Final Stormwater Management Plan

Orchard Woods

1204 Ne Woods Chapel Road
Section: SE ¼ Sec. 9-48N-31W
Lee's Summit, Missouri

Prepared By:

PLANNING
ENGINEERING
IMPLEMENTATION

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PEI #211142
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TABLE OF CONTENTS

LIST OF TABLES & FIGURES

1.0 Introduction

Phelps Engineering, Inc. (PEI) is pleased to submit this Final Stormwater Management Plan for Orchard Woods Single-Family development located northeast of the intersection of Woods Chapel Road and Lakewood Way in the City of Lee's Summit, Jackson County, Missouri. The proposed site area is 13.14 acres and is bound by existing commercial development to the north and west, unplatted land to the south, and existing single-family housing to the east. See Appendix "A" for the project aerial map.

2.0 Existing Conditions and Drainage Computations

The project site is located in the Blue River watershed. The existing site is broken up into two drainage areas. These areas are the northwest and west watersheds.

The northwest watershed consists of a total area of 25.39 acres. Of this, 12.16 acres will be located on-site, and the remaining 13.23 acres are located off-site. Water within the northwest watershed will sheet flow across the site until it reaches a naturally forming drainage ditch. This ditch then routes water to an existing 48" CMP pipe, located in the northwest corner of the site, which routes water away from the site.

The west watershed will consist of an area of 0.98 acres in size and makes up the remainder of the on-site area. Water within the south watershed sheet flows across the site until it is picked up by an existing curb inlet located along Lakewood Way.

Soils data for the site watershed was determined using the NRCS Web Soil Survey for Jackson County. There are three different soil types located on the site. This first soil is Greenton-Urban Land Complex 5-9 percent slopes. This soil covers an area of 11.10 acres and is considered Hydrologic Soil Group (HSG) Type "D". The second soil is Sharpsburg-Urban Land Complex 2-5 percent slopes. This soil covers 0.47 acres and is considered HSG Group Type "D". The final soil found on-site is Sibley Silt Loam, 2-5 percent slopes. This soil covers 1.55 acres and is considered HSG Group Type "C".

The existing onsite land cover is woods/grass in good condition. See Appendix "A" of this report for aerial imagery exhibits and Appendix "B" for the NRCS Web Soil Survey.

Lee's Summit follows the "Comprehensive Control" method of mitigating additional runoff from a proposed development. Due to this the allowable release rate for the on-site portion of each watershed is as follows. During the 2-year storm event the proposed site may release 0.5 CFS of water per acre. The 10-year event allows 2.0 CFS per acre, and the 100-year event allows 3.0 CFS per acre. Therefore, the allowable release rates for each watershed can be seen in Table 1 below.

Table 1 – Allowable Runoff Conditions

Existing Conditions						
Watershed	Area	CN	Tc	Allowable Release Rate		
				2-Year	10-Year	100-Year
Northwest (On-Site)	12.16	81	12.5	6.08	24.32	36.48
Northwest (Off-Site)	13.23	81	13.2	31.10	58.81	97.01
Northwest Total	**25.39**	**81**	**13.2**	**37.18**	**83.13**	**133.49**
West	**0.98**	**76**	**5**	**0.49**	**1.96**	**2.94**

It should be noted that none of the existing areas or time of concentrations provided in Table 1 above match the Preliminary Stormwater Management Plan. This is due to a change in the site boundary since the Preliminary Stormwater Management Plan was written. The previous site boundary was larger than what is currently proposed therefore, resulting in larger drainage areas. These larger areas also resulted in larger time of concentrations. It should also be noted that the CN used for the northwest off-site watershed doesn't match the Preliminary Stormwater Management Plan. This is due to a conservative assumption that was made during the preliminary report. In the Preliminary Stormwater Management Plan, it was assumed that a large portion of the Savannah Ridge development to the west drains on to the site. After receiving As-Builts of the development from the city, it was determined that this water does not drain on to the proposed site. This resulted in a smaller off-site area as well as a lower CN value.

3.0 Proposed Drainage System

The development of the site will result in a shift in the drainage patterns. The northwest watershed will see an increase in area, resulting in a total proposed area of 25.53 acres. Of this, 12.47 acres will be located on-site and 13.06 acres will be off-site area. The off-site area will see a reduction in area due to the proposed grade of NE Orchard Hill Road. The proposed road will slightly shift the ridge line and reduce the off-site area of the northwest watershed. The west watershed will also see a reduction in area resulting in a proposed area of 0.67 acres. Detention has been proposed within the northwest watershed. This will be provided with a proposed extended dry detention basin which will be sized to control the required storm events. Additional information regarding the basin and its design can be found in the next section of this report. See Appendix "D" for the proposed drainage map.

All storm sewers shall be sized to convey the 10-year design storm. The 100-year overflow will be conveyed in the street system in conjunction with overflow path swales where necessary. The minimum building opening elevation (MBOE) of any adjacent building to the 100-year overflow path or detention basin will be set a minimum of two feet above the 100-year water surface elevation (WSE).

Using HydroCAD V10 storm modeling software with SCS Type II 24-hr storm duration, the proposed 2, 10 and 100-year site peak discharges were determined for the site can be found in Table 2 below. See Appendix "D" of this report for the proposed Drainage Map and HydroCAD output.

Table 2 – Proposed Runoff Conditions

Proposed Conditions							Allowable Release Rate		
Watershed	Area	CN	Tc	Proposed Release Rate					
				2-Year	10-Year	100-Year	2-Year	10-Year	100-Year
Northwest Total	25.53	87	13.2	36.75	82.85	133.00	37.18	83.13	133.49
West	0.67	80	5	2.60	4.45	6.90	0.49	1.96	2.94

As can be seen in Table 2 above, the northwest watershed has a proposed release rate less than the allowable for the 2, 10, and 100-year storm events. Thus, making the northwest watershed compliant with the requirements set forth by APWA 5600 as well as the City of Lee's Summit. The west watershed generates an increase in peak runoff for all storm events. Due to the size and location of the watershed it is not feasible to capture and detain the on-site water within the west watershed. As a result of this, a waiver to the Design and Construction Manual is requested for this area.

To justify the requested waiver, a comparison of the west watershed proposed peak release rate to the existing peak release rate has been provided. This analysis does not follow the comprehensive control method of determining the existing runoff release rate. Instead, it was determined using HydroCAD. As can seen from Table 2 above and Table 3 below, the proposed runoff generated by the west watershed exceeds the allowable release rate determined through the comprehensive control method but does not exceed the currently existing runoff conditions.

Table 3 – West Watershed Analysis

West Watershed			
Condition	Storm Event		
	2-Year	10-Year	100-Year
Existing	2.61	5.19	8.82
Proposed	2.60	4.45	6.90

4.0 Stormwater Detention Requirements

Per City of Lee's Summit Municipal Code detention facilities must comply with the "Comprehensive Control" method of detention found in APWA 5600. This states that the allowable peak runoff rate for an on-site watershed is 0.5 CFS per acre in the 2-year event, 2.0 CFS per acre in the 10-year event, and 3.0 CFS per acre in the 100-year storm event. The allowable release rates for each watershed have already been provided in Table 1 above. In addition to the allowable flow requirements, the comprehensive control method also requires that the water quality event be detained and released over a period of 40 hours. This will be achieved by designing the basin an extended dry detention basin.

It has been determined that on-site drainage area to the basin will be 11.84 acres. This area has been calculated to be roughly 38% impervious. In addition to the on-site area, there is also 13.06 acres of off-site area which will contribute to this basin. This ultimate condition of this area, ¼ acre single-family housing, has been modeled as part of the basin's drainage area. However, the northwest basin was not sized to provide meet the

comprehensive control requirements nor to provide a 40-hour draw down time for this off-site area. Only on-site area was considered for these calculations.

The bottom elevation within the basin has been set at 913.00. The on-site area results in a water quality volume of 916.71 within the basin. A V-notched orifice will be placed at the bottom elevation of the basin and will be only orifice opening below the water quality elevation. Thus, meeting the requirements for an extended dry detention basin. The next orifice will be located directly above the water quality elevation at 916.71. This will consist of a 42”x6” rectangular orifice. The next opening will consist of an 84”x10” rectangular orifice set at 919.33. The final orifice will be a 48”x48” top box top which will be set at 921.25. The outlet structure will be drained by a proposed 48” pipe which will connect to the existing 48” CMP located in the northwest corner of the site. See Table 3 below for more information regarding the basin’s performance.

Table 4 – Northwest Watershed Detention Basin

Storm Event	Inflow (cfs)	Water Surface Elevation	Storage (c.f.)	Outflow (cfs)
2-Year	76.14	919.35	53,365	36.48
10-Year	131.27	921.31	82,469	82.27
100-Year	204.63	923.16	155,888	132.05

As seen in Table 4 above, the 100-year water surface within the basin is 923.16. The emergency spillway of the basin has been set at 924.90. This provides more than the 6” of freeboard required by APWA 5600. This was done for two separate reasons. The first is that it was brought to the attention of the engineer that a 60’x12’x3’ existing detention basin, located on Lot 1 of Savannah Ridge, has been removed. To mitigate this, Phelps Engineering has agreed to connect to the existing storm system upstream of the basin and route water so that it bypasses the removed basin. As a result of doing this, the storage volume removed from Lot 1 of Savannah Ridge (2,160 C.F.) will be provided within the northwest basin. The second reason for providing additional storage below the spillway is that when the off-site area which contributes to the basin is developed, the additional storage can be used to minimize the required size of the basin provided with the future development.

5.0 Permitting Requirements

5.1 FEMA/DWR

No FEMA regulatory floodplain exists onsite, and the entire property has been designated as Zone X; per Map Panel 29095C0430G of the Flood Insurance Rate Map dated January 20, 2017. Zone X is defined areas outside the 0.2% annual chance flood plain.

5.2 Stream Buffer

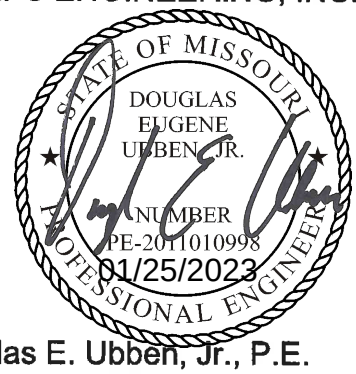
Per APWA 5600, stream buffers are not required for this project as there are no streams on the property with a contributing area over 40 acres.

6.0 Conclusion

This report and attached exhibits complete PEI's Final Stormwater Management Plan for the Orchard Woods Single-Family development located northeast of the intersection of Woods Chapel Road and Lakewood Way in the City of Lee's Summit, Jackson County, Missouri. Please feel free to contact PEI at (913) 393-1155 if you require further information or have additional questions.

Sincerely,

PHELPS ENGINEERING, INC.



Douglas E. Ubben, Jr., P.E.

Kyle Deters E.I.T.

Kyle Deters, E.I.T.

Enclosures

Appendix A


NE DELTA SCHOOL RD
NE JIB CT
NE LAKEWOOD CT
NE WOODS CHAPEL RD
NE PIEDMONT DR
NE GEORGIAN DR
NE BEACH RD
NE MORGAN DR
NE AKIN DR
NE LOVE HILL DR
470

Appendix B

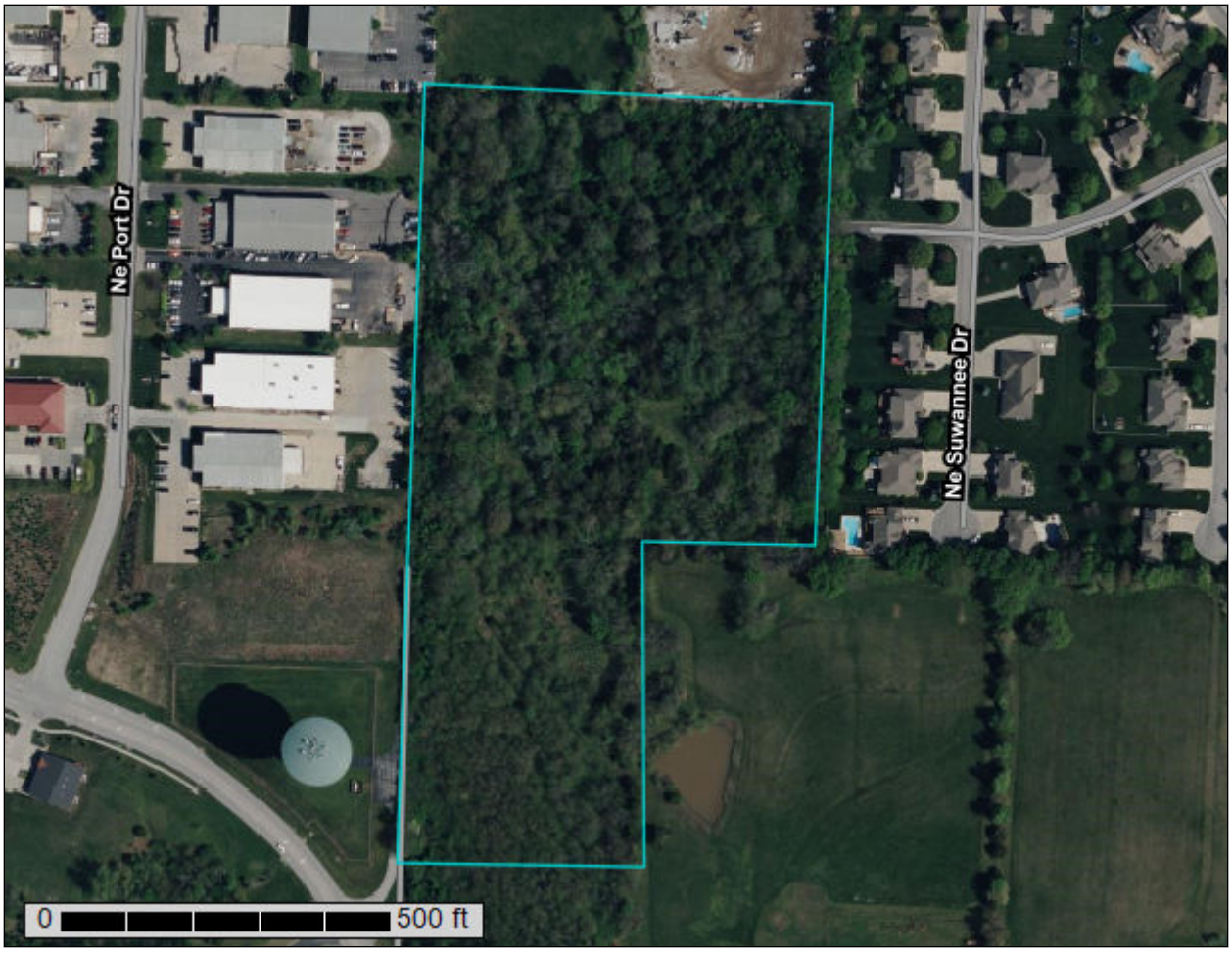
United States Department of Agriculture

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 Jackson County, Missouri



November 18, 2022

Preface

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

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

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

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

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

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

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Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

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

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

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

Soil Map

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

Custom Soil Resource Report
Soil Map

Map Scale: 1:2,120 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 24, Aug 31, 2022

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

Date(s) aerial images were photographed: Apr 26, 2021—Apr 29, 2021

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10024	Greenton-Urban land complex, 5 to 9 percent slopes	11.7	84.5%
10128	Sharpsburg-Urban land complex, 2 to 5 percent slopes	0.5	3.6%
10132	Sibley silt loam, 2 to 5 percent slopes	1.6	11.8%
Totals for Area of Interest		**13.9**	**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.

Jackson County, Missouri

10024—Greenton-Urban land complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2qky4
Elevation: 800 to 1,100 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Greenton and similar soils: 60 percent
Urban land: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Greenton

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave, convex
Parent material: Loess over residuum weathered from limestone and shale

Typical profile

A - 0 to 16 inches: silty clay loam
Bt1 - 16 to 26 inches: silty clay loam
2Bt2 - 26 to 80 inches: silty clay

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: R109XY002MO - Loess Upland Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Across-slope shape: Concave, convex

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

10128—Sharpsburg-Urban land complex, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2ql09
Elevation: 1,000 to 1,320 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 155 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Sharpsburg and similar soils: 60 percent
Urban land: 35 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sharpsburg

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile

A - 0 to 17 inches: silt loam
Bt - 17 to 55 inches: silty clay loam
C - 55 to 60 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: About 24 to 35 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very high (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: D
Ecological site: R109XY002MO - Loess Upland Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Macksburg

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R108XD860IA - Loess Upland Prairie
Hydric soil rating: No

10132—Sibley silt loam, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2ql0d
Elevation: 760 to 1,440 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 49 to 55 degrees F
Frost-free period: 155 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Sibley and similar soils: 95 percent

Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sibley

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile

Ap1 - 0 to 11 inches: silt loam
Ap2 - 11 to 18 inches: silt loam
Bt - 18 to 49 inches: silty clay loam
C - 49 to 72 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R107XB002MO - Deep Loess Upland Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

Minor Components

Higginsville, eroded

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Macksburg

Percent of map unit: 2 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve

Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R108XD860IA - Loess Upland Prairie
Hydric soil rating: No

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Appendix C

EXISTING IMPERVIOUS AREA = 0 S.F.

