STORMWATER MANAGEMENT REPORT

January 2023

Revised: -

Juniper Estates – PZ-22-000109-01

2951 S Masonic Ln
Flagstaff, Arizona, 86005

Prepared for
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VPE Project No: **22004**

PRELIMINARY

ViewPoint Engineering

Table of Contents

ViewPoint Engineering

1.0 INTRODUCTION

Red Oak Development Group, LLC (RODG) is proposing the development of the property located at 2651 S Masonic LN. Juniper Estates is an 87-unit townhome/condominium residential community. The project site is ±13.82 gross acres with ±5.12 acres developed.

The property in questions is further identified parcel number 103-26-002-D. A project location map can be found in the appendix.

Tract Area: **13.82 acres**
Limit of Disturbance: **5.12 acres**

1.1 LEGAL DESCRIPTION

The land referred to herein below is situated in the county of Coconino, state of Arizona, and is described as follows:

A tract of land in the Southeast quarter of Section 28 and in the Southwest quarter of the Southwest quarter of Section 27, Township 21 Norther, Range 7 East of the Gila and Salt River Base and Meridian, Coconino County, Arizona, more particularly described as follows:
BEGINNING at the Southeast corner of said Section 28;
Thence South 89° 13’00” West, a distance of 1321.47 feet along the Section line to the Southwest corner of the Southeast quarter of the Southeast quarter of said Section 28;
Thence South 89° 13’00” West, a distance of 24.80 feet along the Section line to the intersection of the Southerly right-of-way line of Zuni Drive as described in Docket 350, page 203 of the Coconino County Records.
Thence along said Southerly right-of-way line as follows:
North 61° 32’00” East, a distance of 826.32 feet;
Thence along a curve to the right having a radius of 170.00 feet and having a central angle of 24° 32’00” a distance of 72.30 feet;
Thence North 86° 04’00” East, a distance of 549.48 feet to a point on the East line of said Section 28;
Thence North 86° 04’00” East, a distance of 241.41 feet;
Thence along a curve to the right having a radius of 170.00 feet and having a central angle of 33° 52’00”, a distance of 100.42 feet, said curve having tangents bearing North 86° 04’00” East and South 60° 02’00” East, to the Westerly right-of-way line of Lone Tree Road;
Thence South 32° 00’00” East along said Westerly right-of-way line, a distance of 502.08 feet to the Southerly line of said Section 27;

Thence South 89° 48’00” West along Section line, a distance of 601.21 feet to the POINT OF BEGINNING.

1.2 Existing Conditions

The site is currently an existing undeveloped parcel that is densely wooded with pine trees. The ground is rocky with moderate grass coverage. The site has steep slopes that slope towards the north and northwest directing most of the surface runoff towards Zuni Drive and to Masonic Lane. Surface runoff is sheet flow and shallow concentrated flow throughout the site. A single analysis point is representative of the site as all the flow converges to a single point and flows under Zuni Drive after leaving the site. The site zoning does have an RPO layer, both tree and slope preservation have been considered and maintained in this development. To the south of the site is the Pinnacle Pines development consisting of townhomes. To west of the site is National Forest. To the north and the east of the site is vacant undeveloped land that has been purchased by the board of regents for Northern Arizona University. The site currently is intersected with an underground pipe conveying the flow of the upstream development, Pinnacle Pines. These flows have been included in the analysis.

1.3 Proposed Conditions

This report identifies and quantifies the existing runoff conditions and estimates future runoff conditions based on the proposed development. Juniper Estates will comprise of new streets, town homes, open spaces, a nature trail, and sidewalks. Analysis of the proposed site conditions will be utilized to manage and plan development to reduce negative impacts on the proposed homes as well as the existing upstream and downstream developments. Any estimated increases in runoff rates will be mitigated.

1.4 Receiving Waters

The SITE is within the Lower Bow and Arrow Wash. Runoff from the site is intercepted to nearby bow and arrow stream. Bow and arrow stream continues northeast and flows into Rio De Flag.

1.5 Project Area Soils

The site was evaluated using the latest soil survey information and mapped accordingly. The soil types for this site were obtained from the United States Department of Agriculture NRCS Web Soil Survey and a custom report generated (see Appendix). The mapped area extended beyond the property boundary line to ensure adequate coverage of the site.

Table 1: Site Soils

Description	Slopes	Hydrologic Soil Group	Acres of Site
Jacques Clay Loam	0% - 2%	C	0.001
Lynx Loam	0% - 2%	B	2.5
Tortugas-Daze Complex	0% - 15%	D	1.5
Tortugas Cobbly and Gravelly Loam	15% - 30%	D	9.7

1.6 FLOODPLAINS

The site does lie within a regulated flood area. FEMA's Flood Insurance Rate Map for Coconino County, AZ designates the site and surrounding area as "Zone X" or "Areas determined to be outside the 0.2% (500-year) annual chance floodplain" (see Map in Appendix). The northeast corner of the site is in the "Zone AE" or "Areas determined to be within the 0.1% (100-year) annual chance floodplain". Per the City of Flagstaff's resource protection plan there will be no disturbance to the flood plain.

1.7 WETLANDS

There are no wetlands located on site.

2.0 OBJECTIVES AND PROCEDURES

2.1 SUMMARY AND PURPOSE

This report is in relation to the new development of Juniper Estates. The analysis was performed, and this report was written, during the site plan development phase of the project. This report is also pertinent to the rezoning process which will accompany this project.

2.2 DESIGN CRITERIA

The stormwater design standards for the development are set forth by The City of Flagstaff Stormwater Management Design Manual and The City of Flagstaff Low impact Development Manual. Specific design standards and project site conditions are as follows:

2.2-1 CITY OF FLAGSTAFF STORMWATER MANAGEMENT DESIGN MANUAL

1. §8.1 Storage and Detention Facilities: Detention facility storage volume shall be adequate to attenuate the post-development peak discharge rates to pre-development discharge rates for the 2, 10, and 100-year design storms. Reservoir routing calculations must be used to demonstrate that the storage volume is adequate. Detention facility outlet structure release rates shall be less than the pre-development peak runoff rates for the 2, 10, and 100-year storm events, with emergency overflow provisions. Design calculations are required to demonstrate that developed runoff from the 2, 10, and 100-year design storms are controlled. The total combined post-development discharge from a development cannot exceed the total pre-development peak discharge for the 2, 10, and 100-year storms. Drainage flows of all frequencies shall enter and depart the property to be developed in substantially the same manner as under the pre-developed condition.

2. §9.1 Low Impact Development Requirements for Infiltration and Reuse of Stormwater: Developments will be required to retain/infiltrate one (1) inch of runoff from all additional impervious surfaces.

2.2-2 City of Flagstaff Low Impact Development Manual

1. §2.7 Types of ROCV Facilities: Draining impervious areas over vegetated buffers slows down runoff and encourages infiltration, in effect reducing the impact of the impervious area. Runoff from 100-percent of the impervious surfaces of a site must flow through a properly designed installation of one or more of the ROCV IMPs that are listed herein. Alternate designs may be considered, but they must have equivalent functional requirements of these IMPs, including ROCV and its drain times.

2.3 Methodology

The SCS method was utilized to analyze the pre-development and pos-development stormwater flows. The computer program “Hydrocad” Ver. 10 by “Hydrocad Software Solutions LLC” was used to calculate and plot the runoff hydrographs. The SCS Method incorporates the time of concentration, runoff coefficients, the 24-hour rainfall, and associated drainage area to calculate the runoff rates. Input values were obtained from existing and proposed site conditions and the City of Flagstaff Stormwater Management Design Manual.

2.3-1 Curve Number (CN)

The conveyance systems have been designed using the SCS equations to determine peak runoff rates within the systems. The cover conditions within the respective structure/systems drainage

area were analyzed. The curve numbers used in analysis were obtained from ADWR, *Oak Creek Flood Warning System Hydrology Report, TR 90-4, September 1990* and USDA, SCS TR -55, "*Urban hydrology for Small Watersheds"*, June 1986, per the City of Flagstaff Stormwater Management Design Manual. See Appendix for the tables used.

Table 2: SCS Curve Numbers

Cover Type	Hydrologic Soil Group	Curve Numbers (CN)
Ponderosa Pine	D	80
Residential 1/8 Acre (Townhomes)	D	92

2.3-2 TIME OF CONCENTRATION (TOC)

Time of concentrations were determined based on the methodology specified in the USDA Urban Hydrology for Small Watersheds (TR55) manual. A minimum time of concentration of 5 minutes has been utilized and a maximum of 60 minutes per the City of Flagstaff Stormwater Management Design Manual.

2.3-3 DESIGN STORM RAINFALL

Design storm rainfall intensities were taken from table 3-2 of The City of Flagstaff SWM Design Manual.

Table 3: City of Flagstaff Rainfall Intensities (in/hr)

Duration	Frequency (YR)					
	2	5	10	25	50	100
5-min	3.96	5.04	5.76	6.84	7.68	8.52
10-min	3.06	3.90	4.50	5.34	6.00	6.66
15-min	2.48	3.20	3.48	4.40	4.92	5.48
30-min	1.58	2.06	2.40	2.86	3.22	3.58
1-hour	0.95	1.25	1346	1.76	1.98	2.21
2-hour	0.56	0.73	0.85	1.02	1.15	1.28
3-hour	0.41	0.53	0.62	0.74	0.83	0.92
6-hour	0.24	0.31	0.36	0.43	0.48	0.53
12-hour	0.14	0.19	0.21	0.26	0.29	0.32
24-hour	0.08	0.11	0.12	0.15	0.17	0.18

2.3-4 RUNOFF HYDROGRAPH

Hydrographs for the 1-yr, 10-yr, and 100-yr storms were computed with the SCS TR-55 Method utilizing Hydrocad version 10.0 software and the weighted CN's and time of concentration values computed as mentioned above. See the runoff hydrograph in the Appendix of this report for details.

3.0 HYDROLOGY

3.1 PEAK RATE ANALYSIS

Pre-Development Drainage Area 1: Runoff from the Existing conditions of Drainage Area 1 flows via sheet flow for approximately 300 feet before beginning to form shallow concentrated flow. The flows are then intercepted by the storm sewer system of the Pinnacle Pines development and routed downstream onto the Juniper Estates project area. Then the upstream flows are combined with the flows on the West side of Masonic Lane. The combined flows then cross underneath Masonic Lane. The combined flow then converges with the flows from the East side of Masonic Lane and travel to the discharge point #1.

Post-Development: The post-development drainage areas and are described as follows (refer to the drainage area maps in the appendix):

- Proposed DA 1: This area consists of the upstream development, Pinnacle Pines, and the areas on site which will not be routed through the storm system.
- DA1 West: This area encompasses the areas West of Masonic Lane that will be captured, routed, and released to flow to discharge point #1.
- DA1 East: This area encompasses the area East of Masonic Lane that will be captured, routed, and released to flow to discharge point #1.

The following table summarizes the peak rate analysis for the project.

Table 4: Peak Discharge Summary

Design Storm	Pre-Dev (cfs)	Post Dev (cfs)	Net Change (cfs)
2-yr	20.00	17.73	-2.27
10-yr	48.24	44.25	-3.99
100-yr	105.51	98.24	-7.27

3.2 Volume Control/Recharge Volume

In accordance with municipal code, development is required to recharge one inch of runoff from the impervious area.

3.3 Water Quality Design

In accordance with the City of Flagstaff Stormwater Management Design Manual and the City of Flagstaff Low Impact Development Manual 100% of the impervious surfaces must flow through one or more of a ROCV IMP.

3.4 Conveyance Design

Storm sewers have been designed for inlet capacity and conveyance of the 10-yr storm design storm for structures within the tributary area of the peak control device. The Rational Method was utilized to analyze the stormwater flows. The rainfall intensities are taken from the City of Flagstaff Stormwater Management Design Manual.

The computer program “Hydraflow Storm Sewers Extension for Autocad Civil 3D” Ver. 2014 by Autodesk is utilized to design the proposed storm sewer conveyance system.

3.5 Upstream and Downstream Analysis

The flows from the upstream development are not significantly altered within the proposed storm design. Therefore, there are no adverse impacts anticipated. As shown above, the peak rates for the 2-, 5-, and 100-year storms have been reduced when compared to pre-development rates. Erosion potential is a function of velocity of flow, which is directly proportional to flow rate. Therefore, a reduction in the overall rate from the development areas will correspond to a similar reduction is velocity, thereby reducing erosion of the downstream channel.

4.0 Conclusions

The stormwater management facility design detailed within this Stormwater Management Report meets or exceeds the standards set forth by The City of Flagstaff Stormwater Management Design Manual and The City of Flagstaff Low Impact Development Manual.

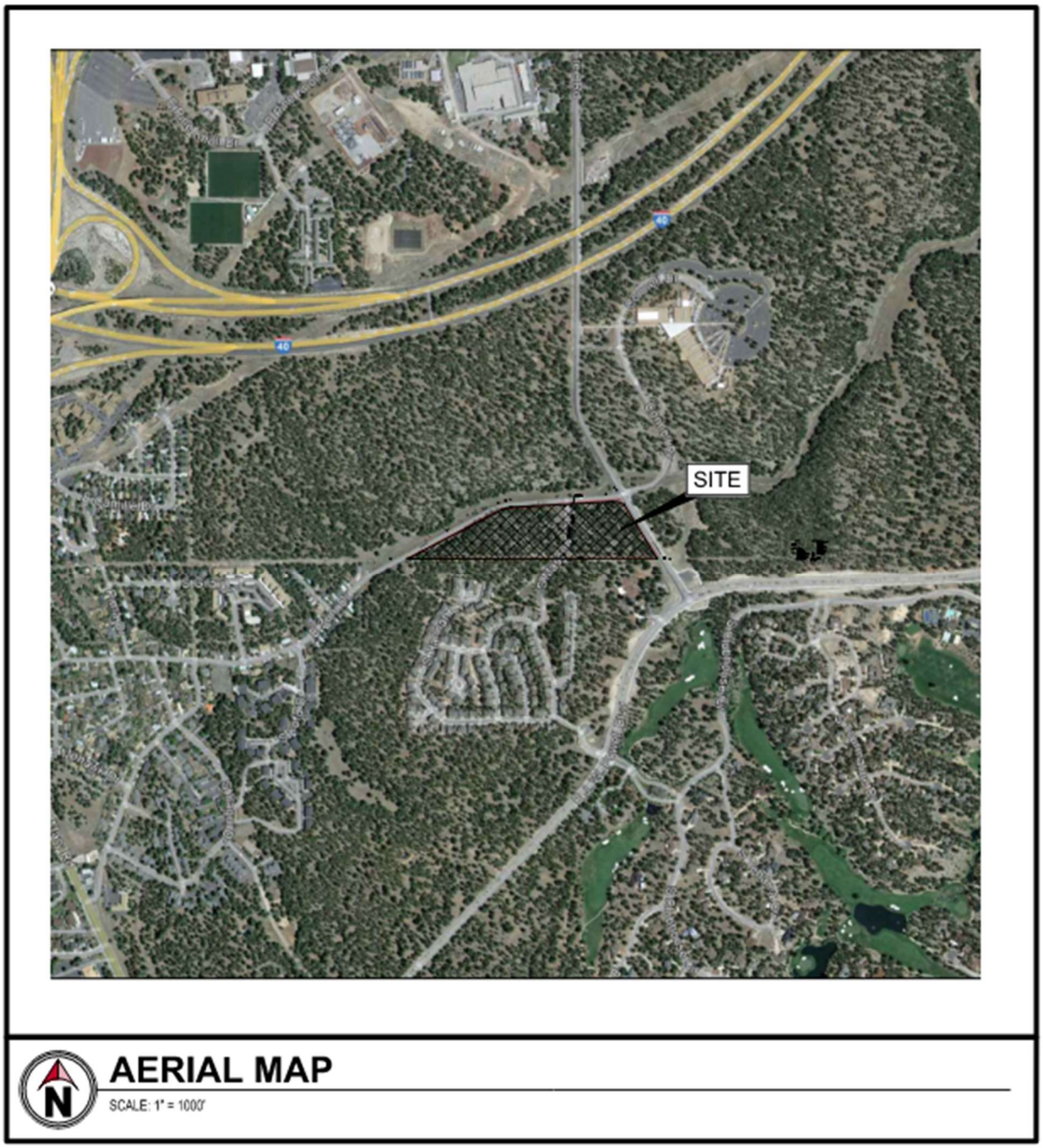
5.0 References

- City of Flagstaff Stormwater Management Design Manual

- City of Flagstaff Low Impact Development Manual
- “ADWR, Oak Creek Flood Warning System Hydrology Report, TR 90-4, September 1990”
- “USDA Urban Hydrology for Small Watersheds Technical Release 55 (TR55)”

