 acres. There is also room for a 3rd 16,050 SF future building planned on the site plan. The improvements also include the addition of two temporary 80'x80' open-ended arch covered structures on the south 2 acres being modified. All construction will conform to the guidelines set forth in the Pinal County pre-application stipulations. This drainage report has been prepared in accordance with the Pinal County Drainage Ordinance and Drainage Manual.



1.2 Project Location

The subject property is approximately 1 mile south of US-60 Freeway, ¾ mile south of Baseline Road, and ¼ mile north of Guadalupe Road, approximately ½ mile east of the Meridian Road alignment, and ½ mile west of Ironwood Drive. (see Vicinity Map above right)

1.3 Existing On-Site Conditions

The site slopes moderately in a general direction from northeast to southwest (less than 1% in most areas). The site has been covered with ground asphalt millings for dust control measures. There is a large existing retention basin on-site that has a depth of 6.5 feet. The site has a block wall along all property lines. The entire 17-acre site drains above ground to the large existing retention basin. There are areas of very shallow slope along the north that tend to pond before draining south to the basin.

1.4 Purpose

This drainage report serves to evaluate the impact of the existing drainage patterns on the subject site, and what, if any, negative impacts may occur by the re-development of the industrial lot. It is also to ensure that the property and adjacent properties are protected from the effects of a 100-yr storm event. Support for the drainage solutions will be given herein and the methodology used will be presented.

1.5 Existing Drainage Studies

A number of previous drainage studies have been prepared in this Industrial Use area. See Appendix A-1. Multiple plans were reviewed to better understand the offsite drainage patterns along Desert View Drive and any contributing areas. Although reports have been reviewed, this report contains all supporting drainage calculations without reference to the existing reports. This report is a standalone document.

1.6 Site Location Relative to Known FEMA Flood Hazard Zones

This site is not located in a known FEMA Flood Hazard Zone. The floodplain designation for the project is Zone X as found on Panel 0200 of 2575, Community – Panel Number 04021C0200E, dated December 4, 2007.

Zone X is defined by the Federal Emergency Management Agency as: “Areas determined to be outside the 0.2% annual chance floodplain.”

See Appendix D for the Firmette copy of the above referenced FEMA Flood Insurance Rate Map.

1.7 Geotechnical Investigation

A Geotechnical Investigation was performed by ATEK ENGINEERING CONSULTANTS on 9/13/2019 as ATEK Project # 190070. The report in it’s entirety is included as Appendix H. The study included a percolation test in the existing retention basin area as well as multiple soil borings on the subject property in the redevelopment areas. The resulting data is referenced in the respective locations of this drainage report.

1.8 Fissure Investigation and Report

A land subsidence and earth fissure evaluation of the property was performed by Kenneth Euge of Geological Consultants, Inc. The final reports were completed 11/27/2019 and copies of these reports are included with as Appendix J. The study identified potential fissure locations in Task 1

and then in Task 2 the fissure locations were further verified on the 5-acre redevelopment parcel in the northeast corner of the property where the 2 new pre-engineered metal buildings are proposed. It is important to note that after extensive field investigations, no fissures were identified on the 5-acre parcel. The Task 1 identified potential locations for fissures on the parcel with the proposed temporary covered structures on the south side of the site. Because of the nature of these temporary structures, the fissures were not further investigated, but are noted on the site plan.

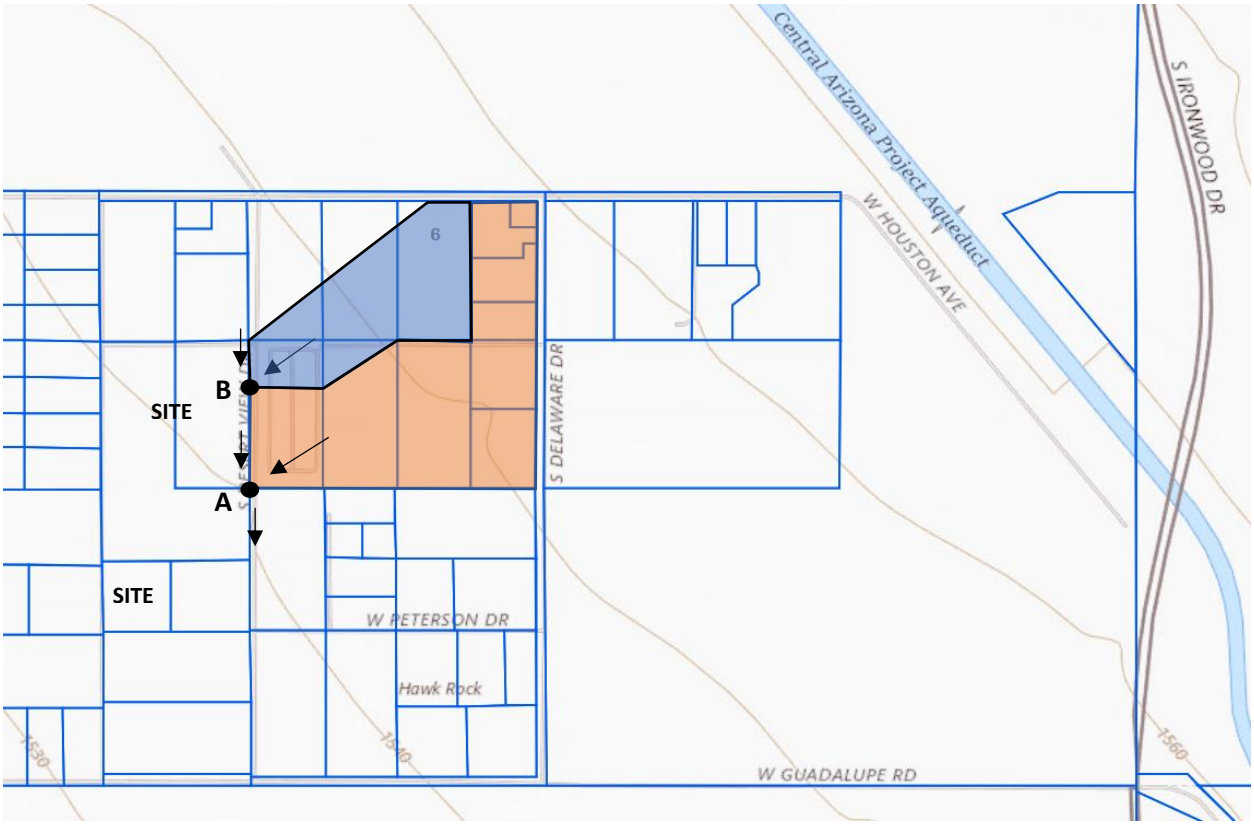
2.0 HYDROLOGIC ANALYSIS

The following section outlines the existing hydrologic conditions affecting the site as well as the hydrology for the project.

2.1 Off-Site Watershed Conditions

The upstream watershed area is limited to the industrial use area bound by Houston Avenue to the north and Delaware Drive to the east. Offsite water beyond this limit is channeled west along Houston Avenue to a channel at the Meridian Road alignment. Offsite water that reaches Delaware Drive enters a channel on the east side of Delaware and flows south to Guadalupe Road where it crosses and is discharged into the desert area south of Guadalupe. These drainage patters were referenced in a number of the drainage reports in the greater industrial area as provided by Pinal County Flood Control District for review (see Appendix A-1).

Within this Off-Site Watershed, the redeveloped property is bound by Desert View Drive along the entire east of the property. Desert View Drive is a well graded private gravel road with existing drainage swales on both sides of the roadway. The offsite drainage from the west is directed south along Desert View Drive. The offsite flow along Desert View Drive has been estimated at two concentration points along the parcel being redeveloped in order to estimate the new driveway flow as well as to estimate the depth of flow along Desert View Drive.



Concentration Point A contains a drainage area of approximately 21.5 acres. The acreage is an industrial use area with various locations of onsite retention, solid block walls impeding flow, and no defined drainage ways. Field visits determined that storm water runoff makes its way to Desert View Drive and flows south within defined drainage swales along the roadway. In discussions with property owners, it was learned that the owner of the storage area on the east side of Desert View Drive, pumps their retention water down Desert View Drive during and after storm events. Once the capacity of this drainage swale in Desert View Drive is exceeded, the design flow continues south along the gravel road within the private ingress/egress easement known as Desert View Drive. The 100-yr Flow was estimated using the Rational Method as provided in Appendix B . The Q-100 flow overtops the centerline of Desert View Drive and flows south on both sides of the gravel roadway. For design purposes, it is assumed that 50% of the Q-100 flow will be on each side of the roadway. This flow continues south on both sides and then crosses the road at Peterson Drive and ultimately makes its way to Guadalupe Road.

Concentration Point B contains a drainage area of approximately 10.3 acres. This drainage area is relatively flat and crosses multiple property lines with solid walls. A field review identified the well-defined drainage swale on the east side of Desert View Drive. The gravel Desert View Drive roadway is relatively flat in this area, but has a slight gradient to the south when the water level exceeds the depth of the drainage swale. The Q-100 flow was estimated using the Rational Method with results and calculations provided in Appendix B. Concentration Point B is a sub area of Point A.

Watershed Resistance Coefficients:
Although the land use is primarily industrial, the Watershed Resistance Coefficients were adjusted to account for the difficulty in drainage accumulation. There are areas with box containers and other storage items that block drainage patterns. Also, block walls and property berms block offsite drainage. Adjusting the Watershed Resistance Coefficients for the 2 different offsite concentration points is a reasonable means to account for the flow.

The offsite drainage patters are not being modified by this development. Desert View Drive is a private roadway and is not being changed.

The review of the drainage report for "Affordable Storage" quantified the Flow of the offsite drainage of Desert View Drive south of Peterson Drive to be:

100yr = 16.5 CFS 50yr = 14.4 CFS 10yr = 9.7 CFS 2yr = 5.1 CFS

These values are believed to be grossly under calculated. The contributing drainage areas for offsite flows to Affordable Storage do not account for true Offsite Contributing areas. They only account for the contributing roadway area. Also, instead of using the Intensity- Depth-Frequency for the area, the "Depth-Duration-Frequency" was used, which also contributed to a much lower estimated design flow.

There are also a number of confirmed and unconfirmed fissures located in the general vicinity of this project. No fissures were found on the 5-acre parcel being redeveloped in the northeast corner of the subject property. This was confirmed after extensive field investigations including open trench explorations as well as seismic refraction surveys. This is well explained in the Investigation Report by Geological Consultants in **Appendix J**. The report showed potential fissures in the 2 acre parcel being redeveloped in the southwest corner of the property. This 2 acre parcel does not have any permanent structures being built so no further explorations was made in this area. Instead, grading was design to direct the water away from the potential fissures. A map of fissure locations has been provided in **Appendix G**.

2.1.1 Impacts to Project Site

Two new pre-engineered buildings will be built on this property in the 5-acre parcel in the northeast corner of the property and a 3rd building in the future . Additionally, two temporary covered structures will be placed within the 2-acre yard space in the southwest corner of the property. As more hard-surface will be added to the land cover, on-site retention will be provided to capture stormwater runoff.

2.1.1 Existing Land Use

The existing land for the two re-developed areas is mostly dirt and covered with ground asphalt millings for dust control measures. The area is being used as a temporary steel laydown area for the owner (Rolling Plains Construction). The surrounding area is all industrial type uses (indoor/outdoor storage, manufacturing, etc.). The site is located within an industrial area zoned

CI-2. The surrounding area is all zoned the same CI-2. The overall area of the industrial zoned properties is over 260 acres. The land in the immediate vicinity consists of a mixture of industrial uses. The larger surrounding area is comprised mostly of vacant land and some residential and industrial developments.

2.2 On-Site Hydrology

On-site retention will be provided for the 100-year, 2-hour storm event. The property line of the property is along the centerline of Desert View Drive, so this area is include in the drainage calculations. All design calculations for retention volumes can be found in **Appendix B.**

On-site hydrology will be governed by the following:

2.2.1 Methodology and Criteria

The lot will be graded in a manner that will allow stormwater runoff to shed away from the proposed structure. The retention basins will be at least 12 inches lower than the finished floor elevation of the structure. Per section 8.4.3.f of the Pinal County Subdivision & Infrastructure Design Manual, the required freeboard used is 6-inches and the side slope are no greater than 4 to 1 (Horizontal to Vertical).

The following subsections provide a brief outline of the design methodology and criteria that will be utilized to design the site as outlined in the Pinal County Drainage Manual (PCDM) Volume I and II.

2.2.2 Detention / Retention Storage Volume Calculations

For determining on-site volumes, formula 2-4 from the Pinal County Drainage Manual Volume II will be used as follows:

$$V = C \times (P/12) \times A$$

Where:

V = Storage volume (CF)
C = Watershed runoff coefficient (Composite C factor calculated for each area)
P = 100-yr, 2-Hour Precipitation (inches), NOAA 14
A = Drainage Area (SF)

2.2.3 Rational Method

For Storm Drain Peak Flows, the Rational Method will be used as follows:

$$Q = C\ i\ A$$

Where:

C = Composite runoff coefficient
i = Intensity corresponding to Tc
Tc = Time of concentration derived as presented below
A = Area in acres

2.2.4 Time of Concentration

Inlet time estimated, system time established based on summation of travel time in system and initial time of concentration based upon the following equation:

$$Tc = 11.4L^{0.5} K_b^{0.52} S^{-0.31} i^{-0.38}$$

Where:

Tc = Time of concentration (hrs): minimum 5 minutes
L = Length of the longest flow path (miles)
Kb = Watershed resistance coefficient – (see PCDM Vol 2)
S = Watercourse slope (ft/mi)
i = Rainfall intensity (in/hr)

3.0 DRAINAGE INFRASTRUCTURE

The following section provides an overview of the storm water drainage system that will be on the lot to convey runoff generated during the 100-yr peak storm event.

3.1 Proposed Drainage Plan

The lot will be graded in a manner that will allow stormwater to shed away from the proposed structures. The roof slopes to the north and south from the middle of the structures. On-site retention will be provided for the 100-yr, 2-yr storm event. A composite C-Coefficient is calculated using Table 2-1 from the PCDM Vol2. The lot area including the half street of Desert View Drive will be accounted for. The retention basin High Water Elevation will be at least 12-inches lower than the finished floor elevation of the structure.

The existing 17 acre property currently all drains toward the south into a large existing retention basin (Basin #3) shown on the site plan. After reviewing the site topography and discussing the onsite drainage patters, it was decided to create two smaller basin areas to capture some of the drainage from the northern portion of the lot. These basins are labeled as Basin 1 and Basin 2. These basins area also shallow in depth (only 12-inches) and have gradual slopes of 10:1. The intent of these basins is to improve the site drainage by creating designated areas of ponding that are interconnected by storm drain. These are areas that were already experiencing ponding and with the graded space and storm drain will improve the storm water drainage to the large retention basin in southwest area of the property.

In working with the property owner, the intent of the proposed drainage plan is to dramatically improve the drainage condition by creating positive drainage for ponding water and design storm drains to collect and remove excess water. The existing site does not have any storm drains. All storm water currently surface drains to the large retention Basin #3. The storm drain pipe capacities have not been included in the drainage calculations, and individual flows have not been assessed because the overflow condition will be lower than the existing conditions. Instead, using the Rational Method, concentration points were evaluated at the overflow of Basin #1 and Basin #2. The depth of flow leaving the basin is estimated using Manning's Equation. The Calculations

Part of the site improvements includes the addition of a 100-ft wide paved drive aisle connecting the southern 2-acres to the existing 10-acre site. The existing parking lot drainage crosses this new 100-ft wide aisle and drains directly to the existing retention basin. The concentrated flow of the parking lot drainage has been calculated at this point using the Rational Method. An additional concentration point has been evaluated as the north side of the site drains into Basin #3.

See **Appendix B** for drainage calculations and **Appendix C** for the Drainage Exhibit.

3.2 Onsite Basin Dewatering Requirements

The retention ponds #1 and #2 are all designed to have a ponding depth of 12-inches or less. As shallow basins, the water will be able to percolate or evaporate within the required time limit. The Geotech Report contains results of two percolation test performed at or near the parcel. The field measured percolation rate from the inner ring test was 1.4 and 5.2 inches per hour. Using the lower percolation rate with an applied safety factor of 2, **the 12-inch deep retention basins will drain in 17.2 hours** which is well within the required 36-hour limit. If the basins fail to meet this requirement, the owner/developer is responsible for bringing the basins into compliance with the Pinal County Drainage Ordinance. The owner is also responsible for maintenance of the drainage system which may include, but is not limited to, routinely cleaning the basin of debris and weeds, and monitoring drain down time, and keeping drainage paths to the basin free from obstruction.

Retention Basin #3 is an existing basin with a ponding depth of 6.5-feet. The field test rate in this basin is 1.4 in/hr and with a safety factor of 2, will drain 2-feet of water (44,548 CF). The property owner has installed and registered two drywells. The field verified infiltration rate for both Drywells is 0.26 CFS. See **Appendix F** for field test percolation results. This calculated drain time for the basin is 31 hours. See **Appendix B**.

If the retention basins cannot dispose of the storm water within 36 hours, additional drywells will be required. All drywells are required to be registered with ADEQ per section 602.3 and 602.4 of the Drainage Ordinance and sections 3.10.4.2 and 3.10.4.3 of Volume I of the Pinal County Drainage Manual.

3.3 Rational Method – Peak Flows (Offsite & Onsite)

Point A Desert View Drive: The offsite drainage for Desert View is calculated in Appendix B. The total Q100 for Desert View Drive is estimated to be 112 CFS which is the combined total of Point A and Point B. This flow runs along the drainage channels on both sides of the road, and also overtops the road as it flows to the south over Peterson Drive. The street is graded such that the flows cross the street to the west and continue south. There are multiple driveway culvert crossings along the west side of the street. On the east side of the street along the subject property, there is a well-defined graded retention area and drainage swale with a culvert crossing at existing driveway location. This areas retains water during a storm event, but the flow ultimately crosses the street and flows south along both sides of Desert View Drive. South of

Peterson Drive, the only drainage swale is on the west side of the street. The existing drainage area along the subject property on the west side of Desert View Drive, will be graded and landscaped to maintain the historic flow pattern. The new driveway crossing on Desert View Drive will be installed with two 12-inch steel storm drain pipes and MAG 501 headwalls. The driveway crossing capacity is calculated below in this section.

Point B: Offsite flows enter Desert View Drive near Point B and collected in a V-shaped drainage ditch on the west side of the street. The capacity of this V-Shaped ditch is shown in **Appendix B**. The Q100 offsite Flow at this location is calculated to be 36.7 CFS.

Driveway Crossings: The driveway crossing calculations have been provided in **Appendix B**. There is only one new driveway being installed and that is along Desert View Drive. The driveway has been designed as an all-weather road with a maximum flow of 8 inches in depth over the culvert across the driveway during the 25-year peak flow event with no adverse backwater effect during a 100-year peak flow event. The sizing was checked using the HY-8 program. The crossing meets the all-weather road requirements.

Onsite Concentration Points: Four locations were selected for evaluation of the Q100 peak flow using the Rational Method. The locations are shown on the Drainage Exhibit in **Appendix C** and the calculations are in **Appendix B**. the four locations were selected to evaluate the above ground depth of flow across the site during a 100-yr storm event. Also, the water surface elevation was checked to ensure the existing and proposed finished floor elevations would all be a minimum of 12-inches above the water surface elevation.

CP#1 – Basin #1 Overflow: The Q100 peak flow was evaluated at the overflow of Basin #1 as it flows south toward Basin #3. The existing and proposed finished floors are 12-inches or more above the water surface elevation. The water depth is approximately 0.3’ with a velocity of less than 1.3 ft/sec. The estimated Q100 flow is 12.7 CFS.

CP#2 – Basin #2 Overflow: The Q100 peak flow was evaluated at the overflow of Basin #2 as it flows west and then south toward Basin #3. The existing and proposed finished floors are more than 12-inches above the water surface elevation. The water depth is approximately 0.5’ with a velocity of less than 1.6 ft/sec. The estimated Q100 flow is 24.9 CFS.

CP#3 – North Inlet to Basin #3: The Q100 peak flow was evaluated where the sheet flow from Basins #1 and #2 enter Basin #3. The existing and proposed finished floors are more than 12-inches above the water surface elevation. The water depth is approximately 0.6’ with a velocity of less than 3.3 ft/sec. The estimated Q100 flow is 56.1 CFS.

CP#4 – Parking lot to Basin #3: The Q100 peak flow was evaluated where the sheet flow from the parking lot crosses the new asphalt pavement and enters Basin #3. The existing and proposed finished floors are more than 12-inches above the water surface elevation. The water depth is approximately 0.3’ with a velocity of less than 1.7 ft/sec. The estimated Q100 flow is 10.0 CFS.

4.0 SPECIAL ISSUES OR CONSIDERATIONS

The following section outlines any issues of significance that may govern the site.

4.1 401/404 Permit

No 401/404 Permits through the United States Army Corp of Engineers will be required for this project.

4.2 Floodplain Use Permit through FCDPC

No Floodplain use permits through the Flood Control District of Pinal County will be required for this project.

4.3 NPDES Permit

The amount of area be disturbed by construction activity will warrant the need for a NPDES permit. This should be submitted through ADEQ and a general construction activity permit. There are no distressed bodies of water within the vicinity of the project.

4.4 Phasing

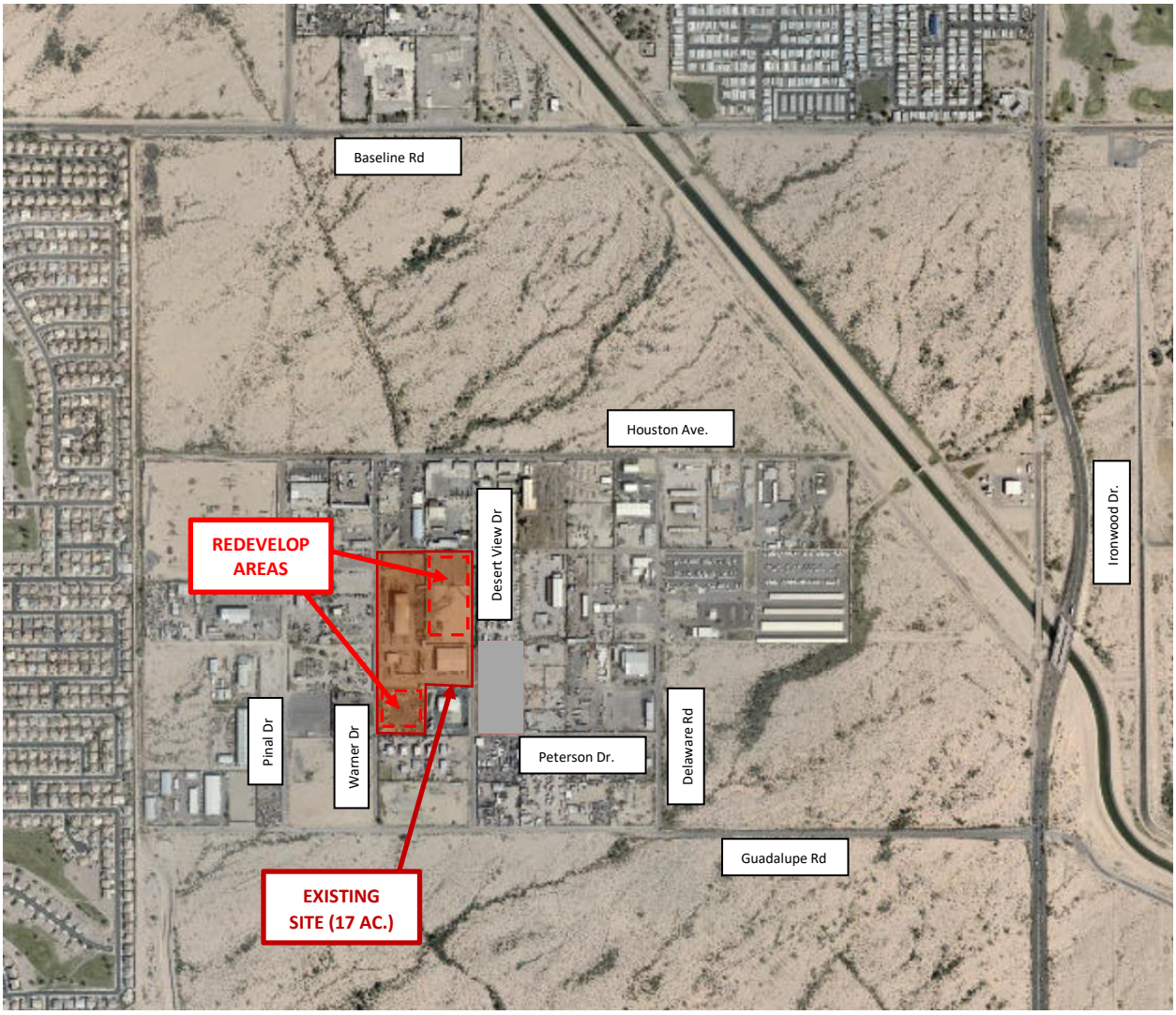
The construction project will not be phased except that Building #3 will be constructed at a later date. All preparation for the building will be completed with the initial site construction.

5.0 SUMMARY AND CONCLUSIONS

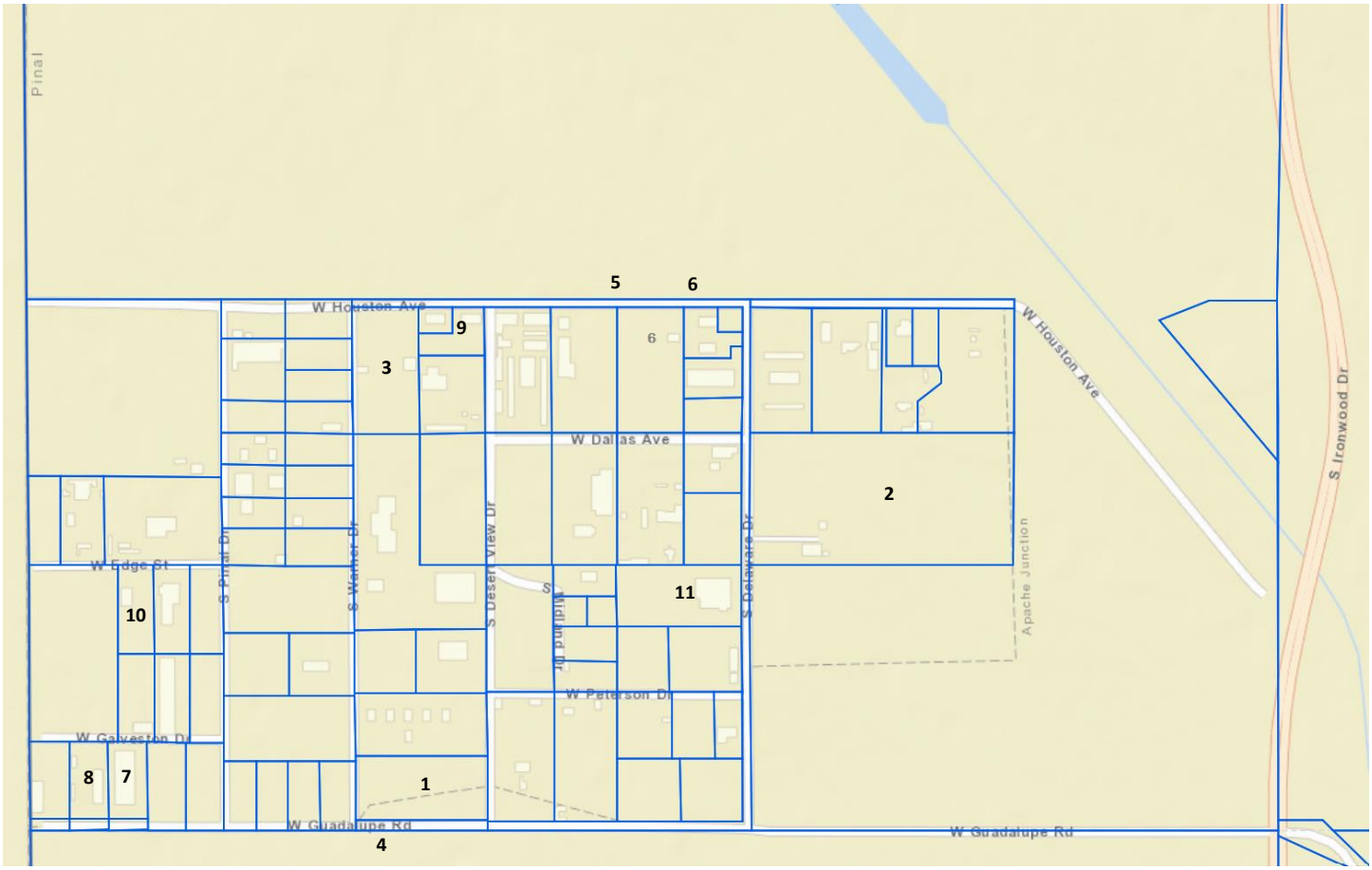
Offsite flows do not adversely affect this property. Offsite flows concentrate along the frontage of Desert View drive at Point A and Point B, and drain south along the private gravel street ultimately to Guadalupe Road. In all cases, the historic drainage pattern is maintained. The relocated driveway along Desert View Drive has a new drainage culvert with a flow depth of less than 8-inches for the 25-yr storm event.

