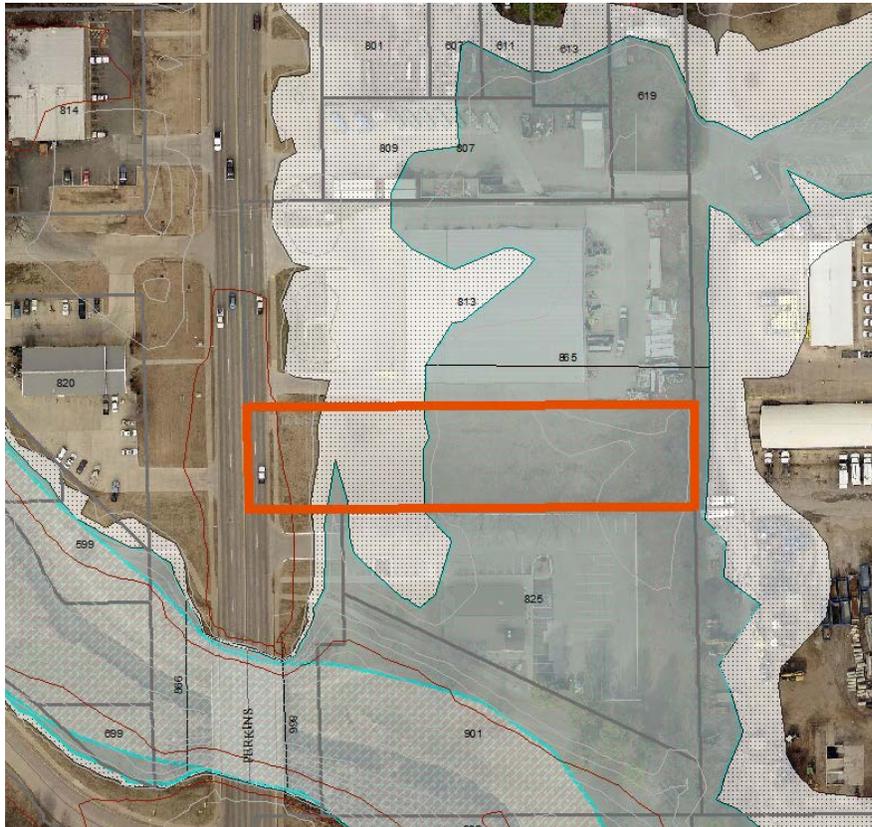


Date of Meeting: July 26, 2016
Subject: Variance Consideration: Detention Basin Requirements
Project Name: Craig Nicholson - Commercial Retail Bldgs.
Location: 819 S Perkins Rd

BACKGROUND

On July 1, 2016 an application was filed with the City of Stillwater requesting a variance from the municipal code requirement to provide onsite detention basin storage as a means to regulate peak discharges. The application was filed after submittal and analysis of the Commercial Use by Right site development plan. The development is proposed on an existing un-platted parcel fronting onto Perkins Road. All adjoining tracts are fully developed.



CODE APPLICATION

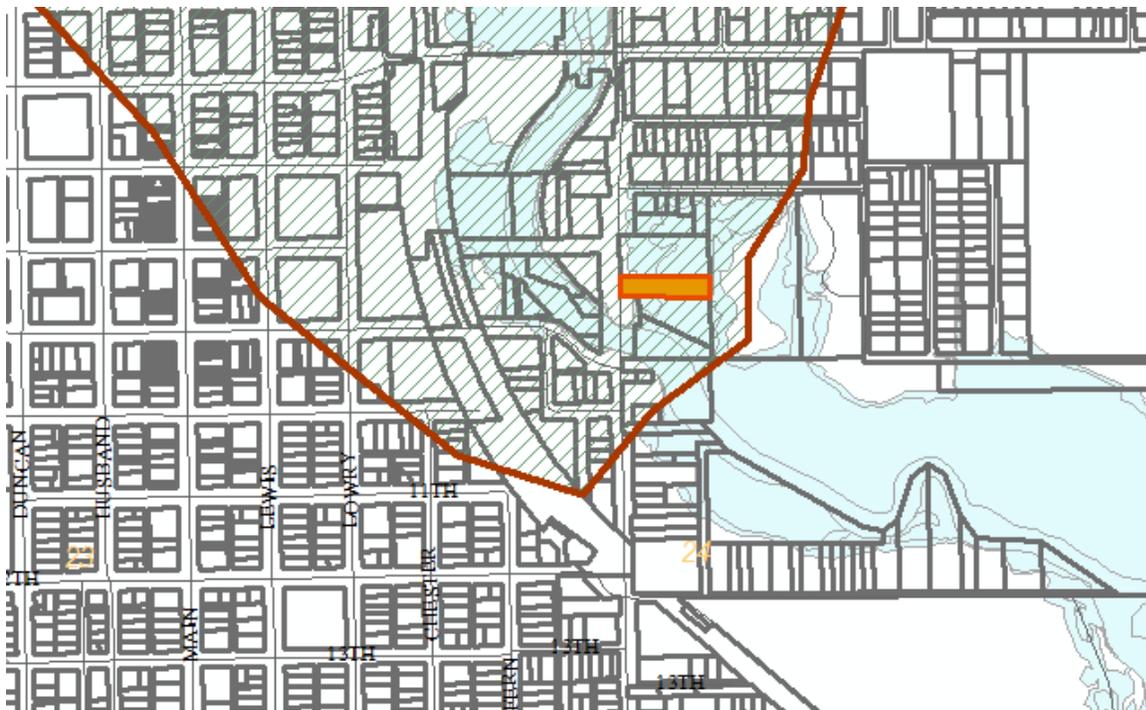
City Code, Chapter 35, Section 35-78 Drainage Policies and Standards.

ANALYSIS

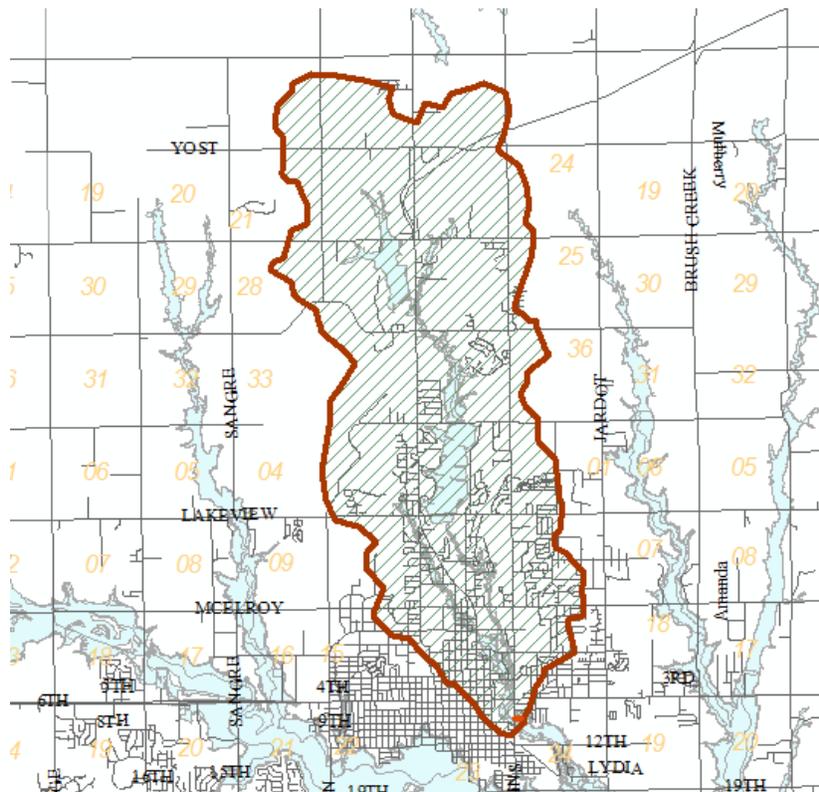
The location of the site in and adjacent to the floodplain make provision of suitable and effective stormwater detention facilities difficult. The overall Boomer Creek watershed to the point of discharge is more than 9,500 acres and has a discharge of approximately 8,000 cubic feet per second. The proposed site covers slightly less than 1 acre and has a 100 year discharge of 6.16 cfs.

Development of the site will require placement of fill within the floodplain area. The fill placement will require the provision of compensatory fill to maintain the floodplain storage relationships. Raising the site high enough above the floodplain to provide onsite detention will require extensive fill resulting in a larger impact on the watershed floodplain.

Site Location in Lower Portion of Watershed.



Boomer Creek Watershed – 9,534 acres



FINDINGS

1. Provision of onsite Stormwater detention will provide no flood reduction or prevention benefit to the watershed or to adjacent property.
2. Delay of peak discharge from the developed site will only increase peak flows from the watershed.
3. Failure to grant the variance will result in an exceptional hardship to the applicant because a significant amount of additional fill would be required to adequately elevate the entire site above the floodplain in order to provide onsite detention. Thus the request meets the criterion set by Code section 35-57(d).
4. All reviews indicate that the project site is uniquely located for such conditions to exist and granting the variance does not set precedence for future development.

Staff recommends that the Board of Drainage Appeals accepts staff findings and make any additional findings, based on any testimony presented, in order to grant or deny the variance.

Prepared by: Mike Beaty, Development Review Manager
Date of Preparation: July 20, 2016
Attachments: Drainage Analysis, Dr. Ellen Stevens
Variance Application

**Variance Application to the
Board of Drainage Appeals**

Case #

General Location and/or Address of Property: 819 S. Perkins Road, Stillwater, OK 74074

Legal Description of Subject Property: See attached Exhibit "A" for complete legal description

Applicant's Name: Craig Nicholson Applicant's Phone Number: (405) 744-8842

Mailing Address: 310 S. Berry Street, Stillwater, OK 74074

Property Owner(s) of Record: Craig Nicholson

Property Owner(s) Mailing Address: 310 S. Berry Street, Stillwater, OK 74074

Description of Proposed Construction or Activity:

Develop a portion of the site for one (1) 3,600 SF retail building and one (1) 1,765 SF future, retail building.

What particular requirements of the City code require a variance to obtain permission for the proposed construction or activity?

The requirement of on-site stormwater storage for regulation of peak flows so the discharge for post-development conditions does not exceed the pre-development conditions.

Article: 2

Section: 35

Paragraph(s): 78

What are the characteristics of the subject property which prevent compliance with the foregoing requirements of the City code? (Such conditions must be unique to the property and not created by any actions of the property owner or applicant.)

It is proposed to develop the site without providing a detention facility, as there is nowhere on the property where it is feasible to store any significant volume at an elevation above the base flood elevation.

What is the particular variance that would be necessary to permit the proposed construction or activity?

To waive on-site detention.

What unnecessary hardship would result if the requirements of the City code were applied to the subject property without a variance?

Providing an on-site detention facility would require that the development portion of the site be raised significantly in elevation to ensure that the site runoff could be captured by a detention facility that could store adequate volume above the BFE. The developable portion of the site would be greatly reduced by the addition of an on-site facility, making development of the site less feasible.