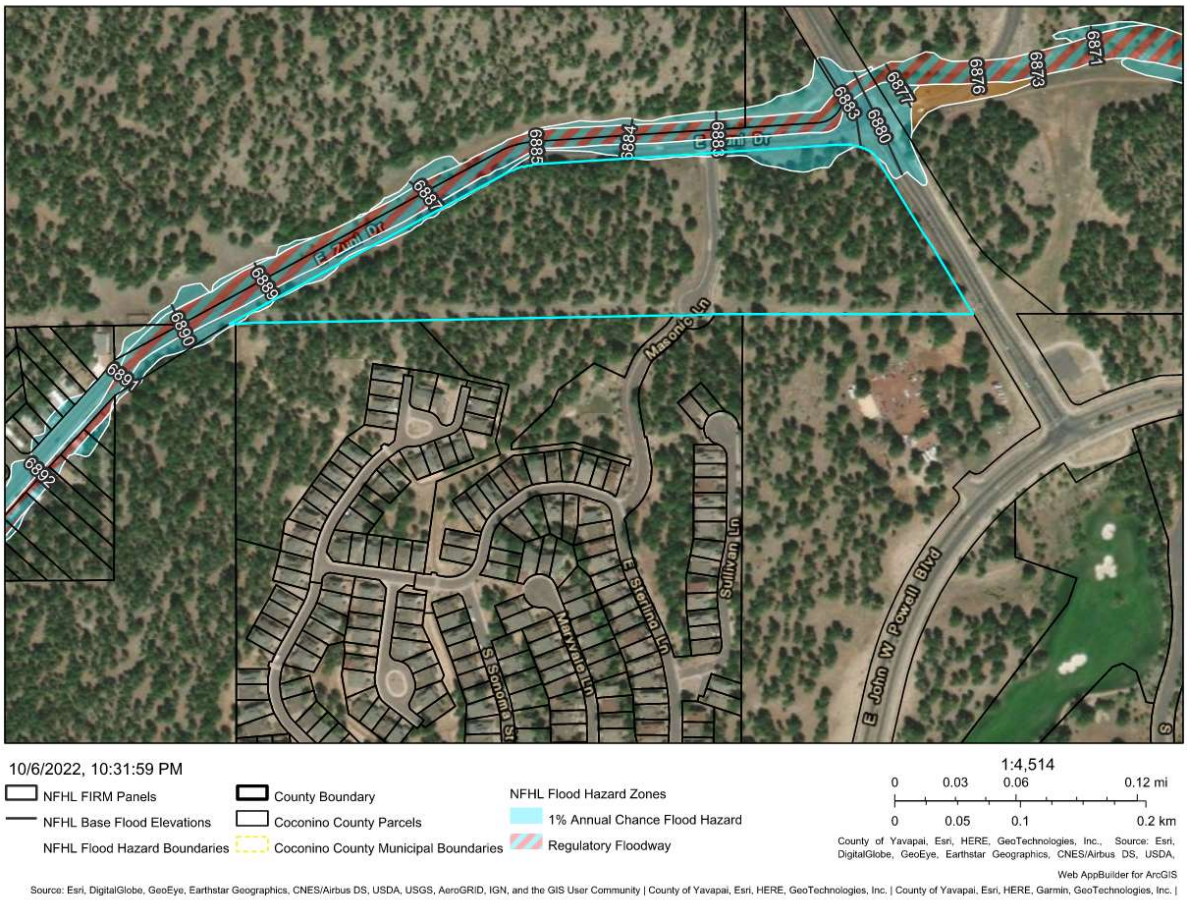
APPENDIX A: SUPPORTING DOCUMENTS

A.1 PROJECT LOCATION MAP



A.2 FEMA Flood Insurance Rate Map

ArcGIS Web Map



A.3 TR-55 Curve Numbers

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.
[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

APPENDIX B: SITE SOILS INVESTIGATION

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Oak Creek-San Francisco Peaks Area, Arizona, Part of Coconino County

January 12, 2023

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:3,300 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Oak Creek-San Francisco Peaks Area, Arizona, Part of Coconino County
Survey Area Data: Version 12, Aug 29, 2022

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

Date(s) aerial images were photographed: Mar 5, 2021—Aug 3, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Jacques clay loam, 0 to 2 percent slopes	0.0	0.0%
13	Lynx loam, 0 to 2 percent slopes	2.5	18.1%
15A	Tortugas-Daze complex, 0 to 15 percent slopes	1.5	11.2%
15B	Tortugas cobbly and gravelly loam, 15 to 30 percent slopes	9.7	70.7%
Totals for Area of Interest		**13.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Oak Creek-San Francisco Peaks Area, Arizona, Part of Coconino County

1—Jacques clay loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 1vhjq
Elevation: 6,580 to 7,080 feet
Mean annual precipitation: 18 to 24 inches
Mean annual air temperature: 43 to 49 degrees F
Frost-free period: 90 to 115 days
Farmland classification: Not prime farmland

Map Unit Composition

Jacques and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Jacques

Setting

Landform: Valleys, drainageways
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

H1 - 0 to 16 inches: clay loam
H2 - 16 to 60 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneFrequent
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Ecological site: R039XA108AZ - Meadow 17-22" p.z.
Hydric soil rating: No

13—Lynx loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 1vhk6
Elevation: 6,560 to 7,030 feet
Mean annual precipitation: 18 to 24 inches
Mean annual air temperature: 43 to 49 degrees F
Frost-free period: 90 to 115 days
Farmland classification: Not prime farmland

Map Unit Composition

Lynx and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lynx

Setting

Landform: Flood plains, alluvial fans
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

H1 - 0 to 60 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneFrequent
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: R039XA130AZ - Loamy Bottom 17-22" p.z.
Hydric soil rating: No

15A—Tortugas-Daze complex, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 1vhkb
Elevation: 6,670 to 7,090 feet
Mean annual precipitation: 18 to 24 inches
Mean annual air temperature: 43 to 49 degrees F
Frost-free period: 90 to 115 days
Farmland classification: Not prime farmland

Map Unit Composition

Tortugas and similar soils: 55 percent
Daze and similar soils: 45 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tortugas

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium and/or residuum weathered from limestone

Typical profile

H1 - 0 to 3 inches: cobbly loam
H2 - 3 to 14 inches: very cobbly loam
R - 14 to 24 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 6 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 50 percent
Available water supply, 0 to 60 inches: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: D
Ecological site: F039XA134AZ - Limestone Upland 17-22" p.z. (PIPO)
Hydric soil rating: No

Description of Daze

Setting

Landform: Hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from limestone and sandstone

Typical profile

H1 - 0 to 3 inches: fine sandy loam
H2 - 3 to 7 inches: clay loam
H3 - 7 to 18 inches: clay
R - 18 to 28 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: D
Ecological site: F039XA139AZ - Limestone/Sandstone Upland 17-22"
Hydric soil rating: No

15B—Tortugas cobbly and gravelly loam, 15 to 30 percent slopes

Map Unit Setting

National map unit symbol: 1vhkc
Elevation: 6,380 to 7,070 feet
Mean annual precipitation: 18 to 24 inches
Mean annual air temperature: 43 to 49 degrees F
Frost-free period: 90 to 115 days
Farmland classification: Not prime farmland

Map Unit Composition

Tortugas and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tortugas

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Side slope, interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium and/or residuum weathered from limestone

Typical profile

H1 - 0 to 3 inches: cobbly loam
H2 - 3 to 14 inches: very cobbly loam
R - 14 to 24 inches: bedrock

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: 6 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 50 percent
Available water supply, 0 to 60 inches: Very low (about 1.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: D
Ecological site: F039XA110AZ - Limestone Hills 17-22" p.z. (PIPO, JUDE2)
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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

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

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

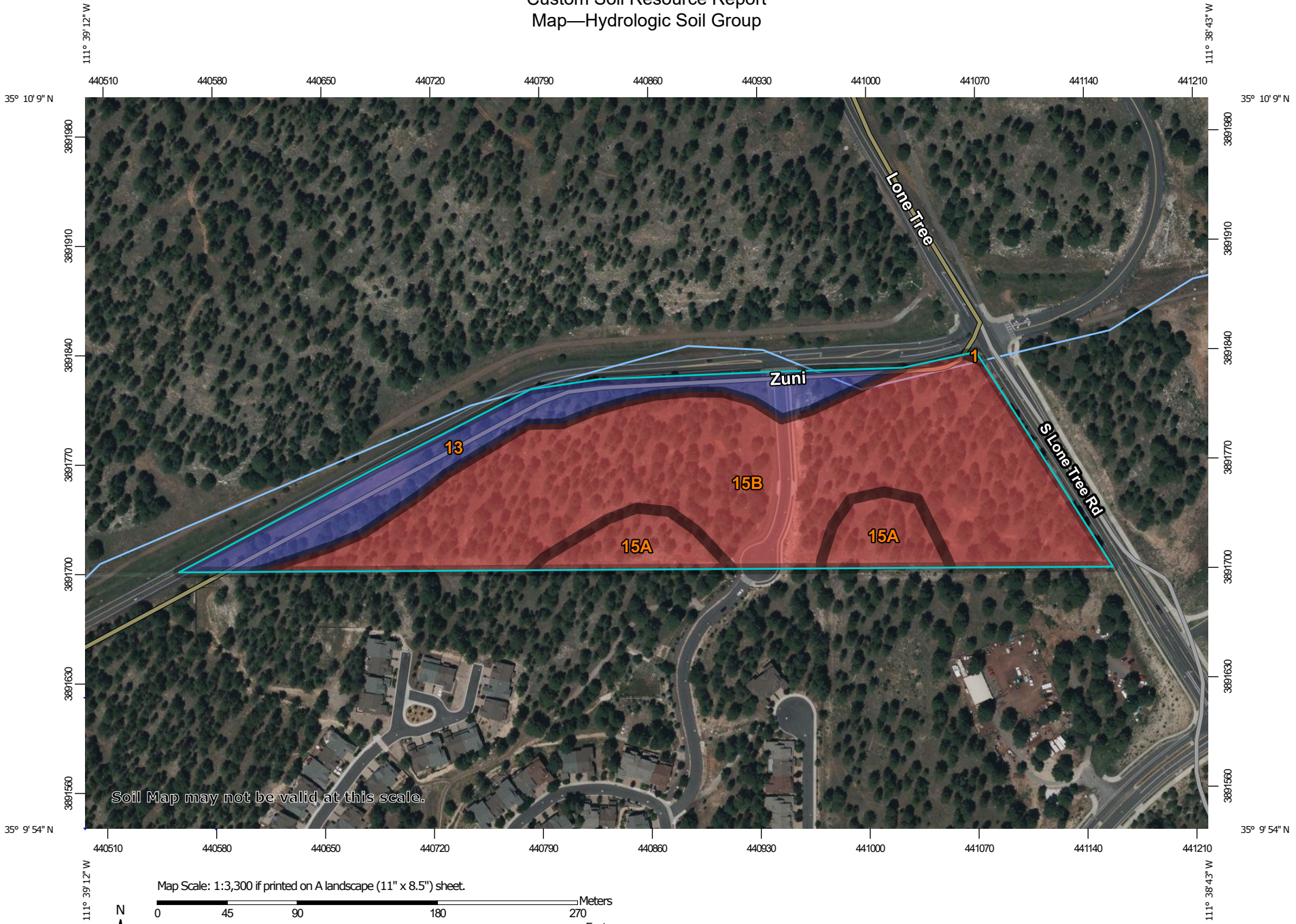
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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

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

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

Custom Soil Resource Report
Map—Hydrologic Soil Group



Map Scale: 1:3,300 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Oak Creek-San Francisco Peaks Area, Arizona, Part of Coconino County
Survey Area Data: Version 12, Aug 29, 2022

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

Date(s) aerial images were photographed: Mar 5, 2021—Aug 3, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND	MAP INFORMATION
	imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Jacques clay loam, 0 to 2 percent slopes	C	0.0	0.0%
13	Lynx loam, 0 to 2 percent slopes	B	2.5	18.1%
15A	Tortugas-Daze complex, 0 to 15 percent slopes	D	1.5	11.2%
15B	Tortugas cobbly and gravelly loam, 15 to 30 percent slopes	D	9.7	70.7%
Totals for Area of Interest			**13.7**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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B.2 SOILS TESTING REPORT

Western Technologies Inc.

GEOTECHNICAL EVALUATION REPORT

MASONIC LANE TOWNHOMES
APN # 103-26-002D
2951 South Masonic Lane
Flagstaff, Arizona
WT Reference No. 2522JB158

PREPARED FOR:
Red Oak Development Group, LLC
8512 Bestride Bend
Austin, Texas 78744
Attn: Mr. Dan Ross, V.P. of Operations
Attn: Ms. Jill Manlove, P.M.
August 19, 2022

Gregory L. E. Burr, R.G., E.I.T.
Director of Geotechnical Services

Craig P. Wiedeman, P.E.
Senior Geotechnical Engineer

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Since 1955

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August 19, 2022

Red Oak Development Group, LLC
8512 Bestride Bend
Austin, Texas 78744

Attn: Mr. Dan Ross, V.P. of Operations
Attn: Ms. Jill Manlove, P.M.

Re: Geotechnical Evaluation — Job No. 2522JB158
Masonic Lane Townhomes
APN # 103-26-002D
2951 South Masonic Lane
Flagstaff, Arizona

Western Technologies Inc. has completed the geotechnical evaluation for the proposed townhomes to be located in Flagstaff, Arizona. This study was performed in general accordance with our proposal number 2522PW273 dated July 8, 2022. The results of our study, including the test pit location diagram, laboratory test results, test pit logs, and the geotechnical recommendations are attached.

We have appreciated being of service to you in the geotechnical engineering phase of this project and are prepared to assist you during the construction phases as well. If design conditions change, or if you have any questions concerning this report or any of our testing, inspection, design and consulting services, please do not hesitate to contact us. We look forward to working with you on future projects.

Sincerely,
WESTERN TECHNOLOGIES, INC.
Geotechnical Engineering Services

Gregory L. E. Burr, R.G., E.I.T.
Director of Geotechnical Services

Copies to: Addressee (emailed)

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

GEOTECHNICAL EVALUATION
MASONIC LANE TOWNHOMES
APN # 103-26-002D
2951 SOUTH MASONIC LANE
FLAGSTAFF, ARIZONA
JOB NO. 2522JB158

1.0 PURPOSE

This report contains the results of our geotechnical evaluation for the proposed townhomes to be located at 2951 South Masonic Lane in Flagstaff, Arizona. The purpose of these services is to provide information and recommendations regarding:

- Subsurface conditions
- Foundation design parameters
- Slabs-on-grade
- On-site pavements
- Lateral earth pressures
- Seismic considerations
- Earthwork guidelines
- Drainage
- Corrosivity

Results of the field exploration, field tests, and laboratory testing program are presented in the Appendices.

2.0 PROJECT DESCRIPTION

Based on information provided by Ms. Jill Manlove, P.M., the proposed project will consist of a subdivision containing one-hundred and five townhomes that will be either single-story or two-story with attached garages, and plan areas ranging from about 1,300 to 3,900 square feet, to be constructed on a lot with a total area of 13.82-acres. It is assumed that the structures will use wood frame and/or masonry construction with slab-on-grade ground floors. Maximum wall and column loads for the structures are assumed to be 3 kips per linear foot and 45 kips, respectively. We anticipate no extraordinary slab-on-grade criteria and that the finished first floor levels will be within about 2 to 3 feet of the existing site grades, although grading plans were not available at the time of this report. In addition, asphalt paved access roads will be included as part of the

proposed development. Should any of our information or assumptions not be correct, we request that the Client notify Western Technologies (WT) immediately.