On-site retention will be provided for the 100-year, 2-hr storm event. Six inches of freeboard is provided at retention Basin #2 and #3. Basin #1 has a freeboard of 12-inches but also has a storm drain connected to Basin #3. The ultimate outfall of the entire 17-acre site is at the existing southwest drive onto Warner Drive (a private gravel roadway) with an elevation of 1537.5. The finished floor of the proposed structures is more than 12-inches higher than the 100-yr water elevation of the proposed adjacent retention basins. The existing Finished Floor of all existing structures is greater than 12-inches above the calculated Water Surface Elevations. Any structures built upon the site will be constructed to conform to Pinal County's requirements. The project shall conform to the Pinal County Drainage Ordinance. The project shall conform to the Pinal County Drainage Manual Volume 1, 2, and 3 and has the ability to provide all-weather access to the site per the Drainage Ordinance requirements. The development will not cause any adverse drainage impacts or increased drainage problem for adjacent upstream or downstream properties.

Figure 1: Enlarged Aerial Vicinity Map



Appendix A-1: Pinal County Existing Drainage Studies



EXISTING DRAINAGE REPORTS TABLE:

#	Name	Date
1	Affordable Storage	7/29/2010
2	AZ RV Boat Storage	8/19/2011
3	Dynamite Manufacturing	1/13/2016
4	Guadalupe Road	3/25/2015
5	Houston Ave Report	7/8/2003
6	Houston Ave Drainage Memo	6/15/2018

#	Name	Date
7	JLE Manufacturing	4/25/2007
8	JS Recycling	7/25/2007
9	Shotcrete Specialists	3/7/2008
10	Sunwest Mobile Modular	10/2/2007
11	Top Drawer Component	10/19/2010

Appendix A-2 -OFFSITE WATERSHED BOUNDARY (north to right of page)

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL

Rolling Plains Construction Site Plan

Volume Required

V = A * C * d (PCDM, Vol 2, Formula 2-4)

Drainage Area 1 (North)

Area=	102690	SF
C=	0.73	(PCDM, Vol 2, Table 2-1) Composit
d=	2.19	NOAA 14 - 100yr 2-hr depth (inches)
Volume =	13615	CF

Drainage Area 2 (Middle)

Area=	166550	SF
C=	0.79	
d=	2.19	inches
Volume =	24002	CF

Drainage Area 3 (South)

Area=	472826	
C=	0.82	
d=	2.19	
Volume =	71088	CF

TOTAL VOLr=	**108704**	**CF**

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Rolling Plains Construction Site Plan

Volume Provided - Conic Approximation Method

$$V = \frac{d}{3}\left(A_{top} + A_{bot} + \sqrt{A_{top}A_{bot}}\right)$$

Basin 1 (north)

Contour	Area	Conc Avg.	Depth	Volume	
1541	4917	3586.935	1	3587	
1540	2405			0	
			Basin Vol =	3587	CF
			Vol Req =	13615	CF
			% extra =	-74%	to Basin 3

Basin 2 (Middle)

Contour	Area	Conc Avg.	Depth	Volume	
1541	3979	3025.792	1	3026	
1540	2164	721.3333		0	
			Basin Vol =	3026	CF
			Vol Req =	24002	CF
			% extra =	-87%	to Basin 3

Basin 3 (South)

Contour	Area	Conc Avg.	Depth	Volume (CF)	
1537	25086	23694.64	1	23695	
1536	22330	20852.96	1	20853	
1535	19410	18329.08	1	18329	
1534	17269	15953.9	1	15954	
1533	14674	13090.78	1	13091	
1532	11569	10300.97	1	10301	
1531	9083	8480.016	0.5	4240	
1530.5	7891				
			Basin Vol =	106462	CF
			Vol Req =	71088	CF
			Vol from Basin 1&2=	31004	
			% extra =	6.15%	

TOTAL SITE RETENTION VOLUME PROVIDED = 113075 CF
TOTAL SITE RETENTION VOLUME REQUIRED = 108704 CF
EXCESS VOLUME = 4371 CF
% EXTRA = 4%

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Rolling Plains Construction Site Plan
Onsite Composite C Factor Calculation
Volume Required
V = A * C * d (PCDM, Vol 2, Formula 2-4)

BASIN 1 AREA

	Area	C Factor	Adj Area
Pavement/Roof	1524	0.95	1447.8
Gravel Roadway	8199	0.85	6969.15
Gravel Yard	78808	0.75	59106
Desert Ldsc	14159	0.50	7079.5

TOTAL	102690	0.73

BASIN 2 AREA

	Area	C Factor	Adj Area
Pavement/Roof	53400	0.95	50730
Gravel Roadway	17340	0.85	14739
Gravel Yard	72570	0.75	54427.5
Desert Ldsc	23240	0.50	11620

TOTAL	166550	0.79

BASIN 3 AREA

	Area	C Factor	Adj Area
Pavement/Roof	192133	0.95	182526.4
Gravel Roadway	9908	0.85	8421.8
Gravel Yard	252722	0.75	189541.5
Desert Ldsc	18063	0.50	9031.5

TOTAL	472826	0.82

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Rolling Plains Construction
Offsite Composite C Factor Calculation
Volume Required
V = A * C * d (PCDM, Vol 2, Formula 2-4)

OFFSITE AREA A

	Area	C Factor	Adj Area
Pavement/Roof	209262	0.95	198798.9
Gravel Roadway	29727	0.85	25267.95
Gravel Yard	575292	0.75	431469
Desert Ldsc	120417	0.50	60208.5

TOTAL	934698	0.77

OFFSITE AREA B

	Area	C Factor	Adj Area
Pavement/Roof	11054	0.95	10501.3
Gravel Roadway	0	0.85	0
Gravel Yard	414990	0.75	311242.5
Desert Ldsc	22005	0.50	11002.5

TOTAL	448049	0.74

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Rolling Plains Construction
Rational Method used to estimate Q100 Offsite and Onsite

Q = C x i x A	Offsite Point A	Offsite Point B	Offsite Point B	Onsite CP#1	Onsite CP#2	Onsite CP#3	Onsite CP#4
Design Event	100	25	100	100	100	100	100
i=	4.55	3.25	4.81	7.39	8.26	6.96	8.26
A=	21.5	10.3	10.3	2.36	3.82	9.79	1.46
C=	0.77	0.64	0.74	0.73	0.79	0.82	0.82
Tc=	**26**	**28**	**24**	**9**	**7**	**10**	**7**
Graph I =	4.55	4.81	4.81	9.12	9.12	9.12	9.12
L= (miles)	0.43	0.33	0.33	0.09	0.13	0.23	0.12
Res. Type	C	C	C	A	A	A	A
Kb=	0.1167	0.1247	0.1247	0.0377	0.0364	0.0338	0.0390
S=	41.65	35.90	35.90	10.67	23.54	25.92	25.14
i=	4.55	3.25	4.81	7.39	8.26	6.96	8.26
m=	-0.025	-0.025	-0.025	-0.00625	-0.00625	-0.00625	-0.00625
b=	0.15	0.15	0.15	0.04	0.04	0.04	0.04
Flow(CFS)=	**74.8**	**21.4**	**36.7**	**12.7**	**24.9**	**56.1**	**10.0**

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

NOAA Atlas 14, Volume 1, Version 5
Location name: Apache Junction, Arizona, USA*
Latitude: 33.3671°, Longitude: -111.5764°
Elevation: 1538.6 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.192 (0.162-0.235)	0.250 (0.211-0.307)	0.339 (0.284-0.413)	0.407 (0.339-0.494)	0.500 (0.409-0.603)	0.571 (0.462-0.687)	0.644 (0.511-0.774)	0.719 (0.561-0.863)	0.819 (0.622-0.983)	0.895 (0.667-1.08)
10-min	0.292 (0.246-0.357)	0.380 (0.322-0.467)	0.515 (0.432-0.628)	0.619 (0.515-0.751)	0.760 (0.622-0.918)	0.869 (0.702-1.05)	0.981 (0.778-1.18)	1.10 (0.854-1.31)	1.25 (0.947-1.50)	1.36 (1.01-1.64)
15-min	0.362 (0.305-0.443)	0.472 (0.399-0.578)	0.639 (0.535-0.779)	0.767 (0.638-0.931)	0.942 (0.772-1.14)	1.08 (0.871-1.30)	1.22 (0.965-1.46)	1.36 (1.06-1.63)	1.55 (1.17-1.85)	1.69 (1.26-2.03)
30-min	0.487 (0.410-0.596)	0.635 (0.537-0.779)	0.860 (0.721-1.05)	1.03 (0.860-1.25)	1.27 (1.04-1.53)	1.45 (1.17-1.75)	1.64 (1.30-1.97)	1.83 (1.43-2.19)	2.08 (1.58-2.50)	2.28 (1.69-2.74)
60-min	0.603 (0.508-0.738)	0.786 (0.664-0.964)	1.07 (0.892-1.30)	1.28 (1.06-1.55)	1.57 (1.29-1.90)	1.80 (1.45-2.16)	2.03 (1.61-2.43)	2.26 (1.76-2.71)	2.58 (1.96-3.09)	2.82 (2.10-3.39)
2-hr	0.683 (0.579-0.820)	0.885 (0.751-1.06)	1.18 (0.994-1.41)	1.40 (1.17-1.68)	1.71 (1.41-2.04)	1.95 (1.59-2.32)	2.19 (1.76-2.61)	2.44 (1.92-2.90)	2.78 (2.13-3.31)	3.04 (2.28-3.64)
3-hr	0.729 (0.616-0.887)	0.933 (0.792-1.14)	1.22 (1.03-1.49)	1.45 (1.22-1.77)	1.78 (1.46-2.14)	2.03 (1.64-2.44)	2.30 (1.83-2.77)	2.59 (2.02-3.11)	2.98 (2.25-3.58)	3.29 (2.43-3.96)
6-hr	0.873 (0.757-1.03)	1.11 (0.960-1.30)	1.41 (1.22-1.66)	1.66 (1.42-1.94)	1.99 (1.69-2.32)	2.26 (1.88-2.63)	2.53 (2.07-2.95)	2.82 (2.26-3.28)	3.21 (2.51-3.74)	3.52 (2.68-4.11)
12-hr	1.00 (0.880-1.15)	1.26 (1.11-1.45)	1.59 (1.39-1.82)	1.85 (1.61-2.11)	2.21 (1.89-2.51)	2.47 (2.10-2.81)	2.75 (2.31-3.13)	3.03 (2.50-3.45)	3.41 (2.75-3.90)	3.71 (2.93-4.27)
24-hr	1.23 (1.10-1.38)	1.54 (1.39-1.75)	1.97 (1.76-2.23)	2.31 (2.06-2.61)	2.79 (2.46-3.13)	3.16 (2.76-3.54)	3.55 (3.06-3.98)	3.95 (3.37-4.43)	4.50 (3.76-5.07)	4.93 (4.06-5.59)
2-day	1.29 (1.15-1.45)	1.64 (1.47-1.85)	2.11 (1.88-2.37)	2.48 (2.21-2.79)	2.99 (2.64-3.35)	3.39 (2.97-3.80)	3.81 (3.30-4.28)	4.24 (3.63-4.77)	4.83 (4.06-5.46)	5.30 (4.38-6.02)
3-day	1.42 (1.28-1.59)	1.81 (1.63-2.02)	2.36 (2.12-2.62)	2.79 (2.50-3.11)	3.41 (3.04-3.78)	3.90 (3.45-4.33)	4.42 (3.88-4.91)	4.96 (4.30-5.53)	5.72 (4.88-6.40)	6.33 (5.34-7.12)
4-day	1.56 (1.42-1.72)	1.99 (1.80-2.20)	2.61 (2.36-2.88)	3.11 (2.80-3.43)	3.83 (3.43-4.22)	4.40 (3.93-4.85)	5.02 (4.45-5.55)	5.68 (4.98-6.28)	6.61 (5.71-7.34)	7.37 (6.29-8.21)
7-day	1.73 (1.57-1.92)	2.21 (2.00-2.44)	2.90 (2.62-3.21)	3.47 (3.13-3.83)	4.28 (3.84-4.72)	4.93 (4.40-5.45)	5.64 (4.99-6.23)	6.39 (5.60-7.08)	7.46 (6.43-8.29)	8.33 (7.10-9.30)
10-day	1.89 (1.72-2.08)	2.41 (2.19-2.65)	3.16 (2.87-3.48)	3.77 (3.41-4.14)	4.63 (4.17-5.09)	5.33 (4.76-5.85)	6.07 (5.39-6.67)	6.85 (6.03-7.54)	7.95 (6.90-8.79)	8.84 (7.59-9.81)
20-day	2.34 (2.12-2.58)	3.00 (2.72-3.31)	3.93 (3.57-4.34)	4.65 (4.20-5.13)	5.63 (5.07-6.20)	6.38 (5.71-7.04)	7.15 (6.37-7.90)	7.93 (7.03-8.78)	9.00 (7.89-10.0)	9.83 (8.54-11.0)
30-day	2.74 (2.49-3.01)	3.51 (3.19-3.86)	4.60 (4.18-5.04)	5.43 (4.93-5.96)	6.56 (5.93-7.20)	7.43 (6.68-8.16)	8.33 (7.45-9.16)	9.25 (8.22-10.2)	10.5 (9.22-11.6)	11.5 (9.98-12.7)
45-day	3.21 (2.92-3.54)	4.13 (3.75-4.54)	5.40 (4.89-5.94)	6.35 (5.75-6.99)	7.61 (6.86-8.38)	8.57 (7.69-9.44)	9.54 (8.52-10.5)	10.5 (9.33-11.6)	11.8 (10.4-13.1)	12.8 (11.2-14.2)
60-day	3.59 (3.27-3.94)	4.62 (4.20-5.07)	6.02 (5.47-6.61)	7.05 (6.39-7.75)	8.40 (7.59-9.23)	9.41 (8.46-10.3)	10.4 (9.33-11.5)	11.4 (10.2-12.6)	12.7 (11.2-14.1)	13.7 (12.0-15.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Rainfall Intensity:

2.3.3 Rainfall Data for Pinal County Communities

Rainfall data for the communities listed in Table 2-4 is given in Tables 2-5 through 2-12. I-D-F and log I-D-F curves are provided for the same list of communities at the end of this chapter.

Table 2-5: Rainfall data for Apache Junction

PREFRE Program Input Data

2-yr, 6-hr =	1.20
2-yr, 24-hr =	1.40
100-yr, 6-hr =	3.20
100-yr, 24-hr =	3.80

Depth-Duration-Frequency (D-D-F)

	Frequency						
Duration	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	500-Yr
5 min	0.33	0.43	0.50	0.60	0.68	0.76	0.94
10 min	0.49	0.65	0.77	0.92	1.04	1.16	1.44
15 min	0.59	0.82	0.97	1.17	1.33	1.49	1.86
30 min	0.79	1.09	1.30	1.58	1.80	2.02	2.53
1-hr	1.00	1.35	1.61	1.97	2.25	2.53	3.17
2-hr	1.04	1.47	1.76	2.15	2.45	2.76	3.46
3-hr	1.10	1.55	1.85	2.27	2.59	2.91	3.65
6-hr	1.20	1.70	2.03	2.49	2.85	3.20	4.01
12-hr	1.30	1.85	2.22	2.72	3.11	3.50	4.40
24-hr	1.40	2.00	2.40	2.95	3.38	3.80	4.78

*D-D-F data obtained from PREFRE Program

Localized Intensity-Depth-Frequency (I-D-F)

Duration	Frequency						
(minutes)	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	500-Yr
5	3.96	5.16	6.00	7.20	8.16	9.12	11.28
10	2.94	3.90	4.62	5.52	6.24	6.96	8.64
15	2.36	3.28	3.88	4.68	5.32	5.96	7.44
30	1.58	2.18	2.60	3.16	3.60	4.04	5.06
60	1.00	1.35	1.61	1.97	2.25	2.53	3.17

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Pinal County Runoff Coefficients

Table 2-1: Runoff Coefficients [1,2]

Land Use Category	2-10 Year		25 Year		50 Year		100 Year	
	min	max	min	max	min	max	min	max
Very Low Density Residential[3]	0.33	0.42	0.36	0.46	0.40	0.50	0.41	0.53
Low Density Residential[3]	0.42	0.48	0.46	0.53	0.50	0.58	0.53	0.60
Medium Density Residential[3]	0.48	0.65	0.53	0.72	0.58	0.78	0.60	0.82
Multiple Family Residential[3]	0.65	0.75	0.72	0.83	0.78	0.90	0.82	0.94
Industrial 1[3]	0.60	0.70	0.66	0.77	0.72	0.84	0.75	0.88
Industrial 2[3]	0.70	0.80	0.77	0.88	0.84	0.95	0.88	0.95
Commercial 1[3]	0.55	0.65	0.61	0.72	0.66	0.78	0.69	0.81
Commercial 2[3]	0.75	0.85	0.83	0.94	0.90	0.95	0.94	0.95
Pavement and Rooftops	0.75	0.85	0.83	0.94	0.90	0.95	0.94	0.95
Gravel Roadways & Shoulders	0.60	0.70	0.66	0.77	0.72	0.84	0.75	0.88
Agricultural	0.10	0.20	0.11	0.22	0.12	0.24	0.13	0.25
Lawns/Parks/Cemeteries	0.10	0.25	0.11	0.28	0.12	0.30	0.13	0.31
Desert Landscaping 1	0.55	0.85	0.61	0.94	0.66	0.95	0.69	0.95
Desert Landscaping 2	0.30	0.40	0.33	0.44	0.36	0.48	0.38	0.50
Undeveloped Desert Rangeland	0.30	0.40	0.33	0.44	0.36	0.48	0.38	0.50
Hillslopes, Sonoran Desert	0.40	0.55	0.44	0.61	0.48	0.66	0.50	0.69
Mountain Terrain	0.60	0.80	0.66	0.88	0.72	0.95	0.75	0.95

[1] Runoff coefficients for 25-, 50-, and 100-Year storm frequencies were derived using adjustment factors of 1.10, 1.20 and 1.25, respectively, applied to the 2-10 Year values with an upper limit of 0.95

[2] The ranges of runoff coefficients shown for urban land uses were derived from lot coverage standards specified in the zoning ordinances for Maricopa Pinal County

[3] **Runoff coefficients for urban land uses are for lot coverage only and do not include the adjacent street and right-of-way, or alleys.**

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Pinal County Watershed Resistance Coefficients

Table 2-2: Watershed Resistance Coefficients

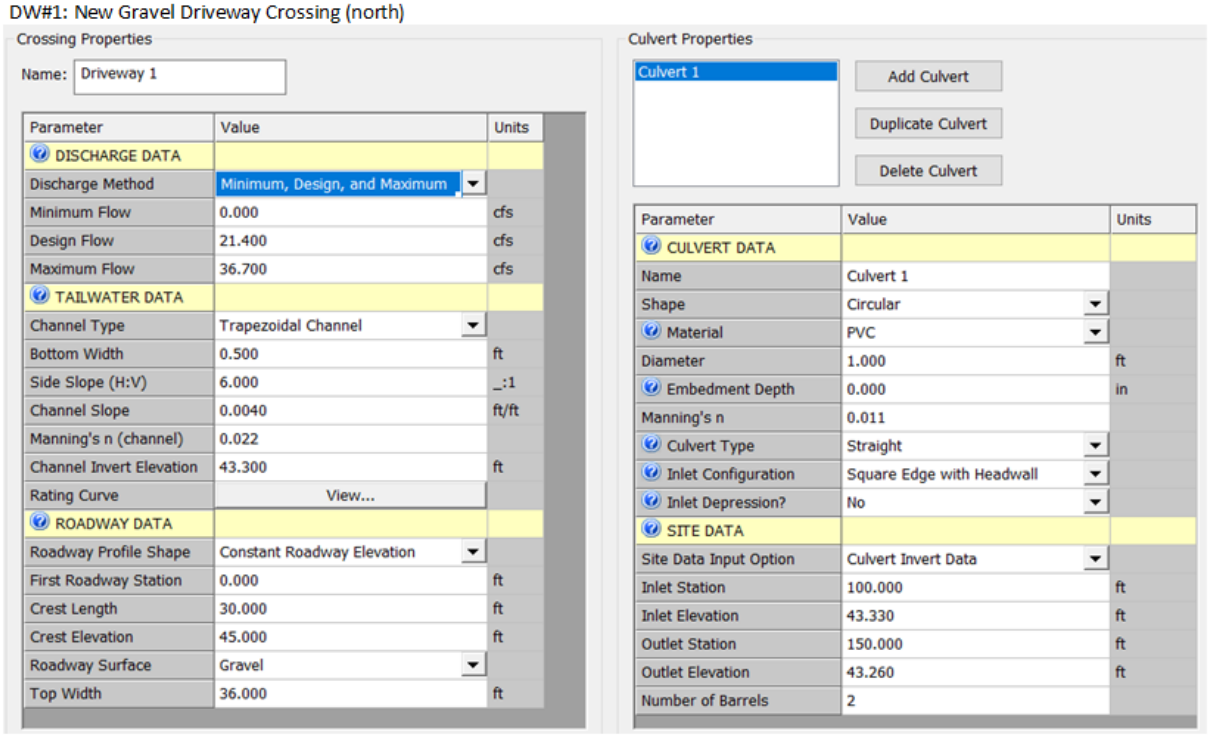
Type	Description	Typical Applications	Equation Parameters	
			m	b
A	Minimal roughness: Relatively smooth and/or well-graded and uniform land surfaces. Surfaces runoff is sheet flow.	Commercial/industrial areas Residential area Parks and golf courses	-0.00625	0.04
B	Moderately low roughness: Land surfaces have irregularly spaced roughness elements that protrude from the surface but the overall character of the surface is relatively uniform. Surface runoff is predominately sheet flow around the roughness elements.	Agricultural fields Pastures Desert rangelands Undeveloped urban lands	-0.01375	0.08
C	Moderately high roughness: Land surfaces that have significant large to medium-sized roughness elements and/or poorly graded land surfaces that cause the flow to be diverted around the roughness elements. Surface runoff is sheet flow for short distances draining into meandering drainage paths	Hillslopes Brushy alluvial fans Hilly rangeland Disturbed land, mining, etc. Forests with underbrush	-0.02500	0.15
D	Maximum roughness: Rough land surfaces with torturous flow paths. Surface runoff is concentrated in numerous short flow paths that are often oblique to the main flow direction.	Mountains Some wetlands	-0.03000	0.20

Reference: Table 3.1, Drainage Design Manual for Maricopa County Vol. I - Hydrology, FCDMC

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Drainage Calculations for Culvert Crossings (HY8 Software Input)

DW#1: New Gravel Driveway Crossing (north)



Crossing Properties

Name: Driveway 1

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	0.000	cfs
Design Flow	21.400	cfs
Maximum Flow	36.700	cfs
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	0.500	ft
Side Slope (H:V)	6.000	_:1
Channel Slope	0.0040	ft/ft
Manning's n (channel)	0.022	
Channel Invert Elevation	43.300	ft
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	30.000	ft
Crest Elevation	45.000	ft
Roadway Surface	Gravel	
Top Width	36.000	ft

Culvert Properties

Culvert 1

Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Circular	
Material	PVC	
Diameter	1.000	ft
Embedment Depth	0.000	in
Manning's n	0.011	
Culvert Type	Straight	
Inlet Configuration	Square Edge with Headwall	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	100.000	ft
Inlet Elevation	43.330	ft
Outlet Station	150.000	ft
Outlet Elevation	43.260	ft
Number of Barrels	2	

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Drainage Calculations for Culvert Crossings (HY8 Software Results)

Rolling Plains Construction Site Plan

DW#1: Existing Gravel Driveway Crossing (north)

Q25 =	21.4	CFS		Elevation
Q100=	36.7	CFS	DW top=	45.0
			8" Depth=	45.67

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
43.33	0.00	0.00	0.00	1
44.84	6.50	6.50	0.00	1
45.17	13.00	7.72	5.20	9
45.27	19.50	8.11	11.31	5
45.30	21.40	8.21	13.14	4
45.44	32.50	8.68	23.74	4
45.52	39.00	8.91	30.07	4
45.58	45.50	9.12	36.29	3
45.65	52.00	9.32	42.63	3
45.71	58.50	9.51	48.97	3
45.76	65.00	9.67	55.31	3
45.00	7.13	7.13	0.00	Overtopping

Results PASS: Driveway overtops at an elevation of 45.0. The Q100 Flow results in a depth of 0.52' above the existing driveway. The Q25 Flow Depth above the drive is at elevation 45.30 which is a depth of 0.30'.