Explain how granting of the variance will not adversely affect the rights of adjacent property owners or residents, will not adversely affect the public health, safety, convenience or general welfare and will not be opposed to the general spirit and intent of the regulations of the City code:

Due to the close proximity of the site to Boomer Creek, stormwater discharge from the site will enter the creek via existing drainage way at the east end of the property. While there was not sufficient modeling data available to evaluate timing of peaks on Boomer Creek, it is very

CITY OF

stillwater

Development Services

**Variance Application to the
Board of Drainage Appeals**

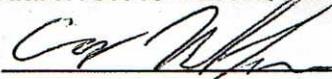
likely that the increase in discharge from the site to Boomer Creek will not coincide with peak discharge on the creek, minimizing the impact of the increase in discharge. The existing drainage way runs north and south along the east property line of the subject property and the west line of an adjacent property owned by the city, flowing south a short distance through Hoyt Grove Park and entering Boomer Creek. The minimal increase in discharge will not affect any adjacent property owners. This variance will not adversely affect the public health, safety convenience, or general welfare and will not be opposed to the general spirit or intent of the regulations of the City code.

Attached are the following:

1. \$55 filing fee (check payable to the City of Stillwater)
2. List of names and mailing addresses of all owners of property within 500 feet of the exterior boundary of the subject property, and/or will be affected by the change in flow.

THE PRECEDING INFORMATION IS CERTIFIED COMPLETE AND ACCURATE.

Applicant's Signature: _____



Date: _____

7/1/16

**Drainage Study
Nicholson Development
819 South Perkins, Stillwater, OK**

Background

The objective of the project is build a retail development on a one-acre site on the east side of South Perkins Road, south of East 8th Avenue. The existing site is presently open land. The site discharges east to the Boomer Creek floodplain and west to an area inlet in the bar ditch along Perkins road.

There are no blue-line creeks on the property. The effective map panel 40119C0231F dated May 16, 2007 shows FEMA floodplain covering portions of the property. According to the profiles in the FIS, the base flood elevation (BFE) at the site is 865.40 feet. It is proposed to excavate from the east portion of the property to place fill and elevate the part to be developed above the BFE. All easements are shown in the plan set and do not impact the surface drainage.

It is proposed to develop the site without providing a detention facility, as there is nowhere on the property where it is feasible to store any significant volume at an elevation above the BFE. The objective of this study is to show no adverse impacts from development of the site, in support of an application for a variance.

Existing and Proposed Conditions Hydrology

The general lay of the land slopes downhill from west to east, however, discharge from the west is intercepted in the inlets in the Perkins Road bar ditch. Therefore, there is no significant runoff entering the property from off site.

For existing conditions, the site was split into two areas – area Pre-1 discharges to the area inlet in the Perkins Road bar ditch and area Pre-2 discharges to the east, into the Boomer Creek Floodplain. Existing site drainage area map is attached.

The proposed site is to be graded to minimize the additional discharge into the inlet on Perkins Road and the remainder of the site will discharge to the Boomer Creek floodplain to the east.

Existing and proposed runoff volumes were determined using the NRCS curve number method. The entire site has hydrologic class B soils, as shown on the attached NRCS soils map. The pervious area of the existing site was represented with a curve number weighted between 69 for open space in fair condition. i.e., unmaintained grass and brush, and 98 for impervious area. For proposed conditions, the curve numbers were obtained by weighting between landscaped areas (open space in good condition, curve number of 61) and impervious area (curve number of 98). A map of proposed drainage areas is attached.

Time of concentration and lag time calculations are attached. For several of the areas, the time of concentration was sufficiently short that the lag time (0.6 times time of concentration) was less than the stability criterion of the NRCS unit hydrograph method. The criterion is that lag time be greater than the time step divided by 0.29, or 3.45 minutes if a one-minute time step is used. Therefore, some of the watersheds were modeled as unrouted.

The HEC-HMS model was used to do the calculations and a time step of 1 minute was used. The NRCS 24-hour, Type II storm was used and the rainfall depths were obtained from the city standards manual. Copies of the HEC-HMS input and output data are attached.

A summary table providing a comparison of the existing and proposed peak discharges is attached. The table shows the discharge into the bar ditch on Perkins Road increases by a maximum of 0.05 cfs in the 100-year event and is less than or equal to existing in the 1 through 10-year events.

The increase in discharge to the Boomer Creek floodplain ranges from 0.95 to 1.12 cfs for the various events modeled. This amount of increase in discharge is minimal compared to the discharge in the main creek, as shown by the FEMA discharges included in the table.

The HEC-RAS model of Boomer Creek was revised to verify that the fill added to the site would not increase the BFE. No fill is to be placed in the regulatory floodway and, as the Firmette shows, the floodplain to the east of the site is a backwater area and not within the main conveyance of the creek.

To represent the site, four cross sections were added to the model, as shown in the attached exhibit. The model was run with the four cross sections to produce an existing conditions model. The sections in the property were then modified to include the extent of the fill and the model confirmed that the water elevation in the base flood event discharge was less than or equal to existing. This is to be expected since the area is a backwater and the velocity is very slow. HEC-RAS input and output are in the Appendix.

Conclusions

Development of the site without providing detention is not predicted to have adverse impacts to adjoining property or to Boomer Creek, as follows:

1. Discharge to the bar ditch on Perkins is less than or equal to existing for the 1 through 10-year events and the maximum increase is 0.05 cfs.
2. Discharge to the Boomer Creek floodplain increases by a maximum of 1.12 cfs, which is 0.02 percent of the 10-year discharge. Increase in the base flood event discharge is 0.95 cfs, which is 0.01 percent of the base flood discharge.

3. While there was not sufficient modeling data available to evaluate timing of peaks on Boomer Creek, it is very likely that the increase in discharge from the site to Boomer Creek will not coincide with peak discharge on the creek, minimizing the impact of the increase in discharge.
4. Placement of fill was evaluated and there was no predicted increase in BFE.

Prepared by:


Ellen W. Stevens, Ph.D.,
June 20, 2016

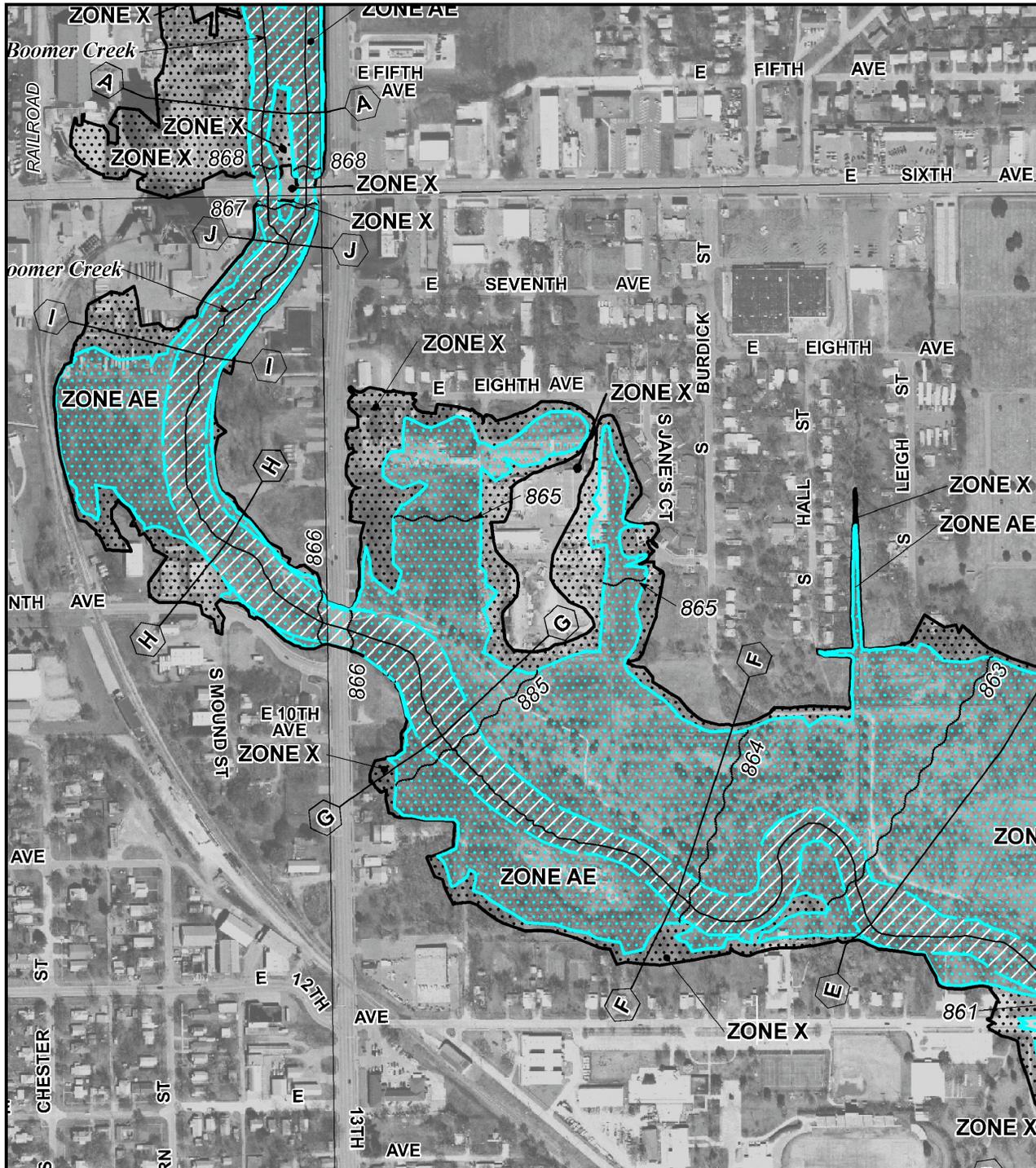


Discharge Comparison Table

Years	Outlet to Perkins Road			Outlet to Floodplain			Boomer Creek
	Existing	Proposed	Increase	Existing	Proposed	Increase	
1	0.21	0.17	-0.03	0.71	1.73	1.03	
2	0.31	0.28	-0.03	1.15	2.24	1.08	
5	0.52	0.49	-0.03	2.06	3.18	1.12	
10	0.66	0.64	-0.02	2.70	3.81	1.11	5047
25	0.85	0.85	0.004	3.57	4.65	1.07	
50	1.02	1.04	0.02	4.34	5.36	1.02	7215
100	1.20	1.25	0.05	5.20	6.16	0.95	8041



MAP SCALE 1" = 500'



NFIP

PANEL 0231F

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
PAYNE COUNTY,
OKLAHOMA
AND INCORPORATED AREAS

PANEL 231 OF 525

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PAYNE COUNTY, UNINCORPORATED AREAS	400493	0231	F
STILLWATER, CITY OF	405380	0231	F

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.



