

iHouse 19 Unit Apartment Building
Tonalea, AZ

Appendix A2

GeoTech Report



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**DRAFT GEOTECHNICAL EXPLORATION
REPORT
IHS IDIQ IHOUSE
INDIAN ROUTE 6290
TONALEA, ARIZONA**

Prepared for:
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ATEK Project # 240012

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Director of Operations
Johnson Smitthipong & Rosamond Associates, Inc.
5210 E. Williams Circle, Suite 600
Tucson, Arizona

Regarding: DRAFT Geotechnical Exploration Report

Project: IHS IDIQ iHouse
Indian Route 6290
Tonalea, Arizona

Dear Mr. Hargreaves:

ATEK Engineering Consultants, LLC is pleased to present the attached DRAFT Geotechnical Exploration Report for the IHS IDIQ iHouse located in Tonalea, Arizona within the Navajo Nation. The purpose of our study was to explore and evaluate the subsurface conditions at the proposed site to develop geotechnical engineering recommendations for project design and construction.

Based on our findings, the site is considered suitable for the proposed construction, provided geotechnical recommendations presented in the attached report are followed. Specific recommendations regarding the geotechnical aspects of the project design and construction are presented in the attached report. The recommendations contained within this report are dependent on the provisions provided in the Limitations and Recommended Additional Services sections of this report.

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

Sincerely,
ATEK Engineering Consultants, LLC

Antonio Lopez, P.E.
Geotechnical Group Manager

Armando Ortega, P.E.
Principal Geotechnical Engineer

Distribution: (1) Addresses (Electronic Copy)

TABLE OF CONTENTS

1.	INTRODUCTION	1
1.1.	Project Description.....	1
1.2.	Purpose.....	1
1.3.	Scope of Services	1
2.	FIELD EXPLORATION.....	2
2.1.	General.....	2
2.2.	Soil Test Borings	2
2.3.	Percolation Test Boring.....	3
3.	LABORATORY TESTING.....	4
4.	GENERAL SITE CONDITIONS	4
4.1.	Surface Conditions.....	4
4.2.	Subsurface Conditions	4
4.3.	Groundwater Conditions.....	5
4.4.	Geologic Hazards	5
4.4.1.	Liquefaction Potential	5
4.4.2.	Collapsible Soils.....	5
4.4.3.	Expansive Soils	6
4.5.	Seismic Considerations.....	6
4.6.	Earth Fissures and Land Subsidence	7
5.	ENGINEERING ANALYSES AND RECOMMENDATIONS	7
5.1.	Earthwork.....	7
5.1.1.	Frost Heave.....	8
5.1.2.	Spread Footings.....	8
5.1.3.	Sidewalks and Exterior Slabs.....	8
5.1.4.	Pavement Site Preparation and Grading	9
5.1.5.	Aggregate Base Course.....	9
5.1.6.	Engineered Fill	10
5.1.7.	Soil-Cement	12
5.2.	Excavation	12
5.2.1.	Trench Backfill.....	13
5.2.2.	Temporary Excavations	14
5.2.1.	Permanent Excavations and Slopes	16
5.3.	Structures.....	16
5.3.1.	Shallow Spread Footings.....	16
5.3.1.1.	Structural Slab.....	17
5.3.2.	Resistance to Lateral Loads	18
5.3.2.1.	Wall Drainage	19
5.3.2.2.	Backfill Placement	19
5.4.	Moisture Protection	19
5.5.	Corrosion Potential.....	20
5.5.1.	Electrical Resistivity	20

5.5.2. Sulfate and Chloride Content	21
5.6. Pavement Areas.....	22
6. CLOSURE.....	23
6.1. Limitations.....	23
6.2. Recommended Additional Services.....	24
APPENDIX A - Site Location Map	
APPENDIX B - Sample Location Plan	
APPENDIX C - Field Study and Boring Logs	
APPENDIX D - Laboratory Test	

1. INTRODUCTION

This report presents the results of our draft geotechnical exploration for the IHS IDIQ iHouse located in Tonalea, Arizona within the Navajo Nation. A Site Location Map is presented in **Appendix A** of this report. The following sections of this report describe our understanding of the project and our scope of services.

1.1. Project Description

The proposed project is the construction of a new 19-unit apartment complex in Tonalea, Arizona just north of the Inscription House Health Clinic. The proposed apartment building will be a one-story building with an approximate footprint of 18,000 square feet. The proposed construction is wood stud framing with stucco and CMU Veneer. Additionally, improvements include parking areas, Recreational Vehicle spaces, and storm drain site retention.

1.2. Purpose

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

1.3. Scope of Services

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

2. FIELD EXPLORATION

2.1. General

Prior to the start of drilling, the Arizona 811 and the Navajo Tribal Utility Authority was contacted to locate existing utilities at the boring locations. The field exploration was performed on May 21, 2024. Three soil borings were drilled to a depth of twenty (20) feet below existing grade. The soil test borings were drilled using a truck mounted CME-55 power drill rig equipped with 7 and ¼-inch outside diameter hollow stem augers. The percolation test was drilled using a truck mounted CME-55 power drill equipped with 15-inch outside diameter solid stem augers. The borings were located in the field at the approximate locations shown on the Sample Location Plan included in **Appendix B** of this report. Upon completion of the borings, the boreholes were backfilled with excavated materials.

2.2. Soil Test Borings

Disturbed and relatively undisturbed samples were taken at the direction of the field engineer during drilling operations. Relatively undisturbed samples of the subsurface materials were obtained using a California sampler with a 2.5-inch inside diameter and a 3.0-inch outside diameter. Disturbed samples were obtained using a Standard Penetration/Split Spoon Sampler (SPT) with a 1.5-inch inside diameter and 2.0-inch outside diameter. The California and the SPT samplers were driven 12 and 18 inches, respectively, using a 140-pound hammer falling 30 inches, and blow counts for successive 6-inch penetration intervals were recorded. After the sampler was withdrawn from the borehole, the samples were removed, sealed to minimize moisture loss, and submitted to the laboratory.

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

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

2.3. Percolation Test Boring

Percolation testing was completed in general accordance with the Arizona Administrative Code Title 18, Chapter 9, A 310 Section F and the sides of the test hole were sleeved with an impermeable surface. The percolation depths and recorded rates are presented in the following table.

Percolation Test Location	Percolation Depth Below Existing Grade (feet)	Percolation Rate (min/inch)	Soil Type (USCS)
P-1	3.0	1.0	SP-SM

Siltation, vegetation growth and other factors tend to slow infiltration rates within the basin. The infiltration rates provided above are unfactored field measurements and a proper reduction factor should be applied in the retention design.

The excavation of the retention basin should be accomplished with light weight excavation equipment to avoid compaction of the exposed native soils. No traffic should be allowed within the retention basin after construction. It should be noted that compaction of the basin will reduce the infiltration rates. If compaction within the basin floor occurs, the exposed surface should be scarified to a minimum depth of 8-inches and left uncompacted.

3. LABORATORY TESTING

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

- Gradation;
- Atterberg limits;
- Moisture content;
- One-dimensional consolidation;
- Undisturbed ring density;
- Standard Proctor;
- Swell potential of soil;
- pH test;
- Resistivity test;
- Sulfate content;
- And chloride content.

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

4. GENERAL SITE CONDITIONS

4.1. Surface Conditions

The project is located approximately 1,000 feet north of the Inscription House Health Clinic in Tonalea, Arizona. The project site is bound by Indian Route 6290 on the east, undeveloped land to the north and west, and the residential staff quarters housing to the south. Rough graded earthen roads connect the project site to the existing residential subdivision. At the time of our field study project site had heavy vegetation.

4.2. Subsurface Conditions

Residual soils were encountered at the project site. In general, these surface soils consist of Silty Sand (SM). These soils were found to have a relative density ranging from loose to very dense. The underlying subsurface soils encountered during our field exploration consisted of Silty Sand (SM). These soils were found to have a relative

density of very dense. **Potential sandstone can be encountered at a depth of 5 feet below existing grade or deeper.** For additional information see Boring Logs presented in **Appendix C.**

4.3. Groundwater Conditions

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

4.4. Geologic Hazards

4.4.1. Liquefaction Potential

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

4.4.2. Collapsible Soils

Collapsible soils are soils with the potential for a decrease in volume with an increase in external load or moisture content. These soils are typically found in areas of alluvial deposits with semi-arid to arid climates. Based on the information collected during our field study and subsequent laboratory testing, we anticipate collapse-susceptible soils will be encountered during construction. Based on ASTM D 5333, a calculated collapse potential, I_c , of the tested undisturbed ring samples collected during our field study resulted in 0.63 percent indicating a slight collapse potential.

4.4.3. Expansive Soils

Residual soil was encountered on the project site and generally have poor to good engineering properties. Expansive soils are soils with the potential for an increase in volume with an increase in moisture content. Based on the information collected during our field study and subsequent laboratory testing, we anticipate expansive-susceptible soils will be encountered during construction. Additionally, based on ASTM 4546, the expansive potential of the remolded sample collected during our field study, in the upper 5 feet, indicated an expansive potential.

4.5. Seismic Considerations

The project site is located in northern Arizona which is an area of low seismic activity. The following values were developed using the Seismic Design Maps by Structural Engineers Association by Location, the ASCE 7-16 Reference and are based on knowledge of local geologic conditions, and subsurface soils encountered during our study. A 100-foot soil test boring was not advanced during our field study. The geographic coordinates listed below were used in developing the seismic design factors.

Central Latitude.....36.597353°
Central Longitude.....-110.791619°

Seismic Design Factors	Value
Site Class	D
F_a , Site Coefficient	1.6
F_v , Site Coefficient	2.4
S_s , Mapped Spectral Acceleration at 0.2-second Period	0.243 g
S_1 , Mapped Spectral Acceleration at 1.0-second Period	0.071 g
S_{MS} , Spectral Acceleration at 0.2-second Period Adjusted for Site Class	0.389 g
S_{M1} , Spectral Acceleration at 1.0-second Period Adjusted for Site Class	0.171 g
S_{DS} , Design Spectral Response Acceleration at 0.2-second Period	0.259 g
S_{D1} , Design Spectral Response Acceleration at 1.0-second Period	0.114 g

4.6. Earth Fissures and Land Subsidence

The project site is located in an area with no documented earth fissures and in an area without measured land subsidence.

5. ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1. Earthwork

All existing structural remnants, fill, pavement, topsoil, vegetation and organic soils should be removed from below structural areas. The following sections present earthwork recommendations based on our understanding of the project, the finding of our field exploration, results of the laboratory tests and engineering analysis. Based on the finding of our field exploration, laboratory test results and engineering analysis, it is our opinion that the proposed construction can be supported on a spread footing system as presented in the following sections.

5.1.1. Frost Heave

This project is in an area with an anticipated frost depth of 30 inches based on Coconino County Arizona Community Development Table R301.2(1) between elevation 5,700 to 7,100 above sea level. To protect against frost heave, the use of fine-grained soils should be avoided in and around structural areas. The potential for snowpack adjacent to the structural areas may allow significant moisture to increase into fills around the outer edge of foundations therefore the exterior should be graded for positive drainage away from the structural areas. Also, to reduce the potential for moisture migration, refer to section 5.4 of this report.

5.1.2. Spread Footings

The existing surface soils should be removed to a minimum depth of one (1) foot below bottom of proposed spread footing elevation or below the existing surface elevation, whichever is deeper. The excavation of the site soils should be within the entire footprint of the structure and extend laterally for a minimum distance of five (5) feet beyond the perimeter of structure. The exposed subsurface soils should be scarified to a depth of eight (8) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM D698. The excavated soils should be replaced with soil-cement per section 5.1.7 of this report to bring the site to finish pad elevation.

5.1.3. Sidewalks and Exterior Slabs

The site soils tested as part of this project exhibit swelling potential and should not be used within one foot of finished subgrade. The existing surface soils below concrete flatwork (sidewalks and exterior slabs) should be replaced with one foot of soil-cement per section 5.1.7.

5.1.4. Pavement Site Preparation and Grading

The pavement section presented in this report is based on the site soils encountered during our field exploration. The native soils should be scarified to a depth of twelve (12) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of ninety-five (95) percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.1.5. Aggregate Base Course

The aggregate base used in support of Portland cement concrete and asphaltic concrete pavements should conform to the local governing agency and/or Maricopa Association of Governments (MAG) Section 702 Specifications. The plasticity index of the fraction of material passing the No. 40 sieve should not exceed five when tested in accordance with ASTM Test Method D 4318. Coarse aggregate should have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM Test Method C 131), of no greater than 40 when exposed to a maximum of 500 revolutions.

A minimum of four (4) inch layer of clean, granular material should be placed beneath concrete slabs to serve as a leveling base, and to aid in concrete curing. The material should conform to the gradation requirements set by the local governing agency and/or MAG section 702 specifications for Aggregate Base Course (ABC). The use of moisture barriers beneath the floor slabs may be helpful, but is not a geotechnical requirement; however, the architect or the slab designer should evaluate their need.

All aggregate base material should be placed in lifts not greater than eight (8) inches and compacted to a minimum of 95 percent of maximum dry density below Portland cement concrete and one hundred percent of maximum dry density below asphaltic concrete pavements as determined by ASTM Test Method D 698 or as specified by local

specification. The moisture content during compaction should be maintained within two percent of optimum moisture content.

5.1.6. Engineered Fill

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

1. Native soils with low expansive potentials can be used as fill material for the following:

- general site grading
- foundation areas
- foundation backfill
- pavement areas

2. Imported soils with low expansive potentials could be used as fill material for the following:

- general site grading
- foundation areas
- interior floor slab areas
- foundation backfill
- exterior slab areas
- pavement areas

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

<u>Gradation</u>	<u>Percent finer by weight (ASTM C136)</u>
3".....	100
No. 4 Sieve.....	50-100
No. 200 Sieve.....	50 (max)
Liquid Limit.....	30 (max)
Plasticity Index.....	15 (max)

Swell Test

Maximum Swell Potential1.5 %*

*Measured on a sample compacted to approximately 95 percent of the ASTM D 698 maximum dry density at about 3 percent below optimum water content.

The sample is confined under a 100 PSF surcharge and submerged.

Corrosion Potential

(PPM)

Sulfate Content (ARIZ 733).....1,000(max)

Chloride Content (ARIZ 736).....500(max)

4. Imported soils (low-frost susceptible) should conform to the following:

<u>Gradation</u>	<u>Percent finer by weight (ASTM C136)</u>
3".....	100
No. 4 Sieve	25-60
No. 200 Sieve.....	15 (max)

Swell Test

Maximum Swell Potential1.5*

*Measured on a sample compacted to approximately 95 percent of the ASTM D 698 maximum dry density at about 3 percent below optimum water content.

The sample is confined under a 100 PSF surcharge and submerged.

Corrosion Potential

(PPM)

Sulfate Content (ARIZ 733).....1,000(max)

Chloride Content (ARIZ 736).....500(max)

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

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

7. The following are intended to guide in establishing adequate support for the conventional foundation elements:

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

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

5.1.7. Soil-Cement

The soil cement should be constructed and replaced in general accordance with Maricopa Association of Governments (MAG) Section 311. The mix design prepared by the Contractor should attain a minimum 7-day compressive strength of 200 psi.

5.2. Excavation

The field sampling and exploration was performed using a truck-mounted drill rig with 7 and 1/4-inch outside diameter hollow stem augers. We present the following general comments regarding ease of excavation with the understanding that they are opinions based on the test borings. The project consultant and contractor should become

familiar with this report including boring logs to evaluate potential hard dig conditions. **Please note that excavation characteristics are best evaluated by performing test excavations with the size and type of equipment the contractor plans on using at the site, which was not conducted as part of this study.**

It is anticipated that shallow excavations in the site soils can most likely be accomplished by conventional earth moving equipment in good operating condition. Excavations deeper than five feet may require specialized equipment. Refusal blow counts, greater than 50 blows per foot, were encountered from 5 feet to 20 feet below existing grade on potential sandstone. Sloughing and caving of near surface soils should be considered during grading operations. Please refer to Section 4 and the boring logs presented in **Appendix C** of this report for more information.

5.2.1. Trench Backfill

Materials

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

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

Recommendations provided above for pipe zone backfill are minimum requirements only. More stringent material specifications may be required to fulfill local codes and/or bedding requirements for specific types of pipes. We recommend the project

Civil Engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

Compaction Criteria

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

Care must be used during compaction of backfill against stem walls. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional excessive wall pressure due to compaction method. To reduce the potential for a subsurface wall blowout, heavy construction equipment should not be operated in close proximity to the below ground structures or earth retaining structures.

5.2.2. Temporary Excavations

General

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

Excavations and Slopes

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

Near-surface soils encountered during our field study consisted predominantly of Silty Sand (SM). In our opinion, these soils would be considered a Type C soil when applying OSHA regulations. For this soils type OSHA recommends a maximum slope inclination of 1½(h):1(v) or flatter for excavations 20 feet or less in depth. Steeper cut slopes may be utilized for excavations less than five (5) feet deep depending on the strength, moisture content, and homogeneity of the soils as observed in the field. Flatter slopes and/or trench shields may be required if loose, cohesionless soils and/or water are encountered along the slope face.

Construction Considerations

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

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

5.2.1. Permanent Excavations and Slopes

We recommend all permanent cut and fill slopes in soil be constructed at a gradient no steeper than 3(h):1(v). During wet weather, erosion could become a problem. Proper drainage and maintenance is recommended. To reduce the potential for surface erosion, a berm or "V" ditch may be located at the top of slopes subject to significant overland water flows in order to intercept and redirect surface runoff.

Fill placed on slopes steeper than 5(h):1(v) should be benched into the existing slope. It is recommended that the slope face be compacted as presented in the earthwork section of this report.

5.3. Structures

5.3.1. Shallow Spread Footings

The anticipated frost depth for the project area is 30-inches below existing site grade. Therefore, concrete slabs and post-tensioned slab-on-ground foundations should have turn downs which extend below the anticipated frost depth.

Allowable Bearing Pressure for Shallow Foundations

Footing Depth Below Finished Grade (ft.)*	Allowable Bearing Pressure (psf)
2.5	2,500
3.0	3,000

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

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

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

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

Settlement of footings designed as recommended above are estimated not to exceed 1-inch. Differential settlements over, a horizontal distance of 50 feet between similarly loaded footings, are expected to be less than $\frac{1}{2}$ -inch and $\frac{3}{4}$ -inch for wall and column footings, respectively. Significant moisture increases above those recommended for compaction could result in additional movements. In order to minimize the sensitivity of the structure to differential settlements, footings should be reinforced to allow for a degree of load redistribution should a localized zone of supporting soils become saturated.

5.3.1.1. Structural Slab

The subgrade in the structural slab area should be prepared as recommended in section 5.1.

For design of structural slabs on grade, a modulus of subgrade reaction, k_s , of 200 pci is recommended for slabs bearing on competent soils prepared as recommended above. However, this k_s value is based on a bearing area of one square foot. In order to account

for size effects a reduction is recommended for larger areas. The following approximation of k_s (based on Terzaghi's equation) can be used for mats of various dimensions.

k_s (in pci) = $200[(B+1)/(2B)]^2$ where B is the width of the mat (in feet)

Additionally, it is recommended that a thickened edge be constructed on the slab to minimize the potential for edge damage.

5.3.2. Resistance to Lateral Loads

Proposed walls/structures that will retain soil must be designed to withstand lateral soil pressures. Cantilevered retaining walls, or unrestrained walls subject to lateral earth pressures, should be designed for an equivalent fluid pressure (EFP) of 37 Pounds per Cubic Foot (PCF). Restrained walls should be designed to withstand a residual or long-term at-rest (K_o) earth pressure condition of 56 PCF.

A passive EFP of 300 PCF may be used for shallow spread footings. A coefficient of friction of 0.39 is recommended for computing lateral resistance between the base of footing and soil in analyzing lateral loads. Vehicular surcharge loads and/or hydrostatic pressure will increase the recommended EFP.

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

5.3.2.1. Wall Drainage

The above-recommended values do not include lateral pressures due to hydrostatic forces. Therefore, wall backfill should be free draining and provisions should be made to collect and dispose of excess water that may accumulate behind earth retaining structures. In cases where site soils become saturated an equivalent fluid pressure of 90 PCF should be used.

Wall drainage should be collected by continuous perforated drainpipes, filter fabric, and gravel connected to weep holes. The drainpipe must run parallel to the wall. We recommend drain rock consist of durable stone having 100 percent passing the 1-inch sieve and zero percent passing the No. 4 sieve. Synthetic filter fabric should have an equivalent opening size (EOS), U.S. Standard Sieve, of between 40 and 70, a permeability of at least 0.02 centimeters per second and minimum puncture strength of 50 pounds.

5.3.2.2. Backfill Placement

All backfill should be placed and compacted in accordance with recommendations provided above for engineered fill. Care must be used during compaction of backfill against the below ground tanks walls. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional excessive wall pressure due to compaction method. To reduce the potential for a subsurface wall blowout, heavy construction equipment should not be operated next to the walls.

5.4. Moisture Protection

Soil support values reduce with an increase of moisture content. Therefore, positive drainage is essential to the successful performance of any structure. Good surface and subsurface drainage should be established during and after construction to prevent the soils below or adjacent to the structural areas and utility trenches from becoming wet.

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

5.5. Corrosion Potential

5.5.1. Electrical Resistivity

Electrical Resistivity of a soil is a measure of resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. As a soil's resistivity decreases, its corrosivity increases.

A commonly accepted correlation between soil resistivity and corrosivity towards ferrous metals is shown in the following table.

<u>Resistivity (ohm-cm)</u>	<u>Corrosivity Classification</u>
0 to 1,000	Severely corrosive
1,000 to 2,000	Corrosive
2,000 to 10,000	Moderately corrosive
Over 10,000	Mildly corrosive

Sample Location	pH	Resistivity (Ohm-cm)
Bulk Sample B-1	8.1	3,400

Based on the laboratory tests as shown above, this soil would be considered "moderately corrosive". It should be noted that these corrosion conditions are for the soils at submerged moisture conditions. Resistivities at drier moisture contents would be less corrosive than the results of the test.

The pH values of the samples tested were slightly basic. In most cases, pH is not a significant factor in corrosion in the near-neutral pH range ($5 < \text{pH} < 9$).

Estimated life for various gage galvanized CMP, based on Figure 6.7 of the Handbook of Steel Drainage & Highway Construction Products published by American Iron and Steel Institute Fourth Edition, 1993, is tabulated below. Details of the laboratory test results are presented in the **Appendix C** of this report.

Sample Location	Design Life (yrs)		
	16 Gage	14 Gage	12 Gage
Bulk Sample B-1	107	139	192

5.5.2. Sulfate and Chloride Content

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

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

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

5.6. Pavement Areas

The on-site soils should be suitable as pavement subgrade soils provided all unsuitable debris, rubble, oversized cobbles, etc. are removed. A flexible and/or rigid pavement is recommended for the pavement areas. The recommended pavement sections are based on the assumption that the subgrade soils are prepared in accordance with section 5.1 of this report.

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

PAVEMENT AREA	ASPHALT SURFACE THICKNESS (IN)	AGGREGATE BASE COURSE THICKNESS (IN)
Parking Areas*	3.0	6.0

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

Areas subject to sustained, heavy concentrated loads, such as dumpster areas should be paved with Portland Cement Concrete (PCC). A pavement section of 6 inches of PCC on 4 inches of aggregate base course is recommended in these areas. We should be contacted for additional recommendations if there are any areas subjected to volumes of traffic heavier than those assumed for this report.

6. CLOSURE

6.1. Limitations

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

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

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

This report is for the exclusive purpose of providing Geotechnical Engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken. This report has also not addressed the site geology and the possible presence of geologic hazards.

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

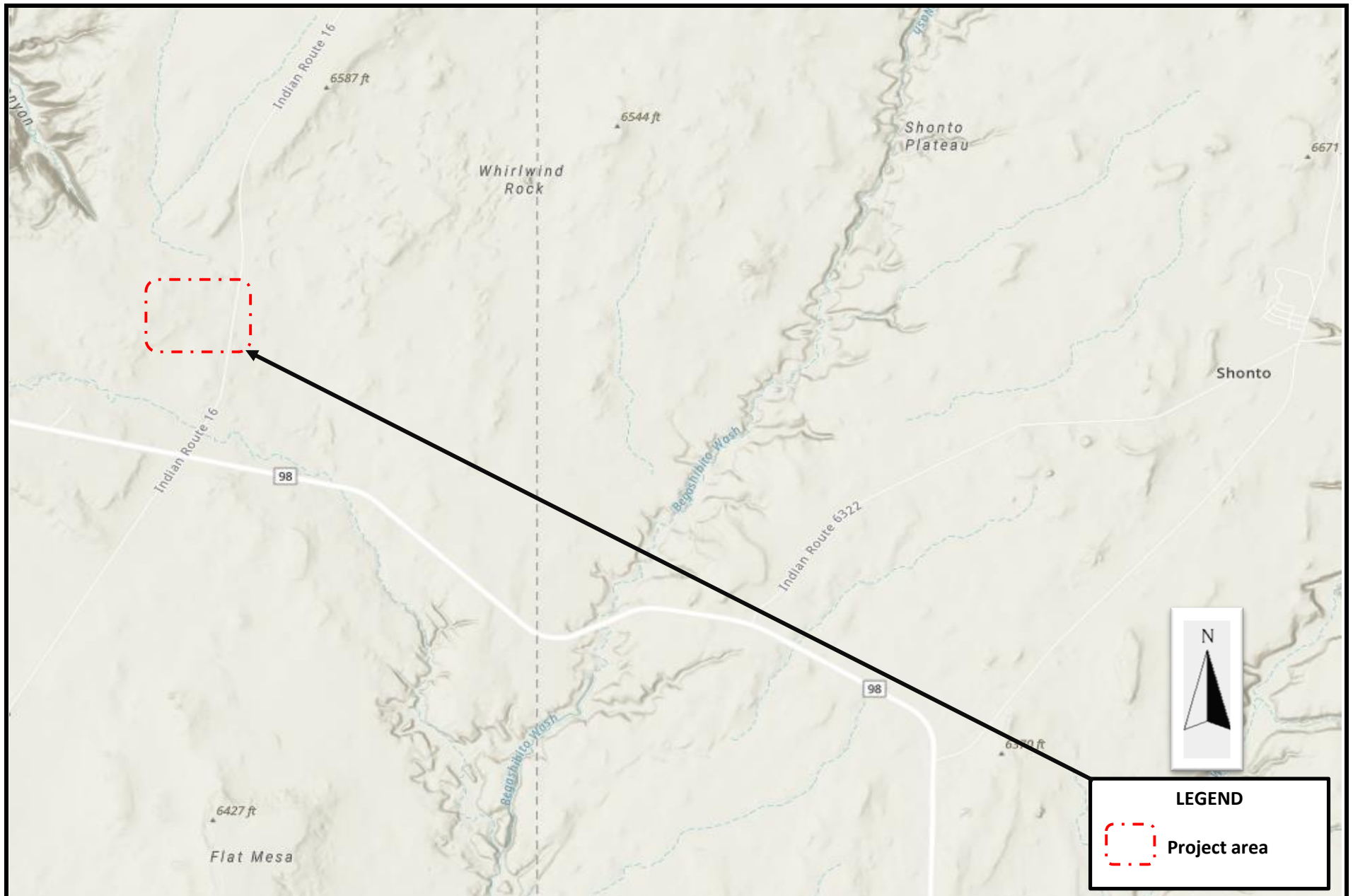
6.2. Recommended Additional Services

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

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

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

APPENDIX A
Site Location Map



Basemap provided by ArcGIS	Project #: 240012	Site Location Map - Sheet 1 of 1	
	Date: 5/20/2024	IHS IDIQ iHouse	
	Drawn by: M Mendoza	Tonalea, Arizona	
		 111 South Weber Drive, Suite 1 Chandler, AZ 85226	

APPENDIX B
Sample Location Plan



LEGEND

 Boring Location

 Percolation Location

Project Address Indian Rte 6290 Tonalea, AZ 86044 Basemap provided by Google Earth	Project #: 240012	Boring Location Plan - Sheet 1 of 1 IHS IDIQ iHouse Tonalea, Arizona	 111 South Weber Drive, Suite 1 Chandler, AZ 85226
	Date: 5/20/2024		
	Drawn by: M Mendoza		

APPENDIX C
FIELD STUDY AND BORING LOGS

APPENDIX C FIELD STUDY

BORINGS

The subsurface conditions at the site were explored on May 21, 2024, by drilling soil borings using a truck mounted CME drill rig with 7 and a ¼-inch outside diameter hollow stem auger. The locations of soil test borings performed for this study are shown in **Appendix B** of this report.

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

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

SAMPLING PROCEDURES

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

LIST OF ATTACHMENTS

The following plates are attached and complete this appendix.

Unified Soil Classification System - C1

Log Key - C2

Charts and Definitions - C3

Terminology Used to Describe Soils - C4

Logs of Soil Borings

UNIFIED SOIL CLASSIFICATION SYSTEM

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

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



UNIFIED SOIL CLASSIFICATION SYSTEM

IHS IDIQ – iHouse 19 Unit Apartment
Johnson Smithipong & Rosamond Associates, Inc.
Tonalea, Arizona

KEY

C-1

Drafted By: AM
Date: May, 2024

Project Number:
240012

LOG SYMBOLS



BULK / GRAB SAMPLE



MODIFIED CALIFORNIA SAMPLER
(2 inch inside diameter)



GRAB SAMPLE



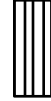
STANDARD PENETRATION
SPLIT SPOON SAMPLER
(2.0-inch O.D. X 1.4-inch I.D.)



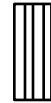
SHELBY TUBE
(3 inch outside diameter)



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



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



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



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



WATER LEVEL
(level after completion)



WATER LEVEL
(level where first encountered)

GENERAL NOTES

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



LOG KEY

IHS IDIQ – iHouse 19 Unit Apartment
Johnson Smithipong & Rosamond Associates, Inc.
Tonalea, Arizona

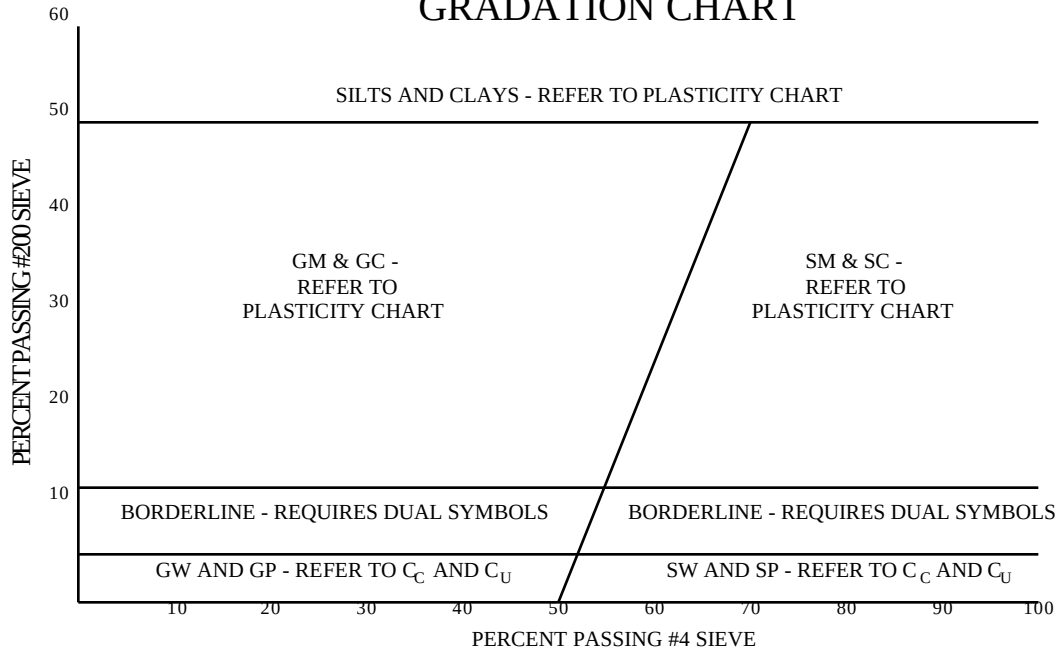
KEY

C-2

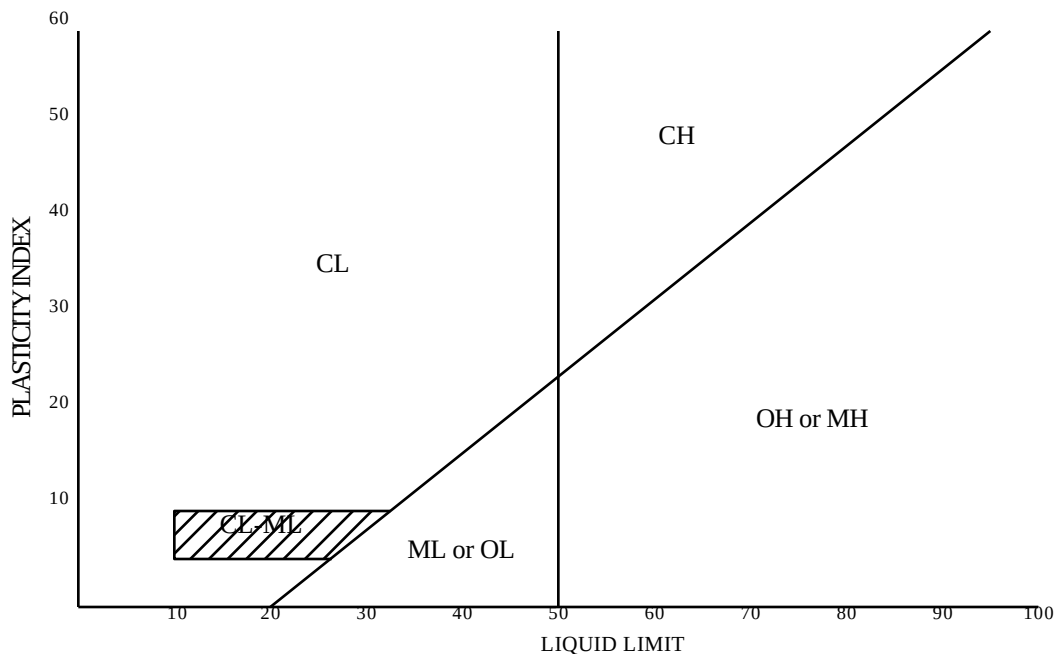
Drafted By: AM
Date: May, 2024

Project Number:
240012

GRADATION CHART



PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

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



CHARTS & DEFINITIONS

IHS IDIQ – iHouse 19 Unit Apartment
Johnson Smithipong & Rosamond Associates, Inc.
Tonalea, Arizona

KEY

C-3

Drafted By: AM

Project Number:

Date: May, 2024

240012

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

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

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

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

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

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

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

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



TERMINOLOGY USED TO DESCRIBE SOILS

IHS IDIQ – iHouse 19 Unit Apartment
Johnson Smithipong & Rosamond Associates, Inc.
Tonalea, Arizona

KEY

C-4

Drafted By: AM
Date: May, 2024

Project Number:
240012

Project Name: IHS IDIQ iHouse						Client: Johnson Smithpong & Rosamond Associates, Inc.							
Borehole Location: See Location Plan									Sheet <u> 1 </u> of <u> 1 </u>				
Borehole Number: B-1						Driller: Wildcat			Logger: Marilyn Mendoza				
Drilling Equipment: CME-55			Borehole Diameter (in.): 7.25 HSA			Date Started: 5/21/2024			Date Finished: 5/21/2024				
Elevation (ft)								Notes:					
DEPTH (ft)	DRILL OPERATION SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT		PLASTICITY INDEX	USCS CLASSIFICATION	GRAPHIC LOG		MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
					LL	PI							
5		2-4	6.2	11.3	100.3	NV	NP	30	SM		SILTY SAND (SM), 70% fine to medium grained sand, 30% fines, loose, nonplastic, reddish brown, slightly moist, no cementation, weak reaction to HCl		Swell Potential of Soil=3.15%
		26-50/2"									Very dense, brown, weak cementation, no reaction to HCl, (weathered sandstone)		
10		50/2"									Light brown, moist		
15		50/3"											
20		50/3"										20.3	
Bottom of auger @ 20.0 feet bgs. Bottom of sampler @ 20.3 feet bgs. No groundwater encountered.													
Sampler Types:			Split Spoon Penetrometer			Operation Types:			WATER LEVEL OBSERVATIONS				
Shelby			Vane Shear			Hand Auger			While Drilling N/A ft Upon Completion of Drilling N/A ft Time After Drilling _____ N/A N/A N/A Depth To Water (ft) _____ N/A N/A N/A Remarks: Not Encountered				
Bulk Sample			California			ODEX							
Grab Sample						Auger Hollow Stem							
						Bullnose							
						Core Barrel							
						Excavated Pit							

ATEK Project Number:
240012
LOG OF EXPLORATORY BORING B-1
Fig. 1

Project Name: IHS IDIQ iHouse					Client: Johnson Smithpong & Rosamond Associates, Inc.																	
Borehole Location: See Location Plan					Sheet 1 of 1																	
Borehole Number: B-2				Driller: Wildcat			Logger: Marilyn Mendoza															
Drilling Equipment: CME-55		Borehole Diameter (in.): 7.25 HSA		Date Started: 5/21/2024			Date Finished: 5/21/2024															
Elevation (ft)								Notes:														
<table><tr><td rowspan="2">DEPTH (ft)</td><td rowspan="2">DRILL OPERATION</td><td rowspan="2">SAMPLE</td><td>STANDARD PENETRATION TEST</td><td rowspan="2">MOISTURE CONTENT (%)</td><td rowspan="2">DRY DENSITY (pcf)</td><td rowspan="2">LIQUID LIMIT</td><td rowspan="2">PLASTICITY INDEX</td><td rowspan="2">USCS CLASSIFICATION</td><td rowspan="2">GRAPHIC LOG</td></tr><tr><td>SPT</td></tr></table>								DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION	GRAPHIC LOG	SPT	MATERIAL DESCRIPTION		DEPTH (ft)	REMARKS
											DEPTH (ft)							DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST		
SPT																						
SILTY SAND (SM), medium dense, nonplastic, reddish brown, moist, weak cementation, no reaction to HCl																						
Very dense, light brown, (weathered sandstone)																						
20.3																						

Bottom of auger @ 20.0 feet bgs.
Bottom of sampler @ 20.3 feet bgs.
No groundwater encountered.

Sampler Types:	☒ Split Spoon	☐ Penetrometer	Operation Types:	☒ Auger Hollow Stem	WATER LEVEL OBSERVATIONS					
	☒ Shelby	☐ Vane Shear		☒ Bullnose	While Drilling	☒ N/A	ft	Upon Completion of Drilling	☒ N/A	ft
	☒ Bulk Sample	☒ California		☒ Core Barrel	Time After Drilling	☒ N/A		☒ N/A	☒ N/A	
	☒ Grab Sample			☒ ODEX	Depth To Water (ft)	☒ N/A		☒ N/A	☒ N/A	
				☒ Excavated Pit	Remarks: Not Encountered					

ATEK Project Number: 240012

LOG OF EXPLORATORY BORING B-2

Fig. 2

Project Name: IHS IDIQ iHouse						Client: Johnson Smitthipong & Rosamond Associates, Inc.																																																																																					
Borehole Location: See Location Plan								Sheet 1 of 1																																																																																			
Borehole Number: B-3						Driller: Wildcat			Logger: Marilyn Mendoza																																																																																		
Drilling Equipment: CME-55				Borehole Diameter (in.): 7.25 HSA			Date Started: 5/21/2024			Date Finished: 5/21/2024																																																																																	
Elevation (ft)									Notes:																																																																																		
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	Grab Sample					Remarks: Not Encountered																																																																																					
ATEK Project Number: 240012								LOG OF EXPLORATORY BORING B-3				Fig. 3																																																																															

APPENDIX D
Laboratory Test

APPENDIX D LABORATORY TESTING

LABORATORY TESTS

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

Sieve Analysis

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

Atterberg Limits

Atterberg Limits tests were performed to aid in soil classification and to evaluate the plasticity characteristics of the material. Tests were performed in general accordance with ASTM Test Method D 4318.

Moisture Content

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

One-Dimensional Consolidation

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

Undisturbed Ring Density

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

Standard Proctor

Standard Proctor tests were performed on bulk soil samples to evaluate the maximum dry density and optimum moisture of the site soils. Test procedures were in general accordance with ASTM Test Method D 698A.

Swell Test

Swell test was performed on bulk soil samples to evaluate the expansion potential of the site soils. Test procedures were in general accordance with ASTM Test Method D 4829.

pH and Resistivity

pH and resistivity tests were performed on the bulk soil sample to evaluate the site soil corrosion potential. Test procedure was in general accordance with Arizona Test Method 236.