UTILITY NOTES:
VISUAL INDICATIONS OF UTILITIES ARE AS SHOWN. UNDERGROUND LOCATIONS SHOWN, AS FURNISHED BY THEIR LESSORS, ARE APPROXIMATE AND SHOULD BE VERIFIED IN THE FIELD AT THE TIME OF CONSTRUCTION. FOR ACTUAL FIELD LOCATIONS OF UNDERGROUND UTILITIES CALL 811.

811 Know what's below. Call before you dig.

LEGEND

- PL — PROPERTY LINE
- LOT LINE
- R/W — RIGHT-OF-WAY
- IMPERVIOUS
- OPEN SPACE
- DRAINAGE BOUNDARY FOR LOS VALUE RATING CALCULATION

N

SCALE: 1"=100'
0' 100' 200'

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PLANNING
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EXISTING CONDITIONS MAP

ORCHARD WOODS

LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

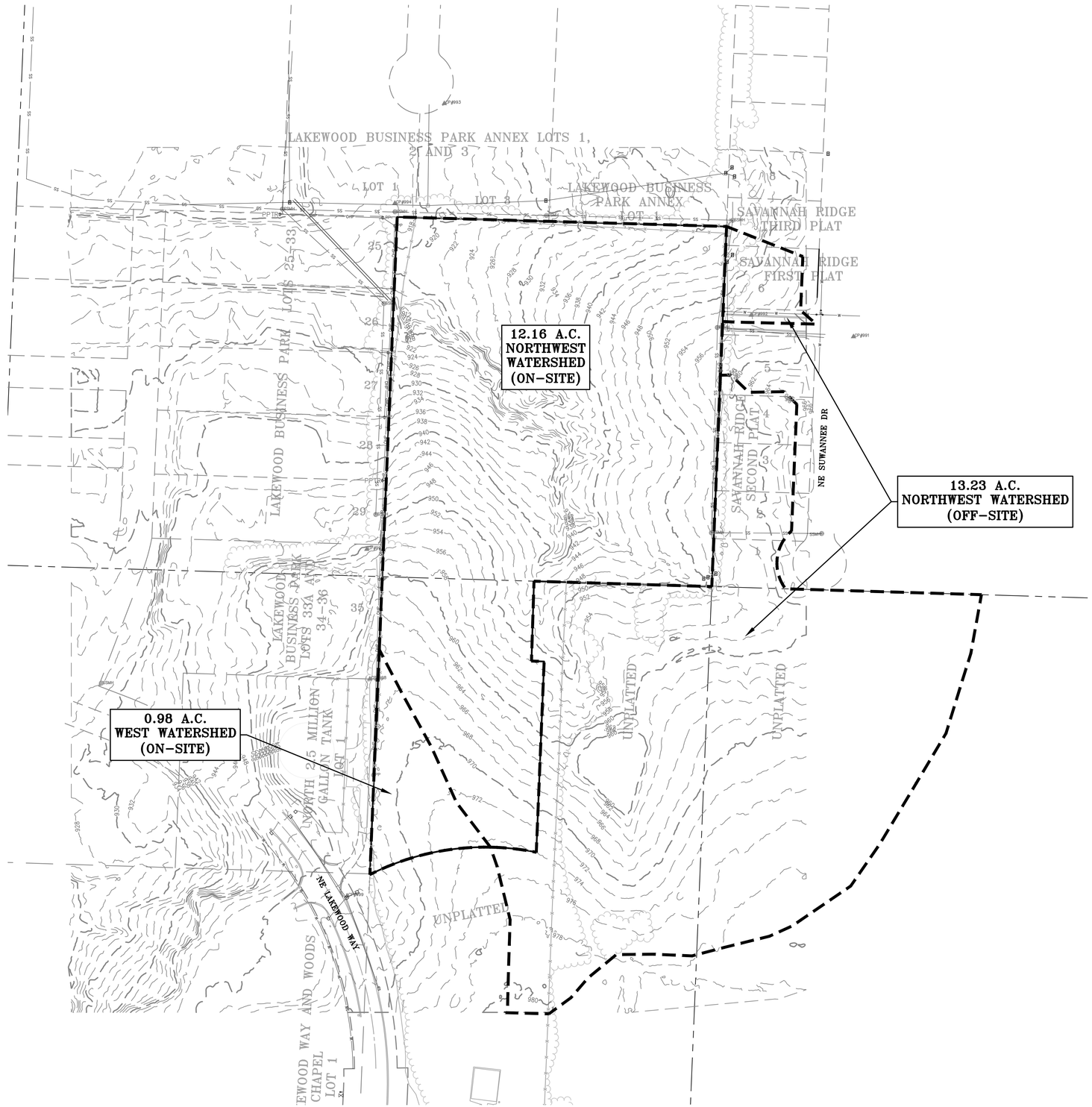
By	App.	No.	Revisions:	Date

PROJECT NO. 211142
DATE: 10-21-2022 | DRAWN: BJC
CHECKED: DEU | APPROVED: DEU

CERTIFICATE OF AUTHORIZATION
KANSAS ENGINEERING - LS-82
ENGINEERING - E-391

CERTIFICATE OF AUTHORIZATION
MISSOURI
LAND SURVEYING-2007001128
ENGINEERING-2007002038

SHEET
A1



LEGEND

- PL — PROPERTY LINE
- LOT LINE
- R/W — RIGHT-OF-WAY
- DRAINAGE BOUNDARY FOR LOS VALUE RATING CALCULATION

N

SCALE: 1"=100'
0' 100' 200'

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EXISTING DRAINAGE MAP

ORCHARD WOODS
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

No.	Revisions:	Date	By	App.

PROJECT NO. 211142
DATE: 10-21-2022 | DRAWN: BLG
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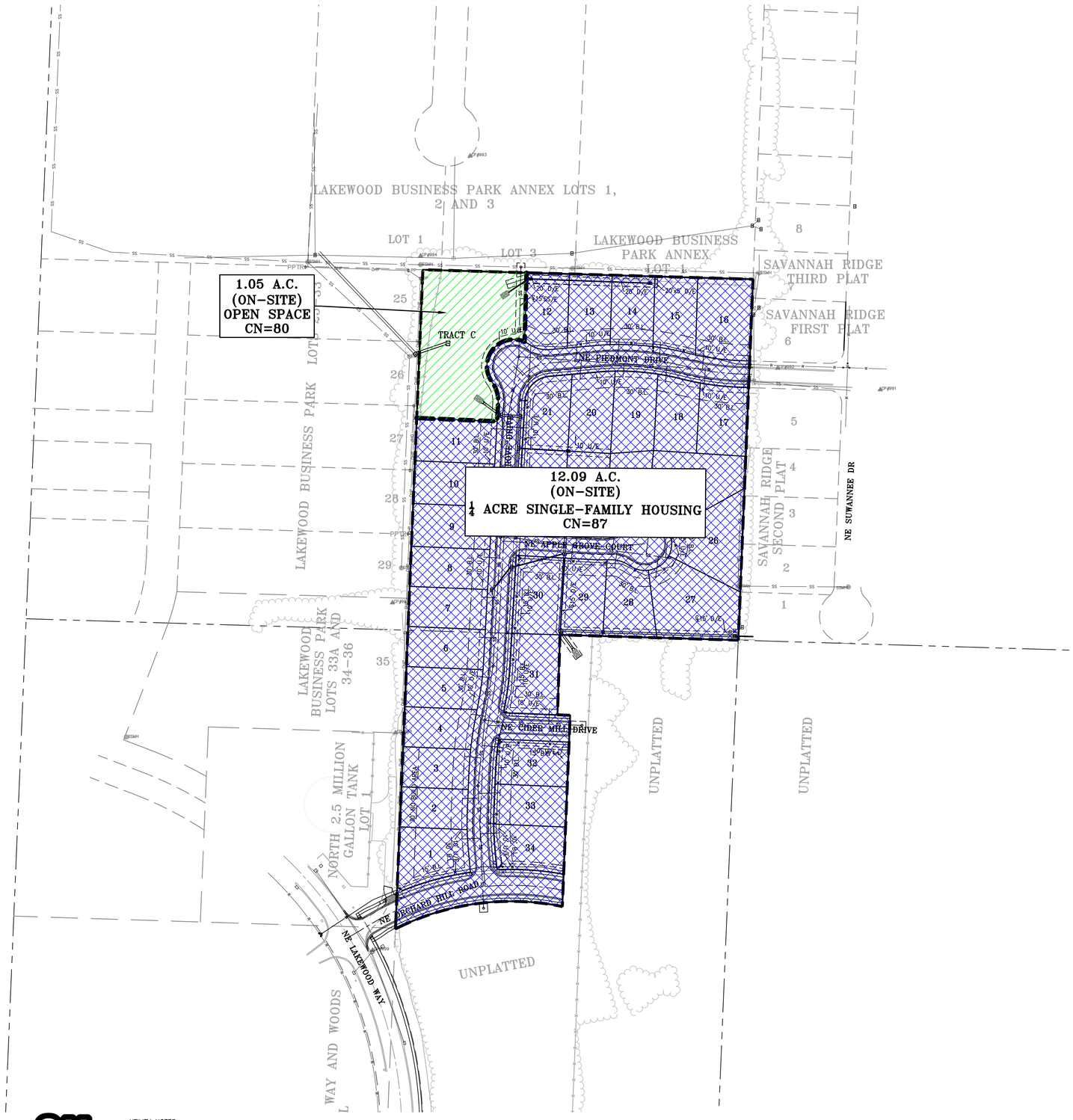
CERTIFICATE OF AUTHORIZATION KANSAS SURVEYING - LS-82 ENGINEERING - E-391
CERTIFICATE OF AUTHORIZATION MISSOURI LAND SURVEYING-2007001128 ENGINEERING-2007005208

SHEET
B1

\\phelps-server\projects\P\211142\stormwater\EXHIBITS.dwg Layout:Existing Drainage B1 Jan. 20, 2023 - 9:01am Kyle Deters

Appendix D



PROPOSED IMPERVIOUS AREA = 12.09 A.C. * 38% IMP. = 200,123 S.F.

LEGEND

- PL — PROPERTY LINE
- LOT LINE
- R/W — RIGHT-OF-WAY
- ¼ ACRE SINGLE-FAMILY HOUSING
- OPEN SPACE
- DRAINAGE BOUNDARY FOR LOS VALUE RATING CALCULATION

SCALE: 1"=100'

0' 100' 200'

811 Know what's below. Call before you dig.

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PROPOSED CONDITIONS MAP

ORCHARD WOODS

LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

No.	Revisions:	Date	By	App

PROJECT NO. 211142
DATE: 10-21-2022 | DRAWN: BJG
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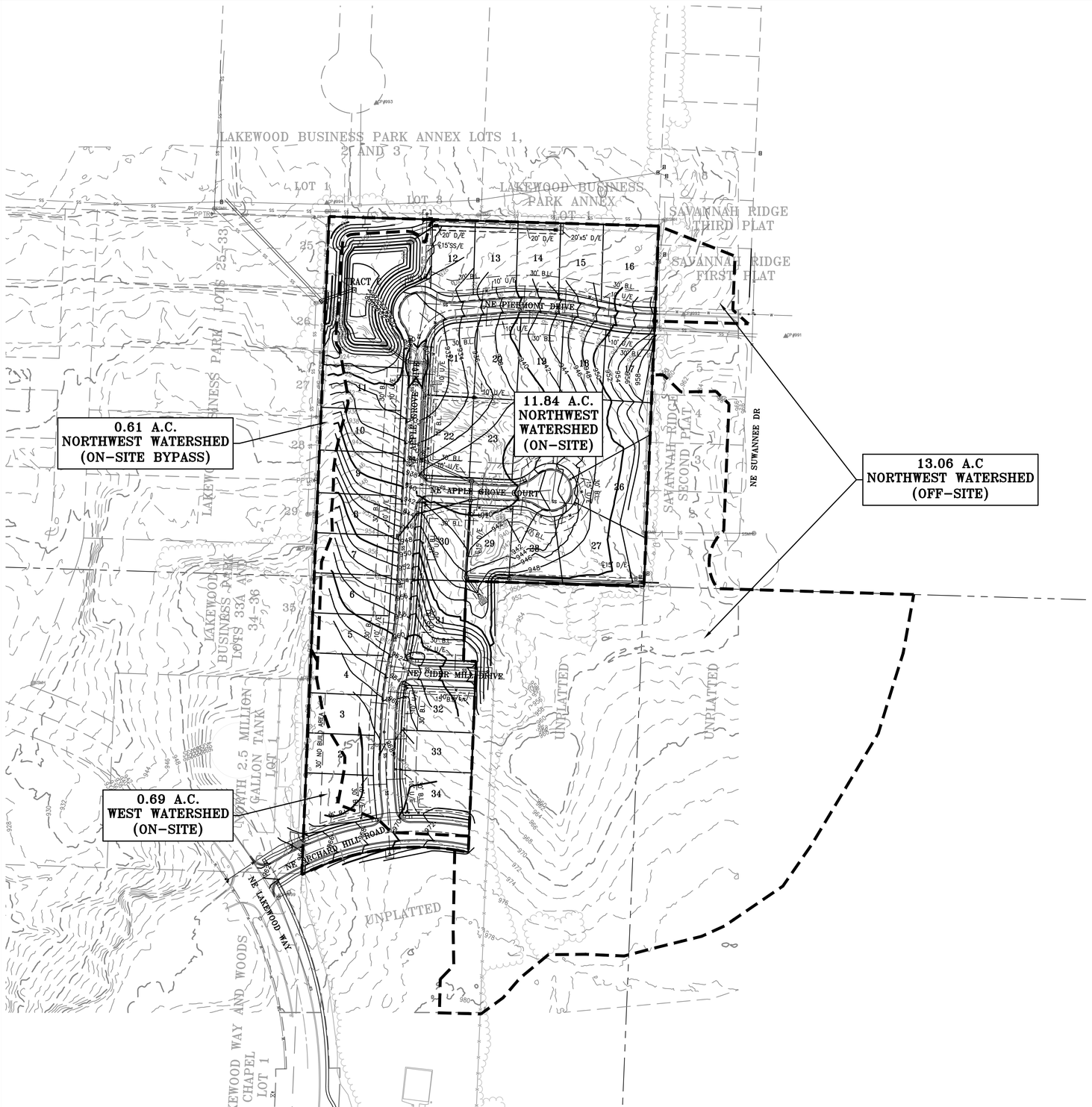
CERTIFICATE OF AUTHORIZATION
KANSAS ENGINEERING - LS-82
ENGINEERING - E-391

CERTIFICATE OF AUTHORIZATION
MISSOURI
LAND SURVEYING-2007001128
ENGINEERING-2007002358

SHEET
A2



811
Know what's **below.**
Call before you dig.

UTILITY NOTES:
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LEGEND

PL	PROPERTY LINE
	LOT LINE
R/W	RIGHT-OF-WAY
	DRAINAGE BOUNDARY FOR LOS VALUE RATING CALCULATION

N

SCALE: 1"=100'
0' 100' 200'

\\phelps-server\projects\P\211142\stormwater\EXHIBITS.dwg Layout:Proposed Drainage B2 Jan 20, 2023 - 9:01am Kyle Deters