3.0 SCOPE OF SERVICES

3.1 Field Exploration

Fourteen test pits were excavated to depths ranging from about 1 to 10 feet below existing site grades at the approximate locations shown on the attached Test Pit Location Diagram. A field log was prepared for each test pit.

These logs contain visual classifications of the materials encountered during excavating as well as interpolation of the subsurface conditions between samples. Final logs, included in Appendix A, represent our interpretation of the field logs and may include modifications based on laboratory observations and tests of the field samples. The final logs describe the materials encountered, their thickness, and the locations where samples were obtained. Two samples of the on-site rock were obtained for laboratory testing.

The Unified Soil Classification System was used to classify soils. The soil classification symbols appear on the test pit logs and are briefly described in Appendix A. Local and regional geologic characteristics were used to estimate the seismic design criteria and liquefaction potential.

3.2 Laboratory Analyses

Laboratory analyses were performed on representative soil and rock samples to aid in material classification and to estimate pertinent engineering properties of the on-site soils and rock for preparation of this report. Testing was performed in general accordance with applicable standard test methods. The following tests were performed and the results are presented in Appendix B.

- Water content
- Dry density
- Compression
- Expansion
- Optimum moisture/maximum density
- Sieve analysis

- Plasticity
- Water soluble salt/sulfate/chloride content
- Corrosivity (ASTM A674)
- Unit weight (rock)
- Unconfined compressive strength (rock)

Test results were utilized in the development of the recommendations contained in this report.

3.3 Analyses and Report

This geotechnical engineering report includes a description of the project, a discussion of the field and laboratory testing programs, a discussion of the subsurface conditions, and design recommendations as appropriate to the purpose. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site, discovery of underground storage tanks or other underground structures, or identification of contaminated or hazardous materials or conditions. If there is concern about the potential for such contamination, other studies should be undertaken. We are available to discuss the scope of such studies with you.

4.0 SITE CONDITIONS

4.1 Surface

At the time of our field exploration, the site was a developed lot. Previous development on the site consisted of a north-south oriented asphalt paved residential roadway with a cul-de-sac that bisects the site, and includes concrete curbs and gutters that all appeared to be in good condition. The site is bordered on the north and west by East Zuni Drive, on the south by developed townhomes, and on the east by South Lone Tree Road. The ground surface was rolling and exhibited gentle to steep slopes down to the north. Evidence of previous surface water ponding was observed throughout the flatter portions of the site. Surface drainage appeared to be poor to good by means of sheet flow to the north. Vegetation on the site consisted of a sparse to heavy growth of ponderosa pine trees, grasses and weeds.

4.2 Subsurface

As presented on the Test Pit Logs, shallow surface and subsoils extending to the full depth of exploration in all but one test pit were found to be low to medium plasticity Silty, Clayey SANDS and Clayey SANDS, both with variable amounts of gravel; low to medium plasticity Silty, Clayey GRAVELS and Clayey GRAVELS, both with variable amounts of sand; and high plasticity CLAYS with variable amounts of sand and gravel. All soils encountered contained random amounts of cobbles and boulders. Refusal to excavator penetration occurred in all test pits, except Test Pit 10, at depths of about 1 to 5 feet on LIMESTONE. Groundwater was not encountered in any test pit at the time of exploration. A detailed description of the soils encountered can be found on the test pit logs in Appendix A.

The test pit logs included in this report are indicators of subsurface conditions only at the specific location and date noted. Variations from the field conditions represented by the test pits may become evident during construction. If variations appear, we should be contacted to re-evaluate our recommendations.

5.0 GEOTECHNICAL PROPERTIES AND ANALYSIS

Laboratory test results indicate that the site soils exhibit low to high compressibility at existing water contents. Moderate to moderately high expansive pressures develop when the water content is increased. Two samples of the on-site rock were tested for unit weight and unconfined compressive strength, and the results are presented in Appendix B.

Near-surface soils contain low to high plasticity fines. These soils exhibit moderately high to very high expansion potential when recompacted, confined by loads approximating floor loads and saturated in accordance with standard Arizona test methods. Slabs-on-grade supported on recompacted native soils have a high potential for heaving if the water content of the soil increases. Densification of the soil by the passage of construction equipment will increase the expansion potential of the native clayey soils.

6.0 RECOMMENDATIONS

6.1 General

Recommendations contained in this report are based on our understanding of the project criteria described in Section 2.0 and the assumption that the soil and subsurface conditions are those disclosed by the explorations. Others may change the plans, final elevations, number and type of structures, foundation loads, and floor levels during design or construction. Substantially different subsurface conditions from those described herein may be encountered or become known. Any changes in the project criteria or subsurface conditions shall be brought to our attention in writing. This report does not encompass the effects, if any, of underlying geologic hazards or regional groundwater withdrawal and expresses no opinion regarding their effects on surface movements at the project site.

6.2 Design Considerations

The borings indicate the presence of medium to high plasticity clayey/clay soils throughout the site. These soils will expand or swell significantly with an increase in moisture content. Structures and related improvements situated on expansive soils will be subject to relatively large movements if the supporting soils experience an increase in moisture content. It should be understood that if moisture penetrates expansive soils, there will be some heave and resultant cracking/distress of the proposed structures and related improvements. Construction of site fences, screen walls and other miscellaneous improvements such as exterior slabs-on-grade within the development that typically fall under building code guidelines will be susceptible to heave as well.

Cobbles and some boulders were encountered in the test pits. These oversized materials, greater than 3 inches, could present construction difficulties for foundation, utility trenches and other excavations. In cut areas and excavations, exposed oversized materials should be removed.

6.3 Foundations

A main geotechnical concern on this project will be the possibility of differential bearing conditions between rock areas and moderately deep soil/fill areas. Basically, four different types of bearing conditions may occur on this site:

1. Structures bearing entirely within shallow rock areas.
2. Structures bearing partially on rock and partially on shallow fills (less than 5 feet deep).
3. Structures bearing entirely on fill.
4. Structures bearing entirely in high plasticity soils

To help reduce differential movements, mixed bearing conditions (rock and fill) should be avoided within an individual structural unit.

Following removal of any existing fill materials, conventional shallow spread footings may be used to support the proposed structures. Footings should bear at least 2.5 feet below the lowest adjacent finished grade. Footings may be designed to impose a maximum dead plus live-load pressure of up to 2500 pounds per square foot. Foundation preparation procedures will vary depending on the structure location within the site. Refer to Section 7.5 **Foundation Preparation** in this report for details.

Settlements will also vary depending on the foundation bearing conditions. For foundation elements bearing on dense rock and/or lean mix (2-sack) concrete backfill extending to dense rock, total and differential settlements should be nominal. Settlement of foundation elements bearing on engineered fill will vary depending on the total depth of the fill, and may approach 1 inch in the deeper fill areas. Differential settlements are anticipated to be approximately one-half of the total settlements. Additional foundation movements could occur if water from any source infiltrates the foundation bearing soils. Therefore, proper drainage should be provided in the final design and during construction.

Finished grade is the lowest adjacent grade for perimeter footings and floor level for interior footings. The design bearing capacity applies to dead loads plus design live load conditions. Recommended minimum widths of column and wall footings are 24 inches and 16 inches, respectively. The bearing value given is a net bearing value and the weight of the concrete in the footings may be ignored.

All footings, stem walls and masonry walls should be reinforced to reduce the potential for distress caused by differential foundation movements. The use of joints at openings or other discontinuities in masonry walls is recommended. Site preparation procedures and foundation excavations should be observed by the geotechnical engineer to assess that adequate bearing conditions exist and that recompaction of native soils and/or placement of engineered fill has been performed satisfactorily. If the soil conditions encountered differ

significantly from those presented in this report, supplemental recommendations will be required.

6.4 Lateral Design Criteria

For cantilevered walls above any free water surface with level backfill and no surcharge loads, recommended equivalent fluid pressures and coefficients of base friction for unrestrained elements are:

- Active:
  Undisturbed subsoil .....38 psf/ft
  Compacted granular backfill .....30 psf/ft
  Compacted site soils (low expansive potential) .....38 psf/ft
  Clay/Clayey site soils (high expansive potential) ..... not recommended for use

- Passive:
  Shallow wall footings (soil) .....225 psf/ft
  Shallow column footings (soil) .....350 psf/ft
  Dense rock .....500 psf/ft

- Coefficient of base friction:
  Soil 0.35*
  Rock 0.55

  * The coefficient of base friction (soil) should be reduced to 0.25 when used in conjunction with passive pressure.

Where the design includes restrained elements, the following equivalent fluid pressures are recommended:

- At-rest:
  Undisturbed subsoil .....68 psf/ft
  Compacted granular backfill .....57 psf/ft

These lateral earth pressures are not applicable for submerged soils. We should be consulted for additional recommendations if such conditions are to be included in the

design. Any surcharge from adjacent loadings must also be considered. Walls below grade should be waterproofed.

We recommend a free-draining soil layer or manufactured geocomposite material, be constructed adjacent to the back of retaining walls. A filter may be required between the soil backfill and drainage layer. This drainage zone should help prevent hydrostatic pressure buildup. This vertical drain should be tied into a gravity drainage system at the base of the wall. It is important that all backfill be properly placed and compacted. Backfill should be mechanically compacted in layers. Flooding or jetting should not be permitted. Care should be taken not to damage the walls when placing the backfill. Backfills should be inspected and tested during placement.

Fill against footings, stem walls and retaining walls should be compacted to densities specified in **EARTHWORK**. Medium to high plasticity clay soils should not be used as backfill against retaining walls. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors. Overcompaction may cause excessive lateral earth pressures which could result in wall movements.

6.5 Seismic Considerations

Structures should be designed in accordance with applicable building codes. The seismic design parameters presented in the following table, in accordance with the 2018 International Building Code and ASCE 7-16, are applicable to the project site:

Seismic Design Parameters International Building Code 2018, ASCE 7-16	
Soil Site Class	C
Mapped Spectral Response Acceleration at 0.2 sec period (S_s)	0.312g
Mapped Spectral Response Acceleration at 1.0 sec period (S_1)	0.096g
Site Coefficient for 0.2 sec period (F_a)	1.3
Site Coefficient for 1.0 sec period (F_v)	1.5
Design Spectral Response Acceleration at 0.2 sec period (S_{DS})	0.271g
Design Spectral Response Acceleration at 1.0 sec period (S_{D1})	0.096g

The soil site class is based upon conditions identified in shallow exploratory test pits and local knowledge of the geotechnical conditions in the vicinity of the site. Conditions extending

beyond the depth of our test pits to a depth of 100 feet were assumed for the purposes of providing the information presented in the table. Based upon the density of the on-site soils, the shallow rock conditions in some areas of the site, and lack of groundwater, the potential settlement and lateral spread due to liquefaction is not a considered to be a significant concern on this site.

6.6 Conventional Slab-on-Grade Support

Slabs-on-grade should be supported on a minimum thickness of 3 feet of properly placed and compacted, imported, low expansive, engineered fill. For design of interior slabs-on-grade, we recommend using a modulus of subgrade reaction (k) of 200 pounds per cubic inch (pci) for the on-site soils and 225 pci for imported fill material, based on a 30-inch diameter plate. For design of interior slabs-on-grade, we recommend using a modulus of subgrade reaction (k) of 200 pounds per cubic inch (pci) for the on-site soils and 225 pci for imported fill material, based on a 30-inch diameter plate. A minimum 4-inch thick layer of base course should be provided beneath all slabs to help prevent capillary rise and a damp slab.

The use of vapor retarders or barriers is desirable for any slab-on-grade where the floor will be covered by products using water-based adhesives, wood, vinyl backed carpet, impermeable floor coatings (urethane, epoxy, acrylic terrazzo, etc.) or where the floor will be in contact with moisture sensitive equipment or product. When used, the design and installation should be in accordance with the guidance given in ACI 302.1R and 302.2R. Final determination on the use of a vapor retarder should be left to the slab designer.

All concrete placement and curing operations should follow the American Concrete Institute manual recommendations. Improper curing techniques and/or high slump (high water-cement ratio) could cause excessive shrinkage, cracking or curling. The plastic properties of the concrete should be documented at the time of placement and specimens should also be prepared for strength testing to verify compliance with project specifications. Concrete slabs should be allowed to cure adequately before placing vinyl or other moisture sensitive floor covering.

6.7 Drainage

The major cause of soil-related foundation and slab-on-ground problems is moisture increase in soils below structures. Properly functioning conventional foundations and floor slabs-on-ground require appropriately constructed and maintained site drainage conditions.

Therefore, it is extremely important that positive drainage be provided during construction and maintained throughout the life of the residential structures. It is also important that proper planning and control of landscape and irrigation practices be performed.

Infiltration of water into utility or foundation excavations must be prevented during construction. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to minimize the possibility of moisture infiltration. If utility line trenches are backfilled with a granular material, then a clay or concrete plug should be placed in the trench adjacent to the structures to prevent water from following the trench back under the structures.

In areas where sidewalks, patios or driveways do not immediately adjoin the structures, protective slopes should be provided with an outfall of about 5 percent for at least 10 feet from perimeter walls. Scuppers or gutters and drain pipes should be designed to provide drainage away from the structures for a minimum distance of 10 feet. Planters or other surface features that could retain water adjacent to residential structures should be avoided if at all possible. If planters and/or landscaping are adjacent to or near the structures, there will be a greater potential for moisture infiltration, soil movement and structure distress. As a minimum, we recommend the following:

- Grades should slope away from the structures.

- Planters should slope away from the structures and should not pond water. Drains should be installed in enclosed planters to facilitate flow out of the planters.
- Only shallow rooted landscaping should be used.

- Watering should be kept to a minimum. Irrigation systems should be situated on the far side of any planting and away from the structures to minimize infiltration beneath foundations from possible leaks.

- Trees should be planted no closer than a distance equal to three-quarters of their mature height or 15 feet, whichever is greater.

It should be understood that these recommendations will help minimize the potential for soil movement and resulting distress, but will not eliminate this potential.

6.8 Corrosivity

Based on the laboratory test results, the on-site soils exhibit a low to moderate corrosive potential to ductile iron piping. This information should be used as an aid in choosing the construction materials that will be in contact with these soils and that will need to be resistant to various corrosive forces. Manufacturers' representatives should be contacted regarding the specific corrosivity resistance for their particular product.

The chemical test results indicate that the site soils are negligibly corrosive to concrete. However, in order to be consistent with standard local practice and for reasons of material availability, we recommend that Type II portland cement be used for all concrete on and below grade.

6.9 Pavements

Based on existing subgrade conditions, the following pavement sections are recommended for the areas indicated:

Traffic Area	Asphalt Concrete (in.)	Base Course (in.)
Passenger car parking/drives (low traffic frequency)	3	7
Residential Roadways (high traffic frequency)	4	5

Bituminous surfacing should be constructed of dense-graded, central plant-mix, asphalt concrete. Base course and asphalt concrete should conform with City of Flagstaff specifications.

Material and compaction requirements should conform to the recommendations presented under **EARTHWORK**. The gradient of paved surfaces should ensure positive drainage. Water should not pond in areas directly adjoining paved sections. The native subgrade soils will soften and lose stability if subjected to conditions which result in an increase in water content.

Due to the high static loads imposed by parked trucks in loading and unloading areas and at dumpster locations, we recommend that a rigid pavement section be considered for these

areas. A minimum 6-inch thick concrete pavement over 4 inches of aggregate base course material is recommended.

6.9.1 Pavement Analyses

The recommended pavement sections are based on the following conditions. This firm should be contacted if any of these conditions change so that revised recommendations can be provided, if necessary.

a. A design R-value of 20 for the on-site soils which corresponds to a resilient modulus of approximately 5,700 pounds per square inch. Any required fills should be constructed using on-site or imported materials with subgrade support characteristics equal to or greater than the subgrade soils in the area being filled.

b. Structural coefficients of 0.40 for asphalt concrete and 0.12 for aggregate base course material.

c. A present serviceability index of 4.5, a terminal serviceability index of 2.5, an overall standard deviation of 0.35, a reliability factor of 85 percent, a drainage coefficient of 0.85, a seasonal variation factor of 3.5, and design life of 20 years.

d. A total 18-kip equivalent single axle load (ESAL) of 25,000 for the passenger car parking areas and 36,500 for the residential roadway areas.