Sulfate Content

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

Chloride Content

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



PROJECT: IHS IDIQ iHouse
LOCATION: Tonalea, Arizona
SAMPLE DATE: 5/21/2024

PROJECT: 240012
WORK ORDER: 2400122
REVIEWED BY: G. Lopez

MOISTURE CONTENT OF SOIL -- ASTM D 2216

LAB #	SAMPLE SOURCE	MOISTURE		
		WET WEIGHT (g)	DRY WEIGHT (g)	MOISTURE CONTENT
1	Bulk, B-1 @ 0.0'-5.0'	553.7	521.3	6.2%
12	Bulk, B-3 @ 0.0'-2.5'	453.4	427.1	6.2%
19	Bulk, PR-1 @ 0.0'-3.0'	578.1	559.2	3.4%



PROJECT: IHS IDIQ iHouse
LOCATION: Tonalea, Arizona
SAMPLE DATE: 5/21/2024

PROJECT: 240012
WORK ORDER: 2400122
REVIEWED BY: G. Lopez

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

LAB #	SAMPLE SOURCE	MOISTURE			# OF RINGS	WET WEIGHT + RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
		WET WEIGHT (g)	DRY WEIGHT (g)	MOISTURE CONTENT				
2	Ring, B-1 @ 2.5'-3.5'	809.1	727.0	11.3%	6	1080.5	271.4	100.3



PROJECT: IHS IDIQ iHouse
LOCATION: Tonalea, Arizona
DATE SAMPLED: 5/21/2024

PROJECT NO: 240012
WORK ORDER NO: 2400122
REVIEWED BY: G. Lopez

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

SIEVE SIZES

Location & Depth	USCS	LL	PL	PI	COBBLES		GRAVEL								SAND								Silt or Clay	Lab #
					6"	4"	3"	2"	1 1/2"	1 1/4"	1"	3/4"	1/2"	3/8"	1/4"	#4	#8	#10	#16	#30	#40	#50	#100	#200

PERCENT PASSING BY WEIGHT

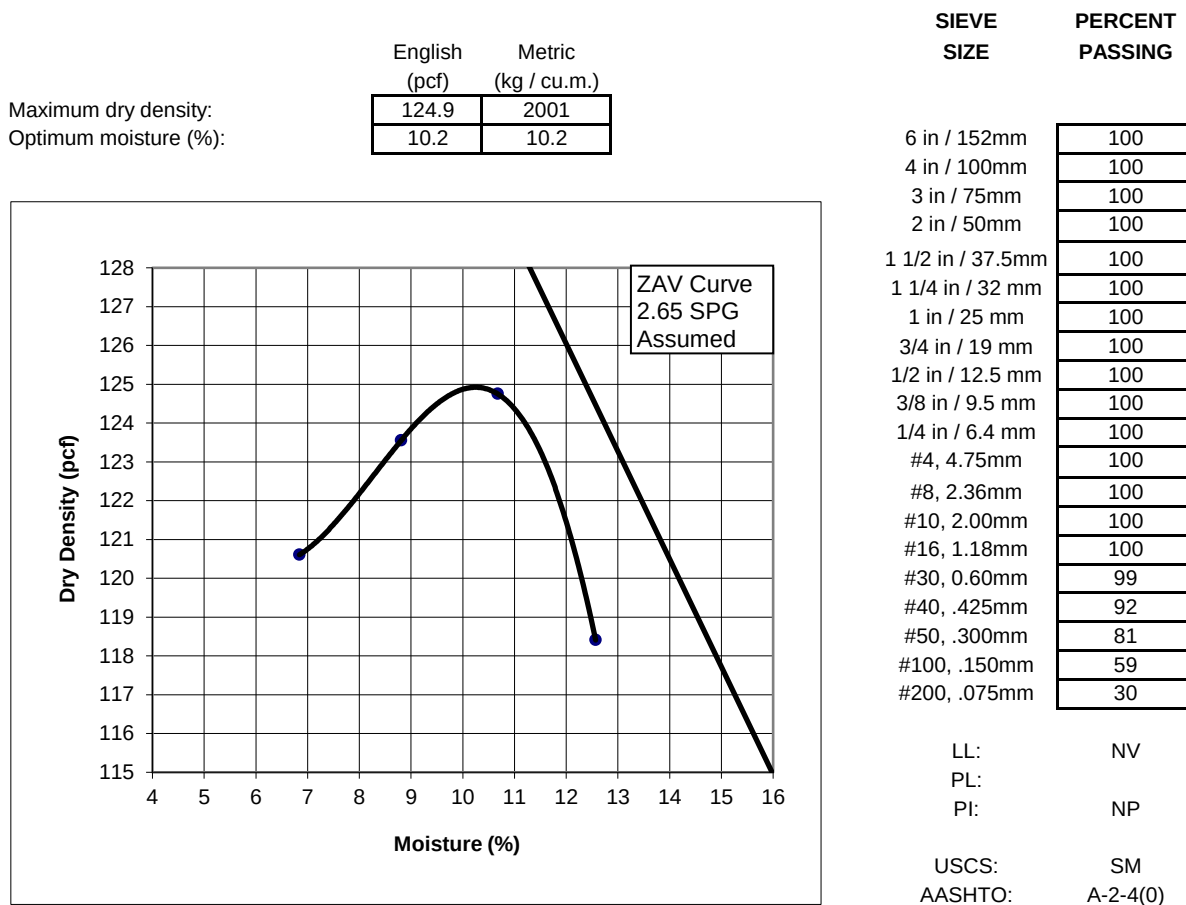
Bulk, B-3 @ 0.0'-2.5'	SM	NV	NP	NP	100	100	100	100	100	100	100	99	99	99	98	98	97	97	97	97	95	89	66	27	12
Bulk, PR-1 @ 0.0'-3.0'	SP-SM	NV	NP	NP	100	100	100	100	100	100	99	98	97	97	96	96	95	95	94	94	92	78	31	8	19

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

PROJECT: IHS IDIQ iHouse
LOCATION: Tonalea, Arizona
MATERIAL: Native
SAMPLE SOURCE: Bulk, B-1 @ 0.0'-5.0'

PROJECT NO: 240012
WORK ORDER NO: 2400122
LAB NO: 1
SAMPLE DATE: 5/21/2024

**LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORT (12,400ft-lb-ft/cu.ft) (ASTM D698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318) (DRY PREP)**



NOTES:

AASHTO Description: Silty gravel and sand

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

Reviewed by: G. Lopez



Project: IHS IDIQ iHouse
Location: Tonalea, Arizona
Client: Johnson Smithipong & Rosamond Associates, Inc.
Material: Native
Sample Source: See Below

Project Number: 240012
Work Order Number: 2400122
Lab Number: See Below
Date Sampled: 05/21/24

Swell Potential of Soil ASTM D4546

Sample Number	Sample Source	Swell (%)	Target Compaction (%)	Actual Compaction (%)	Target Moisture (%)	Actual Moisture (%)
1	Bulk, B-1 @ 0.0'-5.0'	2.6	95.0	95.0	7.2	7.3
Retest 1	Bulk, B-1 @ 0.0'-5.0'	3.7	95.0	95.4	7.2	7.3

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

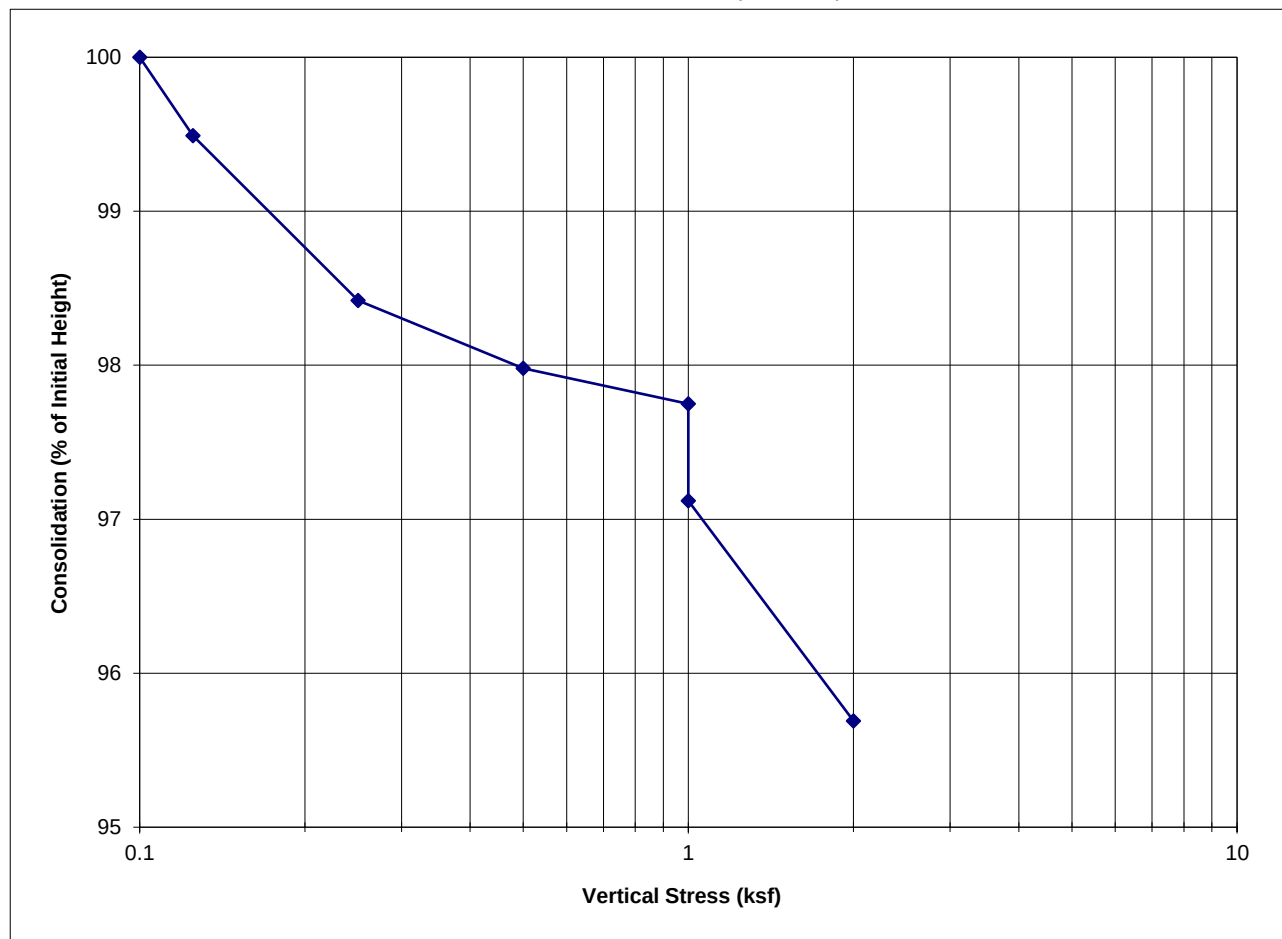


Project: IHS IDIQ iHouse
Project Location: Tonalea, Arizona
Client: JSRA
Material: Native
Sample Source: Ring Sample B-2 @ 2.5'-3.5'
Sample Prep: In-Situ

Project Number: 240012
Work Order Number: 2400122
Lab Number: 7
Date Sampled: 05/21/24

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.41
Initial Moisture Content	6.5%	Final Moisture Content	18.2%
Initial Dry Density(pcf)	106.6	Final Dry Density(pcf)	111.4
Initial Degree of Saturation	31%	Final Degree of Saturation	100%
Initial Void Ratio	0.55	Final Void Ratio	0.48
Estimated Specific Gravity	2.65	Saturated at	1 ksf
		Hydro Collapse Potential	0.63%





Project: IHS IDIQ iHouse
Location: Tonalea, Arizona
Client: Johnson Smitthipong & Rosamond Associates, Inc.
Material: See Below
Sample Source: See Below

Project Number: 2400112
Work Order Number: 2400122
Lab Number: See Below
Date Sampled: 05/21/24

pH & Resistivity (AZ 236)

Sample Number	Sample Source	Resistivity (Ohm-cm)	pH
1	Bulk, B-1 @ 0.0'-5.0'	3,400	8.1



Report: 950998
Reported: 5/28/2024
Received: 5/23/2024
PO: 2400122

Laboratory Analysis Report

Atek Engineering Consultants
Antonio Lopez
111 South Weber Dr Suite 1
Chandler, AZ 85226

Project: 240012

Lab Number	Sample ID
950998-1	1) Bulk, B-1 (0.0-5.0')

Test Parameter

<i>Test</i>	<i>Method</i>	<i>Result</i>	<i>Units</i>
Sulfate	ARIZ 733b	4	ppm
Chloride	ARIZ 736b	8	ppm

iHouse 19 Unit Apartment Building
Tonalea, AZ

Appendix A3

Hydrology Report



JOHNSON SMITTHIPONG & ROSAMOND ASSOCIATES, INC.

5210 E Williams Circle, Suite 600 ■ Tucson, AZ 85711 ■ v:520.547.7904 ■ f:520.547.7905 ■ www.jsra.com

TECHNICAL DRAINAGE STUDY

iHouse Apartments

DOWL Project 3780.41714.01

June 2024

Prepared for:

JSRa Architects
5210 E Williams Cir., Suite 600
Tucson, AZ 85711

Prepared by:



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TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	PROJECT LOCATION AND DESCRIPTION.....	1
1.2	POTENTIAL IMPACTS	1
2.0	OBJECTIVES AND PROCEDURES.....	2
2.1	ON-SITE RUNOFF MANAGEMENT GOALS	2
2.2	OFF-SITE RUNOFF MANAGEMENT GOALS.....	3
2.3	BEST MANAGEMENT PRACTICES	4
3.0	SUMMARY AND PURPOSE	4
3.1	METHODOLOGY AND ASSUMPTIONS.....	4
3.2	SITE DESCRIPTION.....	5
3.3	DESIGN PARAMETERS	6
4.0	HYDROLOGY	6
4.1	EXISTING HYDROLOGY.....	6
4.2	PROPOSED HYDROLOGY	7
5.0	HYDRAULICS.....	9
5.1	ON-SITE CONVEYANCE.....	9
5.2	OFF-SITE CONVEYANCE	9
5.3	FLOODPLAIN ANALYSIS	10
6.0	DETENTION BASIN.....	11
6.1	BASIN DESCRIPTION	11
6.2	INLET STRUCTURES.....	11
7.0	SUMMARY AND CONCLUSIONS	12
7.1	SUMMARY AND CODE ADHERENCE	12

TABLES

Table 1: Assumptions	5
Table 2: "Existing Hydrology"	7
Table 3: "Proposed Hydrology"	8
Table 4: "Existing vs. Proposed"	8
Table 5: "Pipe Inlet Flows"	12

APPENDICES

Appendix 1: Exhibits

1.0 INTRODUCTION

1.1 PROJECT LOCATION AND DESCRIPTION

This project involves the construction of a 20,000-square-foot apartment structure, complemented by three RV parking spots equipped with hook-ups. Additionally, the project will include an access road, necessary parking spaces, utilities, and various other amenities to enhance the overall functionality and appeal of the development. This proposed project is located along Navajo Route 16, roughly seven miles west of Shonto and in close proximity to the Navajo Nation EMS, with precise coordinates at 36°35'49.46"N, 110°47'27.85"W (Section 24, Township 37, Range 14E). The entire property and its proposed amenities are situated wholly within the boundaries of the Navajo Nation.

This project is thoughtfully designed to provide modern housing solutions and necessary amenities, while also enhancing the infrastructure and accessibility for the surrounding community. The use of existing natural features and soil characteristics will aid in efficient runoff management, demonstrating a commitment to sustainable and environmentally conscious development practices.

1.2 POTENTIAL IMPACTS

The current design of the proposed project has been meticulously planned to ensure it has minimal impact on the surrounding community, terrain, flora, and fauna. The layout prioritizes environmental preservation and community well-being through the implementation of safe construction practices, conservative design principles, and the thoughtful integration of utilities and amenities. By adopting these approaches, the project aims to significantly reduce its footprint compared to other similar developments, thereby maintaining the integrity of the local environment and community.

In designing this project, every effort has been made to harmonize with the existing landscape. Construction techniques that minimize disruption to the natural terrain have been selected, ensuring that the slopes, soil, and vegetation remain largely undisturbed. Additionally, the project incorporates sustainable practices that protect local wildlife and plant species, preserving the natural habitat and biodiversity of the area.

The primary objective of this development is to provide affordable and comfortable housing options for members of the community and the Navajo Nation. The apartments are designed to meet modern standards of living while remaining accessible to a broad spectrum of residents. By focusing on affordability and comfort, the project addresses a critical need within the community, offering new housing opportunities that enhance the quality of life for many families. An added benefit of this project is the generation of housing opportunities for the nearby EMS facility.

Providing affordable housing in an opportune location, as we are proposing, will benefit the Navajo Nation.

Furthermore, comprehensive analyses have been conducted to assess the potential impacts of the project. These include evaluations of increased impervious surface areas, which can affect local water runoff and drainage patterns. Measures have been proposed to mitigate any negative effects, such as the use of permeable materials and the strategic placement of green spaces. The anticipated increase in population density and the corresponding demand on utilities have also been thoroughly examined. Plans are in place to ensure that the existing infrastructure can accommodate these changes without compromising service quality.

2.0 OBJECTIVES AND PROCEDURES

2.1 ON-SITE RUNOFF MANAGEMENT GOALS

The intent for on-site stormwater detention is to utilize existing drainage patterns to reflect the current conditions of the site most accurately. The aim is to maintain the natural hydrology as much as possible while accommodating the new development. However, the increase in impervious surfaces, such as paved areas and rooftops, necessitates the incorporation of standard stormwater mitigation facilities. These facilities will include curbs, gutters, catch basins, pipes, manholes, and outfall structures, all designed to manage and control stormwater effectively.

As impervious surfaces increase, so does the volume and speed of stormwater runoff, which can lead to enhanced erosion if not effectively managed. To mitigate these effects, our design focuses on removing runoff from surfaces efficiently and routing it through swales, culverts, inlets, and curb breaks. This changes the stormwater conveyance method from sheet flow, where water spreads across the surface, to channel flow, which is more controlled and directed.

This principle will be meticulously applied throughout the proposed building site and along the new access road. The access road, integral to the project's infrastructure, will be equipped with curb breaks strategically placed along its curblane. These curb breaks are designed to collect runoff efficiently from both the road and the adjacent areas. Once collected, the runoff will be directed into an adjacent stormwater infiltration pond, which has been deemed appropriately sized to handle the increased water volume.

The stormwater infiltration pond will play a crucial role in managing the runoff. By allowing water to infiltrate into the ground, it helps maintain the natural groundwater recharge and reduces the potential for flooding. Analysis of the pond's design considers the soil's high infiltration rates, leveraging the natural characteristics of the site to manage stormwater sustainably.

Additionally, the overall stormwater management plan includes various erosion control measures to prevent soil degradation and protect the local ecosystem. These measures might involve the

use of silt fences, sediment traps, and erosion control blankets, all aimed at stabilizing the soil during and after construction.

By carefully integrating these stormwater management facilities, the project aims to create a development that not only meets the needs of the community but also respects and preserves the natural environment. The thoughtful design and implementation of these systems will ensure that the increased runoff from the new impervious areas is managed in a way that minimizes environmental impact and supports sustainable development principles.

2.2 OFF-SITE RUNOFF MANAGEMENT GOALS

Assessing the effects of off-site drainage is crucial for the success of this project, particularly because the infiltration pond is a key resource utilized by various facets of the community. This basin serves as the primary termination point for runoff generated not only by the new development but also by existing structures, such as the Navajo Nation EMS, and the adjacent community, which comprises 21 residences. Ensuring that this basin can handle the additional load is vital to prevent flooding and other adverse effects.

In evaluating off-site drainage, it is essential to consider several factors. First, the current capacity and condition of the infiltration basin must be thoroughly assessed. This involves analyzing historical data on runoff volumes and patterns to understand the basin's performance under different conditions. By doing so, we can determine whether the existing infrastructure is adequate or if upgrades are necessary to accommodate the increased runoff from the new development.

The next step involves a detailed analysis of the expected runoff volumes. This includes calculating the anticipated increase in impervious surfaces from the new buildings and roadway and estimating the corresponding increase in runoff. These calculations must account for various scenarios, including heavy rainfall events, to ensure that the basin can handle peak flows without exceeding its capacity. Determining how the on-site drainage functions, is critical for accurately assessing off-site runoff. Runoff that would otherwise travel along the natural flow paths away from the basin, are now being directed towards it.

The impacts of increased runoff volumes on the infiltration basin and the surrounding area must also be carefully examined. Increased runoff can lead to several issues, including higher rates of erosion, sedimentation, and potential flooding. These effects can degrade the basin's efficiency and negatively impact the local ecosystem. Therefore, it is essential to implement mitigation measures, such as erosion control techniques and sediment traps, to protect the basin and maintain its functionality.

Our project does not anticipate a significant increase in runoff entering the site at the location of the building itself. This is due to the careful design and placement of structures, which aim to minimize impervious surfaces and promote natural infiltration. However, we do expect that the new roadway will incur large volumes of off-site runoff from the adjacent community. The

roadway's design must, therefore, include features such as catch basins, drainage channels, and curb cuts to manage this runoff effectively.

Additionally, the roadway's alignment and grading must be optimized to direct runoff towards the infiltration basin efficiently. This involves precise engineering to ensure that water flows smoothly and safely without causing erosion or pooling. By incorporating these elements into the design, we can manage off-site runoff in a way that protects both the new infrastructure and the existing community.

Further assessment of the sizing of the infiltration basin, expected runoff volumes, and impacts will be detailed later in this report. This section will provide a comprehensive analysis, including hydrologic models and simulations, to ensure that all potential issues are addressed, and that the basin can perform its intended function effectively.

2.3 BEST MANAGEMENT PRACTICES

Throughout the construction of this project, various stabilization and stormwater-mitigation facilities will be utilized to protect the site and surrounding areas from potential stormwater damage. Temporary structures, such as catch basin covers, silt fences, straw waddles, and construction entrances, will be strategically implemented as runoff mitigation tools. These features are designed to reduce the potential impacts of storm events on disturbed and non-stabilized areas, effectively preventing erosion and sediment displacement.

Catch basin covers will prevent debris from entering the stormwater system, while silt fences will trap sediment and prevent it from washing into nearby water bodies. Straw waddles, placed along slopes, will slow runoff, and promote water infiltration into the soil. Construction entrances will minimize the tracking of mud and sediment onto public roads, reducing the environmental impact.

The project will also incorporate permanent facilities to manage stormwater runoff, including catch basins, swales, pipes, and curb cuts. These permanent facilities will be utilized to mitigate construction runoff where possible.

3.0 SUMMARY AND PURPOSE

3.1 METHODOLOGY AND ASSUMPTIONS

For the extent of this report, as approved by the Navajo County Drainage Policy, the Rational Method was utilized to determine the existing and proposed runoff conditions and volumes. This widely accepted procedure is particularly effective for estimating peak runoff rates in small drainage areas, including urbanized regions. The Rational Method simplifies the complex interactions between rainfall, land surface, and runoff through several key assumptions, ensuring consistency and reliability in calculations. These assumptions, detailed in Table 1, encompass factors such as rainfall intensity, runoff coefficients, and drainage area characteristics, providing

transparency and clarity in our analysis. This comprehensive approach facilitates accurate estimation of runoff volumes and guides the design of stormwater management systems to efficiently manage anticipated flows.

To provide transparency and clarity, the specific assumptions made during this analysis are listed below in Table 1. These assumptions include factors such as runoff coefficients, and drainage area characteristics. By outlining these assumptions, we can understand the limitations and considerations involved in the application of the Rational Method. This comprehensive approach helps in accurately estimating the runoff volumes and ensures that the proposed stormwater management systems are designed to handle the expected flow efficiently.

Table 1: Assumptions

Assumption Number	Assumption Name	Assumption Value	Notes
1	C-Value	0.40	Rational Method & SCSC TR-55 Time of Concentration // C-Value for unimproved surfaces
2	C-Value	0.95	Rational Method & SCSC TR-55 Time of Concentration // C-Value for paved surfaces
3	C-Value	.070	Rational Method & SCSC TR-55 Time of Concentration // C-Value for neighborhood areas
4	C-Value	0.99	Rational Method & SCSC TR-55 Time of Concentration // C-Value for infiltration pond
5	Time of Concentration	SCS TR-55 TOC	Formula used for determining Time of Concentration

3.2 SITE DESCRIPTION

Presently, the project site is characterized by its vacant status, overgrown with rabbit brush and other similar species of flora. The terrain features gentle slopes averaging around 2.5%. The predominant soil type at this location is classified as Mespun-Bispen-Rock outcrop complex, which is moist. This soil type falls under Hydrologic Soil Group A, known for its high infiltration rates and efficient water transmission capabilities. Notably, about 200 feet to the southeast of the project site lies an existing infiltration basin, which our project plans to utilize to effectively manage stormwater runoff. This nearby basin shares nearly identical soil and vegetation characteristics, making it highly suitable for our infiltration needs and ensuring effective stormwater management.

The location intended for the new access road is also currently being used in a manner consistent with the proposed usage. The primary goal of constructing this new access road is to significantly improve community accessibility, both to the new development and to the surrounding residential area, thereby enhancing connectivity and ease of movement for the residents. Runoff from the roadway is expected to follow the existing drainage pattern that terminates in the adjacent detention basin.

3.3 DESIGN PARAMETERS

Designing a stormwater mitigation report for Navajo County, Arizona requires careful consideration of several key parameters to effectively address the region's unique environmental and infrastructural challenges. Navajo County, characterized by its arid climate and occasional intense rainfall events, necessitates a robust approach to managing stormwater to prevent flooding, erosion, and water quality degradation.

Firstly, this report extensively analyzes the site's hydrological characteristics, including rainfall patterns, soil types, and topography. Understanding these factors is crucial for determining the potential impact of stormwater runoff and designing appropriate mitigation measures.

Secondly, this assessment evaluates existing infrastructure such as drainage systems, retention basins, and historic drainage patterns. Identifying the existing capacities and conditions helps in assessing their effectiveness and potential need for upgrades or expansion.

It is crucial that this report and our design adhere to local regulations and guidelines governing stormwater management in Navajo County. Compliance with these regulations ensures that proposed solutions are not only effective but also legally permissible.

4.0 HYDROLOGY

4.1 EXISTING HYDROLOGY

The existing site hydrology consists of eight distinct subbasins. These subbasins converge at the infiltration basin during storm events. The current basin topography has sufficient capacity to allow for the complete collection and retention of runoff from the site, preventing overtopping during 100-year, 24-hour storm events. This ensures that even during extreme weather conditions, the site can manage water flow effectively, mitigating potential flood risks and protecting the surrounding infrastructure. The infiltration basin's design plays a crucial role in maintaining the site's hydrological balance, particularly during significant rainfall events. Additionally, the site's vegetation and soil composition contribute to its ability to absorb and filter stormwater, enhancing the overall efficiency of the hydrological system.

The following Table 2 represents flow quantities and volumes for the 2-, 10-, 50-, and 100-year, 24-hour storms, providing a comprehensive overview of the site's hydrological response to various storm intensities. This data is critical for engineers and planners to develop strategies for

sustainable water management and infrastructure development, ensuring long-term environmental and community health.

Table 2: "Existing Hydrology"

Subbasin Name	Subbasin Size (ac)	Runoff C-Value	Time of Concentration	Outfall Location	Peak Runoff (cfs)				Total Runoff (in)			
					2-year	10-year	50-year	100-year	2-year	10-year	50-year	100-year
1	7.2	0.5	13.3	Infil. Basin	4.1	7.0	11.0	13.2	0.1	0.2	0.3	0.4
2	9.4	0.5	15.0	Infil. Basin	5.2	8.8	13.8	16.6	0.1	0.2	0.4	0.4
3	4.5	0.75	11.3	Infil. Basin	5.1	8.7	13.7	16.4	0.2	0.4	0.6	0.7
4	3.1	0.95	2.5	Infil. Basin	3.1	5.3	8.4	10.0	0.2	0.3	0.5	0.5
5	0.9	0.65	10.2	Infil. Basin	0.9	1.5	2.3	2.8	0.2	0.3	0.4	0.5
6	0.6	0.5	8.6	Infil. Basin	0.4	0.7	1.1	1.3	0.1	0.2	0.3	0.4
10	3.2	0.99	0.0	Infiltration	4.8	8.1	12.7	15.3	0.3	0.4	0.7	0.8
SUMMATION	29.0	0.65	-	-	23.6	40.1	63.0	75.6	1.2	2.0	3.1	3.7

4.2 PROPOSED HYDROLOGY

The intent of the extents of the design is to mimic the existing and historic drainage patterns of the project site most nearly. Current topography of the site indicates that the nearby infiltration basin is the termination point of the majority of the runoff in the immediate vicinity. Therefore, the design was conducted in such a manner that this infiltration basin will be used for a similar purpose. The analysis for the proposed hydrology is centered around the detention basin. Significant runoff will likely not enter the apartment complex parking lot or immediate area from adjacent drainage. However, the roadway will incur significant flow along its path. The analysis of the proposed hydrology serves the purpose to assess the total flows that will be entering the infiltration basin to ensure proper compliance with local codes.

Currently, portions of the project site do not naturally flow towards the infiltration basin. Our design will rectify this and ensure that the majority of the runoff from this site will terminate into the infiltration basin. The logic behind this deviation from the historic drainage pattern is twofold: firstly, it will ensure that runoff from this site does not discharge towards the nearby sewage lagoon; secondly, it will merge our project with the surrounding infrastructure in order to ensure a more uniform drainage pattern moving forward.

Additionally, the new design incorporates advanced hydrological modeling to predict and manage water flow more effectively. This involves creating detailed simulations of various storm scenarios to optimize the placement and capacity of drainage features. By doing so, we can prevent potential flooding and erosion issues that could arise from heavy rainfall events.

The following Table 3 represents flow quantities and volumes for the 2-, 10-, 50-, and 100-year, 24-hour storms, providing a comprehensive overview of the site's hydrological response to various

storm intensities. This data is critical for engineers and planners to develop strategies for sustainable water management and infrastructure development, ensuring long-term environmental and community health.

Table 3: "Proposed Hydrology"

Subbasin Name	Subbasin Size (ac)	Runoff C-Value	Time of Concentration	Outfall Location	Peak Runoff (cfs)				Total Runoff (in)			
					2-year	10-year	50-year	100-year	2-year	10-year	50-year	100-year
1	7.2	0.5	13.3	Infil. Basin	4.1	7.0	11.0	13.2	0.1	0.2	0.3	0.4
2	9.4	0.5	15.0	Infil. Basin	5.2	8.8	13.8	16.6	0.1	0.2	0.4	0.4
3	4.5	0.75	11.3	Infil. Basin	5.1	8.7	13.7	16.4	0.2	0.4	0.6	0.7
4	3.1	0.95	2.5	Infil. Basin	3.1	5.3	8.4	10.0	0.2	0.3	0.5	0.5
5	0.9	0.65	10.2	Infil. Basin	0.9	1.5	2.3	2.8	0.2	0.3	0.4	0.5
6	0.6	0.5	8.6	Infil. Basin	0.4	0.7	1.1	1.3	0.1	0.2	0.3	0.4
7	0.1	0.95	1.5	Infil. Basin	0.2	0.3	0.5	0.7	0.3	0.4	0.7	0.8
8	0.1	0.95	2.5	Infil. Basin	0.2	0.3	0.4	0.5	0.3	0.4	0.7	0.8
9	1.7	0.95	5.8	Infil. Basin	2.5	4.2	6.6	8.0	0.3	0.5	0.8	0.9
10	3.2	0.99	0.0	Infiltration	4.8	8.1	12.7	15.3	0.3	0.4	0.7	0.8
SUMMATION	30.9	0.67	-	-	26.4	45.0	70.6	84.8	2.0	3.3	5.2	6.3

The design also takes into consideration the future development of the surrounding area. By aligning our drainage system with the long-term plans for the region, we ensure that the project not only meets current needs but is also adaptable to future changes. This forward-thinking approach will help maintain the efficiency and effectiveness of the drainage system over time.

The following Table 4 expresses the differences of the weighted C-Value and flows between the proposed and existing conditions.

Table 4: "Existing vs. Proposed"

Value	Existing	Proposed	Delta (as #)	Delta (as %)
Weighted C-Value	0.65	0.67	0.0	3%
Flow, 2-yr	23.6	26.4	2.9	12%
Flow, 10-yr	40.1	45.0	4.8	12%
Flow, 50-yr	63.0	70.6	7.6	12%
Flow, 100-yr	75.6	84.8	9.1	12%

5.0 HYDRAULICS

5.1 ON-SITE CONVEYANCE

The proposed primary form of onsite conveyance of stormwater is sheet flow. Aside from one single catch basin and pipe, the majority of the on-site runoff will be mitigated through careful grading practices, proper erosion control, and thorough spread analysis. The design has been compiled in a manner to convey runoff through this site along curbs, gutters, and swales before its outfall into the nearby infiltration pond.

At this time, on-site conveyance is a remarkably uncomplicated design with a vested interest in preserving the historic drainage pattern while improving the system to increase community safety and health. The use of sheet flow as the primary conveyance method ensures that water is distributed evenly across the surface, reducing the potential for erosion, and promoting natural infiltration into the soil. This approach not only maintains the integrity of the existing landscape but also minimizes the need for extensive and costly underground piping systems.

The grading practices implemented are meticulously planned to create gentle slopes that direct water flow efficiently without causing excessive runoff or erosion. These slopes are complemented by strategically placed curbs and gutters that guide the water towards designated swales. The swales, designed to handle significant volumes of water, act as natural channels that slow down the flow and allow for sediment to settle, improving water quality before it reaches the infiltration pond.

The runoff from the site that is not directed towards the access road and collected there is directed through a curb break. The curb break serves as an avenue for the runoff that will reduce spread onto the roadway and parking lot. The backing of this curb break is a riprap, earthen swale with the purpose of directing flows towards the access road. The termination of the swale is a small detention pond, outfitted with an outlet culvert. This basin serves to reduce sedimentation and increase water quality.

The simplicity of the design with minimal reliance on mechanical systems means that it is easier to maintain and less likely to fail. The focus on preserving historic drainage patterns respects the natural hydrology of the area, ensuring that the project integrates seamlessly with the existing landscape and infrastructure.

The proposed stormwater management design leverages the natural topography and historical drainage patterns of the site to create an efficient, sustainable, and low-maintenance system. By prioritizing sheet flow, careful grading, and erosion control, the design not only mitigates runoff effectively but also enhances the overall environmental health of the area. This approach ensures that the project will provide long-term benefits in terms of community safety, environmental protection, and infrastructure resilience.

5.2 OFF-SITE CONVEYANCE

One of the most critical factors to consider for this design is the runoff effects and historic drainage patterns of the surrounding area. Currently, the majority of the surrounding area to the south of the project, flows via sheet flow to the infiltration pond. Areas that are incorporated in this flow

include the parking lot of the Navajo Nation EMS, the adjacent residential streets, the residences themselves and the surrounding undeveloped rangeland.

An important aspect of our design is to understand how the existing drainage patterns lie and how our design could impact their flow paths. Currently the EMS parking lot, residential streets and 10 of the 21 residences flow along the street curb and gutter and into the southwest corner of the pond. This location is the planned beginning-point of our new access road. In order to accommodate these flows, we had to determine the runoff quantities that will be traveling down this passage. The most-prudent and least-costly method to allow the runoff to leave the street is the implementation of a curb break and riprap. This will allow the runoff on the western portion of the road to flow out of the curb and gutter assembly and directly into the pond.

Runoff on the eastern portion of the roadway can easily leave the curb assemblies through curb breaks, however runoff on the western side cannot do so. The assembly of the western side of the road was designed to have one primary stormwater mitigation method, with two redundant methods. The primary for of runoff relief is through a double catch basin that outfalls directly into the infiltration pond. These catch basins and the associated pipe has been designed to accommodate nearly all of the runoff.

In the event this catch basin is clogged or cannot accommodate the runoff, the crown of the roadway has been carefully designed to be below the back of curb elevation. This will allow runoff to flow across the roadway and in through the curb breaks on the other side of the street. In the event this is not possible, the western side of the roadway has been designed to have a swale along the back of walk. If runoff overflows the curb, it will traverse down the swale before being discharged into a detention pond. This pond has been designed similarly to the one adjacent to the site and the outlet pipe has been designed appropriately.

5.3 FLOODPLAIN ANALYSIS

Per the FEMA FIRMette, the area where the site is located, and the adjacent vicinity are classified as “Zone D.” A “Zone D” is characterized as “Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk” (FEMA, 2022). This type of zoning is typically reserved for lands that are owned by either the US Forest Service, the Bureau of Land Management, or Tribal Nations.

However, a hydraulic modeling and mapping effort was conducted by the US Army Corps of Engineers at the nearby Kayenta community. This community is the Chapter responsible for the land under the project site. Floodplain analysis and mapping determined that there was minimal flood risk to the community. Similar soil types, proximity, and rainfall conditions could lead to the assumption that this site could also be considered to have minimal flood risk.

The Zone D classification indicates a level of uncertainty in flood risk due to the absence of detailed flood hazard analysis. This uncertainty can affect various aspects of planning, development, and insurance within the zone. Despite this, the modeling efforts by the US Army Corps of Engineers provide a valuable reference point. Their detailed analysis at Kayenta, which shares geographic and climatic similarities with our project site, suggests that the flood risk is indeed minimal.

This conclusion is further supported by the comparable soil types and hydrological conditions between Kayenta and our site. The soil composition plays a crucial role in determining the

infiltration rate and runoff potential during heavy rainfall events. The soils in this region, characterized by a mix of sand, silt, and clay, typically have good drainage properties, reducing the likelihood of significant surface water accumulation and flooding.

Additionally, the historical rainfall data for the area indicates that while the region does experience periodic heavy rains, the overall precipitation levels are relatively moderate. This consistent climatic pattern supports the assumption of a low flood risk, as there are fewer instances of extreme weather events that could overwhelm the historic drainage facilities.

6.0 DETENTION BASIN

6.1 BASIN DESCRIPTION

The basin currently presides to the southeast of the proposed project site. The perimeter of the high-water mark before overtopping is nearly 50,000 square feet, and its depth from this elevation to the lowest point is approximately 3.5 feet. A geotechnical report was conducted in June 2024 by Atek Engineering Consultants. This inspection found that the soil is comprised of inorganic silts and fine sands, which contribute to a high infiltration rate.

The report also highlighted the robustness of the basin's design, noting that the soil's composition allows for rapid absorption of water, thereby significantly reducing the risk of overflow during heavy rainfall events. This high infiltration rate ensures that the basin can handle substantial volumes of runoff efficiently, thereby protecting the surrounding infrastructure and minimizing the risk of flooding.

The Navajo County Drainage Policy states that any ponds must be sized to accommodate a 100-year, 2-hour storm event. By our calculations, it was determined that the capacity of the pond (103,885 cubic feet) is not exceeded by the 100-year, 24-hour storm. It was determined that the maximum depth of runoff in the pond is nearly 1.7-feet while the pond has a total depth of 3.0-feet.

6.2 INLET STRUCTURES

Detention basin inlets and inlet structures are a very integral part of the stormwater mitigation plan. These often take the form of pipe inlets, open gutter inlets and canal inlets. Our design has utilized both pipe inlets and open gutter inlets to convey water from the runoff surface into the pond. Along the length of the proposed access road, runoff will accumulate from the surrounding areas. Along the eastern side of the roadway, it is intended for 36-inch curb cuts to be used as spillways where the runoff will be allowed to leave the curb assembly and enter the infiltration basin. At these locations, geotextile fibers and riprap will be installed to ensure erosion is minimized.

There are three locations for this project where pipe inlets will be utilized. The first location is on the southern portion of the proposed access road, near the tie-in location. This drop inlet is responsible for conveying the runoff from one acre of the rangeland, 1.7 acres of the neighborhood, nearly all of the existing roadway (1.8 acres) and the first 120-feet of the proposed access road. Runoff traveling down the existing roadways historically sheet flows off the pavements, onto the unimproved road and into the basin. Adding a crown and pavement to this

area, prevents the runoff from crossing the road. To remedy this, a double-drop inlet will be implemented on the western side of the road with a pipe extending under the roadway and into the infiltration basin. The pipe will outfall into the southwest corner of the basin, similar to the historic drainage pattern. It is proposed that this pipe be 18-inch PVC.

The second pipe inlet is on the northern portion of the proposed roadway, near where the proposed driveway for our site begins. This culvert pipe is responsible for conveying water from the site's drainage swale, under and across the roadway as well as accepting approximately 7.2 acres of rangeland runoff. The pipe outfalls into the northwestern corner of the infiltration basin. The proposed culvert is a 24-inch PVC pipe.

The third culvert is located centrally along the road, south of the project site, and near an existing driveway. This culvert is the outfall of a pond and drainage swale that collect runoff that would historically flow over the location of the proposed access road. The culvert pipe is designed to be 18-inch PVC. The hydraulic information on the three pipe inlets during a 100-year, 24-hour storm is displayed in Table 5.