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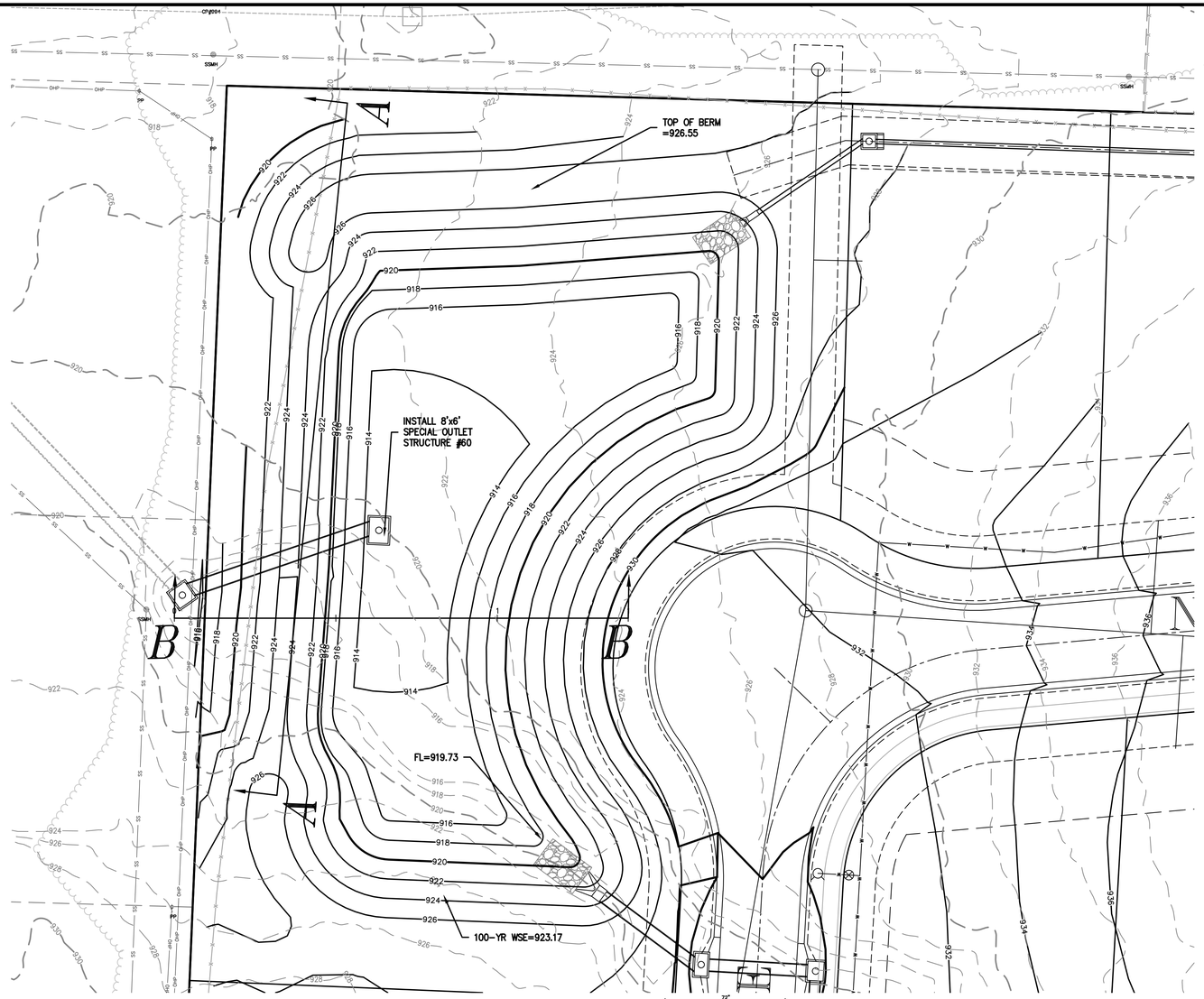
PROPOSED DRAINAGE MAP

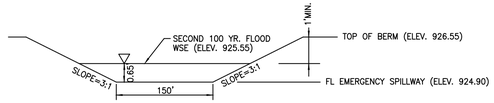
ORCHARD WOODS
LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

No.	Date	Revisions:	By	App.

PROJECT NO. 211142
DATE: 10-21-2022 | DRAWN: BJC
CHECKED: DEU | APPROVED: DEU
CERTIFICATE OF AUTHORIZATION
KANSAS ENGINEERING – LS-82
MISSOURI ENGINEERING – E-391
CERTIFICATE OF AUTHORIZATION
LAND SURVEYING-2007001128
ENGINEERING-2007002508

SHEET
B2





SECTION A-A

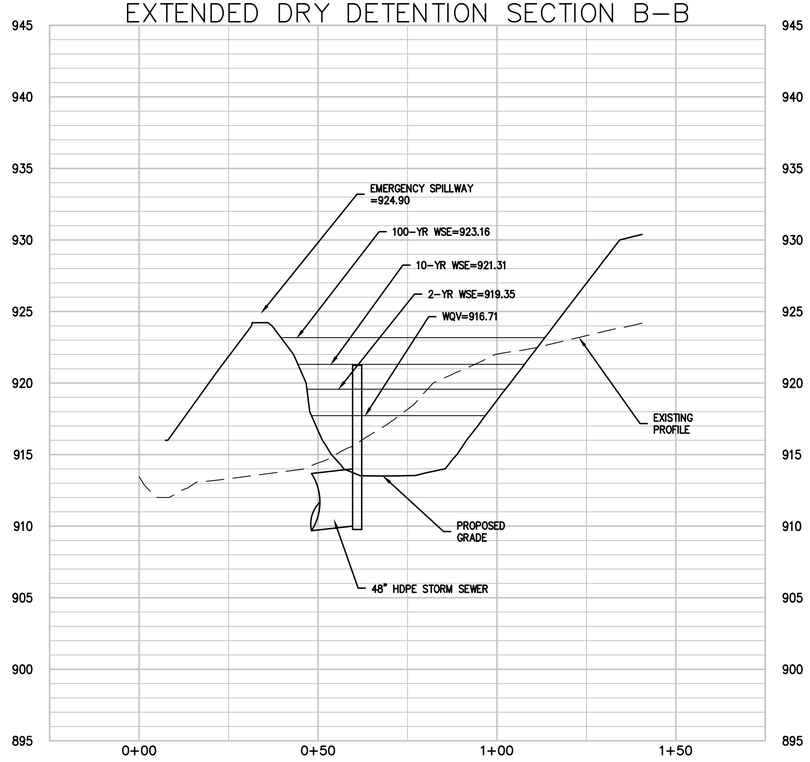
Q100 (INFLOW) = 205.42 cfs

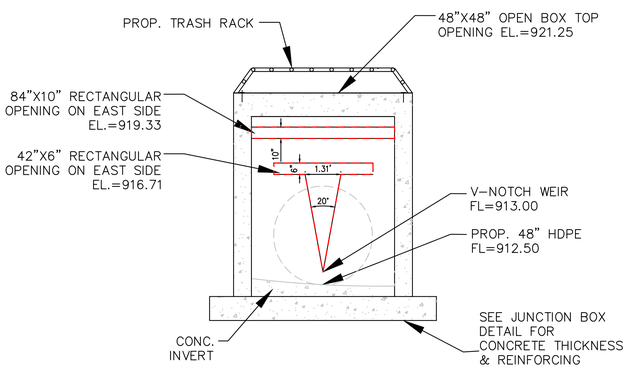
SCALE: 1"=20'

Storm Event	Inflow (cfs)	Water Surface Elevation	Storage (c.f.)	Outflow (cfs)
2-Year	76.14	919.35	53,365	36.48
10-Year	131.27	921.31	82,469	82.27
100-Year	204.63	923.16	155,888	132.05

PROPOSED BASIN PERFORMANCE

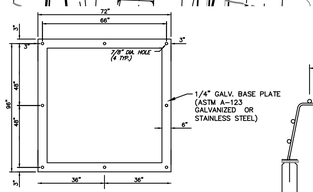
EXTENDED DRY DETENTION SECTION B-B





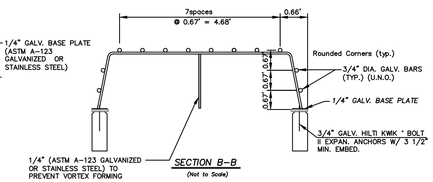
8'x6' SPECIAL OUTLET STRUCTURE #60

(Not to Scale)



TRASH RACK BASE PLATE DETAIL

(Not to Scale)



SECTION B-B

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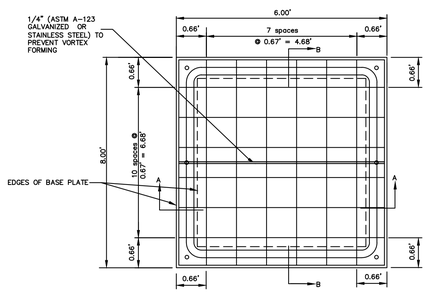

TRASH RACK PLAN

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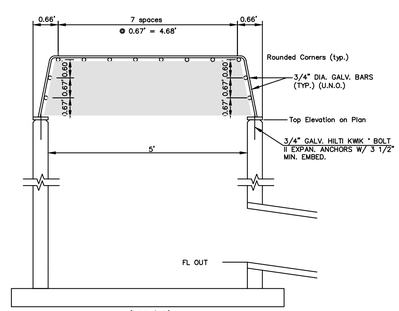


(Not to Scale)

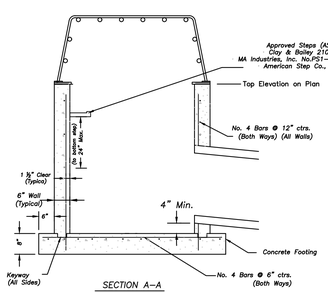
SECTION A-A

(not to scale)

8'X6' TRASH RACK DETAIL

NOTE

1. *All steel components shall be hot dip galvanized.*



SECTION A-A

NOT TO SCALE

8'X6' RISER BOX

NOTE

1. *Concrete & Reinforcing to be constructed per City of Lee's Summit standard Junction Box.*

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DETENTION PLAN

ORCHARD WOODS

LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

No.	Date	Revisions:	By	App.

PROJECT NO. 211142
DATE: 10-21-2022 | DRAWN: BJG
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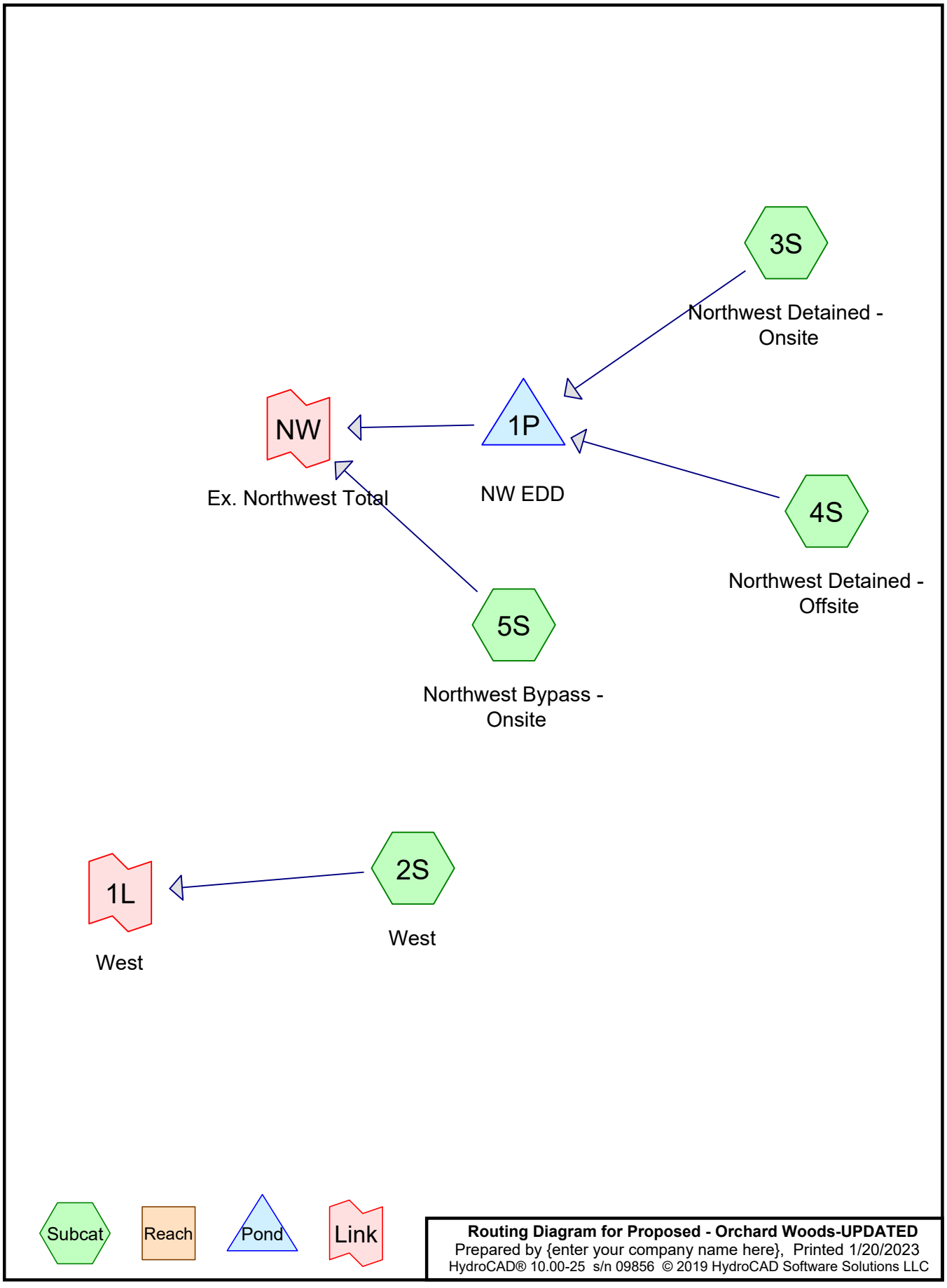
ENGINEERING - E-391

CERTIFICATE OF AUTHORIZATION
MISSOURI SURVEYING-2007001128
LAND SURVEYING-2007000359
ENGINEERING-2007000359

SHEET
18



Routing Diagram for Proposed - Orchard Woods-UPDATED
Prepared by {enter your company name here}, Printed 1/20/2023

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
25.150	87	1/4 acre lots, 38% imp, HSG D (2S, 3S, 4S)
1.050	80	>75% Grass cover, Good, HSG D (3S, 5S)
26.200	**87**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
26.200	HSG D	2S, 3S, 4S, 5S
0.000	Other	
26.200		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	25.150	0.000	25.150	1/4 acre lots, 38% imp	2S, 3S, 4S
0.000	0.000	0.000	1.050	0.000	1.050	>75% Grass cover, Good	3S, 5S
0.000	**0.000**	**0.000**	**26.200**	**0.000**	**26.200**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	1P	912.50	910.12	45.5	0.0523	0.013	41.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment2S: West Runoff Area=0.690 ac 38.00% Impervious Runoff Depth=3.85"
Tc=5.0 min CN=87 Runoff=4.66 cfs 0.221 af

Subcatchment3S: Northwest Detained - Runoff Area=11.840 ac 36.59% Impervious Runoff Depth=3.85"
Tc=10.8 min CN=87 Runoff=65.83 cfs 3.799 af

Subcatchment4S: Northwest Detained - Runoff Area=13.060 ac 38.00% Impervious Runoff Depth=3.85"
Tc=13.5 min CN=87 Runoff=66.57 cfs 4.191 af

Subcatchment5S: Northwest Bypass - Runoff Area=0.610 ac 0.00% Impervious Runoff Depth=3.16"
Tc=5.0 min CN=80 Runoff=3.51 cfs 0.160 af

Pond 1P: NW EDD Peak Elev=921.31' Storage=82,469 cf Inflow=131.18 cfs 7.990 af
Outflow=82.27 cfs 7.990 af

Link 1L: West Inflow=4.66 cfs 0.221 af
Primary=4.66 cfs 0.221 af

Link NW: Ex. Northwest Total Inflow=82.83 cfs 8.151 af
Primary=82.83 cfs 8.151 af

Total Runoff Area = 26.200 ac Runoff Volume = 8.372 af Average Runoff Depth = 3.83"
63.52% Pervious = 16.643 ac 36.48% Impervious = 9.557 ac