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Onsite Concentration Points - Water Surface Elevation – Manning's Equation

Concentration Point #1 Sheet Flow from Basin 1 toward Basin 3 Q100 = 12.7 CFS

Rolling Plains Construction

Concentration Point #1

Inputs		
Bottom width	10	ft
Side slope 1 (horiz./vert.)	60	
Side slope 2 (horiz./vert.)	60	
Manning roughness, n ?	0.03	
Channel slope	.009	rise/run
Flow depth	.3	ft
Bend Angle? (for riprap sizing)	0	
Stone specific gravity (2.65)	2.65	
Lining median rock size	1	ft

Results		
Flow area	8.4003	ft^2
Wetted perimeter	46.0050	ft
Hydraulic radius	0.1826	ft
Velocity, v	1.5123	ft/sec
Flow, Q (See notes)	12.7033	cfs
Velocity head, h_v	0.0355	ft
Top width, T	46.0000	ft
Froude number, F	0.62	
Shear stress (tractive force), tau	0.1026	psf
n per Strickler	0.039	
n per Blodgett	-0.122	
n per Bathurst	0.084	
Blodgett vs. Bathurst	----	
Required bottom angular riprap size, D50, Maricopa County ?	0.0265	ft
Required side slope 1 angular riprap size, D50, Maricopa County ?	0.0265	ft
Required side slope 2 angular riprap size, D50, Maricopa County ?	0.0265	ft
Required angular riprap size, D50, per Maynord, Ruff, and Abt (1989)	0.0235	ft
Required angular riprap size, D50, per Searcy (1967)	0.0153	ft

Concentration Point #2 Sheet Flow from Basin 2 toward Basin 3 Q100 = 24.9 CFS

Rolling Plains Construction

Concentration Point #2

Inputs		
Bottom width	10	ft
Side slope 1 (horiz./vert.)	50	
Side slope 2 (horiz./vert.)	50	
Manning roughness, n ?	0.03	
Channel slope	.005	rise/run
Flow depth	.5	ft
Bend Angle? (for riprap sizing)	0	
Stone specific gravity (2.65)	2.65	
Lining median rock size	1	ft

Results		
Flow area	17.5006	ft^2
Wetted perimeter	60.0100	ft
Hydraulic radius	0.2916	ft
Velocity, v	1.5402	ft/sec
Flow, Q (See notes)	26.9526	cfs
Velocity head, h_v	0.0369	ft
Top width, T	60.0000	ft
Froude number, F	0.50	
Shear stress (tractive force), tau	0.0910	psf
n per Strickler	0.039	
n per Blodgett	-0.388	
n per Bathurst	0.124	
Blodgett vs. Bathurst	----	
Required bottom angular riprap size, D50, Maricopa County ?	0.0274	ft
Required side slope 1 angular riprap size, D50, Maricopa County ?	0.0275	ft
Required side slope 2 angular riprap size, D50, Maricopa County ?	0.0275	ft
Required angular riprap size, D50, per Maynord, Ruff, and Abt (1989)	0.0217	ft
Required angular riprap size, D50, per Searcy (1967)	0.0159	ft

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Onsite Concentration Points - Water Surface Elevation – Manning's Equation

Concentration Point #3 Sheet Flow from Basin 1 & 2 int Basin 3 Q100 = 56.1 CFS

Rolling Plains Construction

Concentration Point #3

Inputs		
Bottom width	5	ft
Side slope 1 (horiz./vert.)	50	
Side slope 2 (horiz./vert.)	50	
Manning roughness, n ?	0.03	
Channel slope	.02	rise/run
Flow depth	.6	ft
Bend Angle? (for riprap sizing)	0	
Stone specific gravity (2.65)	2.65	
Lining median rock size	1	ft

Results		
Flow area	21.0007	ft^2
Wetted perimeter	65.0120	ft
Hydraulic radius	0.3230	ft
Velocity, v	3.2976	ft/sec
Flow, Q (See notes)	69.2498	cfs
Velocity head, h_v	0.1690	ft
Top width, T	65.0000	ft
Froude number, F	1.02	
Shear stress (tractive force), tau	0.4033	psf
n per Strickler	0.039	
n per Blodgett	-0.685	
n per Bathurst	0.060	
Blodgett vs. Bathurst	Bathurst	
Required bottom angular riprap size, D50, Maricopa County ?	0.0847	ft
Required side slope 1 angular riprap size, D50, Maricopa County ?	0.0847	ft
Required side slope 2 angular riprap size, D50, Maricopa County ?	0.0847	ft
Required angular riprap size, D50, per Maynord, Ruff, and Abt (1989)	0.1390	ft
Required angular riprap size, D50, per Searcy (1967)	0.0729	ft

Concentration Point #4 Sheet Flow from Exist Parking Lot into Basin 3 Q100 = 10.0 CFS

Rolling Plains Construction

Concentration Point #4

Inputs		
Bottom width	10	ft
Side slope 1 (horiz./vert.)	50	
Side slope 2 (horiz./vert.)	50	
Manning roughness, n ?	0.03	
Channel slope	.011	rise/run
Flow depth	.3	ft
Bend Angle? (for riprap sizing)	0	
Stone specific gravity (2.65)	2.65	
Lining median rock size	1	ft

Results		
Flow area	7.5002	ft^2
Wetted perimeter	40.0060	ft
Hydraulic radius	0.1875	ft
Velocity, v	1.7016	ft/sec
Flow, Q (See notes)	12.7619	cfs
Velocity head, h_v	0.0450	ft
Top width, T	40.0000	ft
Froude number, F	0.69	
Shear stress (tractive force), tau	0.1287	psf
n per Strickler	0.039	
n per Blodgett	-0.128	
n per Bathurst	0.076	
Blodgett vs. Bathurst	----	
Required bottom angular riprap size, D50, Maricopa County ?	0.0335	ft
Required side slope 1 angular riprap size, D50, Maricopa County ?	0.0335	ft
Required side slope 2 angular riprap size, D50, Maricopa County ?	0.0335	ft
Required angular riprap size, D50, per Maynord, Ruff, and Abt (1989)	0.0316	ft
Required angular riprap size, D50, per Searcy (1967)	0.0194	ft

Appendix B – DRAINAGE CALCULATIONS AND SUPPORTING MATERIAL (Continued)

Basin Dry-up Calculations

Rolling Plains Construction
Basin Dry-Up

Percolation Rate (per Soils Report)

Basin 1

Volume	Depth (in)	Perc Rate (in/hr)	Duration (hr)	Drain Depth (in)	Status
3587	12	1.33	36	48	PASS

Basin 2

Volume	Depth	Perc Rate (in/hr)	Duration (hr)	Drain Depth (in)	Status
3026	12	1.33	36	48	PASS

Basin 3

Volume	Depth	Perc Rate (in/hr)	Duration (hr)	Drain Depth (in)	Status
102092	78	1.33	36	24	FAIL
				Remaining Depth (inches)=	54

Basin 3 requires 2 new drywells. Drywell Calcs below.

Perc. Volume =	44548	(24" of basin depth)
Drywell Volume =	57544	(Remaining Volume)
Drywell Rate =	0.26	cfs (Field Verified Rate)
Drywell Qty =	2	
Hours to Drain =	31	

Contact Arizona 811 at least two full working days before you begin excavation

ARIZONA 811 BLUE STAKE, INC.

Call 811 or click Arizona811.com

APPENDIX C

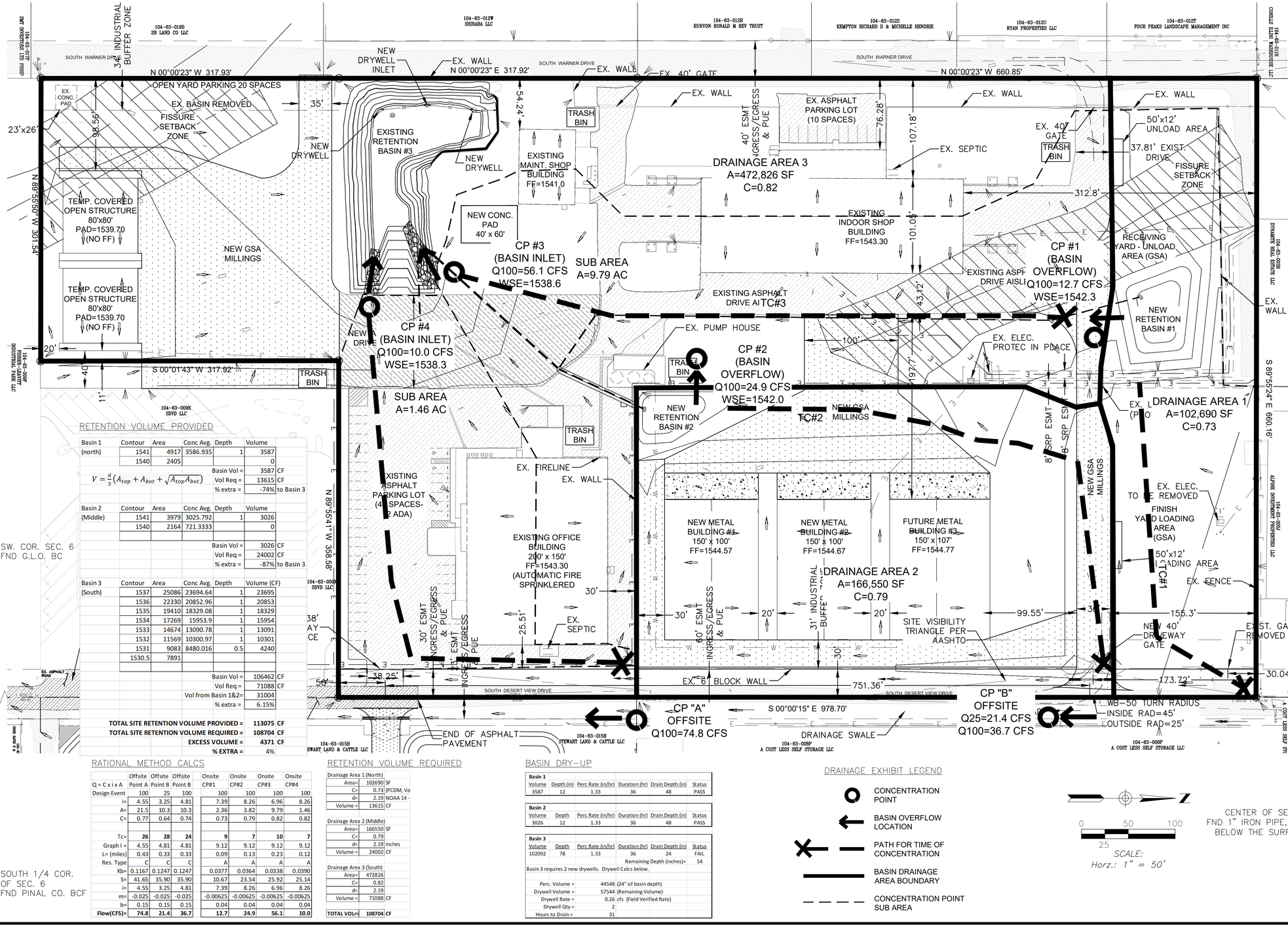
DRAINAGE EXHIBIT FOR ROLLING PLAINS CONSTRUCTION

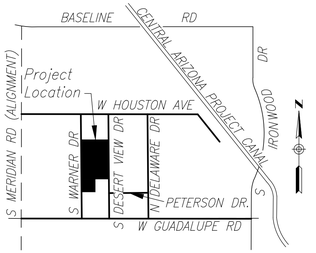
OVERALL SITE PLAN

5050 S. DESERT VIEW DR.

APACHE JUNCTION, AZ 85120

SEC. 6, T1S R8E





VICINITY MAP
Not To Scale

SITE DRAINAGE NARRATIVE:
THE ROLLING PLAINS NDUSTRIAL SITE CURRENTLY SURFACES DRAINS ENTIRELY ABOVE GROUND TO THE EXISTING BASIN #3. THE SITE WILL CONTINUE TO SURFACE DRAIN TO BASIN #3. TWO NEW 12" DEEP BASINS ARE ADDED TO CAPTURE LOCALIZED DRAINAGE AND REDUCE THE OVERALL PEAK FLOW TO BASIN #3. A PRIVATE STORM DRAIN SYSTEM IS ALSO BEING INSTALLED TO ADDRESS LOCALIZED DRAINAGE CONCERNS WITH THE SHALLOW SITE SLOPES. THE STORM DRAIN IS NOT INCLUDED IN ANY DRAINAGE CALCULATIONS. THE STORM DRAIN IS JUST A "BONUS" DRAINAGE FEATURE. WATER SURFACE ELEVATIONS AND Q100 PEAK FLOWS ARE CALCULATED WITHOUT THE BENEFIT OF THE STORM DRAINS. THE STORM DRAINS ARE NOT SHOWN ON THIS EXHIBIT. THE SITE GRADING PLANS SHOW THE STORM DRAIN DESIGN. SEE DRAINAGE REPORT PREPARE FOR ROLLING PLAINS CONSTRUCTION AND REVISED MARCH 2021.

RETENTION VOLUME PROVIDED

	Contour	Area	Conc Avg.	Depth	Volume
Basin 1 (north)	1541	4917	3586.935	1	3587
	1540	2405			0
				Basin Vol =	3587 CF
$V = \frac{d}{3}(A_{top} + A_{bot} + \sqrt{A_{top}A_{bot}})$				Vol Req =	13615 CF
				% extra =	-74% to Basin 3
Basin 2 (Middle)	1541	3979	3025.792	1	3026
	1540	2164	721.3333		0
				Basin Vol =	3026 CF
				Vol Req =	24002 CF
				% extra =	-87% to Basin 3
Basin 3 (South)	1537	25086	23694.64	1	23695
	1536	22330	20852.96	1	20853
	1535	19410	18329.08	1	18329
	1534	17269	15953.9	1	15954
	1533	14674	13090.78	1	13091
	1532	11569	10300.97	1	10301
	1531	9083	8480.016	0.5	4240
	1530.5	7891			
				Basin Vol =	106462 CF
				Vol Req =	71088 CF
				Vol from Basin 1&2=	31004
				% extra =	6.15%
				TOTAL SITE RETENTION VOLUME PROVIDED =	**113075 CF**
				TOTAL SITE RETENTION VOLUME REQUIRED =	**108704 CF**
				EXCESS VOLUME =	**4371 CF**
				% EXTRA =	4%

RATIONAL METHOD CALCS

Q = C x i x A	Offsite Point A	Offsite Point B	Offsite Point B	Onsite CP#1	Onsite CP#2	Onsite CP#3	Onsite CP#4
Design Event	100	25	100	100	100	100	100
i=	4.55	3.25	4.81	7.39	8.26	6.96	8.26
A=	21.5	10.3	10.3	2.36	3.82	9.79	1.46
C=	0.77	0.64	0.74	0.73	0.79	0.82	0.82
Tc=	**26**	**28**	**24**	**9**	**7**	**10**	**7**
Graph I =	4.55	4.81	4.81	9.12	9.12	9.12	9.12
L= (miles)	0.43	0.33	0.33	0.09	0.13	0.23	0.12
Res. Type	C	C	C	A	A	A	A
Kb=	0.1167	0.1247	0.1247	0.0377	0.0364	0.0338	0.0390
S=	41.65	35.90	35.90	10.67	23.54	25.92	25.14
i=	4.55	3.25	4.81	7.39	8.26	6.96	8.26
m=	-0.025	-0.025	-0.025	-0.00625	-0.00625	-0.00625	-0.00625
b=	0.15	0.15	0.15	0.04	0.04	0.04	0.04
Flow(CFS)=	**74.8**	**21.4**	**36.7**	**12.7**	**24.9**	**56.1**	**10.0**

RETENTION VOLUME REQUIRED

Drainage Area 1 (North)

Area=	102690	SF
C=	0.73	(PCDM, Vo
d=	2.19	NOAA 14 -
Volume =	13615	CF

Drainage Area 2 (Middle)

Area=	166550	SF
C=	0.79	
d=	2.19	inches
Volume =	24002	CF

Drainage Area 3 (South)

Area=	472826	
C=	0.82	
d=	2.19	
Volume =	71088	CF
TOTAL VOL=	108704	CF

BASIN DRY-UP

Basin 1 Volume	Depth (in)	Perc Rate (in/hr)	Duration (hr)	Drain Depth (in)	Status
3587	12	1.33	36	48	PASS

Basin 2 Volume	Depth	Perc Rate (in/hr)	Duration (hr)	Drain Depth (in)	Status
3026	12	1.33	36	48	PASS

Basin 3 Volume	Depth	Perc Rate (in/hr)	Duration (hr)	Drain Depth (in)	Status
102092	78	1.33	36	24	FAIL
			Remaining Depth (inches)=		54

Basin 3 requires 2 new drywells. Drywell Calcs below.

Perc. Volume =	44548 (24" of basin depth)
Drywell Volume =	57544 (Remaining Volume)
Drywell Rate =	0.26 cfs (Field Verified Rate)
Drywell Qty =	2
Hours to Drain =	31

DRAINAGE EXHIBIT LEGEND

- CONCENTRATION POINT
- BASIN OVERFLOW LOCATION
- PATH FOR TIME OF CONCENTRATION
- BASIN DRAINAGE AREA BOUNDARY
- CONCENTRATION POINT SUB AREA

N

0 50 100

SCALE: Horz.: 1" = 50'

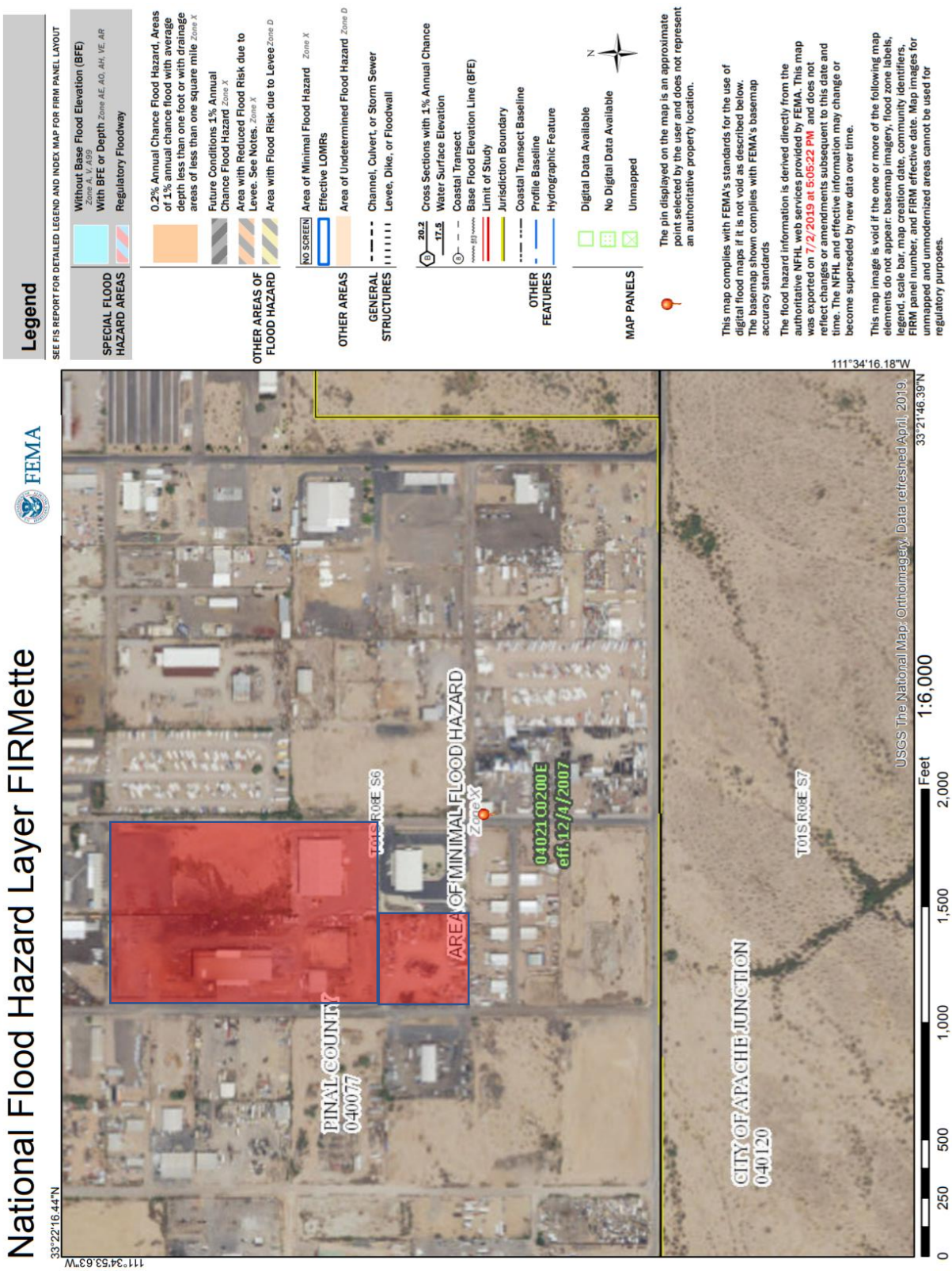
REVISION	DATE
1	
2	
3	

SPECIFIC SITE PLAN FOR ROLLING PLAINS CONSTRUCTION
DRAINAGE EXHIBIT - OVERALL SITE
5050 S. DESERT VIEW DR., APACHE JUNCTION, ARIZONA 85120

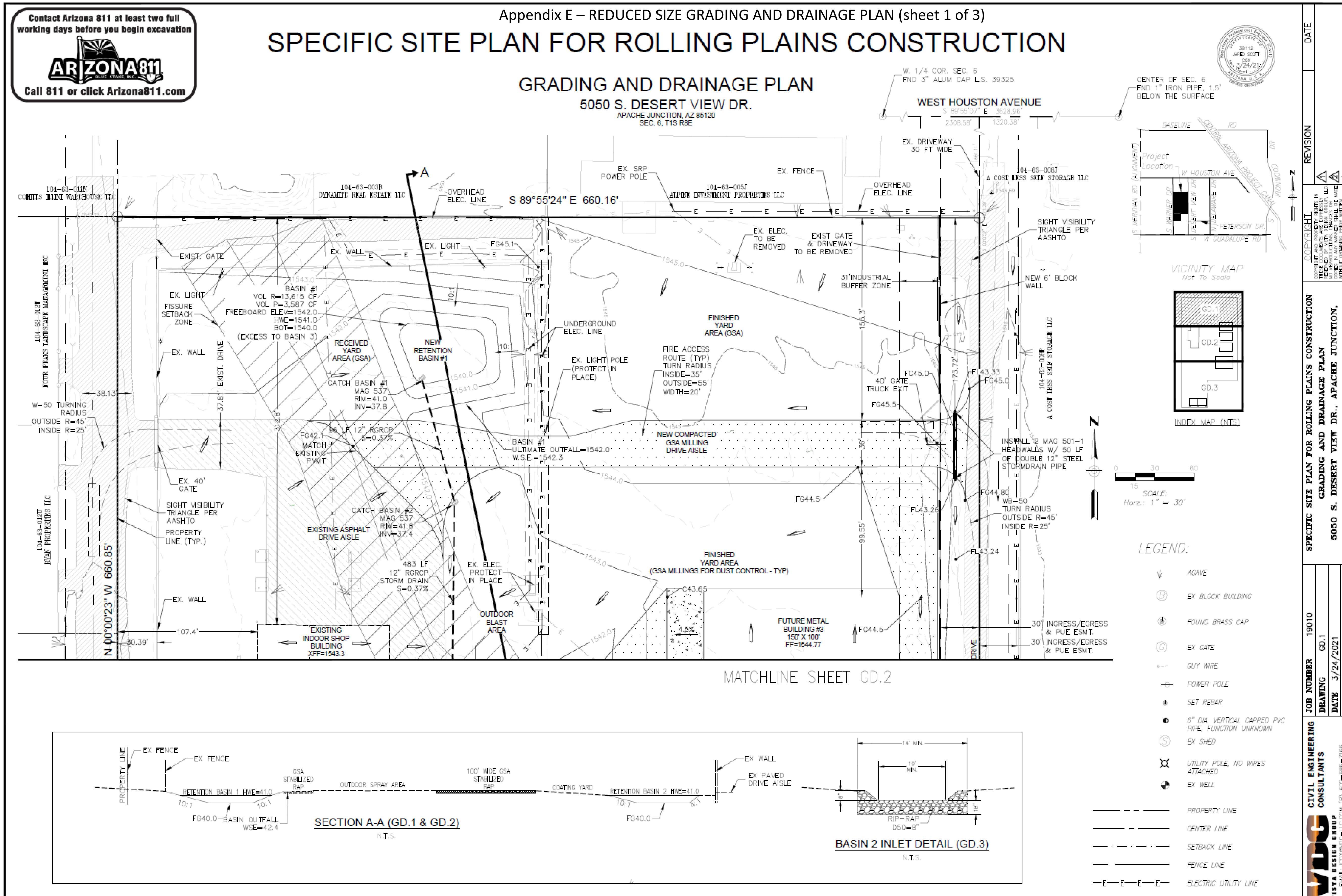
JOB NUMBER	19010
DRAWING	DE.1
DATE	3/24/2021
SHEET	1 OF 1

CIVIL ENGINEERING CONSULTANTS
VISTA DESIGN GROUP
EMAIL: JCOX@VDG-LLC.COM (P) 602-686-7166
2715 E. HERMOSA VISTA DR. MESA, AZ 85213

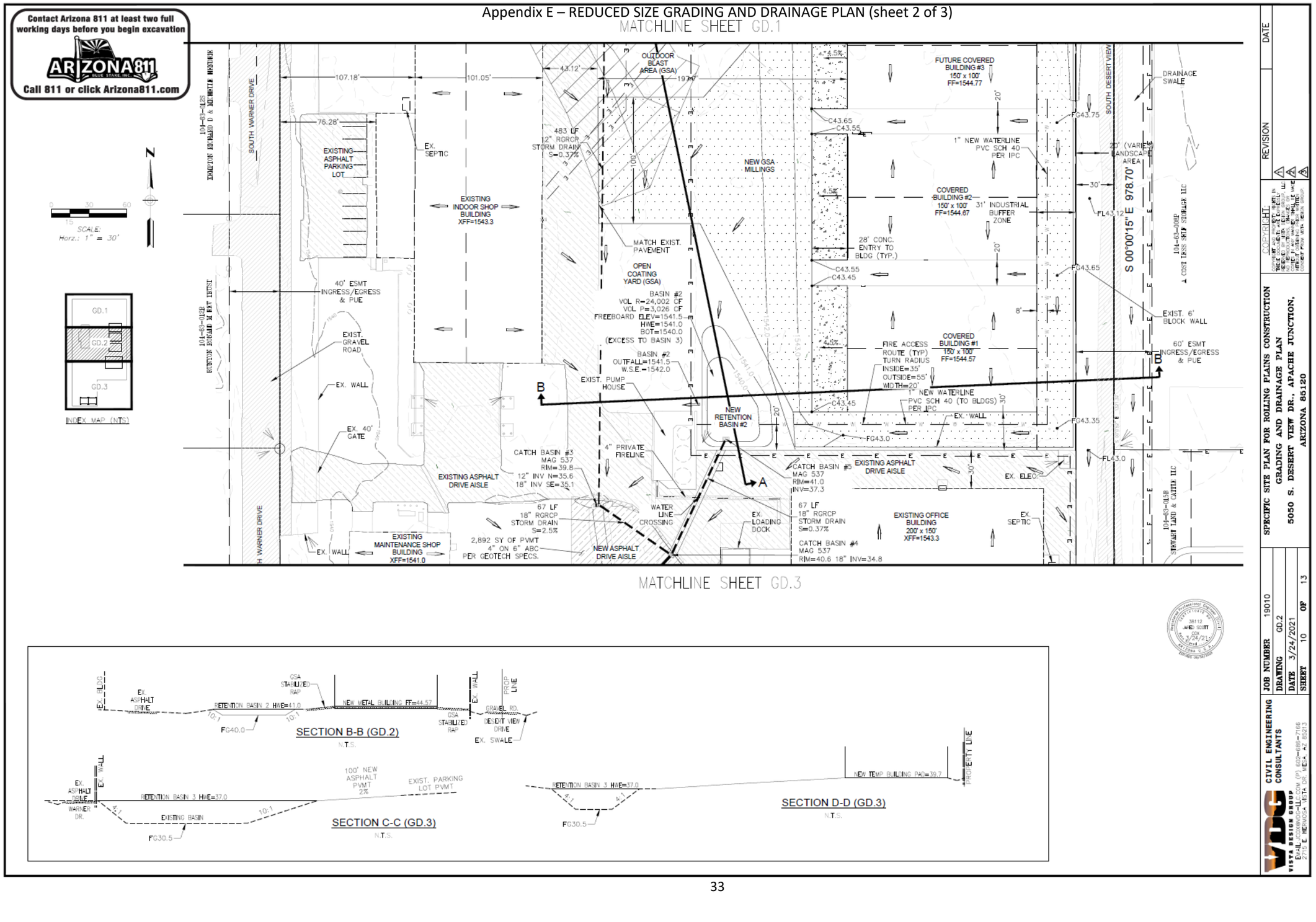
Appendix D – FLOOD INSURANCE RATE MAP (FIRM)



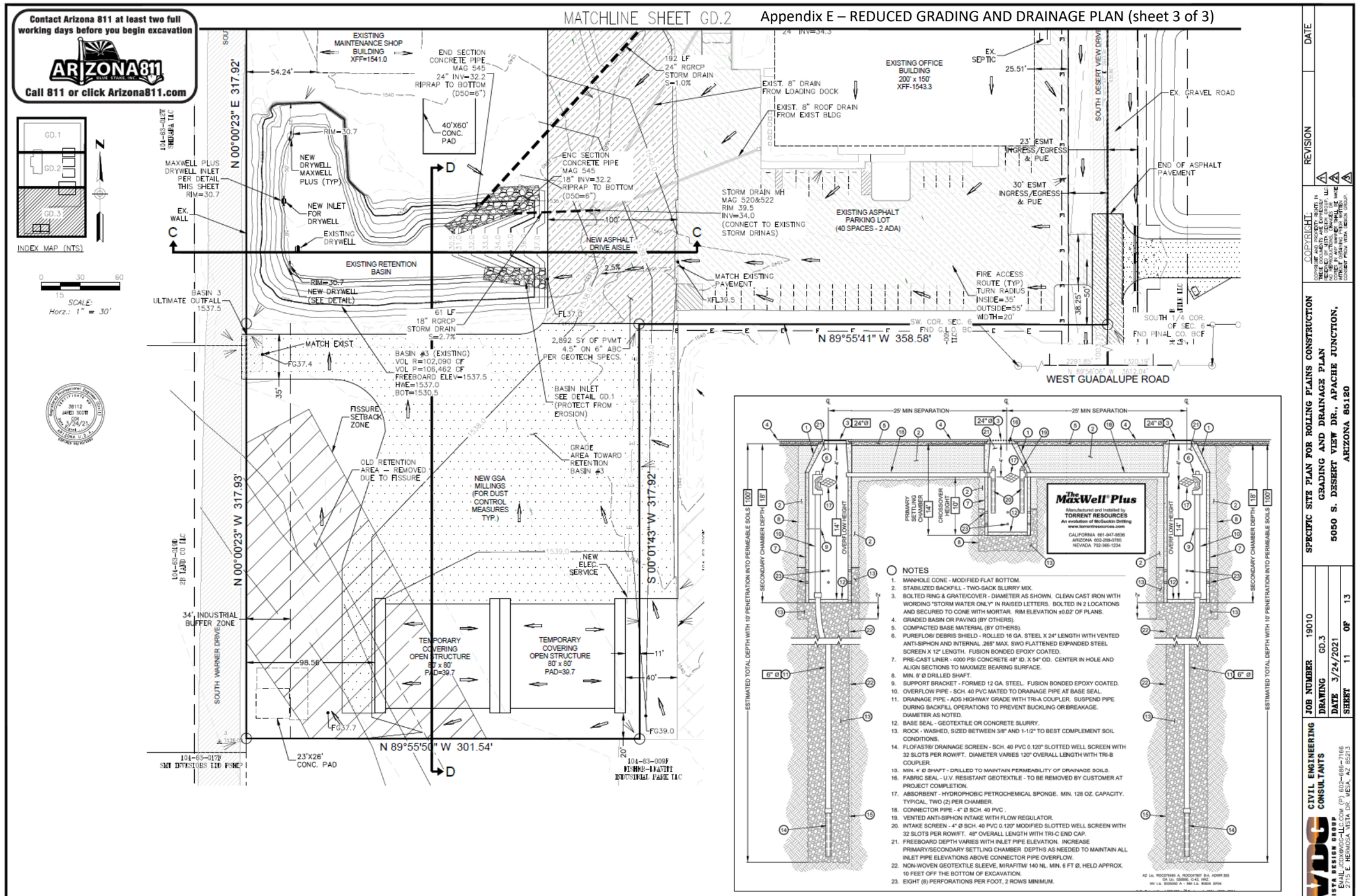
Appendix E – REDUCED SIZE GRADING AND DRAINAGE PLAN (sheet 1 of 3)



Appendix E – REDUCED SIZE GRADING AND DRAINAGE PLAN (sheet 2 of 3)



Appendix E – REDUCED GRADING AND DRAINAGE PLAN (sheet 3 of 3)



Appendix F – DRYWELL PERCOLATION TEST RESULTS Prepared by: Pinal Excavating LLC

Drywell #1 & #2

Pinal Excavating L.L.C.