Table 5: "Pipe Inlet Flows"

<i>Value</i>	<i>Southern Inlet</i>	<i>Central Culvert</i>	<i>Northern Culvert</i>
<i>Pipe Size (in)</i>	18	18	24
<i>Pipe Sloped (%)</i>	1.7	0.5	0.5
<i>Peak Flow (100yr, 24hr // cfs)</i>	14.9	15.5	19.2
<i>Design Flow (cfs)</i>	18.0	10.0	22.2
<i>Velocity (ft/s)</i>	8.4	8.8	6.5

It is important to note that the Central Culvert is surcharged as its peak flow is above its design flow. However, the detention pond sized for this location has sufficient capacity to detain the runoff without overtopping. It is expected that this pond will drain sufficiently in a 100-year storm event.

7.0 SUMMARY AND CONCLUSIONS

7.1 SUMMARY AND CODE ADHERENCE

Using the parameters laid out by the Navajo County Drainage Policy, the site has been meticulously designed to manage not only its own flow but also any off-site flows that may enter the area. This careful planning ensures that the infrastructure can handle water from multiple sources without causing adverse effects.

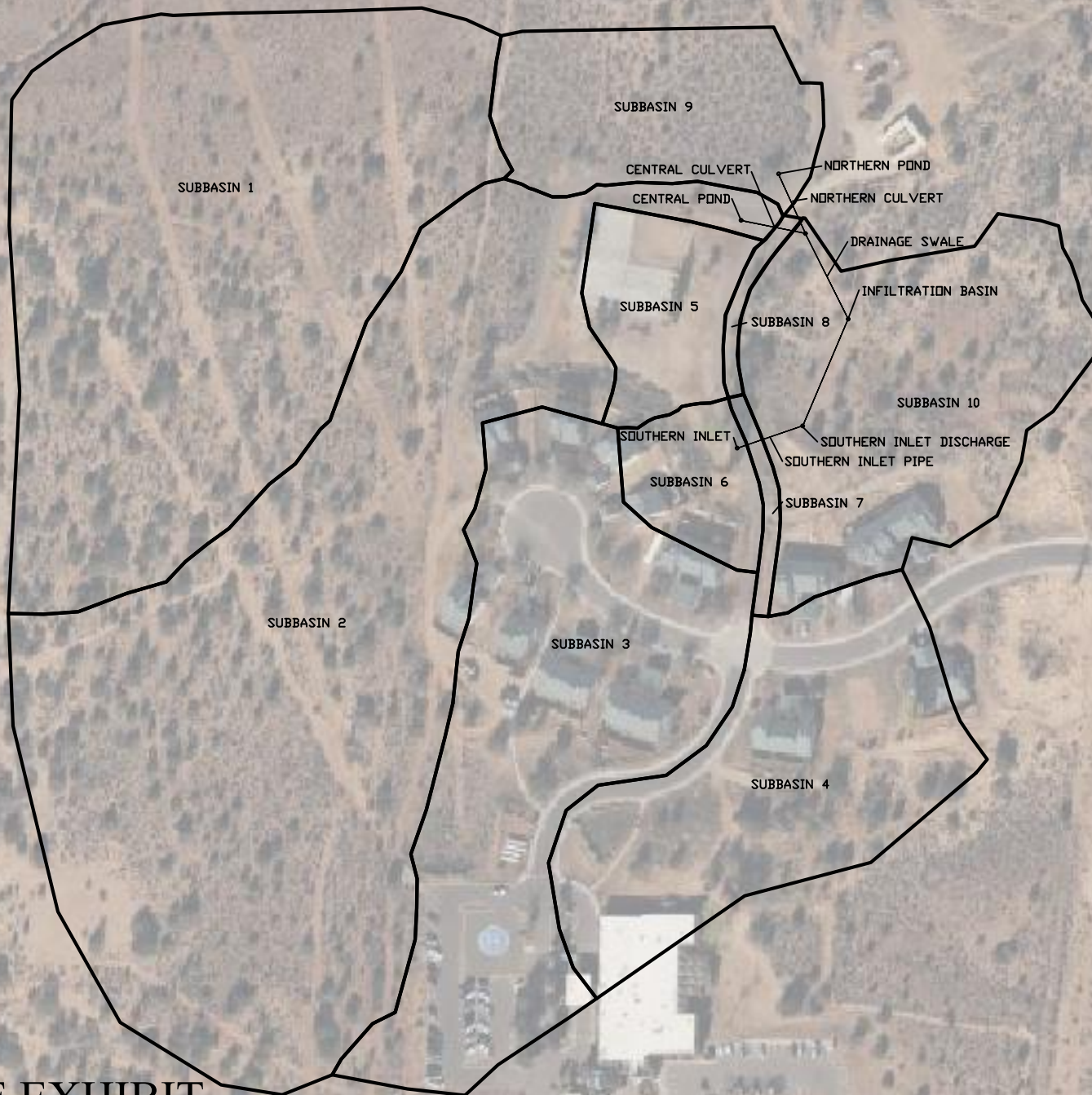
To further ensure the effectiveness of the drainage design, an in-depth analysis was conducted on the nearby infiltration basin. This basin is a crucial component as it is intended to accommodate the increased runoff produced by the site. The comprehensive analysis included evaluating the capacity and performance of the basin under various conditions.

Through this detailed analysis, it was determined that the nearby infiltration basin has sufficient capacity to manage the runoff generated by the site. The study confirmed that the basin can efficiently handle the expected water volume without reaching its limit. Moreover, the evaluation also focused on the inlets leading into the basin and their associated detention ponds. It was verified that these inlets and detention ponds do not overtop or overflow even during a 100-year 24-hour storm event, which is a significant test of their capacity and resilience.

The successful assessment and verification of the drainage and infiltration systems highlight the robustness of the site's design. By adhering to the Navajo County Drainage Policy and conducting thorough analyses, the site is well-prepared to manage water flow and runoff, ensuring stability and sustainability in various weather conditions.

APPENDIX 1: EXHIBITS





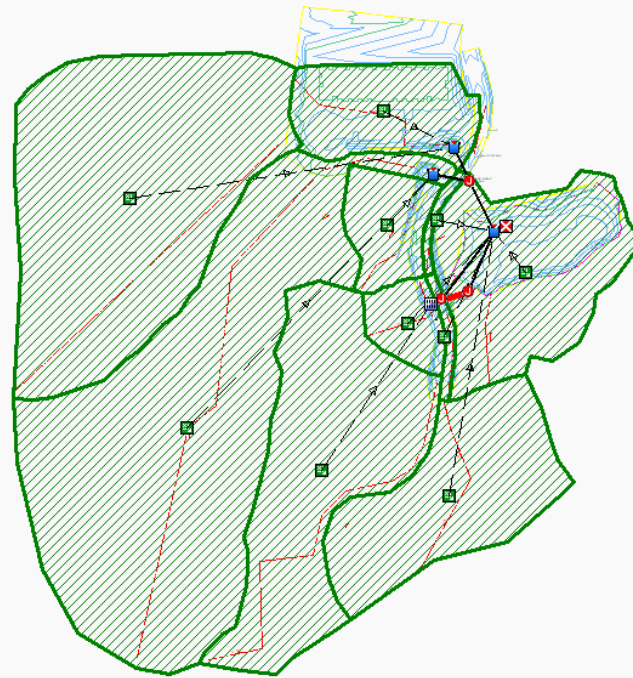
DRAINAGE EXHIBIT

DRAWN BY: DRB
APPROVED BY: SRC
DATE: 28 JUN 2024

N.T.S.

APPENDIX 2: HYDROLOGIC MODEL OUTPUTS





Project Description

File Name ihouse SSA model.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method Rational
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Hydrodynamic
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods YES

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 6:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:05:00 days hh:mm:ss
Routing Time Step 5 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	10
Nodes.....	8
<i>Junctions</i>	3
<i>Outfalls</i>	1
<i>Flow Diversions</i>	0
<i>Inlets</i>	1
<i>Storage Nodes</i>	3
Links.....	8
<i>Channels</i>	3
<i>Pipes</i>	5
<i>Pumps</i>	0
<i>Orifices</i>	0
<i>Weirs</i>	0
<i>Outlets</i>	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period 2 year(s)

Subbasin Summary

SN	Subbasin ID	Area	Weighted Runoff Coefficient	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	Subbasin_1	7.20	0.4000	0.32	0.13	0.91	4.12	0 00:13:15
2	Subbasin_10	3.23	0.9000	0.27	0.25	0.79	4.76	0 00:10:00
3	Subbasin_2	9.38	0.4100	0.34	0.14	1.29	5.17	0 00:14:58
4	Subbasin_3	4.53	0.7300	0.29	0.21	0.97	5.12	0 00:11:16
5	Subbasin_4	3.08	0.6200	0.27	0.17	0.52	3.13	0 00:10:00
6	Subbasin_5	0.93	0.5800	0.28	0.16	0.15	0.88	0 00:10:13
7	Subbasin_6	0.61	0.4000	0.27	0.11	0.07	0.40	0 00:10:00
8	Subbasin_7	0.13	0.9500	0.27	0.26	0.03	0.20	0 00:10:00
9	Subbasin_8	0.11	0.9500	0.27	0.26	0.03	0.17	0 00:10:00
10	Subbasin_9	1.70	0.9500	0.29	0.28	0.47	2.48	0 00:11:30

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	
1	3-Jun	Junction	6339.00	6342.00	0.00	6342.00	0.00	0.00	6339.00	0.00
2	SOUTHERN_INLET_FES	Junction	6339.00	6342.00	0.00	6342.00	0.00	5.05	6342.65	0.00
3	SWALE_CONVERGE	Junction	6338.29	6342.29	0.00	4.00	0.00	9.99	6339.21	0.00
4	Out-04	Outfall	6339.00					0.00	6339.00	
5	CENTRAL_CULVERT	Storage Node	6338.50	6342.50	0.00		0.00	5.79	6339.79	
6	INFIL_POND	Storage Node	6336.00	6339.10	0.00		0.00	21.67	6336.05	
7	NORTH_CULVERT	Storage Node	6337.20	6341.20	0.00		0.00	6.36	6339.46	

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow, Design Flow Ratio
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)	
1	CENTRAL_CULVERT	Pipe	CENTRAL_CULVERT	SWALE_CONVERGE	74.00	6337.57	6337.17	0.5400	18.000	0.0100	4.75	7.27	0.65
2	FAKE_PIPE	Pipe	SOUTHERN_INLET_FES	INFIL_POND	5.00	6342.50	6337.00	110.0000	10.000	0.0050	5.07	59.75	0.08
3	Link-08	Pipe	3-Jun	INFIL_POND	15.00	6345.00	6336.00	60.0000	40.000	0.0010	0.00	8895.17	0.00
4	NORTHERN_CULVERT	Pipe	NORTH_CULVERT	SWALE_CONVERGE	72.00	6336.78	6336.37	0.5700	24.000	0.0100	5.65	36.19	0.16
5	SOUTHERN_PIPE	Pipe	SOUTHERN_INLET	SOUTHERN_INLET_FES	103.00	6340.80	6339.00	1.7500	18.000	0.0100	5.05	18.05	0.28
6	BYPASS	Channel	SOUTHERN_INLET	3-Jun	5.00	6345.00	6345.00	0.0000	6.000	0.0140	0.00	9.15	0.00
7	Link-07	Channel	INFIL_POND	Out-04	5.00	6339.10	6339.00	2.0000	12.000	0.0320	0.00	648.11	0.00
8	SWALE	Channel	SWALE_CONVERGE	INFIL_POND	129.00	6338.39	6337.65	0.5700	36.000	0.0320	9.98	195.20	0.05

Inlet Summary

SN	Element	Inlet	Manufacturer	Inlet	Number of	Catchbasin	Max (Rim)	Initial	Ponded	Peak	Peak Flow	Peak Flow	Inlet	Allowable
	ID	Manufacturer	Part	Location	Inlets	Invert	Elevation	Water	Area	Flow	Intercepted	Bypassing	Efficiency	Spread
			Number			Elevation		Elevation			by	Inlet	during Peak	
						(ft)	(ft)	(ft)	(ft²)	(cfs)	(cfs)	(cfs)	(%)	(ft)
1	SOUTHERN_INLET	FHWA HEC-22 GENERIC	N/A	On Sag	1	6340.80	6345.80	0.00	10.00	5.12	N/A	N/A	N/A	7.00

Subbasin Hydrology

Subbasin : Subbasin_1

Input Data

Area (ac) 7.2
Weighted Runoff Coefficient 0.4

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	7.2	A	0.4
Composite Area & Weighted Runoff Coeff.	7.2		0.4

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$

Where :

- Tc = Time of Concentration (hr)
- n = Manning's roughness
- Lf = Flow Length (ft)
- P = 2 yr, 24 hr Rainfall (inches)
- Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

- V = 16.1345 * (Sf^0.5) (unpaved surface)
- V = 20.3282 * (Sf^0.5) (paved surface)
- V = 15.0 * (Sf^0.5) (grassed waterway surface)
- V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
- V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
- V = 7.0 * (Sf^0.5) (short grass pasture surface)
- V = 5.0 * (Sf^0.5) (woodland surface)
- V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
- Tc = (Lf / V) / (3600 sec/hr)

Where:

- Tc = Time of Concentration (hr)
- Lf = Flow Length (ft)
- V = Velocity (ft/sec)
- Sf = Slope (ft/ft)

	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	4.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.17	0	0
Computed Flow Time (min) :	9.9	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	696	0	0
Slope (%) :	4.6	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.46	0	0
Computed Flow Time (min) :	3.35	0	0
Total TOC (min)	13.25		

Subbasin Runoff Results

Total Rainfall (in)	0.32
Total Runoff (in)	0.13
Peak Runoff (cfs)	4.12
Rainfall Intensity	1.431
Weighted Runoff Coefficient	0.4
Time of Concentration (days hh:mm:ss)	0 00:13:15

Subbasin : Subbasin_1

Runoff Hydrograph



Subbasin : Subbasin_10

Input Data

Area (ac) 3.23
Weighted Runoff Coefficient 0.9

Runoff Coefficient

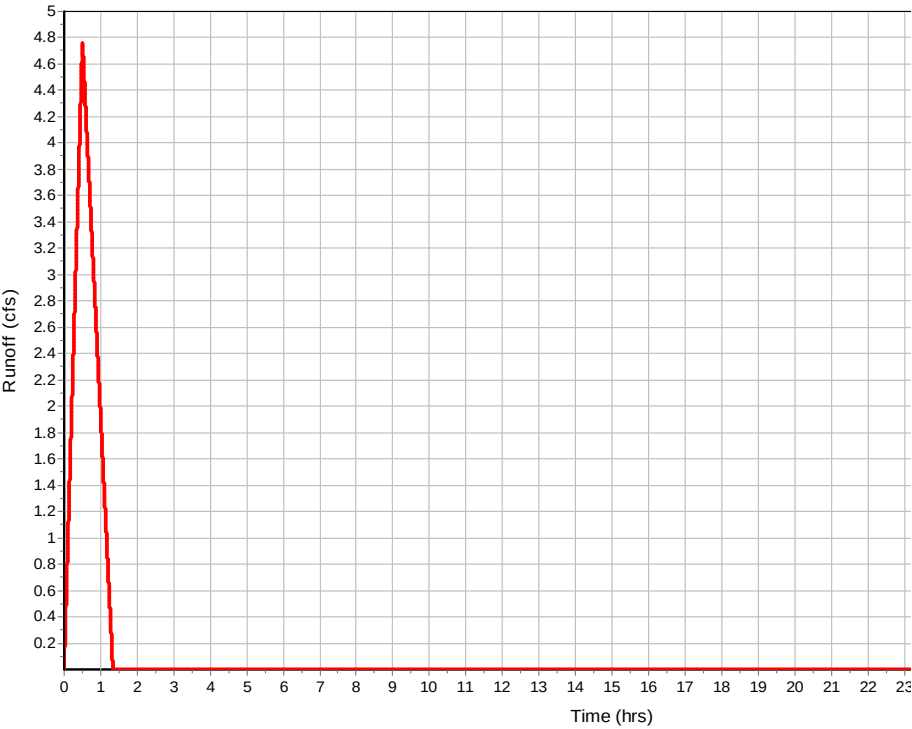
Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	3.23	A	0.9
Composite Area & Weighted Runoff Coeff.	3.23		0.9

Time of Concentration

Subbasin Runoff Results

Total Rainfall (in) 0.27
Total Runoff (in) 0.25
Peak Runoff (cfs) 4.76
Rainfall Intensity 1.638
Weighted Runoff Coefficient 0.9
Time of Concentration (days hh:mm:ss) 0 00:00:00

Runoff Hydrograph



Subbasin : Subbasin_2

Input Data

Area (ac)	9.38
Weighted Runoff Coefficient	0.41

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.16	A	0.7
-	9.22	A	0.4
Composite Area & Weighted Runoff Coeff.	9.38		0.41

Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.21	0	0
Computed Flow Time (min) :	8.1	0	0
Shallow Concentrated Flow Computations			
Flow Length (ft) :	1278	0	0
Slope (%) :	3.7	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.1	0	0
Computed Flow Time (min) :	6.87	0	0
Total TOC (min)	14.97		

Subbasin Runoff Results

Total Rainfall (in)	0.34
Total Runoff (in)	0.14
Peak Runoff (cfs)	5.17
Rainfall Intensity	1.343
Weighted Runoff Coefficient	0.41
Time of Concentration (days hh:mm:ss)	0 00:14:58

Runoff Hydrograph



Subbasin : Subbasin_3

Input Data

Area (ac)	4.53
Weighted Runoff Coefficient	0.73

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	1.74	A	0.7
-	1	A	0.4
-	1.79	A	0.95
Composite Area & Weighted Runoff Coeff.	4.53		0.73

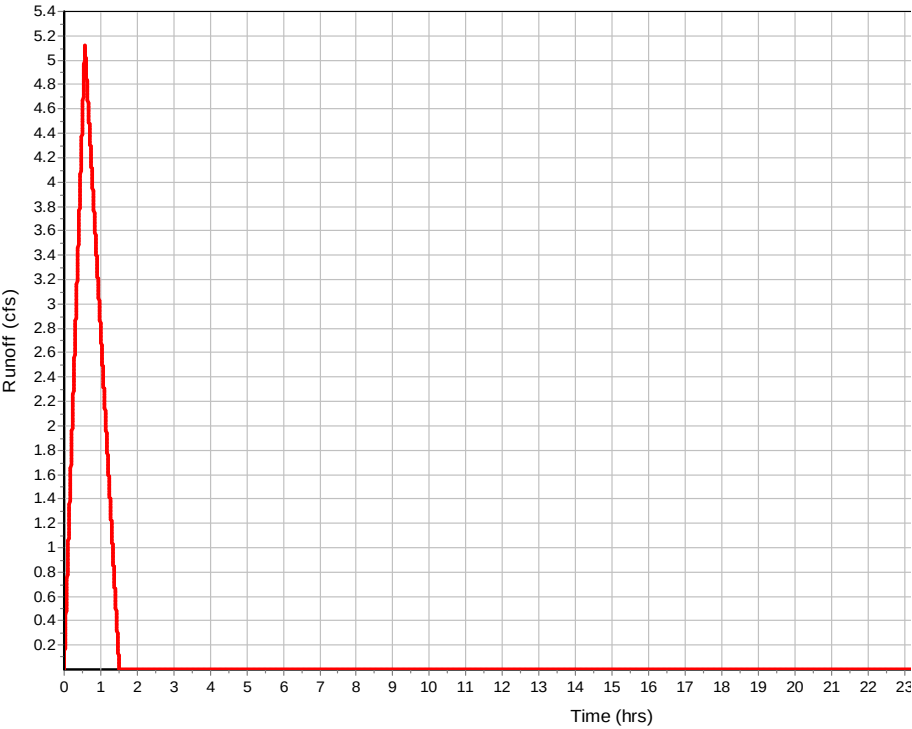
Time of Concentration

	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	115	0	0
Slope (%) :	10.8	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.24	0	0
Computed Flow Time (min) :	7.87	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	820	0	0
Slope (%) :	3.9	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	4.01	0	0
Computed Flow Time (min) :	3.41	0	0
Total TOC (min)	11.28		

Subbasin Runoff Results

Total Rainfall (in)	0.29
Total Runoff (in)	0.21
Peak Runoff (cfs)	5.12
Rainfall Intensity	1.549
Weighted Runoff Coefficient	0.73
Time of Concentration (days hh:mm:ss)	0 00:11:17

Runoff Hydrograph



Subbasin : Subbasin_4

Input Data

Area (ac) 3.08
Weighted Runoff Coefficient 0.62

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.62	A	0.7
-	1.55	A	0.4
-	0.91	A	0.95
Composite Area & Weighted Runoff Coeff.	3.08		0.62

Time of Concentration

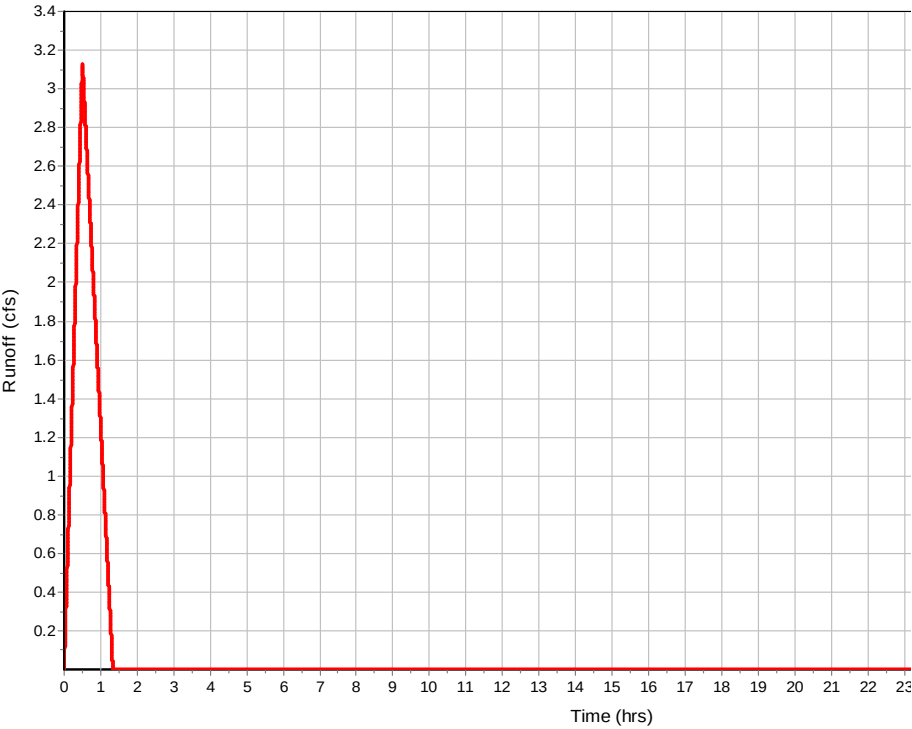
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.21	0	0
Computed Flow Time (min) :	8.1	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	103	125	56
Slope (%) :	7.6	3.7	1.8
Surface Type :	Bare & untilled	Unpaved	Paved
Velocity (ft/sec) :	2.76	3.1	2.73
Computed Flow Time (min) :	0.62	0.67	0.34
Total TOC (min)	9.74		

Subbasin Runoff Results

Total Rainfall (in) 0.27
Total Runoff (in) 0.17
Peak Runoff (cfs) 3.13
Rainfall Intensity 1.638
Weighted Runoff Coefficient 0.62
Time of Concentration (days hh:mm:ss) 0 00:09:44

Subbasin : Subbasin_4

Runoff Hydrograph



Subbasin : Subbasin_5

Input Data

Area (ac)	0.93
Weighted Runoff Coefficient	0.58

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.31	A	0.95
-	0.62	A	0.4
Composite Area & Weighted Runoff Coeff.	0.93		0.58

Time of Concentration

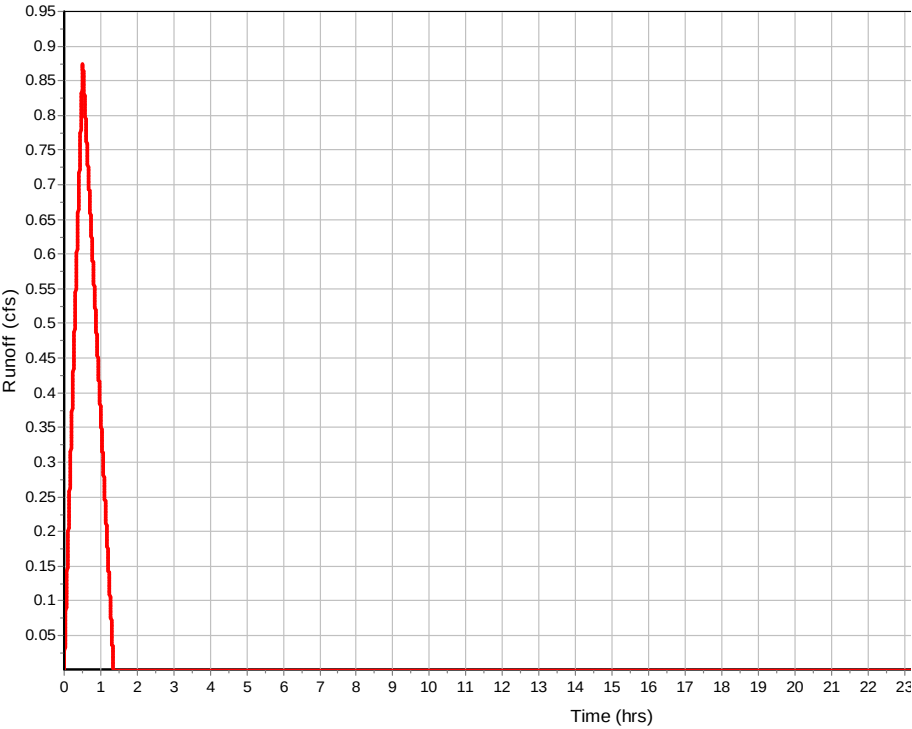
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	5.2	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.18	0	0
Computed Flow Time (min) :	9.43	0	0
Shallow Concentrated Flow Computations			
Flow Length (ft) :	174	0	0
Slope (%) :	5.2	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.68	0	0
Computed Flow Time (min) :	0.79	0	0
Total TOC (min)	10.22		

Subbasin Runoff Results

Total Rainfall (in)	0.28
Total Runoff (in)	0.16
Peak Runoff (cfs)	0.88
Rainfall Intensity	1.622
Weighted Runoff Coefficient	0.58
Time of Concentration (days hh:mm:ss)	0 00:10:13

Subbasin : Subbasin_5

Runoff Hydrograph



Subbasin : Subbasin_6

Input Data

Area (ac) 0.61
Weighted Runoff Coefficient 0.4

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.61	A	0.4
Composite Area & Weighted Runoff Coeff.	0.61		0.4

Time of Concentration

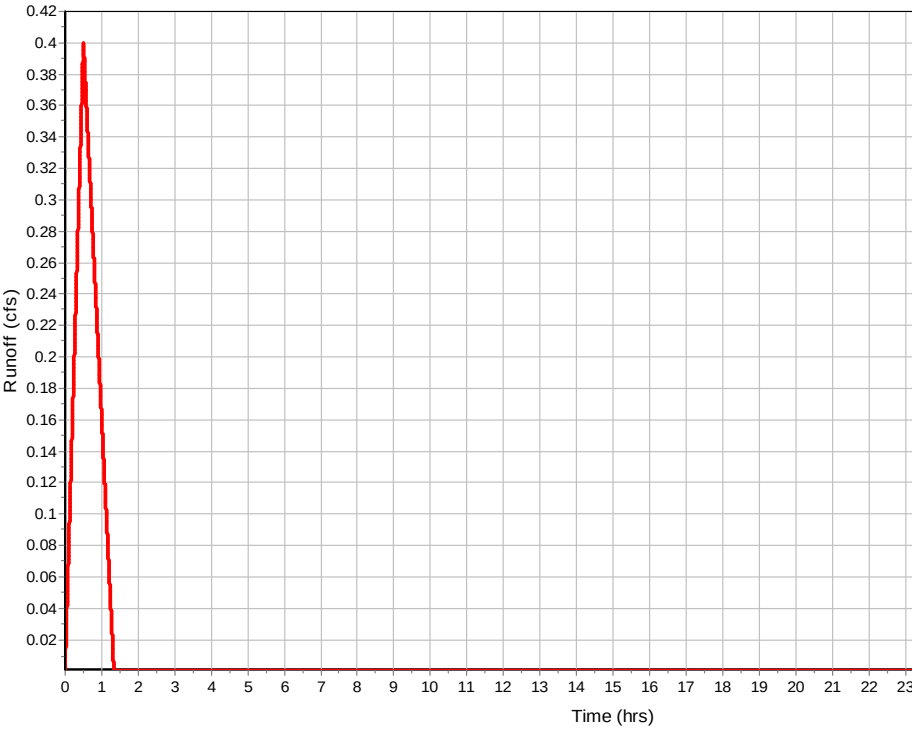
Sheet Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	0.13	0	0
	Flow Length (ft) :	100	0
	Slope (%) :	7.4	0
	2 yr, 24 hr Rainfall (in) :	1.28	0
	Velocity (ft/sec) :	0.2	0
	Computed Flow Time (min) :	8.19	0
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	131	0	0
	Flow Length (ft) :	100	0
	Slope (%) :	7.4	0
	Surface Type :	Paved	Unpaved
	Velocity (ft/sec) :	5.53	0
	Computed Flow Time (min) :	0.39	0
Total TOC (min)8.58			

Subbasin Runoff Results

Total Rainfall (in) 0.27
Total Runoff (in) 0.11
Peak Runoff (cfs) 0.4
Rainfall Intensity 1.638
Weighted Runoff Coefficient 0.4
Time of Concentration (days hh:mm:ss) 0 00:08:35

Subbasin : Subbasin_6

Runoff Hydrograph



Subbasin : Subbasin_7

Input Data

Area (ac) 0.13
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.13	A	0.95
Composite Area & Weighted Runoff Coeff.	0.13		0.95

Time of Concentration

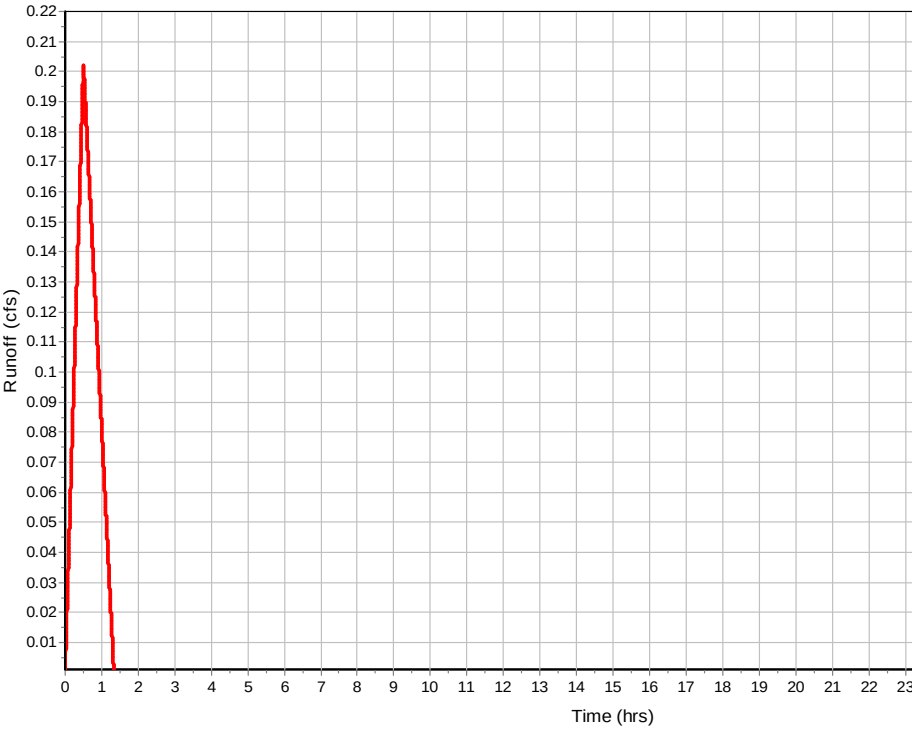
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
Flow Length (ft) :	264	0	0
Slope (%) :	2	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	2.87	0	0
Computed Flow Time (min) :	1.53	0	0
Total TOC (min)	1.53		

Subbasin Runoff Results

Total Rainfall (in) 0.27
Total Runoff (in) 0.26
Peak Runoff (cfs) 0.2
Rainfall Intensity 1.638
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:01:32

Subbasin : Subbasin_7

Runoff Hydrograph



Subbasin : Subbasin_8

Input Data

Area (ac) 0.11
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.11	A	0.95
Composite Area & Weighted Runoff Coeff.	0.11		0.95

Time of Concentration

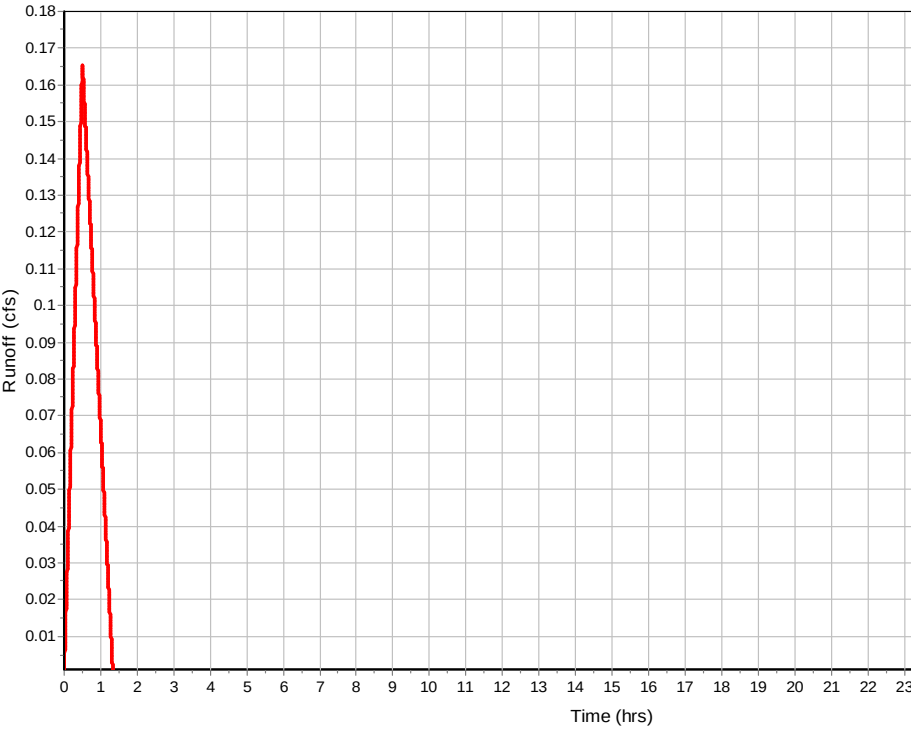
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.68	0	0
Computed Flow Time (min) :	2.46	0	0
Total TOC (min)2.46			

Subbasin Runoff Results

Total Rainfall (in) 0.27
Total Runoff (in) 0.26
Peak Runoff (cfs) 0.17
Rainfall Intensity 1.638
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:02:28

Subbasin : Subbasin_8

Runoff Hydrograph



Subbasin : Subbasin_9

Input Data

Area (ac) 1.7
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	1.7	A	0.95
Composite Area & Weighted Runoff Coeff.	1.7		0.95

Time of Concentration

	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	80	0	0
Slope (%) :	3	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	9.83	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	300	44	0
Slope (%) :	3	3	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	3.52	2.79	0
Computed Flow Time (min) :	1.42	0.26	0
Total TOC (min)	11.51		

Subbasin Runoff Results

Total Rainfall (in) 0.29
Total Runoff (in) 0.28
Peak Runoff (cfs) 2.48
Rainfall Intensity 1.534
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:11:31

Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Mini C
1	3-Jun	6339.00	6342.00	3.00	0.00	-6339.00	6342.00	0.00	0.00	
2	SOUTHERN_INLET_FES	6339.00	6342.00	3.00	0.00	-6339.00	6342.00	0.00	0.00	
3	SWALE_CONVERGE	6338.29	6342.29	4.00	0.00	-6338.29	4.00	-6338.29	0.00	1

Junction Results

SN	Element ID	Peak Inflow	Peak Lateral Inflow	Max HGL Elevation Attained	Max HGL Depth Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time Max Occurred
		(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)
1	3-Jun	0.00	0.00	6339.00	0.00	0.00	9.33	6339.00	0.00	0 00
2	SOUTHERN_INLET_FES	5.05	0.00	6342.65	3.65	0.00	0.69	6342.47	3.47	0 00
3	SWALE_CONVERGE	9.99	0.00	6339.21	0.92	0.00	3.08	6338.33	0.04	0 00

Channel Input

SN	Element ID	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Drop	Average Slope	Shape	Height	Width	Manning's Roughness	Entrance Loss
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(ft)	(ft)		
1	BYPASS	5.00	6345.00	4.20	6345.00	6.00	0.00	0.0000	Rectangular	0.500	20.000	0.0140	0.000
2	Link-07	5.00	6339.10	3.10	6339.00	0.00	0.10	2.0000	Rectangular	1.000	100.000	0.0320	0.000
3	SWALE	129.00	6338.39	0.10	6337.65	1.65	0.74	0.5700	Trapezoidal	3.000	22.000	0.0320	0.500

Channel Results

SN	Element	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)	
1	BYPASS	0.00	0 00:00	9.15	0.00	0.00		0.00	0.00	0.00	
2	Link-07	0.00	0 00:00	648.11	0.00	0.00		0.00	0.00	0.00	
3	SWALE	9.98	0 00:44	195.20	0.05	2.53	0.85	0.66	0.22	0.00	

Pipe Input

SN	Element ID	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Drop	Average Slope	Pipe Shape	Pipe Diameter or Height	Pipe Width
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(in)	(in)
1	CENTRAL_CULVERT	74.00	6337.57	-0.93	6337.17	-1.12	0.40	0.5400	CIRCULAR	18.000	18.000
2	FAKE_PIPE	5.00	6342.50	3.50	6337.00	1.00	5.50	110.0000	CIRCULAR	9.960	9.960
3	Link-08	15.00	6345.00	6.00	6336.00	0.00	9.00	60.0000	CIRCULAR	39.960	39.960
4	NORTHERN_CULVERT	72.00	6336.78	-0.42	6336.37	-1.92	0.41	0.5700	CIRCULAR	24.000	24.000
5	SOUTHERN_PIPE	103.00	6340.80	0.00	6339.00	0.00	1.80	1.7500	CIRCULAR	18.000	18.000

No. of
Barrels

	1
	1
	1
	1
	1

Pipe Results

SN Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Surcharge
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		
1 CENTRAL_CULVERT	4.75	0 00:46	7.27	0.65	3.76	0.33	1.10	0.73	
2 FAKE_PIPE	5.07	0 00:35	59.75	0.08	50.00	0.00	0.16	0.19	
3 Link-08	0.00	0 00:00	8895.17	0.00	0.00		0.03	0.01	
4 NORTHERN_CULVERT	5.65	0 00:40	36.19	0.16	2.31	0.52	1.46	0.73	
5 SOUTHERN_PIPE	5.05	0 00:35	18.05	0.28	5.77	0.30	1.50	1.00	17

Inlet Input

SN Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Inlet Depth (ft)	Init Wat Elevati (
1 SOUTHERN_INLET	FHWA HEC-22 GENERIC	N/A	On Sag	1	6340.80	6345.80	5.00	0.0

Roadway & Gutter Input

SN	Element	Roadway Longitudinal Slope (ft/ft)	Roadway Cross Slope (ft/ft)	Roadway Manning's Roughness	Gutter Cross Slope (ft/ft)	Gutter Width (ft)	Gutter Depression (in)	Allowable Spread (ft)
1	SOUTHERN_INLET	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00

Inlet Results

SN	Element ID	Peak Flow	Peak Lateral Inflow	Peak Flow Intercepted	Peak Flow Bypassing Inlet	Inlet Efficiency during Peak Flow	Max Gutter Spread during Peak Flow	Max Gutter Water Elev. during Peak Flow	Max Gutter Water Depth during Peak Flow	Time to Max Depth Occurrence
		(cfs)	(cfs)	(cfs)	(cfs)	(%)	(ft)	(ft)	(ft)	(days hh:mm)
1	SOUTHERN_INLET	5.12	5.12	N/A	N/A	N/A	14.28	6346.19	0.39	0 0

Storage Nodes

Storage Node : CENTRAL_CULVERT

Input Data

Invert Elevation (ft)	6338.50
Max (Rim) Elevation (ft)	6342.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6338.50
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