MAP NUMBER
40119C0231F
EFFECTIVE DATE
MAY 16, 2007

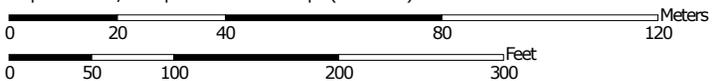
Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Hydrologic Soil Group—Payne County, Oklahoma



Map Scale: 1:1,390 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 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: Payne County, Oklahoma
 Survey Area Data: Version 13, Sep 18, 2014

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

Date(s) aerial images were photographed: Feb 28, 2011—Mar 23, 2011

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.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Payne County, Oklahoma (OK119)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6	Pulaski fine sandy loam, 0 to 1 percent slopes, frequently flooded	A	1.5	14.1%
EasA	Easpor loam, 0 to 1 percent slopes, occasionally flooded	B	8.9	85.9%
Totals for Area of Interest			10.3	100.0%

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

PRE-Development Areas								
Pre	SF	AC	sq mi	CN	Description	Soil Type		%
DA-1	5,568	0.12782	0.00020	72.8		B		0.124407901
DA-2	39,188	0.89963	0.00141	69.4		B		0.875592099
Total	44,756	1.02746	0.00161		Overall Site CN 70			

1

Time of Concentration Data		
Parameter	Existing Conditions	
	DA-1	DA-2
El up, ft	899.00	899.00
El down, ft	896.00	892.50
Length, ft	167.00	483.00
Slope	0.0180	0.0135
K		
Tc, min	0.00	0.00
Lag, min	0.00	0.00
Area, sq.mi.	0.00020	0.00141
CN	72.8	69.4

*(ODOT DRAINAGE DESIGN MANUAL PG. I-23 FIG I-10)-residential

Weighted Curve Number Calculations											
Pre	Building			Concrete			Vegetation B SOIL			TOTAL (SF)	TOTAL (%)
	Area	CN	%	Area	CN	%	Area	CN	%		
DA-1	0	98	0.00	733	98	0.13	4,835	69	0.87	5,568	1.00
DA-2	0	98	0.00	533	98	0.01	38,655	69	0.99	39,188	1.00

44,756

POST-Development Areas								
Pre	SF	AC	sq mi	CN	Description	Soil Type		%
DA-1	6,115	0.14038	0.00022	64.6		C,D		0.279453432
DA-2	22,874	0.52511	0.00082	91.4		C,D		1.045334065
DA-3	15,311	0.35149	0.00055	61.2		C,D		0.699707522
DA-4	456	0.01047	0.00002	98.0		C		0.020839046
Total	21,882	0.50234	0.00078		Overall Site CN	63		

1

Weighted Curve Number Calculations											
POST	Building			Concrete			Vegetation B SOIL			TOTAL (SF)	TOTAL (%)
	Area	CN	%	Area	CN	%	Area	CN	%		
DA-1	0	98	0.00	588	98	0.10	5,527	61	0.90	6,115	1.00
DA-2	5,365	98	0.23	13,444	98	0.59	4,065	61	0.18	22,874	1.00
DA-3	0	98	0.00	75	98	0.00	15,236	61	1.00	15,311	1.00
DA-4	0	98	0.00	456	98	1.00	0	61	0.00	456	1.00

44,756

Time of Concentration Calculation

Overland Travel Time

Name	P2	UP	DOWN	Length	OL length	n	Slope	Tc hours	Minutes
Pre 1	3.77	870	866	57.14	57.14	0.24	0.070	0.08	5.09
Pre 2	3.77	869	864	400.00	100.00	0.24	0.013	0.26	15.87
Post 1	3.77	870	866	47.62	47.62	0.24	0.084	0.07	4.09
Post 2	3.77	869	868	38.10	38.10	0.41	0.026	0.14	8.36
Post 3	3.77	865	864	104.76	100.00	0.41	0.010	0.45	27.13

Shallow Concentrated Time

Totals

Name	SC length	Slope	a	V, fps	SC Time	Total	Lag
Pre 1	0	0.070	16.1	4.26	0.00	5.09	3.05
Pre 2	300	0.013	16.1	1.80	2.78	18.64	11.19
Post 1	0	0.084	16.1	4.67	0.00	4.09	2.45
Post 2	0	0.026	20.3	3.29	0.00	8.36	5.02
Post 3	4.76	0.010	16.1	1.57	0.05	27.18	16.31

Basin Model [Existing]

Subbasin Area [Existing]

Show Elements: All Elements ▾ Sorting: Hydrologic ▾

Subbasin	Area (MI ²)
Pre 1	0.00020
Pre 2	0.00141

Apply Close

Pre 1 Pre 2

Existing Conditions Model Input Data

Curve Number Loss [Existing]

Show Elements: All Elements Sorting: Hydrologic

Subbasin	Initial Abstraction (IN)	Curve Number	Impervious (%)
Pre 1		72.8	
Pre 2		69.4	

Apply Close

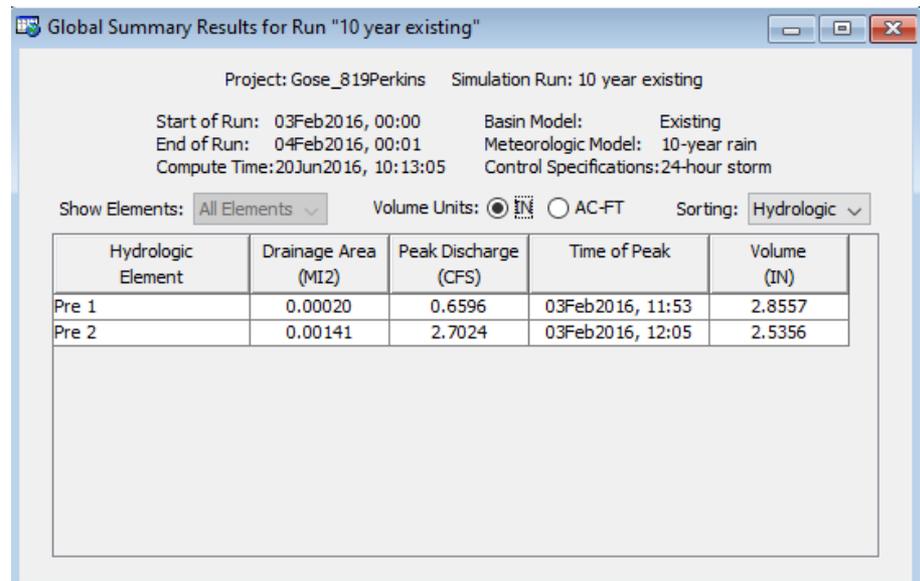
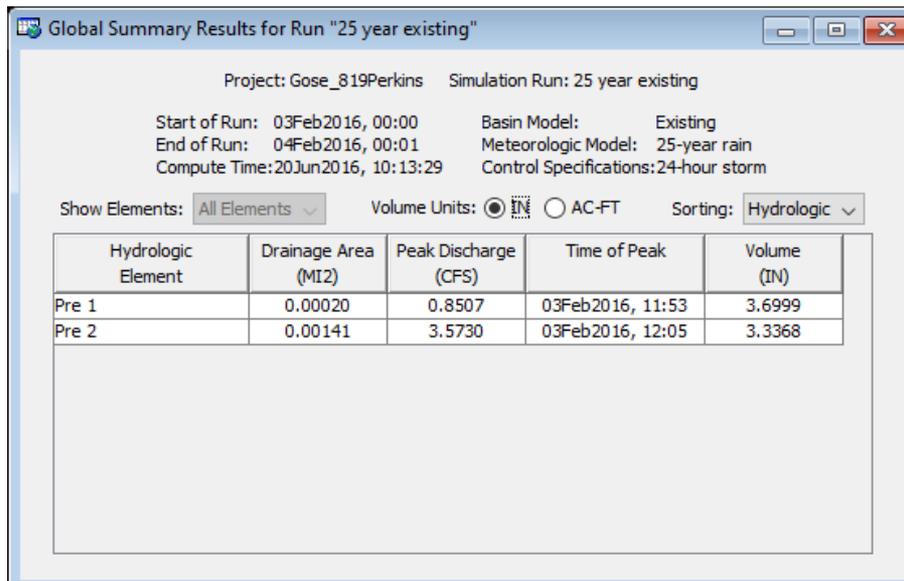
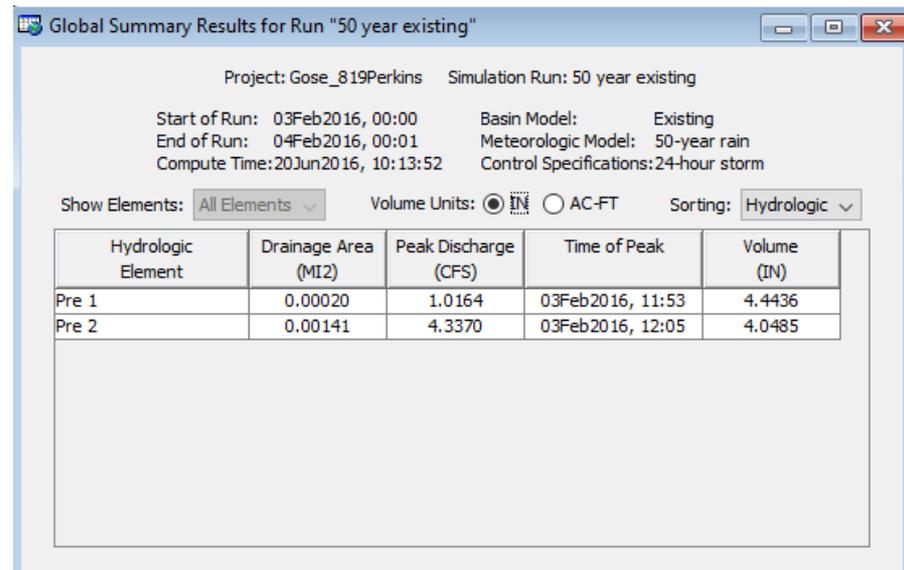
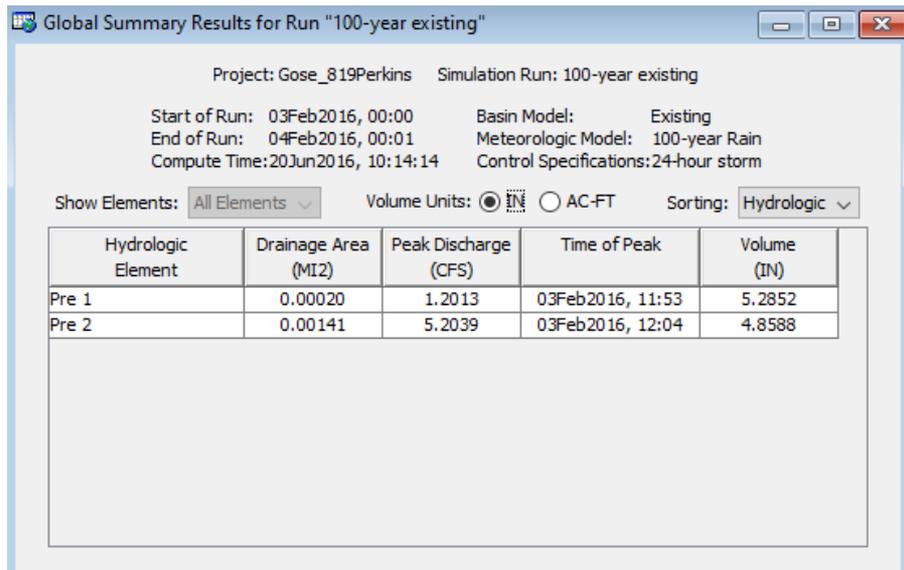
Curve Number Loss [Existing]