CONSTANT FLOW PERCOLATION TEST

DATE: 12/30/2020

PROJECT: Rolling Plains

PROJECT ADDRESS: 5050 S Desert View Dr. Apache Junction

CONTACT:

DRYWELL #: 1 N **DRYWELL TYPE: Single Chamber**

TIME	METER	GPM	*cfs*
10:00am	500100		
10:30am	504000	3900	
10:31am	504120	120	0.26738
10:32am	504230	110	0.245098
10:33am	504350	120	0.26738
10:34am	504465	115	0.256239
10:35am	504580	115	0.256239
10:36am	504710	130	0.289661
			0
		0	0

P.E. DRILLING

TOTAL GAL. USED: 4,610 ***CFS: .267***

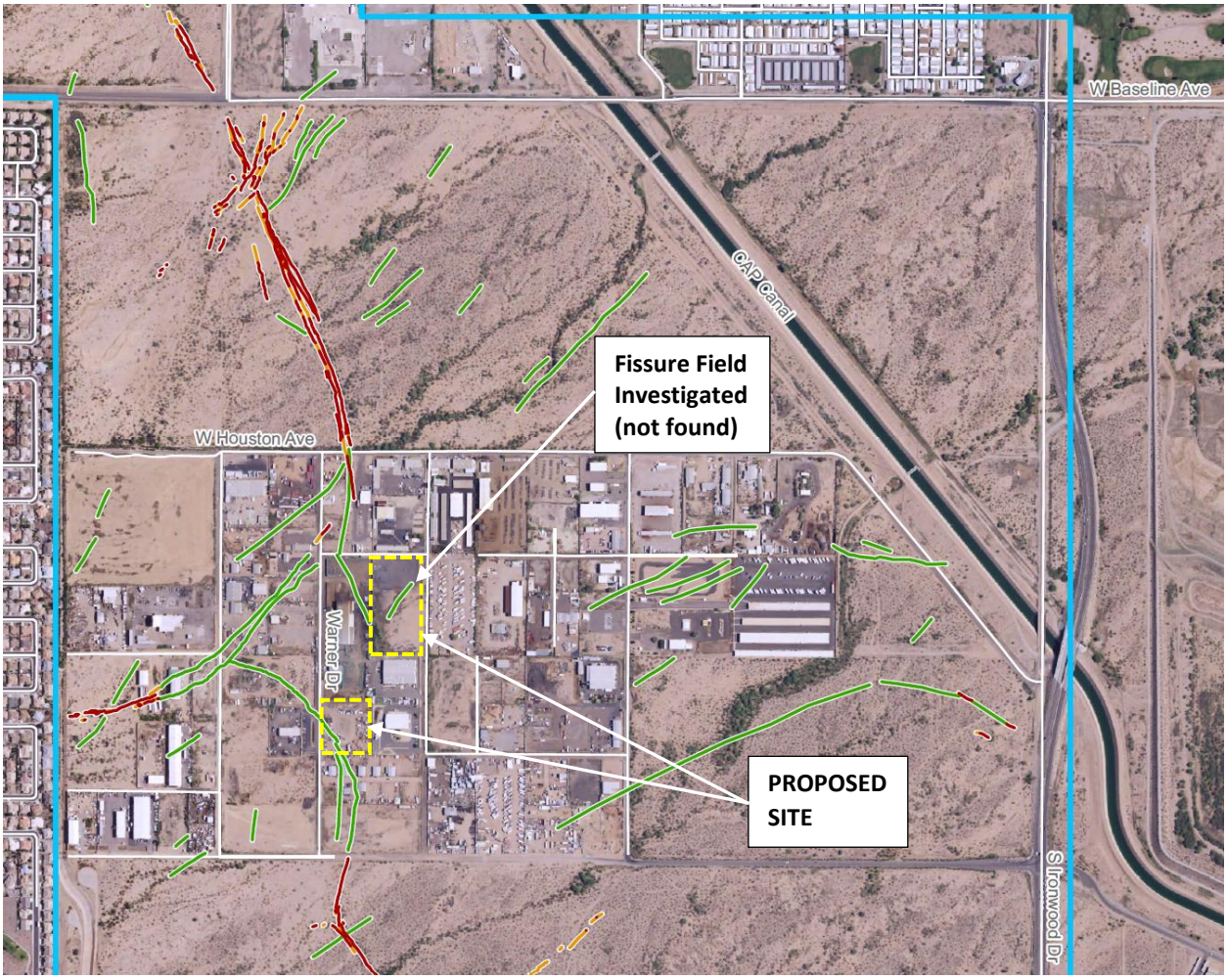
DRYWELL #: 2 S **DRYWELL TYPE: Single Chamber**

TIME	METER	GPM	*cfs*
11:00am	504720		
11:30am	508000	3280	
11:31am	508120	120	0.26738
11:32am	508240	120	0.26738
11:33am	508360	120	0.26738
11:34am	508480	120	0.26738
11:35am	508595	115	0.256239
11:36am	508710	115	0.256239
			0
		0	0

P.E. DRILLING

TOTAL GAL. USED: 3,990 ***CFS: .259***

Appendix G – FISSURE MAP



MAP EXPLANATION

Red lines represent the location of continuous earth fissures manifested as open cracks or gullies.

Orange lines represent the location of discontinuous earth fissures manifested as elongated to circular depressions or as abbreviated or irregular linear depressions. These discontinuous surface features frequently represent an incipient surface expression of an earth fissure.

Yellow lines represent the location of fissures confirmed by non-AZGS personnel or clear evidence of earth fissures on aerial imagery. Traditional field investigation of these features by AZGS was hindered by agricultural or urban modification of the land surface.

Green lines represent the approximate locations of unconfirmed earth fissures, defined as fissures which could not be confirmed by surface investigations by AZGS geologists, but which have been previously reported by Professional Geologists in published documents or maps.

The outline of the Study Area is shown in blue. The limits of the study area are based on interpretation of modern and recent ground subsidence data provided by the Arizona Department of Water Resources. Historical and modern aerial photos taken within this area were searched for anomalous lineaments. These lineaments were then investigated in the field to determine if there was any evidence of earth fissures.

Appendix H – GEOTECHNICAL INVESTIGATION

GEOTECHNICAL EXPLORATION REPORT
ROLLING PLAINS FACILITY –
ADDITIONAL STRUCTURES
5136 SOUTH DESERT VIEW DRIVE
APACHE JUNCTION, ARIZONA 85120

Prepared for:
Rolling Plains Construction
5136 South Desert View Drive
Apache Junction, Arizona 85120

atek
ENGINEERING CONSULTANTS

Prepared by:
ATEK Engineering Consultants, LLC
111 South Weber Drive, Suite 1
Chandler, Arizona 85226

Expires 9/30/2021

ATEK Project # 190070

September 13, 2019

September 13, 2019
ATEK Project #190070

Rolling Plains Construction
Attn: Chris Henderson, Operations Manager
5136 S. Desert View Drive
Apache Junction, AZ 85120

Regarding: Geotechnical Exploration Report

Project: Rolling Plains Facility – Additional Structures
5136 S. Desert View Drive
Apache Junction, AZ 85120

Dear Mr. Henderson:

ATEK Engineering Consultants, LLC is pleased to present the attached Geotechnical Exploration Report for the additional structures at the existing Rolling Plains Facility located in Apache Junction, Arizona. The purpose of our study was to explore and evaluate the subsurface conditions at the proposed site to develop geotechnical engineering recommendations for project design and construction.

Based on our findings, the site is considered suitable for the proposed construction, provided geotechnical recommendations presented in the attached report and land subsidence and earth fissure avoidance and mitigation recommendation provided under separate report by Geological Consultants, Inc. are followed. Specific recommendations regarding the geotechnical aspects of the project design and construction are presented in the attached report. The recommendations contained within this report are dependent on the provisions provided in the Limitations and Recommended Additional Services sections of this report.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Sincerely,
ATEK Engineering Consultants, LLC

Registered Professional Engineer (Civil)
CERTIFICATE NO.
39511
ARMANDO
ORTEGA
Date Signed 9/13/19
ARIZONA, U.S.A.

Expires 9/30/2021

Antonio Lopez, E.I.T
Staff Professional

Armando Ortega, P.E.
Principal Geotechnical Engineer

Distribution: (1) Addresses (Electronic Copy)

111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
P (480) 659-8065
F (480) 656-9658

TABLE OF CONTENTS

Expires 9/30/2021

atek ENGINEERING CONSULTANTS

Expires 9/30/2021

1. INTRODUCTION

This report presents the results of our geotechnical exploration for the additional structures at the Rolling Plains Facility located in Apache Junction, Arizona. A Site Location Map is presented in **Appendix A** of this report. The following sections of this report describe our understanding of the project and our scope of services.

1.1. Project Description

The project consists of constructing additional structures within parcels adjoining the existing Rolling Plains facility located at 5136 South Desert View Drive in Apache Junction, Arizona. The additional structures will consist of the following: two-100 feet by 150-feet covered buildings, a 12-feet by 85-feet premanufactured office building, an 80-feet by 80-feet temporary covering and a future finished yard building (specific building square footage not defined at the time of this report). As part of this study, the existing soil characteristic were explored within an additional area, referenced as parcel 5, for future development (specific building location and square foot not defined at the time of this report). It is anticipated that the structures will be supported on relatively shallow spread footings or relatively shallow drilled cast-in-place foundations. The site improvements will also include modification to an existing retention basin and excavation of a new retention basin.

In addition to the structures and basin improvements it is anticipated that the site development will include asphaltic concrete pavement for light duty parking, heavy duty parking areas and improvements to East Monte Avenue.

1.2. Purpose

The purpose of this geotechnical study was to evaluate the general surface and subsurface conditions at the site, and to present recommendations related to geotechnical aspects of design and construction of the proposed project.

1.3. Scope of Services

Our study included a site reconnaissance, subsurface exploration, soil sampling, field and laboratory testing, engineering analyses, and preparation of this report. This report presents geotechnical recommendations for design and construction of proposed structures. The recommendations contained in this report are subject to the limitations presented herein. Attention is directed to the "Limitations" section of this report.

2. FIELD EXPLORATION

2.1. General

The field exploration was performed between August 23, 2019 and August 27, 2019. The field exploration consisted of advancing ten (10) soil borings and two (2) soil test pits. Prior to the start of drilling, the Arizona Blue Stake Center was contacted to locate the existing utilities at the test locations. Upon completion of the borings and test pits, the holes were backfilled with excavated materials. The borings and test pits were located in the field at the approximate locations shown on the Sample Location Plan included in **Appendix B** of this report.

2.2. Soil Test Borings

The ten (10) soil borings were drilled to depths ranging between fifteen (15) and twenty-five (25) feet below existing grade. The soil test borings were drilled using a truck mounted CME-75 power drill rig equipped with 7 and ¼-inch outside diameter hollow stem augers.

Disturbed and relatively undisturbed samples were taken at the direction of the field engineer during drilling operations. Relatively undisturbed samples of the subsurface materials were obtained using a California sampler with a 2.5-inch inside diameter and a 3.0-inch outside diameter. Disturbed samples were obtained using a Standard

Penetration/Split Spoon Sampler (SPT) with a 1.5-inch inside diameter and 2.0-inch outside diameter. The California and the SPT samplers were driven 12 and 18 inches, respectively, using a 140-pound hammer falling 30 inches, and blow counts for successive 6-inch penetration intervals were recorded. After the sampler was withdrawn from the borehole, the samples were removed, sealed to minimize moisture loss, and submitted to the laboratory.

Soil classifications made in the field from auger cuttings and samples were re-evaluated in the laboratory after further examination and testing. The soils were classified in accordance with the Unified Soil Classification System presented in **Appendix C**.

Sample classifications, blow counts recorded during sampling, and other related information, were recorded on the soil boring logs. The boring logs are presented in **Appendix C**. The information presented on the logs are a combination of factual and interpretive information. Lines delineating subsurface strata and group symbols are based on field observations made at the time of the field study. Actual subsurface lines delineating subsurface strata may be gradual and vary.

2.3. Soil Test Pits and Infiltration Testing

The two (2) soil test pits were excavated using to Bobcat E-26 mini excavator using a 24-inch wide bucket to a depth of approximately three feet below the existing site elevation. An infiltration test was performed within each of the soil test pits in general accordance with the American Society for Testing and Materials (ASTM) D 3385. The lowest measured infiltration rate of the inner ring during the final four, one-hour test periods are presented in the following table for each test location.

Infiltration Test Location	Inner Ring Infiltration Rate (in/hr)
TP-1/DR-1	1.4
TP-2/DR-2	5.2

1. Based on Table 6.14 of the Flood Control District of Maricopa County Drainage Policies and Standards for Maricopa County, Arizona Revised August 22, 2018, a design factor of 0.5 should be applied to double ring infiltration test results performed within Maricopa County.

3. LABORATORY TESTING

Selected soil samples from the borings were tested in the laboratory for classification purposes and to evaluate their engineering properties. The laboratory tests included:

- Gradation;
- Atterberg limits;
- Moisture content;
- One-dimensional consolidation;
- Undisturbed ring density;
- Sulfate content;
- Chloride content;
- Remolded Swell;
- And standard proctor.

A brief description of each test performed on the soil samples and the results are presented in **Appendix D** of this report.

4. GENERAL SITE CONDITIONS

4.1. Surface Conditions

The project includes construction within five parcels located within and around the existing Rolling Plains facility. Parcel 1 is located east of the existing facility and appeared to have been rough graded prior to our field study. Parcel 1 was relatively flat and had a thin layer of surface gravel. Parcel 2 is located northeast of the existing facility and was being used as a laydown area for recently painted structural steel members at the time of our field study. Based on a review of historical aerial

photographs and published earth fissure data, parcel 2 contains earth fissures which were not visually apparent at the time of our field study due to a relatively recent surface layer of gravel. Parcel 3, the existing Rolling Plains facility, contained three steel building, an asphaltic concrete parking lot and a retention basin. Parcel 4 is located south of the existing facility, had a surface layer of asphaltic concrete millings. At the time of our field study, a contactor was observed constructing a shade structure utilizing shipping containers supported on shallow drilled cast in place concrete piers with a light gauge metal roof. Parcel 5 is located west of the existing facility and contained various construction related equipment and debris. Parcel 5 topography sloped downhill from the east to the west across the lot.

4.2. Subsurface Conditions

As indicated by the exploratory borings, in general the surface soils consist of Clayey Sand (SC) and Sandy Clay (CL) with low to medium plasticity. These soils were found to have a relative firmness ranging from moderately firm to hard. Fill material ranging from two (2) to three (3) feet below the existing surface elevation was observed within soil test borings B-2, B-3 and B-5. The underlying subsurface soils encountered during our field exploration consisted of Silty sand (SM), Clayey Sand (SC), and Clayey Gravel with Sand (GC). These soils were found to have a relative firmness ranging from firm to hard. For additional information see Boring Logs presented in **Appendix C**.

4.3. Groundwater Conditions

Groundwater was not encountered within the soil test borings and it is anticipated that groundwater will not be a factor in design or construction of the planned improvements. It should be noted that soil moisture conditions within the area may vary depending on rainfall and/or runoff conditions not apparent at the time of our field study.

4.4. Geologic Hazards

4.4.1. Liquefaction Potential

Based on the site soils and groundwater conditions encountered at the project site during this study, the preliminary potential for soil liquefaction is considered to be negligible.

4.4.2. Collapsible Soils

Collapsible soils are soils with the potential for a decrease in volume with an increase in external load or moisture content. These soils are typically found in areas of alluvial deposits with semi-arid to arid climates. Based on the information collected during our field study and subsequent laboratory testing, we anticipate collapse-susceptible soils will be encountered during construction. Based on ASTM D 5333, a calculated collapse potential, I_C, of the undisturbed ring samples collected during our field study ranged from 3.3 to 7.6 percent indicating a moderate to moderately severe collapse potential.

4.5. Seismic Considerations

The project site is located in north-central Arizona which is an area of low seismic activity. The following values were developed using the ATC Hazard by Location (https://hazards.atcouncil.org) the 2012 International Building Code (IBC) and are based on knowledge of local geologic conditions, and subsurface soils encountered during our study. A 100-foot soil test boring was not advanced during our field study. The geographic coordinates listed below were used in developing the seismic design factors.

Central Latitude.....33.368731˚
Central Longitude.....-111.576870˚

Seismic Design Factors	Value
Site Class	D
F_a, Site Coefficient	1.6
F_v, Site Coefficient	2.4
S_s, Mapped Spectral Acceleration at 0.2-second Period	0.215 g
S_1, Mapped Spectral Acceleration at 1.0-second Period	0.066 g
S_{MS}, Spectral Acceleration at 0.2-second Period Adjusted for Site Class	0.344 g
S_{M1}, Spectral Acceleration at 1.0-second Period Adjusted for Site Class	0.159 g
S_{DS}, Design Spectral Response Acceleration at 0.2-second Period	0.229 g
S_{D1}, Design Spectral Response Acceleration at 1.0-second Period	0.106 g

4.6. Earth Fissures and Land Subsidence

The project site is located in an area with several confirmed and unconfirmed earth fissures (Earth Fissure Map of the Apache Junction Study Area: Pima and Maricopa County, Arizona, dated June 2019 prepared by the Arizona Geological Survey, http://data.azgs.az.gov/hazard-viewer/). The project is also located in an area with a measured land subsidence ranging from zero (0) to one (1) inch (Total Land Subsidence in the Hawk Road Area, Maricopa and Pinal Counties based on Radarsat-2 Satellite Interferometric Synthetic Aperture Radar (InSAR) data Time Periods of Analysis: 8.9 Years May 15, 2010 to March 29, 2019, https://www.azwaterlgov.azdwr/).

It is our understanding that Geological Consultants Inc. (GCI) has prepared a *Task 1 Land Subsidence and Earth Fissure Evaluation*. The Task 1 report discusses earth fissures within and trending towards the parcels referenced within this report, and a Task 2 Earth Fissure Exploration was recommended. In addition to our geotechnical recommendations, avoidance and mitigation recommendation presented in the GCI reports will need to be implemented. ATEK requests that the results of the Task 2

report be provided to us to evaluate any potential changes to our geotechnical recommendations.

5. ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1. Earthwork

The following sections present earthwork recommendations based on our understanding of the project, the finding of our field exploration, results of the laboratory tests and engineering analysis. Based on the finding of our field exploration, laboratory test results and engineering analysis, it is our opinion that the proposed construction can be supported on a spread footing system and/or drilled cast-in-place foundations as presented in the following sections. In addition to our geotechnical recommendations, avoidance and mitigation recommendation presented in the GCI reports will need to be implemented.

5.1.1. Spread Footings

The existing surface soils should be removed to a minimum depth of 3-feet below bottom of proposed spread footing elevation or below the existing surface elevation whichever is deeper. The excavation of the site soils should be within the entire footprint of the structure and should extend laterally for a minimum distance of five (5) feet beyond the perimeter of structure.

The exposed subsurface soils should be scarified to a depth of (8) inches: moisture conditioned to within two (2) percent of optimum moisture and compacted to ninety-five (95) percent of maximum dry density. The excavated material should be moisture conditioned to within two (2) percent of optimum moisture and compacted to ninety-five (95) percent of maximum dry density and used as engineered fill to bring site to within one foot of finished pad elevation. Optimum moisture content

and maximum dry density should be determined by American Society for Testing and Materials (ASTM) D 698.

5.1.2. Conventional Slab

The existing surface soils sampled as part of our field exploration have expansive characteristic and should not be placed within one (1) foot of the bottom of the conventional slab elevation. Engineered material (Native or Import) meeting the recommendations presented in section 5.1.6 may be used to raise the site elevation to the finished pad elevation. Optimum moisture content and maximum dry density should be determined by American Society for Testing and Materials (ASTM) D 698.

5.1.3. Pier Foundations (Drilled Cast-in-Place)

It is anticipated that pier foundations will be used to support shade structures. The pier foundation excavations should be advanced with single-flight auger, rock auger, or bucket auger bits to the design tip elevation. The depth of excavation should be verified by measurement and inspection. The bottom of the hole should be cleaned such that no more than three inches of loose material remains. Depending on the type of auger used and the depth of the shaft excavation, alternative cleaning techniques, including hand cleaning or vacuuming, may be required.

A minimum shaft diameter of 30-inches should be drilled to allow for proper cleaning, bottom preparation and inspection. Provisions should be made for removal of groundwater from the drilled shafts excavations. While groundwater is not anticipated, the drilled pier contractor should have pumps on hand to remove water in the event seepage into the drilled pier is encountered. Concrete slumps ranging between 4 and 7 inches should be specified to fill irregularities along the sides and bottom of the drilled hole, displace water as it is placed (if encountered), and permit placement of reinforcing cages into the fluid concrete. Temporary protective steel casing should be used to prevent side wall collapse, water intrusion, and to allow

worker to safely enter, clean and inspect the drilled shaft. The protective casing many be extracted as the concrete is placed in the drill shaft, providing that a sufficient head of concrete is maintained inside the steel casing to prevent soil or water intrusion in the shaft. The concrete should be placed into the drilled shaft though a chute to reduce side flow or segregation. The geotechnical engineer or his representative should approve the rock socket surface prior to concrete placement.

5.1.4. Pavement Site Preparation and Grading

The pavement section presented in this report are based on the site soils encountered during our field exploration. The native soils should be scarified to a depth of twelve (12) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of ninety-five (95) percent of maximum dry density. Any materials with a diameter larger than 3-inches encountered within the pavement subgrade area during scarification should be removed prior to compaction. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.1.5. Aggregate Base Course

Aggregate base used in support of Portland cement concrete and asphaltic concrete pavements should conform to the local governing agency and/or Maricopa Association of Governments (MAG) Section 702 Specifications. The plasticity index of the fraction of material passing the No. 40 sieve should not exceed five when tested in accordance with ASTM Test Method D 4318. Coarse aggregate should have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM Test Method C 131), of no greater than 40.

A minimum of four (4) inch layer of clean, granular material should be placed beneath concrete slabs to serve as a leveling base, and to aid in concrete curing. The material should conform to the gradation requirements set by the local governing agency

and/or MAG section 702 specifications for Aggregate Base Course (ABC). The use of moisture barriers beneath the floor slabs may be helpful, but is not a geotechnical requirement; however, the architect or the slab designer should evaluate their need.

All aggregate base material should be placed in lifts not greater than eight (8) inches and compacted to a minimum of ninety-five (95) percent of maximum dry density below Portland cement concrete and one hundred (100) percent of maximum dry density below asphaltic concrete pavements as determined by ASTM Test Method D 698 or as specified by local specification. The moisture content during compaction should be maintained within two (2) percent of optimum moisture content.

5.1.6. Engineered Fill

Engineered fill may consist of native soils and/or imported soils utilized in areas as identified in item 1 and 2 below. Pea gravel and poorly-graded materials should not be used as engineered fill unless approved by the geotechnical engineer. All engineered fills should be compacted as noted in section 5.

1. Native soils could be used as fill material for the following:
    - general site grading
    - foundation areas
    - foundation backfill
    - greater than 1-foot below slab areas
    - pavement areas

2. Imported soils with low expansive potentials could be used as fill material for the following:
    - general site grading
    - foundation areas
    - interior floor slab areas
    - foundation backfill
    - exterior slab areas
    - pavement areas

3. Imported soils (if required) should conform to the following:

Percent finer by weight

Gradation	**(ASTM C136)**
3"	100
No. 4 Sieve	50-100
No. 200 Sieve	50 (max)
Liquid Limit	30 (max)
Plasticity Index	15 (max)

Swell Test

Maximum Swell Potential ..... 1.5 %*

*Measured on a sample compacted to approximately 95 percent of the ASTM D 698 maximum dry density at about 2 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

Corrosion Potential	**(PPM)**
Sulfate Content (ARIZ 733)	1,000(max)
Chloride Content (ARIZ 736)	500(max)

4. Aggregate base should conform to MAG and/or local governing specifications.

5. The following are intended to guide in establishing adequate support for the conventional foundation elements:
   - Any natural washes, depressions or new excavations which are to be filled, should be widened as necessary to accommodate compaction equipment and provide a level base for placing fill.
   - Any engineered fill (backfill) materials placed beneath the foundations should meet the requirements for Engineered Fill Materials.
   - All footing excavations should be relatively level and free of loose or disturbed material and inspected by a qualified representative of the Geotechnical Engineer.