Summary for Subcatchment 2S: West

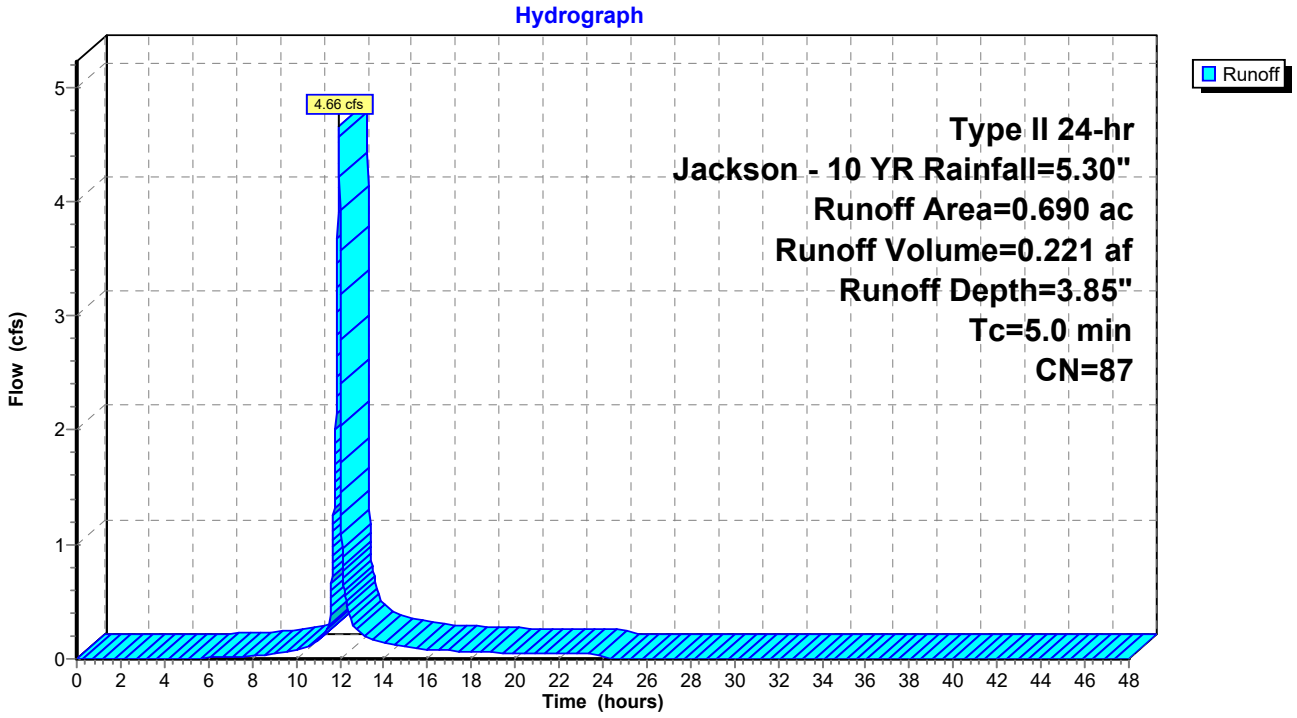
Runoff = 4.66 cfs @ 11.96 hrs, Volume= 0.221 af, Depth= 3.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 10 YR Rainfall=5.30"

Area (ac)	CN	Description
0.690	87	1/4 acre lots, 38% imp, HSG D
0.428		62.00% Pervious Area
0.262		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: West



Summary for Subcatchment 3S: Northwest Detained - Onsite

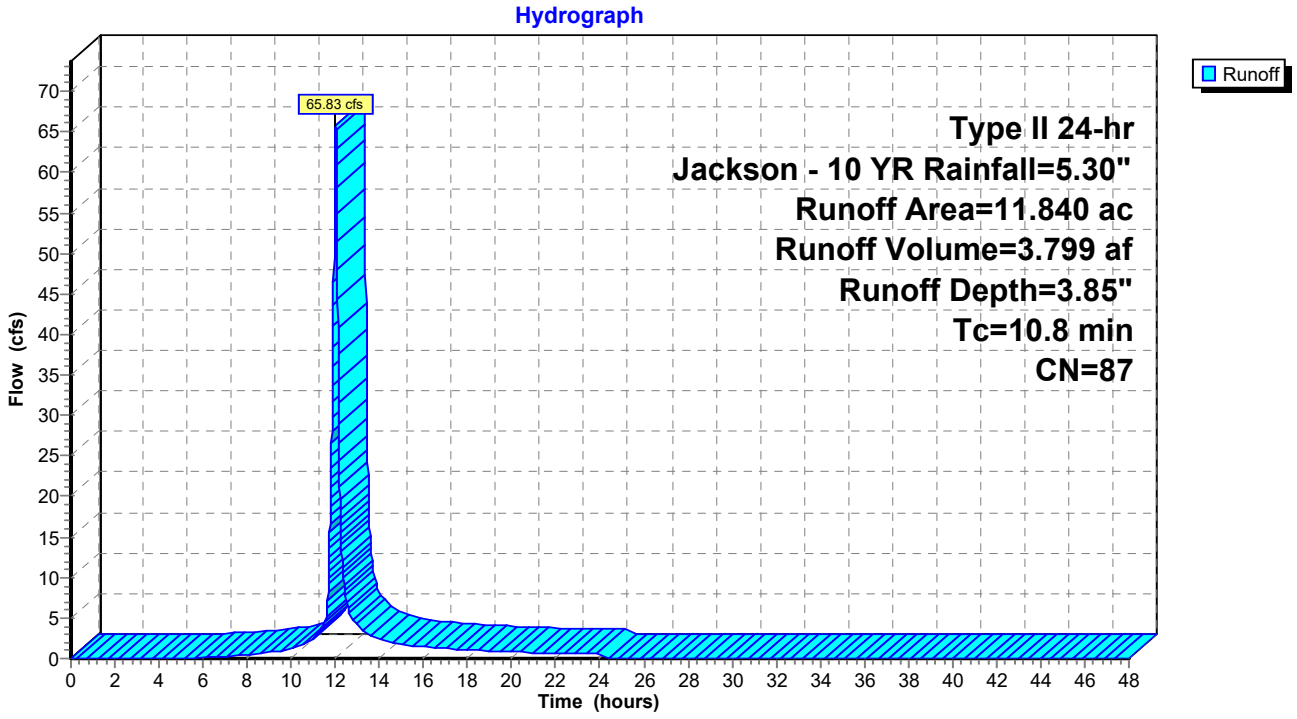
Runoff = 65.83 cfs @ 12.02 hrs, Volume= 3.799 af, Depth= 3.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 10 YR Rainfall=5.30"

Area (ac)	CN	Description
11.400	87	1/4 acre lots, 38% imp, HSG D
0.440	80	>75% Grass cover, Good, HSG D
11.840	87	Weighted Average
7.508		63.41% Pervious Area
4.332		36.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8					**Direct Entry,**

Subcatchment 3S: Northwest Detained - Onsite



Summary for Subcatchment 4S: Northwest Detained - Offsite

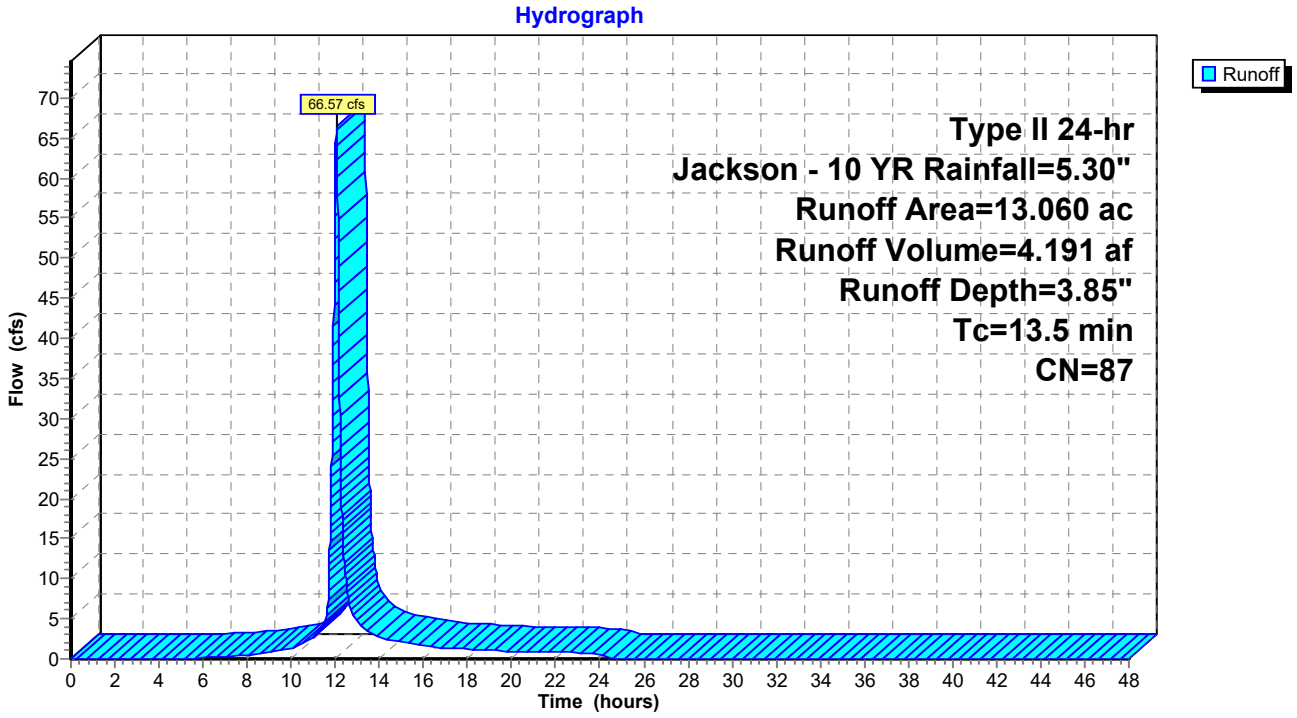
Runoff = 66.57 cfs @ 12.05 hrs, Volume= 4.191 af, Depth= 3.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 10 YR Rainfall=5.30"

Area (ac)	CN	Description
13.060	87	1/4 acre lots, 38% imp, HSG D
8.097		62.00% Pervious Area
4.963		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5					**Direct Entry,**

Subcatchment 4S: Northwest Detained - Offsite



Summary for Subcatchment 5S: Northwest Bypass - Onsite

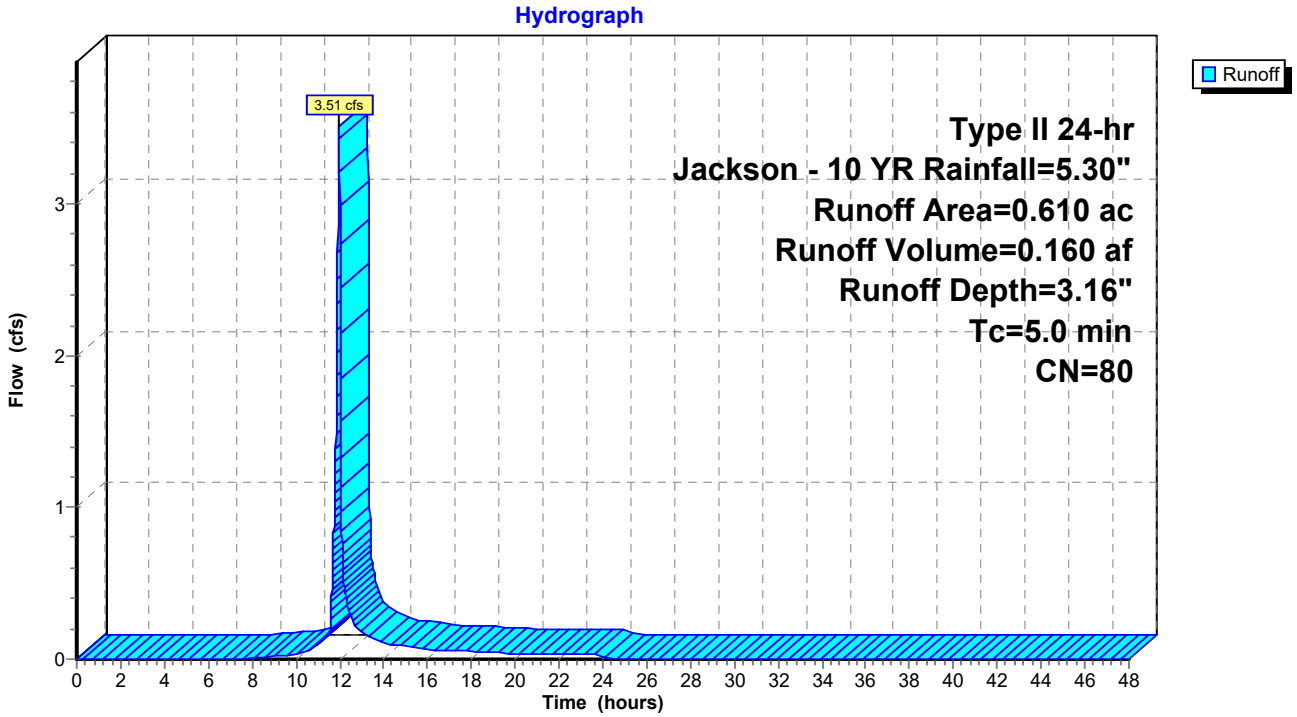
Runoff = 3.51 cfs @ 11.96 hrs, Volume= 0.160 af, Depth= 3.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 10 YR Rainfall=5.30"

Area (ac)	CN	Description
0.610	80	>75% Grass cover, Good, HSG D
0.610		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5S: Northwest Bypass - Onsite



Summary for Pond 1P: NW EDD

Inflow Area = 24.900 ac, 37.33% Impervious, Inflow Depth = 3.85" for Jackson - 10 YR event
Inflow = 131.18 cfs @ 12.03 hrs, Volume= 7.990 af
Outflow = 82.27 cfs @ 12.14 hrs, Volume= 7.990 af, Atten= 37%, Lag= 6.5 min
Primary = 82.27 cfs @ 12.14 hrs, Volume= 7.990 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 921.31' @ 12.14 hrs Surf.Area= 16,347 sf Storage= 82,469 cf

Plug-Flow detention time= 31.2 min calculated for 7.990 af (100% of inflow)
Center-of-Mass det. time= 31.1 min (832.8 - 801.7)

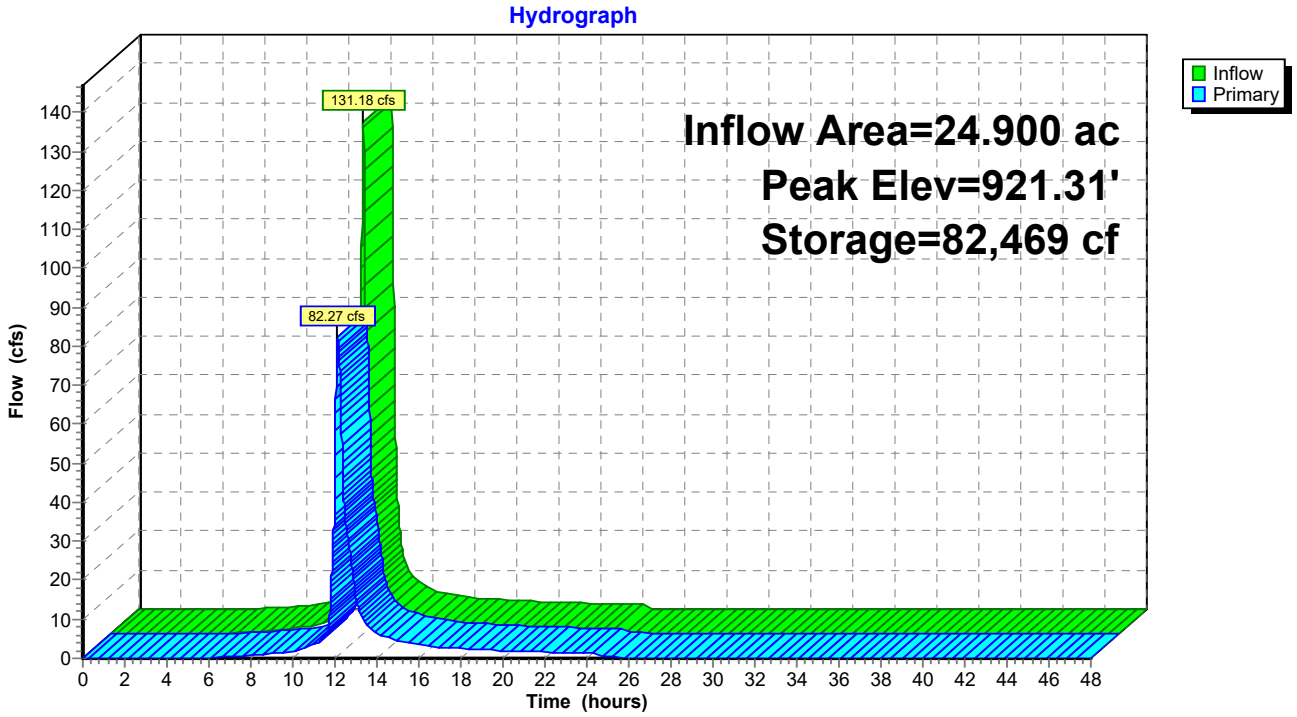
Volume	Invert	Avail.Storage	Storage Description
#1	913.00'	133,347 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
913.00	19	0	0
914.00	3,406	1,713	1,713
915.00	7,435	5,421	7,133
916.00	8,995	8,215	15,348
917.00	10,536	9,766	25,114
918.00	11,789	11,163	36,276
919.00	13,077	12,433	48,709
920.00	14,404	13,741	62,450
921.00	15,780	15,092	77,542
922.00	17,630	16,705	94,247
923.00	19,536	18,583	112,830
924.00	21,498	20,517	133,347