7.0 EARTHWORK

7.1 General

The conclusions contained in this report for the proposed construction are contingent upon compliance with recommendations presented in this section. Any excavating, trenching, or disturbance that occurs after completion of the earthwork must be backfilled, compacted and tested in accordance with the recommendations contained herein. It is not reasonable to rely upon our conclusions and recommendations if any future unobserved and untested trenching, earthwork activities or backfilling occurs.

7.2 Site Clearing

Strip and remove all vegetation, debris, and any other deleterious materials from the building and pavement areas. The building area is defined as that area within the building footprint plus 5 feet beyond the perimeter of that footprint. All exposed surfaces should be free of mounds and depressions that could prevent uniform compaction.

7.3 Excavation

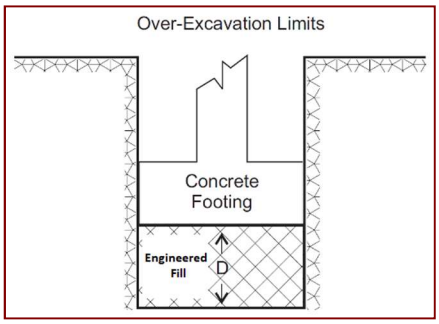
We anticipate that excavations into the site soils for the proposed construction can be accomplished with conventional equipment. Excavations penetrating the underlying limestone may require the use of heavy duty, specialized equipment to facilitate rock break-up and removal.

On-site soils will pump or become unworkable at high water contents. Workability may be improved by scarifying and drying. Over-excavation of wet zones and replacement with drier granular materials may be necessary. The use of lightweight excavation and compaction equipment may be required to minimize subgrade pumping.

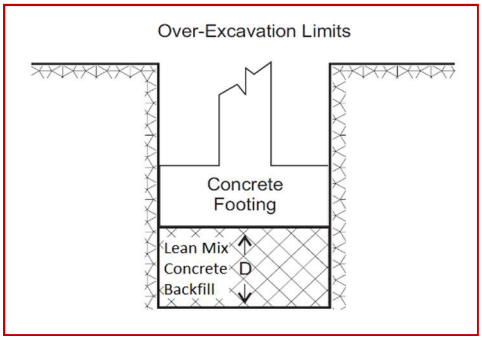
7.4 Foundation Preparation

For structures located within cut areas of the site where rock is encountered throughout the entire building area, remove all loose or disturbed materials from the bottoms and sides of the footing excavations prior to the placement of foundation reinforcement and concrete. The depth of removal required for this condition will vary and is best determined in the field during foundation excavation operations. If desired, lean mix (2-sack) concrete backfill may be used to backfill any deeper portions of the excavations to design bottom of foundation elevation.

For structures bearing partially on rock and partially on fill, provide a minimum thickness of 2 feet of engineered fill material below all foundation elements (depth D in the diagram to the right). Removal and replacement in rock areas may extend straight down along the sides of the footing.

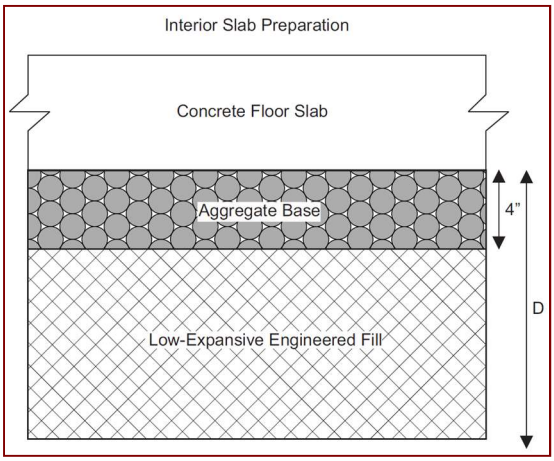


For structures bearing partially or entirely on high plasticity soils, remove existing soils to a minimum depth of 3 feet below the bottom of the footing (depth D in the diagram to the right). Removal should extend straight down along the sides of the footing. Replace the removed soils with properly consolidated, lean mix (2-sack) concrete backfill material.



7.5 Slab-on-Grade Preparation

Slabs-on-grade should be founded on a minimum thickness of 3 feet of imported, low expansive, engineered fill material. Remove native soils, as necessary, to a minimum depth of 3 feet below the bottom of the slab (depth D in the diagram below). Following the removal, scarify, moisten or dry as required, and compact all subgrade soils to a minimum depth of 8 inches. Replace the removed soils with properly compacted, imported, low to non-expansive, engineered fill material. The aggregate base course below the slab may be included as part of the low to non-expansive engineered fill. Removal and/or scarifying and compacting are not required in areas where dense limestone is encountered.



The subgrade preparation should be accomplished in a manner that will result in uniform water contents and densities after compaction.

7.6 Exterior Slab Preparation

Some of the soils on this site have the potential to expand and shrink with changes in moisture content. In addition, frost penetration in the upper soils may cause surface heaving. Therefore, relatively lightweight exterior concrete flatwork such as sidewalks and patios may experience movements resulting in cracking or vertical offsets. To reduce the potential for damage, we recommend:

- Use of fill with low expansion potential
- Use of fill with low to negligible frost susceptibility
- Placement of effective control joints on relatively close centers
- Moisture-density control during placement of subbase fills
- Provision for adequate drainage in areas adjoining the slabs
- Use of designs which allow vertical movement between the exterior slabs and adjoining structural elements

It should be understood that these recommendations will help reduce the potential for soil movement and resulting distress, but will not eliminate this potential. Furthermore, the use of municipal specifications and details may not mitigate the potential for movements of the expansive or frost susceptible on-site soils.

7.7 Pavement Preparation

Prior to placement of fill and/or pavement materials, the exposed subgrade soils should be proof-rolled and observed by the geotechnical engineer or his qualified representative to verify that stable subgrade conditions exist. Any loose, soft, disturbed, or otherwise unsuitable materials should be over-excavated and replaced with engineered fill. The subgrade should then be scarified, moisture conditioned as required, and recompacted for a minimum depth of 8 inches. Scarifying and compacting are not required in areas where dense limestone is encountered.

7.8 Materials

a. Clean on-site soils with low expansive potential and a maximum dimension of 6 inches or imported materials may be used as fill material for the following:

- Foundation areas
- Interior slab areas
- Pavement areas
- Backfill

b. On-site clay/clayey soils are not recommended for use beneath foundations, conventional interior or exterior slabs-on-grade or as backfill below slabs. Imported, low expansive, engineered fill should be used in these areas.

c. Frozen soils should not be used as fill or backfill.

d. Lean mix (2-sack) concrete backfill should consist of aggregate base course type material combined with 2 sacks of cement per cubic yard. A coarse rock mix should not be used.

e. Imported soils should conform to the following:

- Gradation (ASTM C136): percent finer by weight

6"	100
4"	85-100
¾”	70-100
No. 4 Sieve	50-100
No. 200 Sieve	40 (max)

- Maximum expansive potential (%)[1] 1.5

- Maximum soluble sulfates (%) 0.10

f. Base course should conform to City of Flagstaff, Current Edition specifications.

[1] Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

7.9 Placement and Compaction

a. Place and compact fill in horizontal lifts, using equipment and procedures that will produce recommended water contents and densities throughout the lift.

b. Uncompacted lift thickness should not exceed 8 inches.

c. Materials should be compacted to the following:

Material	Minimum Percent Compaction (ASTM D698)
• On-site soil, reworked:	
Below slabs-on-grade	90
Pavement areas	95
• On-site soil (moderate expansive potential), fill:	
Pavement areas	95
Landscape areas	85
• Imported and on-site soil (low expansive potential), fill:	
Below foundations	95
Below slabs-on-grade	95
Pavement areas	95
• Aggregate base:	
Below slabs-on-grade	95
Pavement areas	100
• Backfill:	
Structural	95
Nonstructural	90

d. On-site soils should be compacted with a moisture content in the range of optimum to 4 percent above optimum. Imported soils with low expansive potential and aggregate base course materials should be compacted with a moisture content in the range of 3 percent below to 3 percent above optimum.

7.10 Compliance

Recommendations for foundations, slabs-on-grade and pavements supported on compacted fills or prepared subgrade depend upon compliance with the **EARTHWORK** recommendations. To assess compliance, observation and testing should be performed under the direction of a WT geotechnical engineer. Please contact us to provide these observation and testing services.

8.0 ADDITIONAL SERVICES

The recommendations provided in this report are based on the assumption that a sufficient schedule of tests and observations will be performed during construction to verify compliance. At a minimum, these tests and observations should be comprised of the following:

- Observations and testing during site preparation and earthwork,
- Observation of foundation excavations, and
- Consultation as may be required during construction.

Retaining the geotechnical engineer who developed your report to provide construction observation is the best way to verify compliance and to help you manage the risks associated with unanticipated conditions.

9.0 LIMITATIONS

This report has been prepared assuming the project criteria described in **2.0 PROJECT DESCRIPTION**. If changes in the project criteria occur, or if different subsurface conditions are encountered or become known, the conclusions and recommendations presented herein shall become invalid. In any such event, WT should be contacted in order to assess the effect that such variations may have on our conclusions and recommendations. If WT is not retained for the construction observation and testing services to determine compliance with this report, our professional responsibility is accordingly limited.

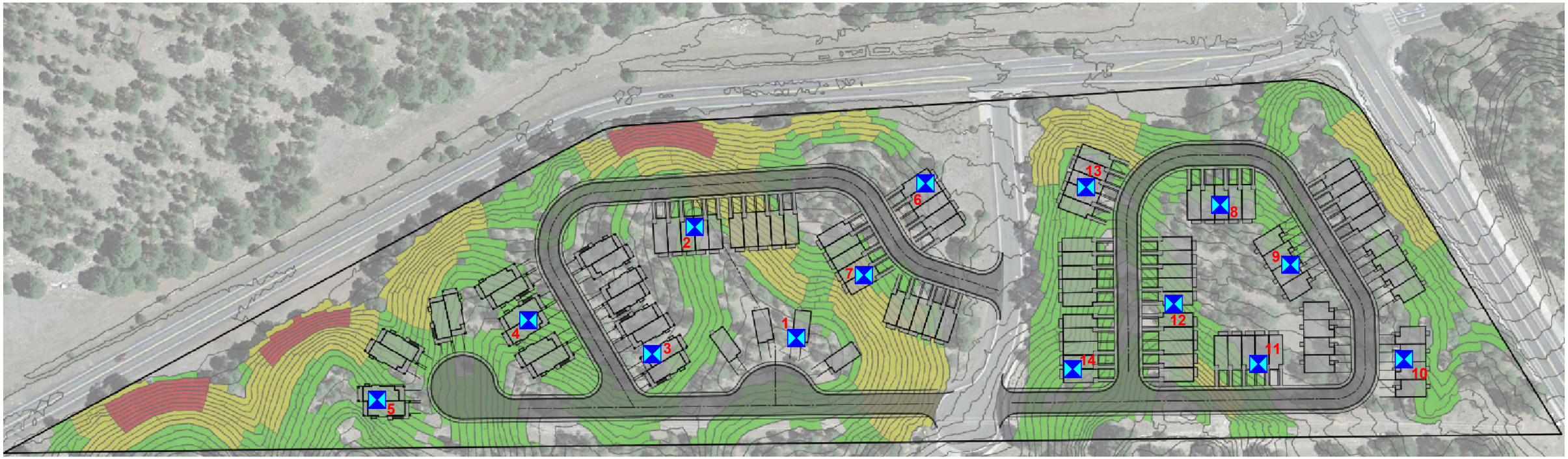
The recommendations presented are based entirely upon data derived from a limited number of samples obtained from widely spaced explorations. The attached logs are indicators of

subsurface conditions only at the specific locations and times noted. This report assumes the uniformity of the geology and soil structure between explorations, however variations can and often do exist. Whenever any deviation, difference, or change is encountered or becomes known, WT should be contacted.

This report is for the exclusive benefit of our client alone. There are no intended third-party beneficiaries of our contract with the client or this report, and nothing contained in the contract or this report shall create any express or implied contractual or any other relationship with, or claim or cause of action for, any third party against WT.
This report is valid for the earlier of one year from the date of issuance, a change in circumstances, or discovered variations. After expiration, no person or entity shall rely on this report without the express written authorization of WT.

10.0 CLOSURE

We prepared this report as an aid to the designers of the proposed project. The comments, statements, recommendations and conclusions set forth in this report reflect the opinions of the authors. These opinions are based upon data obtained at the location of the explorations, and from laboratory tests. Work on your project was performed in accordance with generally accepted standards and practices utilized by professionals providing similar services in this locality. No other warranty, express or implied, is made.



Not to Scale

Approximate Test Pit Location

Geotechnical Environmental Inspections Materials

Western Technologies Inc. The Quality People Since 1955

MASONIC LANE TOWNHOMES

Test Pit Location Diagram

Western Technologies Inc.

Job No.: 2522JB158

Plate: 1

Allowable Soil Bearing Capacity	The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.
Backfill	A specified material placed and compacted in a confined area.
Base Course	A layer of specified aggregate material placed on a subgrade or subbase.
Base Course Grade	Top of base course.
Bench	A horizontal surface in a sloped deposit.
Caisson/Drilled Shaft	A concrete foundation element cast in a circular excavation which may have an enlarged base (or belled caisson).
Concrete Slabs-On-Grade	A concrete surface layer cast directly upon base course, subbase or subgrade.
Crushed Rock Base Course	A base course composed of crushed rock of a specified gradation.
Differential Settlement	Unequal settlement between or within foundation elements of a structure.
Engineered Fill	Specified soil or aggregate material placed and compacted to specified density and/or moisture conditions under observations of a representative of a soil engineer.
Existing Fill	Materials deposited through the action of man prior to exploration of the site.
Existing Grade	The ground surface at the time of field exploration.
Expansive Potential	The potential of a soil to expand (increase in volume) due to absorption of moisture.
Fill	Materials deposited by the actions of man.
Finished Grade	The final grade created as a part of the project.
Gravel Base Course	A base course composed of naturally occurring gravel with a specified gradation.
Heave	Upward movement.
Native Grade	The naturally occurring ground surface.
Native Soil	Naturally occurring on-site soil.
Rock	A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.
Sand and Gravel Base Course	A base course of sand and gravel of a specified gradation.
Sand Base Course	A base course composed primarily of sand of a specified gradation.
Scarify	To mechanically loosen soil or break down existing soil structure.
Settlement	Downward movement.
Soil	Any unconsolidated material composed of discrete solid particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water.
Strip	To remove from present location.
Subbase	A layer of specified material placed to form a layer between the subgrade and base course.
Subbase Grade	Top of subbase.
Subgrade	Prepared native soil surface.

COARSE-GRAINED SOILS

LESS THAN 50% FINES

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
GW	WELL-GRADED GRAVEL OR WELL-GRADED GRAVEL WITH SAND, LESS THAN 5% FINES	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE
GP	POORLY-GRADED GRAVEL OR POORLY-GRADED GRAVEL WITH SAND, LESS THAN 5% FINES	
GM	SILTY GRAVEL OR SILTY GRAVEL WITH SAND, MORE THAN 12% FINES	
GC	CLAYEY GRAVEL OR CLAYEY GRAVEL WITH SAND, MORE THAN 12% FINES	
SW	WELL-GRADED SAND OR WELL-GRADED SAND WITH GRAVEL, LESS THAN 5% FINES	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE
SP	POORLY-GRADED SAND OR POORLY-GRADED SAND WITH GRAVEL, LESS THAN 5% FINES	
SM	SILTY SAND OR SILTY SAND WITH GRAVEL, MORE THAN 12% FINES	
SC	CLAYEY SAND OR CLAYEY SAND WITH GRAVEL, MORE THAN 12% FINES	

NOTE: Coarse-grained soils receive dual symbols if they contain 5% to 12% fines (e.g., SW-SM, GP-GC).