Show Elements: All Elements Sorting: Hydrologic

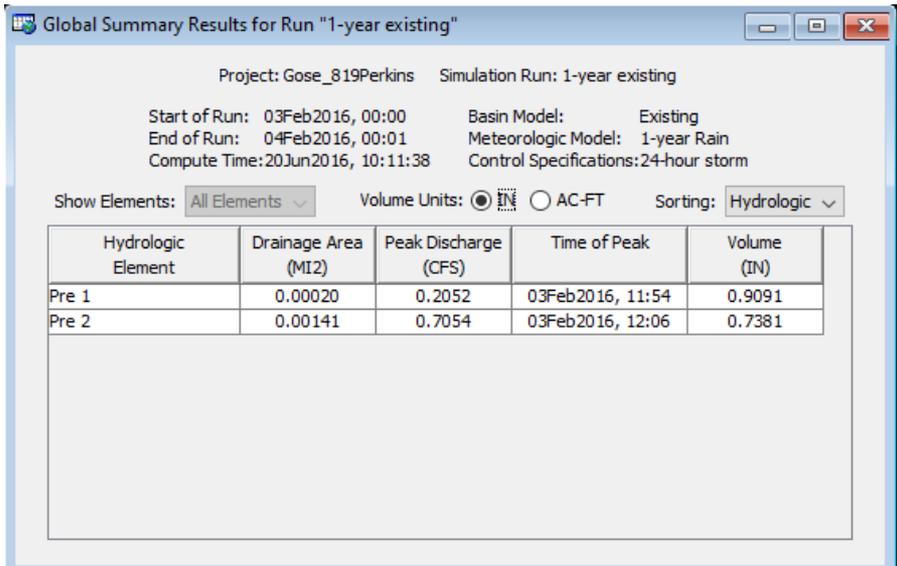
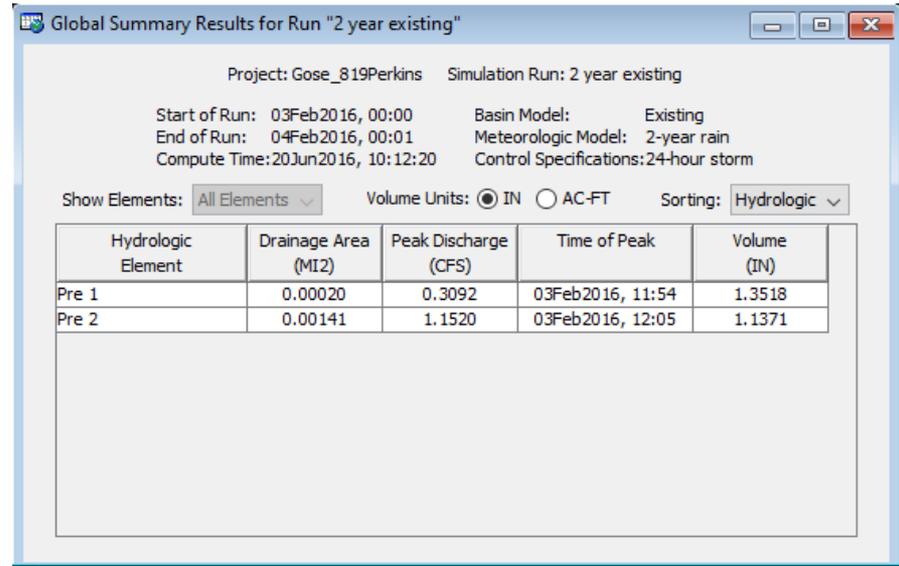
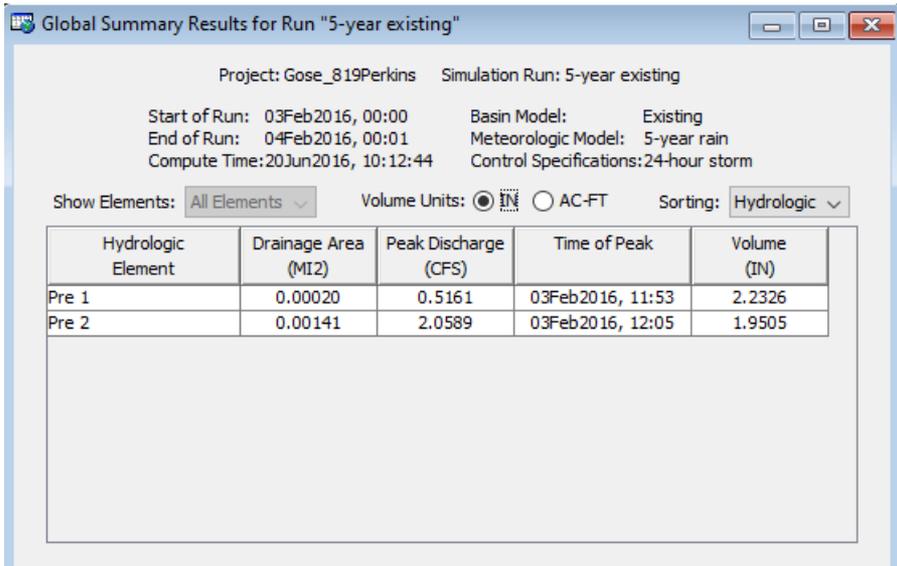
Subbasin	Initial Abstraction (IN)	Curve Number	Impervious (%)
Pre 1		72.8	
Pre 2		69.4	

Apply Close

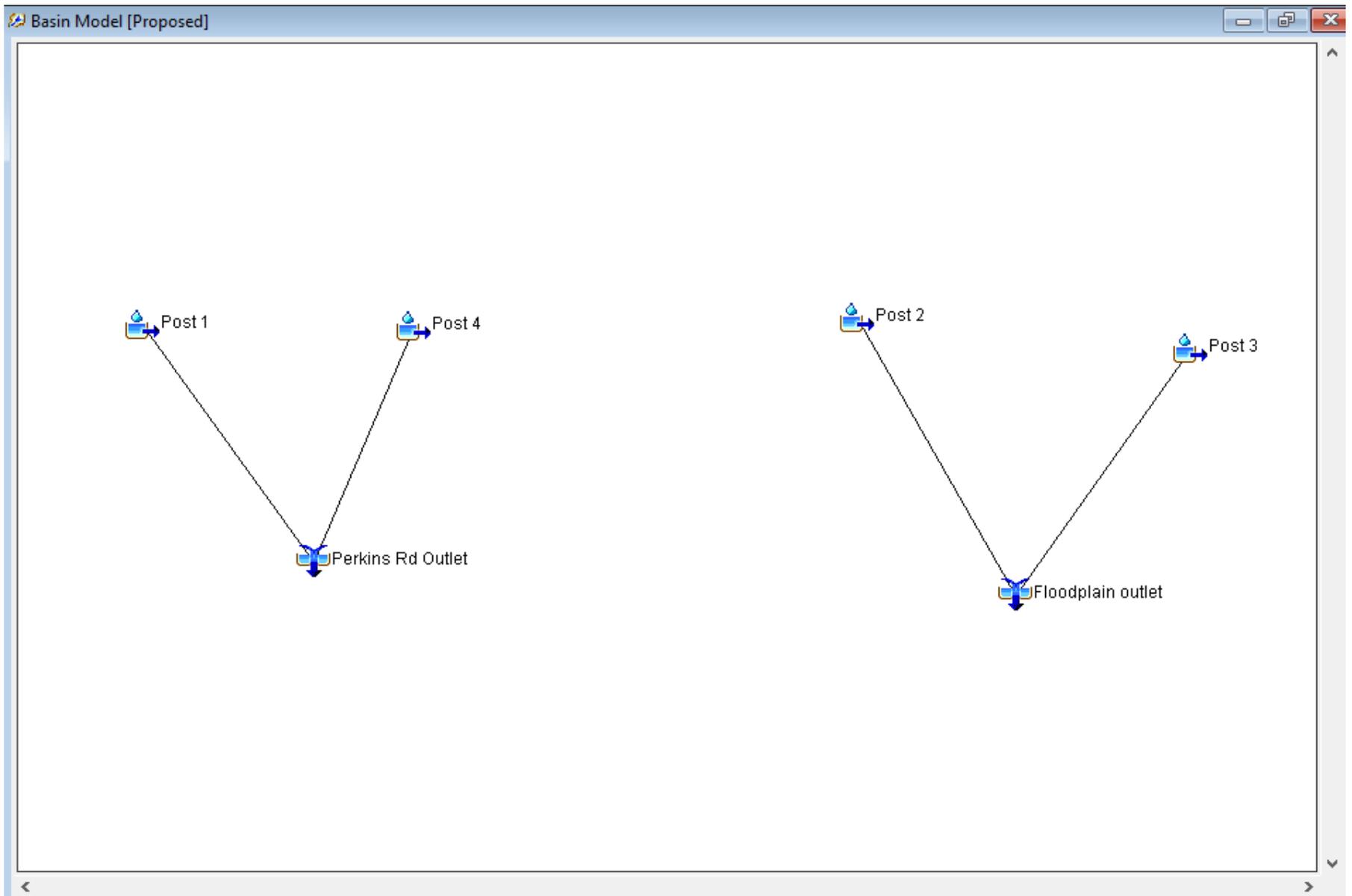
Existing Conditions Model Input Data



Existing Conditions Model Output Data



Existing Conditions Model Output Data



Existing Conditions Model Input Data

Subbasin Area [Proposed]

Show Elements: All Elements Sorting: Hydrologic

Subbasin	Area (MI2)
Post 1	0.00022
Post 4	0.00002
Post 2	0.00082
Post 3	0.00055

Apply Close

Curve Number Loss [Proposed]

Show Elements: All Elements Sorting: Hydrologic

Subbasin	Initial Abstraction (IN)	Curve Number	Impervious (%)
Post 1		64.6	
Post 4		98.0	
Post 2		91.4	
Post 3		61.2	