Device	Routing	Invert	Outlet Devices
#1	Primary	912.50'	**41.0" Round Culvert** L= 45.5' Ke= 0.500 Inlet / Outlet Invert= 912.50' / 910.12' S= 0.0523 '/' Cc= 0.900 n= 0.013, Flow Area= 9.17 sf
#2	Device 1	913.00'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 3.71 3.71 Width (feet) 0.00 1.31 0.00
#3	Device 1	916.71'	**42.0" W x 6.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	919.33'	**84.0" W x 10.0" H Vert. Orifice/Grate** C= 0.600
#5	Device 1	921.25'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=81.96 cfs @ 12.14 hrs HW=921.31' (Free Discharge)
└**1=Culvert** (Passes 81.96 cfs of 117.61 cfs potential flow)
  ├**2=Custom Weir/Orifice** (Orifice Controls 28.75 cfs @ 11.83 fps)
  ├**3=Orifice/Grate** (Orifice Controls 17.56 cfs @ 10.04 fps)
  ├**4=Orifice/Grate** (Orifice Controls 34.96 cfs @ 5.99 fps)
  └**5=Orifice/Grate** (Weir Controls 0.69 cfs @ 0.77 fps)

Pond 1P: NW EDD

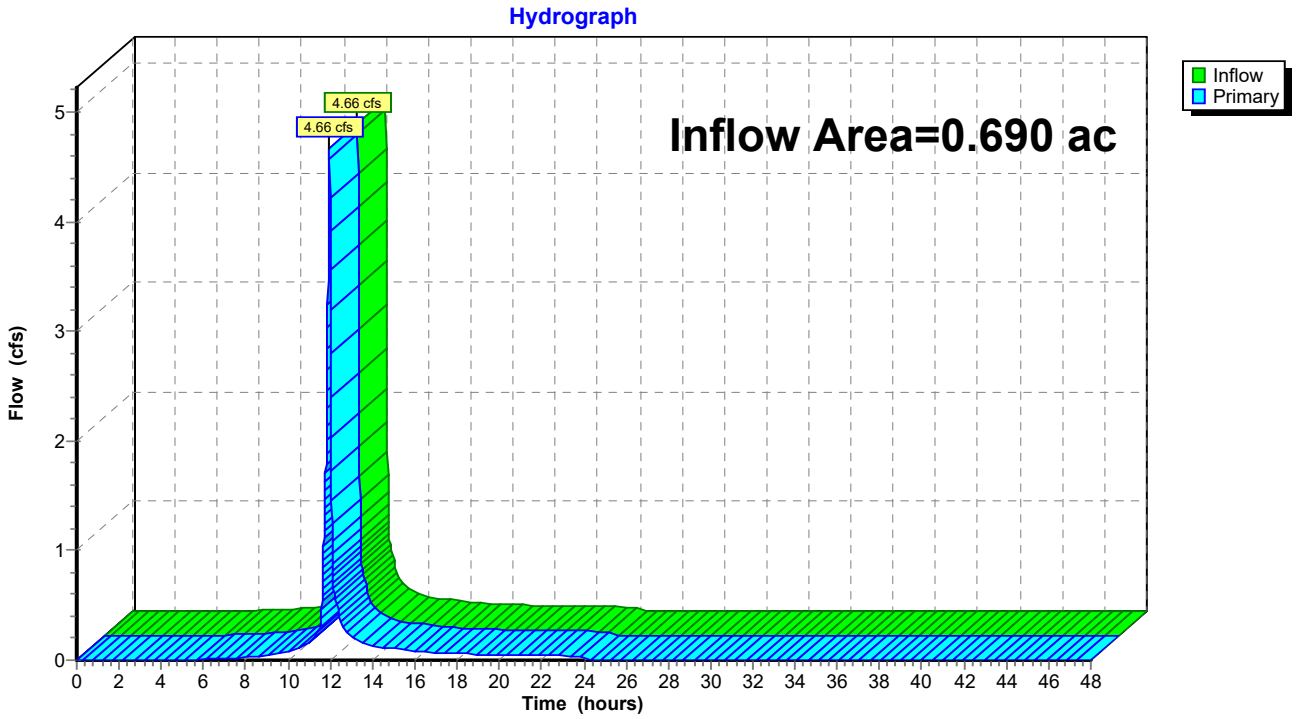


Summary for Link 1L: West

Inflow Area = 0.690 ac, 38.00% Impervious, Inflow Depth = 3.85" for Jackson - 10 YR event
Inflow = 4.66 cfs @ 11.96 hrs, Volume= 0.221 af
Primary = 4.66 cfs @ 11.96 hrs, Volume= 0.221 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: West

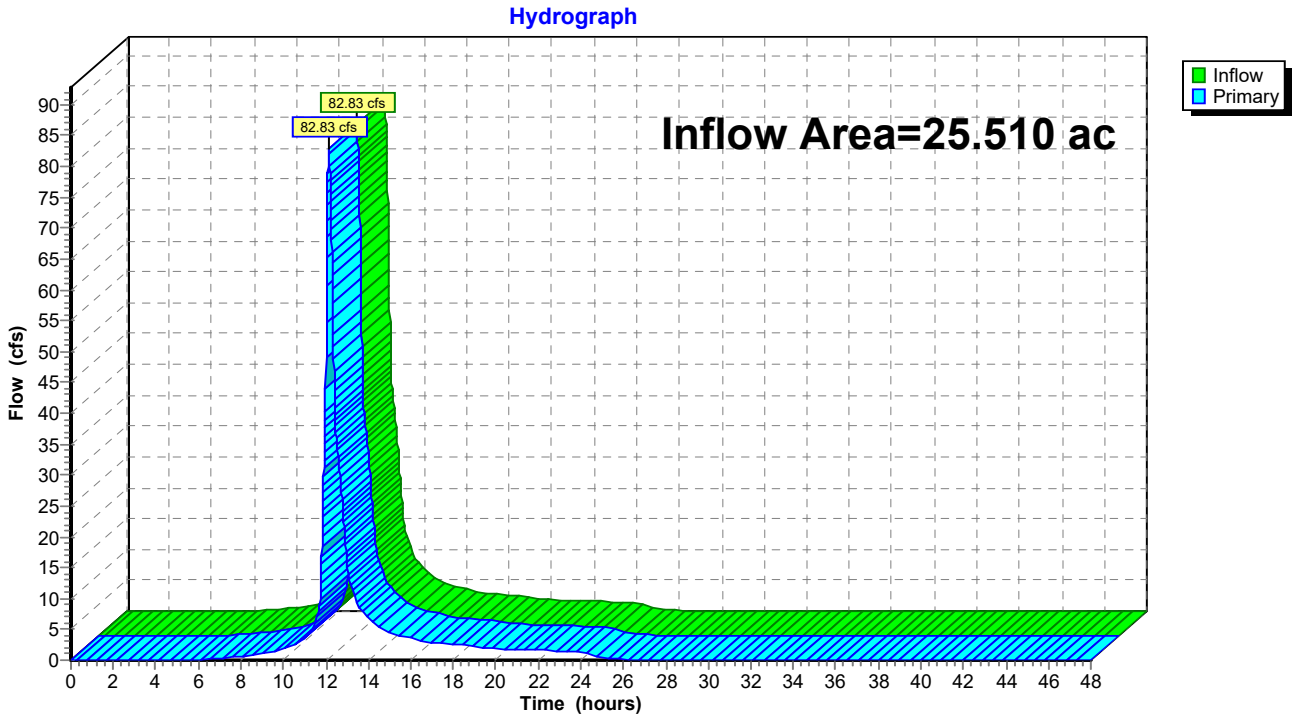


Summary for Link NW: Ex. Northwest Total

Inflow Area = 25.510 ac, 36.44% Impervious, Inflow Depth = 3.83" for Jackson - 10 YR event
Inflow = 82.83 cfs @ 12.14 hrs, Volume= 8.151 af
Primary = 82.83 cfs @ 12.14 hrs, Volume= 8.151 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link NW: Ex. Northwest Total



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment2S: West Runoff Area=0.690 ac 38.00% Impervious Runoff Depth=6.16"
Tc=5.0 min CN=87 Runoff=7.23 cfs 0.354 af

Subcatchment3S: Northwest Detained - Runoff Area=11.840 ac 36.59% Impervious Runoff Depth=6.16"
Tc=10.8 min CN=87 Runoff=102.51 cfs 6.076 af

Subcatchment4S: Northwest Detained - Runoff Area=13.060 ac 38.00% Impervious Runoff Depth=6.16"
Tc=13.5 min CN=87 Runoff=103.85 cfs 6.702 af

Subcatchment5S: Northwest Bypass - Runoff Area=0.610 ac 0.00% Impervious Runoff Depth=5.34"
Tc=5.0 min CN=80 Runoff=5.79 cfs 0.272 af

Pond 1P: NW EDD Peak Elev=923.16' Storage=115,888 cf Inflow=204.50 cfs 12.778 af
Outflow=132.05 cfs 12.778 af

Link 1L: West Inflow=7.23 cfs 0.354 af
Primary=7.23 cfs 0.354 af

Link NW: Ex. Northwest Total Inflow=132.97 cfs 13.049 af
Primary=132.97 cfs 13.049 af

Total Runoff Area = 26.200 ac Runoff Volume = 13.403 af Average Runoff Depth = 6.14"
63.52% Pervious = 16.643 ac 36.48% Impervious = 9.557 ac

Summary for Subcatchment 2S: West

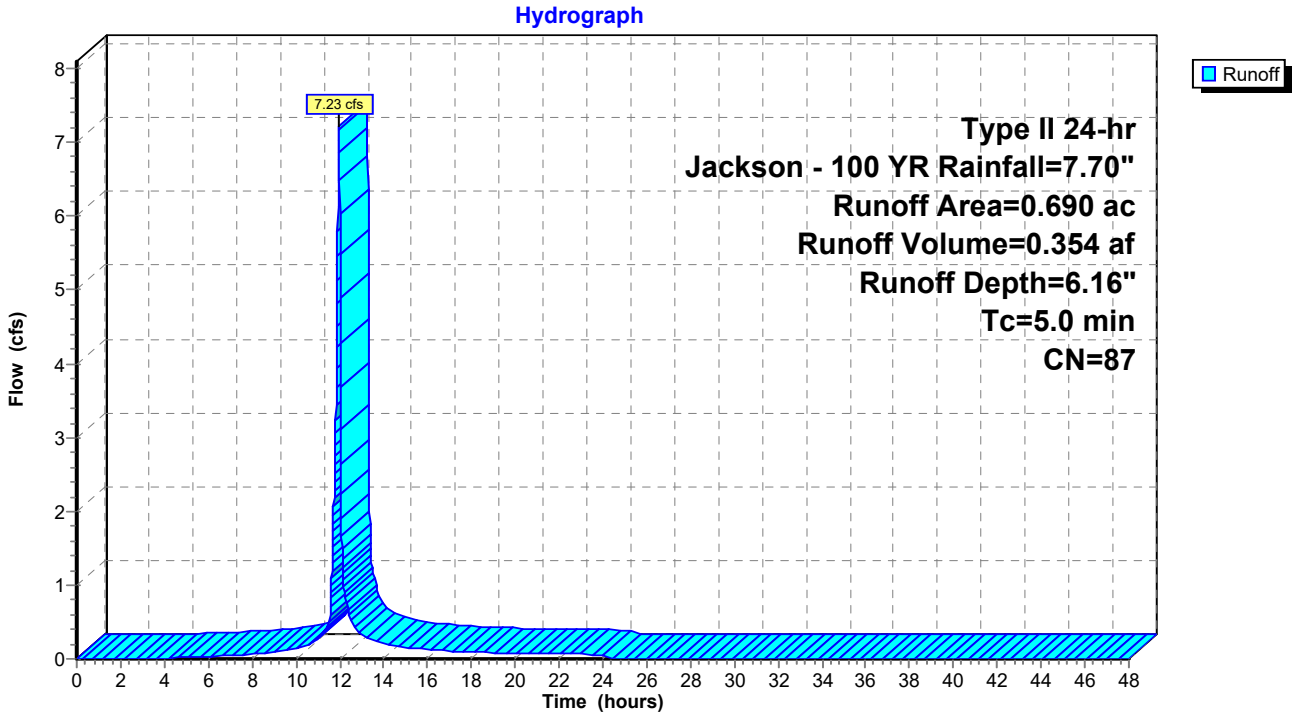
Runoff = 7.23 cfs @ 11.96 hrs, Volume= 0.354 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 100 YR Rainfall=7.70"

Area (ac)	CN	Description
0.690	87	1/4 acre lots, 38% imp, HSG D
0.428		62.00% Pervious Area
0.262		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: West



Summary for Subcatchment 3S: Northwest Detained - Onsite

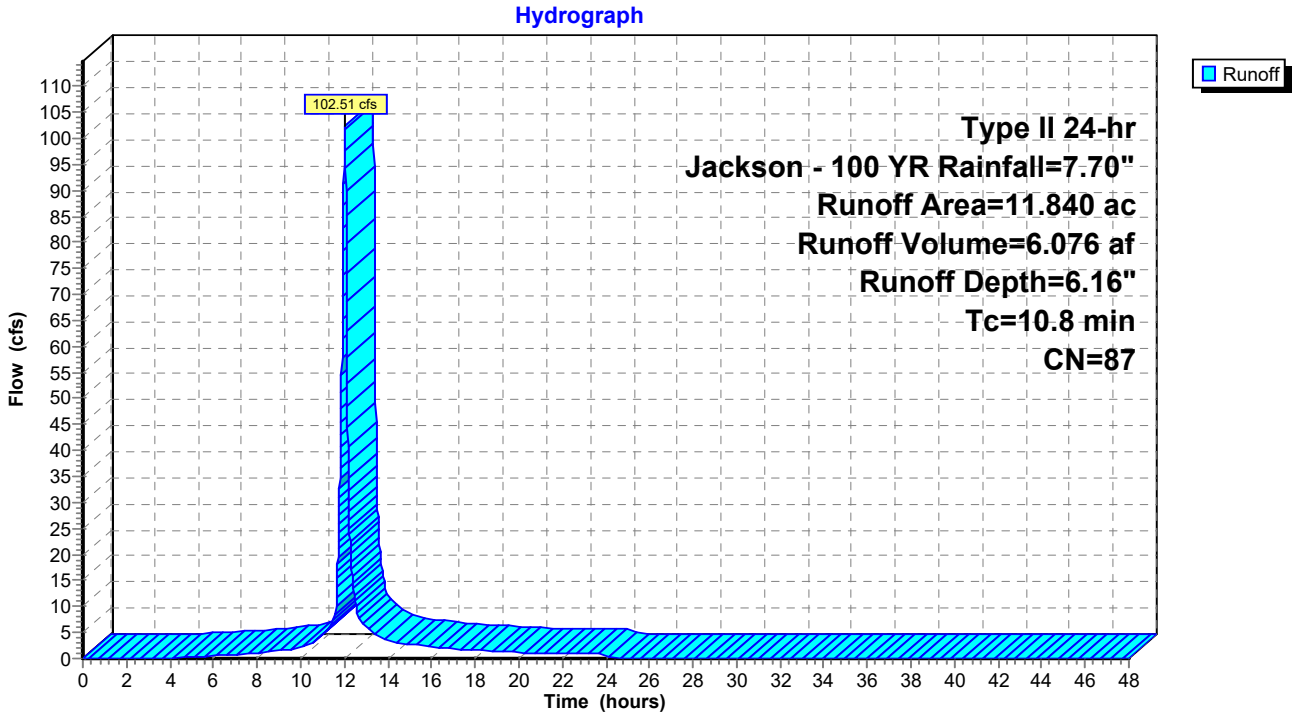
Runoff = 102.51 cfs @ 12.02 hrs, Volume= 6.076 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 100 YR Rainfall=7.70"

Area (ac)	CN	Description
11.400	87	1/4 acre lots, 38% imp, HSG D
0.440	80	>75% Grass cover, Good, HSG D
11.840	87	Weighted Average
7.508		63.41% Pervious Area
4.332		36.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8					**Direct Entry,**