FINE-GRAINED SOILS

MORE THAN 50% FINES

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
ML	SILT, SILT WITH SAND OR GRAVEL, SANDY SILT, OR GRAVELLY SILT	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50
CL	LEAN CLAY OF LOW TO MEDIUM PLASTICITY, SANDY CLAY, OR GRAVELLY CLAY	
OL	ORGANIC SILT OR ORGANIC CLAY OF LOW TO MEDIUM PLASTICITY	
MH	ELASTIC SILT, SANDY ELASTIC SILT, OR GRAVELLY ELASTIC SILT	SILTS AND CLAYS LIQUID LIMIT MORE THAN 50
CH	FAT CLAY OF HIGH PLASTICITY, SANDY FAT CLAY, OR GRAVELLY FAT CLAY	
OH	ORGANIC SILT OR ORGANIC CLAY OF HIGH PLASTICITY	
PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	HIGHLY ORGANIC SOILS

NOTE: Fine-grained soils may receive dual classification based upon plasticity characteristics (e.g. CL-ML).

SOIL SIZES

COMPONENT	SIZE RANGE
BOULDERS	Above 12 in.
COBBLES	3 in. – 12 in.
GRAVEL	No. 4 – 3 in.
Coarse	¾ in. – 3 in.
Fine	No. 4 – ¾ in.
SAND	No. 200 – No. 4
Coarse	No. 10 – No. 4
Medium	No. 40 – No. 10
Fine	No. 200 – No. 40
Fines (Silt or Clay)	Below No. 200

NOTE: Only sizes smaller than three inches are used to classify soils

CONSISTENCY

CLAYS & SILTS	BLOWS PER FOOT
VERY SOFT	0 – 2
SOFT	3 – 4
FIRM	5 – 8
STIFF	9 – 15
VERY STIFF	16 – 30
HARD	OVER 30

RELATIVE DENSITY

SANDS & GRAVELS	BLOWS PER FOOT
VERY LOOSE	0 – 4
LOOSE	5 – 10
MEDIUM DENSE	11 – 30
DENSE	31 – 50
VERY DENSE	OVER 50

NOTE: Number of blows using 140-pound hammer falling 30 inches to drive a 2-inch-OD (1⅜-inch ID) split-barrel sampler (ASTM D1586).

PLASTICITY OF FINE GRAINED SOILS

PLASTICITY INDEX	TERM
0	NON-PLASTIC
1 – 7	LOW
8 – 20	MEDIUM
Over 20	HIGH

DEFINITION OF WATER CONTENT

DRY
SLIGHTLY DAMP
DAMP
MOIST
WET
SATURATED

The number shown in **"TEST PIT"** refers to the approximate location of the same number indicated on the "Test Pit Location Diagram" as positioned in the field by pacing or measurement from property lines and/or existing features.

"EQUIPMENT TYPE" refers to the equipment used in the excavation of the test pit, and may include the width of the bucket on the excavator and the use of “rock” teeth or attachments.

"SAMPLE TYPE" refers to the form of sample recovery, in which **R** = Ring sample and **G** = Grab Sample.

"DRY DENSITY (LBS/CU FT)" refers to the laboratory-determined dry density in pounds per cubic foot. A double vertical line within the symbol indicates no sample recovery. A circle within the symbol indicates sample disturbance.

"WATER (MOISTURE) CONTENT” (% of Dry Wt.) refers to the laboratory-determined water content in percent using the standard test method ASTM D2216.

"USCS" refers to the “Unified Soil Classification System” Group Symbol for the soil type as defined by ASTM D2487 and D2488. The soils were classified visually in the field, and where appropriate, classifications were modified by visual examination of samples in the laboratory and/or by appropriate tests.

These notes and test pit logs are intended for use in conjunction with the purposes of our services defined in the text. Test pit log data should not be construed as part of the construction plans nor as defining construction conditions.

The test pit logs depict our interpretations of subsurface conditions at the locations and on the date(s) noted. Variations in subsurface conditions and characteristics may occur between test pits. Groundwater levels may fluctuate due to seasonal variations and other factors.

The stratification lines shown on the test pit logs represent our interpretation of the approximate boundary between soil or rock types based upon visual field classification at the test pit location. The transition between materials is approximate and may be more or less gradual than indicated.

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 1

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				GC		Clayey GRAVEL; with sand, cobbles and boulders, light brown/white, damp
					5			**Excavator Refusal at 2 Feet on LIMESTONE**
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

Geotechnical Environmental Inspections Materials

Western Technologies Inc.
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Since 1955

PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-4**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 2

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				GC		Clayey GRAVEL; with sand, cobbles and boulders, dark brown, damp
					5			**Excavator Refusal at 2 Feet on LIMESTONE**
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-5**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 3

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				SC-SM		Silty, Clayey SAND; with gravel, cobbles and boulders, light brown, damp
					5			**Excavator Refusal at 4 Feet on LIMESTONE**
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

Geotechnical Environmental Inspections Materials

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-6**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 4

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				SC		Clayey SAND; with gravel, cobbles and boulders, brown, damp
								Excavator Refusal at 2 Feet on LIMESTONE

5

10

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-7**

TEST PIT LOG

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 5

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				GC		Clayey GRAVEL; with sand, cobbles and boulders, dark brown, damp
					5			**Excavator Refusal at 3 Feet on LIMESTONE**
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-8**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 6

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				SC-SM		Silty, Clayey SAND; some gravel, cobbles and boulders, black/dark brown, damp
					5			**Excavator Refusal at 2 Feet on LIMESTONE**
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-9**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 7

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				GC-GM		Silty, Clayey GRAVEL; with sand, cobbles and boulders, brown, damp
					5			**Excavator Refusal at 3 Feet on LIMESTONE**
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-10**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 8

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				GC-GM		Silty, Clayey GRAVEL; with sand, cobbles and boulders, light brown, damp
		R		Push				
								Excavator Refusal at 4 Feet on LIMESTONE
					5			
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-11**

TEST PIT LOG

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 9

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
						SC-SM		Silty, Clayey SAND; with gravel, cobbles and boulders, tan, damp
18.4	99	R		Push		CH		Sandy Fat CLAY; some gravel, brown, damp
		G						
					5			**Excavator Refusal at 5 Feet on LIMESTONE**
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-12**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 10

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				CH		Sandy Fat CLAY; some gravel, brown, moist
20.2	99	R		Push				
					5			
					10			**Excavation Stopped at 10 Feet**

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-13**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 11

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				SC-SM		Silty, Clayey SAND; with gravel, cobbles and boulders, tan, damp
					5			**Excavator Refusal at 2 Feet on LIMESTONE**
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE
A-14

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 12

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				GC-GM		Silty, Clayey GRAVEL; with sand, cobbles and boulders, brown, damp
					5			**Excavator Refusal at 2 Feet on LIMESTONE**
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-15**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 13

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				GC-GM		Silty, Clayey GRAVEL; with sand, cobbles and boulders, black/dark brown, damp
								Excavator Refusal at 1 Foot on LIMESTONE
					5			
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-16**

TEST PIT LOG

DATE EXCAVATED: **7-22-22**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

TEST PIT NO. 14

EQUIPMENT: **CASE 580 N**
EXCAVATION TYPE: **24" BUCKET**
FIELD ENGINEER: **C. Senior**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		G				GC-GM		Silty, Clayey GRAVEL; with sand, cobbles and boulders, black/dark brown, damp
								Excavator Refusal at 1 Foot on LIMESTONE
					5			
					10			

N- **STANDARD PENETRATION TEST**
R- **RING SAMPLE**
C- **CORE: %RECOVERY/RQD**
G- **GRAB SAMPLE**
B- **BUCKET SAMPLE**

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **MASONIC LANE TOWNHOMES**
PROJECT NO.: **2522JB158**

PLATE **A-17**

TEST PIT LOG

Test Pit No.	Depth (ft)	USCS Class.	Particle Size Distribution (%) Passing by Weight							Atterberg Limits		Laboratory Compaction Characteristics			Remarks
			3"	¾"	#4	#10	#40	#200	2µ	LL	PI	Dry Density (pcf)	Optimum Moisture (%)	Method	
1	0-2	GC	100	60	45	40	36	25.0		39	23				2
4	0-2	SC	100	88	80	76	71	36.3		34	16				2
5	0-3	GC	80	58	53	50	48	30.1		32	13				2
6	0-2	SC-SM		100	90	85	79	41.7		28	7				2
8	0-4	GC-GM	100	80	70	66	62	44.0		28	7				2
10	0-5	CH	100	92	89	87	83	51.1		53	38				2
12	0-2	GC-GM	83	60	49	45	40	18.9		30	7				2

NOTE: NP = Non-plastic
µ = microns (2µ = 0.002mm)

REMARKS

Classification / Particle Size / Moisture-Density Relationship
1. Visual
2. Laboratory Tested
3. Minus #200 Only
4. Test Method ASTM D698/AASHTO T99
5. Test Method ASTM D1557/AASHTO T180
6. From the ADOT Family of Curves

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PROJECT: MASONIC LANE TOWNHOMES
JOB NO.: 2522JB158

PLATE
B-1

SOIL PROPERTIES

Test Pit No.	Depth (ft.)	USCS Class.	Initial Dry Density (pcf)	Initial Water Content (%)	Laboratory Compaction Characteristics			Expansion Properties		Plasticity		Soluble		Remarks
					Dry Density(pcf)	Optimum Moisture(%)	Method	Surcharge (ksf)	Expansion (%)	LL	PI	Salts (ppm)	Sulfate (ppm)	
4	0-2	SC	96.9	14.2	102.0	17.3	A	0.1	3.4					1,2,3
10	0-5	CH	88.2	19.7	92.5	23.2	A	0.1	8.1					1,2,3

Notes: Initial Dry Density and Initial Water Content are remolded.

Remarks

1. Compacted density (approx. 95% of ASTM D698 max. density at moisture content slightly below optimum.)
2. Submerged to approximate saturation.
3. Test Method ASTM D698/AASHTO T99
4. Test Method ASTM D1557/AASHTO T180
5. From the ADOT Family of Curves

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PROJECT: MASONIC LANE TOWNHOMES

JOB NO.: 2522JB158

SOIL PROPERTIES

PLATE

B-2

Test No.	Depth (ft)	Rock Classification	Unit Weight (pcf)	Unconfined Compressive Strength (psi)	Remarks
1	Surface	Limestone	156.3	10,680	1,2
2	Surface	Limestone	160.1	13,700	1,2

REMARKS:

1. ASTM D7012 – Unit Weight of Rock Cores
2. ASTM C39 – Unconfined Compressive Strength of Rock Cores

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PROJECT: MASONIC LANE TOWNHOMES
JOB NO.: 2522JB158

PLATE
B-3

ROCK PROPERTIES

CORROSIVITY TEST RESULTS

The procedures for soil survey tests and observations can be found in Appendix X1.1 of ASTM A674-10 and includes five soil properties: earth resistivity • pH • redox potential • sulfides • moisture.

Test Pit 4(0-2):

Analysis	Results		Points
Resistivity (ohm-cm)	2851		1
pH	8.2		0
Redox Potential (mV)	+396		0
Sulfides	trace		2
Moisture	fair		1
		Total Points	4

Test Pit 10(0-5):

Analysis	Results		Points
Resistivity (ohm-cm)	1136		10
pH	8.2		0
Redox Potential (mV)	+347		0
Sulfides	trace		2
Moisture	fair		1
		Total Points	13

The test procedure states that if the sum of the points is greater than 10, the soil is considered corrosive to ductile iron pipe and special protection against exterior corrosion is necessary. This conclusion is limited to soil corrosion and does not include consideration of stray direct current.

MOTZZ LABORATORY, INC.

Laboratory Analysis Report

Western Technologies - Flagstaff
Gregory L. E. Burr
2400 East Huntington
Flagstaff, AZ 86004-8934

Project: 2522JB158
Date Received: 7/29/2022
Date Reported: 8/3/2022
PO Number: 2522P163

Lab Number: 943102-1 **1 (0-2')**

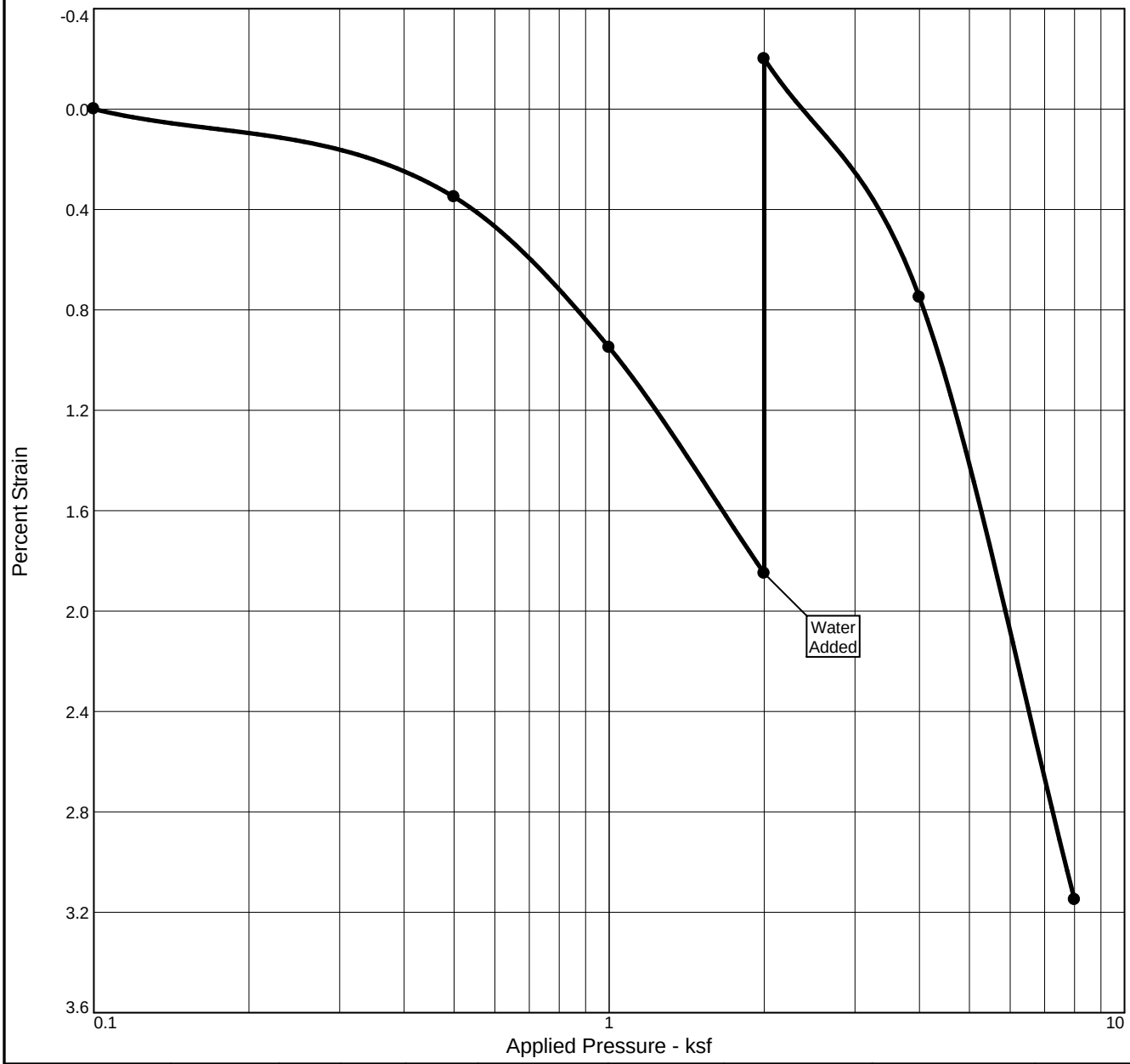
Test Parameter	Method	Result	Units	Levels
Soluble Salts	ARIZ 237b	326	ppm	
Sulfate	ARIZ 733b	9	ppm	
Chloride	ARIZ 736b	3	ppm	
Redox Potential	ASTM G200-09	396	(Eo) mV	

Lab Number: 943102-2 **12 (0-2')**

Test Parameter	Method	Result	Units	Levels
Soluble Salts	ARIZ 237b	402	ppm	
Sulfate	ARIZ 733b	19	ppm	
Chloride	ARIZ 736b	9	ppm	
Redox Potential	ASTM G200-09	347	(Eo) mV	

Plate B-5

COMPRESSION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	e_o	Swell Press. (ksf)	Swell %	C_r
Sat.	Moist.									
71.9 %	18.4 %	98.6			2.65		0.678	3.6	2.0	