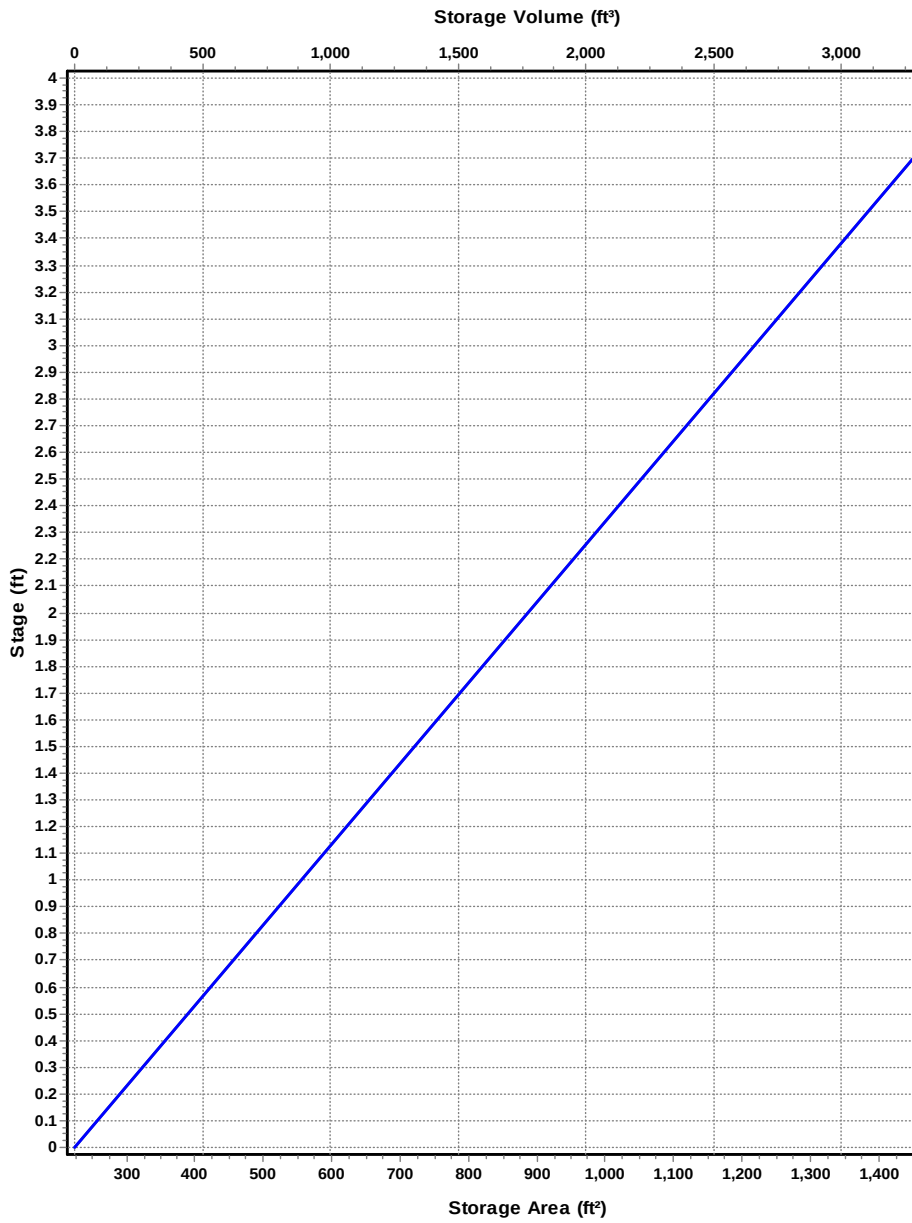
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : CENTRAL CULVERT

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	224	0
4	1550	3548

Storage Area Volume Curves



Storage Node : CENTRAL_CULVERT (continued)

Output Summary Results

Peak Inflow (cfs)	5.79
Peak Lateral Inflow (cfs)	5.79
Peak Outflow (cfs)	4.75
Peak Exfiltration Flow Rate (cfm)	55.27
Max HGL Elevation Attained (ft)	6339.79
Max HGL Depth Attained (ft)	1.29
Average HGL Elevation Attained (ft)	6338.55
Average HGL Depth Attained (ft)	0.05
Time of Max HGL Occurrence (days hh:mm)	0 00:46
Total Exfiltration Volume (1000-ft³)	4.728
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : INFIL_POND

Input Data

Invert Elevation (ft)	6336.00
Max (Rim) Elevation (ft)	6339.10
Max (Rim) Offset (ft)	3.10
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6336.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

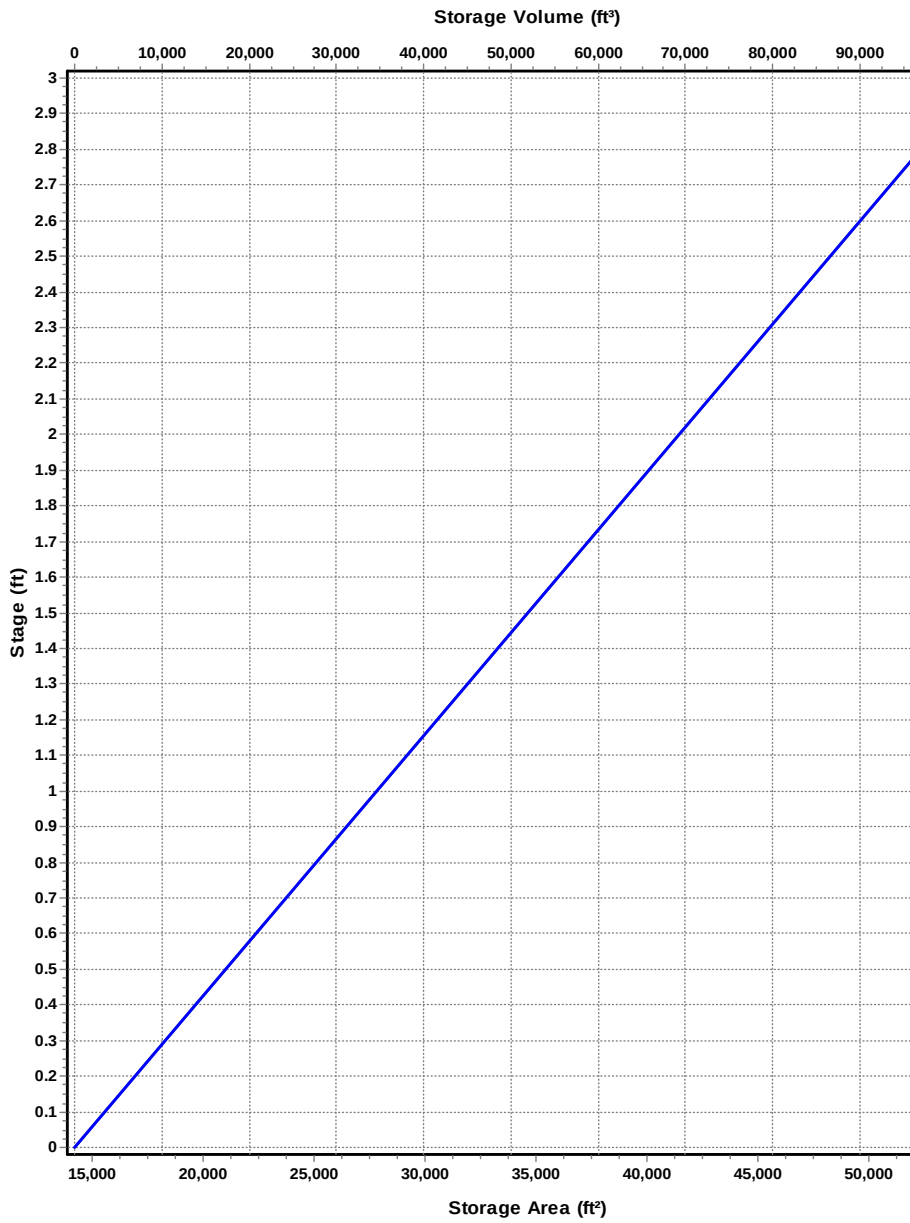
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : INFILTRATION POND

Stage	Storage Area	Storage Volume
(ft)	(ft²)	(ft³)
0	14221	0
3	55036	103885.5

Storage Area Volume Curves



Storage Node : INFIL_POND (continued)

Output Summary Results

Peak Inflow (cfs)	21.67
Peak Lateral Inflow (cfs)	8.65
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	1242.36
Max HGL Elevation Attained (ft)	6336.05
Max HGL Depth Attained (ft)	0.05
Average HGL Elevation Attained (ft)	6336
Average HGL Depth Attained (ft)	0
Time of Max HGL Occurrence (days hh:mm)	0 00:43
Total Exfiltration Volume (1000-ft³)	63.427
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : NORTH_CULVERT

Input Data

Invert Elevation (ft)	6337.20
Max (Rim) Elevation (ft)	6341.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6337.20
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

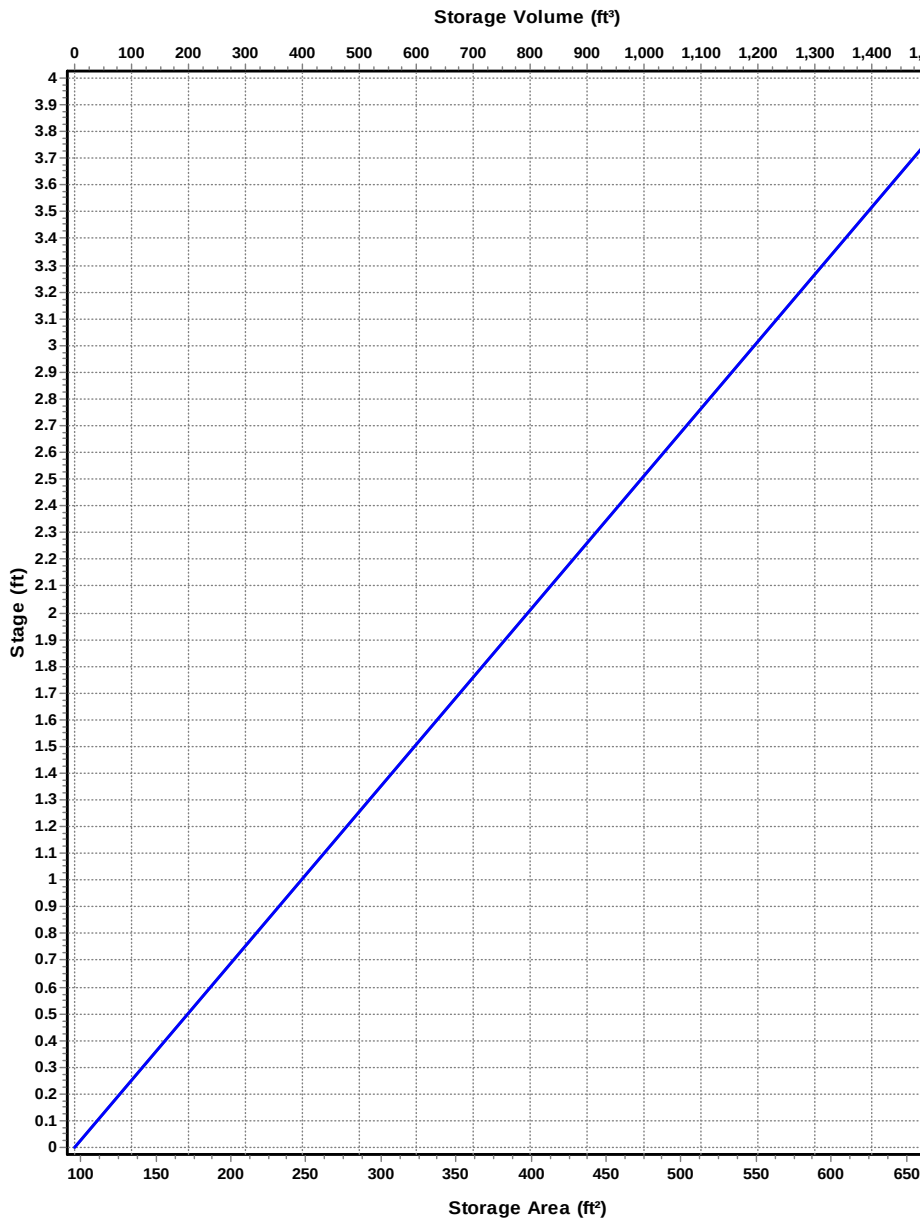
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : NORTHERN CULVERT

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	96	0
4	700	1592

Storage Area Volume Curves



Storage Node : NORTH_CULVERT (continued)

Output Summary Results

Peak Inflow (cfs)	6.36
Peak Lateral Inflow (cfs)	6.36
Peak Outflow (cfs)	5.65
Peak Exfiltration Flow Rate (cfm)	38.66
Max HGL Elevation Attained (ft)	6339.46
Max HGL Depth Attained (ft)	2.26
Average HGL Elevation Attained (ft)	6337.33
Average HGL Depth Attained (ft)	0.13
Time of Max HGL Occurrence (days hh:mm)	0 00:40
Total Exfiltration Volume (1000-ft³)	4.41
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ihouse SSA model.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method Rational
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Hydrodynamic
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods YES

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 6:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:05:00 days hh:mm:ss
Routing Time Step 5 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	10
Nodes.....	8
<i>Junctions</i>	3
<i>Outfalls</i>	1
<i>Flow Diversions</i>	0
<i>Inlets</i>	1
<i>Storage Nodes</i>	3
Links.....	8
<i>Channels</i>	3
<i>Pipes</i>	5
<i>Pumps</i>	0
<i>Orifices</i>	0
<i>Weirs</i>	0
<i>Outlets</i>	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period 10 year(s)

Subbasin Summary

SN	Subbasin ID	Area	Weighted Runoff Coefficient	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	Subbasin_1	7.20	0.4000	0.54	0.22	1.56	7.02	0 00:13:15
2	Subbasin_10	3.23	0.9000	0.47	0.42	1.35	8.10	0 00:10:00
3	Subbasin_2	9.38	0.4100	0.57	0.23	2.19	8.79	0 00:14:58
4	Subbasin_3	4.53	0.7300	0.50	0.36	1.65	8.72	0 00:11:16
5	Subbasin_4	3.08	0.6200	0.47	0.29	0.89	5.32	0 00:10:00
6	Subbasin_5	0.93	0.5800	0.47	0.27	0.25	1.49	0 00:10:13
7	Subbasin_6	0.61	0.4000	0.47	0.19	0.11	0.68	0 00:10:00
8	Subbasin_7	0.13	0.9500	0.47	0.44	0.06	0.34	0 00:10:00
9	Subbasin_8	0.11	0.9500	0.47	0.44	0.05	0.28	0 00:10:00
10	Subbasin_9	1.70	0.9500	0.50	0.48	0.81	4.22	0 00:11:30

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)
1	3-Jun	Junction	6339.00	6342.00	0.00	6342.00	0.00	0.00	6339.00	0.00
2	SOUTHERN_INLET_FES	Junction	6339.00	6342.00	0.00	6342.00	0.00	8.49	6342.68	0.00
3	SWALE_CONVERGE	Junction	6338.29	6342.29	0.00	4.00	0.00	17.74	6339.46	0.00
4	Out-04	Outfall	6339.00					0.00	6339.00	
5	CENTRAL_CULVERT	Storage Node	6338.50	6342.50	0.00		0.00	9.86	6340.33	
6	INFIL_POND	Storage Node	6336.00	6339.10	0.00		0.00	37.65	6336.64	
7	NORTH_CULVERT	Storage Node	6337.20	6341.20	0.00		0.00	10.83	6339.98	

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow Design Flow Ratio
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)	
1	CENTRAL_CULVERT	Pipe	CENTRAL_CULVERT	SWALE_CONVERGE	74.00	6337.57	6337.17	0.5400	18.000	0.0100	8.47	7.27	1.1
2	FAKE_PIPE	Pipe	SOUTHERN_INLET_FES	INFIL_POND	5.00	6342.50	6337.00	110.0000	10.000	0.0050	8.51	59.75	0.1
3	Link-08	Pipe	3-Jun	INFIL_POND	15.00	6345.00	6336.00	60.0000	40.000	0.0010	0.00	8895.17	0.0
4	NORTHERN_CULVERT	Pipe	NORTH_CULVERT	SWALE_CONVERGE	72.00	6336.78	6336.37	0.5700	24.000	0.0100	9.98	36.19	0.2
5	SOUTHERN_PIPE	Pipe	SOUTHERN_INLET	SOUTHERN_INLET_FES	103.00	6340.80	6339.00	1.7500	18.000	0.0100	8.49	18.05	0.4
6	BYPASS	Channel	SOUTHERN_INLET	3-Jun	5.00	6345.00	6345.00	0.0000	6.000	0.0140	0.00	9.15	0.0
7	Link-07	Channel	INFIL_POND	Out-04	5.00	6339.10	6339.00	2.0000	12.000	0.0320	0.00	648.11	0.0
8	SWALE	Channel	SWALE_CONVERGE	INFIL_POND	129.00	6338.39	6337.65	0.5700	36.000	0.0320	17.74	195.20	0.0

Inlet Summary

SN	Element	Inlet	Manufacturer	Inlet	Number of	Catchbasin	Max (Rim)	Initial	Ponded	Peak	Peak Flow	Peak Flow	Inlet	Allowable
ID		Manufacturer	Part	Location	Inlets	Invert	Elevation	Water	Area	Flow	Intercepted	Bypassing	Efficiency	Spread
			Number			Elevation		Elevation			by	Inlet	during Peak	
						(ft)	(ft)	(ft)	(ft²)	(cfs)	(cfs)	(cfs)	(%)	(ft)
1	SOUTHERN_INLET	FHWA HEC-22 GENERIC	N/A	On Sag	1	6340.80	6345.80	0.00	10.00	8.72	N/A	N/A	N/A	7.00

Subbasin Hydrology

Subbasin : Subbasin_1

Input Data

Area (ac) 7.2
Weighted Runoff Coefficient 0.4

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	7.2	A	0.4
Composite Area & Weighted Runoff Coeff.	7.2		0.4

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$

Where :

- Tc = Time of Concentration (hr)
- n = Manning's roughness
- Lf = Flow Length (ft)
- P = 2 yr, 24 hr Rainfall (inches)
- Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

- V = 16.1345 * (Sf^0.5) (unpaved surface)
- V = 20.3282 * (Sf^0.5) (paved surface)
- V = 15.0 * (Sf^0.5) (grassed waterway surface)
- V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
- V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
- V = 7.0 * (Sf^0.5) (short grass pasture surface)
- V = 5.0 * (Sf^0.5) (woodland surface)
- V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
- Tc = (Lf / V) / (3600 sec/hr)

Where:

- Tc = Time of Concentration (hr)
- Lf = Flow Length (ft)
- V = Velocity (ft/sec)
- Sf = Slope (ft/ft)

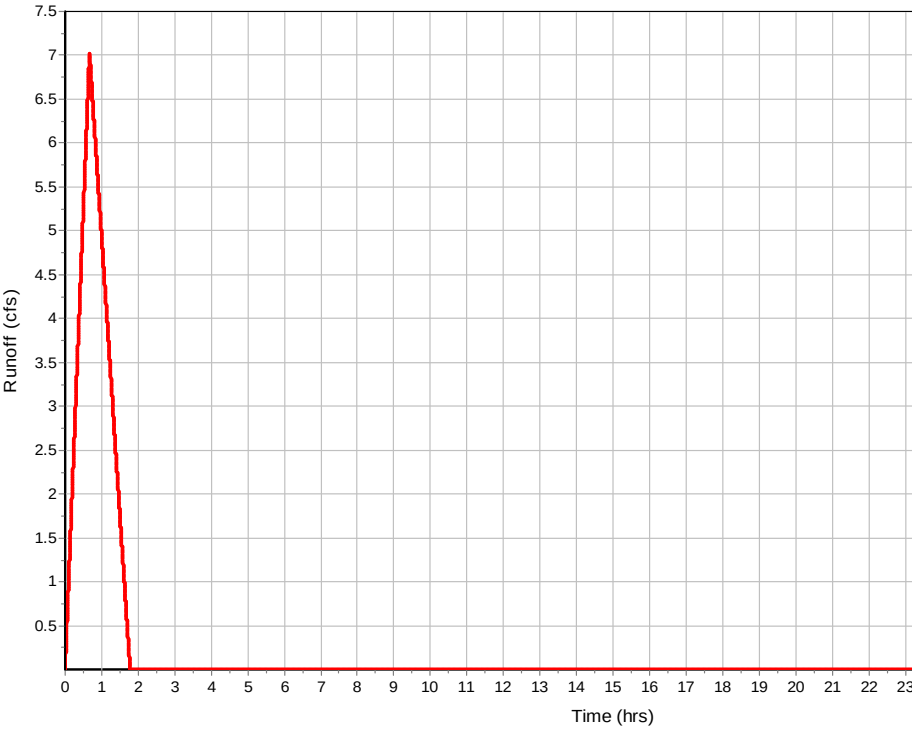
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	4.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.17	0	0
Computed Flow Time (min) :	9.9	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	696	0	0
Slope (%) :	4.6	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.46	0	0
Computed Flow Time (min) :	3.35	0	0
Total TOC (min)	13.25		

Subbasin Runoff Results

Total Rainfall (in)	0.54
Total Runoff (in)	0.22
Peak Runoff (cfs)	7.02
Rainfall Intensity	2.436
Weighted Runoff Coefficient	0.4
Time of Concentration (days hh:mm:ss)	0 00:13:15

Subbasin : Subbasin_1

Runoff Hydrograph



Subbasin : Subbasin_10

Input Data

Area (ac) 3.23
Weighted Runoff Coefficient 0.9

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	3.23	A	0.9
Composite Area & Weighted Runoff Coeff.	3.23		0.9

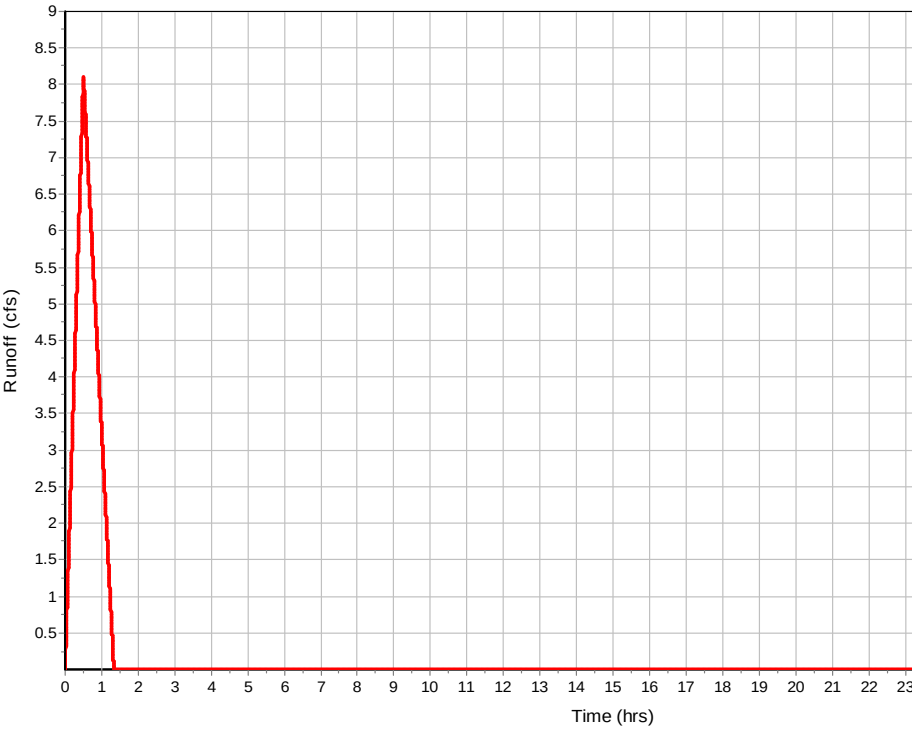
Time of Concentration

Subbasin Runoff Results

Total Rainfall (in) 0.47
Total Runoff (in) 0.42
Peak Runoff (cfs) 8.1
Rainfall Intensity 2.787
Weighted Runoff Coefficient 0.9
Time of Concentration (days hh:mm:ss) 0 00:00:00

Subbasin : Subbasin_10

Runoff Hydrograph



Subbasin : Subbasin_2

Input Data

Area (ac)	9.38
Weighted Runoff Coefficient	0.41

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.16	A	0.7
-	9.22	A	0.4
Composite Area & Weighted Runoff Coeff.	9.38		0.41

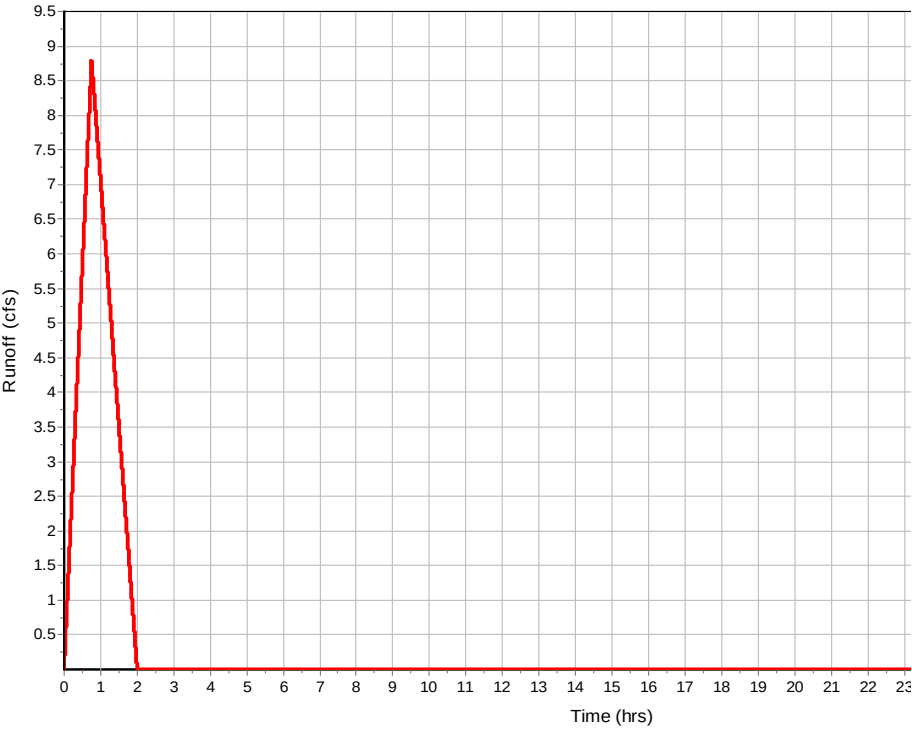
Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.21	0	0
Computed Flow Time (min) :	8.1	0	0
Shallow Concentrated Flow Computations			
Flow Length (ft) :	1278	0	0
Slope (%) :	3.7	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.1	0	0
Computed Flow Time (min) :	6.87	0	0
Total TOC (min)	14.97		

Subbasin Runoff Results

Total Rainfall (in)	0.57
Total Runoff (in)	0.23
Peak Runoff (cfs)	8.79
Rainfall Intensity	2.286
Weighted Runoff Coefficient	0.41
Time of Concentration (days hh:mm:ss)	0 00:14:58

Runoff Hydrograph



Subbasin : Subbasin_3

Input Data

Area (ac)	4.53
Weighted Runoff Coefficient	0.73

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	1.74	A	0.7
-	1	A	0.4
-	1.79	A	0.95
Composite Area & Weighted Runoff Coeff.	4.53		0.73

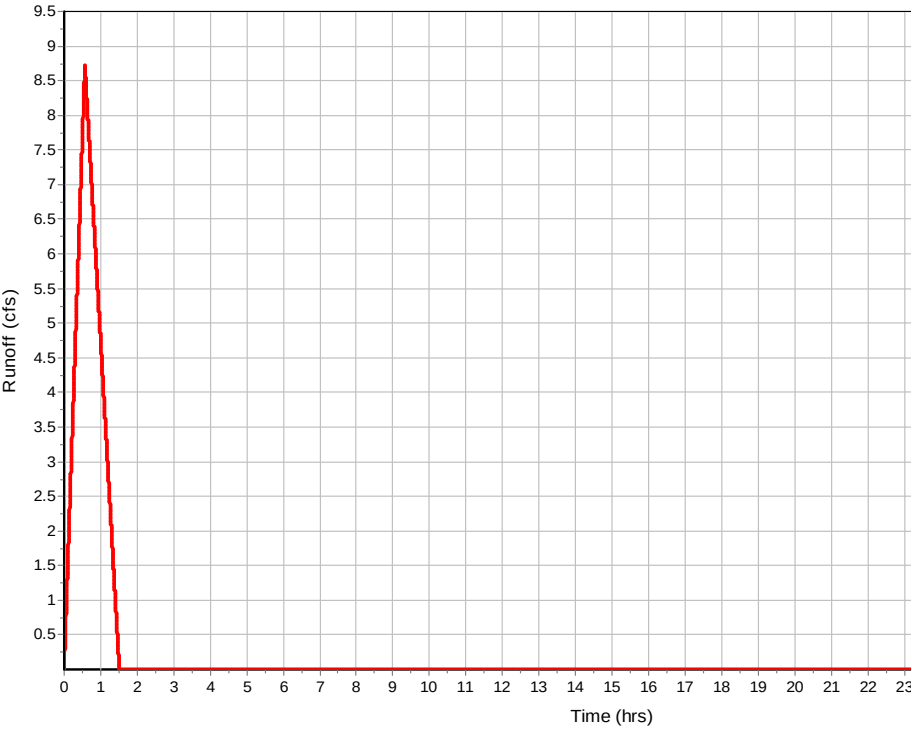
Time of Concentration

	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	115	0	0
Slope (%) :	10.8	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.24	0	0
Computed Flow Time (min) :	7.87	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	820	0	0
Slope (%) :	3.9	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	4.01	0	0
Computed Flow Time (min) :	3.41	0	0
Total TOC (min)	11.28		

Subbasin Runoff Results

Total Rainfall (in)	0.5
Total Runoff (in)	0.36
Peak Runoff (cfs)	8.72
Rainfall Intensity	2.636
Weighted Runoff Coefficient	0.73
Time of Concentration (days hh:mm:ss)	0 00:11:17

Runoff Hydrograph



Subbasin : Subbasin_4

Input Data

Area (ac) 3.08
Weighted Runoff Coefficient 0.62

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.62	A	0.7
-	1.55	A	0.4
-	0.91	A	0.95
Composite Area & Weighted Runoff Coeff.	3.08		0.62

Time of Concentration

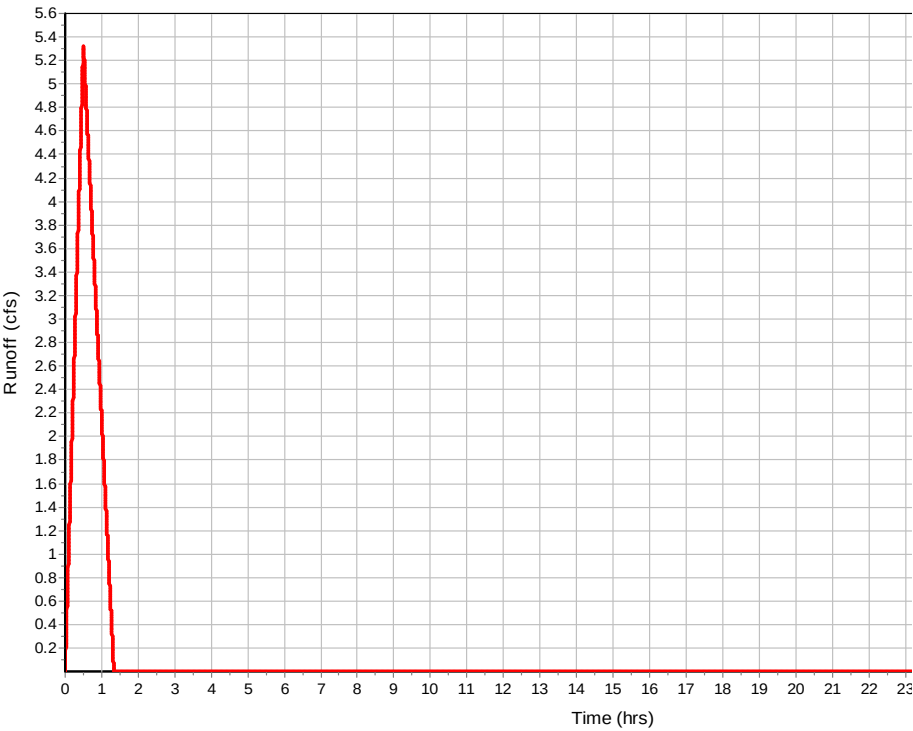
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.21	0	0
Computed Flow Time (min) :	8.1	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	103	125	56
Slope (%) :	7.6	3.7	1.8
Surface Type :	Bare & untilled	Unpaved	Paved
Velocity (ft/sec) :	2.76	3.1	2.73
Computed Flow Time (min) :	0.62	0.67	0.34
Total TOC (min)	9.74		

Subbasin Runoff Results

Total Rainfall (in) 0.47
Total Runoff (in) 0.29
Peak Runoff (cfs) 5.32
Rainfall Intensity 2.787
Weighted Runoff Coefficient 0.62
Time of Concentration (days hh:mm:ss) 0 00:09:44

Subbasin : Subbasin_4

Runoff Hydrograph



Subbasin : Subbasin_5

Input Data

Area (ac)	0.93
Weighted Runoff Coefficient	0.58

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.31	A	0.95
-	0.62	A	0.4
Composite Area & Weighted Runoff Coeff.	0.93		0.58

Time of Concentration

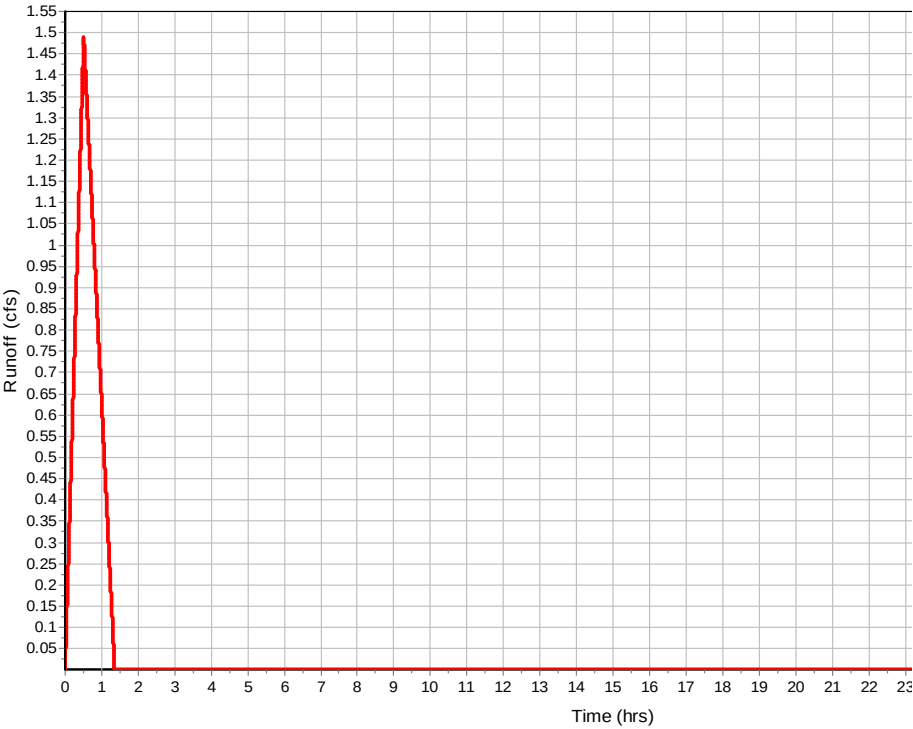
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	5.2	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.18	0	0
Computed Flow Time (min) :	9.43	0	0
Shallow Concentrated Flow Computations			
Flow Length (ft) :	174	0	0
Slope (%) :	5.2	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.68	0	0
Computed Flow Time (min) :	0.79	0	0
Total TOC (min)	10.22		

Subbasin Runoff Results

Total Rainfall (in)	0.47
Total Runoff (in)	0.27
Peak Runoff (cfs)	1.49
Rainfall Intensity	2.76
Weighted Runoff Coefficient	0.58
Time of Concentration (days hh:mm:ss)	0 00:10:13

Subbasin : Subbasin_5

Runoff Hydrograph



Subbasin : Subbasin_6

Input Data

Area (ac) 0.61
Weighted Runoff Coefficient 0.4

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.61	A	0.4
Composite Area & Weighted Runoff Coeff.	0.61		0.4

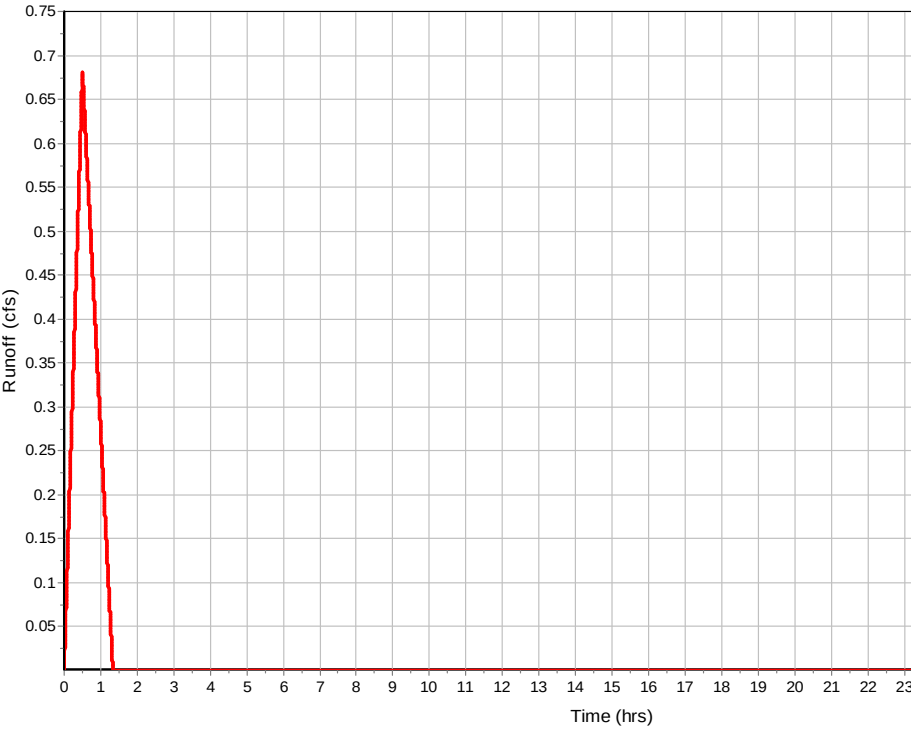
Time of Concentration

Sheet Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	0.13	0	0
	Flow Length (ft) :	100	0
	Slope (%) :	7.4	0
	2 yr, 24 hr Rainfall (in) :	1.28	0
	Velocity (ft/sec) :	0.2	0
	Computed Flow Time (min) :	8.19	0
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	131	0	0
	Flow Length (ft) :	100	0
	Slope (%) :	7.4	0
	Surface Type :	Paved	Unpaved
	Velocity (ft/sec) :	5.53	0
	Computed Flow Time (min) :	0.39	0
Total TOC (min)8.58			

Subbasin Runoff Results

Total Rainfall (in) 0.47
Total Runoff (in) 0.19
Peak Runoff (cfs) 0.68
Rainfall Intensity 2.787
Weighted Runoff Coefficient 0.4
Time of Concentration (days hh:mm:ss) 0 00:08:35

Runoff Hydrograph



Subbasin : Subbasin_7

Input Data

Area (ac) 0.13
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.13	A	0.95
Composite Area & Weighted Runoff Coeff.	0.13		0.95