Apply Close

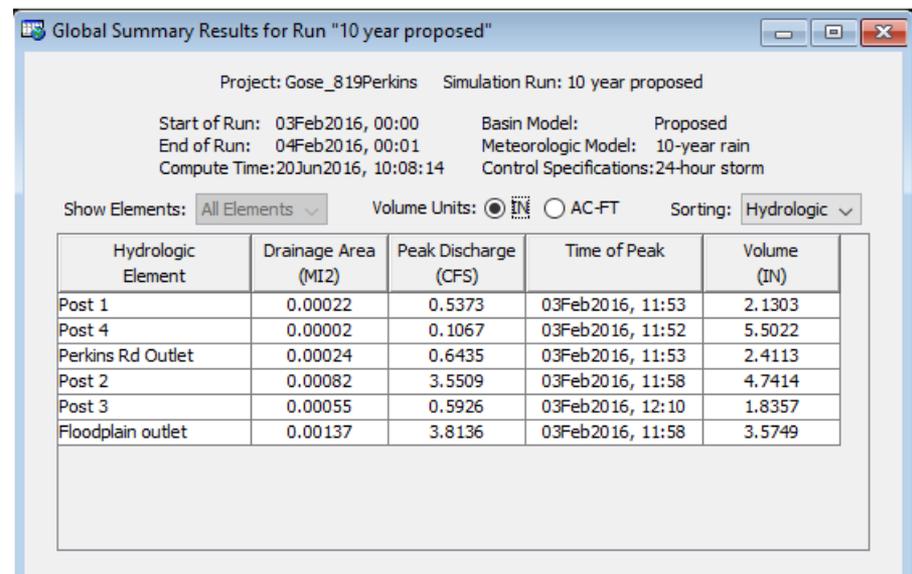
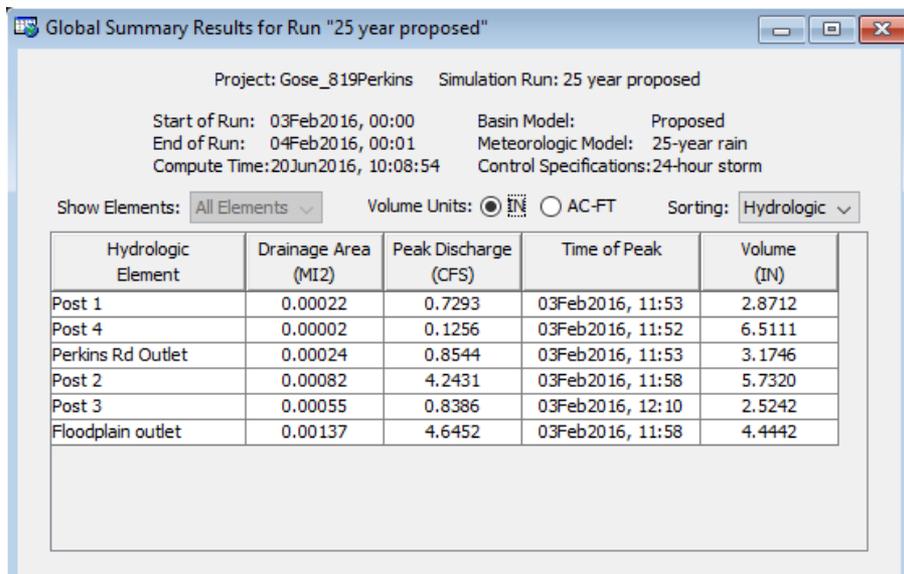
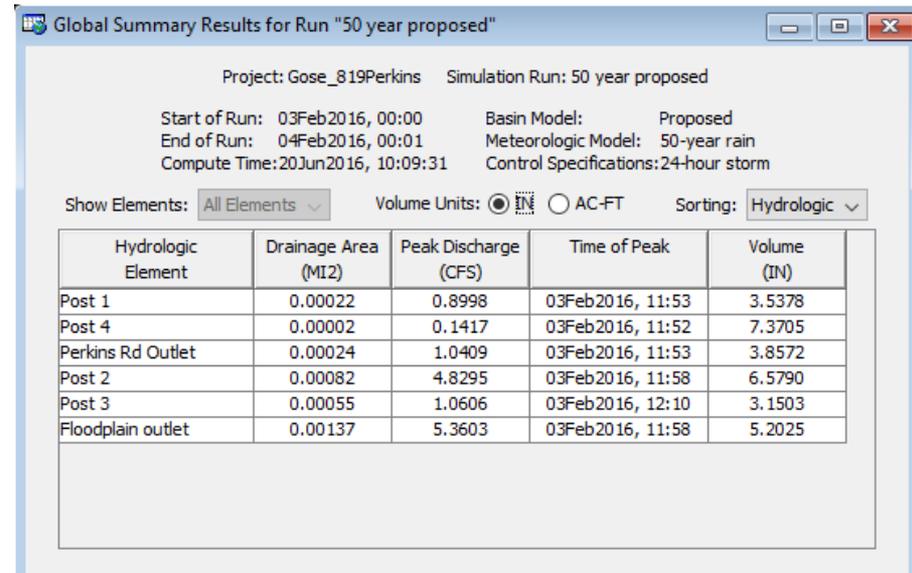
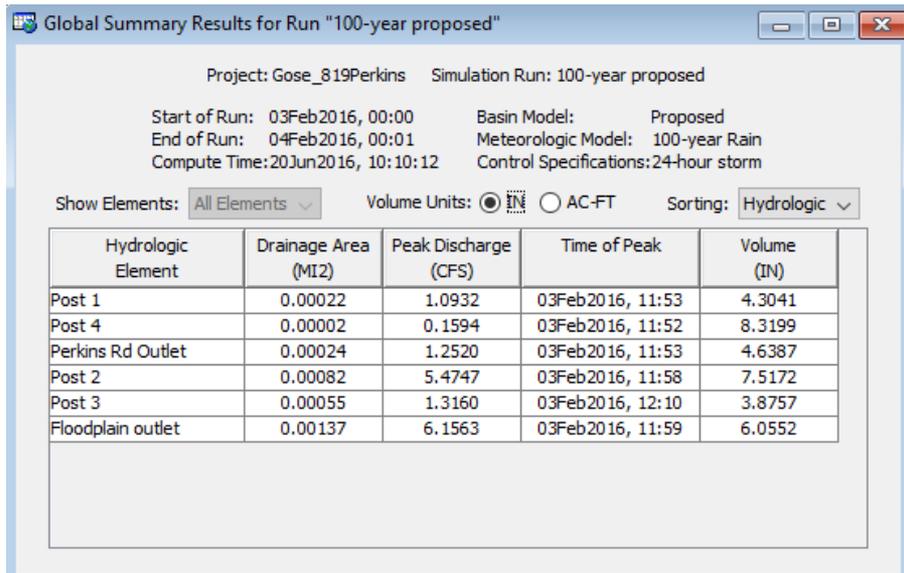
SCS Transform[Proposed]

Show Elements: All Elements Sorting: Hydrologic

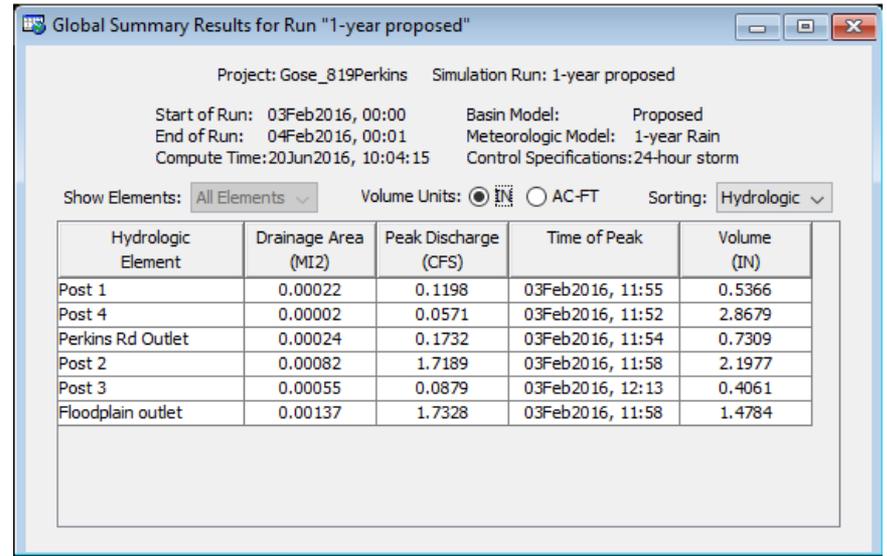
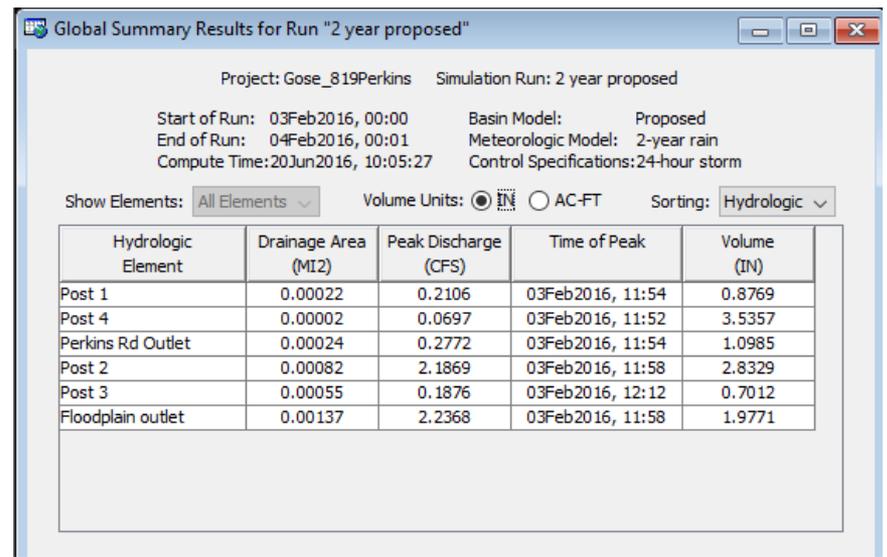
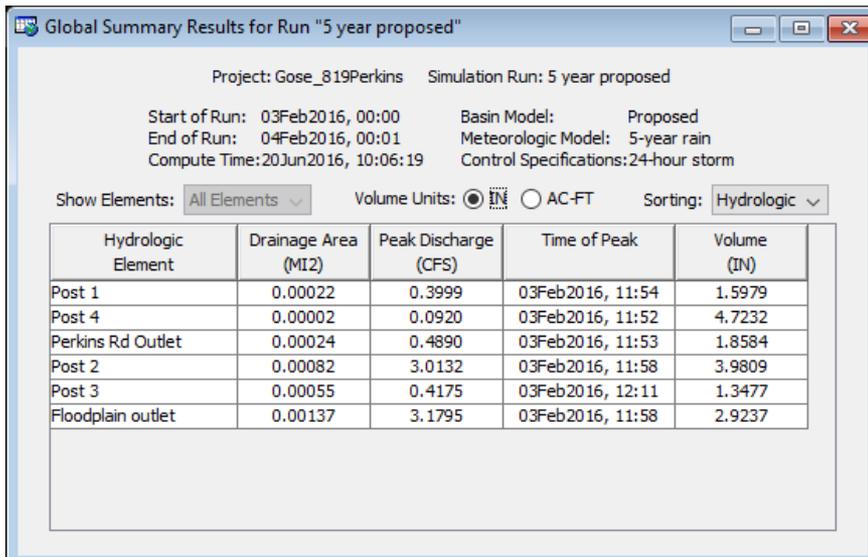
Subbasin	Graph Type	Lag Time (MIN)
Post 2	Standard	5.02
Post 3	Standard	16.31