MATERIAL DESCRIPTION	USCS	AASHTO
SANDY FAT CLAY	CH	

Project No. 2522JB158 **Client:** RED OAK DEVELOPMENT GROUP, LLC

Project: MASONIC LANE TOWNHOMES

Source: RING SAMPLE **Depth:** 2-3 FEET **Sample No.:** TEST PIT 9

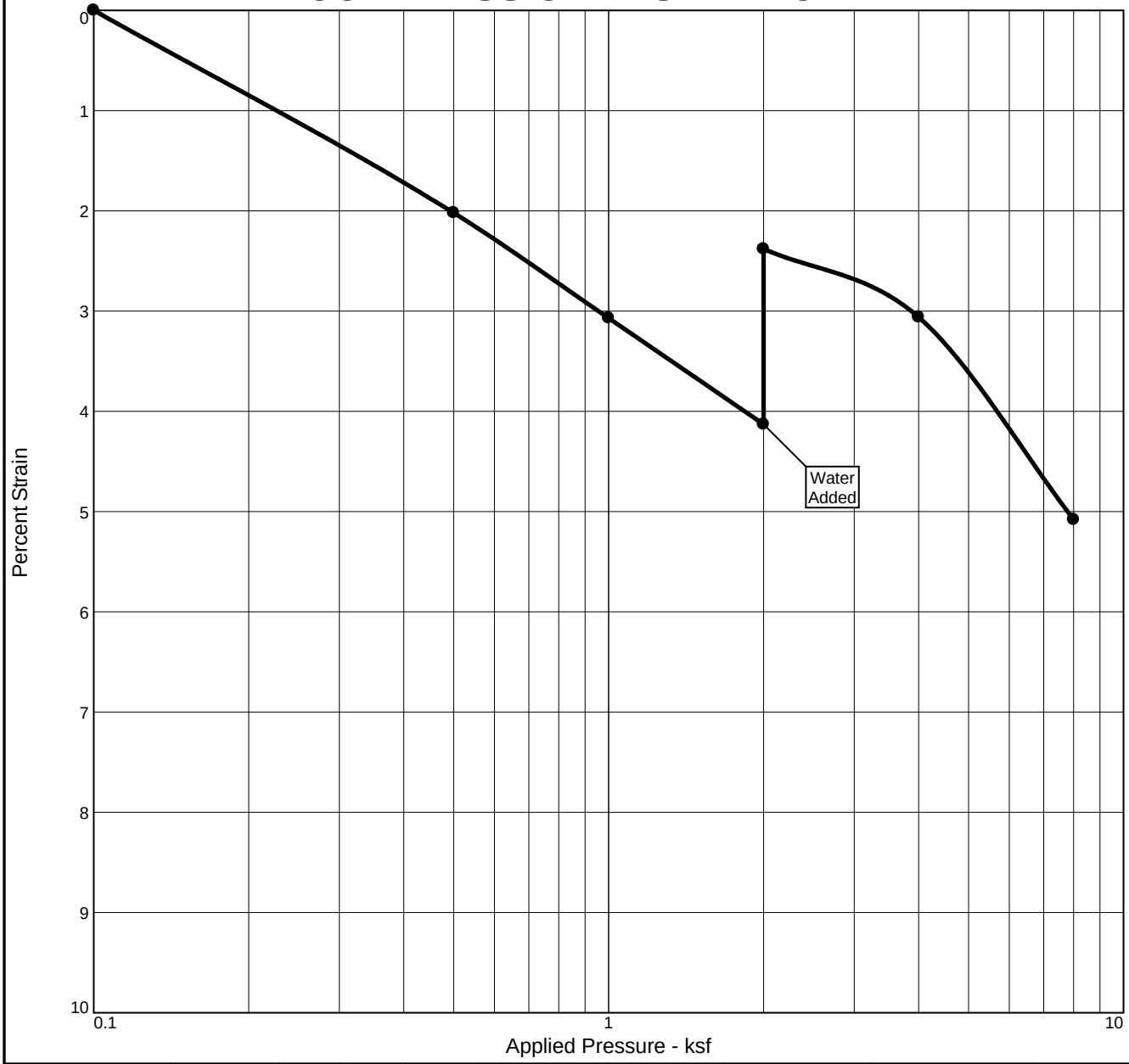
Remarks:

Western Technologies, Inc.

Flagstaff, AZ

Figure B-6

COMPRESSION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	e_o	Swell Press. (ksf)	Swell %	C_r
Sat.	Moist.									
79.7 %	20.2 %	99.1			2.65		0.670	3.9	1.7	

MATERIAL DESCRIPTION	USCS	AASHTO
SANDY FAT CLAY	CH	

Project No. 2522JB158 **Client:** RED OAK DEVELOPMENT GROUP, LLC

Project: MASONIC LANE TOWNHOMES

Source: RING SAMPLE **Depth:** 2-3 FEET **Sample No.:** TEST PIT 10

Remarks:

Western Technologies, Inc.

Flagstaff, AZ

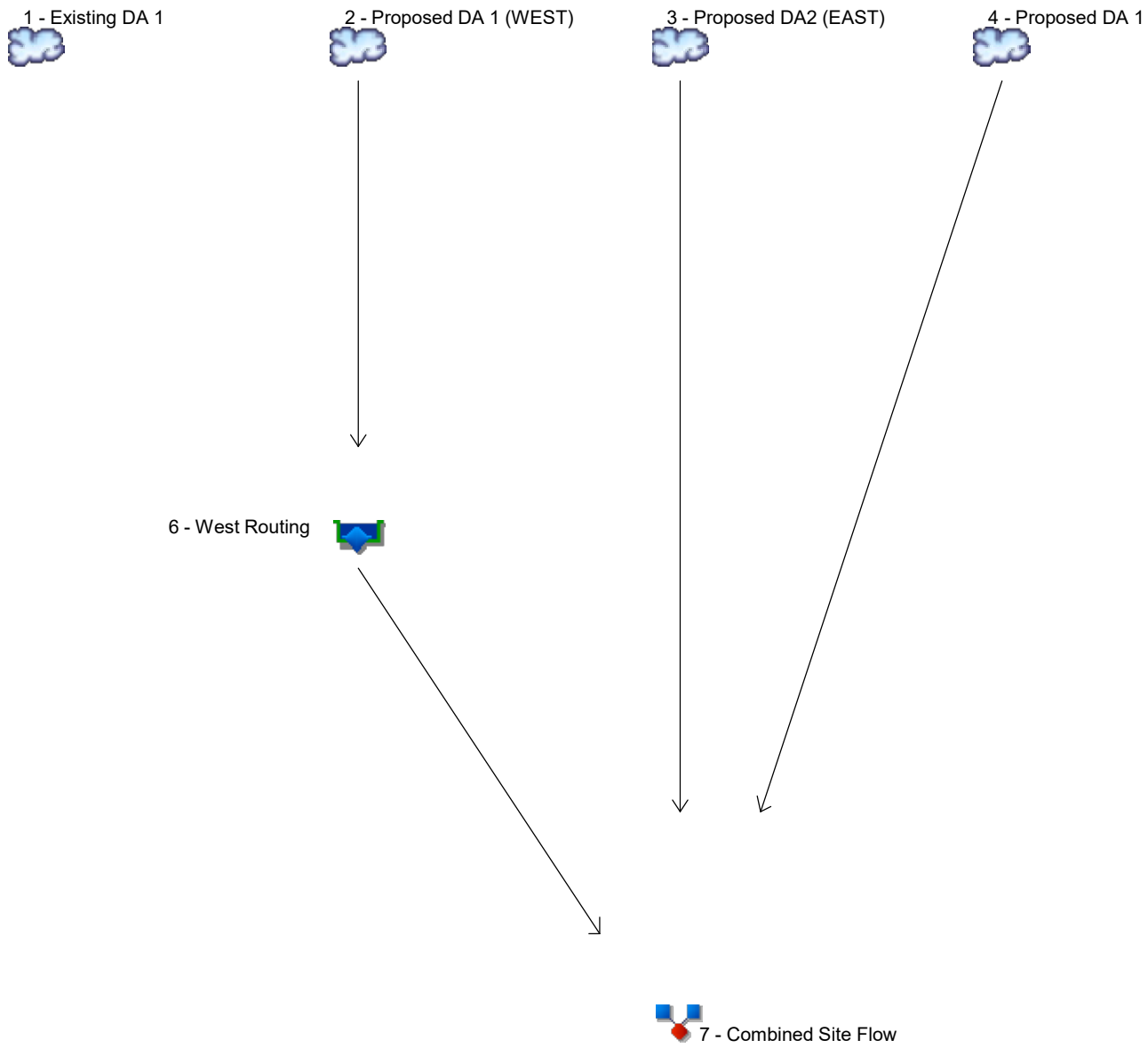
Figure B-7

ViewPoint Engineering

APPENDIX C: PEAK RATE & VOLUME ANALYSIS

Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023



Legend

Hyd.	Origin	Description
1	SCS Runoff	Existing DA 1
2	SCS Runoff	Proposed DA 1 (WEST)
3	SCS Runoff	Proposed DA2 (EAST)
4	SCS Runoff	Proposed DA 1
6	Reservoir	West Routing
7	Combine	Combined Site Flow

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)							Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	36.05	-------	-------	69.53	-------	-------	131.33	Existing DA 1
2	SCS Runoff	------	-------	4.872	-------	-------	8.346	-------	-------	14.40	Proposed DA 1 (WEST)
3	SCS Runoff	------	-------	4.387	-------	-------	7.515	-------	-------	12.97	Proposed DA2 (EAST)
4	SCS Runoff	------	-------	16.83	-------	-------	42.27	-------	-------	94.70	Proposed DA 1
6	Reservoir	2	-------	0.741	-------	-------	2.982	-------	-------	7.485	West Routing
7	Combine	3, 4, 6	-------	17.73	-------	-------	44.25	-------	-------	98.24	Combined Site Flow

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

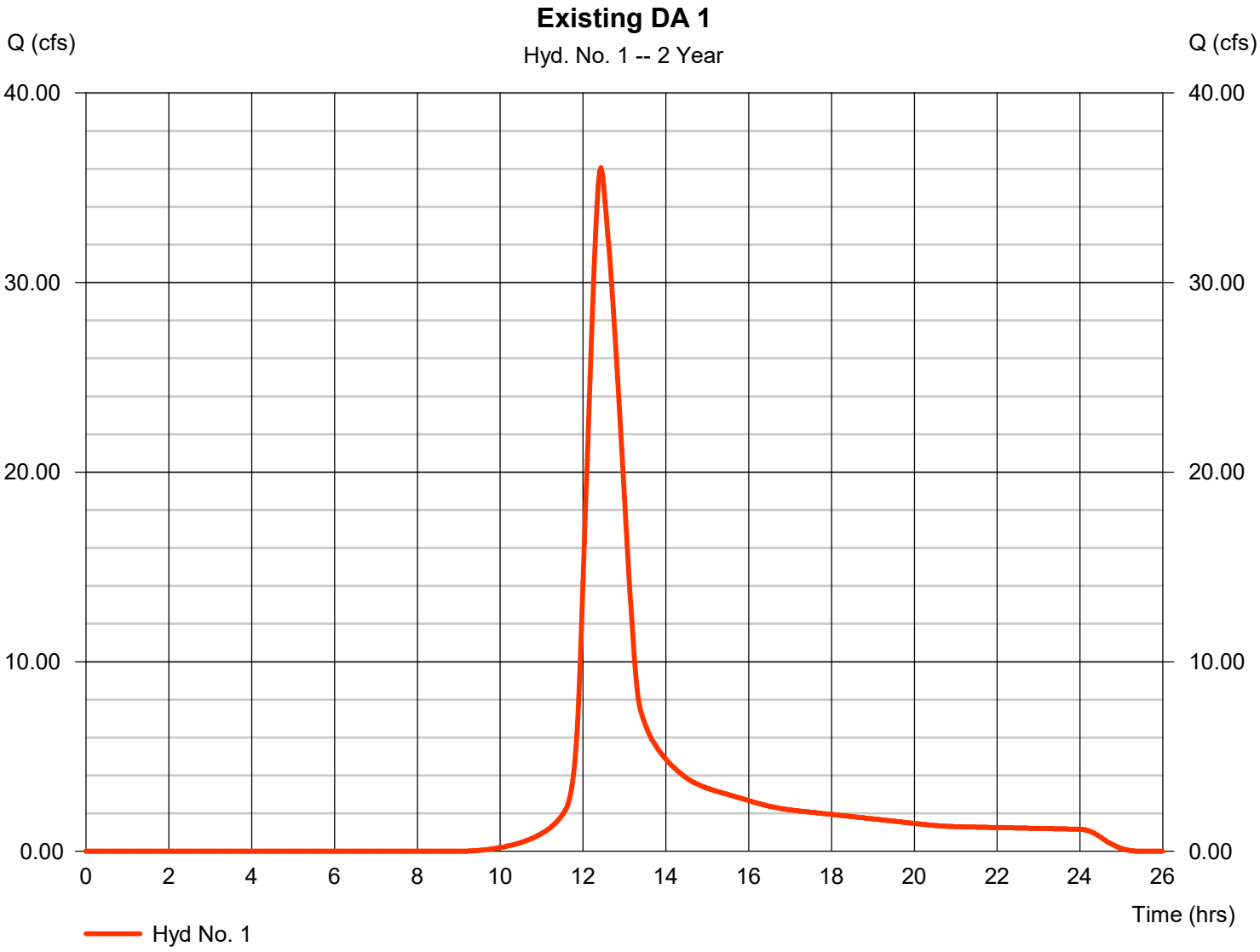
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	36.05	2	746	218,163	------	------	------	Existing DA 1
2	SCS Runoff	4.872	2	716	9,956	------	------	------	Proposed DA 1 (WEST)
3	SCS Runoff	4.387	2	716	8,965	------	------	------	Proposed DA2 (EAST)
4	SCS Runoff	16.83	2	748	115,807	------	------	------	Proposed DA 1
6	Reservoir	0.741	2	702	7,263	2	6883.88	4,608	West Routing
7	Combine	17.73	2	748	132,035	3, 4, 6	------	------	Combined Site Flow

Hydrograph Report

Hyd. No. 1

Existing DA 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	36.05 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.43 hrs
Time interval	=	2 min	Hyd. volume	=	218,163 cuft
Drainage area	=	66.170 ac	Curve number	=	88
Basin Slope	=	5.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	52.40 min
Total precip.	=	1.92 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