6. All fill soils to be used beneath the foundations; slabs and pavements should be approved by the Geotechnical Engineer. Fill should be placed in eight (8) inch loose lifts, moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of ninety-five (95) percent of maximum dry density. Fill materials placed at depth greater than five (5) feet should be compacted to one hundred (100) percent of maximum dry density to finished grade elevation. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.2. Excavation

The field sampling and exploration was performed using a truck-mounted drill rig with 7 and ¼-inch outside diameter hollow stem augers. We present the following general comments regarding ease of excavation with the understanding that they are opinions based on the test borings. The project consultant and contractor should become familiar with this report including boring logs to evaluate potential hard dig conditions. **Please note that excavation characteristics are best evaluated by performing test excavations with the size and type of equipment the contractor plans on using at the site, which was not conducted as part of this study.**

It is anticipated that shallow excavations in the site soils can most likely be accomplished by conventional earth moving equipment in good operating condition. Due to the presence of subsurface cementation, deep excavations may require specialized excavating equipment. Sloughing and caving of near surface soils should be considered during grading operations. Please refer to Section 4 and the boring logs presented in **Appendix** C of this report for more information.

5.2.1. Trench Backfill

Utilities should avoid crossing existing or potential earth fissures or should be constructed to span the earth fissure.

Materials

Pipe zone backfill (i.e., material beneath and in the immediate vicinity of the pipe) should consist of soil with a maximum particle size less than one inch. Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) may consist of soil that meets the requirements for structural fill provided above.

If import material is used for pipe or trench zone backfill, we recommend it consist of fine-grained sand. In general, poorly graded coarse-grained sand and gravel should not be used for pipe or trench zone backfill due to the potential for site soil migration into the relatively large void spaces present in this type of material and water seepage along trenches backfilled with coarse-grained sand and/or gravel.

Recommendations provided above for pipe zone backfill are minimum requirements only. More stringent material specifications may be required to fulfill local codes and/or bedding requirements for specific types of pipes. We recommend the project Civil Engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

Compaction Criteria

Backfill of trenches should utilize site soils with particle diameter less than 3-inches, in order to aid compaction and reduce potential differential settlement problems. Backfilling of utility trenches should be in 12-inch maximum loose lifts, and compacted to a minimum of 90 percent and 95 percent of ASTM D-698 (standard Proctor), in non-structural areas and structural areas, respectively. Please note that the local governing agency specifications may surpass these trench backfill requirements. Jetting, flooding, or puddling of cohesive backfill soils should not be utilized under any circumstances.

Care must be used during compaction of backfill against stem walls. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional excessive wall pressure due to compaction method. To reduce the potential for a

subsurface wall blowout, heavy construction equipment should not be operated next to the below ground reservoir tanks and value vault walls.

5.2.2. Temporary Excavations

General

All excavations must comply with applicable local, state, and federal safety regulations including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. Generally, Construction site safety is solely the responsibility of the Contractor, who shall also be responsible for the means, methods, and sequencing of construction operations. We are providing the information below strictly as a service to our client. Under no circumstances should the information be interpreted that ATEK is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

Excavations and Slopes

The Contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, and/or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Such regulations are strictly enforced; and, if not followed, could result in substantial penalties to the Owner, Contractor, and/or earthwork subcontractor and/or utility subcontractors.

Near-surface soils encountered during our field study consisted predominantly of Clayey Sands and Sandy Clays. In our opinion, these soils would be considered a Type B soil when applying OSHA regulations. For this soils type OSHA recommends a maximum slope inclination of 1(h):1(v) or flatter for excavations 20 feet or less in depth. Steeper cut slopes may be utilized for excavations less than 5 feet deep depending on the strength, moisture content, and homogeneity of the soils as

observed in the field. Flatter slopes and/or trench shields may be required if loose, cohesionless soils and/or water are encountered along the slope face.

Construction Considerations

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within one-third the slope height from the top of any excavation. Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning may be required to provide structural stability and to protect personnel working within the excavation. Shoring, bracing, or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Arizona.

During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff water should be collected and disposed of outside the construction limits.

5.3. Structures

Areas where structures will be constructed should not be within the earth fissures areas identified by Geological Consultants, Inc. reports.

5.3.1. Shallow Spread Footings

Shallow spread footings bearing on engineered fill can be used to support the structures as recommended (See section 5.1). Recommended footing depths and allowable bearing pressures are presented below.

Allowable Bearing Pressure for Shallow Foundations

Footing Depth Below Finished Grade (ft.)*	Allowable Bearing Pressure (psf)
2.5	3,000
3.0	3,500

***Note**: Footing depth is defined as the depth below the lowest adjacent finished grade elevation within 5-feet of the edge of the footing.

A one-third increase may be applied to the design bearing pressures when considering short duration loads, such as wind and seismic.

Continuous footings and isolated column footings should have a minimum width of 16-inches and 24 inches respectively. The minimum widths are recommended for ease of construction, and to provide a margin of safety against a local or punching shear failure of the foundation soils. All footings should be reinforced to reduce potential distress caused by differential foundation movement.

All the footing excavations should be observed by the Geotechnical Engineer prior to placement of reinforcing steel and/or concrete. If subsurface conditions are encountered that are different than indicated by the borings, revised recommendations may be required.

Settlement of footings designed as recommended above are estimated not to exceed 1-inch. Differential settlements over, a horizontal distance of 50 feet between similarly loaded footings, are expected to be less than ½-inch and ¾-inch for wall and column footings, respectively. Significant moisture increases above those recommended for compaction could result in additional movements. In order to minimize the sensitivity of the structure to differential settlements, footings should

be reinforced to allow for a degree of load redistribution should a localized zone of supporting soils become saturated.

5.3.2. Resistance to Lateral Loads

Proposed walls/structures that will retain soil must be designed to withstand lateral soil pressures. Cantilevered retaining walls, or unrestrained walls subject to lateral earth pressures, should be designed for an equivalent fluid pressure (EFP) of 36 PCF. Restrained walls should be designed to withstand a residual or long-term at-rest (Ko) earth pressure condition of 53 pounds per cubic foot (PCF).

A passive EFP of 277 PCF may be used for shallow spread footings. A coefficient of friction of 0.34 is recommended for computing lateral resistance between the base of footing and soil in analyzing lateral loads. Vehicular surcharge loads and/or hydrostatic pressure will increase the recommended EFP.

Only cohesionless, free-draining granular materials should be used as backfill, adjacent to earth-retaining structures. We recommend that backfill directly behind the walls be compacted with light, hand-held compactors. Heavy compactors and grading equipment should not be allowed to operate within 3 feet of the walls during backfilling, to avoid developing excessive temporary or long-term lateral soil pressures. Positive gravity drainage of the backfill should be provided.

5.4. Deep Foundations

5.4.1. Foundations (Drilled Cast-in-Place)

Pier foundations (Drilled Cast-in-Place) bearing on undisturbed native soils can be used to support the shade structures. The following values should be used in design.

Design Parameters	
Lateral Bearing Capacity	150 psf/ft, Maximum lateral resistance is limited to 2,250 psf.
Lateral Sliding Resistance	0.25

Foundation Depth Below Finish Grade (ft.)	Allowable Toe Bearing Capacity (psf)
5-10	4,000
11-15	5,000
15+	6,000

A one-third increase may be applied to the design bearing pressures when considering short duration loads, such as wind and seismic.

All the foundation excavations should be observed by the Geotechnical Engineer prior to placement of reinforcing steel and/or concrete. A minimum of 8 hours should be allowed between concrete placement in one pole foundation before drilling an adjacent shaft within 5 diameters, center-to-center. Loose soils at the bottom of the drilled holes should be removed to the extent possible. If subsurface conditions are encountered that are different than indicated by the test borings and/or water is encountered, revised recommendations may be required.

5.4.1.1. Steel and Concrete Placement

We recommend steel reinforcement and concrete be placed immediately upon completion of each shaft excavation. Concrete used for shaft construction should be discharged vertically into the drilled hole to minimize aggregate segregation. Under no circumstances should concrete be allowed to free-fall against either the steel reinforcement or the sides of the excavation during shaft construction.

For construction in a dry hole, concrete should be placed through a suitable tube or tremie, so that it is channeled in such a manner to free-fall and clear the walls of the excavation and reinforcing steel until it strikes the bottom. Adequate compaction will be achieved by free-fall of the concrete up to the top 10 feet. The top 10 feet of concrete should be vibrated in order to achieve proper compaction. Placement of concrete and concrete mix design details should be in accordance with Section 609 of the ADOT Standard Specifications.

5.4.1.2. Quality Assurance

Observation of the drilled shaft construction should be performed by a representative of the Geotechnical Engineer to verify proper diameter, depth and cleaning, and to also verify the nature of the materials encountered in the shaft excavations. Concrete placement should be observed by the engineer's representative to ensure that it meets requirements. A quality control report should be submitted on each shaft, documenting compliance with design details and specifications.

5.4.1.3. Estimated Settlements

Settlement of pier foundations designed as recommended above are estimated not to exceed ¾-inch. Significant moisture increases above those recommended for compaction could result in additional movements. In order to minimize the sensitivity of the structure to differential settlements, footings should be reinforced to allow for a degree of load redistribution should a localized zone of supporting soils become saturated.

5.5. Moisture Protection

Soil support values reduce with an increase of moisture content. Therefore, positive drainage is essential to the successful performance of any structure. Good surface and subsurface drainage should be established during and after construction to prevent

the soils below or adjacent to the structural areas and utility trenches from becoming wet.

Infiltration of water into utility or foundation excavations must be prevented during construction. The drainage design must route all storm and sprinkler water away from the structural areas in a positive manner. All water should be diverted away from areas where it could penetrate the ground surface near the structural areas. Watering of plants should be avoided adjacent to the buildings. Desert-type landscaping is advisable near the structural areas. Plants, which require more water, should be located and drained away from the structural areas.

5.6. Corrosion Potential

Selected samples of the near-surface soils encountered at the site were subjected to chemical analysis for the purpose of corrosion assessment. The samples were tested for soluble sulfates, and soluble chlorides. The samples were tested in general accordance with Arizona Test Methods 733, and 736 for soluble sulfates, and soluble chlorides, respectively. The test results are provided in **Appendix C**.

Based on provisions of American Concrete Institute (ACI) 318 Section 4.3, Table 4.3.1, *Requirements for Concrete Exposed to Sulfate-Containing Solutions* a sulfate concentration below 0.10 percent by weight (1,000 ppm) is negligible. Based on the laboratory results, sulfate contents of the site soils tested indicate a negligible corrosion potential to concrete.

Based on the laboratory result of the sample collected for this project, chloride contents of the site soils tested indicate a negligible corrosion potential.

5.7. Pavement Areas

The on-site soils should be suitable as pavement subgrade soils provided all unsuitable debris, rubble, oversized cobbles, etc. are removed. A flexible and/or rigid

pavement is recommended for the pavement areas. The recommended pavement sections are based on the assumption that the subgrade soils are prepared in accordance with section 5.1 of this report.

The flexible pavement section should consist of Central Plant Mix Asphaltic Concrete Pavement (AC) on compacted Aggregate Base Course (ABC) as recommended in the table below. Flexible pavement should be placed in accordance with MAG Section 321 and local municipality standards.

PAVEMENT AREA	ASPHALT SURFACE THICKNESS (IN)	AGGREGATE BASE COURSE THICKNESS (IN)	ESTIMATED ESAL VALUES
Parking Areas (On-Site)	3	6	150,000
Heavy Traffic Areas (On-Site)	4	6	500,000
East Monte Avenue	4	10	*

*Note: Pavement recommendation for East Monte Avenue is based on the minimum structural number required to Local Road (Industrial/Commercial Subdivisions) per Maricopa County Department of Transportation of 2.88.

Our calculations for design of the pavements section is based upon our classification of the subsurface soils, the calculated traffic in 18 kips equivalent single axle loads, the site preparation and grading recommendations provided above. A design life of 20 years was used in design.

Areas subject to sustained, heavy concentrated loads, such as dumpster areas should be paved with PCC. A pavement section of 6 inches of PCC on 4 inches of aggregate base course is recommended in these areas. We should be contacted for additional

recommendations if there will be any areas subjected to volumes of traffic heavier than those assumed for this report.

6. CLOSURE

6.1. Limitations

Our professional services have been performed using that degree and skill ordinarily exercised, under similar circumstances, by reputable Geotechnical Engineers practicing in this or similar localities. No warranty is expressed or implied.

The recommendations contained in this report are based on our field exploration, laboratory test results, and our understanding of the proposed construction. The subsurface data used in the preparation of this report was obtained from the test borings excavated during the field subsurface exploration. It is anticipated that some variations in the soil conditions will exist on-site. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, we should be immediately notified so that we may make any necessary revisions to the recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, our firm should also be notified.

It is the Client's responsibility to see that all parties to the project including the designer, contractor, subcontractor, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

This report is for the exclusive purpose of providing Geotechnical Engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the

owner is concerned about the potential for such contamination, other studies should be undertaken. This report has also not addressed the site geology and the possible presence of geologic hazards.

This report may be used only by the Client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on and off-site), or other factors may change over time, and additional work may be required with the passage of time. Any party, other than the Client, who wishes to use this report, shall notify ATEK of such intended use. Based on the intended use of this report, ATEK may require that additional work be performed and that an updated report be issued.

6.2. Recommended Additional Services

The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be performed during the construction. These tests and observations should be performed by the Geotechnical Engineer's representative and should include, but not limited to the following:

- Observe and document that any existing surficial vegetation and other deleterious materials have been removed from the site as required in site preparation section.
- Approve any material used as import to document that it meets the requirements outlined above before placement.
- Monitor the backfill procedures.
- Perform field density tests, as needed, to verify compaction compliance. The representative should monitor the progress of compaction and filling operations.
- Keep records of on-site activities and progress.

Observation of footing excavations should be performed prior to placement of reinforcing and concrete to confirm that satisfactory bearing materials are present. Construction testing, including field and laboratory evaluation of fill and backfill materials, concrete and steel should be performed to determine whether applicable project requirements have been met.

APPENDIX A
Site Location Map

atek
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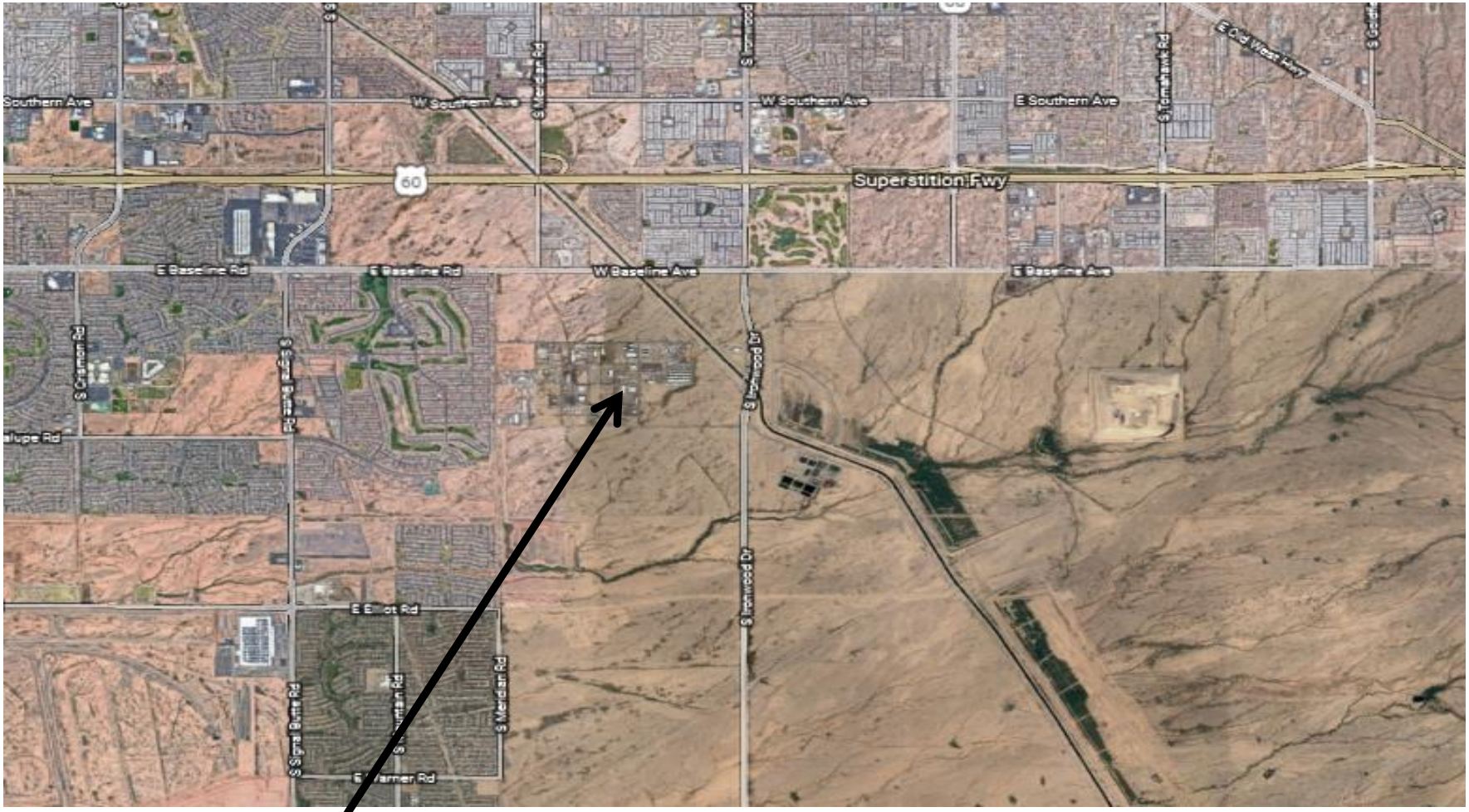


Project Site

N

Site image from earth.google.com.

*Note: not to scale.

Site Location Map

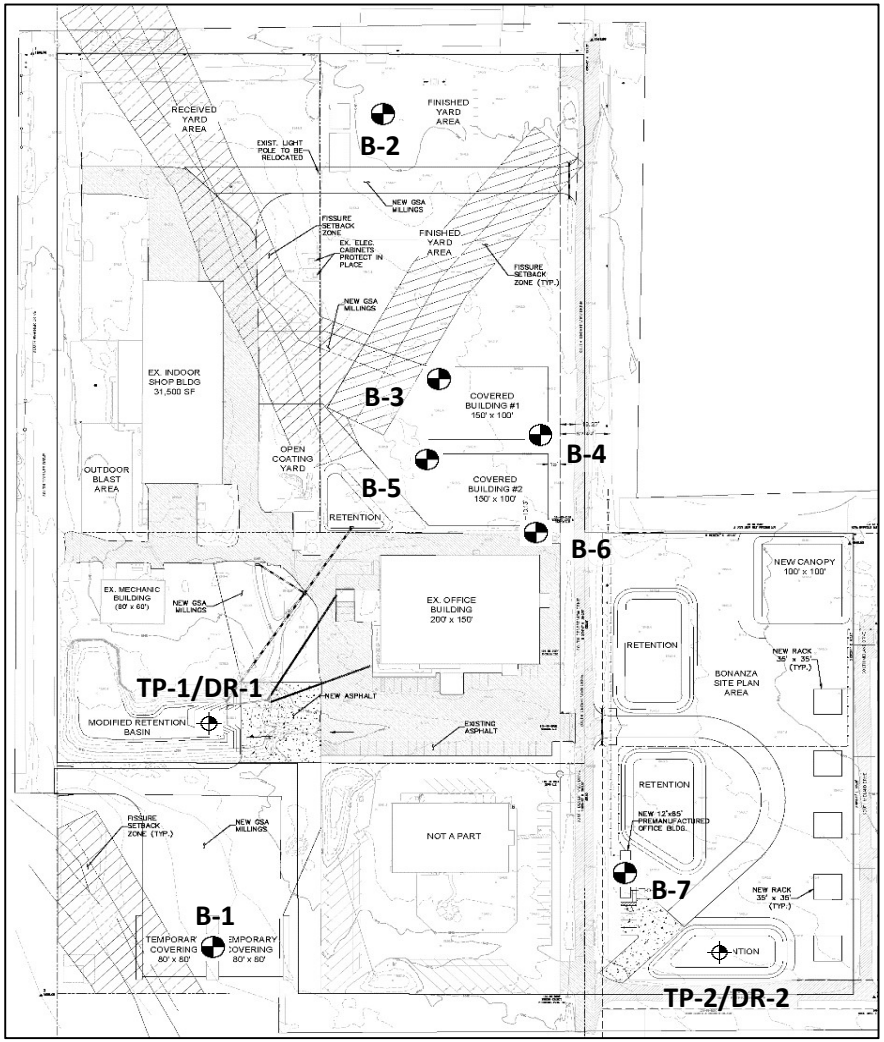
atek ENGINEERING CONSULTANTS

Sheet 1 of 1

ATEK Engineering Consultants, LLC
111 South Weber Drive, Suite 1
Chandler, AZ 85226

Rolling Plains Facility	
Project Number:	190070
Date:	September-19
Drawn By:	A Lopez

APPENDIX B
Sample Location Plan



Legend:

Soil Test Boring

Test Pit/Infiltration Location

Site image from Preliminary Site Layout

*Note: not to scale.

Sample Location Plan

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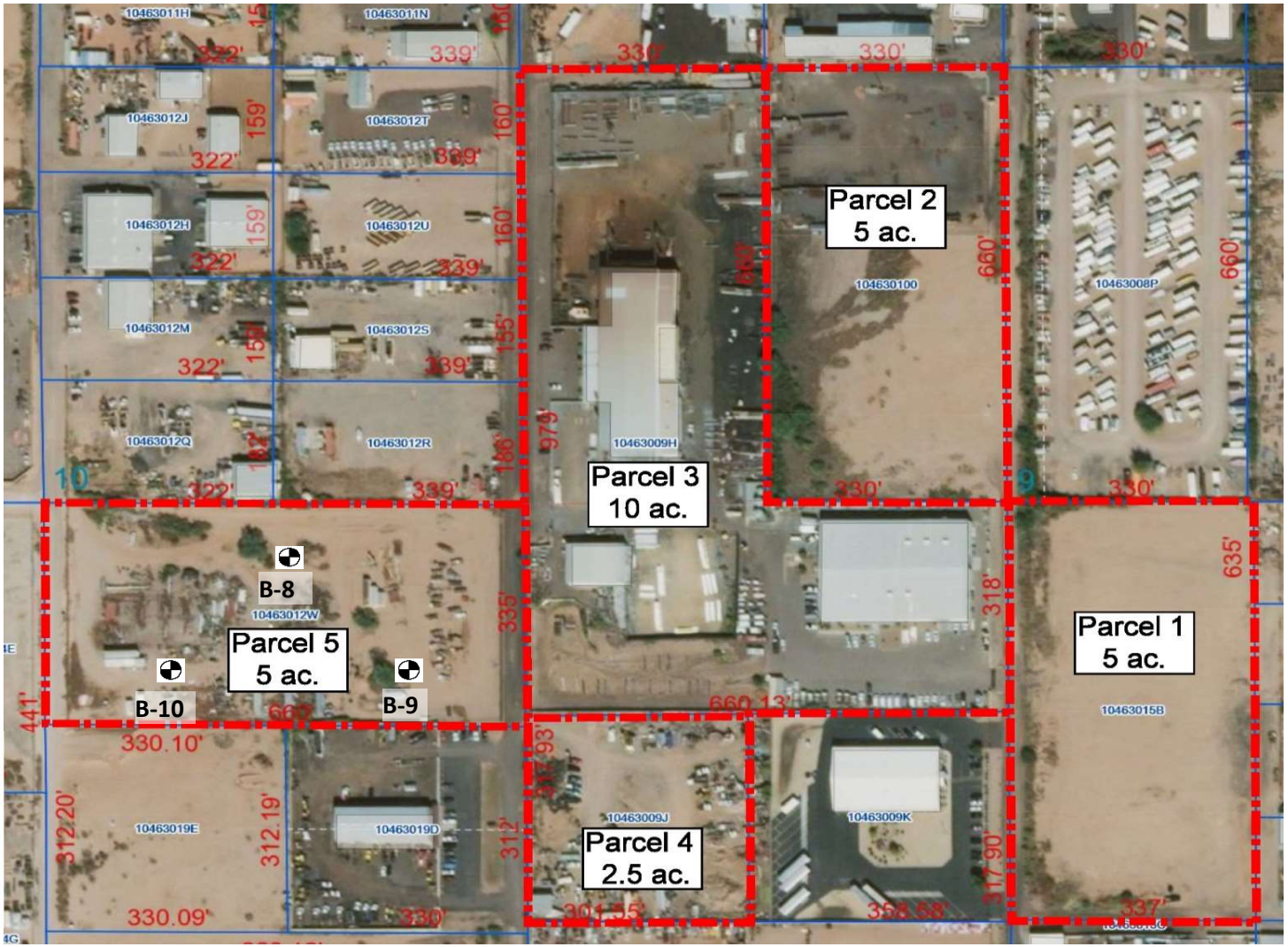
Sheet 1 of 2

ATEK Engineering Consultants, LLC
111 South Weber Drive, Suite 1
Chandler, AZ 85226

Rolling Plains Facility	
Project Number:	190070
Date:	August-19
Drawn By:	J Floyd



Legend:

Soil Test Boring

Test Pit/Infiltration Location

Site image from earth.google.com.

*Note: not to scale.

Sample Location Plan

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Sheet 2 of 2

ATEK Engineering Consultants, LLC
111 South Weber Drive, Suite 1
Chandler, AZ 85226

Rolling Plains Facility	
Project Number:	190070
Date:	September-19
Drawn By:	A Lopez

APPENDIX C
FIELD STUDY AND BORING LOGS

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APPENDIX C
FIELD STUDY

BORINGS

The subsurface conditions at the site were explored on August 23, 2019, by drilling soil borings using a truck mounted CME drill rig with 7 and a ¼-inch outside diameter hollow stem auger. The locations of soil test borings performed for this study are shown in **Appendix B** of this report.

The locations of borings were located by visual sighting and pacing from existing site features and, therefore, should be considered approximate. Actual boring locations may vary from those indicated in **Appendix B**.

Our field engineer maintained a log of the excavations; visually classified soils encountered according to the Unified Soil Classification System (USCS) (see USCS Table); and obtained samples of the subsurface materials.

SAMPLING PROCEDURES

Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance, and returned to our laboratory for further testing. After borings were completed, they were backfilled with the excavated soils.

LIST OF ATTACHMENTS

The following plates are attached and complete this appendix.

Unified Soil Classification System – C1
Log Key – C2
Charts and Definitions – C3
Terminology Used to Describe Soils – C4
Logs of Soil Borings

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LESS THAN 5% PASSING NO. 200 SIEVE	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% PASSING NO. 200 SIEVE	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LESS THAN 5% PASSING NO. 200 SIEVE	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% PASSING NO. 200 SIEVE	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

Note: Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing No. 200 sieve require dual USCS symbols. (See KEY A-3 if provided)

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Drafted By: ALE

Date: September, 2019

Project Number: 190070

UNIFIED SOIL CLASSIFICATION SYSTEM

Rolling Plains Facility
Rolling Plains Construction
Apache Junction, Arizona

KEY

C-1

LOG SYMBOLS


BULK / GRAB SAMPLE


MODIFIED CALIFORNIA SAMPLER
(2 inch inside diameter)


GRAB SAMPLE


STANDARD PENETRATION
SPLIT SPOON SAMPLER
(2.0-inch O.D. X 1.4-inch I.D.)


SHELBY TUBE
(3 inch outside diameter)


NON-STANDARD PENETRATION
SPLIT SPOON SAMPLER
(1.5-inch O.D. X 0.9-inch I.D.)


BDBGM SIZE CORE BARREL
(1.65-inch I.D.)


BW44 SIZE CORE BARREL
(1.75-inch I.D.)


HQ-3 SIZE CORE BARREL
(2.4-inch I.D.)