Apply Close

Existing Conditions Model Input Data



Proposed Conditions Model Output Data



Proposed Conditions Model Output Data

HEC-RAS River: Boomer Creek Reach: Reach - 1 Profile: 100-Year

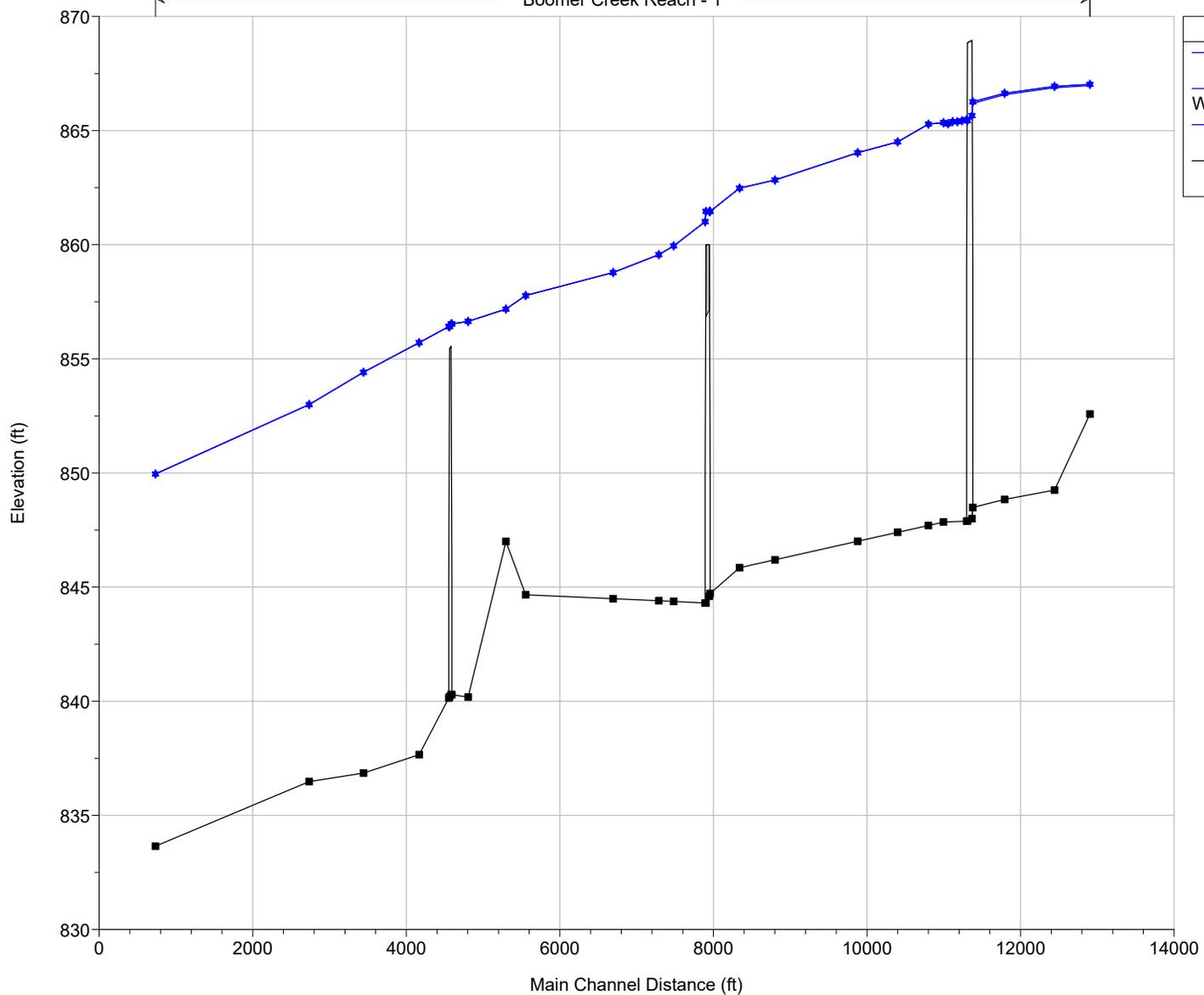
Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach - 1	12903.2	100-Year	Plan01	8041.00	852.58	866.97		867.49	0.001079	6.34	1631.50	174.64	0.32
Reach - 1	12903.2	100-Year	Sectionsadded	8041.00	852.58	867.02		867.54	0.001060	6.31	1641.47	174.92	0.32
Reach - 1	12903.2	100-Year	With fill	8041.00	852.58	867.02		867.54	0.001060	6.31	1641.47	174.92	0.32
Reach - 1	12441.5	100-Year	Plan01	8041.00	849.25	866.88		867.13	0.000386	4.19	2196.11	192.30	0.20
Reach - 1	12441.5	100-Year	Sectionsadded	8041.00	849.25	866.94		867.19	0.000380	4.17	2207.41	192.73	0.20
Reach - 1	12441.5	100-Year	With fill	8041.00	849.25	866.94		867.19	0.000380	4.17	2207.41	192.73	0.20
Reach - 1	11791.9	100-Year	Plan01	8041.00	848.84	866.57		866.86	0.000434	4.42	1985.32	179.39	0.21
Reach - 1	11791.9	100-Year	Sectionsadded	8041.00	848.84	866.63		866.92	0.000427	4.40	1996.69	180.18	0.21
Reach - 1	11791.9	100-Year	With fill	8041.00	848.84	866.63		866.92	0.000427	4.40	1996.69	180.18	0.21
Reach - 1	11377.7	100-Year	Plan01	8041.00	848.49	866.19	857.31	866.58	0.000981	5.01	1605.64	267.57	0.29
Reach - 1	11377.7	100-Year	Sectionsadded	8041.00	848.49	866.26	857.31	866.64	0.000970	4.97	1617.92	271.81	0.29
Reach - 1	11377.7	100-Year	With fill	8041.00	848.49	866.26	857.31	866.64	0.000970	4.97	1617.92	271.81	0.29
Reach - 1	11337.7		Bridge										
Reach - 1	11297.7	100-Year	Plan01	8041.00	847.89	865.40	856.73	865.81	0.001008	5.11	1574.22	256.49	0.29
Reach - 1	11297.7	100-Year	Sectionsadded	8041.00	847.89	865.48	856.73	865.88	0.000997	5.07	1586.64	260.91	0.29
Reach - 1	11297.7	100-Year	With fill	8041.00	847.89	865.48	856.73	865.88	0.000997	5.07	1586.64	260.91	0.29
Reach - 1	11237.2*	100-Year	Sectionsadded	8041.00	847.88	865.43		865.81	0.000944	4.93	1639.29	512.60	0.29
Reach - 1	11237.2*	100-Year	With fill	8041.00	847.88	865.43		865.81	0.000944	4.93	1639.29	512.60	0.29
Reach - 1	11176.8*	100-Year	Sectionsadded	8041.00	847.87	865.39	856.74	865.76	0.000601	5.00	1773.06	356.29	0.24
Reach - 1	11176.8*	100-Year	With fill	8041.00	847.87	865.39	856.74	865.76	0.000601	5.00	1773.06	356.29	0.24
Reach - 1	11116.4*	100-Year	Sectionsadded	8041.00	847.87	865.39	857.28	865.69	0.000507	4.36	1943.09	195.37	0.22
Reach - 1	11116.4*	100-Year	With fill	8041.00	847.87	865.39	857.28	865.69	0.000507	4.36	1943.09	195.37	0.22
Reach - 1	11056.0*	100-Year	Sectionsadded	8041.00	847.86	865.30		865.64	0.000534	4.77	2143.49	422.71	0.23
Reach - 1	11056.0*	100-Year	With fill	8041.00	847.86	865.30		865.64	0.000534	4.77	2143.49	422.71	0.23
Reach - 1	10995.6	100-Year	Plan01	8041.00	847.85	865.35		865.54	0.000323	3.76	2931.84	310.11	0.18
Reach - 1	10995.6	100-Year	Sectionsadded	8041.00	847.85	865.35		865.54	0.000323	3.76	2931.84	310.11	0.18
Reach - 1	10995.6	100-Year	With fill	8041.00	847.85	865.35		865.54	0.000323	3.76	2931.84	310.11	0.18
Reach - 1	10800.0	100-Year	Plan01	8041.00	847.70	865.28		865.48	0.000352	3.84	3110.64	541.37	0.19
Reach - 1	10800.0	100-Year	Sectionsadded	8041.00	847.70	865.28		865.48	0.000352	3.84	3110.64	541.37	0.19
Reach - 1	10800.0	100-Year	With fill	8041.00	847.70	865.28		865.48	0.000352	3.84	3110.64	541.37	0.19
Reach - 1	10400.0	100-Year	Plan01	8041.00	847.40	864.50		865.19	0.001371	7.67	2620.34	808.36	0.34
Reach - 1	10400.0	100-Year	Sectionsadded	8041.00	847.40	864.50		865.19	0.001371	7.67	2620.34	808.36	0.34
Reach - 1	10400.0	100-Year	With fill	8041.00	847.40	864.50		865.19	0.001371	7.67	2620.34	808.36	0.34
Reach - 1	9878.1	100-Year	Plan01	8041.00	847.01	864.03		864.59	0.000896	6.48	2147.46	573.70	0.29
Reach - 1	9878.1	100-Year	Sectionsadded	8041.00	847.01	864.03		864.59	0.000896	6.48	2147.46	573.70	0.29
Reach - 1	9878.1	100-Year	With fill	8041.00	847.01	864.03		864.59	0.000896	6.48	2147.46	573.70	0.29
Reach - 1	8800.5	100-Year	Plan01	7812.00	846.20	862.84		863.46	0.001331	7.41	2380.78	919.26	0.33
Reach - 1	8800.5	100-Year	Sectionsadded	7812.00	846.20	862.84		863.46	0.001331	7.41	2380.78	919.26	0.33
Reach - 1	8800.5	100-Year	With fill	7812.00	846.20	862.84		863.46	0.001331	7.41	2380.78	919.26	0.33
Reach - 1	8339.5	100-Year	Plan01	7812.00	845.85	862.48		862.94	0.000812	6.06	3188.44	900.05	0.28
Reach - 1	8339.5	100-Year	Sectionsadded	7812.00	845.85	862.48		862.94	0.000812	6.06	3188.44	900.05	0.28
Reach - 1	8339.5	100-Year	With fill	7812.00	845.85	862.48		862.94	0.000812	6.06	3188.44	900.05	0.28
Reach - 1	7957.5	100-Year	Plan01	7812.00	844.72	861.46	855.47	862.34	0.002175	8.32	1975.90	969.20	0.38
Reach - 1	7957.5	100-Year	Sectionsadded	7812.00	844.72	861.46	855.47	862.34	0.002175	8.32	1975.90	969.20	0.38
Reach - 1	7957.5	100-Year	With fill	7812.00	844.72	861.46	855.47	862.34	0.002175	8.32	1975.90	969.20	0.38
Reach - 1	7925.0		Bridge										
Reach - 1	7892.5	100-Year	Plan01	7812.00	844.30	861.01	855.04	861.90	0.002214	8.38	1948.19	967.20	0.39
Reach - 1	7892.5	100-Year	Sectionsadded	7812.00	844.30	861.01	855.04	861.90	0.002214	8.38	1948.19	967.20	0.39
Reach - 1	7892.5	100-Year	With fill	7812.00	844.30	861.01	855.04	861.90	0.002214	8.38	1948.19	967.20	0.39
Reach - 1	7482.4	100-Year	Plan01	7812.00	844.37	859.95	853.99	861.02	0.001868	8.38	1207.46	439.39	0.40
Reach - 1	7482.4	100-Year	Sectionsadded	7812.00	844.37	859.95	853.99	861.02	0.001868	8.38	1207.46	439.39	0.40
Reach - 1	7482.4	100-Year	With fill	7812.00	844.37	859.95	853.99	861.02	0.001868	8.38	1207.46	439.39	0.40
Reach - 1	7288.1	100-Year	Plan01	7632.00	844.40	859.56		860.60	0.002431	9.04	1278.95	302.86	0.43
Reach - 1	7288.1	100-Year	Sectionsadded	7632.00	844.40	859.56		860.60	0.002431	9.04	1278.95	302.86	0.43
Reach - 1	7288.1	100-Year	With fill	7632.00	844.40	859.56		860.60	0.002431	9.04	1278.95	302.86	0.43
Reach - 1	6694.0	100-Year	Plan01	7632.00	844.49	858.78		859.46	0.001315	6.65	1474.00	404.24	0.34
Reach - 1	6694.0	100-Year	Sectionsadded	7632.00	844.49	858.78		859.46	0.001315	6.65	1474.00	404.24	0.34
Reach - 1	6694.0	100-Year	With fill	7632.00	844.49	858.78		859.46	0.001315	6.65	1474.00	404.24	0.34
Reach - 1	5555.3	100-Year	Plan01	7632.00	844.66	857.77		858.14	0.000915	5.32	2546.21	987.67	0.29
Reach - 1	5555.3	100-Year	Sectionsadded	7632.00	844.66	857.77		858.14	0.000915	5.32	2546.21	987.67	0.29
Reach - 1	5555.3	100-Year	With fill	7632.00	844.66	857.77		858.14	0.000915	5.32	2546.21	987.67	0.29

HEC-RAS River: Boomer Creek Reach: Reach - 1 Profile: 100-Year (Continued)