Subcatchment 3S: Northwest Detained - Onsite



Summary for Subcatchment 4S: Northwest Detained - Offsite

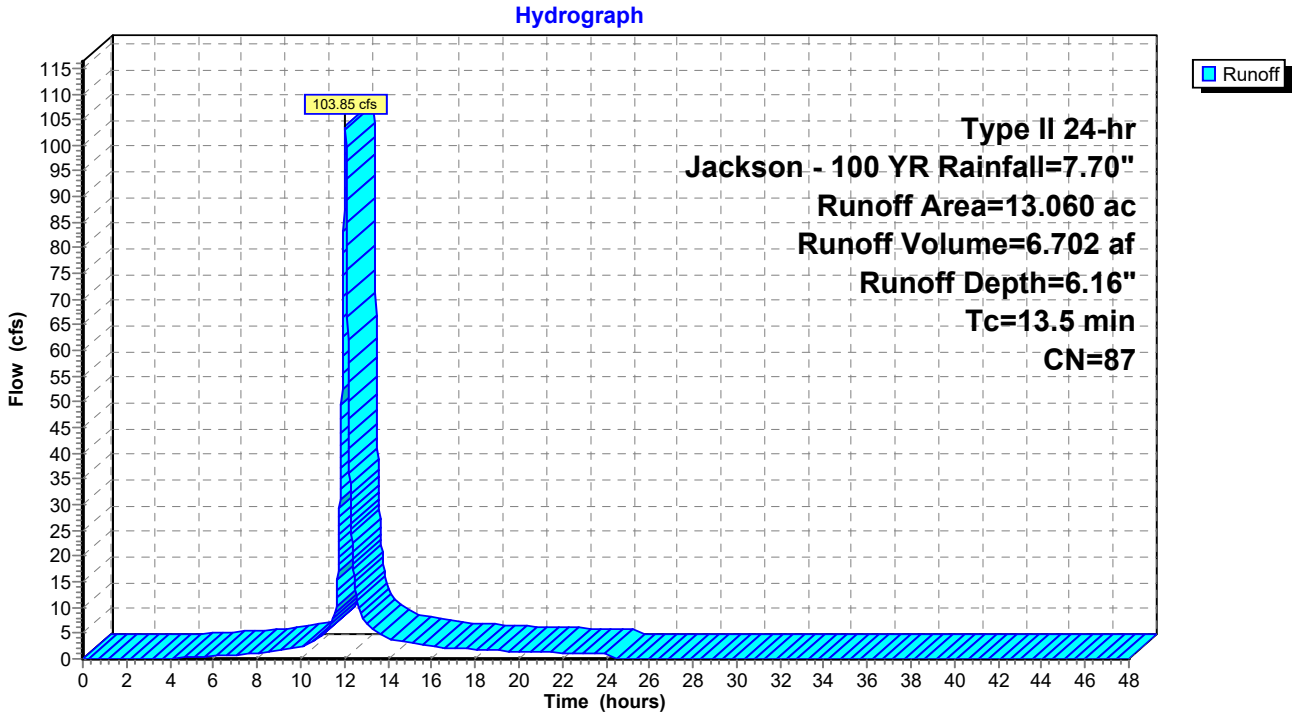
Runoff = 103.85 cfs @ 12.05 hrs, Volume= 6.702 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 100 YR Rainfall=7.70"

Area (ac)	CN	Description
13.060	87	1/4 acre lots, 38% imp, HSG D
8.097		62.00% Pervious Area
4.963		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5					**Direct Entry,**

Subcatchment 4S: Northwest Detained - Offsite



Summary for Subcatchment 5S: Northwest Bypass - Onsite

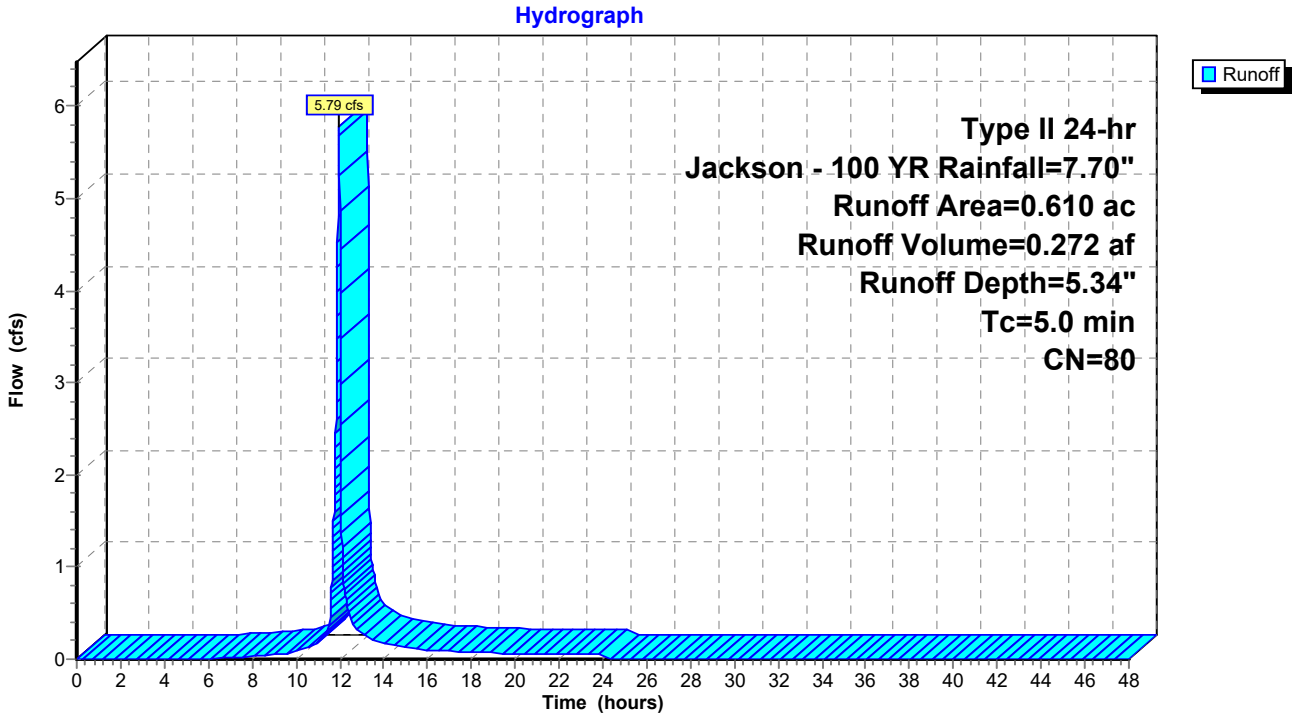
Runoff = 5.79 cfs @ 11.96 hrs, Volume= 0.272 af, Depth= 5.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 100 YR Rainfall=7.70"

Area (ac)	CN	Description
0.610	80	>75% Grass cover, Good, HSG D
0.610		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5S: Northwest Bypass - Onsite



Summary for Pond 1P: NW EDD

Inflow Area = 24.900 ac, 37.33% Impervious, Inflow Depth = 6.16" for Jackson - 100 YR event
Inflow = 204.50 cfs @ 12.03 hrs, Volume= 12.778 af
Outflow = 132.05 cfs @ 12.14 hrs, Volume= 12.778 af, Atten= 35%, Lag= 6.3 min
Primary = 132.05 cfs @ 12.14 hrs, Volume= 12.778 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 923.16' @ 12.14 hrs Surf.Area= 19,841 sf Storage= 115,888 cf

Plug-Flow detention time= 27.7 min calculated for 12.778 af (100% of inflow)
Center-of-Mass det. time= 27.6 min (816.3 - 788.7)

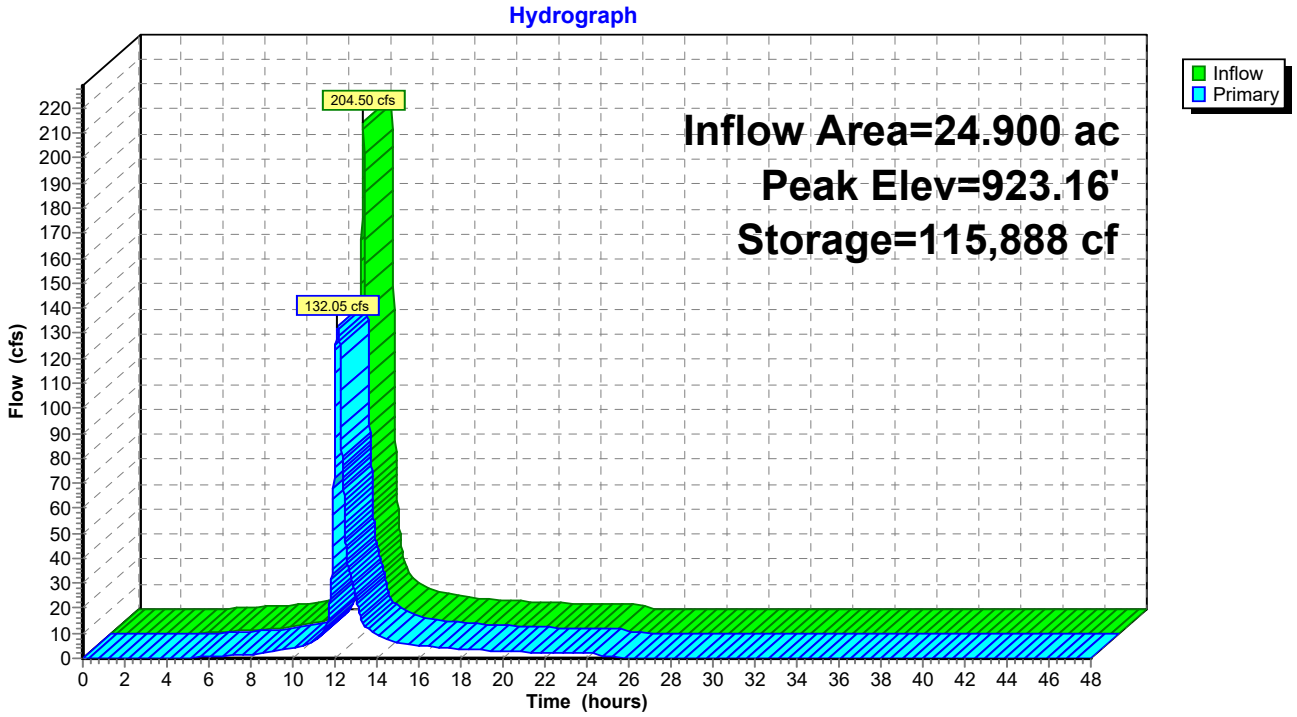
Volume	Invert	Avail.Storage	Storage Description
#1	913.00'	133,347 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
913.00	19	0	0
914.00	3,406	1,713	1,713
915.00	7,435	5,421	7,133
916.00	8,995	8,215	15,348
917.00	10,536	9,766	25,114
918.00	11,789	11,163	36,276
919.00	13,077	12,433	48,709
920.00	14,404	13,741	62,450
921.00	15,780	15,092	77,542
922.00	17,630	16,705	94,247
923.00	19,536	18,583	112,830
924.00	21,498	20,517	133,347

Device	Routing	Invert	Outlet Devices
#1	Primary	912.50'	**41.0" Round Culvert** L= 45.5' Ke= 0.500 Inlet / Outlet Invert= 912.50' / 910.12' S= 0.0523 '/' Cc= 0.900 n= 0.013, Flow Area= 9.17 sf
#2	Device 1	913.00'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 3.71 3.71 Width (feet) 0.00 1.31 0.00
#3	Device 1	916.71'	**42.0" W x 6.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	919.33'	**84.0" W x 10.0" H Vert. Orifice/Grate** C= 0.600
#5	Device 1	921.25'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=132.03 cfs @ 12.14 hrs HW=923.15' (Free Discharge)
└**1=Culvert** (Inlet Controls 132.03 cfs @ 14.40 fps)
  ├**2=Custom Weir/Orifice** (Passes < 33.03 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 20.97 cfs potential flow)
  ├**4=Orifice/Grate** (Passes < 51.81 cfs potential flow)
  └**5=Orifice/Grate** (Passes < 106.29 cfs potential flow)

Pond 1P: NW EDD

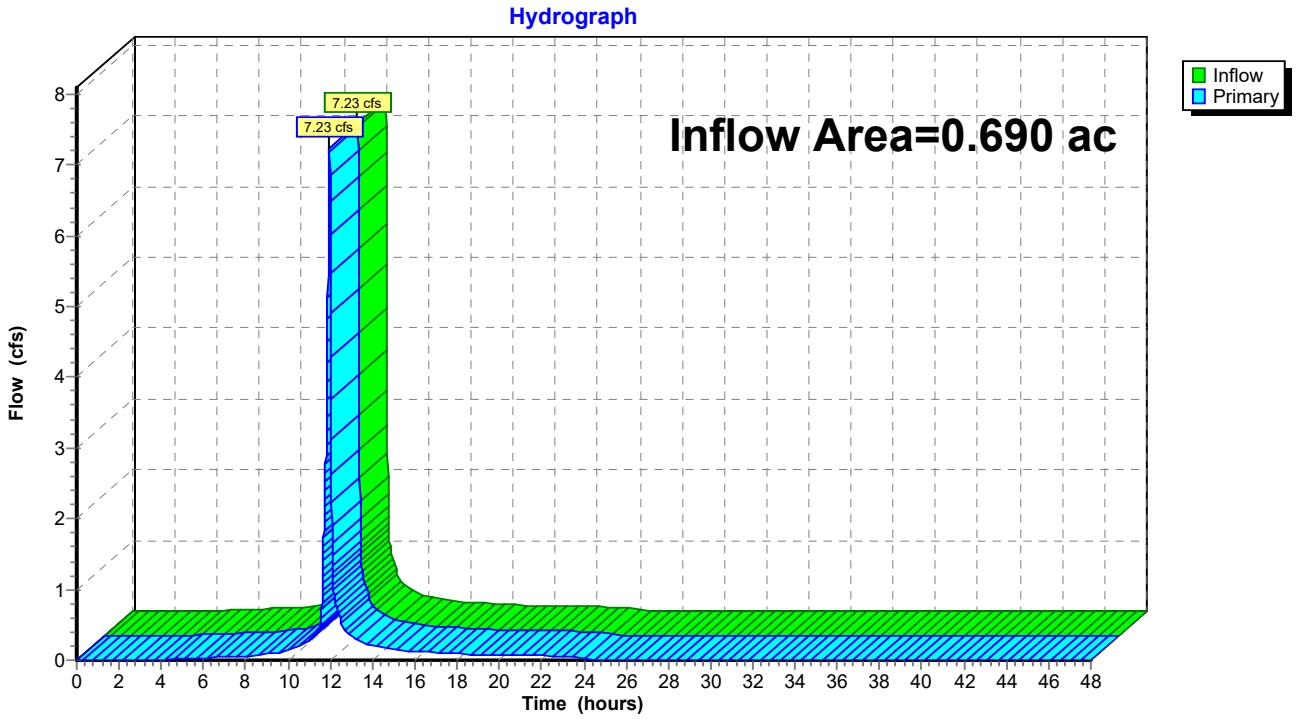


Summary for Link 1L: West

Inflow Area = 0.690 ac, 38.00% Impervious, Inflow Depth = 6.16" for Jackson - 100 YR event
Inflow = 7.23 cfs @ 11.96 hrs, Volume= 0.354 af
Primary = 7.23 cfs @ 11.96 hrs, Volume= 0.354 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: West