Time of Concentration

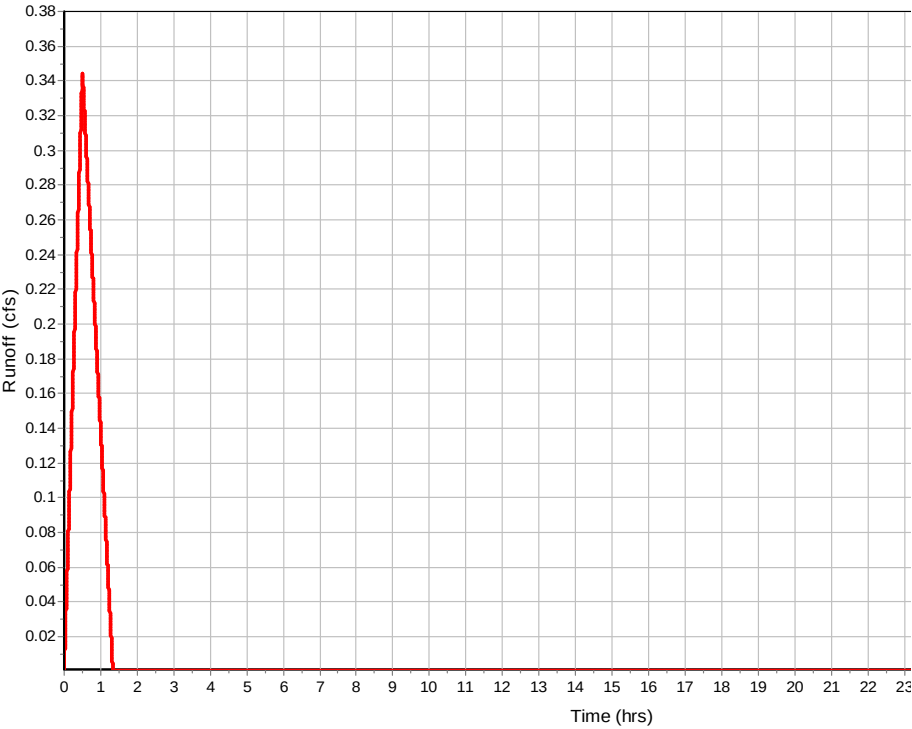
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
Flow Length (ft) :	264	0	0
Slope (%) :	2	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	2.87	0	0
Computed Flow Time (min) :	1.53	0	0
Total TOC (min)	1.53		

Subbasin Runoff Results

Total Rainfall (in) 0.47
Total Runoff (in) 0.44
Peak Runoff (cfs) 0.34
Rainfall Intensity 2.787
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:01:32

Subbasin : Subbasin_7

Runoff Hydrograph



Subbasin : Subbasin_8

Input Data

Area (ac) 0.11
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.11	A	0.95
Composite Area & Weighted Runoff Coeff.	0.11		0.95

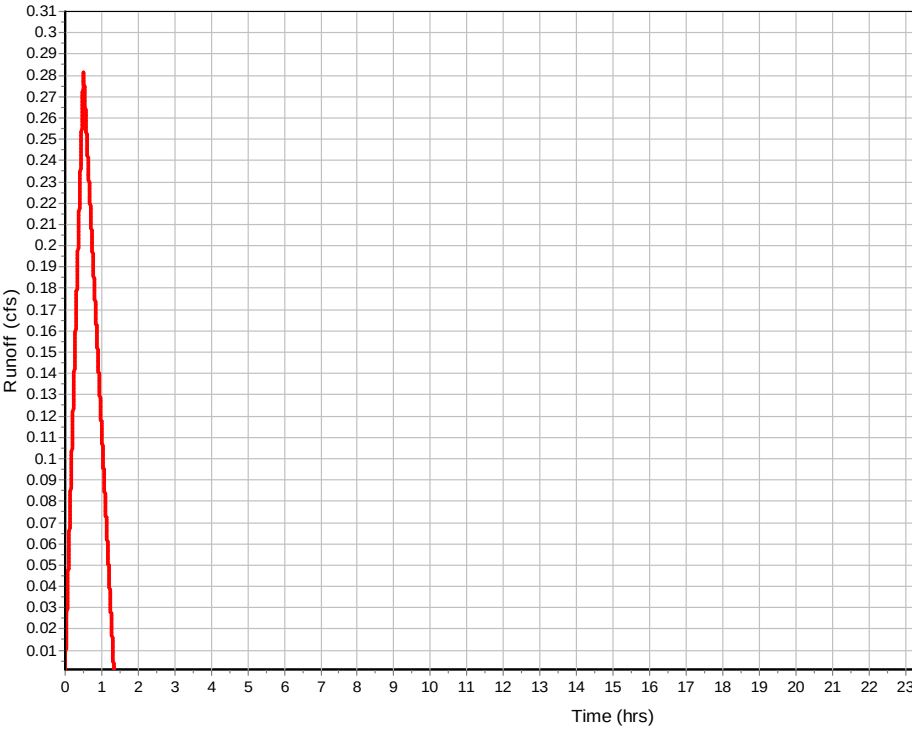
Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.68	0	0
Computed Flow Time (min) :	2.46	0	0
Total TOC (min)2.46			

Subbasin Runoff Results

Total Rainfall (in) 0.47
Total Runoff (in) 0.44
Peak Runoff (cfs) 0.28
Rainfall Intensity 2.787
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:02:28

Runoff Hydrograph



Subbasin : Subbasin_9

Input Data

Area (ac) 1.7
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	1.7	A	0.95
Composite Area & Weighted Runoff Coeff.	1.7		0.95

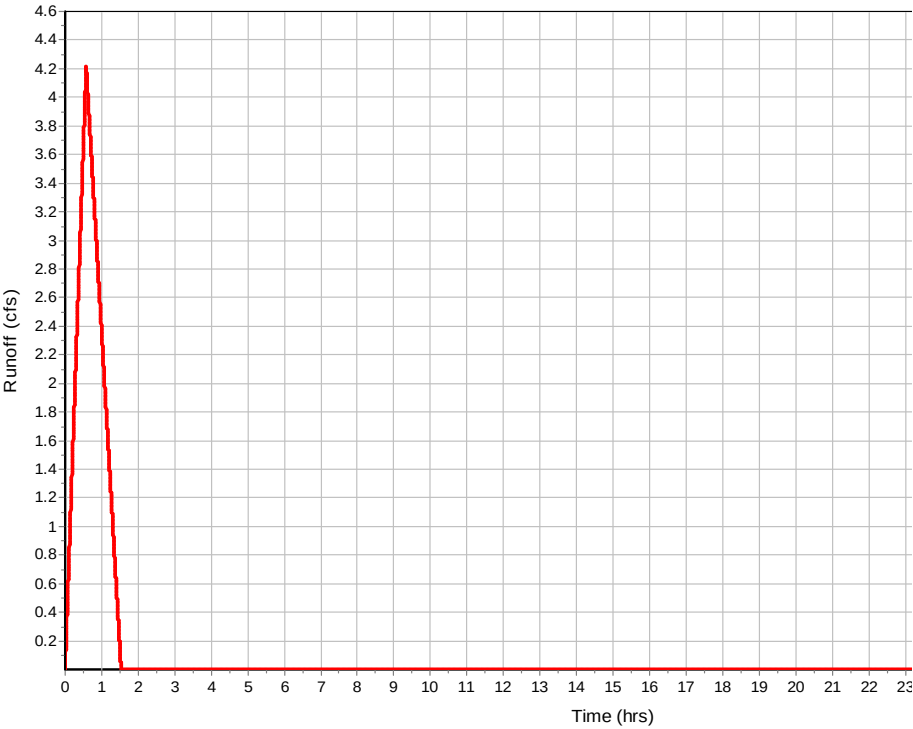
Time of Concentration

	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	80	0	0
Slope (%) :	3	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.14	0	0
Computed Flow Time (min) :	9.83	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	300	44	0
Slope (%) :	3	3	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	3.52	2.79	0
Computed Flow Time (min) :	1.42	0.26	0
Total TOC (min)	11.51		

Subbasin Runoff Results

Total Rainfall (in) 0.5
Total Runoff (in) 0.48
Peak Runoff (cfs) 4.22
Rainfall Intensity 2.611
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:11:31

Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim Elevation (Max) (ft)	Ground/Rim Offset (Max) (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Mini C
1	3-Jun	6339.00	6342.00	3.00	0.00	-6339.00	6342.00	0.00	0.00	
2	SOUTHERN_INLET_FES	6339.00	6342.00	3.00	0.00	-6339.00	6342.00	0.00	0.00	
3	SWALE_CONVERGE	6338.29	6342.29	4.00	0.00	-6338.29	4.00	-6338.29	0.00	1

Junction Results

SN	Element ID	Peak Inflow	Peak Lateral Inflow	Max HGL Elevation Attained	Max HGL Depth Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time to Max Occurrence
		(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)
1	3-Jun	0.00	0.00	6339.00	0.00	0.00	9.33	6339.00	0.00	0 00
2	SOUTHERN_INLET_FES	8.49	0.00	6342.68	3.68	0.00	0.65	6342.48	3.48	0 00
3	SWALE_CONVERGE	17.74	0.00	6339.46	1.17	0.00	2.83	6338.34	0.05	0 00

Channel Input

SN	Element ID	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Drop	Average Slope	Shape	Height	Width	Manning's Roughness	Entrance Loss
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(ft)	(ft)		
1	BYPASS	5.00	6345.00	4.20	6345.00	6.00	0.00	0.0000	Rectangular	0.500	20.000	0.0140	0.000
2	Link-07	5.00	6339.10	3.10	6339.00	0.00	0.10	2.0000	Rectangular	1.000	100.000	0.0320	0.000
3	SWALE	129.00	6338.39	0.10	6337.65	1.65	0.74	0.5700	Trapezoidal	3.000	22.000	0.0320	0.500

Channel Results

SN	Element	Peak	Time of	Design Flow	Peak Flow/	Peak Flow	Travel	Peak Flow	Peak Flow	Total Time	Frouc
	ID	Flow	Peak Flow	Capacity	Design Flow	Velocity	Time	Depth	Depth/	Surcharged	Numb
			Occurrence		Ratio				Total Depth		
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)	Ratio	(min)	
1	BYPASS	0.00	0 00:00	9.15	0.00	0.00		0.00	0.00	0.00	
2	Link-07	0.00	0 00:00	648.11	0.00	0.00		0.00	0.00	0.00	
3	SWALE	17.74	0 00:44	195.20	0.09	3.00	0.72	0.89	0.30	0.00	

Pipe Input

SN	Element ID	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Drop	Average Slope	Pipe Shape	Pipe Diameter or Height	Pipe Width
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(in)	(in)
1	CENTRAL_CULVERT	74.00	6337.57	-0.93	6337.17	-1.12	0.40	0.5400	CIRCULAR	18.000	18.000
2	FAKE_PIPE	5.00	6342.50	3.50	6337.00	1.00	5.50	110.0000	CIRCULAR	9.960	9.960
3	Link-08	15.00	6345.00	6.00	6336.00	0.00	9.00	60.0000	CIRCULAR	39.960	39.960
4	NORTHERN_CULVERT	72.00	6336.78	-0.42	6336.37	-1.92	0.41	0.5700	CIRCULAR	24.000	24.000
5	SOUTHERN_PIPE	103.00	6340.80	0.00	6339.00	0.00	1.80	1.7500	CIRCULAR	18.000	18.000

No. of
Barrels

	1
	1
	1
	1
	1

Pipe Results

SN Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Surcharge
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		
1 CENTRAL_CULVERT	8.47	0 00:46	7.27	1.16	5.10	0.24	1.34	0.89	
2 FAKE_PIPE	8.51	0 00:35	59.75	0.14	50.00	0.00	0.20	0.24	
3 Link-08	0.00	0 00:00	8895.17	0.00	0.00		0.32	0.10	
4 NORTHERN_CULVERT	9.98	0 00:40	36.19	0.28	3.75	0.32	1.59	0.79	
5 SOUTHERN_PIPE	8.49	0 00:36	18.05	0.47	6.41	0.27	1.50	1.00	176

Inlet Input

SN Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Inlet Depth (ft)	Init Wat Elevati (
1 SOUTHERN_INLET	FHWA HEC-22 GENERIC	N/A	On Sag	1	6340.80	6345.80	5.00	0.0

Roadway & Gutter Input

SN	Element	Roadway Longitudinal Slope (ft/ft)	Roadway Cross Slope (ft/ft)	Roadway Manning's Roughness	Gutter Cross Slope (ft/ft)	Gutter Width (ft)	Gutter Depression (in)	Allowable Spread (ft)
1	SOUTHERN_INLET	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00

Inlet Results

SN	Element ID	Peak Flow (cfs)	Peak Lateral Inflow (cfs)	Peak Flow Intercepted (cfs)	Peak Flow Bypassing (cfs)	Inlet Efficiency during Peak Flow (%)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)	Max Gutter Water Depth during Peak Flow (ft)	Time to Max Depth (days hh:mm)
1	SOUTHERN_INLET	8.72	8.72	N/A	N/A	N/A	25.06	6346.41	0.61	0 0

Storage Nodes

Storage Node : CENTRAL_CULVERT

Input Data

Invert Elevation (ft)	6338.50
Max (Rim) Elevation (ft)	6342.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6338.50
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

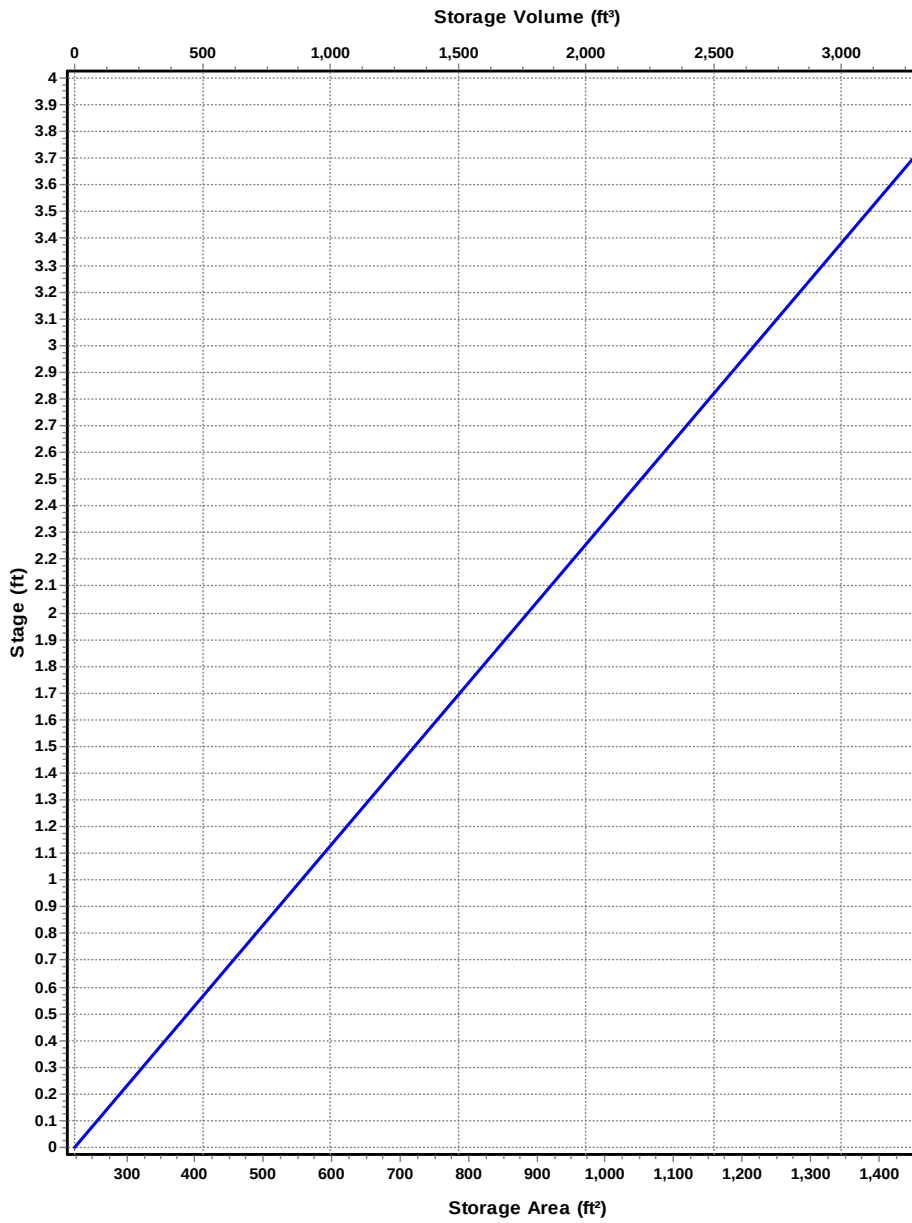
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : CENTRAL CULVERT

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	224	0
4	1550	3548

Storage Area Volume Curves



Storage Node : CENTRAL_CULVERT (continued)

Output Summary Results

Peak Inflow (cfs)	9.86
Peak Lateral Inflow (cfs)	9.86
Peak Outflow (cfs)	8.47
Peak Exfiltration Flow Rate (cfm)	70.85
Max HGL Elevation Attained (ft)	6340.33
Max HGL Depth Attained (ft)	1.83
Average HGL Elevation Attained (ft)	6338.57
Average HGL Depth Attained (ft)	0.07
Time of Max HGL Occurrence (days hh:mm)	0 00:46
Total Exfiltration Volume (1000-ft³)	5.964
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : INFIL_POND

Input Data

Invert Elevation (ft)	6336.00
Max (Rim) Elevation (ft)	6339.10
Max (Rim) Offset (ft)	3.10
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6336.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

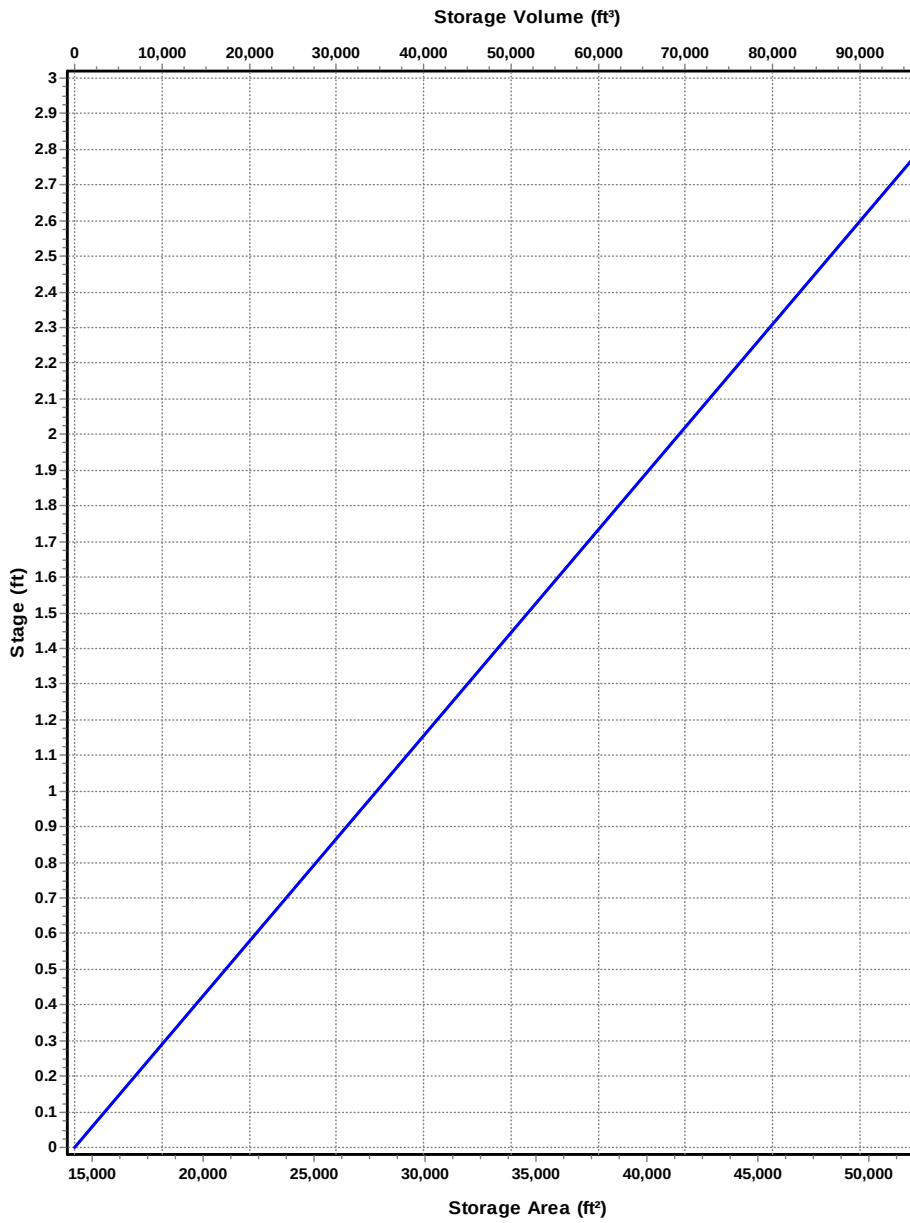
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : INFILTRATION POND

Stage	Storage	Storage
(ft)	Area	Volume
	(ft²)	(ft³)
0	14221	0
3	55036	103885.5

Storage Area Volume Curves



Storage Node : INFIL_POND (continued)

Output Summary Results

Peak Inflow (cfs)	37.65
Peak Lateral Inflow (cfs)	14.73
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	1907.85
Max HGL Elevation Attained (ft)	6336.64
Max HGL Depth Attained (ft)	0.64
Average HGL Elevation Attained (ft)	6336.01
Average HGL Depth Attained (ft)	0.01
Time of Max HGL Occurrence (days hh:mm)	0 00:50
Total Exfiltration Volume (1000-ft³)	114.568
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : NORTH_CULVERT

Input Data

Invert Elevation (ft)	6337.20
Max (Rim) Elevation (ft)	6341.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6337.20
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

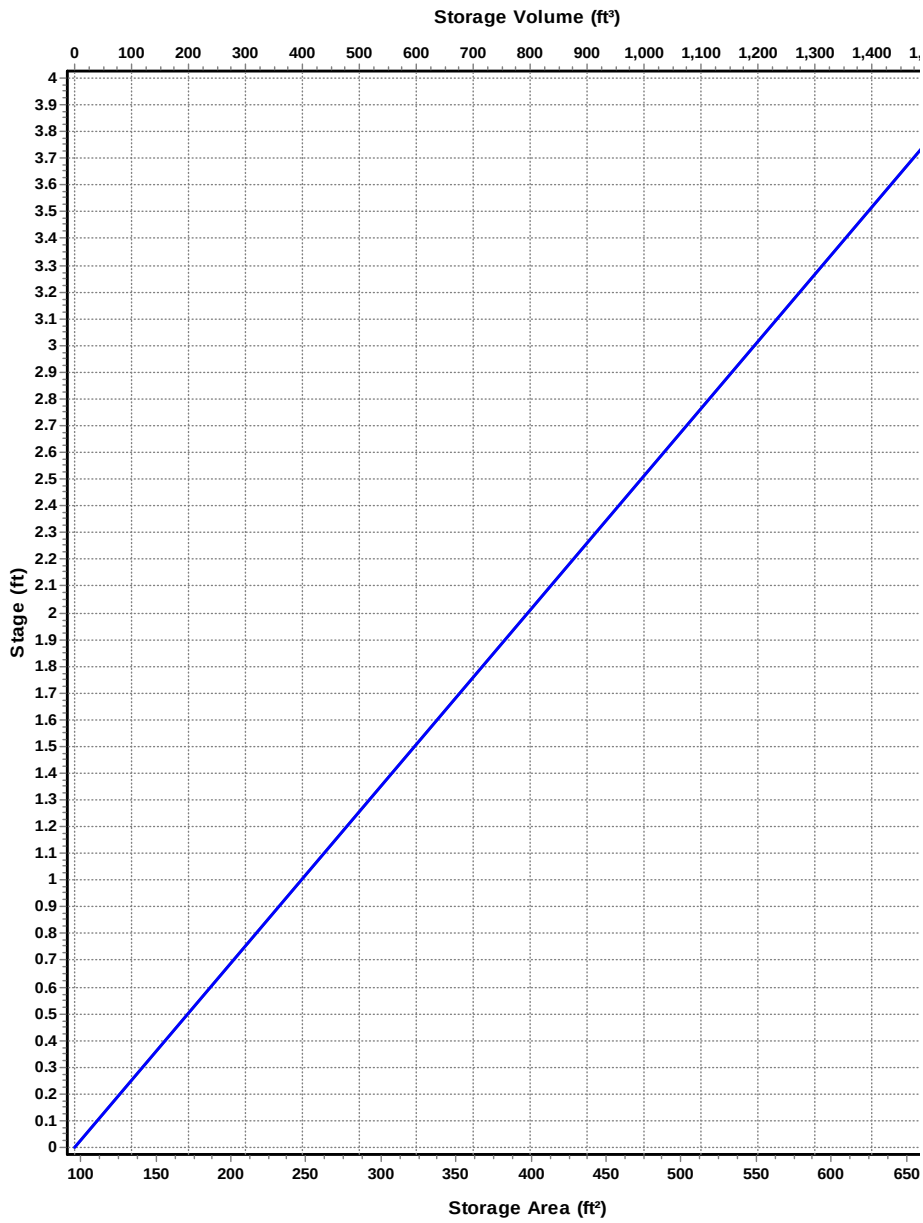
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : NORTHERN CULVERT

Stage	Storage	Storage
(ft)	Area	Volume
	(ft²)	(ft³)
0	96	0
4	700	1592

Storage Area Volume Curves



Storage Node : NORTH_CULVERT (continued)

Output Summary Results

Peak Inflow (cfs)	10.83
Peak Lateral Inflow (cfs)	10.83
Peak Outflow (cfs)	9.98
Peak Exfiltration Flow Rate (cfm)	46.16
Max HGL Elevation Attained (ft)	6339.98
Max HGL Depth Attained (ft)	2.78
Average HGL Elevation Attained (ft)	6337.35
Average HGL Depth Attained (ft)	0.15
Time of Max HGL Occurrence (days hh:mm)	0 00:40
Total Exfiltration Volume (1000-ft³)	5.017
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ihouse SSA model.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method Rational
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Hydrodynamic
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods YES

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 6:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:05:00 days hh:mm:ss
Routing Time Step 5 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	10
Nodes.....	8
<i>Junctions</i>	3
<i>Outfalls</i>	1
<i>Flow Diversions</i>	0
<i>Inlets</i>	1
<i>Storage Nodes</i>	3
Links.....	8
<i>Channels</i>	3
<i>Pipes</i>	5
<i>Pumps</i>	0
<i>Orifices</i>	0
<i>Weirs</i>	0
<i>Outlets</i>	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period 50 year(s)

Subbasin Summary

SN	Subbasin ID	Area	Weighted Runoff Coefficient	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	Subbasin_1	7.20	0.4000	0.85	0.34	2.45	11.02	0 00:13:15
2	Subbasin_10	3.23	0.9000	0.73	0.66	2.12	12.72	0 00:10:00
3	Subbasin_2	9.38	0.4100	0.90	0.37	3.45	13.81	0 00:14:58
4	Subbasin_3	4.53	0.7300	0.78	0.57	2.59	13.69	0 00:11:16
5	Subbasin_4	3.08	0.6200	0.73	0.45	1.39	8.36	0 00:10:00
6	Subbasin_5	0.93	0.5800	0.73	0.43	0.40	2.34	0 00:10:13
7	Subbasin_6	0.61	0.4000	0.73	0.29	0.18	1.07	0 00:10:00
8	Subbasin_7	0.13	0.9500	0.73	0.69	0.09	0.54	0 00:10:00
9	Subbasin_8	0.11	0.9500	0.73	0.69	0.07	0.44	0 00:10:00
10	Subbasin_9	1.70	0.9500	0.79	0.75	1.27	6.62	0 00:11:30

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	(ft)
1	3-Jun	Junction	6339.00	6342.00	0.00	6342.00	0.00	0.00	6339.00	0.00
2	SOUTHERN_INLET_FES	Junction	6339.00	6342.00	0.00	6342.00	0.00	13.17	6342.82	0.00
3	SWALE_CONVERGE	Junction	6338.29	6342.29	0.00	4.00	0.00	28.01	6339.71	0.00
4	Out-04	Outfall	6339.00					0.00	6339.00	
5	CENTRAL_CULVERT	Storage Node	6338.50	6342.50	0.00		0.00	15.48	6341.26	
6	INFIL_POND	Storage Node	6336.00	6339.10	0.00		0.00	59.35	6337.38	
7	NORTH_CULVERT	Storage Node	6337.20	6341.20	0.00		0.00	17.01	6340.58	

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow Design Flow Ratio
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)	
1	CENTRAL_CULVERT	Pipe	CENTRAL_CULVERT	SWALE_CONVERGE	74.00	6337.57	6337.17	0.5400	18.000	0.0100	13.21	7.27	1.8
2	FAKE_PIPE	Pipe	SOUTHERN_INLET_FES	INFIL_POND	5.00	6342.50	6337.00	110.0000	10.000	0.0050	14.23	59.75	0.2
3	Link-08	Pipe	3-Jun	INFIL_POND	15.00	6345.00	6336.00	60.0000	40.000	0.0010	0.00	8895.17	0.0
4	NORTHERN_CULVERT	Pipe	NORTH_CULVERT	SWALE_CONVERGE	72.00	6336.78	6336.37	0.5700	24.000	0.0100	15.97	36.19	0.4
5	SOUTHERN_PIPE	Pipe	SOUTHERN_INLET	SOUTHERN_INLET_FES	103.00	6340.80	6339.00	1.7500	18.000	0.0100	13.17	18.05	0.7
6	BYPASS	Channel	SOUTHERN_INLET	3-Jun	5.00	6345.00	6345.00	0.0000	6.000	0.0140	0.00	9.15	0.0
7	Link-07	Channel	INFIL_POND	Out-04	5.00	6339.10	6339.00	2.0000	12.000	0.0320	0.00	648.11	0.0
8	SWALE	Channel	SWALE_CONVERGE	INFIL_POND	129.00	6338.39	6337.65	0.5700	36.000	0.0320	27.99	195.20	0.1

Inlet Summary

SN	Element	Inlet	Manufacturer	Inlet	Number of	Catchbasin	Max (Rim)	Initial	Ponded	Peak	Peak Flow	Peak Flow	Inlet	Allowable
	ID	Manufacturer	Part	Location	Inlets	Invert	Elevation	Water	Area	Flow	Intercepted	Bypassing	Efficiency	Spread
			Number			Elevation		Elevation			by	Inlet	during Peak	
						(ft)	(ft)	(ft)	(ft²)	(cfs)	(cfs)	(cfs)	(%)	(ft)
1	SOUTHERN_INLET	FHWA HEC-22 GENERIC	N/A	On Sag	1	6340.80	6345.80	0.00	10.00	13.69	N/A	N/A	N/A	7.00

Subbasin Hydrology

Subbasin : Subbasin_1

Input Data

Area (ac) 7.2
Weighted Runoff Coefficient 0.4

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	7.2	A	0.4
Composite Area & Weighted Runoff Coeff.	7.2		0.4

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$

Where :

- Tc = Time of Concentration (hr)
- n = Manning's roughness
- Lf = Flow Length (ft)
- P = 2 yr, 24 hr Rainfall (inches)
- Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

- V = 16.1345 * (Sf^0.5) (unpaved surface)
- V = 20.3282 * (Sf^0.5) (paved surface)
- V = 15.0 * (Sf^0.5) (grassed waterway surface)
- V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
- V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
- V = 7.0 * (Sf^0.5) (short grass pasture surface)
- V = 5.0 * (Sf^0.5) (woodland surface)
- V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
- Tc = (Lf / V) / (3600 sec/hr)

Where:

- Tc = Time of Concentration (hr)
- Lf = Flow Length (ft)
- V = Velocity (ft/sec)
- Sf = Slope (ft/ft)

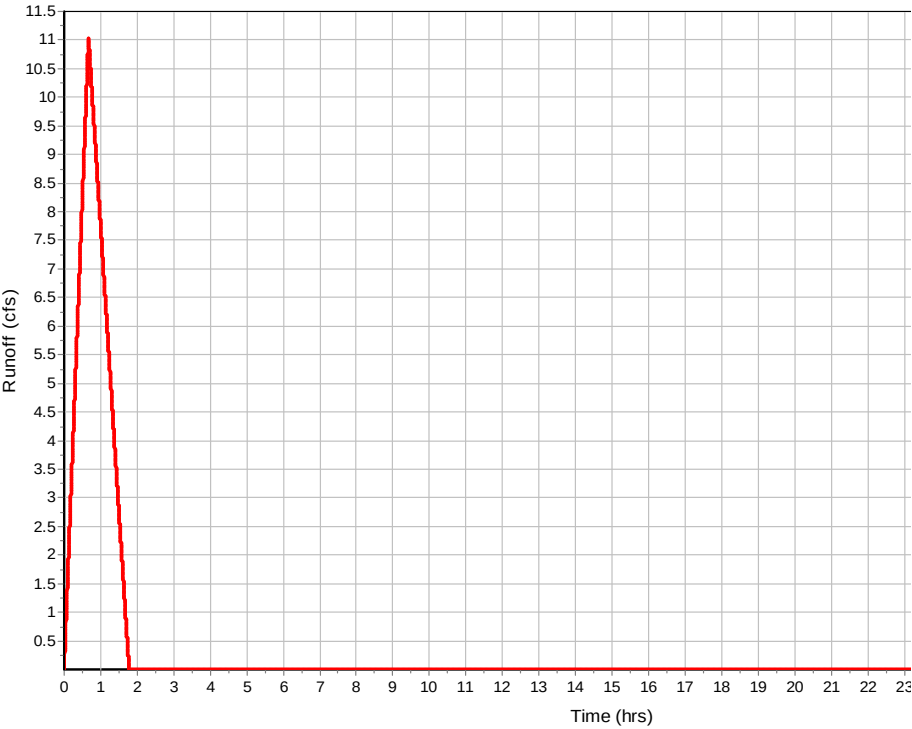
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	4.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.17	0	0
Computed Flow Time (min) :	9.9	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	696	0	0
Slope (%) :	4.6	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.46	0	0
Computed Flow Time (min) :	3.35	0	0
Total TOC (min)	13.25		

Subbasin Runoff Results

Total Rainfall (in)	0.85
Total Runoff (in)	0.34
Peak Runoff (cfs)	11.02
Rainfall Intensity	3.826
Weighted Runoff Coefficient	0.4
Time of Concentration (days hh:mm:ss)	0 00:13:15

Subbasin : Subbasin_1

Runoff Hydrograph



Subbasin : Subbasin_10

Input Data

Area (ac) 3.23
Weighted Runoff Coefficient 0.9

Runoff Coefficient

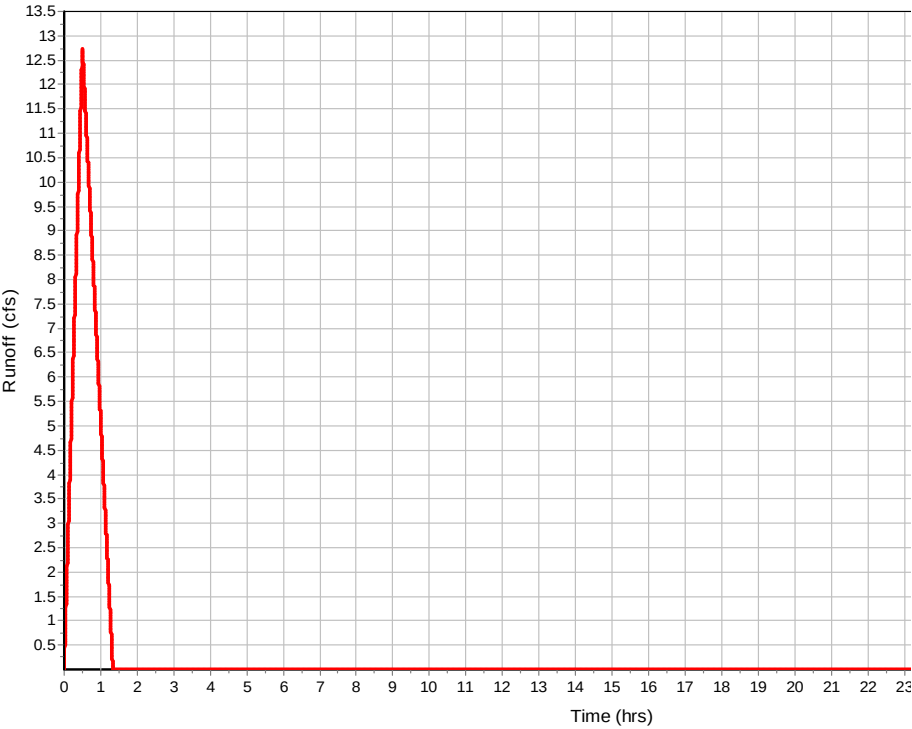
Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	3.23	A	0.9
Composite Area & Weighted Runoff Coeff.	3.23		0.9

Time of Concentration

Subbasin Runoff Results

Total Rainfall (in) 0.73
Total Runoff (in) 0.66
Peak Runoff (cfs) 12.72
Rainfall Intensity 4.377
Weighted Runoff Coefficient 0.9
Time of Concentration (days hh:mm:ss) 0 00:00:00

Runoff Hydrograph



Subbasin : Subbasin_2

Input Data

Area (ac)	9.38
Weighted Runoff Coefficient	0.41

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.16	A	0.7
-	9.22	A	0.4
Composite Area & Weighted Runoff Coeff.	9.38		0.41

Time of Concentration

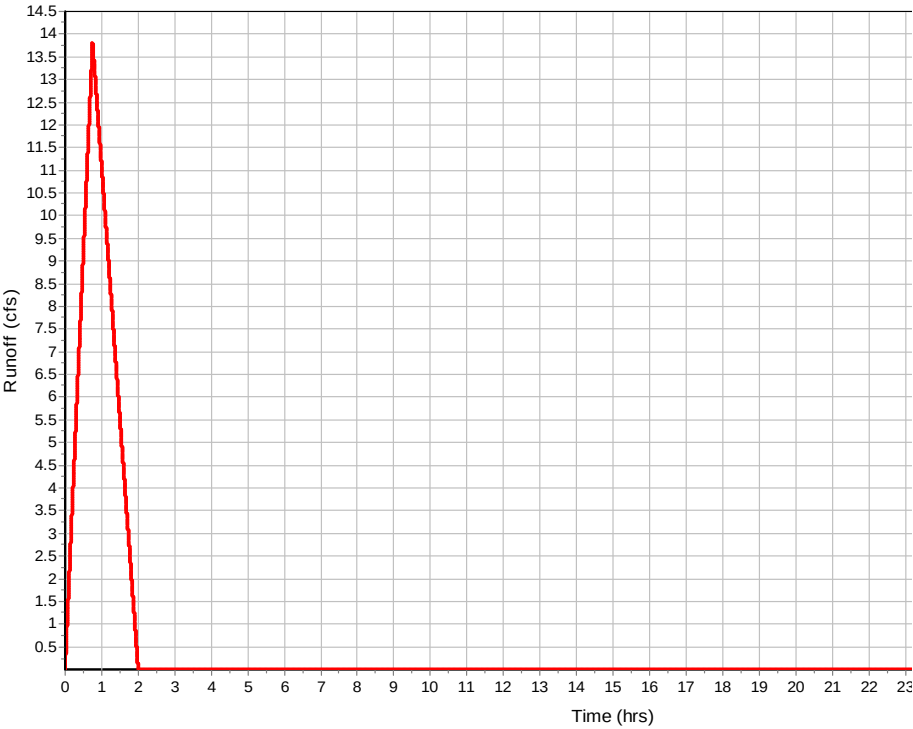
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.21	0	0
Computed Flow Time (min) :	8.1	0	0
Shallow Concentrated Flow Computations			
Flow Length (ft) :	1278	0	0
Slope (%) :	3.7	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.1	0	0
Computed Flow Time (min) :	6.87	0	0
Total TOC (min)	14.97		

Subbasin Runoff Results

Total Rainfall (in)	0.9
Total Runoff (in)	0.37
Peak Runoff (cfs)	13.81
Rainfall Intensity	3.591
Weighted Runoff Coefficient	0.41
Time of Concentration (days hh:mm:ss)	0 00:14:58

Subbasin : Subbasin_2

Runoff Hydrograph



Subbasin : Subbasin_3

Input Data

Area (ac)	4.53
Weighted Runoff Coefficient	0.73

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	1.74	A	0.7
-	1	A	0.4
-	1.79	A	0.95
Composite Area & Weighted Runoff Coeff.	4.53		0.73

Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	115	0	0
Slope (%) :	10.8	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.24	0	0
Computed Flow Time (min) :	7.87	0	0
Shallow Concentrated Flow Computations			
Flow Length (ft) :	820	0	0
Slope (%) :	3.9	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	4.01	0	0
Computed Flow Time (min) :	3.41	0	0
Total TOC (min)	11.28		

Subbasin Runoff Results

Total Rainfall (in)	0.78
Total Runoff (in)	0.57
Peak Runoff (cfs)	13.69
Rainfall Intensity	4.141
Weighted Runoff Coefficient	0.73
Time of Concentration (days hh:mm:ss)	0 00:11:17

Runoff Hydrograph



Subbasin : Subbasin_4

Input Data

Area (ac) 3.08
Weighted Runoff Coefficient 0.62

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.62	A	0.7
-	1.55	A	0.4
-	0.91	A	0.95
Composite Area & Weighted Runoff Coeff.	3.08		0.62