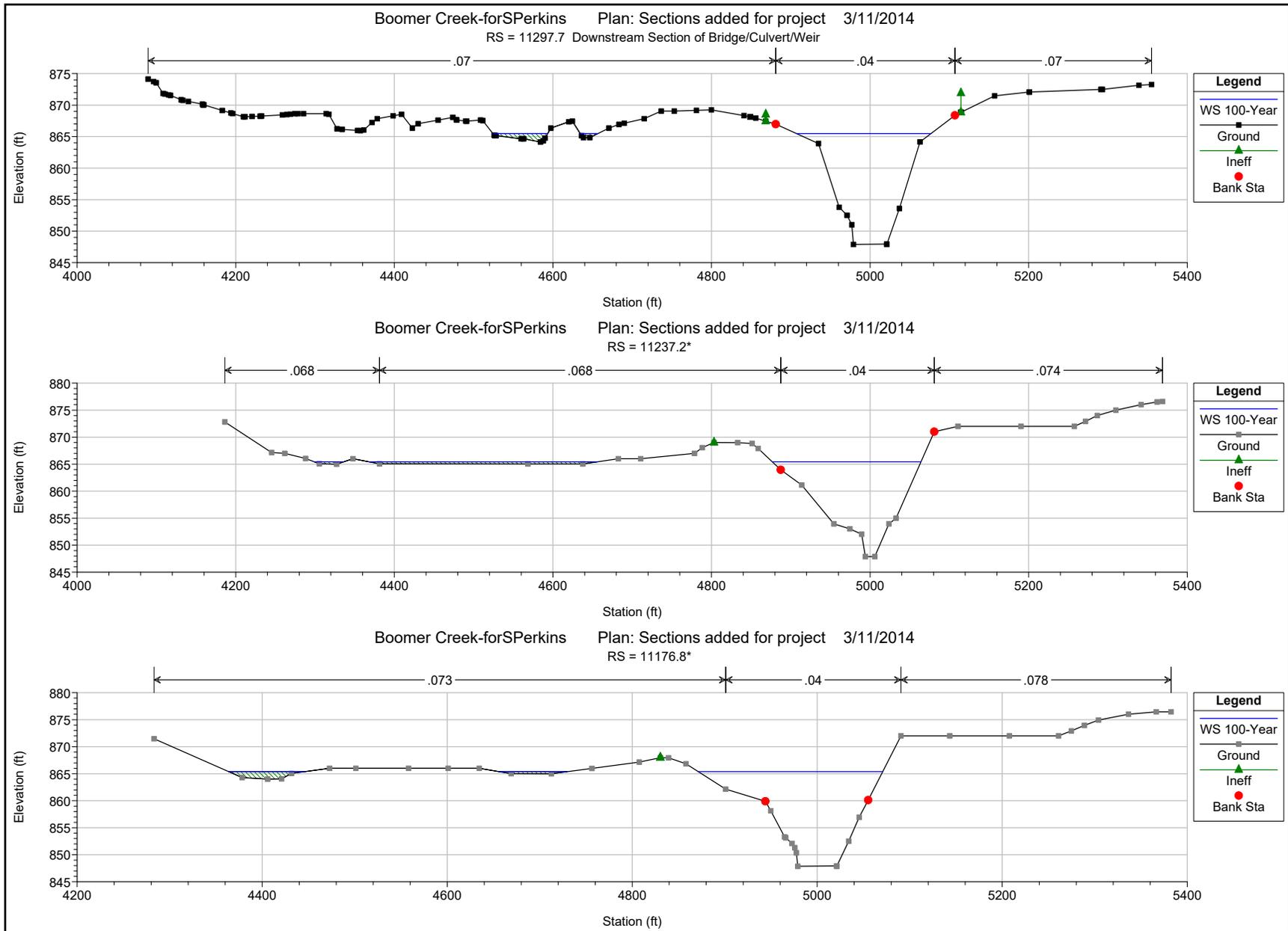
Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach - 1	5297.1	100-Year	Plan01	7632.00	847.00	857.18		857.79	0.001855	6.70	1992.84	970.60	0.40
Reach - 1	5297.1	100-Year	Sectionsadded	7632.00	847.00	857.18		857.79	0.001855	6.70	1992.84	970.60	0.40
Reach - 1	5297.1	100-Year	With fill	7632.00	847.00	857.18		857.79	0.001855	6.70	1992.84	970.60	0.40
Reach - 1	4804.8	100-Year	Plan01	7632.00	840.18	856.64		857.09	0.000995	6.21	2916.86	1074.93	0.31
Reach - 1	4804.8	100-Year	Sectionsadded	7632.00	840.18	856.64		857.09	0.000995	6.21	2916.86	1074.93	0.31
Reach - 1	4804.8	100-Year	With fill	7632.00	840.18	856.64		857.09	0.000995	6.21	2916.86	1074.93	0.31
Reach - 1	4593.5	100-Year	Plan01	7632.00	840.29	856.53	851.67	856.70	0.000585	4.57	4772.57	2247.54	0.23
Reach - 1	4593.5	100-Year	Sectionsadded	7632.00	840.29	856.53	851.67	856.70	0.000585	4.57	4772.57	2247.54	0.23
Reach - 1	4593.5	100-Year	With fill	7632.00	840.29	856.53	851.67	856.70	0.000585	4.57	4772.57	2247.54	0.23
Reach - 1	4573.5		Bridge										
Reach - 1	4553.5	100-Year	Plan01	7632.00	840.14	856.42	851.51	856.59	0.000573	4.54	4810.58	2254.82	0.23
Reach - 1	4553.5	100-Year	Sectionsadded	7632.00	840.14	856.42	851.51	856.59	0.000573	4.54	4810.58	2254.82	0.23
Reach - 1	4553.5	100-Year	With fill	7632.00	840.14	856.42	851.51	856.59	0.000573	4.54	4810.58	2254.82	0.23
Reach - 1	4167.2	100-Year	Plan01	7632.00	837.66	855.71		856.21	0.000915	6.29	2966.37	1176.12	0.30
Reach - 1	4167.2	100-Year	Sectionsadded	7632.00	837.66	855.71		856.21	0.000915	6.29	2966.37	1176.12	0.30
Reach - 1	4167.2	100-Year	With fill	7632.00	837.66	855.71		856.21	0.000915	6.29	2966.37	1176.12	0.30
Reach - 1	3442.2	100-Year	Plan01	8884.00	836.85	854.41		855.30	0.001598	8.11	2411.19	1019.64	0.39
Reach - 1	3442.2	100-Year	Sectionsadded	8884.00	836.85	854.41		855.30	0.001598	8.11	2411.19	1019.64	0.39
Reach - 1	3442.2	100-Year	With fill	8884.00	836.85	854.41		855.30	0.001598	8.11	2411.19	1019.64	0.39
Reach - 1	2733.5	100-Year	Plan01	8884.00	836.48	853.00		854.02	0.001971	8.66	1501.64	184.68	0.43
Reach - 1	2733.5	100-Year	Sectionsadded	8884.00	836.48	853.00		854.02	0.001971	8.66	1501.64	184.68	0.43
Reach - 1	2733.5	100-Year	With fill	8884.00	836.48	853.00		854.02	0.001971	8.66	1501.64	184.68	0.43
Reach - 1	732.1	100-Year	Plan01	7742.00	833.65	849.96	844.97	850.64	0.001402	7.25	1701.45	214.10	0.36
Reach - 1	732.1	100-Year	Sectionsadded	7742.00	833.65	849.96	844.97	850.64	0.001402	7.25	1701.45	214.10	0.36
Reach - 1	732.1	100-Year	With fill	7742.00	833.65	849.96	844.97	850.64	0.001402	7.25	1701.45	214.10	0.36

Boomer Creek-forSPerkins Plan: 1) Plan01 8/11/2013 2) Sectionsadded 3/11/2014 3) With fill 3/11/2014

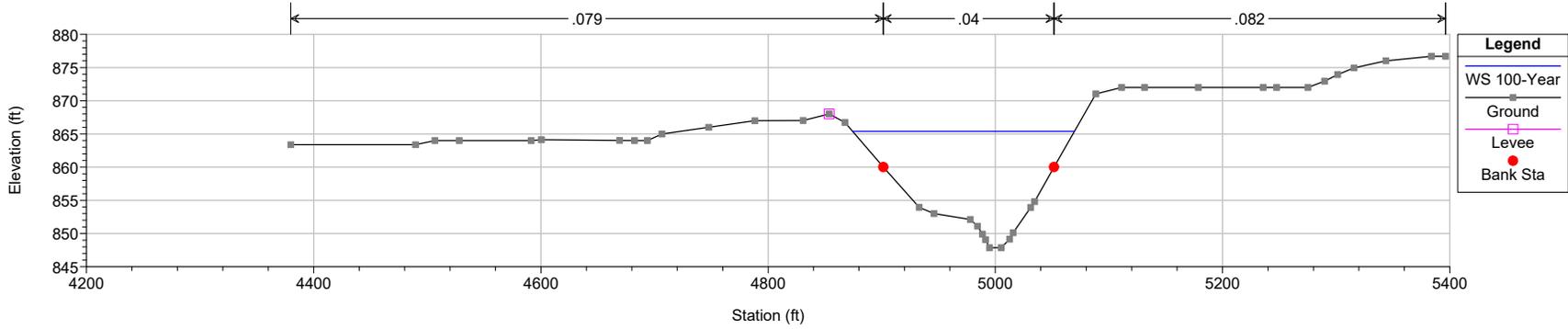
Boomer Creek Reach - 1



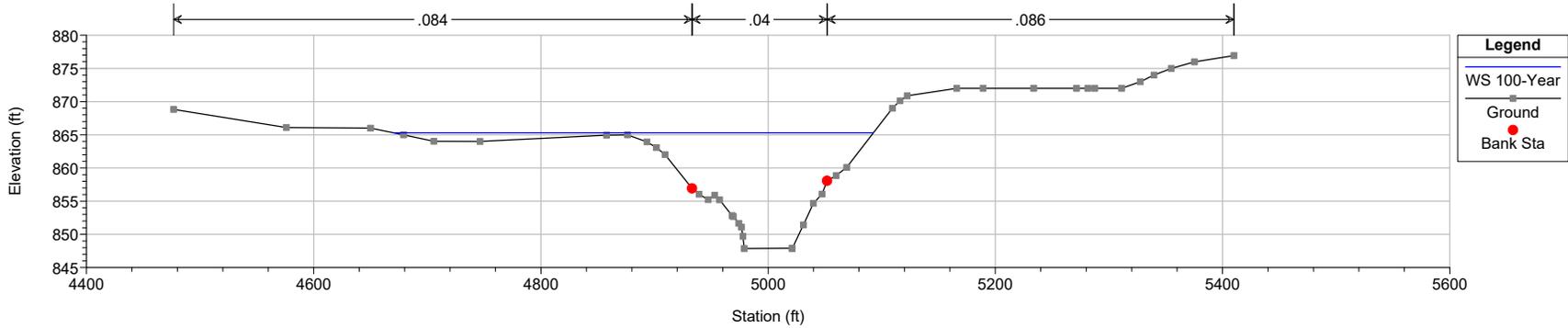
Legend	
WS 100-Year - Plan01	▲
WS 100-Year - Sectionsadded	▲
WS 100-Year - With fill	▲
Ground	■