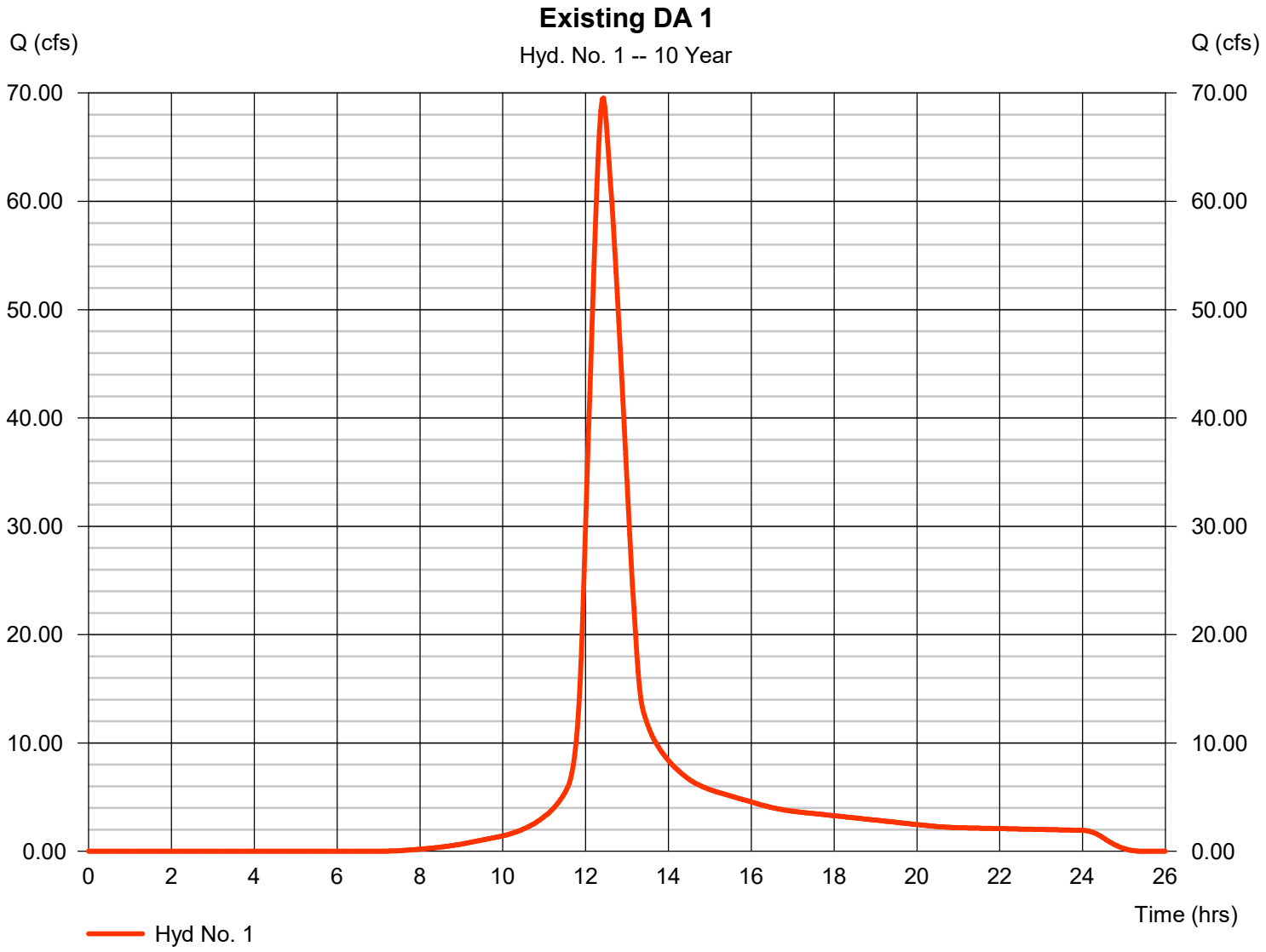
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	69.53	2	746	414,410	------	------	------	Existing DA 1
2	SCS Runoff	8.346	2	716	17,494	------	------	------	Proposed DA 1 (WEST)
3	SCS Runoff	7.515	2	716	15,751	------	------	------	Proposed DA2 (EAST)
4	SCS Runoff	42.27	2	746	261,323	------	------	------	Proposed DA 1
6	Reservoir	2.982	2	724	14,800	2	6884.31	6,789	West Routing
7	Combine	44.25	2	746	291,875	3, 4, 6	------	------	Combined Site Flow

Hydrograph Report

Hyd. No. 1

Existing DA 1

Hydrograph type	= SCS Runoff	Peak discharge	= 69.53 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.43 hrs
Time interval	= 2 min	Hyd. volume	= 414,410 cuft
Drainage area	= 66.170 ac	Curve number	= 88
Basin Slope	= 5.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 52.40 min
Total precip.	= 2.88 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

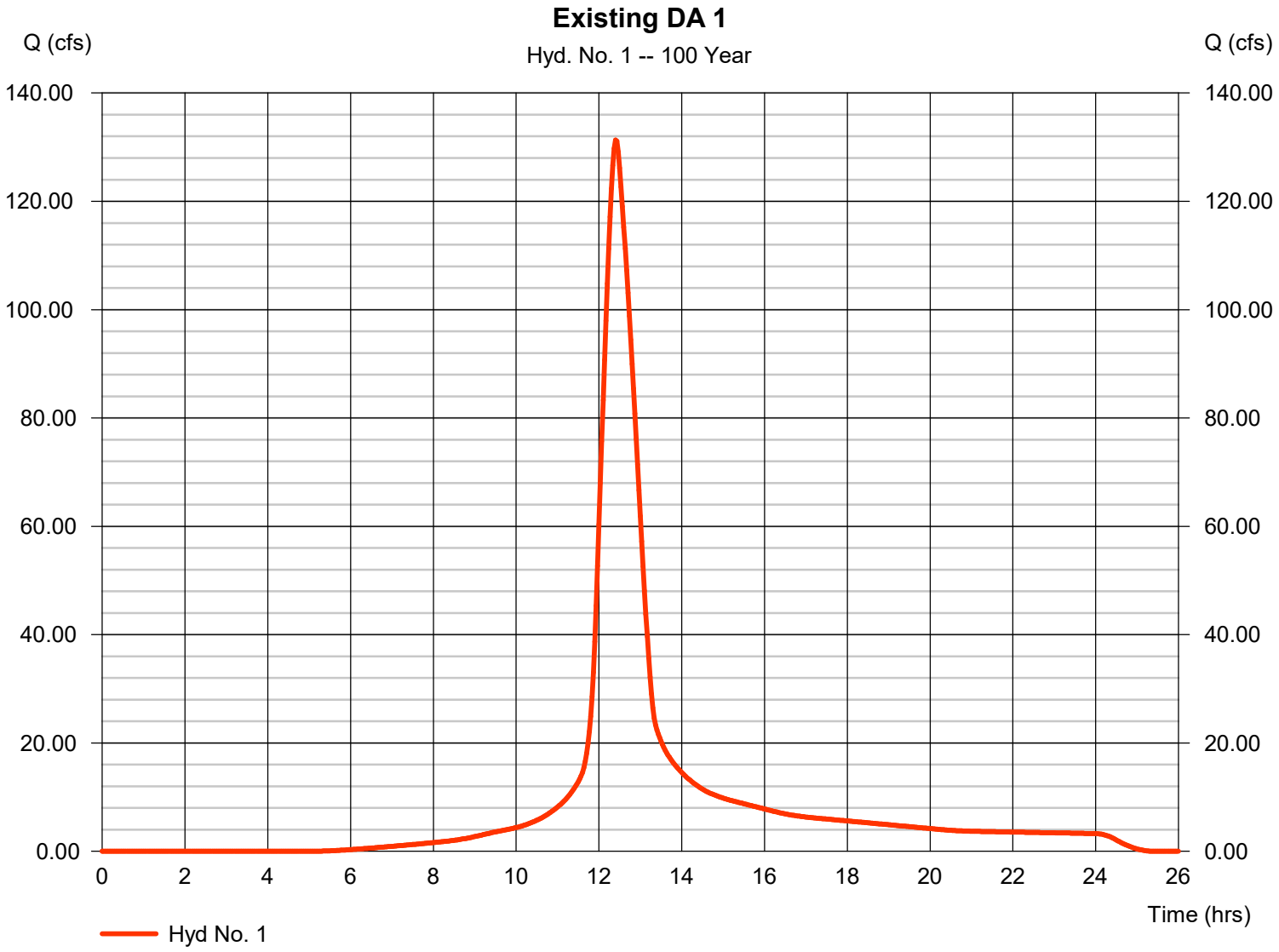
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	131.33	2	744	787,393	------	------	------	Existing DA 1
2	SCS Runoff	14.40	2	716	31,267	------	------	------	Proposed DA 1 (WEST)
3	SCS Runoff	12.97	2	716	28,152	------	------	------	Proposed DA2 (EAST)
4	SCS Runoff	94.70	2	746	565,707	------	------	------	Proposed DA 1
6	Reservoir	7.485	2	722	28,573	2	6885.03	10,134	West Routing
7	Combine	98.24	2	744	622,433	3, 4, 6	------	------	Combined Site Flow

Hydrograph Report

Hyd. No. 1

Existing DA 1

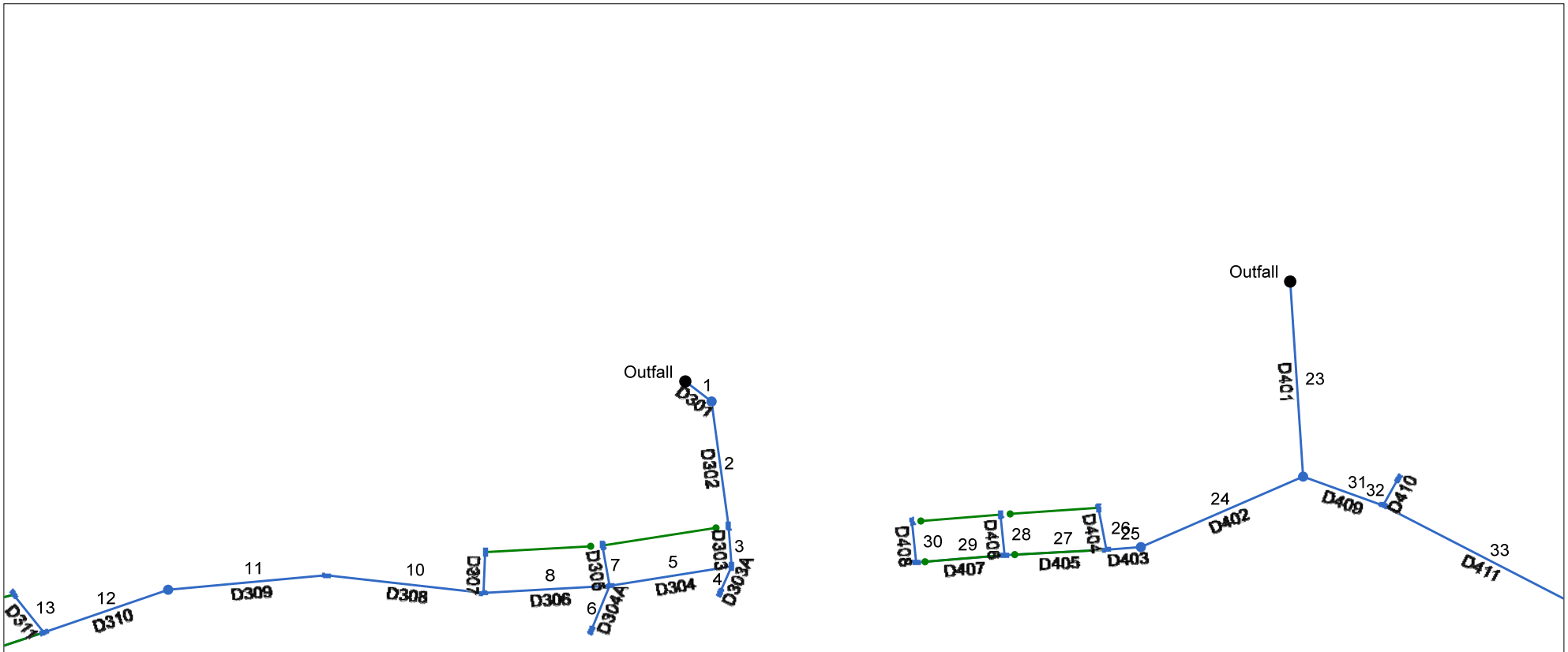
Hydrograph type	=	SCS Runoff	Peak discharge	=	131.33 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	787,393 cuft
Drainage area	=	66.170 ac	Curve number	=	88
Basin Slope	=	5.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	52.40 min
Total precip.	=	4.56 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



APPENDIX D: WATER QUALITY ANALYSIS

APPENDIX E: CONVEYANCE DESIGN

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: 22004 Juniper Estates.stm	Number of lines: 40	Date: 5/26/2023

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
40	D418	0.10	18	Cir	22.48	6887.50	6887.61	0.489	6887.62	6887.73	0.04	6887.76	39	Grate
39	D417	0.15	18	Cir	42.65	6887.00	6887.30	0.703	6887.22	6887.44	n/a	6887.44 j	37	Grate
38	D416	0.19	18	Cir	21.81	6891.89	6892.00	0.504	6892.05	6892.16	0.06	6892.16	37	Grate
37	D415	0.34	18	Cir	33.18	6886.80	6887.00	0.603	6887.00	6887.22	n/a	6887.22	36	Grate
36	D414	0.40	18	Cir	49.08	6886.30	6886.60	0.612	6886.52	6886.83	n/a	6886.83	34	Grate
35	D413	0.19	18	Cir	21.87	6901.00	6901.19	0.869	6901.14	6901.35	0.06	6901.35	34	Grate
34	D412	0.63	18	Cir	28.82	6885.60	6885.80	0.693	6885.86	6886.09	0.14	6886.09	33	Grate
33	D411	0.62	18	Cir	115.21	6884.80	6885.40	0.521	6885.08	6885.69	n/a	6885.69	31	Manhole
32	D410	0.36	18	Cir	15.89	6899.92	6900.00	0.504	6900.14	6900.22	n/a	6900.22	31	Grate
31	D409	0.95	18	Cir	43.19	6884.30	6884.60	0.695	6884.69	6884.96	n/a	6884.96 j	23	Grate
30	D408	0.41	18	Cir	20.89	6889.90	6890.00	0.479	6890.13	6890.24	n/a	6890.24	29	Grate
29	D407	0.47	18	Cir	44.99	6889.40	6889.70	0.667	6889.63	6889.96	0.13	6889.96	27	Grate
28	D406	0.10	18	Cir	20.82	6889.40	6889.50	0.481	6889.63	6889.64	0.02	6889.66	27	Grate
27	D405	1.32	18	Cir	51.74	6888.90	6889.20	0.580	6889.30	6889.63	n/a	6889.63	25	Grate
26	D404	0.44	18	Cir	21.77	6897.09	6897.20	0.507	6897.33	6897.44	0.08	6897.44	25	Grate
25	D403	1.96	18	Cir	17.54	6888.20	6888.40	1.139	6888.61	6888.93	0.32	6888.93	24	Grate
24	D402	1.95	18	Cir	89.82	6887.60	6888.00	0.445	6888.12	6888.53	0.07	6888.53	23	Manhole
23	D401	2.39	18	Cir	99.59	6883.00	6884.10	1.105	6883.48	6884.69	0.21	6884.69	End	Manhole
22	D319	0.29	18	Cir	31.07	6889.61	6889.77	0.515	6889.80	6889.97	0.07	6889.97	21	Grate
21	D318	0.39	18	Cir	35.26	6889.23	6889.41	0.511	6889.45	6889.64	0.08	6889.64	19	Grate
20	D317A	0.41	18	Cir	17.91	6896.00	6897.00	5.582	6896.13	6897.24	n/a	6897.24	19	DropGrate
19	D317	0.86	18	Cir	23.93	6888.91	6889.03	0.500	6889.36	6889.37	n/a	6889.37 j	16	Grate
18	D316	2.16	18	Cir	48.20	6893.30	6898.00	9.752	6893.55	6898.55	0.21	6898.55	17	Grate
17	D315	2.20	18	Cir	50.90	6888.91	6889.62	1.395	6889.36	6890.18	n/a	6890.18	16	Grate

Project File: 22004 Juniper Estates.stm | Number of lines: 40 | Run Date: 5/26/2023

NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
16	D314	2.90	18	Cir	36.27	6888.54	6888.71	0.468	6889.18	6889.36	0.36	6889.36	15	Grate
15	D313	3.06	18	Cir	91.42	6887.88	6888.34	0.503	6888.52	6889.01	0.13	6889.01	12	Grate
14	D312	0.15	18	Cir	57.33	6901.04	6901.33	0.506	6901.18	6901.47	0.05	6901.52	13	Grate
13	D311	0.20	18	Cir	24.59	6900.73	6900.84	0.447	6900.90	6901.01	n/a	6901.08 j	12	Grate
12	D310	2.94	18	Cir	66.75	6887.03	6887.38	0.525	6887.65	6888.03	n/a	6888.03	11	Grate
11	D309	2.91	18	Cir	80.46	6886.46	6886.83	0.460	6887.10	6887.48	n/a	6887.48	10	Manhole
10	D308	3.03	18	Cir	80.41	6885.86	6886.26	0.497	6886.50	6886.92	0.13	6886.92	8	Grate
9	D307	0.41	18	Cir	20.82	6898.30	6898.50	0.962	6898.50	6898.74	n/a	6898.74	8	Grate
8	D306	3.42	18	Cir	64.04	6885.34	6885.66	0.500	6886.02	6886.37	0.42	6886.37	5	Grate
7	D305	0.12	18	Cir	20.82	6894.50	6894.60	0.481	6894.63	6894.73	0.04	6894.77	5	Grate
6	D304A	1.11	18	Cir	24.49	6896.00	6896.49	2.002	6896.27	6896.88	n/a	6896.88	5	DropGrate
5	D304	4.41	18	Cir	62.71	6884.83	6885.14	0.494	6886.06	6885.95	n/a	6885.95	3	Grate
4	D303A	1.31	18	Cir	14.75	6890.00	6890.50	3.389	6890.25	6890.93	n/a	6890.93	3	DropGrate
3	D303	5.40	18	Cir	20.70	6884.53	6884.63	0.483	6885.61	6885.64	0.43	6886.06	2	Grate
2	D302	5.44	18	Cir	63.98	6884.17	6884.33	0.250	6885.35	6885.50	0.10	6885.61	1	Grate
1	D301	5.42	18	Cir	16.80	6884.00	6884.17	1.012	6884.75	6885.07	n/a	6885.07	End	Manhole