Time of Concentration

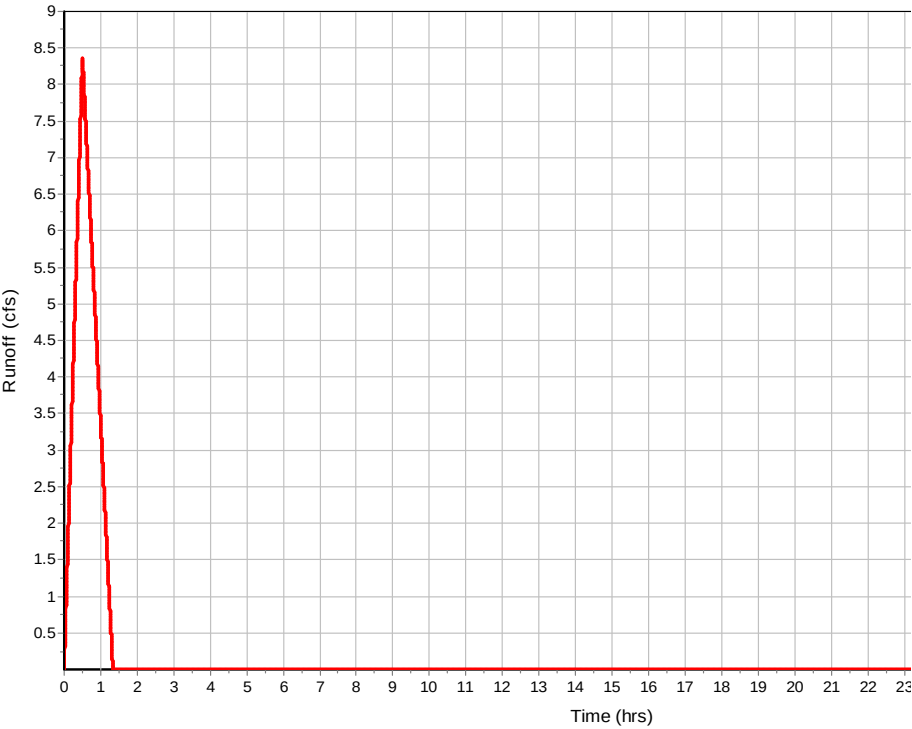
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.21	0	0
Computed Flow Time (min) :	8.1	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	103	125	56
Slope (%) :	7.6	3.7	1.8
Surface Type :	Bare & untilled	Unpaved	Paved
Velocity (ft/sec) :	2.76	3.1	2.73
Computed Flow Time (min) :	0.62	0.67	0.34
Total TOC (min)	9.74		

Subbasin Runoff Results

Total Rainfall (in) 0.73
Total Runoff (in) 0.45
Peak Runoff (cfs) 8.36
Rainfall Intensity 4.377
Weighted Runoff Coefficient 0.62
Time of Concentration (days hh:mm:ss) 0 00:09:44

Subbasin : Subbasin_4

Runoff Hydrograph



Subbasin : Subbasin_5

Input Data

Area (ac)	0.93
Weighted Runoff Coefficient	0.58

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.31	A	0.95
-	0.62	A	0.4
Composite Area & Weighted Runoff Coeff.	0.93		0.58

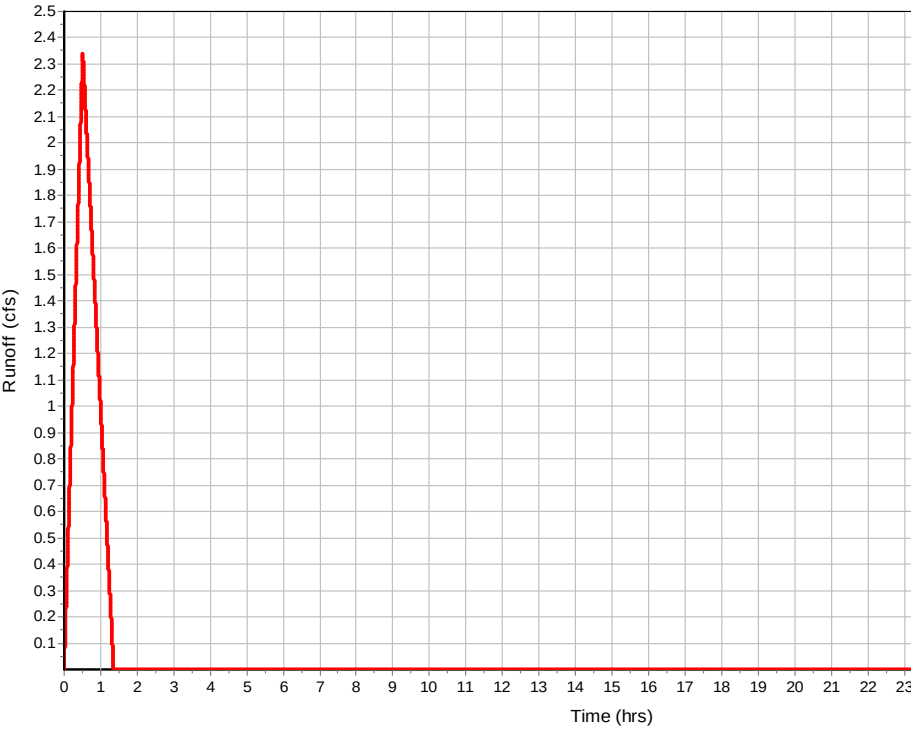
Time of Concentration

	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	5.2	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.18	0	0
Computed Flow Time (min) :	9.43	0	0
Shallow Concentrated Flow Computations			
Flow Length (ft) :	174	0	0
Slope (%) :	5.2	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.68	0	0
Computed Flow Time (min) :	0.79	0	0
Total TOC (min)	10.22		

Subbasin Runoff Results

Total Rainfall (in)	0.73
Total Runoff (in)	0.43
Peak Runoff (cfs)	2.34
Rainfall Intensity	4.334
Weighted Runoff Coefficient	0.58
Time of Concentration (days hh:mm:ss)	0 00:10:13

Runoff Hydrograph



Subbasin : Subbasin_6

Input Data

Area (ac) 0.61
Weighted Runoff Coefficient 0.4

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.61	A	0.4
Composite Area & Weighted Runoff Coeff.	0.61		0.4

Time of Concentration

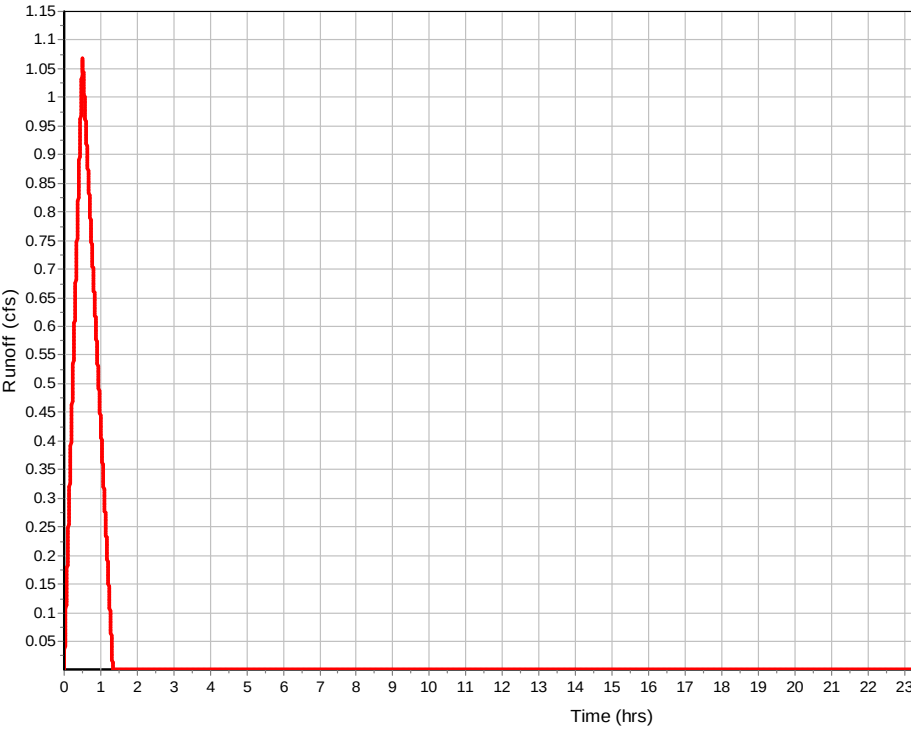
Sheet Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	0.13	0	0
	Flow Length (ft) :	100	0
	Slope (%) :	7.4	0
	2 yr, 24 hr Rainfall (in) :	1.28	0
	Velocity (ft/sec) :	0.2	0
	Computed Flow Time (min) :	8.19	0
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	131	0	0
	Flow Length (ft) :	100	0
	Slope (%) :	7.4	0
	Surface Type :	Paved	Unpaved
	Velocity (ft/sec) :	5.53	0
	Computed Flow Time (min) :	0.39	0
Total TOC (min)8.58			

Subbasin Runoff Results

Total Rainfall (in) 0.73
Total Runoff (in) 0.29
Peak Runoff (cfs) 1.07
Rainfall Intensity 4.377
Weighted Runoff Coefficient 0.4
Time of Concentration (days hh:mm:ss) 0 00:08:35

Subbasin : Subbasin_6

Runoff Hydrograph



Subbasin : Subbasin_7

Input Data

Area (ac) 0.13
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.13	A	0.95
Composite Area & Weighted Runoff Coeff.	0.13		0.95

Time of Concentration

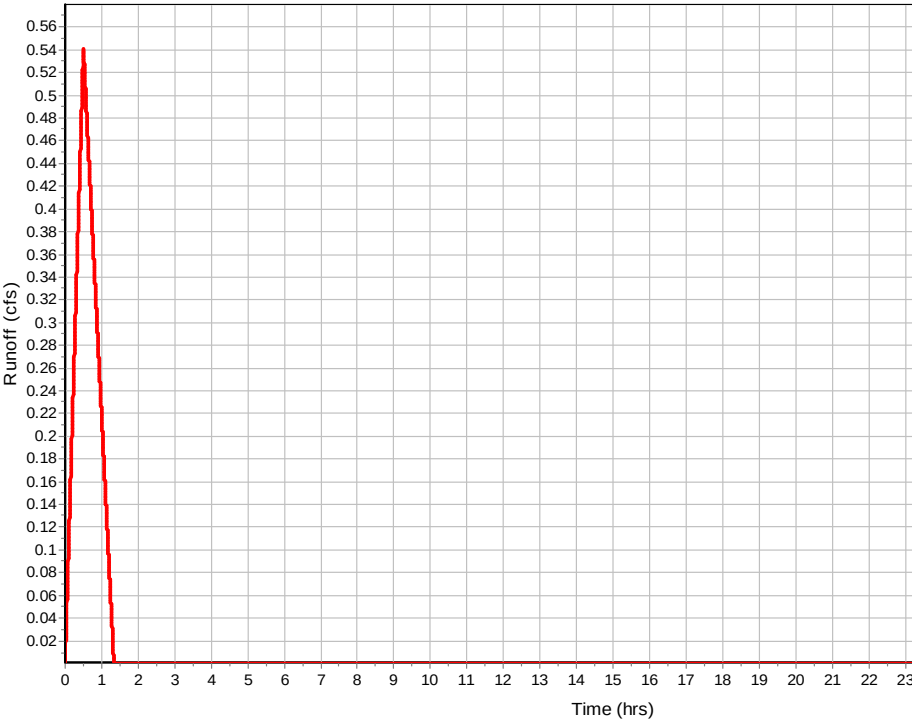
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
Flow Length (ft) :	264	0	0
Slope (%) :	2	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	2.87	0	0
Computed Flow Time (min) :	1.53	0	0
Total TOC (min)	1.53		

Subbasin Runoff Results

Total Rainfall (in) 0.73
Total Runoff (in) 0.69
Peak Runoff (cfs) 0.54
Rainfall Intensity 4.377
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:01:32

Subbasin : Subbasin_7

Runoff Hydrograph



Subbasin : Subbasin_8

Input Data

Area (ac) 0.11
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.11	A	0.95
Composite Area & Weighted Runoff Coeff.	0.11		0.95

Time of Concentration

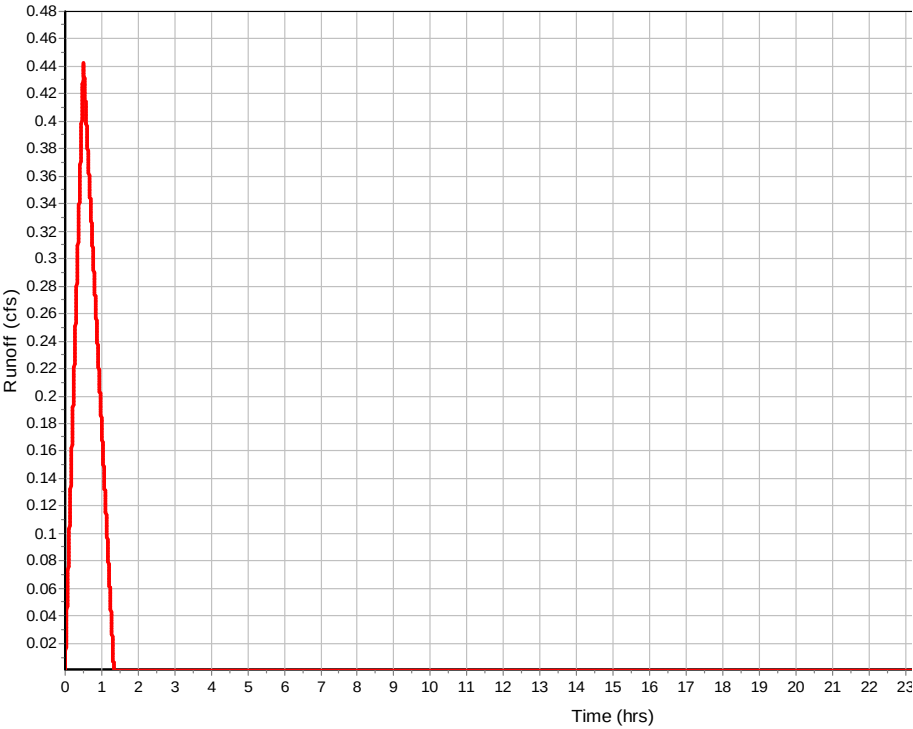
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.68	0	0
Computed Flow Time (min) :	2.46	0	0
Total TOC (min)2.46			

Subbasin Runoff Results

Total Rainfall (in) 0.73
Total Runoff (in) 0.69
Peak Runoff (cfs) 0.44
Rainfall Intensity 4.377
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:02:28

Subbasin : Subbasin_8

Runoff Hydrograph



Subbasin : Subbasin_9

Input Data

Area (ac) 1.7
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	1.7	A	0.95
Composite Area & Weighted Runoff Coeff.	1.7		0.95

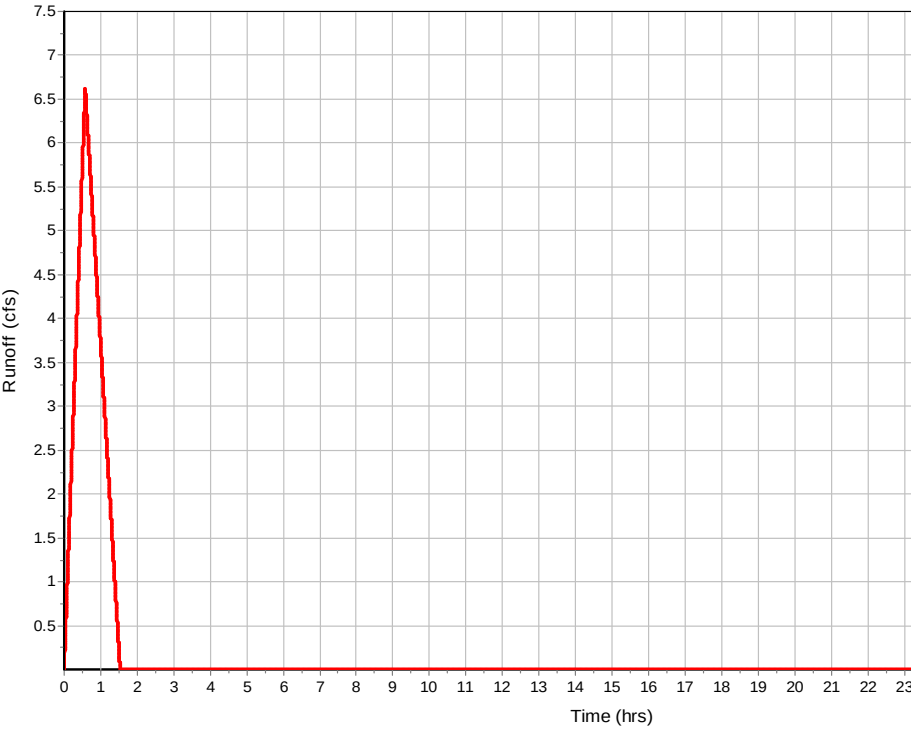
Time of Concentration

Sheet Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	0.13	0	0
	Flow Length (ft) :	80	0
	Slope (%) :	3	0
	2 yr, 24 hr Rainfall (in) :	1.28	0
	Velocity (ft/sec) :	0.14	0
	Computed Flow Time (min) :	9.83	0
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	300	44	0
	Flow Length (ft) :	3	3
	Slope (%) :	3	0
	Surface Type :	Paved	Unpaved
	Velocity (ft/sec) :	3.52	2.79
	Computed Flow Time (min) :	1.42	0.26
Total TOC (min)11.51			

Subbasin Runoff Results

Total Rainfall (in) 0.79
Total Runoff (in) 0.75
Peak Runoff (cfs) 6.62
Rainfall Intensity 4.101
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:11:31

Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Mini C
1	3-Jun	6339.00	6342.00	3.00	0.00	-6339.00	6342.00	0.00	0.00	
2	SOUTHERN_INLET_FES	6339.00	6342.00	3.00	0.00	-6339.00	6342.00	0.00	0.00	
3	SWALE_CONVERGE	6338.29	6342.29	4.00	0.00	-6338.29	4.00	-6338.29	0.00	1

Junction Results

SN	Element ID	Peak Inflow	Peak Lateral Inflow	Max HGL Elevation Attained	Max HGL Depth Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time Max Occurrence
		(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)
1	3-Jun	0.00	0.00	6339.00	0.00	0.00	9.33	6339.00	0.00	0 00
2	SOUTHERN_INLET_FES	13.17	0.00	6342.82	3.82	0.00	0.52	6342.49	3.49	0 00
3	SWALE_CONVERGE	28.01	0.00	6339.71	1.42	0.00	2.58	6338.36	0.07	0 00

Channel Input

SN	Element ID	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Drop	Average Slope	Shape	Height	Width	Manning's Roughness	Entrance Loss
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(ft)	(ft)		
1	BYPASS	5.00	6345.00	4.20	6345.00	6.00	0.00	0.0000	Rectangular	0.500	20.000	0.0140	0.000
2	Link-07	5.00	6339.10	3.10	6339.00	0.00	0.10	2.0000	Rectangular	1.000	100.000	0.0320	0.000
3	SWALE	129.00	6338.39	0.10	6337.65	1.65	0.74	0.5700	Trapezoidal	3.000	22.000	0.0320	0.500

Channel Results

SN	Element	Peak	Time of	Design Flow	Peak Flow/	Peak Flow	Travel	Peak Flow	Peak Flow	Total Time	Froude
	ID	Flow	Peak Flow	Capacity	Design Flow	Velocity	Time	Depth	Depth/	Surcharged	Number
			Occurrence		Ratio				Total Depth		
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)	Ratio	(min)	
1	BYPASS	0.00	0 00:00	9.15	0.00	0.00		0.00	0.00	0.00	
2	Link-07	0.00	0 00:00	648.11	0.00	0.00		0.00	0.00	0.00	
3	SWALE	27.99	0 00:43	195.20	0.14	3.41	0.63	1.12	0.37	0.00	

Pipe Input

SN	Element ID	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Drop	Average Slope	Pipe Shape	Pipe Diameter or Height	Pipe Width
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(in)	(in)
1	CENTRAL_CULVERT	74.00	6337.57	-0.93	6337.17	-1.12	0.40	0.5400	CIRCULAR	18.000	18.000
2	FAKE_PIPE	5.00	6342.50	3.50	6337.00	1.00	5.50	110.0000	CIRCULAR	9.960	9.960
3	Link-08	15.00	6345.00	6.00	6336.00	0.00	9.00	60.0000	CIRCULAR	39.960	39.960
4	NORTHERN_CULVERT	72.00	6336.78	-0.42	6336.37	-1.92	0.41	0.5700	CIRCULAR	24.000	24.000
5	SOUTHERN_PIPE	103.00	6340.80	0.00	6339.00	0.00	1.80	1.7500	CIRCULAR	18.000	18.000

No. of
Barrels

	1
	1
	1
	1
	1

Pipe Results

SN Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Surcharge
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		
1 CENTRAL_CULVERT	13.21	0 00:48	7.27	1.82	7.54	0.16	1.46	0.97	
2 FAKE_PIPE	14.23	0 00:45	59.75	0.24	50.00	0.00	0.30	0.36	
3 Link-08	0.00	0 00:00	8895.17	0.00	0.00		0.69	0.21	
4 NORTHERN_CULVERT	15.97	0 00:40	36.19	0.44	5.59	0.21	1.71	0.86	
5 SOUTHERN_PIPE	13.17	0 00:36	18.05	0.73	7.45	0.23	1.50	1.00	17

Inlet Input

SN Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Inlet Depth (ft)	Init Wat Elevati (
1 SOUTHERN_INLET	FHWA HEC-22 GENERIC	N/A	On Sag	1	6340.80	6345.80	5.00	0.0

Roadway & Gutter Input

SN	Element	Roadway Longitudinal Slope (ft/ft)	Roadway Cross Slope (ft/ft)	Roadway Manning's Roughness	Gutter Cross Slope (ft/ft)	Gutter Width (ft)	Gutter Depression (in)	Allowable Spread (ft)
1	SOUTHERN_INLET	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00

Inlet Results

SN	Element	Peak Flow	Peak Lateral Inflow	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)	Max Gutter Water Depth during Peak Flow (ft)	Ti Max I Occur (days hh)
1	SOUTHERN_INLET	13.69	13.69	N/A	N/A	N/A	30.19	6346.51	0.71	0

Storage Nodes

Storage Node : CENTRAL_CULVERT

Input Data

Invert Elevation (ft)	6338.50
Max (Rim) Elevation (ft)	6342.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6338.50
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

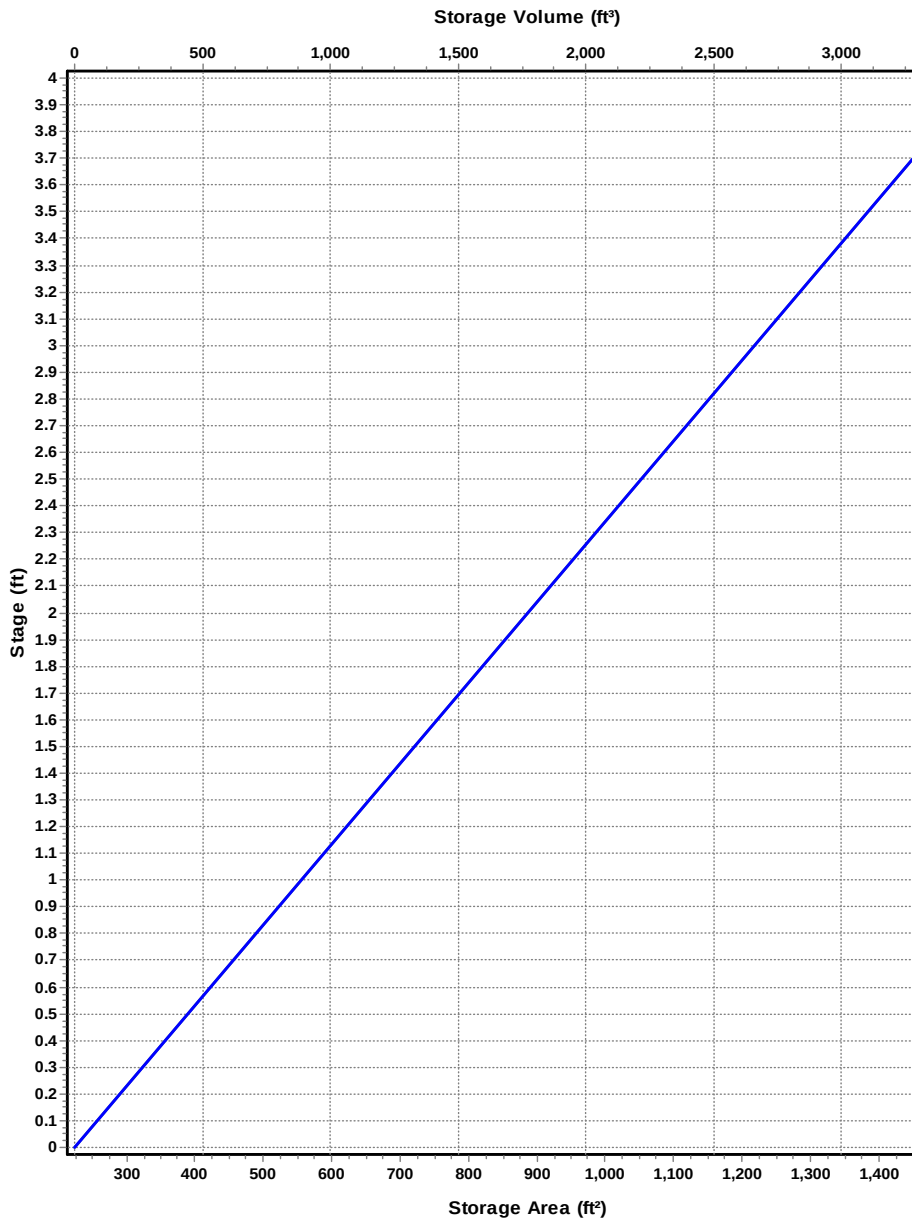
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : CENTRAL CULVERT

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	224	0
4	1550	3548

Storage Area Volume Curves



Storage Node : CENTRAL_CULVERT (continued)

Output Summary Results

Peak Inflow (cfs)	15.48
Peak Lateral Inflow (cfs)	15.48
Peak Outflow (cfs)	13.21
Peak Exfiltration Flow Rate (cfm)	98.05
Max HGL Elevation Attained (ft)	6341.26
Max HGL Depth Attained (ft)	2.76
Average HGL Elevation Attained (ft)	6338.61
Average HGL Depth Attained (ft)	0.11
Time of Max HGL Occurrence (days hh:mm)	0 00:47
Total Exfiltration Volume (1000-ft³)	7.549
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : INFIL_POND

Input Data

Invert Elevation (ft)	6336.00
Max (Rim) Elevation (ft)	6339.10
Max (Rim) Offset (ft)	3.10
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6336.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

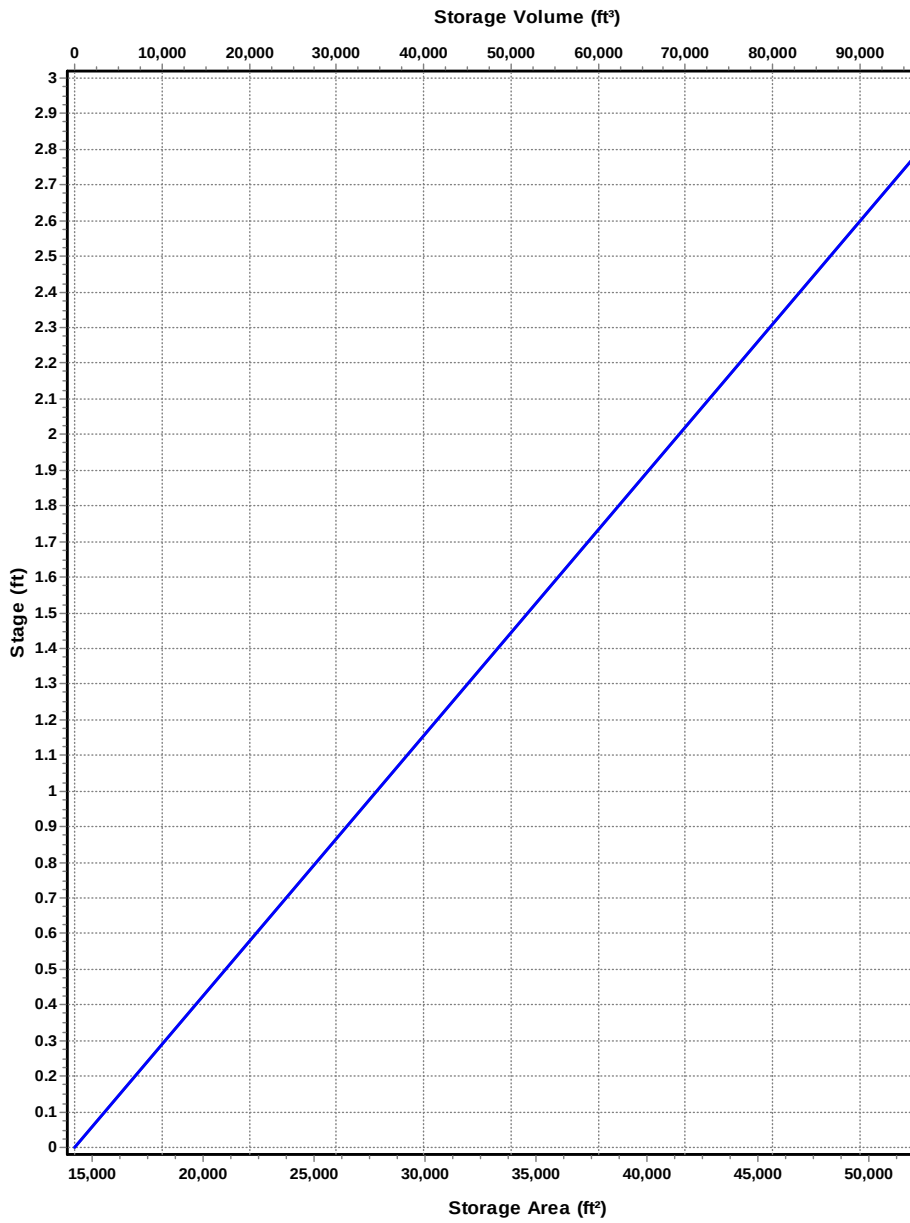
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : INFILTRATION POND

Stage	Storage	Storage
	Area	Volume
(ft)	(ft²)	(ft³)
0	14221	0
3	55036	103885.5

Storage Area Volume Curves



Storage Node : INFIL_POND (continued)

Output Summary Results

Peak Inflow (cfs)	59.35
Peak Lateral Inflow (cfs)	23.13
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	2748.21
Max HGL Elevation Attained (ft)	6337.38
Max HGL Depth Attained (ft)	1.38
Average HGL Elevation Attained (ft)	6336.04
Average HGL Depth Attained (ft)	0.04
Time of Max HGL Occurrence (days hh:mm)	0 00:55
Total Exfiltration Volume (1000-ft³)	185.715
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : NORTH_CULVERT

Input Data

Invert Elevation (ft)	6337.20
Max (Rim) Elevation (ft)	6341.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6337.20
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

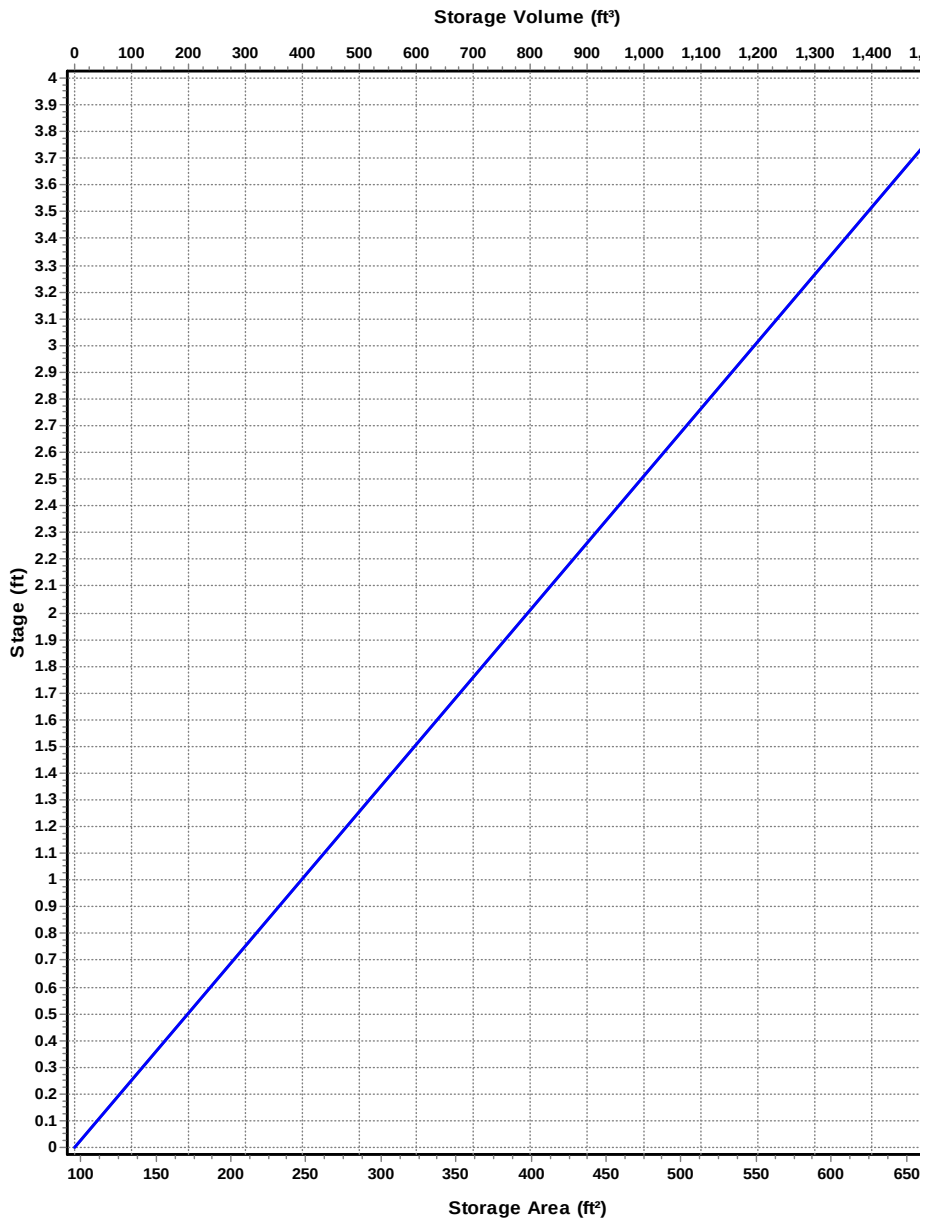
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : NORTHERN CULVERT

Stage	Storage	Storage
(ft)	Area	Volume
	(ft²)	(ft³)
0	96	0
4	700	1592

Storage Area Volume Curves



Storage Node : NORTH_CULVERT (continued)

Output Summary Results

Peak Inflow (cfs)	17.01
Peak Lateral Inflow (cfs)	17.01
Peak Outflow (cfs)	15.97
Peak Exfiltration Flow Rate (cfm)	54.7
Max HGL Elevation Attained (ft)	6340.58
Max HGL Depth Attained (ft)	3.38
Average HGL Elevation Attained (ft)	6337.38
Average HGL Depth Attained (ft)	0.18
Time of Max HGL Occurrence (days hh:mm)	0 00:40
Total Exfiltration Volume (1000-ft³)	5.663
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name ihouse SSA model.SPF

Project Options

Flow Units CFS
Elevation Type Elevation
Hydrology Method Rational
Time of Concentration (TOC) Method SCS TR-55
Link Routing Method Hydrodynamic
Enable Overflow Ponding at Nodes YES
Skip Steady State Analysis Time Periods YES

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 6:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days 0 days
Runoff (Dry Weather) Time Step 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step 0 00:05:00 days hh:mm:ss
Reporting Time Step 0 00:05:00 days hh:mm:ss
Routing Time Step 5 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	10
Nodes.....	8
<i>Junctions</i>	3
<i>Outfalls</i>	1
<i>Flow Diversions</i>	0
<i>Inlets</i>	1
<i>Storage Nodes</i>	3
Links.....	8
<i>Channels</i>	3
<i>Pipes</i>	5
<i>Pumps</i>	0
<i>Orifices</i>	0
<i>Weirs</i>	0
<i>Outlets</i>	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period 100 year(s)

Subbasin Summary

SN	Subbasin ID	Area	Weighted Runoff Coefficient	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	Subbasin_1	7.20	0.4000	1.02	0.41	2.94	13.23	0 00:13:15
2	Subbasin_10	3.23	0.9000	0.88	0.79	2.55	15.27	0 00:10:00
3	Subbasin_2	9.38	0.4100	1.08	0.44	4.15	16.58	0 00:14:58
4	Subbasin_3	4.53	0.7300	0.94	0.69	3.10	16.43	0 00:11:16
5	Subbasin_4	3.08	0.6200	0.88	0.54	1.67	10.03	0 00:10:00
6	Subbasin_5	0.93	0.5800	0.88	0.51	0.48	2.81	0 00:10:13
7	Subbasin_6	0.61	0.4000	0.88	0.35	0.21	1.28	0 00:10:00
8	Subbasin_7	0.13	0.9500	0.88	0.83	0.11	0.65	0 00:10:00
9	Subbasin_8	0.11	0.9500	0.88	0.83	0.09	0.53	0 00:10:00
10	Subbasin_9	1.70	0.9500	0.94	0.90	1.52	7.95	0 00:11:30

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Surcharge Elevation	Ponded Area	Peak Inflow	Max HGL Elevation Attained	Max Surcharge Depth
			(ft)	(ft)	(ft)	(ft)	(ft²)	(cfs)	(ft)	
1	3-Jun	Junction	6339.00	6342.00	0.00	6342.00	0.00	1.38	6339.70	0.00
2	SOUTHERN_INLET_FES	Junction	6339.00	6342.00	0.00	6342.00	0.00	14.97	6342.86	0.00
3	SWALE_CONVERGE	Junction	6338.29	6342.29	0.00	4.00	0.00	33.32	6339.82	0.00
4	Out-04	Outfall	6339.00					0.00	6339.00	
5	CENTRAL_CULVERT	Storage Node	6338.50	6342.50	0.00		0.00	18.58	6341.98	
6	INFIL_POND	Storage Node	6336.00	6339.10	0.00		0.00	72.70	6337.74	
7	NORTH_CULVERT	Storage Node	6337.20	6341.20	0.00		0.00	20.42	6340.91	

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow Design Flow Ratio
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)	
1	CENTRAL_CULVERT	Pipe	CENTRAL_CULVERT	SWALE_CONVERGE	74.00	6337.57	6337.17	0.5400	18.000	0.0100	15.57	7.27	2.1
2	FAKE_PIPE	Pipe	SOUTHERN_INLET_FES	INFIL_POND	5.00	6342.50	6337.00	110.0000	10.000	0.0050	17.63	59.75	0.3
3	Link-08	Pipe	3-Jun	INFIL_POND	15.00	6345.00	6336.00	60.0000	40.000	0.0010	0.00	8895.17	0.0
4	NORTHERN_CULVERT	Pipe	NORTH_CULVERT	SWALE_CONVERGE	72.00	6336.78	6336.37	0.5700	24.000	0.0100	19.25	36.19	0.5
5	SOUTHERN_PIPE	Pipe	SOUTHERN_INLET	SOUTHERN_INLET_FES	103.00	6340.80	6339.00	1.7500	18.000	0.0100	14.97	18.05	0.8
6	BYPASS	Channel	SOUTHERN_INLET	3-Jun	5.00	6345.00	6345.00	0.0000	6.000	0.0140	1.38	9.15	0.1
7	Link-07	Channel	INFIL_POND	Out-04	5.00	6339.10	6339.00	2.0000	12.000	0.0320	0.00	648.11	0.0
8	SWALE	Channel	SWALE_CONVERGE	INFIL_POND	129.00	6338.39	6337.65	0.5700	36.000	0.0320	33.30	195.20	0.1

Inlet Summary

SN	Element	Inlet	Manufacturer	Inlet	Number of	Catchbasin	Max (Rim)	Initial	Ponded	Peak	Peak Flow	Peak Flow	Inlet	Allowable
	ID	Manufacturer	Part	Location	Inlets	Invert	Elevation	Water	Area	Flow	Intercepted	Bypassing	Efficiency	Spread
			Number			Elevation		Elevation			by	Inlet	during Peak	
						(ft)	(ft)	(ft)	(ft²)	(cfs)	(cfs)	(cfs)	(%)	(ft)
1	SOUTHERN_INLET	FHWA HEC-22 GENERIC	N/A	On Sag	1	6340.80	6345.80	0.00	10.00	16.43	N/A	N/A	N/A	7.00

Subbasin Hydrology

Subbasin : Subbasin_1

Input Data

Area (ac) 7.2
Weighted Runoff Coefficient 0.4

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	7.2	A	0.4
Composite Area & Weighted Runoff Coeff.	7.2		0.4

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

$T_c = (0.007 * ((n * L_f)^{0.8})) / ((P^{0.5}) * (S_f^{0.4}))$

Where :