WATER LEVEL
(level after completion)


WATER LEVEL
(level where first encountered)

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
3. Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
4. In general, the Unified Soil Classification designations presented on the logs were based on visual classification in the field, modified where appropriate by visual classifications in the office, and/or laboratory gradation and index testing.
5. NA = Not Analyzed

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Drafted By: ALE
Date: September, 2019

Project Number: 190070

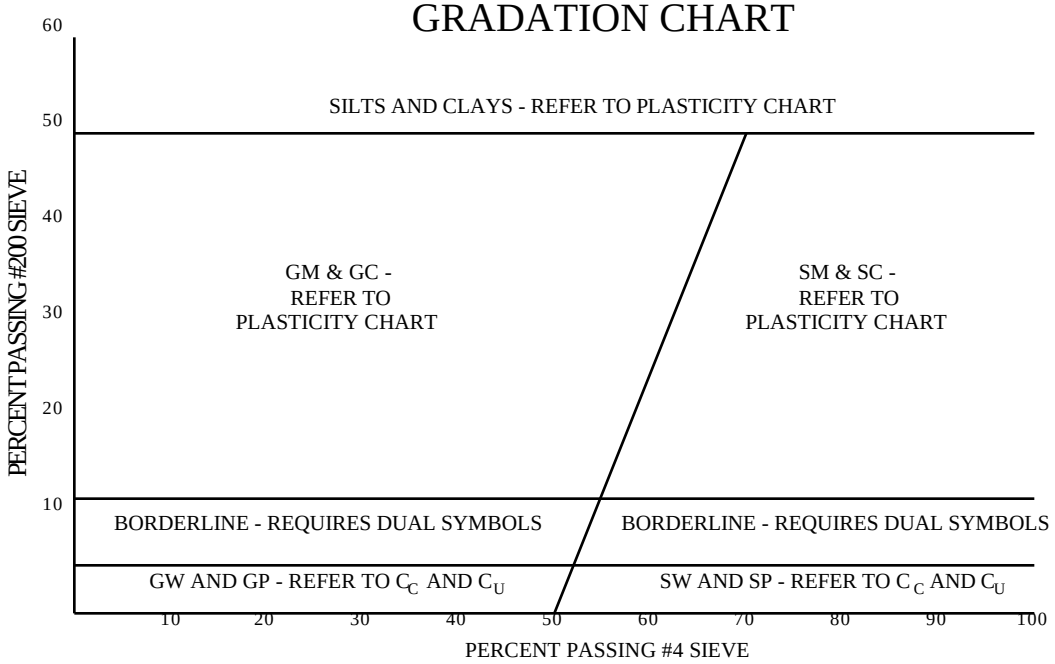
LOG KEY

Rolling Plains Facility
Rolling Plains Construction
Apache Junction, Arizona

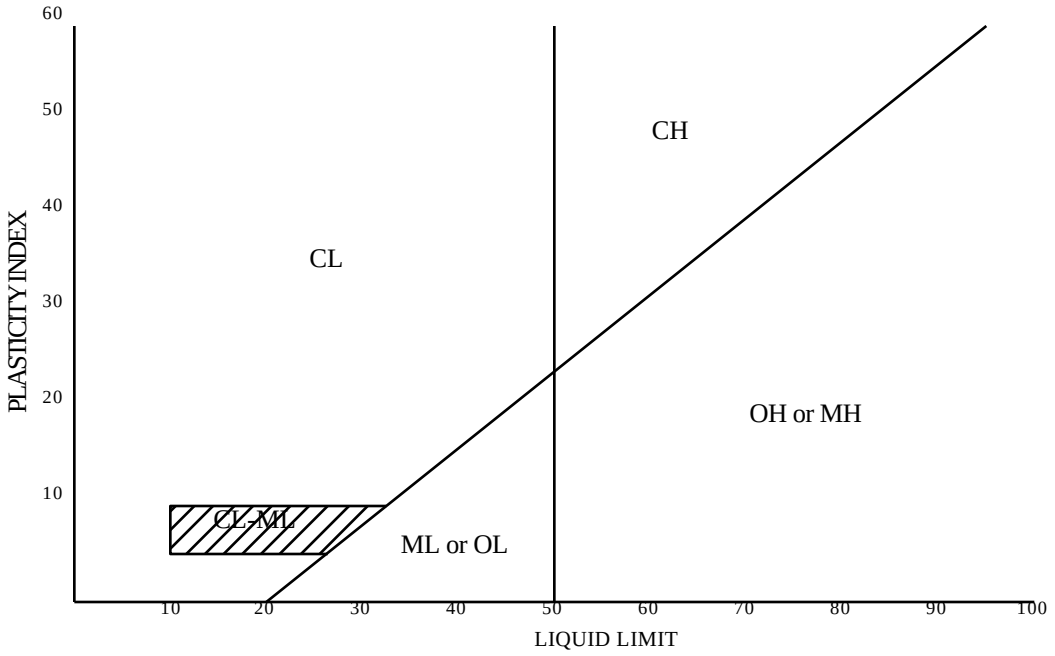
KEY

C-2

GRADATION CHART



PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL FRACTION	PARTICLE SIZE RANGE
Boulders	Greater than 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Coarse Gravel	75mm to 19mm (3in. to 3/4in.)
Fine Gravel	19mm (3/4in.) to No. 4 sieve
Coarse Sand	No. 4 sieve to No. 10 sieve
Medium Sand	No. 10 sieve to No. 40 sieve
Fine Sand	No. 40 sieve to No. 200 sieve
Fines	less than No. 200 sieve

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Drafted By: ALE

Date: September, 2019

Project Number: 190070

CHARTS & DEFINITIONS

Rolling Plains Facility
Rolling Plains Construction
Apache Junction, Arizona

KEY

C-3

TERMINOLOGY USED ON THE BORING LOGS TO DESCRIBE
THE FIRMNESS, DENSITY, OR CONSISTENCY OF SOILS

The standard penetration resistance (**N**) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. Terms for description of partially saturated and/or cemented soils including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0 - 4	Very soft
5 - 8	soft
9 - 15	Moderately firm
16 - 30	Firm
31 - 50	Very firm
51+	Hard

2. Terms for description of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
51+	Very dense

3. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency
0 - 2	Very soft
3 - 4	soft
5 - 8	Moderately stiff
9 - 15	Stiff
16 - 30	Very Stiff
31+	Hard

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Drafted By: ALE
Date: September, 2019

Project Number: 190070

TERMINOLOGY USED TO DESCRIBE SOILS

Rolling Plains Facility
Rolling Plains Construction
Apache Junction, Arizona

KEY

C-4

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-1		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
				5.1		26	10	34	SC		CLAYEY SAND (SC) 12% fine graded gravel, 54% coarse to fine grained subrounded sand, 34% fines, moderately firm to firm, medium plasticity, medium brown, moist, no cementation, no reaction to HCl (NATIVE MATERIAL)		
			3-6	7.3	97.9								
5			10-10-15									6	
									SM		SILTY SAND (SM) 60% coarse to fine grained subrounded to subangular sand, 40% fines, firm to hard, low plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)		
10			10-12-14										
15			21-27-34										
20			50/6"									20.5	

Bottom of boring @ 20 feet bgs.
Bottom of sampler @ 20.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 190070

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LOG OF EXPLORATORY BORING B-1

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-2		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			2-5-9	5.3		27	12	55	CL		SANDY CLAY (CL) 8% coarse to fine graded gravel, 37% coarse to fine grained sand, 55% fines, moderately firm, medium plasticity, medium brown, moist, no cementation, no reaction to HCl (FILL MATERIAL)	3	
5			15-21	5.2	102.4				SC		CLAYEY SAND (SC) 60% coarse to fine grained subrounded to subangular sand, 40% fines, very firm to hard to very firm, low plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)		
10			12-24-36										
15			19-20-22									16.5	

Bottom of boring @ 15 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 190070

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LOG OF EXPLORATORY BORING B-2

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-3		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									CL		SANDY CLAY (CL) 10% coarse to fine graded gravel, 30% coarse to fine grained sand, 60% fines, medium plasticity, reddish brown, moist, no cementation, no reaction to HCl (FILL MATERIAL)	2	
			5-6-10	5.1		29	14	56	CL		SANDY CLAY (CL) 6% fine graded gravel, 38% coarse to fine grained sand, 56% fines, firm, medium plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)		
5			13-17	7.1	99.4								
												9	
10			14-14-16						SC		CLAYEY SAND (SC) 60% coarse to fine grained subrounded to subangular sand, 40% fines, firm to hard to very firm to hard, low to medium plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)		
15			19-25-34										
20			19-20-26										
25			36-50/4"									25.8	

Bottom of boring @ 25 feet bgs.
Bottom of sampler @ 25.8 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 190070

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LOG OF EXPLORATORY BORING B-3

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-4		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
0				3.1		26	11	34	SC		CLAYEY SAND (SC) 10% fine graded gravel, 56% coarse to fine grained sand, 34% fines, firm to very firm to hard to very firm to hard, medium plasticity, medium brown, moist, weak to strong cementation, strong reaction to HCl (NATIVE MATERIAL)		
			10-16										
5			9-9-15										
10			12-19-19										
15			27-29-34										
20			20-22-26										
25			35-50/4.5"									25.9	

Bottom of boring @ 25 feet bgs.
Bottom of sampler @ 25.9 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 190070

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LOG OF EXPLORATORY BORING B-4

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-5		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									CL		SANDY CLAY (CL) 10% coarse to fine graded gravel, 30% coarse to fine grained sand, 60% fines, medium plasticity, reddish brown, moist, no cementation, no reaction to HCl (FILL MATERIAL)	2	
			5-6	7.6 4.3	87.5	28	10	59	CL		SANDY CLAY (CL) 2% fine graded gravel, 39% coarse to fine grained sand, 59% fines, moderately firm, medium plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)	5	
5			20-18-9						GC		CLAYEY GRAVEL WITH SAND (GC) 50% coarse to fine graded gravel, 25% coarse to fine grained sand, 25% fines, firm, low plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)	8	
									CL		SANDY CLAY (CL) 40% coarse to fine grained sand, 60% fines, very firm, medium plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)		
10			16-21-25										
15			29-50/5"						GC		CLAYEY GRAVEL WITH SAND (GC) 50% coarse to fine graded gravel, 25% coarse to fine grained sand, 25% fines, hard, low plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)	15 15.9	

Bottom of boring @ 15 feet bgs.
Bottom of sampler @ 15.9 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 190070

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LOG OF EXPLORATORY BORING B-5

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-6		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
0				3.1		26	10	50	CL		SANDY CLAY (CL) 5% fine graded gravel, 45% coarse to fine grained sand, 50% fines, firm to very firm, medium plasticity, reddish brown, moist, no cementation, no reaction to HCl (NATIVE MATERIAL)		
			6-10										
5			15-18-18										
10			18-18-26						SC		CLAYEY SAND (SC) 65% coarse to fine grained sand, 35% fines, very firm, medium plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)	10	
15			10-11-26									16.5	

Bottom of boring @ 15 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 190070

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LOG OF EXPLORATORY BORING B-6

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-7		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
0				3.3		25	8	47	SC		CLAYEY SAND (SC) 2% fine graded gravel, 51% coarse to fine grained sand, 47% fines, firm, low plasticity, medium to light brown, moist, no cementation, no reaction to HCl (NATIVE MATERIAL)	8	
5			7-10										
			6-11-10										
									GC		CLAYEY GRAVEL WITH SAND (GC) 40% coarse to find graded gravel, 30% coarse to fine grained sand, 30% fines, low plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)	10	
10			14-16-16						SC		CLAYEY SAND (SC) 5% fine graded gravel, 65% coarse to fine grained sand, 30% fines, very firm to hard, low plasticity, medium to light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)		
15			24-27-36									16.5	

Bottom of boring @ 15 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 190070

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LOG OF EXPLORATORY BORING B-7

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-8		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
5			8-10-12						SC		CLAYEY SAND (SC) 11% fine graded gravel, 54% coarse to fine grained sand, 35% fines, firm to very firm, medium plasticity, medium to light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)		
			18-19	10.5 6.2	96.4	42	22	35					
10			11-13-14									12.5	
15			24-26-29						GC		CLAYEY GRAVEL WITH SAND (GC) 45% coarse to find graded gravel, 35% coarse to fine grained sand, 20% fines, hard, low plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)	16.5	

Bottom of boring @ 15 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 190070

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LOG OF EXPLORATORY BORING B-8

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-9		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
				2.9		25	9	51	CL		SANDY CLAY (CL) 4% fine graded gravel, 45% coarse to fine grained sand, 51% fines, firm, low plasticity, medium to light brown, moist, no cementation, weak reaction to HCl (NATIVE MATERIAL)		
			8-8	8.5	84								
5			9-7-8										
10			14-16-18						SC		CLAYEY SAND (SC) 65% coarse to fine grained sand, 45% fines, very firm, low plasticity, light brown, moist, weak cementation, strong reaction to HCl (NATIVE MATERIAL)	10	
15			13-16-18									16.5	

Bottom of boring @ 15 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 190070

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LOG OF EXPLORATORY BORING B-9

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Rolling Plains Facility		Client: Rolling Plains Construction	
Borehole Location: See Sample Location Plan			Sheet 1 of 1
Borehole Number: B-10		Driller: Southland	Logger: J Floyd
Drilling Equipment: CME-75	Borehole Diameter (in.): 7 1/4 HSA	Date Started: 8/23/19	Date Finished: 8/23/19

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
0				3.5		28	12	40	SC		CLAYEY SAND (SC) 7% fine graded gravel, 53% coarse to fine grained sand, 40% fines, firm to very firm to hard, medium plasticity, medium to light brown, moist, no cementation, weak reaction to HCl (NATIVE MATERIAL)		
			10-16										
5			12-18-20										
10			18-19-25										
15			19-25-27									16.5	

Bottom of boring @ 15 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Mud Rotary; Air Rotary; Auger Solid Stem; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 190070

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-10

190070 ROLLING PLAINS FACILITY.GPJ ` 9-3-19 ` J Floyd ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

APPENDIX D
Laboratory Test

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APPENDIX D
LABORATORY TESTING

LABORATORY TESTS
Laboratory tests were performed on selected samples to aid in soil classification and to evaluate physical properties of the soils, which may affect the Geotechnical aspects of project design and construction. A description of the laboratory testing program is presented below.

Sieve Analysis
Sieve analyses were performed to evaluate the gradation characteristics of the material and to aid in soil classification. Tests were performed in general accordance with ASTM Test Method C 136 and D 2487.

Atterberg Limits
Atterberg Limits tests were performed to aid in soil classification and to evaluate the plasticity characteristics of the material. Additionally, test results were correlated to published data to evaluate the shrink/swell potential of near-surface site soils. Tests were performed in general accordance with ASTM Test Method D 4318.

Moisture Content
Moisture content tests were performed to evaluate moisture-conditioning requirements during site preparation and earthwork grading. Moisture content was evaluated in general accordance with ASTM Test Method D 2216.

One-Dimensional Consolidation
A one-dimensional consolidation test was performed on a ring samples to evaluate consolidation potential of the site soil. Test procedure was in general accordance with ASTM Test Method D 2435.

Undisturbed Ring Density
Undisturbed ring density tests were performed on ring samples to evaluate the in-situ density and moisture content of the site soils. Test procedures were in general accordance with ASTM Test Method D 2937.

Sulfate Content
Sulfate content tests were performed to evaluate the corrosion potential of the on-site soils. Tests were performed in general accordance with ARIZ 733.

Chloride Content
Chloride content tests were performed to evaluate the corrosion potential of the on-site soils. Tests were performed in general accordance with ARIZ 736.

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PROJECT: Rolling Plains Facility
LOCATION: Apache Junction, AZ
DATE SAMPLED: 8/23/2019

PROJECT NO: 190070
WORK ORDER NO: 1910254
REVIEWED BY: J Floyd

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

					COBBLES		GRAVEL									SAND								Silt or Clay	
							Coarse					Fine				Coarse		Medium			Fine				
Location & Depth	USCS	LL	PL	PI	6"	4"	3"	2"	1 1/2"	1 1/4"	1"	3/4"	1/2"	3/8"	1/4"	#4	#8	#10	#16	#30	#40	#50	#100	#200	Lab #
Bulk Sample B-1 @ 0.0'-5.0'	SC	26	16	10	100	100	100	100	100	100	100	99	98	96	92	88	79	75	67	57	52	49	42	34	1
Bulk Sample B-2 @ 0.0'-3.0'	CL	27	15	12	100	100	100	100	100	100	99	98	95	94	93	92	90	88	85	79	76	73	65	55	6
Bulk Sample B-3 @ 2.0'-5.0'	CL	29	15	14	100	100	100	100	100	100	100	99	98	96	95	94	88	86	80	74	71	69	64	56	11
Bulk Sample B-4 @ 0.0'-5.0'	SC	26	15	11	100	100	100	100	100	100	100	99	98	97	93	90	79	75	67	56	51	47	41	34	17
Bulk Sample B-5 @ 2.0'-5.0'	CL	28	18	10	100	100	100	100	100	100	100	100	99	99	98	98	94	92	87	81	78	75	69	59	24
Bulk Sample B-6 @ 0.0'-5.0'	CL	26	16	10	100	100	100	100	100	100	100	99	99	99	97	95	89	87	81	73	68	66	59	50	29
Bulk Sample B-7 @ 0.0'-2.5'	SC	25	17	8	100	100	100	100	100	100	100	100	100	100	99	98	93	91	84	75	71	67	58	47	34
Bulk Sample B-8 @ 5.0'-10.0	SC	42	20	22	100	100	100	100	100	100	100	100	98	97	93	89	80	76	68	57	53	49	42	35	39
Bulk Sample B-9 @ 0.0'-5.0'	CL	25	16	9	100	100	100	100	100	100	100	100	99	98	97	96	91	89	84	77	73	69	61	51	43
Bulk Sample B-10 @ 0.0'-5.0	SC	28	16	12	100	100	100	100	100	100	100	100	99	98	96	93	85	82	74	64	60	56	49	40	48

PERCENT PASSING BY WEIGHT

This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at client's request.

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PROJECT: Rolling Plains Facility
LOCATION: Apache Junction, AZ
SAMPLE DATE: 8/23/2019

PROJECT: 190070
WORK ORDER: 1910254
REVIEWED BY:

DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD -- ASTM D 2937

LAB #	SAMPLE SOURCE	MOISTURE			# OF RINGS	WET WEIGHT + RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
		WET WEIGHT (g)	DRY WEIGHT (g)	MOISTURE CONTENT				
8	Ring B-2 @ 5.0-6.0'	779.0	740.6	5.2%	6	1047.6	267.3	102.4
13	Ring B-3 @ 5.0-6.0'	771.3	720.0	7.1%	6	1044.2	272.3	99.4
41	Ring B-8 @ 5.0-6.0'	771.6	698.1	10.5%	6	1043.6	271.3	96.4

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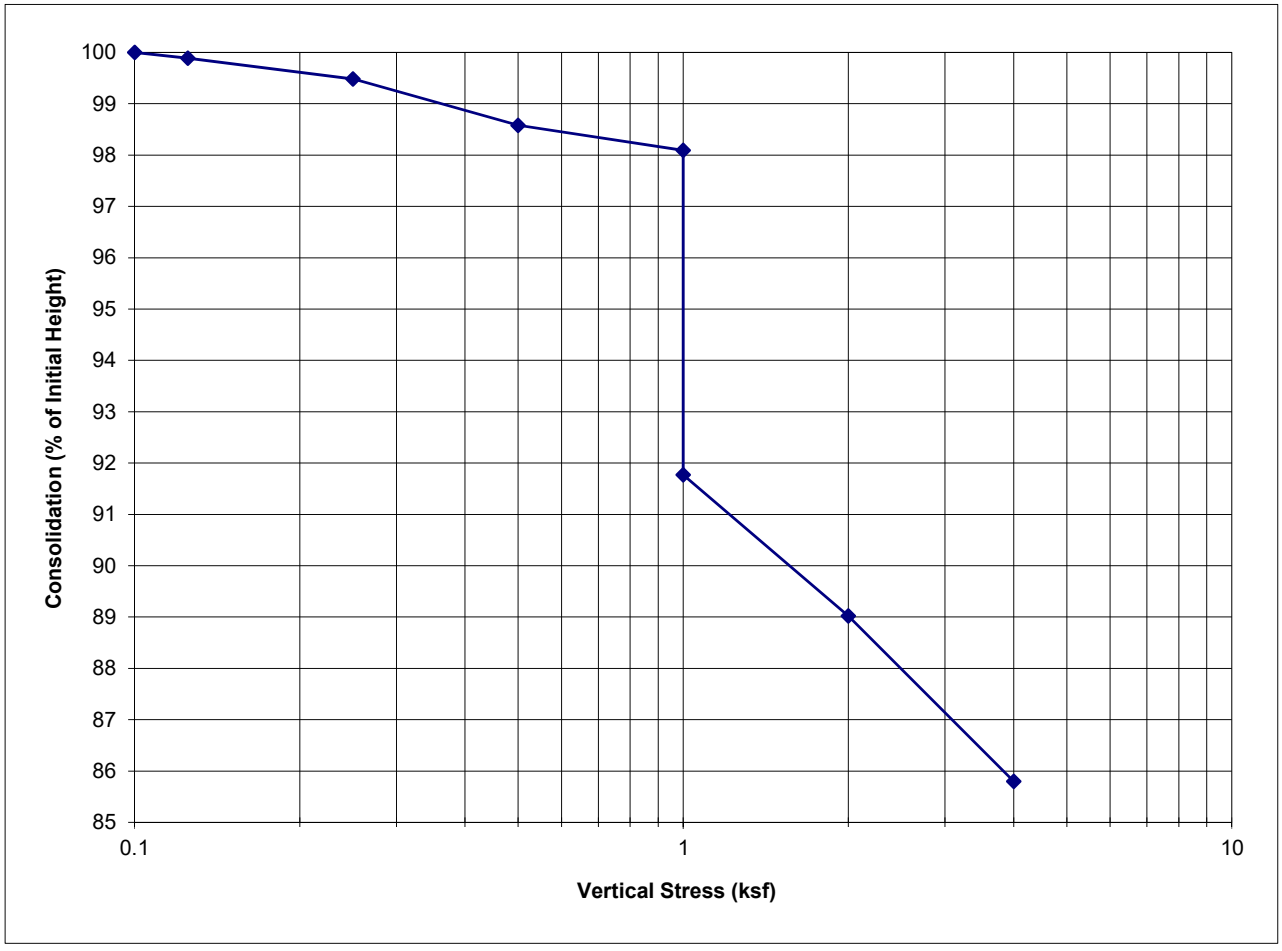
Project:	Rolling Plains Facility	**Project Number:**	190070
Project Location:	Apache Junction, Arizona	**Work Order Number:**	1910254
Client:	Rolling Plains Facility	**Lab Number:**	2
Material:	Native	**Date Sampled:**	08/23/19
Sample Source:	Ring Sample B-1 @ 2.5'-3.5'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	3.95
Initial Moisture Content	7.3%	Final Moisture Content	17.0%
Initial Dry Density(pcf)	97.9	Final Dry Density(pcf)	114.0
Initial Degree of Saturation	28%	Final Degree of Saturation	100%
Initial Void Ratio	0.7	Final Void Ratio	0.5
Estimated Specific Gravity	2.65	Saturated at	1 ksf



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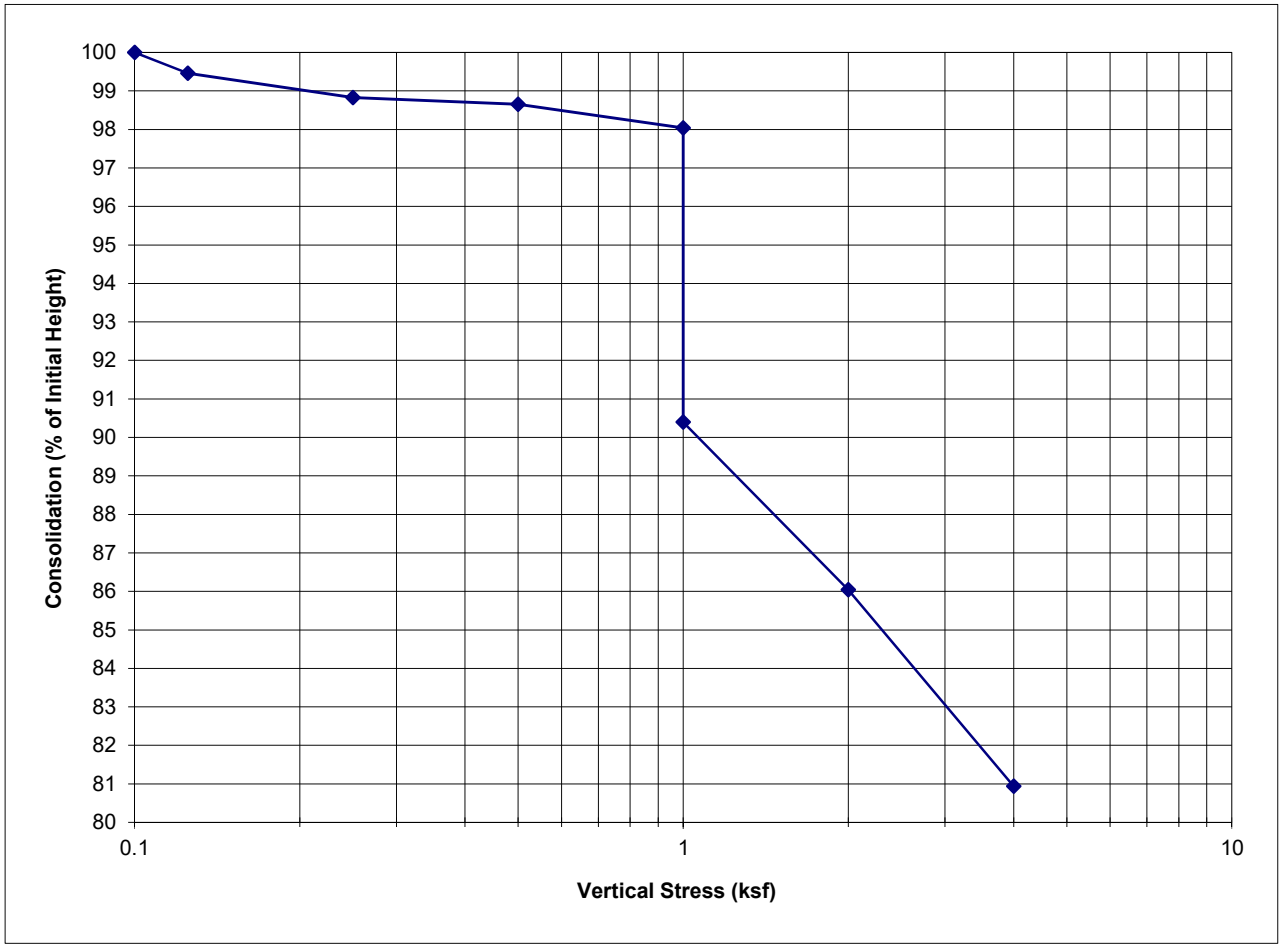
Project:	Rolling Plains Facility	**Project Number:**	190070
Project Location:	Apache Junction, Arizona	**Work Order Number:**	1910254
Client:	Rolling Plains Facility	**Lab Number:**	25
Material:	Native	**Date Sampled:**	08/23/19
Sample Source:	Ring Sample B-5 @ 2.5'-3.5'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	3.73
Initial Moisture Content	7.6%	Final Moisture Content	20.1%
Initial Dry Density(pcf)	87.5	Final Dry Density(pcf)	108.0
Initial Degree of Saturation	23%	Final Degree of Saturation	100%
Initial Void Ratio	0.9	Final Void Ratio	0.5
Estimated Specific Gravity	2.65	Saturated at	1 ksf