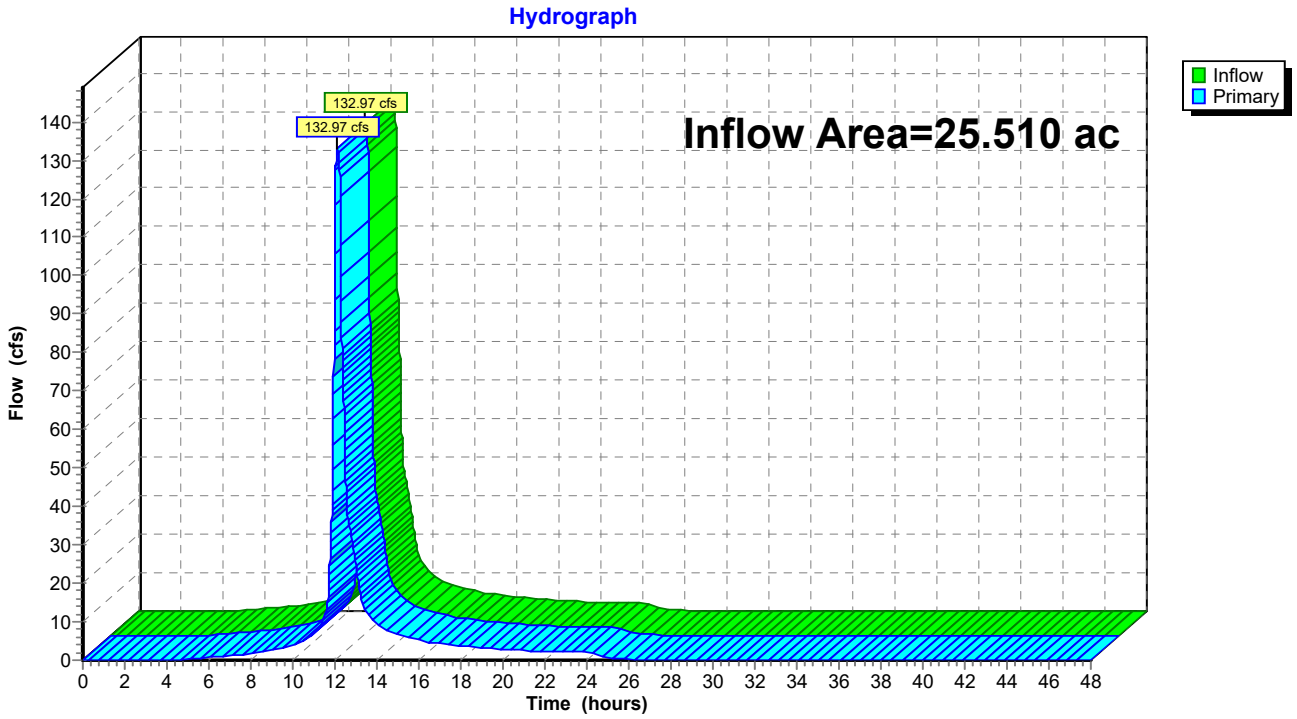


Summary for Link NW: Ex. Northwest Total

Inflow Area = 25.510 ac, 36.44% Impervious, Inflow Depth = 6.14" for Jackson - 100 YR event
Inflow = 132.97 cfs @ 12.13 hrs, Volume= 13.049 af
Primary = 132.97 cfs @ 12.13 hrs, Volume= 13.049 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link NW: Ex. Northwest Total



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment2S: West Runoff Area=0.690 ac 38.00% Impervious Runoff Depth=2.18"
Tc=5.0 min CN=87 Runoff=2.73 cfs 0.125 af

Subcatchment3S: Northwest Detained - Runoff Area=11.840 ac 36.59% Impervious Runoff Depth=2.18"
Tc=10.8 min CN=87 Runoff=38.23 cfs 2.153 af

Subcatchment4S: Northwest Detained - Runoff Area=13.060 ac 38.00% Impervious Runoff Depth=2.18"
Tc=13.5 min CN=87 Runoff=38.55 cfs 2.375 af

Subcatchment5S: Northwest Bypass - Runoff Area=0.610 ac 0.00% Impervious Runoff Depth=1.64"
Tc=5.0 min CN=80 Runoff=1.86 cfs 0.083 af

Pond 1P: NW EDD Peak Elev=919.35' Storage=53,352 cf Inflow=76.07 cfs 4.529 af
Outflow=36.47 cfs 4.529 af

Link 1L: West Inflow=2.73 cfs 0.125 af
Primary=2.73 cfs 0.125 af

Link NW: Ex. Northwest Total Inflow=36.74 cfs 4.612 af
Primary=36.74 cfs 4.612 af

Total Runoff Area = 26.200 ac Runoff Volume = 4.737 af Average Runoff Depth = 2.17"
63.52% Pervious = 16.643 ac 36.48% Impervious = 9.557 ac

Summary for Subcatchment 2S: West

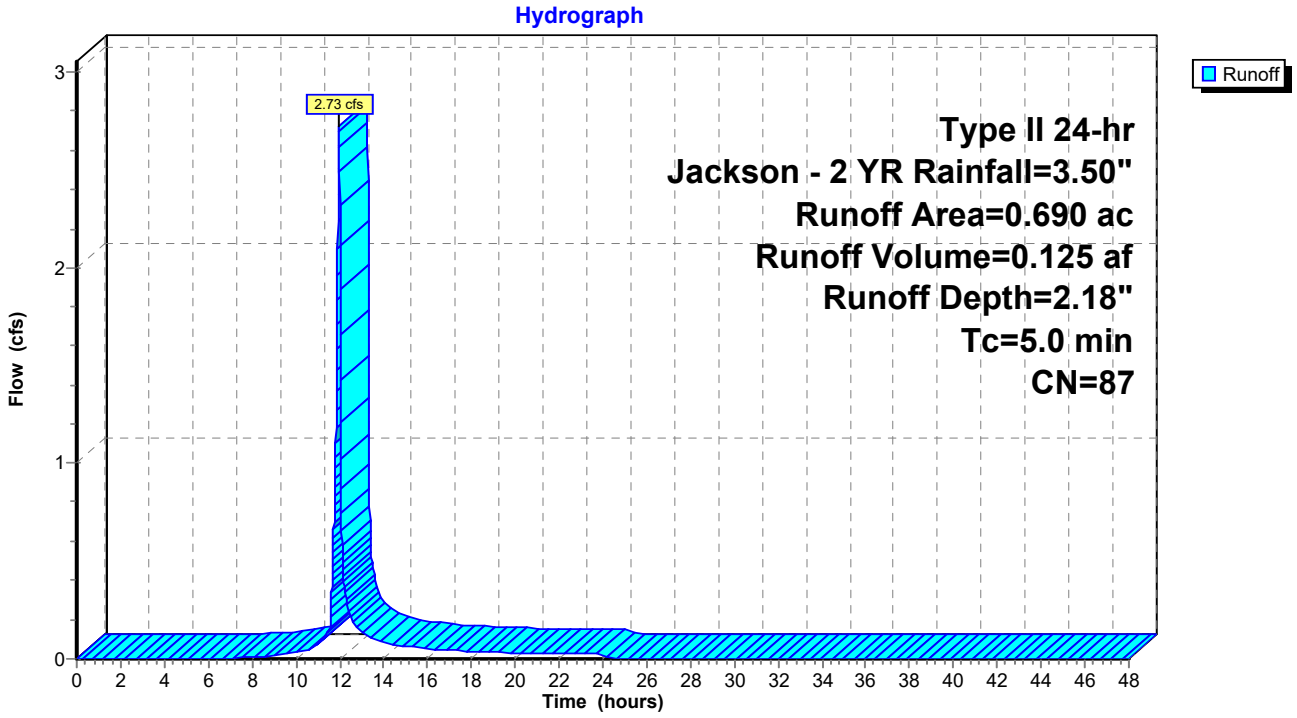
Runoff = 2.73 cfs @ 11.96 hrs, Volume= 0.125 af, Depth= 2.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 2 YR Rainfall=3.50"

Area (ac)	CN	Description
0.690	87	1/4 acre lots, 38% imp, HSG D
0.428		62.00% Pervious Area
0.262		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: West



Summary for Subcatchment 3S: Northwest Detained - Onsite

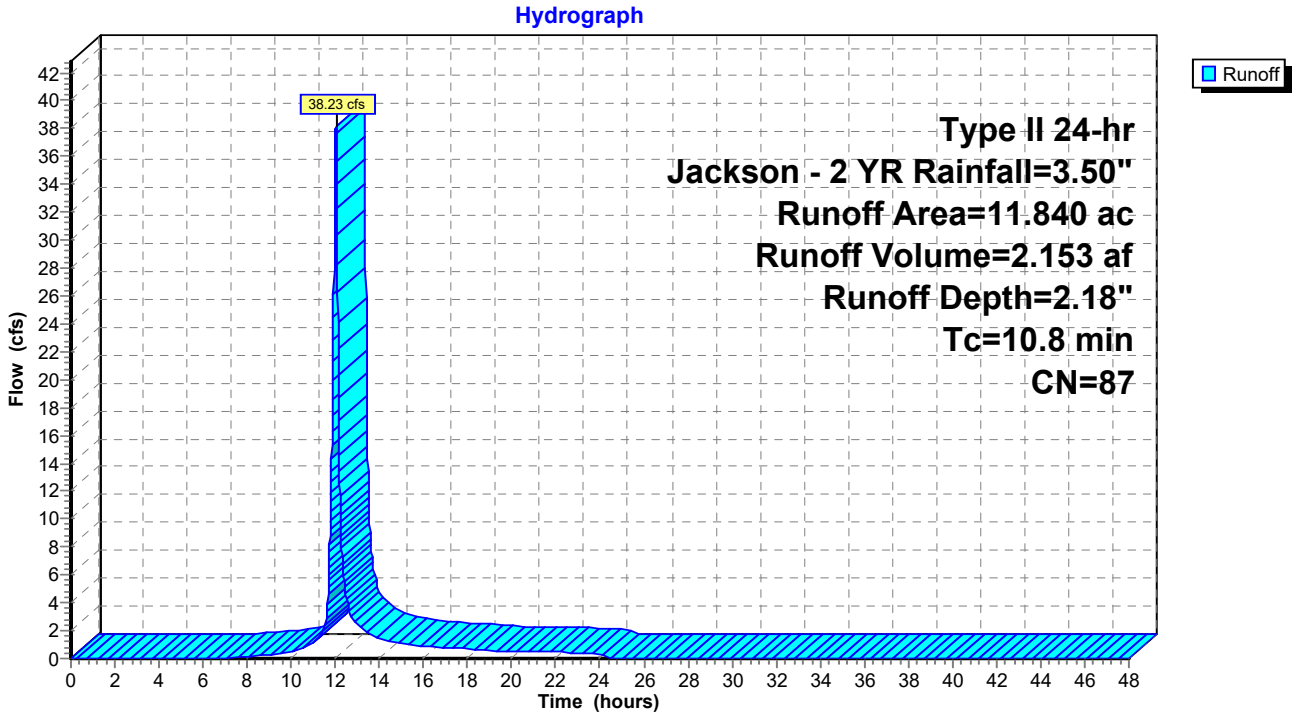
Runoff = 38.23 cfs @ 12.02 hrs, Volume= 2.153 af, Depth= 2.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 2 YR Rainfall=3.50"

Area (ac)	CN	Description
11.400	87	1/4 acre lots, 38% imp, HSG D
0.440	80	>75% Grass cover, Good, HSG D
11.840	87	Weighted Average
7.508		63.41% Pervious Area
4.332		36.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8					**Direct Entry,**

Subcatchment 3S: Northwest Detained - Onsite



Summary for Subcatchment 4S: Northwest Detained - Offsite

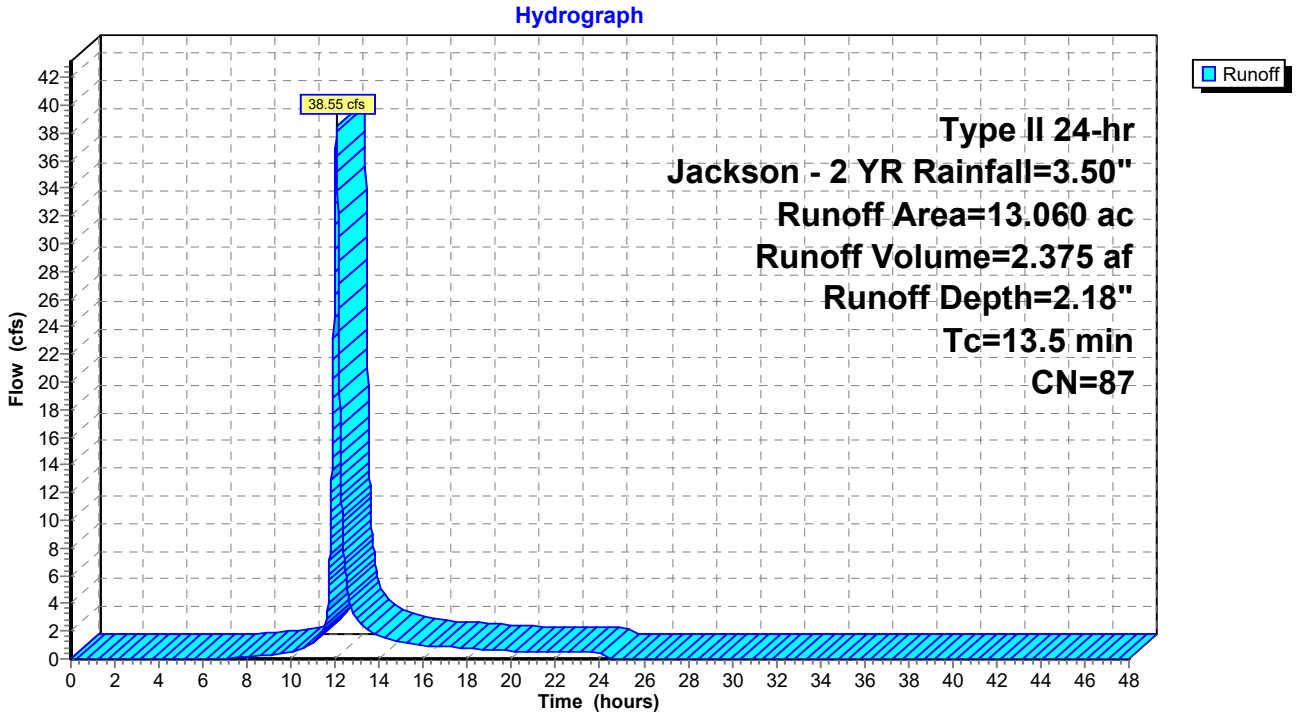
Runoff = 38.55 cfs @ 12.05 hrs, Volume= 2.375 af, Depth= 2.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 2 YR Rainfall=3.50"

Area (ac)	CN	Description
13.060	87	1/4 acre lots, 38% imp, HSG D
8.097		62.00% Pervious Area
4.963		38.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.5					**Direct Entry,**

Subcatchment 4S: Northwest Detained - Offsite



Summary for Subcatchment 5S: Northwest Bypass - Onsite

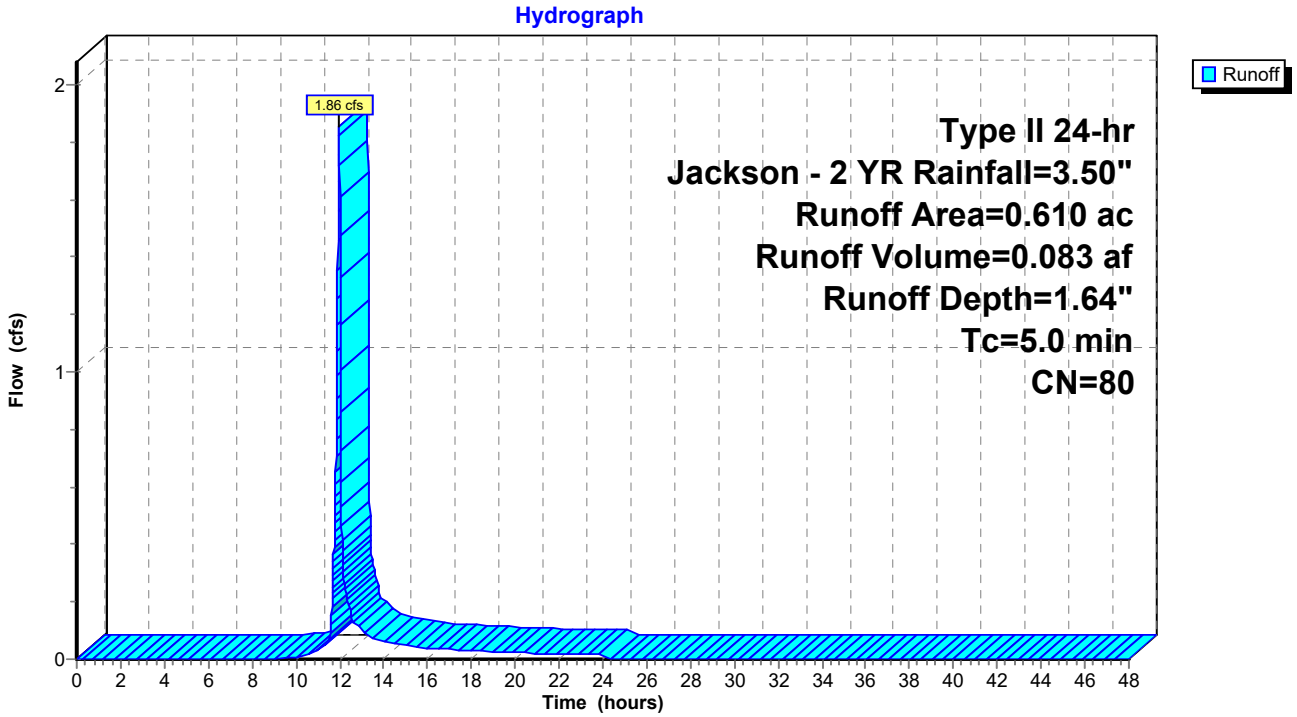
Runoff = 1.86 cfs @ 11.96 hrs, Volume= 0.083 af, Depth= 1.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type II 24-hr Jackson - 2 YR Rainfall=3.50"