- Tc = Time of Concentration (hr)
- n = Manning's roughness
- Lf = Flow Length (ft)
- P = 2 yr, 24 hr Rainfall (inches)
- Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

- V = 16.1345 * (Sf^0.5) (unpaved surface)
- V = 20.3282 * (Sf^0.5) (paved surface)
- V = 15.0 * (Sf^0.5) (grassed waterway surface)
- V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
- V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
- V = 7.0 * (Sf^0.5) (short grass pasture surface)
- V = 5.0 * (Sf^0.5) (woodland surface)
- V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
- Tc = (Lf / V) / (3600 sec/hr)

Where:

- Tc = Time of Concentration (hr)
- Lf = Flow Length (ft)
- V = Velocity (ft/sec)
- Sf = Slope (ft/ft)

	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	4.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.17	0	0
Computed Flow Time (min) :	9.9	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	696	0	0
Slope (%) :	4.6	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.46	0	0
Computed Flow Time (min) :	3.35	0	0
Total TOC (min)	13.25		

Subbasin Runoff Results

Total Rainfall (in)	1.02
Total Runoff (in)	0.41
Peak Runoff (cfs)	13.23
Rainfall Intensity	4.593
Weighted Runoff Coefficient	0.4
Time of Concentration (days hh:mm:ss)	0 00:13:15

Subbasin : Subbasin_1

Runoff Hydrograph



Subbasin : Subbasin_10

Input Data

Area (ac) 3.23
Weighted Runoff Coefficient 0.9

Runoff Coefficient

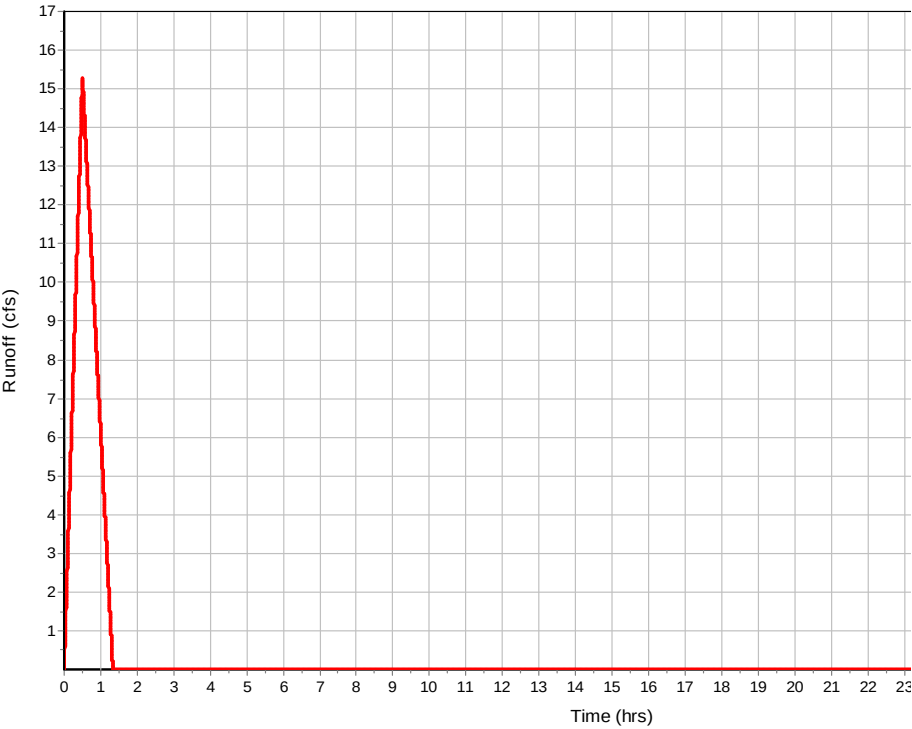
Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	3.23	A	0.9
Composite Area & Weighted Runoff Coeff.	3.23		0.9

Time of Concentration

Subbasin Runoff Results

Total Rainfall (in) 0.88
Total Runoff (in) 0.79
Peak Runoff (cfs) 15.27
Rainfall Intensity 5.251
Weighted Runoff Coefficient 0.9
Time of Concentration (days hh:mm:ss) 0 00:00:00

Runoff Hydrograph



Subbasin : Subbasin_2

Input Data

Area (ac)	9.38
Weighted Runoff Coefficient	0.41

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.16	A	0.7
-	9.22	A	0.4
Composite Area & Weighted Runoff Coeff.	9.38		0.41

Time of Concentration

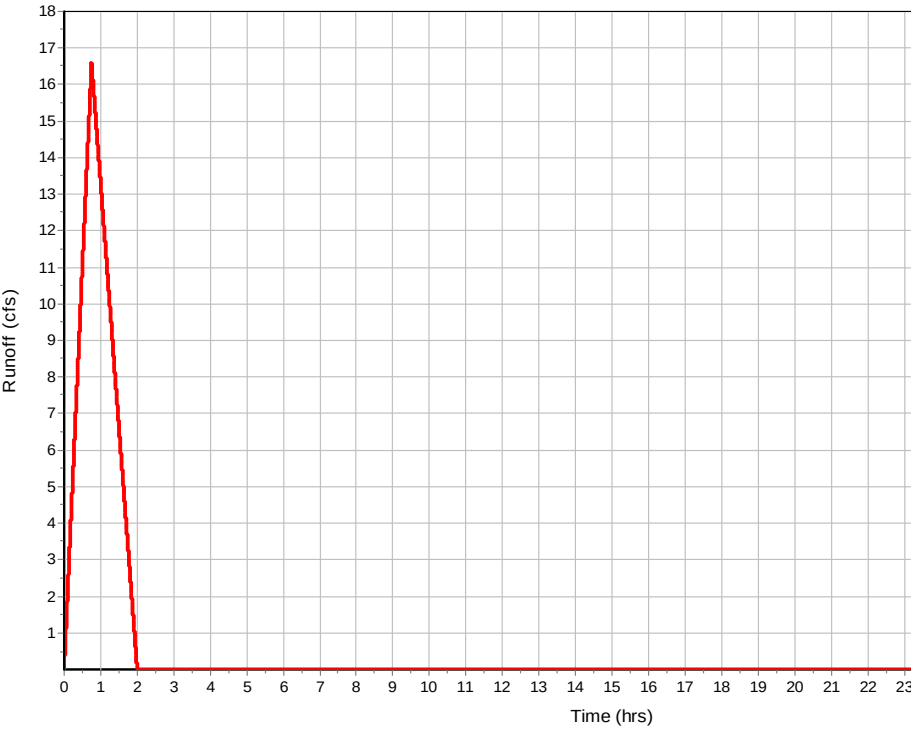
Sheet Flow Computations	Subarea	Subarea	Subarea
	A	B	C
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.21	0	0
Computed Flow Time (min) :	8.1	0	0
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
Flow Length (ft) :	1278	0	0
Slope (%) :	3.7	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.1	0	0
Computed Flow Time (min) :	6.87	0	0
Total TOC (min)	14.97		

Subbasin Runoff Results

Total Rainfall (in)	1.08
Total Runoff (in)	0.44
Peak Runoff (cfs)	16.58
Rainfall Intensity	4.311
Weighted Runoff Coefficient	0.41
Time of Concentration (days hh:mm:ss)	0 00:14:58

Subbasin : Subbasin_2

Runoff Hydrograph



Subbasin : Subbasin_3

Input Data

Area (ac)	4.53
Weighted Runoff Coefficient	0.73

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	1.74	A	0.7
-	1	A	0.4
-	1.79	A	0.95
Composite Area & Weighted Runoff Coeff.	4.53		0.73

Time of Concentration

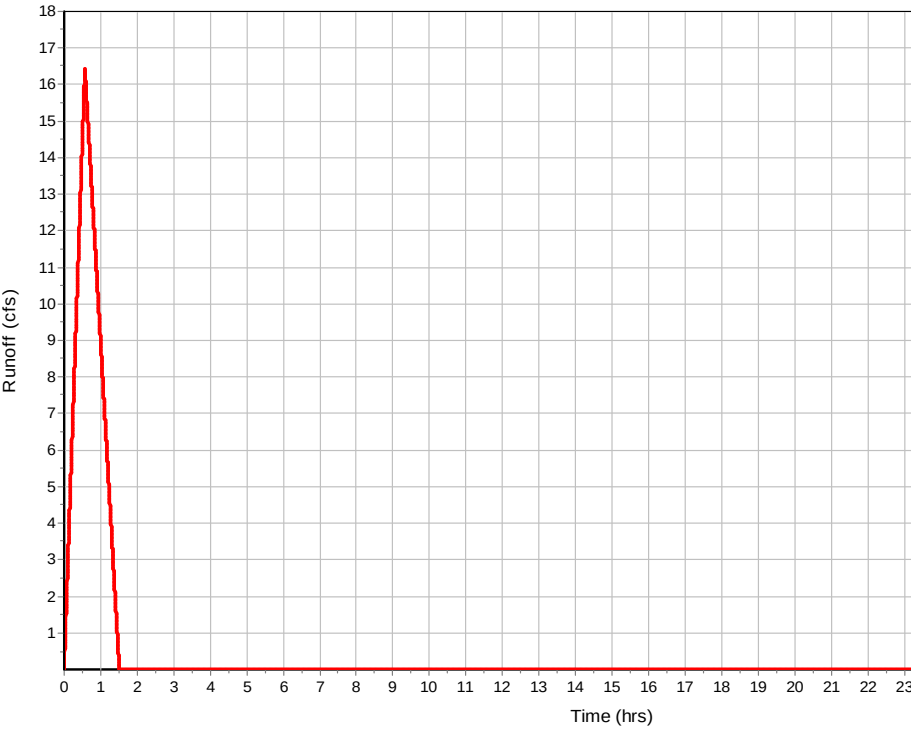
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	115	0	0
Slope (%) :	10.8	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.24	0	0
Computed Flow Time (min) :	7.87	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	820	0	0
Slope (%) :	3.9	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	4.01	0	0
Computed Flow Time (min) :	3.41	0	0
Total TOC (min)	11.28		

Subbasin Runoff Results

Total Rainfall (in)	0.94
Total Runoff (in)	0.69
Peak Runoff (cfs)	16.43
Rainfall Intensity	4.969
Weighted Runoff Coefficient	0.73
Time of Concentration (days hh:mm:ss)	0 00:11:17

Subbasin : Subbasin_3

Runoff Hydrograph



Subbasin : Subbasin_4

Input Data

Area (ac) 3.08
Weighted Runoff Coefficient 0.62

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.62	A	0.7
-	1.55	A	0.4
-	0.91	A	0.95
Composite Area & Weighted Runoff Coeff.	3.08		0.62

Time of Concentration

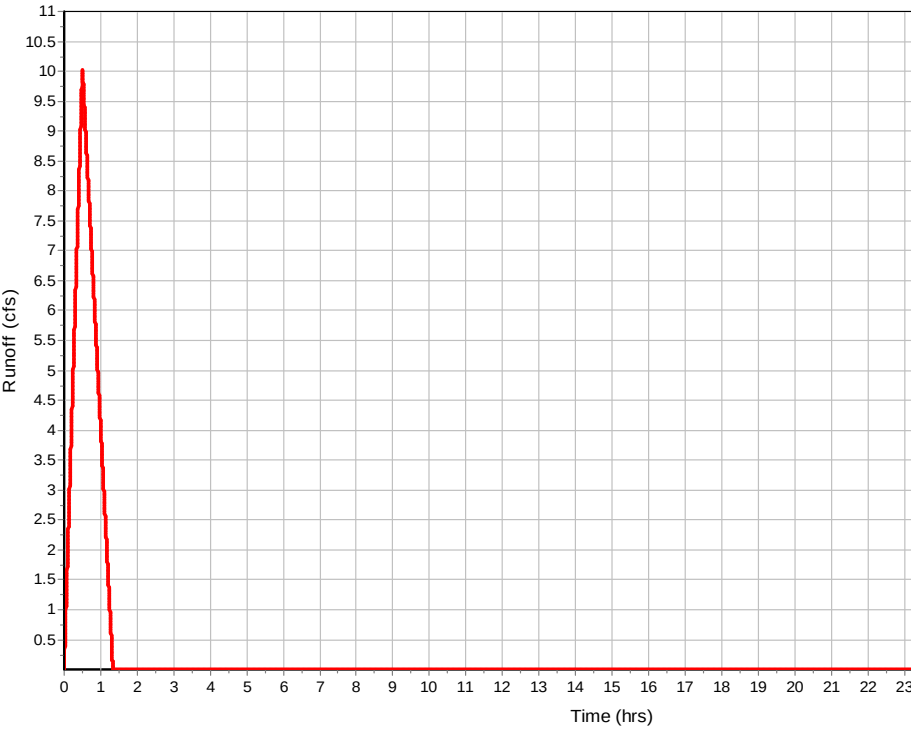
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.6	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.21	0	0
Computed Flow Time (min) :	8.1	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	103	125	56
Slope (%) :	7.6	3.7	1.8
Surface Type :	Bare & untilled	Unpaved	Paved
Velocity (ft/sec) :	2.76	3.1	2.73
Computed Flow Time (min) :	0.62	0.67	0.34
Total TOC (min)	9.74		

Subbasin Runoff Results

Total Rainfall (in) 0.88
Total Runoff (in) 0.54
Peak Runoff (cfs) 10.03
Rainfall Intensity 5.251
Weighted Runoff Coefficient 0.62
Time of Concentration (days hh:mm:ss) 0 00:09:44

Subbasin : Subbasin_4

Runoff Hydrograph



Subbasin : Subbasin_5

Input Data

Area (ac)	0.93
Weighted Runoff Coefficient	0.58

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.31	A	0.95
-	0.62	A	0.4
Composite Area & Weighted Runoff Coeff.	0.93		0.58

Time of Concentration

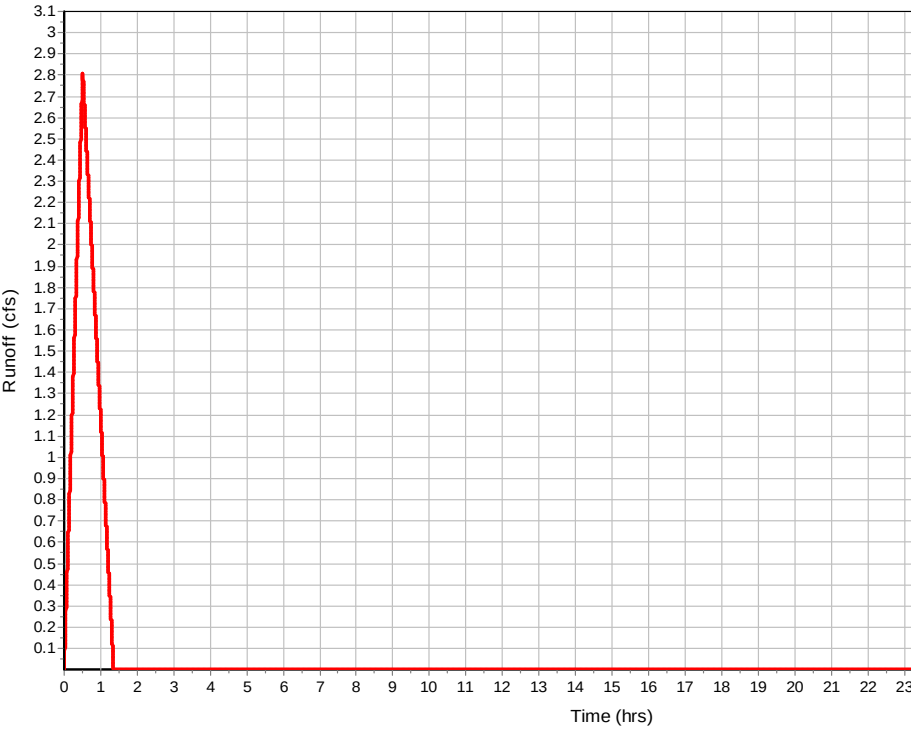
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	5.2	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.18	0	0
Computed Flow Time (min) :	9.43	0	0
Shallow Concentrated Flow Computations			
Flow Length (ft) :	174	0	0
Slope (%) :	5.2	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	3.68	0	0
Computed Flow Time (min) :	0.79	0	0
Total TOC (min)	10.22		

Subbasin Runoff Results

Total Rainfall (in)	0.88
Total Runoff (in)	0.51
Peak Runoff (cfs)	2.81
Rainfall Intensity	5.2
Weighted Runoff Coefficient	0.58
Time of Concentration (days hh:mm:ss)	0 00:10:13

Subbasin : Subbasin_5

Runoff Hydrograph



Subbasin : Subbasin_6

Input Data

Area (ac) 0.61
Weighted Runoff Coefficient 0.4

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.61	A	0.4
Composite Area & Weighted Runoff Coeff.	0.61		0.4

Time of Concentration

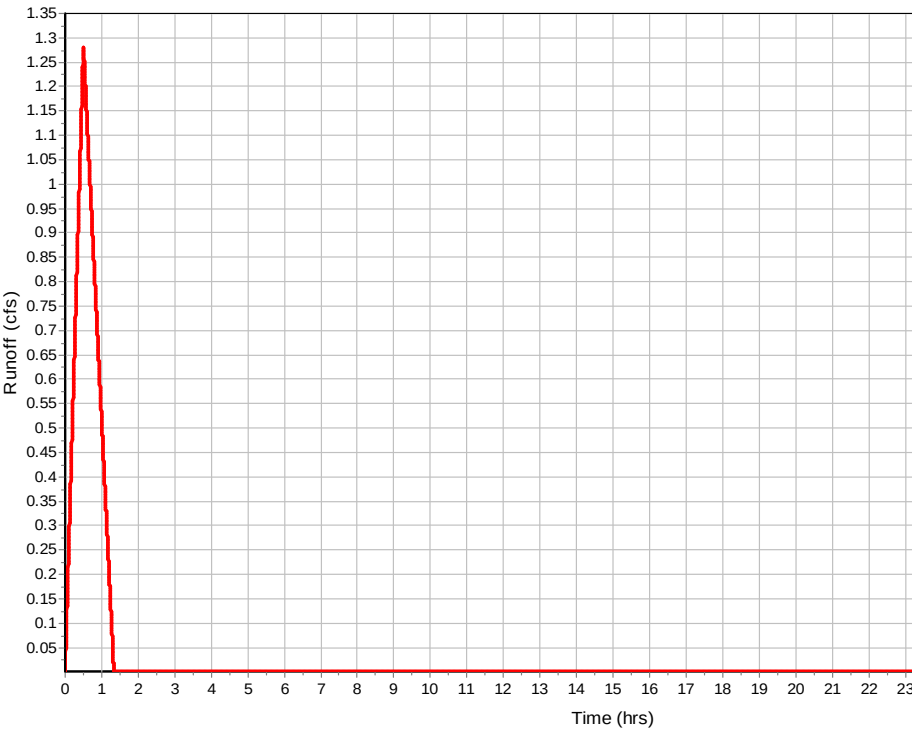
	Subarea	Subarea	Subarea
	A	B	C
Sheet Flow Computations			
Manning's Roughness :	0.13	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	7.4	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.2	0	0
Computed Flow Time (min) :	8.19	0	0
	Subarea	Subarea	Subarea
	A	B	C
Shallow Concentrated Flow Computations			
Flow Length (ft) :	131	0	0
Slope (%) :	7.4	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	5.53	0	0
Computed Flow Time (min) :	0.39	0	0
Total TOC (min)	8.58		

Subbasin Runoff Results

Total Rainfall (in) 0.88
Total Runoff (in) 0.35
Peak Runoff (cfs) 1.28
Rainfall Intensity 5.251
Weighted Runoff Coefficient 0.4
Time of Concentration (days hh:mm:ss) 0 00:08:35

Subbasin : Subbasin_6

Runoff Hydrograph



Subbasin : Subbasin_7

Input Data

Area (ac) 0.13
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.13	A	0.95
Composite Area & Weighted Runoff Coeff.	0.13		0.95

Time of Concentration

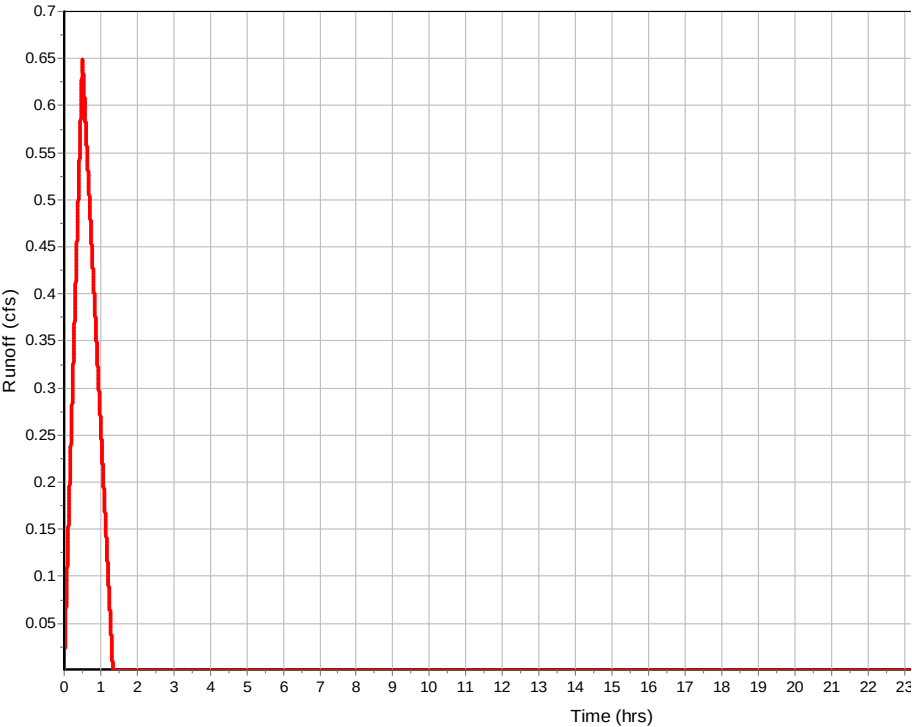
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
Flow Length (ft) :	264	0	0
Slope (%) :	2	0	0
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	2.87	0	0
Computed Flow Time (min) :	1.53	0	0
Total TOC (min)	1.53		

Subbasin Runoff Results

Total Rainfall (in) 0.88
Total Runoff (in) 0.83
Peak Runoff (cfs) 0.65
Rainfall Intensity 5.251
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:01:32

Subbasin : Subbasin_7

Runoff Hydrograph



Subbasin : Subbasin_8

Input Data

Area (ac) 0.11
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.11	A	0.95
Composite Area & Weighted Runoff Coeff.	0.11		0.95

Time of Concentration

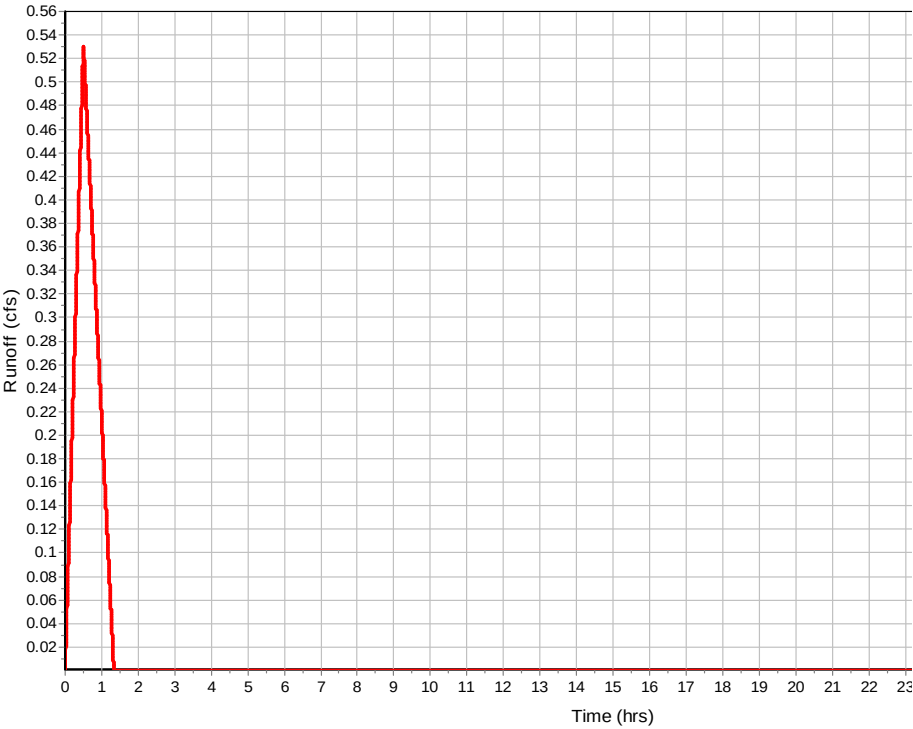
	Subarea A	Subarea B	Subarea C
Sheet Flow Computations			
Manning's Roughness :	0.015	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2	0	0
2 yr, 24 hr Rainfall (in) :	1.28	0	0
Velocity (ft/sec) :	0.68	0	0
Computed Flow Time (min) :	2.46	0	0
Total TOC (min)2.46			

Subbasin Runoff Results

Total Rainfall (in) 0.88
Total Runoff (in) 0.83
Peak Runoff (cfs) 0.53
Rainfall Intensity 5.251
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:02:28

Subbasin : Subbasin_8

Runoff Hydrograph



Subbasin : Subbasin_9

Input Data

Area (ac) 1.7
Weighted Runoff Coefficient 0.95

Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	1.7	A	0.95
Composite Area & Weighted Runoff Coeff.	1.7		0.95

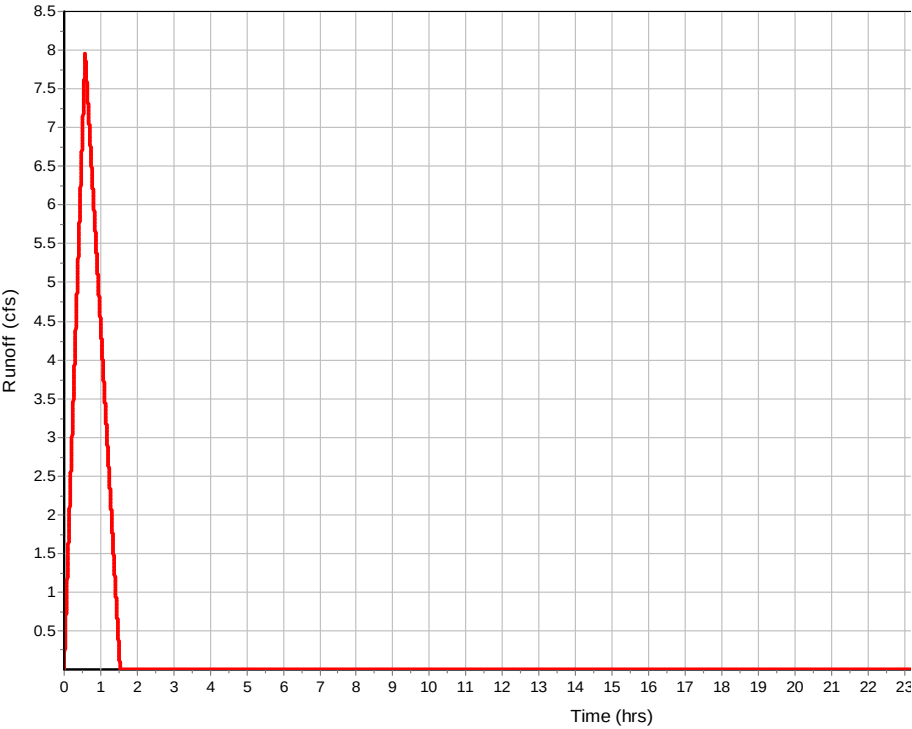
Time of Concentration

Sheet Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	0.13	0	0
	Flow Length (ft) :	80	0
	Slope (%) :	3	0
	2 yr, 24 hr Rainfall (in) :	1.28	0
	Velocity (ft/sec) :	0.14	0
	Computed Flow Time (min) :	9.83	0
Shallow Concentrated Flow Computations	Subarea	Subarea	Subarea
	A	B	C
	300	44	0
	Flow Length (ft) :	3	0
	Slope (%) :	3	0
	Surface Type :	Paved	Unpaved
	Velocity (ft/sec) :	3.52	2.79
	Computed Flow Time (min) :	1.42	0.26
Total TOC (min)11.51			

Subbasin Runoff Results

Total Rainfall (in) 0.94
Total Runoff (in) 0.9
Peak Runoff (cfs) 7.95
Rainfall Intensity 4.922
Weighted Runoff Coefficient 0.95
Time of Concentration (days hh:mm:ss) 0 00:11:31

Runoff Hydrograph



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Mini C
1	3-Jun	6339.00	6342.00	3.00	0.00	-6339.00	6342.00	0.00	0.00	
2	SOUTHERN_INLET_FES	6339.00	6342.00	3.00	0.00	-6339.00	6342.00	0.00	0.00	
3	SWALE_CONVERGE	6338.29	6342.29	4.00	0.00	-6338.29	4.00	-6338.29	0.00	1

Junction Results

SN	Element ID	Peak Inflow	Peak Lateral Inflow	Max HGL Elevation Attained	Max HGL Depth Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time Max Occurrence
		(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)
1	3-Jun	1.38	0.00	6339.70	0.70	0.00	8.64	6339.68	0.68	0 00
2	SOUTHERN_INLET_FES	14.97	0.00	6342.86	3.86	0.00	0.48	6342.49	3.49	0 00
3	SWALE_CONVERGE	33.32	0.00	6339.82	1.53	0.00	2.47	6338.36	0.07	0 00

Channel Input

SN	Element ID	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Drop	Average Slope	Shape	Height	Width	Manning's Roughness	Entrance Loss
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(ft)	(ft)		
1	BYPASS	5.00	6345.00	4.20	6345.00	6.00	0.00	0.0000	Rectangular	0.500	20.000	0.0140	0.000
2	Link-07	5.00	6339.10	3.10	6339.00	0.00	0.10	2.0000	Rectangular	1.000	100.000	0.0320	0.000
3	SWALE	129.00	6338.39	0.10	6337.65	1.65	0.74	0.5700	Trapezoidal	3.000	22.000	0.0320	0.500

Channel Results

SN	Element	Peak	Time of	Design Flow	Peak Flow/	Peak Flow	Travel	Peak Flow	Peak Flow	Total Time	Froude
	ID	Flow	Peak Flow	Capacity	Design Flow	Velocity	Time	Depth	Depth/	Surcharged	Number
			Occurrence		Ratio				Total Depth		
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)	Ratio	(min)	
1	BYPASS	1.38	0 00:34	9.15	0.15	1.08	0.08	0.06	0.13	0.00	
2	Link-07	0.00	0 00:00	648.11	0.00	0.00		0.00	0.00	0.00	
3	SWALE	33.30	0 00:43	195.20	0.17	3.57	0.60	1.22	0.41	0.00	

Pipe Input

SN	Element ID	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Drop	Average Slope	Pipe Shape	Pipe Diameter or Height	Pipe Width
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(in)	(in)
1	CENTRAL_CULVERT	74.00	6337.57	-0.93	6337.17	-1.12	0.40	0.5400	CIRCULAR	18.000	18.000
2	FAKE_PIPE	5.00	6342.50	3.50	6337.00	1.00	5.50	110.0000	CIRCULAR	9.960	9.960
3	Link-08	15.00	6345.00	6.00	6336.00	0.00	9.00	60.0000	CIRCULAR	39.960	39.960
4	NORTHERN_CULVERT	72.00	6336.78	-0.42	6336.37	-1.92	0.41	0.5700	CIRCULAR	24.000	24.000
5	SOUTHERN_PIPE	103.00	6340.80	0.00	6339.00	0.00	1.80	1.7500	CIRCULAR	18.000	18.000

No. of
Barrels

	1
	1
	1
	1
	1

Pipe Results

SN	Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Surcharge
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		
1	CENTRAL_CULVERT	15.57	0 00:49	7.27	2.14	8.81	0.14	1.50	1.00	
2	FAKE_PIPE	17.63	0 00:37	59.75	0.30	50.00	0.00	0.49	0.59	
3	Link-08	0.00	0 00:00	8895.17	0.00	0.00		0.87	0.26	
4	NORTHERN_CULVERT	19.25	0 00:40	36.19	0.53	6.56	0.18	1.77	0.88	
5	SOUTHERN_PIPE	14.97	0 00:34	18.05	0.83	8.47	0.20	1.50	1.00	17

Inlet Input

SN Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Inlet Depth (ft)	Init Wat Elevati (
1 SOUTHERN_INLET	FHWA HEC-22 GENERIC	N/A	On Sag	1	6340.80	6345.80	5.00	0.0

Roadway & Gutter Input

SN	Element	Roadway	Roadway	Roadway	Gutter	Gutter	Gutter	Allowable
	ID	Longitudinal	Cross	Manning's	Cross	Width	Depression	Spread
		Slope	Slope	Roughness	Slope			
		(ft/ft)	(ft/ft)		(ft/ft)	(ft)	(in)	(ft)
1	SOUTHERN_INLET	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00

Inlet Results

SN	Element	Peak Flow	Peak Lateral Inflow	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)	Max Gutter Water Depth during Peak Flow (ft)	Ti Max I Occur (days hh)
1	SOUTHERN_INLET	16.43	16.43	N/A	N/A	N/A	33.01	6346.57	0.77	0

Storage Nodes

Storage Node : CENTRAL_CULVERT

Input Data

Invert Elevation (ft)	6338.50
Max (Rim) Elevation (ft)	6342.50
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6338.50
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

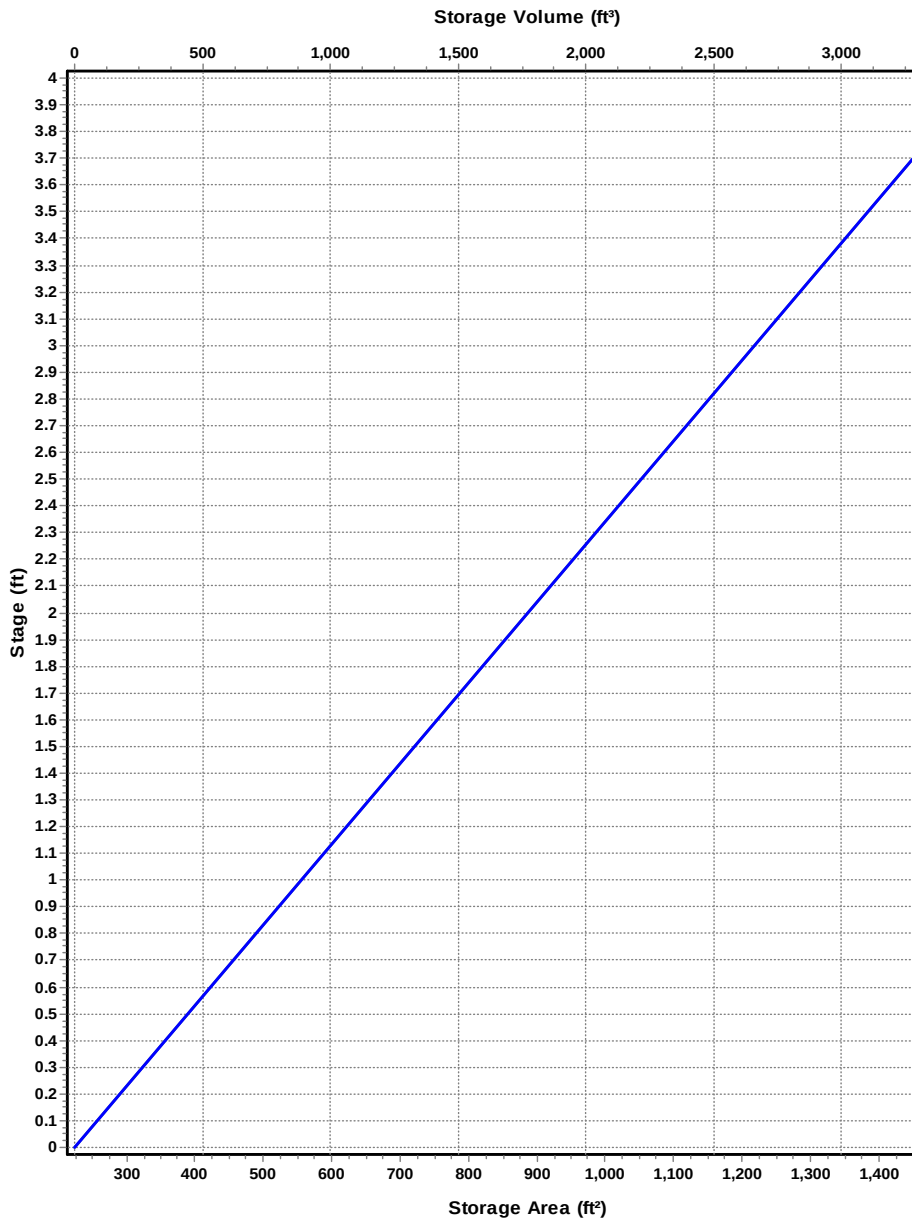
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : CENTRAL CULVERT

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	224	0
4	1550	3548

Storage Area Volume Curves



Storage Node : CENTRAL_CULVERT (continued)

Output Summary Results

Peak Inflow (cfs)	18.58
Peak Lateral Inflow (cfs)	18.58
Peak Outflow (cfs)	15.57
Peak Exfiltration Flow Rate (cfm)	119.36
Max HGL Elevation Attained (ft)	6341.98
Max HGL Depth Attained (ft)	3.48
Average HGL Elevation Attained (ft)	6338.63
Average HGL Depth Attained (ft)	0.13
Time of Max HGL Occurrence (days hh:mm)	0 00:48
Total Exfiltration Volume (1000-ft³)	8.62
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : INFIL_POND

Input Data

Invert Elevation (ft)	6336.00
Max (Rim) Elevation (ft)	6339.10
Max (Rim) Offset (ft)	3.10
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6336.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

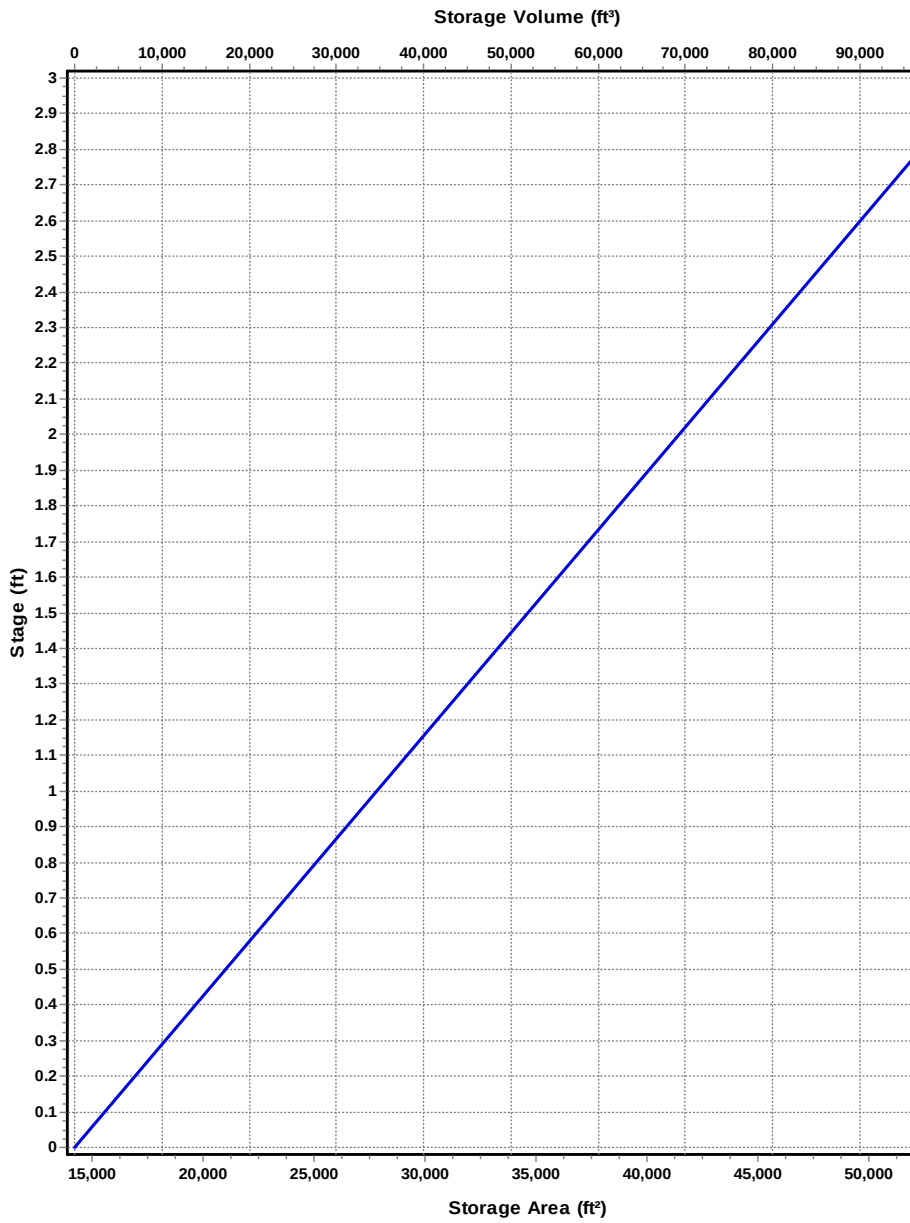
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : INFILTRATION POND