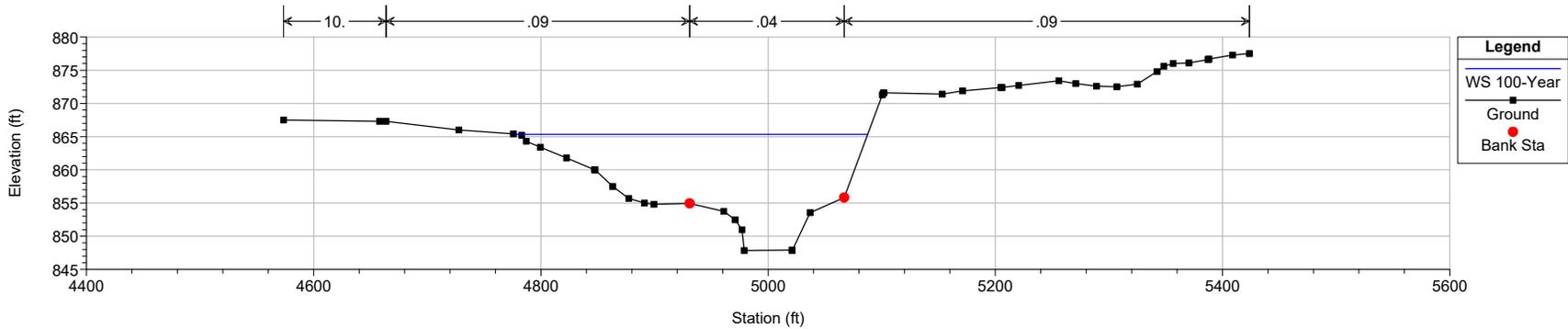
Boomer Creek-forSPerkins Plan: Sections added for project 3/11/2014
RS = 11116.4*



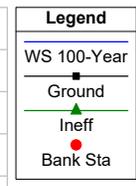
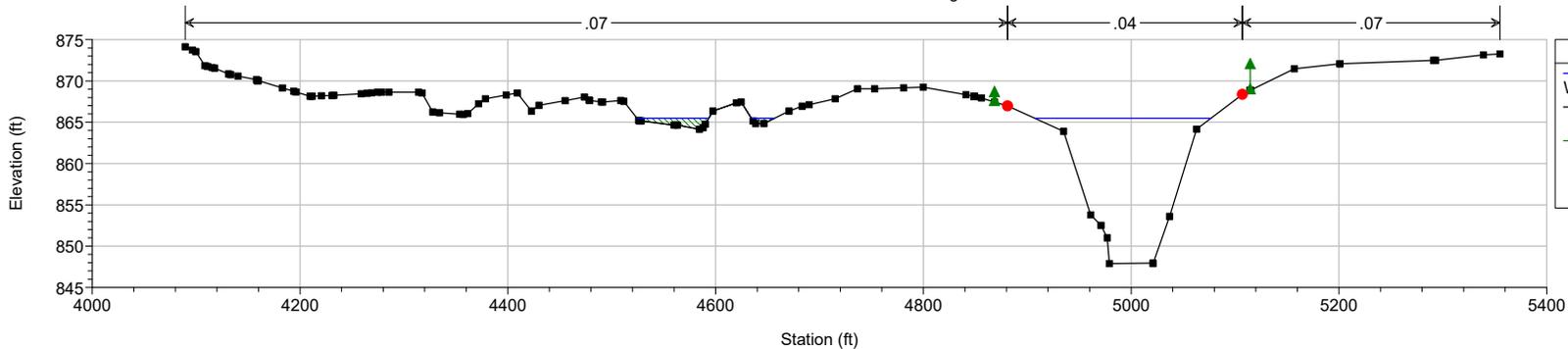
Boomer Creek-forSPerkins Plan: Sections added for project 3/11/2014
RS = 11056.0*



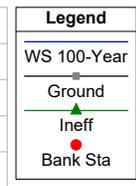
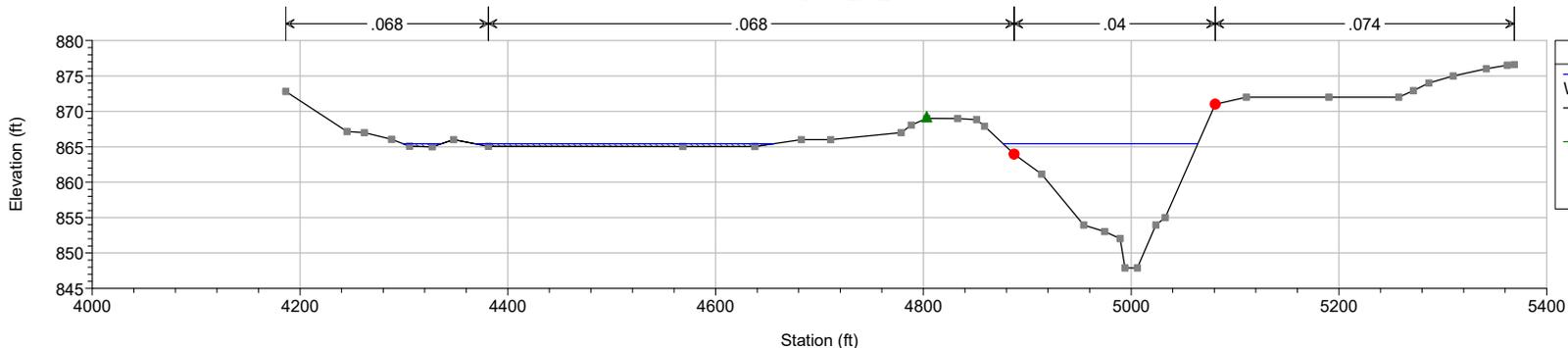
Boomer Creek-forSPerkins Plan: Sections added for project 3/11/2014
RS = 10995.6 Cross Section Boomer Creek 28.0



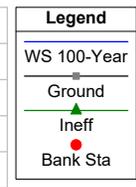
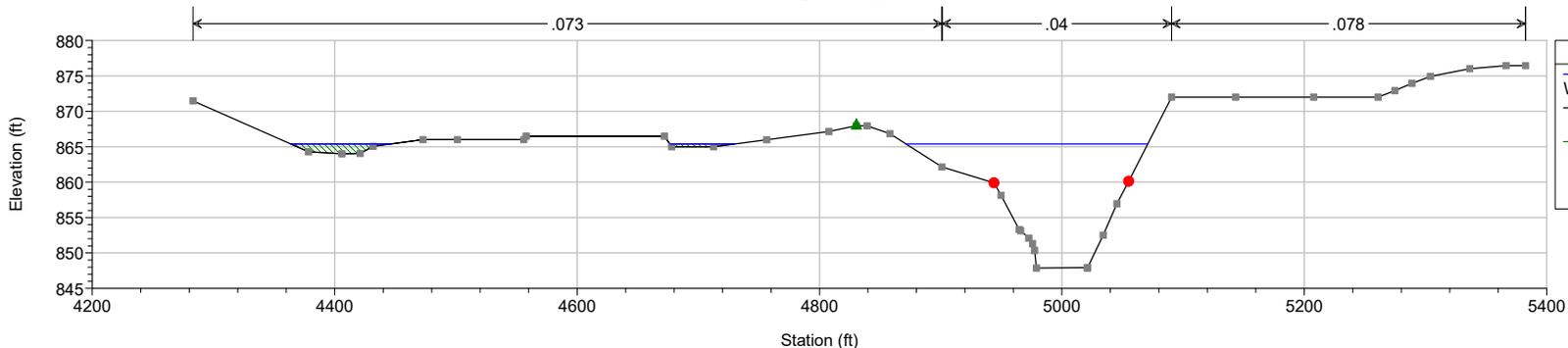
Boomer Creek-forSPerkins Plan: Fill added for project 3/11/2014
 RS = 11297.7 Downstream Section of Bridge/Culvert/Weir



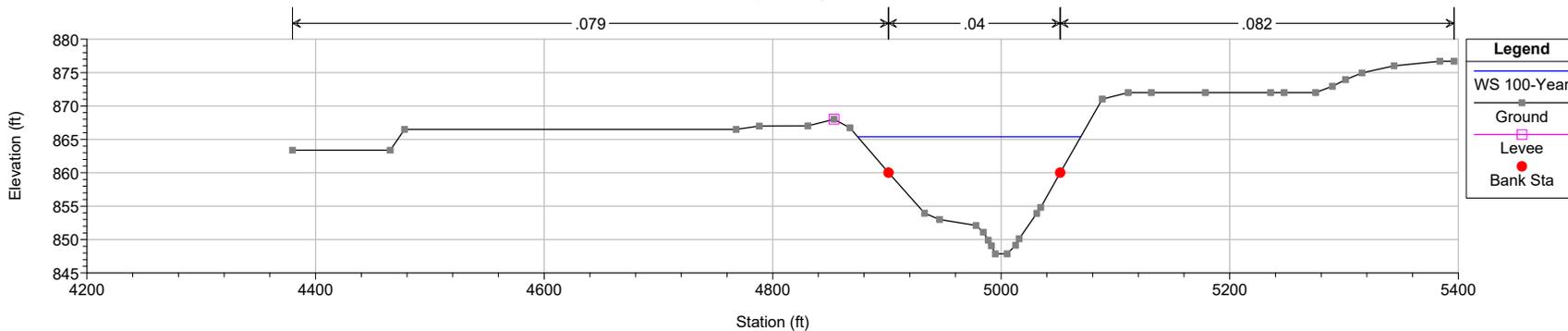
Boomer Creek-forSPerkins Plan: Fill added for project 3/11/2014
 RS = 11237.2*



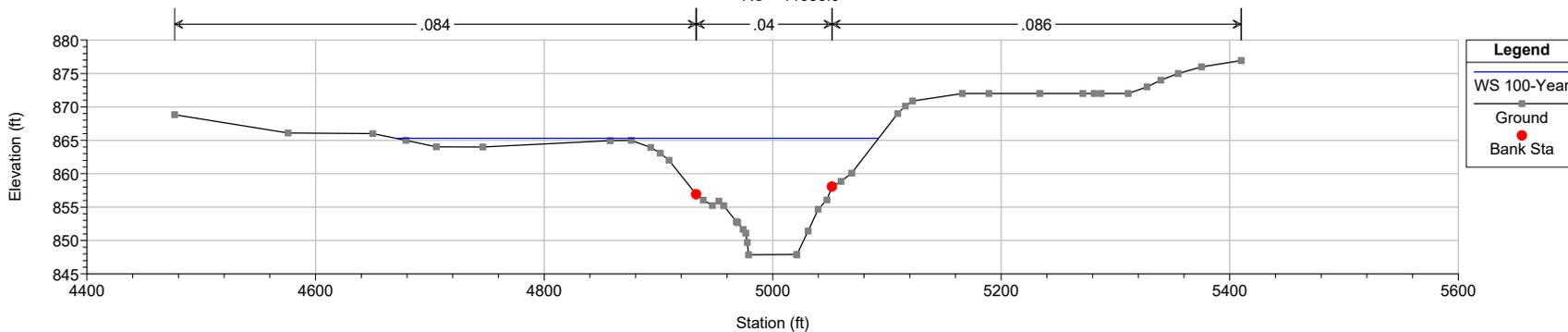
Boomer Creek-forSPerkins Plan: Fill added for project 3/11/2014
 RS = 11176.8*



Boomer Creek-forSPerkins Plan: Fill added for project 3/11/2014
RS = 11116.4*



Boomer Creek-forSPerkins Plan: Fill added for project 3/11/2014
RS = 11056.0*



Boomer Creek-forSPerkins Plan: Fill added for project 3/11/2014
RS = 10995.6 Cross Section Boomer Creek 28.0