Project File: 22004 Juniper Estates.stm | Number of lines: 40 | Run Date: 5/26/2023

NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
40	39	22.48	0.04	0.04	0.45	0.02	0.02	6.0	6.0	5.4	0.10	7.95	1.54	18	0.49	6887.50	6887.61	6887.62	6887.73	6893.99	6893.33	D418
39	37	42.65	0.03	0.07	0.45	0.01	0.03	6.0	12.8	4.8	0.15	9.54	1.37	18	0.70	6887.00	6887.30	6887.22	6887.44	6898.79	6893.99	D417
38	37	21.81	0.08	0.08	0.45	0.04	0.04	6.0	6.0	5.4	0.19	8.07	1.89	18	0.50	6891.89	6892.00	6892.05	6892.16	6898.79	6898.39	D416
37	36	33.18	0.03	0.18	0.45	0.01	0.08	6.0	20.3	4.2	0.34	8.84	2.30	18	0.60	6886.80	6887.00	6887.00	6887.22	6902.59	6898.79	D415
36	34	49.08	0.04	0.22	0.45	0.02	0.10	6.0	22.5	4.1	0.40	8.90	2.41	18	0.61	6886.30	6886.60	6886.52	6886.83	6907.11	6902.59	D414
35	34	21.87	0.08	0.08	0.45	0.04	0.04	6.0	6.0	5.4	0.19	10.60	2.09	18	0.87	6901.00	6901.19	6901.14	6901.35	6907.11	6906.49	D413
34	33	28.82	0.06	0.36	0.45	0.03	0.16	6.0	25.2	3.9	0.63	9.47	2.80	18	0.69	6885.60	6885.80	6885.86	6886.09	6908.25	6907.11	D412
33	31	115.21	0.00	0.36	0.00	0.00	0.16	0.0	26.2	3.8	0.62	8.21	2.65	18	0.52	6884.80	6885.40	6885.08	6885.69	6904.21	6908.25	D411
32	31	15.89	0.15	0.15	0.45	0.07	0.07	6.0	6.0	5.4	0.36	8.08	2.26	18	0.50	6899.92	6900.00	6900.14	6900.22	6904.21	6904.21	D410
31	23	43.19	0.08	0.59	0.45	0.04	0.27	6.0	30.2	3.6	0.95	9.49	2.76	18	0.70	6884.30	6884.60	6884.69	6884.96	6904.35	6904.21	D409
30	29	20.89	0.17	0.17	0.45	0.08	0.08	6.0	6.0	5.4	0.41	7.87	2.33	18	0.48	6889.90	6890.00	6890.13	6890.24	6896.56	6896.56	D408
29	27	44.99	0.03	0.20	0.45	0.01	0.09	6.0	7.5	5.2	0.47	9.29	2.56	18	0.67	6889.40	6889.70	6889.63	6889.96	6898.82	6896.56	D407
28	27	20.82	0.04	0.04	0.45	0.02	0.02	6.0	6.0	5.4	0.10	7.89	0.86	18	0.48	6889.40	6889.50	6889.63	6889.64	6898.82	6898.82	D406
27	25	51.74	0.37	0.61	0.45	0.17	0.27	6.0	12.3	4.8	1.32	8.67	3.35	18	0.58	6888.90	6889.20	6889.30	6889.63	6902.18	6898.82	D405
26	25	21.77	0.18	0.18	0.45	0.08	0.08	6.0	6.0	5.4	0.44	8.10	2.38	18	0.51	6897.09	6897.20	6897.33	6897.44	6902.18	6901.91	D404
25	24	17.54	0.13	0.92	0.45	0.06	0.41	6.0	13.4	4.7	1.96	12.14	4.29	18	1.14	6888.20	6888.40	6888.61	6888.93	6903.25	6902.18	D403
24	23	89.82	0.00	0.92	0.00	0.00	0.41	0.0	13.6	4.7	1.95	7.59	3.56	18	0.45	6887.60	6888.00	6888.12	6888.53	6904.35	6903.25	D402
23	End	99.59	0.00	1.51	0.00	0.00	0.68	0.0	31.1	3.5	2.39	11.96	4.32	18	1.10	6883.00	6884.10	6883.48	6884.69	6904.50	6904.35	D401
22	21	31.07	0.12	0.12	0.45	0.05	0.05	6.0	6.0	5.4	0.29	8.17	2.13	18	0.52	6889.61	6889.77	6889.80	6889.97	6896.13	6894.56	D319
21	19	35.26	0.05	0.17	0.45	0.02	0.08	6.0	9.1	5.1	0.39	8.13	2.32	18	0.51	6889.23	6889.41	6889.45	6889.64	6900.52	6896.13	D318
20	19	17.91	0.17	0.17	0.45	0.08	0.08	6.0	6.0	5.4	0.41	26.88	3.92	18	5.58	6896.00	6897.00	6896.13	6897.24	6900.52	6902.44	D317A
19	16	23.93	0.05	0.39	0.45	0.02	0.18	6.0	11.7	4.9	0.86	8.04	2.37	18	0.50	6888.91	6889.03	6889.36	6889.37	6901.66	6900.52	D317

Project File: 22004 Juniper Estates.stm | Number of lines: 40 | Run Date: 5/26/2023

NOTES:Intensity = 5465747000000000000000.00 / (Inlet time + 447.02) ^ 7.91; Return period =Yrs. 100 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
18	17	48.20	0.89	0.89	0.45	0.40	0.40	6.0	6.0	5.4	2.16	35.53	7.36	18	9.75	6893.30	6898.00	6893.55	6898.55	6901.16	6903.00	D316
17	16	50.90	0.03	0.92	0.45	0.01	0.41	6.0	6.7	5.3	2.20	13.44	4.33	18	1.39	6888.91	6889.62	6889.36	6890.18	6901.66	6901.16	D315
16	15	36.27	0.03	1.34	0.45	0.01	0.60	6.0	12.4	4.8	2.90	7.79	4.03	18	0.47	6888.54	6888.71	6889.18	6889.36	6905.28	6901.66	D314
15	12	91.42	0.08	1.42	0.45	0.04	0.64	6.0	12.8	4.8	3.06	8.07	4.15	18	0.50	6887.88	6888.34	6888.52	6889.01	6911.25	6905.28	D313
14	13	57.33	0.06	0.06	0.45	0.03	0.03	6.0	6.0	5.4	0.15	8.09	1.73	18	0.51	6901.04	6901.33	6901.18	6901.47	6910.94	6907.45	D312
13	12	24.59	0.04	0.10	0.45	0.02	0.05	6.0	17.6	4.4	0.20	7.60	1.85	18	0.45	6900.73	6900.84	6900.90	6901.01	6911.25	6910.94	D311
12	11	66.75	0.04	1.56	0.45	0.02	0.70	6.0	20.6	4.2	2.94	8.24	4.13	18	0.52	6887.03	6887.38	6887.65	6888.03	6911.79	6911.25	D310
11	10	80.46	0.00	1.56	0.00	0.00	0.70	0.0	21.2	4.2	2.91	7.72	4.02	18	0.46	6886.46	6886.83	6887.10	6887.48	6908.47	6911.79	D309
10	8	80.41	0.08	1.64	0.45	0.04	0.74	6.0	21.8	4.1	3.03	8.02	4.13	18	0.50	6885.86	6886.26	6886.50	6886.92	6903.22	6908.47	D308
9	8	20.82	0.17	0.17	0.45	0.08	0.08	6.0	6.0	5.4	0.41	11.16	2.65	18	0.96	6898.30	6898.50	6898.50	6898.74	6903.22	6903.25	D307
8	5	64.04	0.06	1.87	0.45	0.03	0.84	6.0	22.4	4.1	3.42	8.05	4.28	18	0.50	6885.34	6885.66	6886.02	6886.37	6899.30	6903.22	D306
7	5	20.82	0.05	0.05	0.45	0.02	0.02	6.0	6.0	5.4	0.12	7.89	1.63	18	0.48	6894.50	6894.60	6894.63	6894.73	6899.30	6899.30	D305
6	5	24.49	0.46	0.46	0.45	0.21	0.21	6.0	6.0	5.4	1.11	16.10	4.12	18	2.00	6896.00	6896.49	6896.27	6896.88	6899.30	6900.00	D304A
5	3	62.71	0.05	2.43	0.45	0.02	1.09	6.0	22.8	4.0	4.41	8.00	3.70	18	0.49	6884.83	6885.14	6886.06	6885.95	6896.88	6899.30	D304
4	3	14.75	0.54	0.54	0.45	0.24	0.24	6.0	6.0	5.4	1.31	20.94	4.87	18	3.39	6890.00	6890.50	6890.25	6890.93	6896.88	6896.58	D303A
3	2	20.70	0.02	2.99	0.45	0.01	1.35	6.0	23.2	4.0	5.40	7.91	4.12	18	0.48	6884.53	6884.63	6885.61	6885.64	6896.88	6896.88	D303
2	1	63.98	0.03	3.02	0.45	0.01	1.36	6.0	23.3	4.0	5.44	5.69	3.67	18	0.25	6884.17	6884.33	6885.35	6885.50	6892.56	6896.88	D302
1	End	16.80	0.00	3.02	0.00	0.00	1.36	0.0	23.5	4.0	5.42	11.44	5.53	18	1.01	6884.00	6884.17	6884.75	6885.07	6893.50	6892.56	D301

Project File: 22004 Juniper Estates.stm

Number of lines: 40

Run Date: 5/26/2023

NOTES:Intensity = 5465747000000000000000.00 / (Inlet time + 447.02) ^ 7.91; Return period =Yrs. 100 ; c = cir e = ellip b = box

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
40	D418	0.10	0.00	0.10	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.05	1.02	0.00	0.00	0.0	Off
39	D417	0.07	0.00	0.07	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.05	0.91	0.00	0.00	0.0	Off
38	D416	0.19	0.00	0.19	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.07	1.32	0.00	0.00	0.0	40
37	D415	0.07	0.00	0.07	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.05	0.91	0.00	0.00	0.0	39
36	D414	0.10	0.00	0.10	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.05	1.02	0.00	0.00	0.0	37
35	D413	0.19	0.00	0.19	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.030	2.00	0.050	0.020	0.013	0.08	1.66	0.00	0.00	0.0	38
34	D412	0.15	0.00	0.15	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.030	2.00	0.050	0.020	0.013	0.07	1.49	0.00	0.00	0.0	36
33	D411	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
32	D410	0.36	0.00	0.36	0.00	Grate	0.0	0.00	8.00	4.00	2.00	Sag	2.00	0.050	0.020	0.000	0.11	2.56	0.11	2.56	0.0	Off
31	D409	0.19	0.00	0.19	0.00	Grate	0.0	0.00	8.00	4.00	2.00	Sag	2.00	0.050	0.020	0.000	0.08	1.61	0.08	1.61	0.0	Off
30	D408	0.41	0.00	0.41	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.030	2.00	0.050	0.020	0.013	0.11	2.49	0.01	0.21	0.0	Off
29	D407	0.07	0.04	0.11	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.030	2.00	0.050	0.020	0.013	0.07	1.35	0.00	0.00	0.0	Off
28	D406	0.10	0.00	0.10	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.050	2.00	0.050	0.020	0.013	0.06	1.16	0.00	0.00	0.0	30
27	D405	0.90	0.00	0.86	0.04	Grate	0.0	0.00	0.00	4.00	2.00	0.050	2.00	0.050	0.020	0.013	0.13	3.60	0.04	0.83	0.0	29
26	D404	0.44	0.00	0.44	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.050	2.00	0.050	0.020	0.013	0.10	2.10	0.00	0.00	0.0	28
25	D403	0.32	0.00	0.32	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.050	2.00	0.050	0.020	0.013	0.09	1.80	0.00	0.00	0.0	27
24	D402	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
23	D401	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
22	D319	0.29	0.00	0.29	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.08	1.54	0.00	0.00	0.0	Off
21	D318	0.12	0.00	0.12	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.06	1.11	0.00	0.00	0.0	Off
20	D317A	0.41	0.00	0.41	0.00	DrGrt	0.0	0.00	8.00	4.00	2.00	Sag	2.00	0.020	0.020	0.000	0.05	7.07	0.05	7.07	0.0	Off
19	D317	0.12	0.00	0.12	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.06	1.11	0.00	0.00	0.0	21
18	D316	2.16	0.00	2.16	0.00	Grate	0.0	0.00	8.00	4.00	2.00	Sag	2.00	0.050	0.020	0.000	0.25	9.52	0.25	9.52	0.0	Off

Project File: 22004 Juniper Estates.stm | Number of lines: 40 | Run Date: 5/26/2023

NOTES: Inlet N-Values = 0.016; Intensity = 5465747000000000000000.00 / (Inlet time + 447.02) ^ 7.91; Return period = 100 Yrs. ; * Indicates Known Q added. All curb inlets are throat.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
17	D315	0.07	0.00	0.07	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.030	2.00	0.050	0.020	0.013	0.06	1.15	0.00	0.00	0.0	22
16	D314	0.07	0.00	0.07	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.05	0.91	0.00	0.00	0.0	22
15	D313	0.19	0.00	0.19	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.07	1.32	0.00	0.00	0.0	16
14	D312	0.15	0.00	0.15	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.06	1.19	0.00	0.00	0.0	19
13	D311	0.10	0.00	0.10	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.05	1.02	0.00	0.00	0.0	14
12	D310	0.10	0.00	0.10	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.100	2.00	0.050	0.020	0.013	0.05	1.02	0.00	0.00	0.0	15
11	D309	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off
10	D308	0.19	0.00	0.19	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.050	2.00	0.050	0.020	0.013	0.08	1.50	0.00	0.00	0.0	8
9	D307	0.41	0.00	0.41	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.050	2.00	0.050	0.020	0.013	0.10	2.00	0.00	0.00	0.0	7
8	D306	0.15	0.00	0.15	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.050	2.00	0.050	0.020	0.013	0.07	1.35	0.00	0.00	0.0	5
7	D305	0.12	0.00	0.12	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.050	2.00	0.050	0.020	0.013	0.06	1.26	0.00	0.00	0.0	2
6	D304A	1.11	0.00	1.11	0.00	DrGrt	0.0	0.00	8.00	4.00	2.00	Sag	2.00	0.020	0.020	0.000	0.10	11.85	0.10	11.85	0.0	Off
5	D304	0.12	0.00	0.12	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.050	2.00	0.050	0.020	0.013	0.06	1.26	0.00	0.00	0.0	3
4	D303A	1.31	0.00	1.31	0.00	DrGrt	0.0	0.00	8.00	4.00	2.00	Sag	2.00	0.020	0.020	0.000	0.11	12.96	0.11	12.96	0.0	Off
3	D303	0.05	0.00	0.05	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.030	2.00	0.050	0.020	0.013	0.05	0.98	0.00	0.00	0.0	Off
2	D302	0.07	0.00	0.07	0.00	Grate	0.0	0.00	0.00	4.00	2.00	0.030	2.00	0.050	0.020	0.013	0.06	1.15	0.00	0.00	0.0	Off
1	D301	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.0	Off

Project File: 22004 Juniper Estates.stm | Number of lines: 40 | Run Date: 5/26/2023

NOTES: Inlet N-Values = 0.016; Intensity = 5465747000000000000000.00 / (Inlet time + 447.02) ^ 7.91; Return period = 100 Yrs. ; * Indicates Known Q added. All curb inlets are throat.

APPENDIX F: DRAINAGE MAPS