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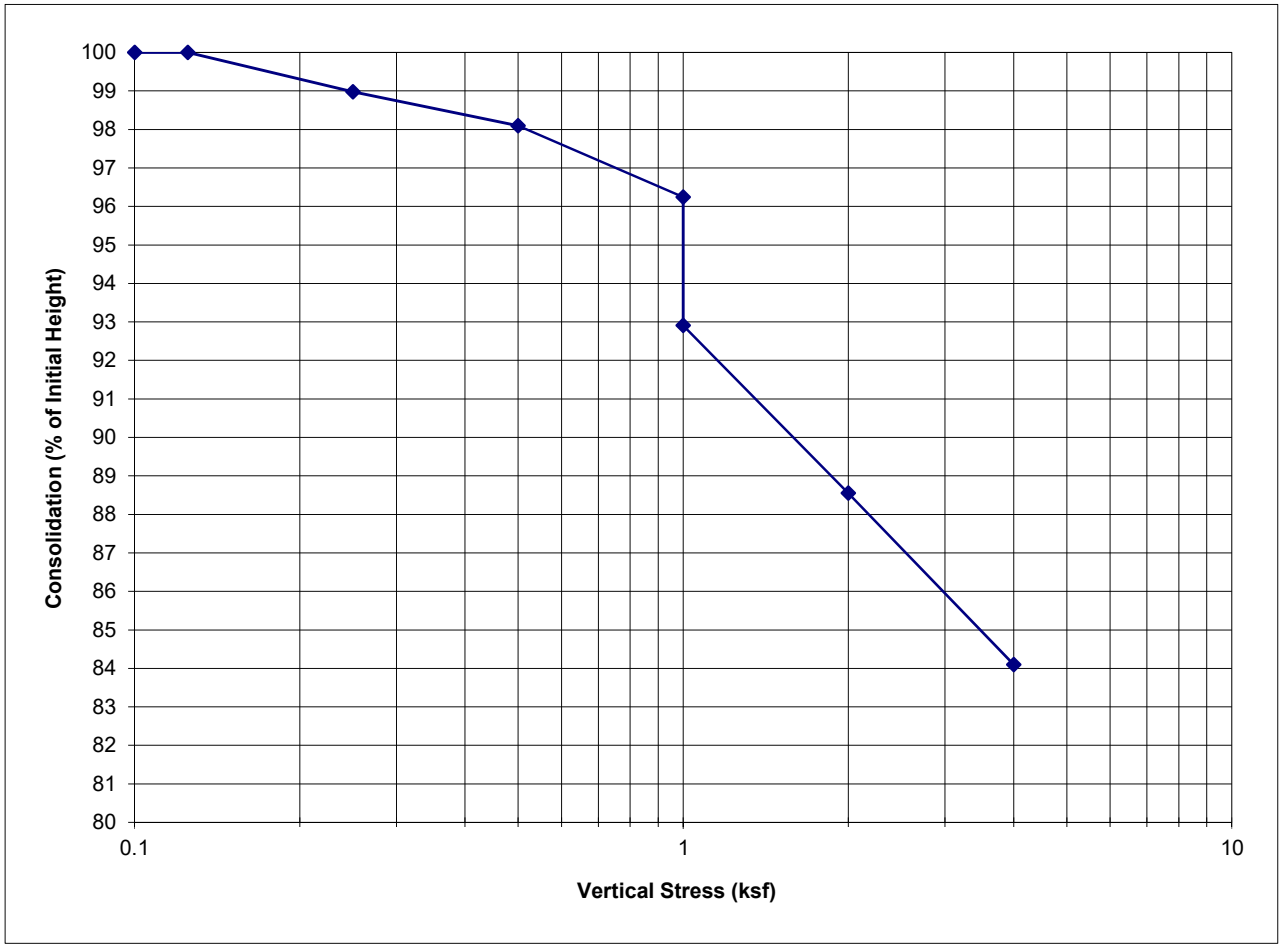
Project:	Rolling Plains Facility	**Project Number:**	190070
Project Location:	Apache Junction, Arizona	**Work Order Number:**	1910254
Client:	Rolling Plains Facility	**Lab Number:**	44
Material:	Native	**Date Sampled:**	08/23/19
Sample Source:	Ring Sample B-9 @ 2.5'-3.5'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	3.87
Initial Moisture Content	8.5%	Final Moisture Content	24.6%
Initial Dry Density(pcf)	84.0	Final Dry Density(pcf)	99.8
Initial Degree of Saturation	23%	Final Degree of Saturation	99%
Initial Void Ratio	1.0	Final Void Ratio	0.7
Estimated Specific Gravity	2.65	Saturated at	1 ksf



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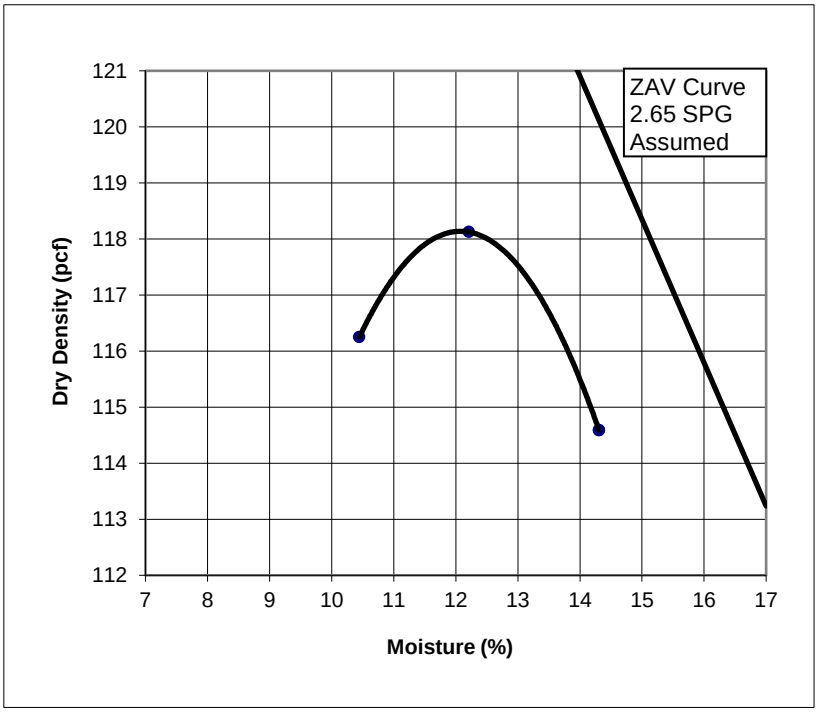
PROJECT:	Rolling Plains Facility	**PROJECT NO:**	190070
LOCATION:	Apache Junction, Arizona	**WORK ORDER NO:**	1910254
MATERIAL:	Native	**LAB NO:**	11
SAMPLE SOURCE:	Bulk Sample B-3 @ 2.0'-5.0'	**SAMPLE DATE:**	8/23/2019

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORT (12,400ft-lb-ft/cu.ft) (ASTMD698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318) (DRY PREP)

	English (pcf)	Metric (kg / cu.m.)	Rock Correction
Maximum dry density:	118.1	1892	118.1
Optimum moisture (%):	12.2	12.2	12.2



SIEVE SIZE	PERCENT PASSING	SPECS
6 in / 152mm	100	
4 in / 100mm	100	
3 in / 75mm	100	
2 in / 50mm	100	
1 1/2 in / 37.5mm	100	
1 1/4 in / 32 mm	100	
1 in / 25 mm	100	
3/4 in / 19 mm	99	
1/2 in / 12.5 mm	98	
3/8 in / 9.5 mm	96	
1/4 in / 6.4 mm	95	
#4, 4.75mm	94	
#8, 2.36mm	88	
#10, 2.00mm	86	
#16, 1.18mm	80	
#30, 0.60mm	74	
#40, .425mm	71	
#50, .300mm	69	
#100, .150mm	64	
#200, .075mm	56	

LL:	29
PL:	15
PI:	14
USCS:	CL
AASHTO:	A-6(5)

NOTES:

AASHTO Description: Clayey soils

- The zero air void curve represents a specific gravity of: 2.65 assumed, (also used in the 'Rock Correction Calculation)
- This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at clients request.
- The "Rock Correction" is based on the sieve performed for this sample

Reviewed by: _____

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Project:	Rolling Plains Facility	**Project Number:**	190070
Location:	Apache Junction, Arizona	**Work Order Number:**	1910254
Client:	Rolling Plains Facility	**Lab Number:**	See Below
Material:	Native	**Date Sampled:**	08/23/19
Sample Source:	See Below		

Swell Potential of Soil ASTM D4546

Sample Number	Sample Source	Swell (%)	Target Compaction (%)	Actual Compaction (%)	Target Moisture (%)	Actual Moisture (%)
11	Bulk Sample B-3 @ 2.0'-5.0'	1.6	95.0	95.0	9.2	9.3

Note: Ring Samples were subjected to a 100 psf surcharge.

MOTZZ LABORATORY, INC.

Soil Analysis Report

Atek Engineering Consultants
James Floyd
111 South Weber Drive, Suite 1
Chandler, AZ 85226

Project: 190070
Date Received: 8/27/2019
Date Reported: 8/30/2019
PO Number: 1910254

Lab Number: 929884-1 **1) Bulk Sample B-1 (0.0-5.0')**

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	108	ppm	
Chloride, Cl	ARIZ 736	32	ppm	

Lab Number: 929884-2 **6) Bulk Sample B-2 (0.0-3.0')**

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	60	ppm	
Chloride, Cl	ARIZ 736	17	ppm	

Lab Number: 929884-3 **17) Bulk Sample B-4 (0.0-3.0')**

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	8	ppm	
Chloride, Cl	ARIZ 736	5	ppm	

Lab Number: 929884-4 **34) Bulk Sample B-7 (0.0-2.5')**

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	52	ppm	
Chloride, Cl	ARIZ 736	16	ppm	

Lab Number: 929884-5 **43) Bulk Sample B-9 (0.0-5.0')**

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	48	ppm	
Chloride, Cl	ARIZ 736	15	ppm	

APPENDIX E
Pavement Design

Flexible Pavement Design (AASHTO)

Project Name:	Rolling Plains Facility
Project Number:	190070
Client:	Rolling Plains
Location:	Apache Junction, Arizona
Design Section:	Parking Areas
Engineer:	J Floyd
Date:	9/4/2019

Flexible Pavement Structural Design:

Resilient Modulus (psi)	16,023
Subbase Type	AB
Subbase Thickness (inches)	6.0
Asphaltic Concrete Thickness (inches)	3.00
Structural Number	1.98
Required Structural Number	1.90
Performance (years)	20.0
Allowable 18-kip ESAL Repetition	150,000.0

Design Parameters:

Standard Normal Deviate	-1.282
Combined Standard error	0.45
Design Serviceability Loss	1.5
Desired Level of Reliability (percent)	90.0
Asphaltic Concrete Layer Coefficient	0.42
Subbase Layer Coefficient	0.12

Flexible Pavement Design (AASHTO)

Project Name:	Rolling Plains Facility
Project Number:	190070
Client:	Rolling Plains
Location:	Apache Junction, Arizona
Design Section:	Heavy Traffic Areas
Engineer:	J Floyd
Date:	9/4/2019

Flexible Pavement Structural Design:

Resilient Modulus (psi)	16,023
Subbase Type	AB
Subbase Thickness (inches)	6.0
Asphaltic Concrete Thickness (inches)	4.00
Structural Number	2.40
Required Structural Number	2.33
Performance (years)	20.0
Allowable 18-kip ESAL Repetition	500,000.0

Design Parameters:

Standard Normal Deviate	-1.282
Combined Standard error	0.45
Design Serviceability Loss	1.5
Desired Level of Reliability (percent)	90.0
Asphaltic Concrete Layer Coefficient	0.42
Subbase Layer Coefficient	0.12

Flexible Pavement Design (AASHTO)

Project Name:	Rolling Plains Facility
Project Number:	190070
Client:	Rolling Plains
Location:	Apache Junction, Arizona
Design Section:	East Monte Avenue
Engineer:	J Floyd
Date:	9/4/2019

Flexible Pavement Structural Design:

Resilient Modulus (psi)	16,023
Subbase Type	AB
Subbase Thickness (inches)	10.0
Asphaltic Concrete Thickness (inches)	4.00
Structural Number	2.88
Required Structural Number	2.63
Performance (years)	20.0
Allowable 18-kip ESAL Repetition	1,000,000.0

Design Parameters:

Standard Normal Deviate	-1.282
Combined Standard error	0.45
Design Serviceability Loss	1.5
Desired Level of Reliability (percent)	90.0
Asphaltic Concrete Layer Coefficient	0.42
Subbase Layer Coefficient	0.12

Appendix J – EARTH FISSURE INVESTIGATION – TASK 1 AND TASK 2

Prepared by: Geological Consultants Inc. (Kenneth Euge)

Report Prepared for:

Rolling Plains Construction Inc.
5136 South Desert View Drive
Apache Junction, AZ 85120

Attn: Mr. Chris Henderson
Operations Manager

Report Prepared by:

Geological Consultants Inc.
2333 West Northern Avenue, Suite 1A
Phoenix, Arizona 85021

Kenneth M. Euge, R.G.
Principal Geologist

EARTH FISSURE INVESTIGATION - TASK 2
ROLLING PLAINS CONSTRUCTION
PARCEL 1, 5 ACRES, PARCEL NO. 104-63-010O
WEST OF SOUTH DESERT VIEW DRIVE
APACHE JUNCTION, PINAL COUNTY, ARIZONA

Project No. 2019-114T2

November 27, 2019

NOTICE

The geologic and soil's observations, findings, conclusions and recommendations presented in this report are based on (1) data from published and unpublished sources available at the time of this study, including GCI Task 1 Land Subsidence and Earth Fissure Evaluation dated June 5, 2019, (2) photo-geological interpretation and (3) subsurface exploration of "reported but unconfirmed" earth fissures within the parcel. The services provided by Geological Consultants to Rolling Plains Construction Inc. were performed according to generally accepted principles and standard practices used by members of the geological profession in this locale at the time of this study.

It must be recognized that subsurface geologic and soil conditions may vary from place to place and from those interpreted at locations where evaluations are made by the investigator. No warranty or representation, either expressed or implied, is or should be construed regarding geological or soil conditions at locations other than those observed by the investigator.

The accurate prediction of where earth fissures will form, or when they will form, is not possible due to the dynamics of the natural system in which they could form. Ground failure, as a result of earth fissure formation processes, can be caused by natural events (induced stresses, weather) or by human activity (groundwater pumping, land development). Several interrelated factors, over which we have no control, come into play that can induce land subsidence and cause earth fissures to form. Therefore, we make no guarantees regarding the safety of individuals or properties in these environments. However, the use of sound professional geological and engineering judgement, principles, and practices, applied by experienced geologists and engineers to the evaluation of land subsidence and potential or actual earth fissure formation can identify potential risks and generally, potential risk areas or 'earth fissure risk mitigation zones'. Once this information is available, reasonable designs can be developed to reduce the risk of injury and damage to properties.

We offer the recommendations presented herein for the purpose of improving the safety within properties affected by land subsidence and earth fissures, but we cannot guarantee the effectiveness of the recommendations provided herein for the prevention of personal injury or damage to structures.

This report was prepared in accordance with the scope of work outlined in Geological Consultants proposal for geological services dated June 19, 2019, to Mr. Chris Henderson, Operations Manager with Rolling Plains Construction Inc.

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FIGURES

EARTH FISSURE INVESTIGATION - TASK 2
ROLLING PLAINS CONSTRUCTION
PARCEL 1, 5 ACRES, PARCEL NO. 104-63-010O
WEST OF SOUTH DESERT VIEW DRIVE
APACHE JUNCTION, PINAL COUNTY, ARIZONA

1.0 INTRODUCTION

Geological Consultants, Inc. (GCI) performed a Land Subsidence and Earth Fissure Investigation - Task 1, in June 2019 on the 5-acre parcel, Parcel No. 104-63-010O, located west of South Desert View Drive, Pinal County, Arizona (Figure 1)(GCI, 2019). During the performance of the Task 1 investigation, GCI noted two "reported but unconfirmed" earth fissures were documented in the Arizona Geological Society (AZGS) earth fissure maps within or extending toward the property boundary (Figure 2). The project site is located in an area of active earth fissure activity within the Hawk Rock area where several mapped earth fissures are located within a one-mile radius of the site. GCI did not observe any surface features that would suggest the presence of an earth fissure within the 5-acre parcel during the site reconnaissance performed for the Task 1 investigation. However, because of the "reported but unconfirmed" earth fissures, GCI recommended this Task 2 Earth Fissure Exploration Program be implemented to confirm or refute the presence of earth fissures on this property.

The Task 2 earth fissure exploration investigation included the examination and logging of four backhoe trenches located across the traces of "unconfirmed" earth fissures identified from the AZGS during the site reconnaissance (Figure 2).

The ultimate objective of this investigation was to perform a subsurface exploration at the locations of the"reported but unconfirmed" earth fissures mapped (AZGS, 2017) within and trending toward the 5-acre parcel boundary in order to:

- Confirm (or refute) the existence of a possible earth fissure at the locations identified during the Task 1 investigation.

- Determine the lateral extent, width, length, and directional orientation of the earth fissures (if located).

- If necessary, define earth fissure mitigation zones and prepare recommendations to mitigate the potential effects if the earth fissure is confirmed and to accommodate these geologic hazards in the site development plans.

1.1 Scope of Work

The scope of work implemented to complete this earth fissure exploration program included the following:

- Excavation of four backhoe trenches across the unconfirmed earth fissure features to depths of at least five feet and to lengths ranging from approximately 118 feet to 131.5 feet.

- Conducting a detailed geologic examination of the excavations to locate any earth fissures that may be present and prepare logs of the trenches detailing the trench dimensions, soil profile, and other relevant information.

- Performing three seismic refraction surveys to determine if earth fissure features could be encountered at a depth inaccessible by trenching and to assess the possibility that the earth fissure features may continue beyond their mapped limits.

- Examining and interpreting the six seismogram records, two seismograms from each of the seismic surveys, to identify possible seismic signatures that may indicate the existence of an open earth fissure feature at depth.

- Preparation of this report documenting the results of the earth fissure field investigation and subsurface exploration program.

The direct and indirect subsurface explorations were conducted on November 7, 8, and 19, 2019 by Mr. Kenneth M. Euge, R.G., Principal Geologist with GCI, assisted by Ms. Nicole Marin, Project Geoscientist.

1.2 Project Background

During the research portion of the Task 1 Investigation, GCI noted that "reported but unconfirmed" earth fissures were mapped on the AZGS 2017 Earth Fissure Maps. Historical aerial photography (Maricopa County, GIS Mapping Applications), taken prior to development of the project parcel were also reviewed and interpreted to assist with the identification of earth fissures within the parcel. However, during the site reconnaissance, GCI did not observe any surface features that would suggest the presence of an earth fissure on the site because the parcel has been extensively disturbed by human activity. GCI contacted AZGS to determine when the features were identified, as well as how they were determined to be possible earth fissures. AZGS did not have this information readily available (personal communication, AzGS, 2019). GCI has completed several studies in the site vicinity documenting earth fissures and there are several confirmed earth fissures within the project vicinity leading GCI to recommend a Task 2 Earth Fissure Exploration Program in order to confirm or refute the presence of earth fissures on the project site.

2.0 SUBSURFACE EXPLORATIONS

Four trench locations were selected by GCI and a backhoe was used to excavate trenches across an "unconfirmed" earth fissure withing the 5-acre parcel and across the projection into the 5-acre parcel from one earth fissure trace adjacent to the parcel's west boundary. The trench locations are shown in Figure 3. Figures 4, 5, 6, and 7 document the exploration trench details.

Three seismic refraction surveys were conducted to indirectly investigate 'reported, but unconfirmed' earth fissures that are not readily exposed at the ground surface or within the limits of direct trench explorations.

2.1 Exploration Trench Field Procedures

Trench logging required the careful cleaning of excess dirt and removal of smeared soil marks from the trench walls and floors that were caused by the backhoe bucket. The cleaning was required to log the soil stratigraphy and to clearly expose discontinuities such as cracks or fissure features that might be present. Following the completion of the trench logs each of the trenches were photo-logged and backfilled.

2.1.1 Trench RP-T1

Trench RP-T1 was excavated in a northwest to southeast direction across the mapped "unconfirmed" earth fissure trace within the parcel. The exploration trench was 131.5 feet in length and it was about 5.2 feet deep at the location shown in Figure 3. No earth fissure was observed in this trench (Figure 4).

2.1.2 Trench RP-T2

Trench RP-T2 was excavated in a northwest to southeast direction inside the north boundary of the 5-acre parcel across the mapped "unconfirmed" earth fissure. The exploration trench length was 118.5 feet and approximately 5 feet deep at the location shown in Figure 3. No earth fissure was observed in this trench (Figure 5).

2.1.3 Trench RP-T3

Trench RP-T3 was excavated in a north to south direction inside the property boundaries, north of the entrance on the west side of the 5-acre parcel across the trace of a mapped "unconfirmed" earth fissure projecting into the parcel. The exploration trench length was 118 feet and approximately 5 feet deep at the location shown in Figure 3. No earth fissure was observed in this trench (Figure 6).

2.1.4 Trench RP-T4

Trench RP-T4 was excavated in a north to south direction inside the property boundaries, south of the entrance on the west side of the 5-acre parcel across the trace of a mapped "unconfirmed" earth fissure projecting into the parcel. The exploration trench length was 124 feet and approximately 5 feet deep at the location shown in Figure 3. No earth fissure was observed in this trench (Figure 7).

2.1.4.1 Exploration Trench Observations

The subsurface exploration program did not identify any earth fissures or suspect features within the limits of the trenches excavated. The trenches were characterized by continuous, uninterrupted soil profiles, or soil layers. The observed soil profiles show no evidence of open, subsidence-related fissures, abrupt vertical breaks across the soil profile, crack voids, filled traces, or any other indication of earth fissuring activity.

2.2 Seismic Refraction Survey Geophysical Subsurface Exploration

Three seismic refraction surveys were conducted to indirectly investigate 'reported, but unconfirmed' earth fissures that are not readily exposed at the ground surface or within the limits of direct trench explorations. The seismic refraction survey records (seismograms) are used to identify the presence or absence of seismogram wave form anomaly signatures that can be indicative of earth fissure features, or lack thereof, at depths that are not easily accessible by trenching and to assess the possibility that the earth fissure features may continue beyond their mapped limits.

Each spread was approximately 110 feet in length, with shot points established offset from each end of the seismic lines. Seismic waves were generated at the shot points located 10 feet from each end of the survey line spreads. Twelve geophones were placed at 10-foot intervals along each line. Travel time data for the seismic traverses were obtained using a Geometries Inc. Model S12 Smartseis, 12-Channel Exploration Seismograph. Seismic wave arrivals are detected with digital grade vertical geophones with a dual hum-bucking coil and frequency response above 14 Hz natural frequency. The seismic shock wave was produced by repeated impacts of a 16-pound sledge hammer onto a soft steel striking plate. Forward and reverse seismograms were collected for each spread and carefully analyzed in our attempt to identify a discrete seismic signal signature that could be representative of the seismic wave intersecting an earth fissure along the seismic survey line. The seismic wave signatures at a fissure crack can be a loss of seismic signals and the rapid attenuation or degradation of the seismic signal at the same location(s) of the geophone sensors. Seismic survey line locations are depicted in Figure 2.

2.2.1 Seismic Refraction Survey Spread RP-S1

Seismic refraction survey spread RP-S1 was centered along the mapped "unconfirmed" earth fissure, midway between exploratory trenches RP-T1 and RP-T2, oriented parallel to the trenches.

2.2.2 Seismic Refraction Survey Spread RP-S2 and RP-S3

Seismic refraction survey spread RP-S2 was parallel to trench RP-T3 (oriented north-south) across the trace of a mapped "unconfirmed" earth fissure projecting into the parcel. Seismic refraction survey spread RP-S3 was oriented southwest to northeast and began near the south end of trench RP-T4 (Figure 3).

2.2.2.1 Indirect Geophysical Subsurface Exploration Findings

The results of the seismic refraction surveys conducted across the AZGS mapped "unconfirmed" earth fissure, displayed typical seismogram waveform signatures and attenuation of the seismic traces that would be expected for normal ground conditions within basin fills soils that are variably cemented with caliche.

The three seismic survey line spreads were run in both a forward and reverse direction to provide the most definitive data possible. There were no indications of degradation or interruption of the seismic wave form due to loss of seismic signal or rapid seismic wave attenuations to suggest the presence of an earth fissure within the range of seismic refraction surveys. The subsurface soil conditions, including the variable cementation and soil layers, provided unremarkable seismograms (Figures 8, 9, & 10). No evidence of the earth fissure traces was interpreted from the seismograms records.

3.0 CONCLUSIONS AND RECOMMENDATIONS

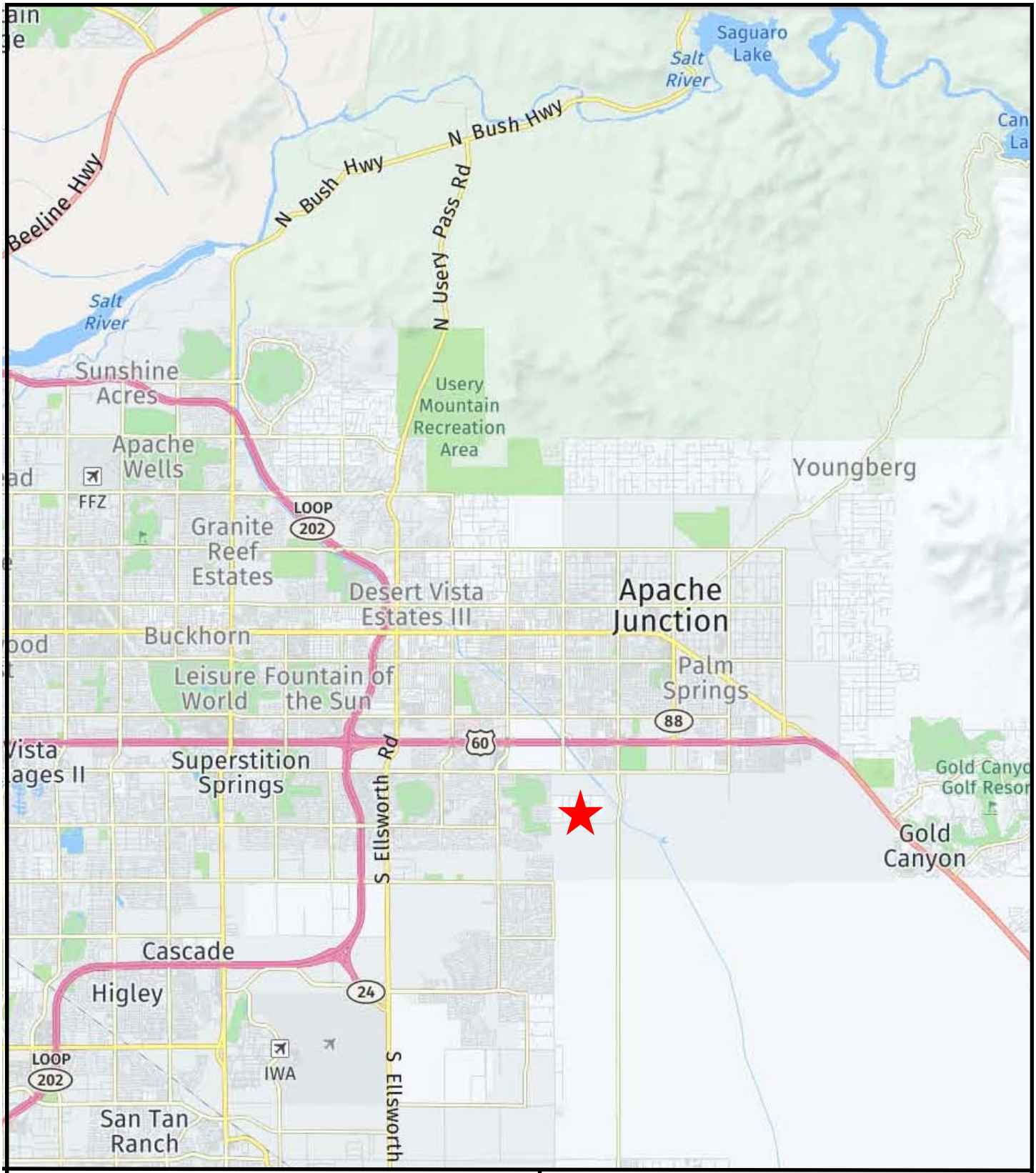
3.1 Based on the detailed examination of the Task 2 exploration trenches excavated and logged within the 5-acre parcel, no earth fissures or earth fissure-related features were observed.