Area (ac)	CN	Description
0.610	80	>75% Grass cover, Good, HSG D
0.610		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5S: Northwest Bypass - Onsite



Summary for Pond 1P: NW EDD

Inflow Area = 24.900 ac, 37.33% Impervious, Inflow Depth = 2.18" for Jackson - 2 YR event
Inflow = 76.07 cfs @ 12.04 hrs, Volume= 4.529 af
Outflow = 36.47 cfs @ 12.18 hrs, Volume= 4.529 af, Atten= 52%, Lag= 8.7 min
Primary = 36.47 cfs @ 12.18 hrs, Volume= 4.529 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Peak Elev= 919.35' @ 12.18 hrs Surf.Area= 13,540 sf Storage= 53,352 cf

Plug-Flow detention time= 35.6 min calculated for 4.528 af (100% of inflow)
Center-of-Mass det. time= 35.7 min (853.5 - 817.8)

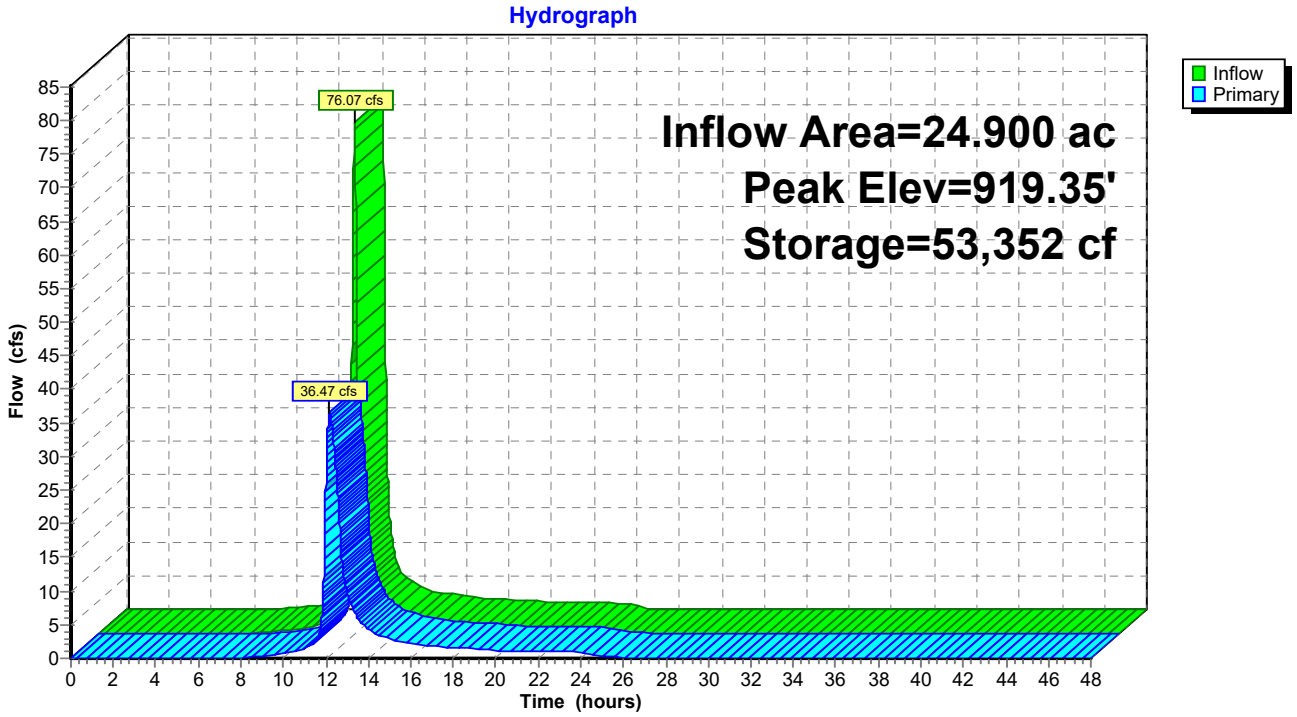
Volume	Invert	Avail.Storage	Storage Description
#1	913.00'	133,347 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
913.00	19	0	0
914.00	3,406	1,713	1,713
915.00	7,435	5,421	7,133
916.00	8,995	8,215	15,348
917.00	10,536	9,766	25,114
918.00	11,789	11,163	36,276
919.00	13,077	12,433	48,709
920.00	14,404	13,741	62,450
921.00	15,780	15,092	77,542
922.00	17,630	16,705	94,247
923.00	19,536	18,583	112,830
924.00	21,498	20,517	133,347

Device	Routing	Invert	Outlet Devices
#1	Primary	912.50'	**41.0" Round Culvert** L= 45.5' Ke= 0.500 Inlet / Outlet Invert= 912.50' / 910.12' S= 0.0523 '/' Cc= 0.900 n= 0.013, Flow Area= 9.17 sf
#2	Device 1	913.00'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 3.71 3.71 Width (feet) 0.00 1.31 0.00
#3	Device 1	916.71'	**42.0" W x 6.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	919.33'	**84.0" W x 10.0" H Vert. Orifice/Grate** C= 0.600
#5	Device 1	921.25'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=36.43 cfs @ 12.18 hrs HW=919.35' (Free Discharge)
└─**1=Culvert** (Passes 36.43 cfs of 100.09 cfs potential flow)
  ├─**2=Custom Weir/Orifice** (Orifice Controls 23.35 cfs @ 9.61 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 13.02 cfs @ 7.44 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.06 cfs @ 0.44 fps)
  └─**5=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: NW EDD

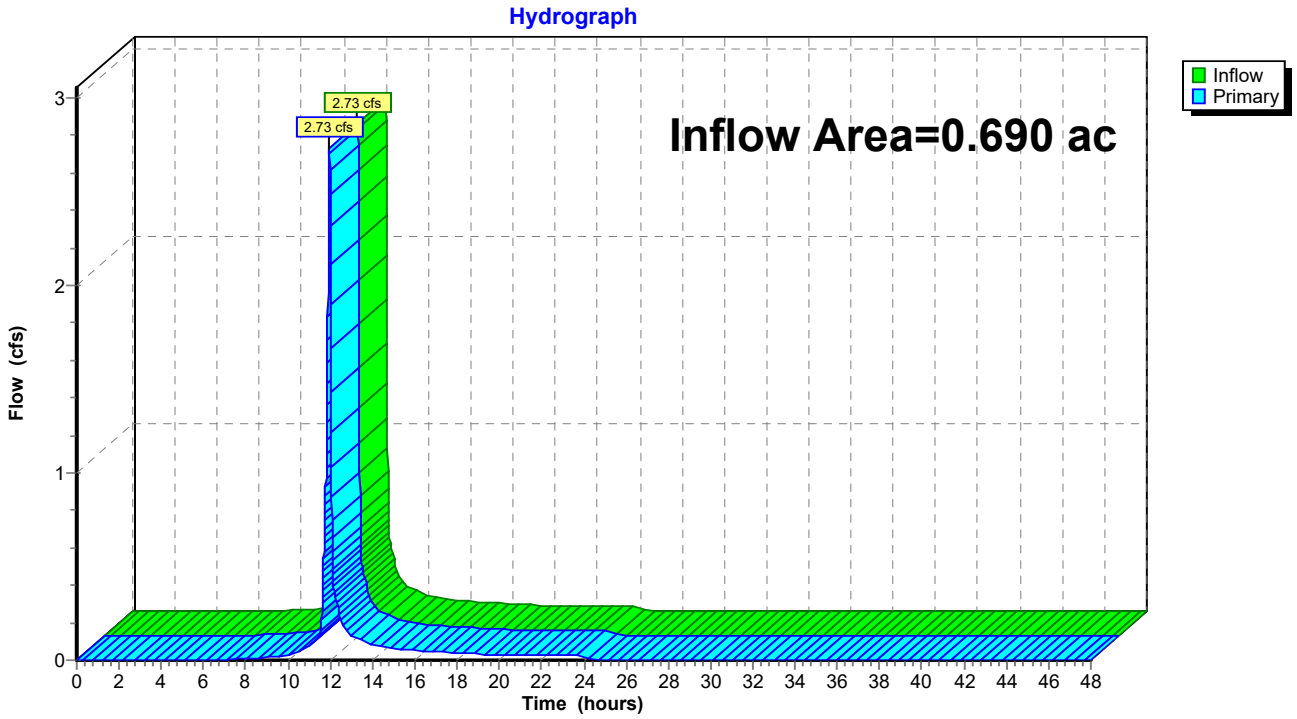


Summary for Link 1L: West

Inflow Area = 0.690 ac, 38.00% Impervious, Inflow Depth = 2.18" for Jackson - 2 YR event
Inflow = 2.73 cfs @ 11.96 hrs, Volume= 0.125 af
Primary = 2.73 cfs @ 11.96 hrs, Volume= 0.125 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link 1L: West

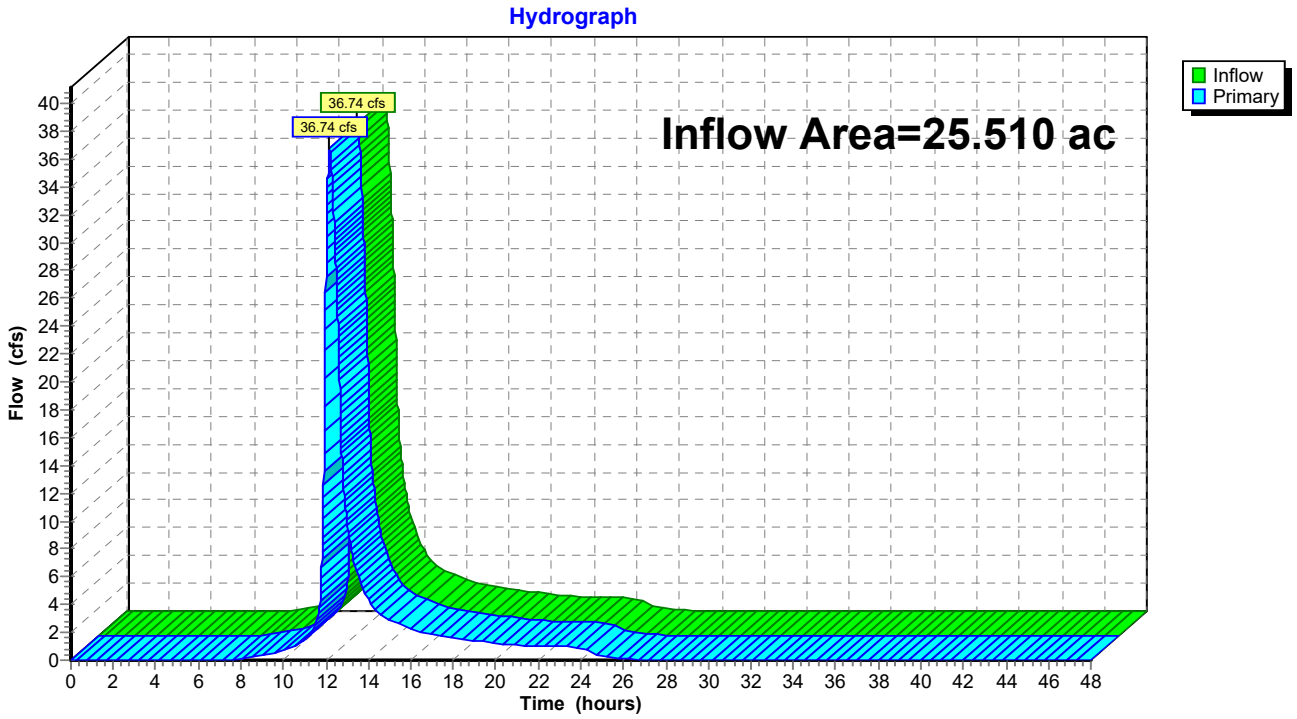


Summary for Link NW: Ex. Northwest Total

Inflow Area = 25.510 ac, 36.44% Impervious, Inflow Depth = 2.17" for Jackson - 2 YR event
Inflow = 36.74 cfs @ 12.18 hrs, Volume= 4.612 af
Primary = 36.74 cfs @ 12.18 hrs, Volume= 4.612 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Link NW: Ex. Northwest Total



Appendix E

Design Procedure Form: Extended Wet Detention Basin
Main Worksheet

Designer:	KAD
Checked By:	DEU
Company:	Phelps Engineering, Inc
Date:	1/19/2023
Project:	Orchard Woods
Location:	Lee's Summit, Missouri

I. Basin Water Quality Volume

Step 1) Tributary area to EDW, A_T (ac) — A_T (ac) = 11.8

Step 2) Calculate WQv using methodology in Section 6 — WQv (ac-ft) = 0.5

IIa. Water Quality Outlet Type

Step 1) Set water quality outlet type: — Outlet Type = 3

Type 1 = single orifice
Type 2 = perforated riser or plate
Type 3 = v-notch weir

Step 2) Proceed to part IIb, IIC, or IID based on water quality outlet type selected.

IIb. Water Quality Pool Outlet, Single Orifice

Step 1) Depth of water quality volume above permanent pool, Z_{WQ} (ft) — Z_{WQ} (ft) = 3.71

Step 2) Average head of water quality volume over invert of orifice, H_{WQ} (ft)

$H_{WQ} = 0.5 * Z_{WQ}$ — H_{WQ} (ft) = 1.9

Step 3) Average water quality outflow rate, Q_{WQ} (cfs)

$Q_{WQ} = (WQv * 43{,}560)/(40 * 3{,}600)$ — Q_{WQ} (cfs) = 0.16

Step 4) Set value of orifice discharge coefficient, C_o

$C_o = 0.66$ when thickness of riser/weir plate is = or < orifice diameter

$C_o = 0.80$ when thickness of riser/weir plate is > orifice diameter — C_o = 0.66

Step 5) Water quality outlet orifice diameter (minimum of 4 inches), D_o (in)

$D_o = 12 * 2 * (Q_{WQ}/(C_o * \pi * (2 * g * H)^{0.5}))^{0.5}$ — D_o (in) = 2.02

(If orifice diameter < 4 inches, use outlet type 2 or 3)

Step 6) To size outlet orifice for EDW with an irregular stage-volume relationship, use the Single Orifice Worksheet

IIc. Water Quality Outlet, Perforated Riser

Step 1) Depth of water quality volume above permanent pool, Z_{WQ} (ft)	Z_{WQ} (ft) =	3.71
Step 2) Recommended maximum outlet area per row, A_o (in^2) Ao = WQv/(0.013 * Z_{WQ}^2 + 0.22 * Z_{WQ} - 0.10)	A_o (in^2) =	0.59
Step 3) Circular perforation diameter per row assuming a single column, D_1 (in)	D_1 (in) =	0.9
Step 4) Number of columns, n_c	n_c =	
Step 5) Design circular perforation diameter (between 1 and 2 inches), D_{perf} (in)	D_{perf} (in) =	1.0
Step 6) Horizontal perforation column spacing when n_c > 1, center to center, S_c If D_{perf} >/= 1.0 in, S_c = 4	S_c (in) =	NA
Step 7) Number of rows (4" vertical spacing between perforations, center to center), n_r	n_r =	11

IId. Water Quality Outlet, V-Notch Weir

Step 1) Depth of water quality volume above permanent pool, Z_{WQ} (ft)	Z_{WQ} (ft) =	3.71
Step 2) Average head of water quality pool volume over invert of v-notch, H_{WQ} (ft) H_{WQ} = 0.5 * Z_{WQ}	H_{WQ} (ft) =	1.9
Step 3) Average water quality pool outflow rate, Q_{WQ} (cfs) Q_{WQ} = (WQv * 43,560)/(40 * 3,600)	Q_{WQ} (cfs) =	0.16
Step 4) V-notch weir coefficient, C_v	C_v =	2.5
Step 5) V-notch weir angle, θ (deg) θ = 2 * arctan(Q_{WQ}/(C_v * $H_{WQ}^{5/2}$)) V-notch angle should be at least 20 degrees. Set to 20 degrees if calculated angle is smaller.	θ (deg, 20 min) =	20
Step 6) V-notch weir top width, W_v (ft) W_v = 2 * Z_{WQ} * TAN(θ/2)	W_v (ft) = Height (ft) =	1.31 3.71
Step 7) To calculate v-notch angle for EDW with an irregular stage-volume relationship, use the V-notch Weir Worksheet		

Appendix F

National Flood Hazard Layer FIRMette

FEMA

94°21'14"W 38°59'19"N

94°20'37"W 38°58'51"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

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
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

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 1/18/2023 at 4:41 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.