Stage	Storage Area	Storage Volume
(ft)	(ft²)	(ft³)
0	14221	0
3	55036	103885.5

Storage Area Volume Curves



Storage Node : INFIL_POND (continued)

Output Summary Results

Peak Inflow (cfs)	72.7
Peak Lateral Inflow (cfs)	27.75
Peak Outflow (cfs)	0
Peak Exfiltration Flow Rate (cfm)	3161.67
Max HGL Elevation Attained (ft)	6337.74
Max HGL Depth Attained (ft)	1.74
Average HGL Elevation Attained (ft)	6336.06
Average HGL Depth Attained (ft)	0.06
Time of Max HGL Occurrence (days hh:mm)	0 00:57
Total Exfiltration Volume (1000-ft³)	224.355
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : NORTH_CULVERT

Input Data

Invert Elevation (ft)	6337.20
Max (Rim) Elevation (ft)	6341.20
Max (Rim) Offset (ft)	4.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	-6337.20
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Infiltration/Exfiltration

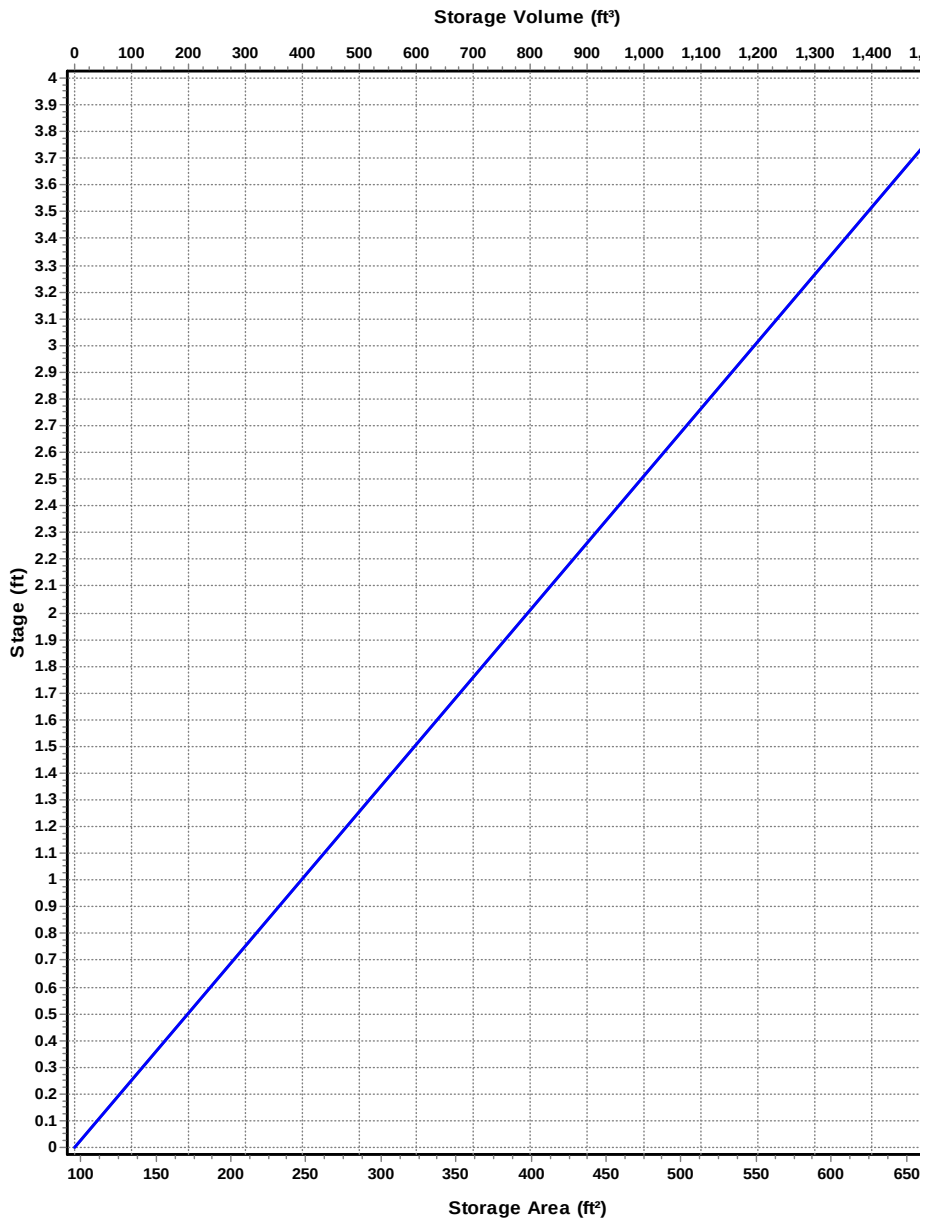
Exfiltration Rate (in/hr)	60
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Storage Area Volume Curves

Storage Curve : NORTHERN CULVERT

Stage	Storage Area	Storage Volume
(ft)	(ft²)	(ft³)
0	96	0
4	700	1592

Storage Area Volume Curves



Storage Node : NORTH_CULVERT (continued)

Output Summary Results

Peak Inflow (cfs)	20.42
Peak Lateral Inflow (cfs)	20.42
Peak Outflow (cfs)	19.25
Peak Exfiltration Flow Rate (cfm)	59.53
Max HGL Elevation Attained (ft)	6340.91
Max HGL Depth Attained (ft)	3.71
Average HGL Elevation Attained (ft)	6337.39
Average HGL Depth Attained (ft)	0.19
Time of Max HGL Occurrence (days hh:mm)	0 00:40
Total Exfiltration Volume (1000-ft³)	5.98
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

APPENDIX 3: NOAA PRECIPITATION DATA





NOAA Atlas 14, Volume 1, Version 5
Location name: Kaibeto, Arizona, USA*
Latitude: 36.597°, Longitude: -110.791°
Elevation: 6344 ft**

* source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

PF tabular

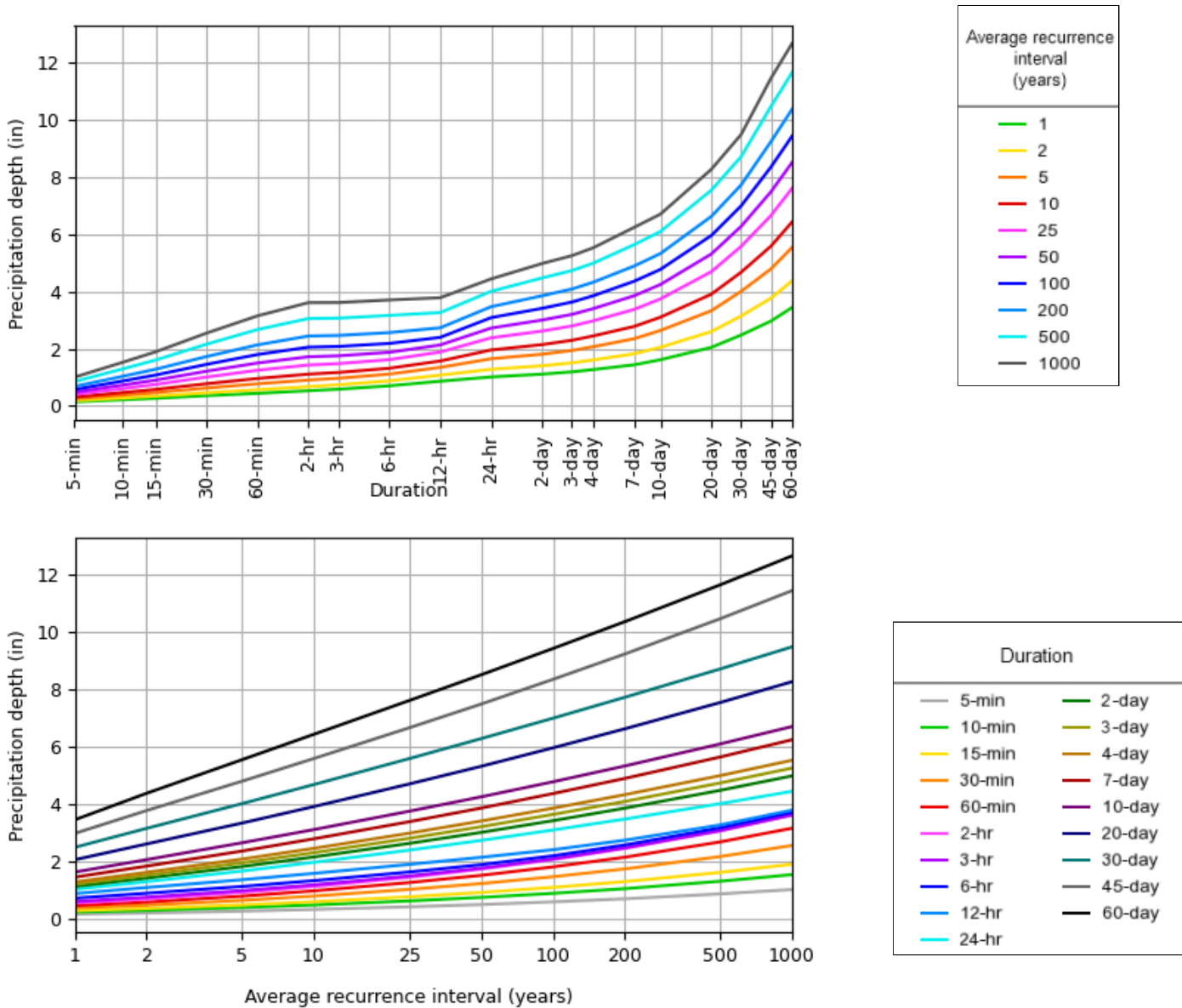
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.139 (0.118-0.164)	0.179 (0.153-0.212)	0.245 (0.208-0.290)	0.304 (0.255-0.360)	0.396 (0.325-0.470)	0.476 (0.385-0.565)	0.570 (0.451-0.681)	0.678 (0.522-0.818)	0.848 (0.627-1.04)	1.00 (0.715-1.24)
10-min	0.212 (0.180-0.250)	0.272 (0.232-0.322)	0.373 (0.317-0.441)	0.462 (0.387-0.547)	0.602 (0.495-0.716)	0.725 (0.586-0.860)	0.868 (0.686-1.04)	1.03 (0.794-1.24)	1.29 (0.954-1.58)	1.52 (1.09-1.89)
15-min	0.262 (0.223-0.310)	0.338 (0.288-0.400)	0.462 (0.392-0.547)	0.573 (0.480-0.678)	0.747 (0.614-0.887)	0.898 (0.726-1.07)	1.08 (0.850-1.28)	1.28 (0.985-1.54)	1.60 (1.18-1.96)	1.89 (1.35-2.35)
30-min	0.352 (0.300-0.418)	0.454 (0.388-0.538)	0.622 (0.528-0.736)	0.772 (0.646-0.914)	1.00 (0.826-1.20)	1.21 (0.977-1.44)	1.45 (1.14-1.73)	1.72 (1.33-2.08)	2.16 (1.59-2.63)	2.54 (1.82-3.16)
60-min	0.436 (0.371-0.517)	0.562 (0.480-0.666)	0.769 (0.653-0.911)	0.955 (0.800-1.13)	1.24 (1.02-1.48)	1.50 (1.21-1.78)	1.79 (1.42-2.14)	2.13 (1.64-2.57)	2.67 (1.97-3.26)	3.15 (2.25-3.91)
2-hr	0.526 (0.456-0.612)	0.668 (0.577-0.777)	0.900 (0.772-1.04)	1.11 (0.939-1.28)	1.43 (1.19-1.66)	1.72 (1.41-2.00)	2.05 (1.64-2.41)	2.44 (1.91-2.90)	3.05 (2.29-3.68)	3.61 (2.62-4.41)
3-hr	0.579 (0.510-0.666)	0.734 (0.642-0.845)	0.963 (0.841-1.11)	1.16 (1.01-1.34)	1.48 (1.26-1.70)	1.75 (1.47-2.02)	2.08 (1.71-2.41)	2.46 (1.98-2.92)	3.07 (2.39-3.71)	3.61 (2.74-4.46)
6-hr	0.698 (0.625-0.787)	0.872 (0.778-0.981)	1.11 (0.983-1.25)	1.31 (1.16-1.48)	1.61 (1.41-1.82)	1.87 (1.61-2.12)	2.18 (1.85-2.49)	2.56 (2.13-2.95)	3.16 (2.57-3.75)	3.70 (2.94-4.50)
12-hr	0.859 (0.776-0.957)	1.07 (0.968-1.20)	1.34 (1.21-1.50)	1.57 (1.40-1.75)	1.88 (1.67-2.10)	2.13 (1.87-2.38)	2.39 (2.09-2.69)	2.73 (2.35-3.09)	3.26 (2.75-3.79)	3.78 (3.14-4.55)
24-hr	1.01 (0.897-1.14)	1.28 (1.14-1.44)	1.65 (1.46-1.86)	1.95 (1.73-2.20)	2.38 (2.09-2.68)	2.72 (2.38-3.08)	3.08 (2.68-3.49)	3.47 (2.99-3.93)	4.00 (3.41-4.57)	4.44 (3.73-5.09)
2-day	1.11 (0.982-1.25)	1.40 (1.24-1.58)	1.80 (1.60-2.04)	2.14 (1.88-2.42)	2.61 (2.29-2.96)	3.00 (2.60-3.40)	3.41 (2.93-3.87)	3.85 (3.28-4.39)	4.47 (3.75-5.13)	4.98 (4.12-5.74)
3-day	1.19 (1.05-1.34)	1.50 (1.33-1.70)	1.94 (1.71-2.18)	2.29 (2.02-2.59)	2.79 (2.44-3.16)	3.20 (2.78-3.62)	3.63 (3.12-4.12)	4.08 (3.48-4.66)	4.73 (3.97-5.42)	5.25 (4.35-6.06)
4-day	1.27 (1.13-1.43)	1.60 (1.42-1.81)	2.07 (1.83-2.33)	2.44 (2.15-2.76)	2.97 (2.60-3.36)	3.40 (2.95-3.85)	3.85 (3.32-4.37)	4.32 (3.69-4.92)	4.99 (4.19-5.72)	5.53 (4.59-6.37)
7-day	1.43 (1.28-1.62)	1.82 (1.62-2.06)	2.35 (2.08-2.66)	2.78 (2.45-3.14)	3.37 (2.96-3.82)	3.85 (3.36-4.38)	4.36 (3.77-4.96)	4.89 (4.19-5.59)	5.64 (4.77-6.48)	6.24 (5.21-7.22)
10-day	1.61 (1.44-1.81)	2.05 (1.83-2.30)	2.64 (2.34-2.96)	3.10 (2.75-3.48)	3.74 (3.29-4.21)	4.24 (3.71-4.78)	4.77 (4.14-5.39)	5.33 (4.58-6.04)	6.10 (5.18-6.96)	6.70 (5.63-7.69)
20-day	2.04 (1.82-2.30)	2.60 (2.31-2.92)	3.32 (2.96-3.75)	3.90 (3.46-4.40)	4.69 (4.13-5.29)	5.31 (4.65-6.00)	5.96 (5.18-6.75)	6.63 (5.71-7.53)	7.54 (6.42-8.63)	8.27 (6.97-9.52)
30-day	2.48 (2.21-2.79)	3.14 (2.81-3.54)	4.00 (3.56-4.52)	4.67 (4.15-5.28)	5.58 (4.92-6.31)	6.28 (5.51-7.11)	7.00 (6.10-7.94)	7.73 (6.69-8.79)	8.72 (7.46-9.98)	9.49 (8.04-10.9)
45-day	2.96 (2.65-3.34)	3.76 (3.36-4.24)	4.79 (4.26-5.41)	5.58 (4.95-6.33)	6.66 (5.87-7.55)	7.49 (6.56-8.50)	8.36 (7.26-9.52)	9.24 (7.96-10.6)	10.5 (8.90-12.1)	11.5 (9.62-13.3)
60-day	3.44 (3.06-3.87)	4.37 (3.89-4.91)	5.54 (4.92-6.24)	6.43 (5.69-7.26)	7.61 (6.69-8.59)	8.51 (7.43-9.64)	9.44 (8.18-10.7)	10.4 (8.93-11.8)	11.7 (9.90-13.4)	12.7 (10.6-14.6)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

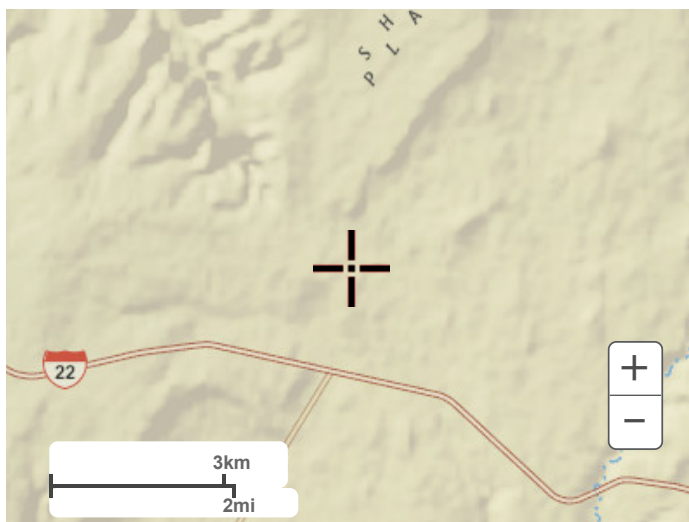
PF graphical

PDS-based depth-duration-frequency (DDF) curves
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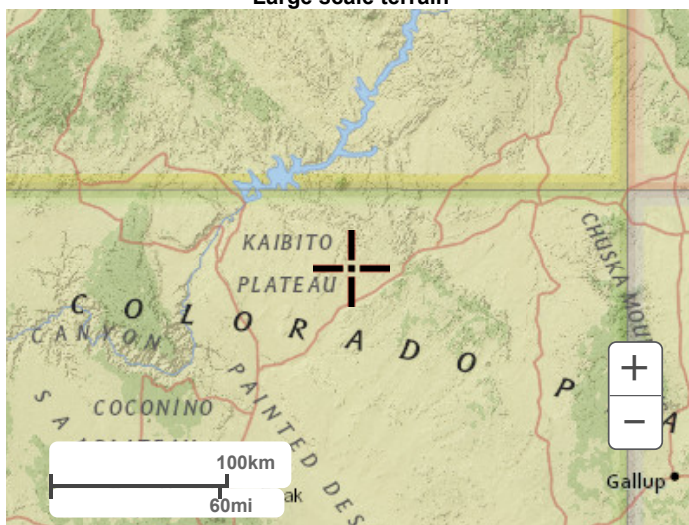


Maps & aerials

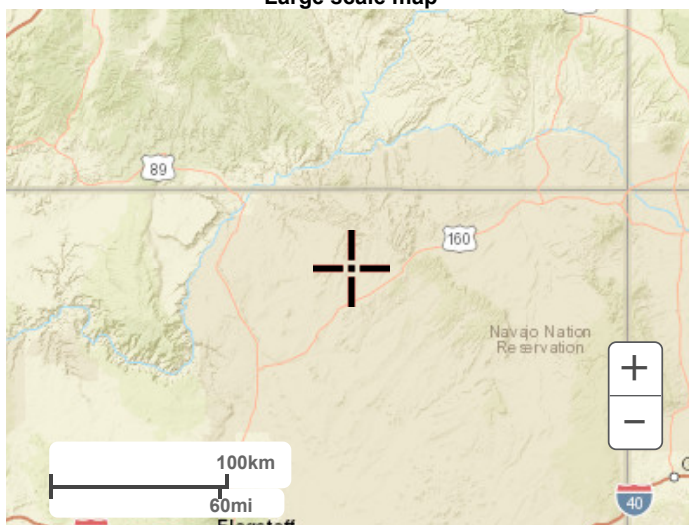
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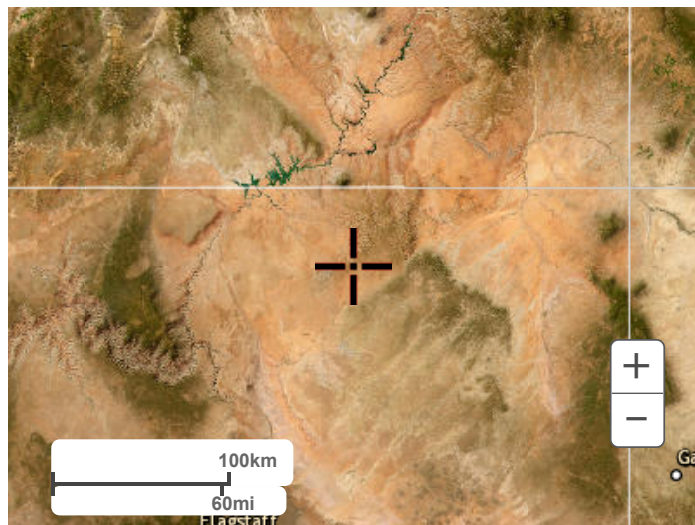
Large scale terrain



Large scale map



Large scale aerial



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NOAA Atlas 14, Volume 1, Version 5
Location name: Kaibeto, Arizona, USA*
Latitude: 36.597°, Longitude: -110.791°
Elevation: 6344 ft**

* source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

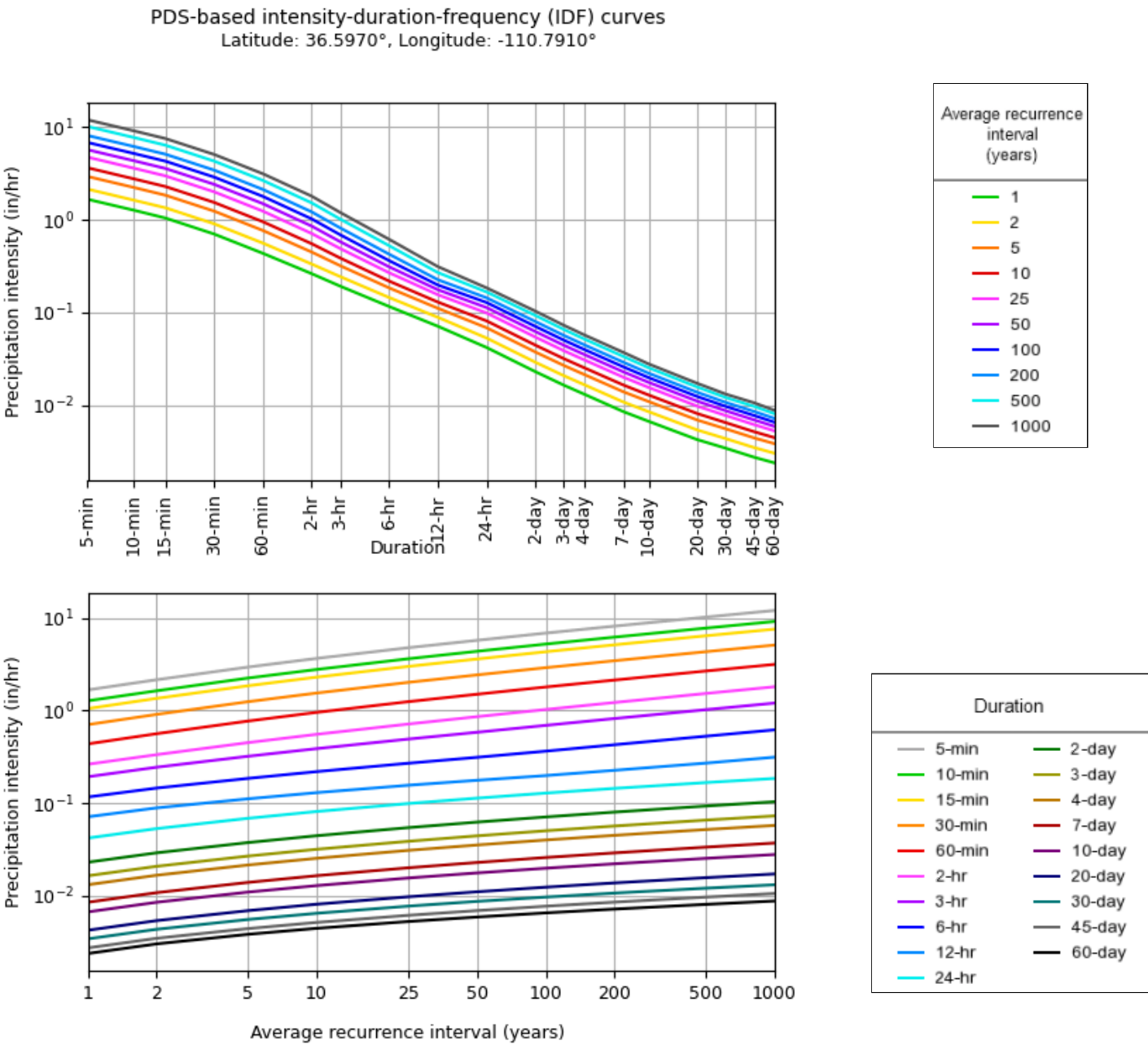
PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	1.67 (1.42-1.97)	2.15 (1.84-2.54)	2.94 (2.50-3.48)	3.65 (3.06-4.32)	4.75 (3.90-5.64)	5.71 (4.62-6.78)	6.84 (5.41-8.17)	8.14 (6.26-9.82)	10.2 (7.52-12.4)	12.0 (8.58-14.9)
10-min	1.27 (1.08-1.50)	1.63 (1.39-1.93)	2.24 (1.90-2.65)	2.77 (2.32-3.28)	3.61 (2.97-4.30)	4.35 (3.52-5.16)	5.21 (4.12-6.22)	6.19 (4.76-7.47)	7.75 (5.72-9.46)	9.14 (6.53-11.4)
15-min	1.05 (0.892-1.24)	1.35 (1.15-1.60)	1.85 (1.57-2.19)	2.29 (1.92-2.71)	2.99 (2.46-3.55)	3.59 (2.90-4.26)	4.30 (3.40-5.14)	5.12 (3.94-6.17)	6.40 (4.73-7.82)	7.55 (5.40-9.38)
30-min	0.704 (0.600-0.836)	0.908 (0.776-1.08)	1.24 (1.06-1.47)	1.54 (1.29-1.83)	2.01 (1.65-2.39)	2.42 (1.95-2.87)	2.90 (2.29-3.46)	3.45 (2.65-4.16)	4.31 (3.19-5.27)	5.09 (3.63-6.32)
60-min	0.436 (0.371-0.517)	0.562 (0.480-0.666)	0.769 (0.653-0.911)	0.955 (0.800-1.13)	1.24 (1.02-1.48)	1.50 (1.21-1.78)	1.79 (1.42-2.14)	2.13 (1.64-2.57)	2.67 (1.97-3.26)	3.15 (2.25-3.91)
2-hr	0.263 (0.228-0.306)	0.334 (0.288-0.388)	0.450 (0.386-0.522)	0.553 (0.469-0.642)	0.713 (0.596-0.829)	0.857 (0.703-1.00)	1.02 (0.822-1.20)	1.22 (0.953-1.45)	1.53 (1.15-1.84)	1.80 (1.31-2.21)
3-hr	0.192 (0.169-0.221)	0.244 (0.213-0.281)	0.320 (0.280-0.368)	0.387 (0.334-0.446)	0.491 (0.418-0.564)	0.582 (0.488-0.671)	0.691 (0.569-0.802)	0.819 (0.660-0.973)	1.02 (0.796-1.24)	1.20 (0.913-1.48)
6-hr	0.116 (0.104-0.131)	0.145 (0.129-0.163)	0.185 (0.164-0.208)	0.219 (0.193-0.246)	0.269 (0.235-0.303)	0.312 (0.269-0.353)	0.364 (0.309-0.415)	0.427 (0.356-0.491)	0.528 (0.428-0.626)	0.618 (0.490-0.751)
12-hr	0.071 (0.064-0.079)	0.088 (0.080-0.099)	0.111 (0.100-0.124)	0.129 (0.116-0.144)	0.156 (0.138-0.174)	0.176 (0.155-0.197)	0.198 (0.173-0.223)	0.226 (0.195-0.256)	0.270 (0.228-0.314)	0.313 (0.260-0.377)
24-hr	0.042 (0.037-0.047)	0.053 (0.047-0.060)	0.068 (0.061-0.077)	0.081 (0.071-0.091)	0.099 (0.087-0.111)	0.113 (0.099-0.128)	0.128 (0.111-0.145)	0.144 (0.124-0.163)	0.166 (0.142-0.190)	0.184 (0.155-0.212)
2-day	0.023 (0.020-0.025)	0.029 (0.025-0.032)	0.037 (0.033-0.042)	0.044 (0.039-0.050)	0.054 (0.047-0.061)	0.062 (0.054-0.070)	0.071 (0.061-0.080)	0.080 (0.068-0.091)	0.093 (0.078-0.106)	0.103 (0.085-0.119)
3-day	0.016 (0.014-0.018)	0.020 (0.018-0.023)	0.026 (0.023-0.030)	0.031 (0.028-0.035)	0.038 (0.033-0.043)	0.044 (0.038-0.050)	0.050 (0.043-0.057)	0.056 (0.048-0.064)	0.065 (0.055-0.075)	0.072 (0.060-0.084)
4-day	0.013 (0.011-0.014)	0.016 (0.014-0.018)	0.021 (0.019-0.024)	0.025 (0.022-0.028)	0.030 (0.027-0.035)	0.035 (0.030-0.040)	0.040 (0.034-0.045)	0.045 (0.038-0.051)	0.051 (0.043-0.059)	0.057 (0.047-0.066)
7-day	0.008 (0.007-0.009)	0.010 (0.009-0.012)	0.013 (0.012-0.015)	0.016 (0.014-0.018)	0.020 (0.017-0.022)	0.022 (0.019-0.026)	0.025 (0.022-0.029)	0.029 (0.024-0.033)	0.033 (0.028-0.038)	0.037 (0.031-0.042)
10-day	0.006 (0.006-0.007)	0.008 (0.007-0.009)	0.010 (0.009-0.012)	0.012 (0.011-0.014)	0.015 (0.013-0.017)	0.017 (0.015-0.019)	0.019 (0.017-0.022)	0.022 (0.019-0.025)	0.025 (0.021-0.028)	0.027 (0.023-0.032)
20-day	0.004 (0.003-0.004)	0.005 (0.004-0.006)	0.006 (0.006-0.007)	0.008 (0.007-0.009)	0.009 (0.008-0.011)	0.011 (0.009-0.012)	0.012 (0.010-0.014)	0.013 (0.011-0.015)	0.015 (0.013-0.017)	0.017 (0.014-0.019)
30-day	0.003 (0.003-0.003)	0.004 (0.003-0.004)	0.005 (0.004-0.006)	0.006 (0.005-0.007)	0.007 (0.006-0.008)	0.008 (0.007-0.009)	0.009 (0.008-0.011)	0.010 (0.009-0.012)	0.012 (0.010-0.013)	0.013 (0.011-0.015)
45-day	0.002 (0.002-0.003)	0.003 (0.003-0.003)	0.004 (0.003-0.005)	0.005 (0.004-0.005)	0.006 (0.005-0.006)	0.006 (0.006-0.007)	0.007 (0.006-0.008)	0.008 (0.007-0.009)	0.009 (0.008-0.011)	0.010 (0.008-0.012)
60-day	0.002 (0.002-0.002)	0.003 (0.002-0.003)	0.003 (0.003-0.004)	0.004 (0.003-0.005)	0.005 (0.004-0.005)	0.005 (0.005-0.006)	0.006 (0.005-0.007)	0.007 (0.006-0.008)	0.008 (0.006-0.009)	0.008 (0.007-0.010)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
 Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
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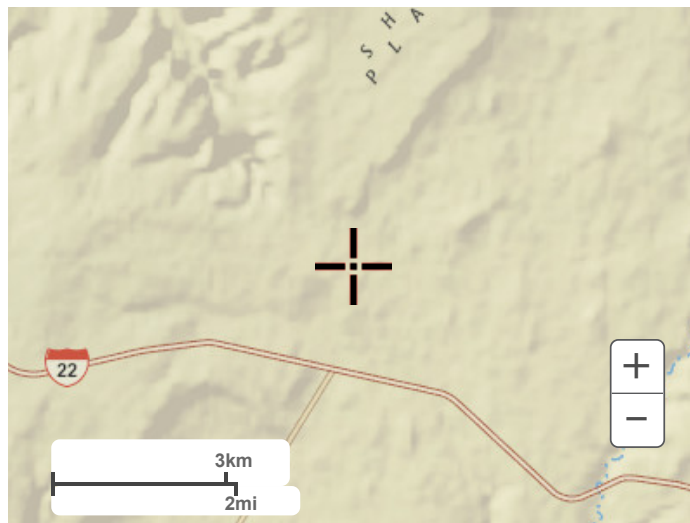
[Back to Top](#)

PF graphical

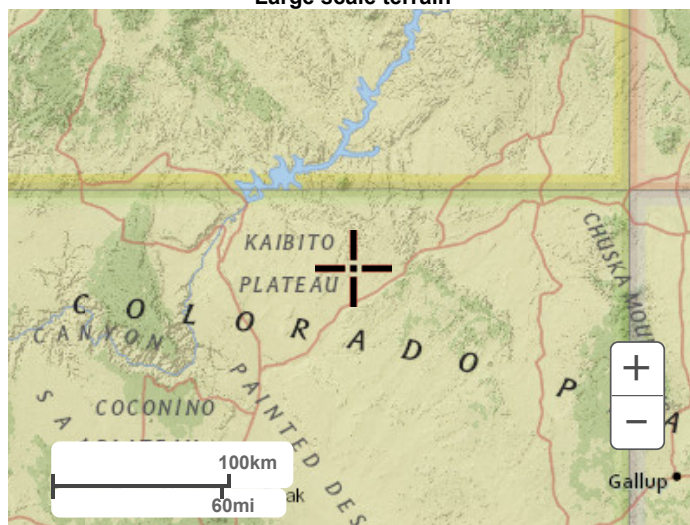


Maps & aerials

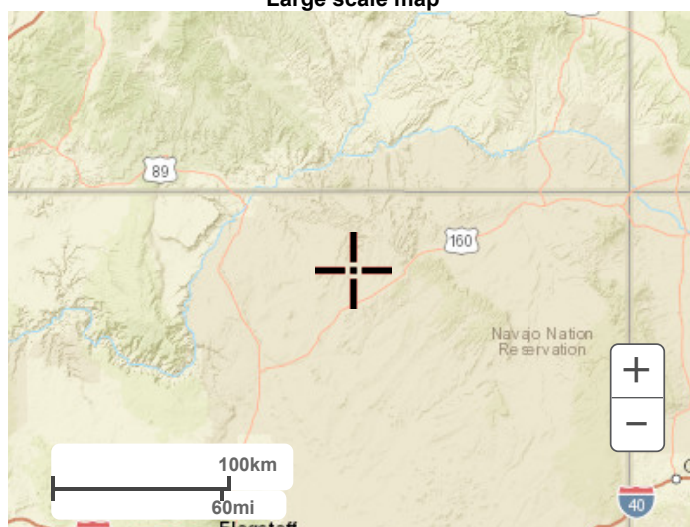
Small scale terrain



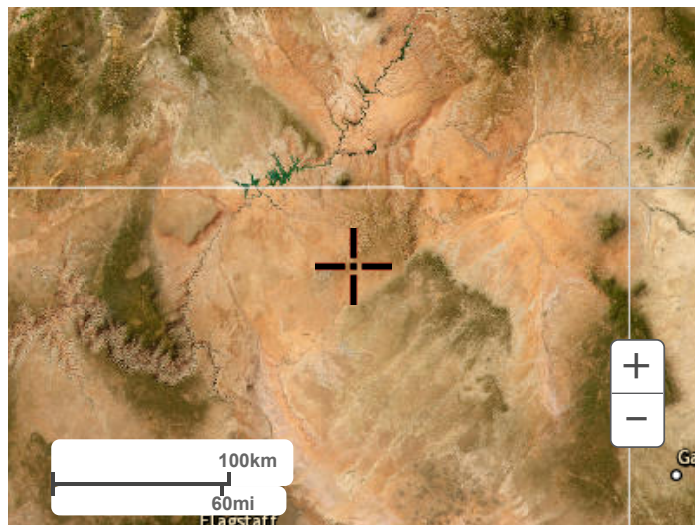
Large scale terrain



Large scale map



Large scale aerial



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APPENDIX 4: WEB SOIL SURVEY





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 Navajo Mountain Area, Arizona, Parts of Apache, Coconino and Navajo Counties



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

Preface	2
How Soil Surveys Are Made	5
Soil Map	8
Soil Map.....	9
Legend.....	10
Map Unit Legend.....	12
Map Unit Descriptions.....	12
Navajo Mountain Area, Arizona, Parts of Apache, Coconino and Navajo Counties.....	14
20—Mespun-Bispen-Rock outcrop complex, moist, 1 to 15 percent slopes.....	14
References	17

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

Custom Soil Resource Report

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



Custom Soil Resource Report

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: Navajo Mountain Area, Arizona, Parts of Apache, Coconino and Navajo Counties
Survey Area Data: Version 19, Sep 7, 2023

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

Date(s) aerial images were photographed: Nov 18, 2021—Nov 30, 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
20	Mespu-Bispen-Rock outcrop complex, moist, 1 to 15 percent slopes	1.2	100.0%
Totals for Area of Interest		1.2	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.

Navajo Mountain Area, Arizona, Parts of Apache, Coconino and Navajo Counties

20—Mespun-Bispen-Rock outcrop complex, moist, 1 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2rqrx

Elevation: 5,900 to 7,000 feet

Mean annual precipitation: 12 to 14 inches

Mean annual air temperature: 50 to 54 degrees F

Frost-free period: 135 to 165 days

Farmland classification: Not prime farmland

Map Unit Composition

Mespun and similar soils: 40 percent

Bispen and similar soils: 25 percent

Rock outcrop: 25 percent

Minor components: 10 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mespun

Setting

Landform: Dune fields

Down-slope shape: Convex

Across-slope shape: Convex

Parent material: Alluvium derived from sandstone and/or eolian sands derived from sandstone over residuum weathered from sandstone

Typical profile

C1 - 0 to 4 inches: sand

C2 - 4 to 21 inches: loamy sand

C3 - 21 to 37 inches: fine sand

C4 - 37 to 60 inches: fine sand

Properties and qualities

Slope: 1 to 10 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Excessively drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 4 percent

Gypsum, maximum content: 2 percent

Maximum salinity: Nonsaline (0.1 to 1.0 mmhos/cm)

Sodium adsorption ratio, maximum: 4.0

Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6c

Custom Soil Resource Report

Hydrologic Soil Group: A

Ecological site: R035XC315AZ - Sandy Upland 10-14" p.z.

Hydric soil rating: No

Description of Bispen

Setting

Landform: Dune fields

Down-slope shape: Concave

Across-slope shape: Convex

Parent material: Alluvium derived from sandstone and/or eolian sands derived from sandstone over residuum weathered from sandstone

Typical profile

C1 - 0 to 3 inches: fine sand

C2 - 3 to 17 inches: sand

C3 - 17 to 42 inches: fine sand

C4 - 42 to 49 inches: fine sandy loam

R - 49 to 59 inches: bedrock

Properties and qualities

Slope: 2 to 15 percent

Depth to restrictive feature: 40 to 60 inches to lithic bedrock

Drainage class: Somewhat excessively drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 2 percent

Gypsum, maximum content: 2 percent

Maximum salinity: Nonsaline (0.0 to 0.7 mmhos/cm)

Sodium adsorption ratio, maximum: 2.0

Available water supply, 0 to 60 inches: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6c

Hydrologic Soil Group: A

Ecological site: R035XC315AZ - Sandy Upland 10-14" p.z.

Hydric soil rating: No

Description of Rock Outcrop

Properties and qualities

Depth to restrictive feature: 0 to 4 inches to lithic bedrock

Minor Components

Unnamed soils

Percent of map unit: 10 percent

Hydric soil rating: No

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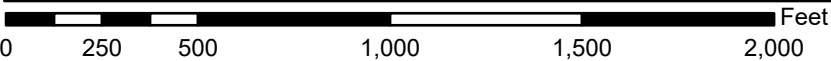
APPENDIX 5: FEMA FIRMETTE



National Flood Hazard Layer FIRMMette



110°47'46"W 36°36'3"N



1:6,000

110°47'9"W 36°35'34"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/26/2024 at 12:53 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.