3.2 In our opinion, based on the results of the earth fissure explorations made within the 5-acre parcel, additional explorations at this site are not necessary and special earth fissure mitigation measures are not required. However, if proposed construction-related excavations are excavated to design depths more than two feet deep below the existing preconstruction ground surface elevation in the vicinity of mapped “unconfirmed” earth fissure traces (Figure 2), we recommend the open excavations should be carefully examined by an experienced geologist for confirmation of the Task 2 exploration program findings.

3.3 The expression of an earth fissure trace at or below the ground surface is usually determined, in part, by the soil units in which the fissure is located. In soil units containing greater quantities of caliche (middle and upper Piedmont surfaces), the fissure trace usually appears as a well formed open or filled crack that is visible in both sides of the trench walls and across the trench bottom. In soil units that are poorly consolidated or cemented finer grained silt or fine sand (lower Piedmont and basin fill surfaces), the earth fissure trace may appear as a lineation filled with material that has a different color and texture than the surrounding unit. The soil units uncovered in the exploration trenches excavated within the 5-acre parcel should have allowed for the confirmation of an earth fissure, if present. However, no earth fissure trace exhibiting the aforementioned characteristics was found in the trenches excavated at the site.

3.4 Three seismic refraction surveys were conducted across the earth fissure features to produce forward and reverse line compression (P-wave) seismograms to assess, whether or not, the suspect and "unconfirmed" earth fissures that have not breached the ground surface, are present below the ground surface. Based on our evaluation of the six seismograms, we did not identify any distinctive, significant seismic signatures commonly associated with earth fissure cracks, such as seismic wave attenuation, wave travel-time delays, or blockage of the seismic signal.

Figures



Explanation:

★ Approximate site location

Note: Revised from GCI Task 1 Report, June 2019

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Land Subsidence & Earth Fissure Evaluation - Task 2
5136 S. Desert View Drive, Apache Junction, AZ
Site Vicinity Map
Figure 1

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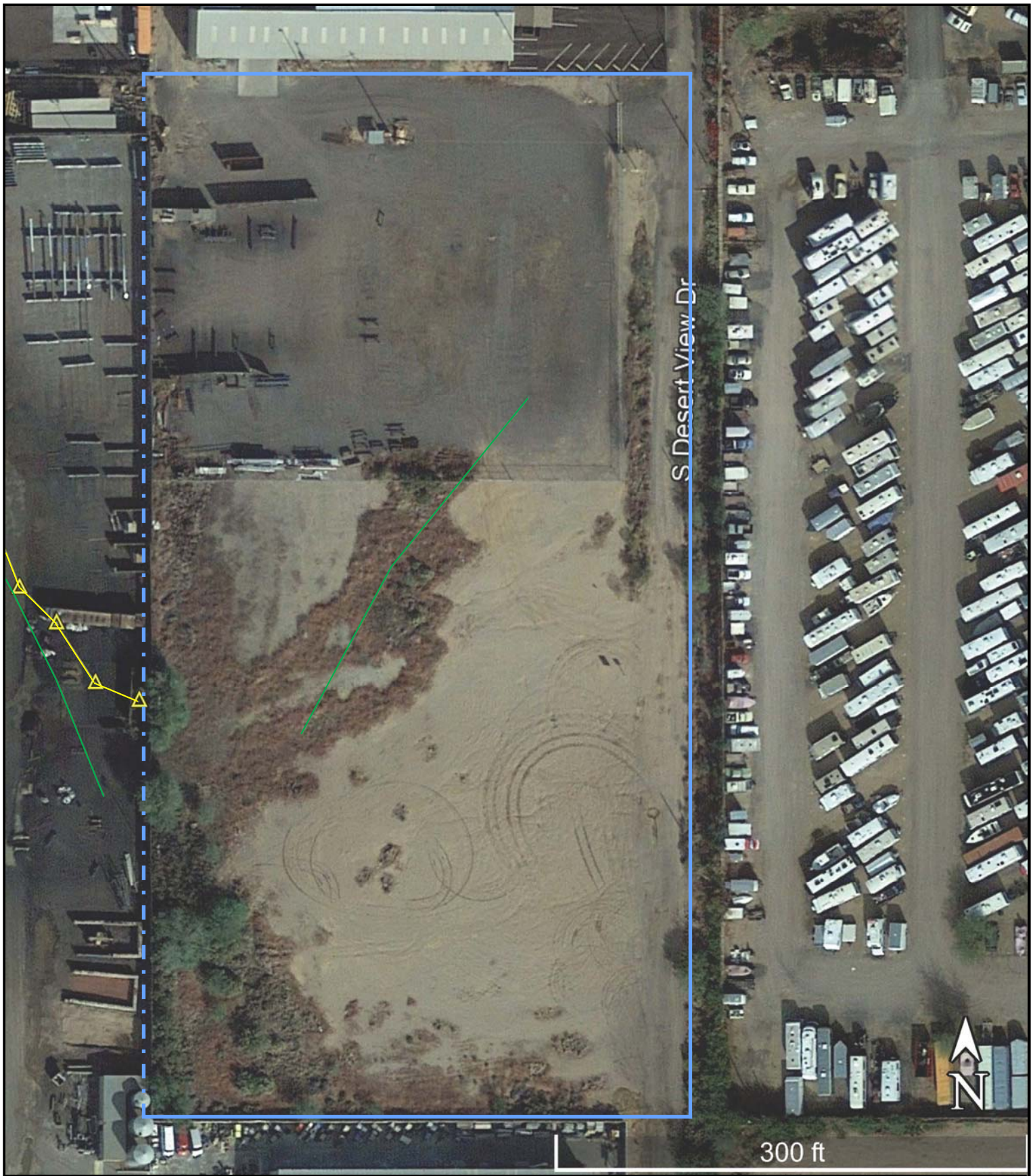

Explanation:

P1-EF1 - Earth Fissure, interpreted GCI (2019); 2000 Historical Aerial Photo (Note 1)
Unconfirmed Earth Fissure, AZGS (2017) (Note 2)
Parcel Boundary, approximate.

Note 1: Source Maricopa County; 2017; Office of Enterprise Technology/GIS.
Note 2: Arizona Geological Survey (AZGS); Location of Mapped Earth Fissure Traces in AZ; DG-39, v 11.06.17.
Note 3: Base map aerial photograph (2018) modified by GCI to depict interpreted and mapped earth fissure locations.

Land Subsidence & Earth Fissure Evaluation - Task 2
5136 S. Desert View Drive, Apache Junction, AZ
Earth Fissure Location Map - Parcel 1
Figure 2

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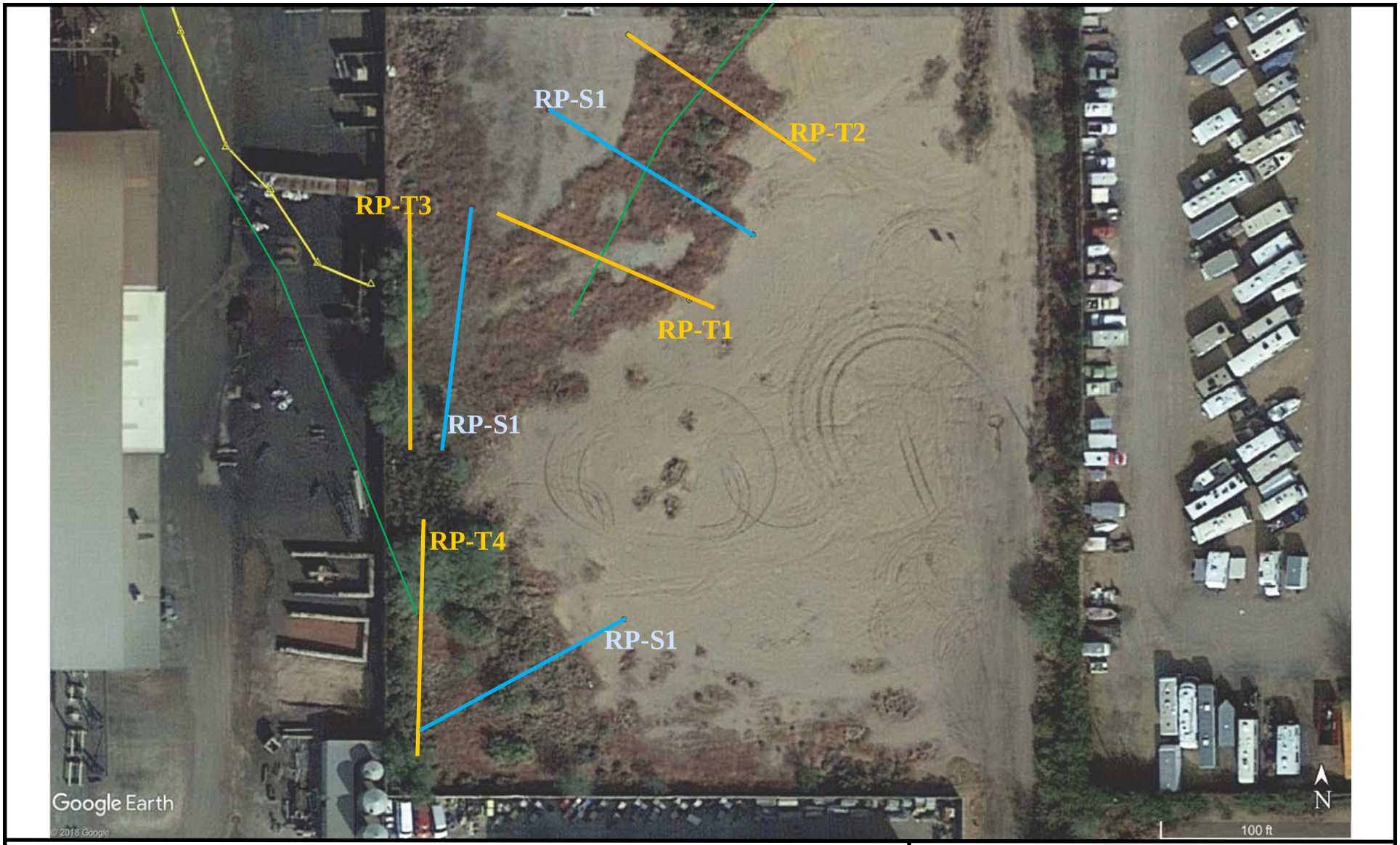

Explanation:

Seismic Location

Trench Location

P1-EF1 - Earth Fissure, interpreted GCI (2019); 2000 Historical Aerial Photo (Note 1)

Unconfirmed Earth Fissure, AZGS (2017) (Note 2)

Note 1: Source Maricopa County; 2017; Office of Enterprise Technology/GIS.
Note 2: Arizona Geological Survey (AZGS); Location of Mapped Earth Fissure Traces in AZ; DG-39, v 11.06.17.
Note 3: Base map aerial photograph (2018) modified by GCI to depict interpreted and mapped earth fissure locations.

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Land Subsidence & Earth Fissure Evaluation - Task 2
5136 S. Desert View Drive, Apache Junction, AZ
Exploration Trench & Seismic Survey Location Map
Figure 3

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Photo 1: View of Trench RP-T1 from northwest to southeast.

Photo 2: Soil profile in Trench RP-T1 sidewall. Orange-brown silty sand with gravel to 1.35' overlying dark yellow-brown silty clay to clayey sand with caliche filaments to 4.25' overlying silty clay with large caliche nodules to 5.2'. Very dense throughout.

Trench Designation - RP-T1 ***No Earth Fissure Feature Identified***

Trench Length: 131.5' Average Trench Depth : 5.2' (variable)
Trench Width: 3.0'
Bearing of Trench: S62˚E

Refer to Figure 3 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation - Task 2
5136 S. Desert View Drive, Apache Junction, AZ
Trench RP-T1 Details & Photos
Figure 4

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Photo 1: View of Trench RP-T2 from northwest to southeast.

Photo 2: Soil profile in Trench RP-T2 sidewall. Dark orange-brown dense silty clay—clayey silt to 0.9' overlying poorly sorted stream channel deposits with fine to coarse sand and gravel to 1.75' overlying hard clayey silty with some sand, mottled with caliche, high shrinkage and expansion potential to 5'

Trench Designation - RP-T2 ***No Earth Fissure Feature Identified***

Trench Length: 118.5' Average Trench Depth : 5' (variable)
Trench Width: 3.0'
Bearing of Trench: S45˚E

Refer to Figure 3 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation - Task 2
5136 S. Desert View Drive, Apache Junction, AZ
Trench RP-T2 Details & Photos
Figure 5

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Photo 1: View of Trench RP-T3 from north to south.

Photo 2: Soil profile in Trench RP-T3 sidewall. Coarse gravel with sand fill (ABC grade) to 0.68' overlying sheet flow deposit to 1.85' over yellow-brown porous medium dense to dense silty clay to 4.3 overlying light pink fine sandy clay with caliche nodules

Trench Designation - RP-T3 ***No Earth Fissure Feature Identified***

Trench Length: 118' Average Trench Depth : 5' (variable)
Trench Width: 3.0'
Bearing of Trench: N00E

Refer to Figure 3 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation - Task 2
5136 S. Desert View Drive, Apache Junction, AZ
Trench RP-T3 Details & Photos
Figure 6

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Photo 1: View of Trench RP-T4 from north to south.

Photo 2: Soil profile in Trench RP-T4 sidewall. Dark yellow brown very dense sandy silt—silty sand with pea-sized gravel to 1' overlying porous sandy clay with pea-gravel lenses to 4.45' homogenous silt with minor fine sand, mottled with secondary caliche and filaments to 5'

Trench Designation - RP-T4 ***No Earth Fissure Feature Identified***

Trench Length: 124' Average Trench Depth : 5' (variable)
Trench Width: 3.0'
Bearing of Trench: due North

Refer to Figure 3 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation - Task 2
5136 S. Desert View Drive, Apache Junction, AZ
Trench RP-T4 Details & Photos
Figure 7

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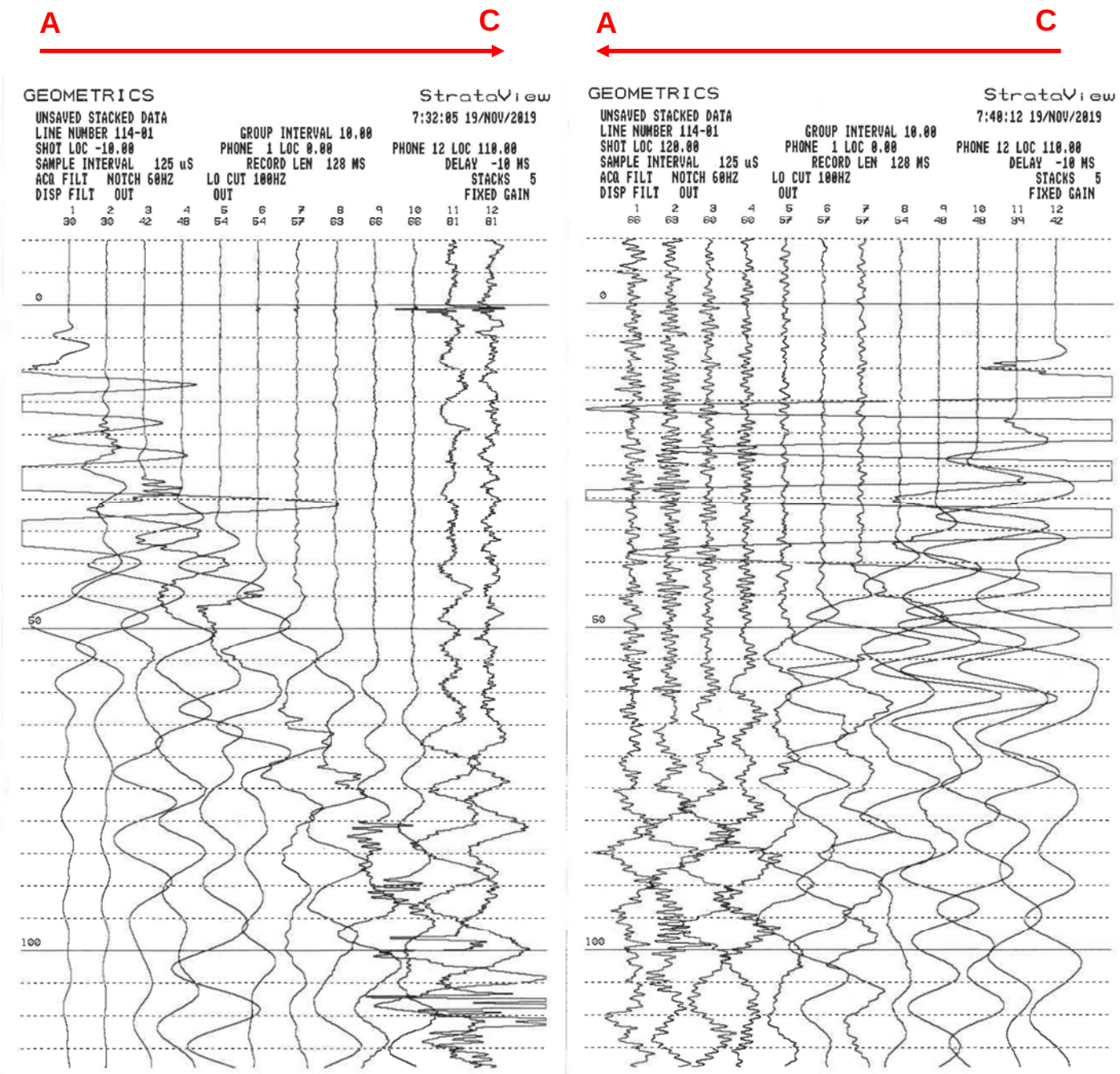

Refer to Figure 3 for seismic refraction survey line locations.

Seismic surveys conducted 11/19/2019, K. Euge, R.G. , GCI.

Land Subsidence & Earth Fissure Evaluation
5136 S. Desert View Drive, Apache Junction, AZ
Task 2 Earth Fissure Exploration Program
Seismic Survey Seismogram RP-S1
Figure 8

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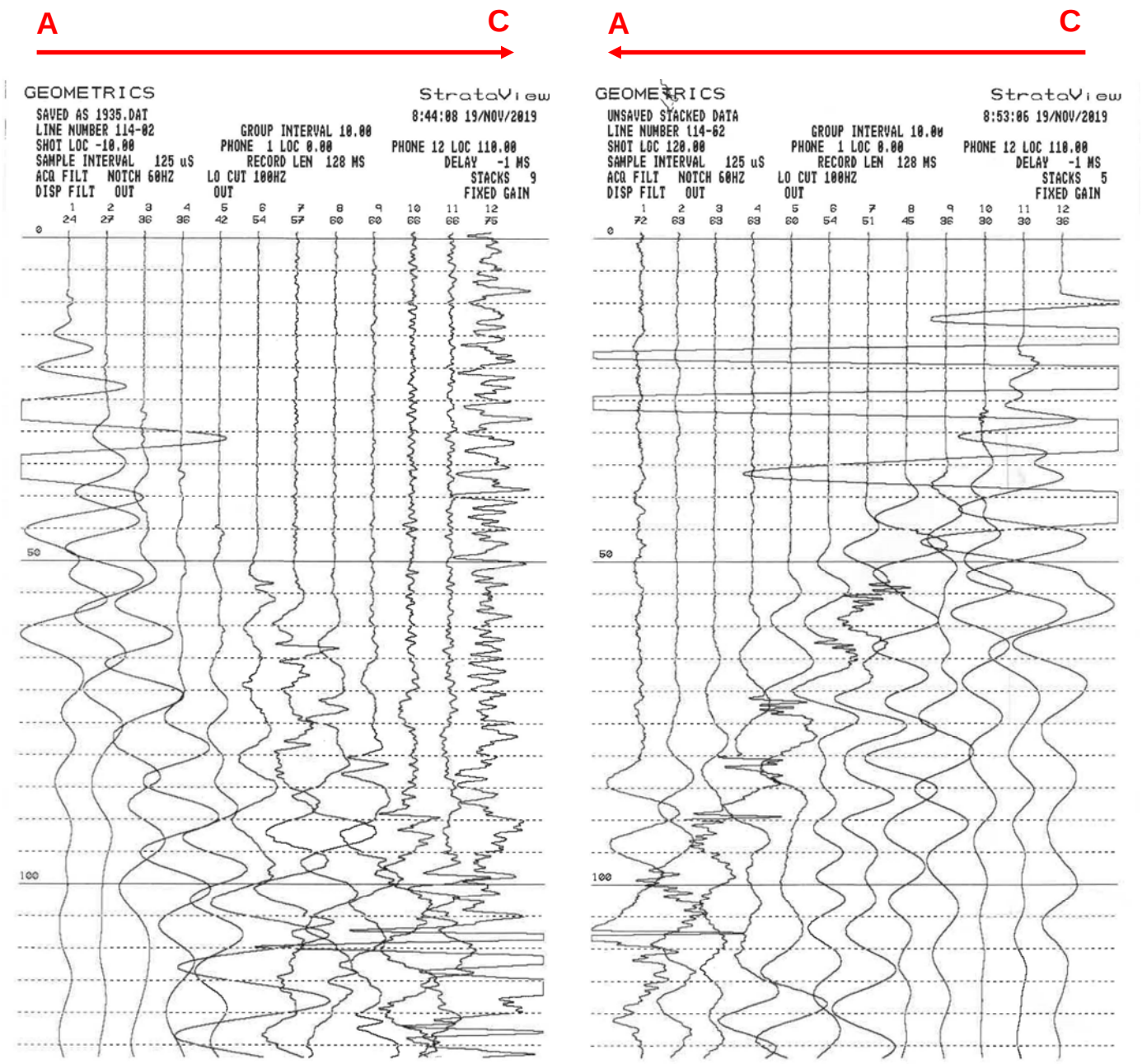

Refer to Figure 3 for seismic refraction survey line locations.

Seismic surveys conducted 11/19/2019, K. Euge, R.G. , GCI.

Land Subsidence & Earth Fissure Evaluation
5136 S. Desert View Drive, Apache Junction, AZ
Task 2 Earth Fissure Exploration Program
Seismic Survey Seismogram RP-S2
Figure 9

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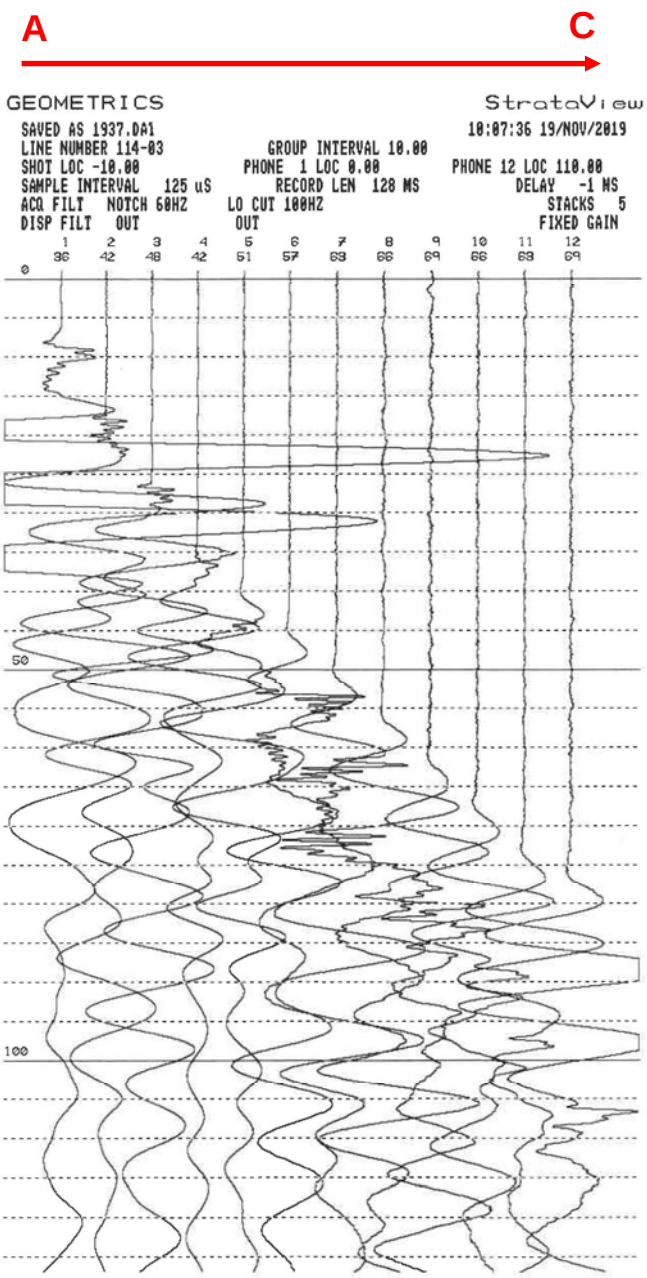

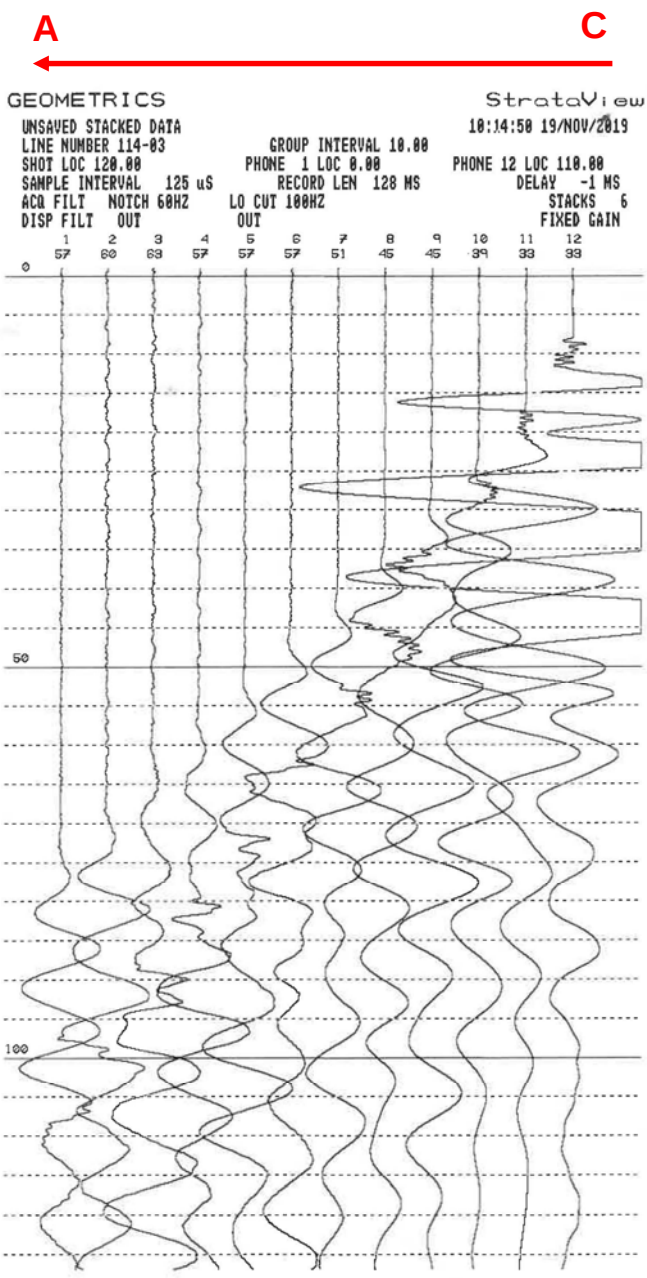

Refer to Figure 3 for seismic refraction survey line locations.

Seismic surveys conducted 11/19/2019, K. Euge, R.G. , GCI.

Land Subsidence & Earth Fissure Evaluation
5136 S. Desert View Drive, Apache Junction, AZ
Task 2 Earth Fissure Exploration Program
Seismic Survey Seismogram RP-S3
Figure 10

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