# Stormwater Level of Service Study - Phase 2 Flooding Adjacent to Rock Creek

## City of Fairway, Kansas

**Fairway Stormwater Level of Service Study - Phase 2**
**Project No. 108200**

**Revision 1**
**12/6/2018**

# Stormwater Level of Service Study - Phase 2
# Flooding Adjacent to Rock Creek

**prepared for**

## City of Fairway, Kansas
**Fairway Stormwater Level of Service Study - Phase 2**
**Fairway, Kansas**

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**Revision 1**
**12/6/2018**

**prepared by**


## Burns & McDonnell Engineering Company, Inc.
**Kansas City, Missouri**

## INDEX AND CERTIFICATION

## City of Fairway, Kansas
## Stormwater Level of Service Study - Phase 2
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### Certification

I hereby certify, as a Professional Engineer in the state of Kansas, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the City of Fairway, Kansas or others without specific verification or adaptation by the Engineer.

Leon J. Staab
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# LIST OF ABBREVIATIONS

| **Abbreviation** | **Term/Phrase/Name** |
|---|---|
| APWA | American Public Works Association |
| BFE | Base Flood Elevation |
| FEMA | Federal Emergency Management Agency |
| LAG | Lowest Adjacent Grade |
| LOMA | Letter of Map Amendment |
| LOMR | Letter of Map Revision |
| NOAA | National Oceanic and Atmospheric Administration |
| NRCS | Natural Resources Conservation Service |
| RCB | Reinforced Concrete Box |
| WSE | Water Surface Elevation |

# 1.0 EXECUTIVE SUMMARY

This study investigates potential solutions to alleviate flash flooding along Rock Creek within the City of Fairway. Three alternatives were evaluated: two potential solutions proposed stormwater storage in the upstream community of Mission, Kansas and one alternative proposed modifications to the Rock Creek channel conveyance within Fairway. While none of the alternatives afforded a definitive solution, the alternatives for stormwater detention within the City of Mission have been dismissed as viable strategies for stormwater management. The recommended strategy (Alternative 3) is a continued focus on conveyance in Rock Creek.

## 1.1 Alternate 3 – Channel Modifications

The preferred alternative evaluated channel modifications to Rock Creek within Fairway city limits. Two scenarios of channel modifications were included as part of this study: vegetation management and channel improvements. Selection of either scenarios may require the City to acquire permanent easements to provide regular maintenance or improvements. Both scenarios were analyzed for the 10-year and 100-year events. Modeling predicts only a slight improvement for the 100-year event. Therefore, the City should consider continuation of a buyout strategy for homes within the 100-year floodplain. If the City pursues a preliminary engineering study for the preferred alternative, it should define an acceptable risk of flooding for residents adjacent to Rock Creek and maintain channel improvements to that level of service. Two opinions of probable cost were developed for this alternative, one for each scenario. Likely, the selected channel modifications project would be a hybrid of the vegetation management and channel improvements scenarios, ranging from $2.0 million to $5.7 million.

## 1.2 Alternative 1 – Stormwater Detention

**Table 1-1: Required Storage Volumes**

| Rainfall Event | Detention Volume (acre-feet) | Detention Volume (million gallons) |
|---|---|---|
| Water Quality | 10.6 | 3.5 |
| 1-year | 35.1 | 11.4 |
| 2-year | 48.7 | 15.9 |
| 5-year | 64.5 | 21.0 |
| 10-year | 86.5 | 28.2 |

This alternative analyzed the amount of storage required upstream of Fairway in the Rock Creek Watershed to have a significant impact on the reduction of peak flows. A detention facility was modeled at The Gateway site near Roe Avenue and Johnson Drive. At the time of the study, this was the largest undeveloped site along Rock and upstream of the City. The detention basin was sized for design storms ranging from the Water Quality to the 10-year event to provide a level of scale for storage volumes necessary to reduce peak flows. To reduce peak flows by just 20 percent, 3.5 million gallons would need to be provided for the water quality event and 28.2 million gallons for the 10-year event. Table 1-1 shows the predicted storage volume requirements for a 20% peak discharge reduction.

Two opinions of probable cost were developed to define a range of expected costs for a stormwater detention facility that reduces peak flows by 10 to 30 percent. Depending on the level of service to be provided, a stormwater detention facility could range from $5.7 million for a 10% reduction in flow to $12.7 million for a 30% reduction in flow. Although The Gateway site is no longer a feasible option (it is currently being developed), the study demonstrates that a large volume of detention is required to make a significant impact in Rock Creek. Because the upstream watershed is fully urbanized, there may not be viable locations to accommodate the storage required. Therefore, this alternative was discounted as a viable strategy.

## 1.3 Alternative 2 – Inline Storage

This alternative evaluated the storage capacity of the existing storm sewers beneath The Gateway site. This study considered an adjustable control structure to store stormwater within the large box culverts. Despite the large size of the culverts, the available storage capacity is limited by the slope of these structures and the potential for flooding that would result upstream of the culverts. The study concluded that 0.66 million gallons of storage could be provided by an adjustable control structure 4-feet in height. This equates to approximately 2.2% of the runoff generated by the Water Quality event; which was the smallest storm modeled. When compared to the runoff volumes generated by flash flood events, the culverts provide a relatively low storage volume. Modeling suggests that the storage would be at capacity soon after rainfall begins, and little attenuation could be provided during the peak period of rainfall.

## 1.4 Conclusion

The Rock Creek Watershed has essentially reached full build-out. With most of the watershed upstream of the City and outside of Fairway's control, few opportunities exist to provide detention. Fairway, like other communities in the watershed is also fully developed. Few sites lend themselves for detention within City limits. It is the conclusion of this study that the best opportunities to alleviate flooding to properties along Rock Creek are property buyouts, vegetation management along the channel, and channel improvements for increased conveyance within the creek.

## 2.0 BACKGROUND

The City of Fairway (City) is located in the Rock Creek Watershed, just downstream of the confluence of Rock Creek and Cooper Creek as seen in Figure 2-1. General perception in the Fairway community is that urbanization and channel improvements upstream of Fairway in have increased the frequency and severity of flash flooding in Fairway (1).

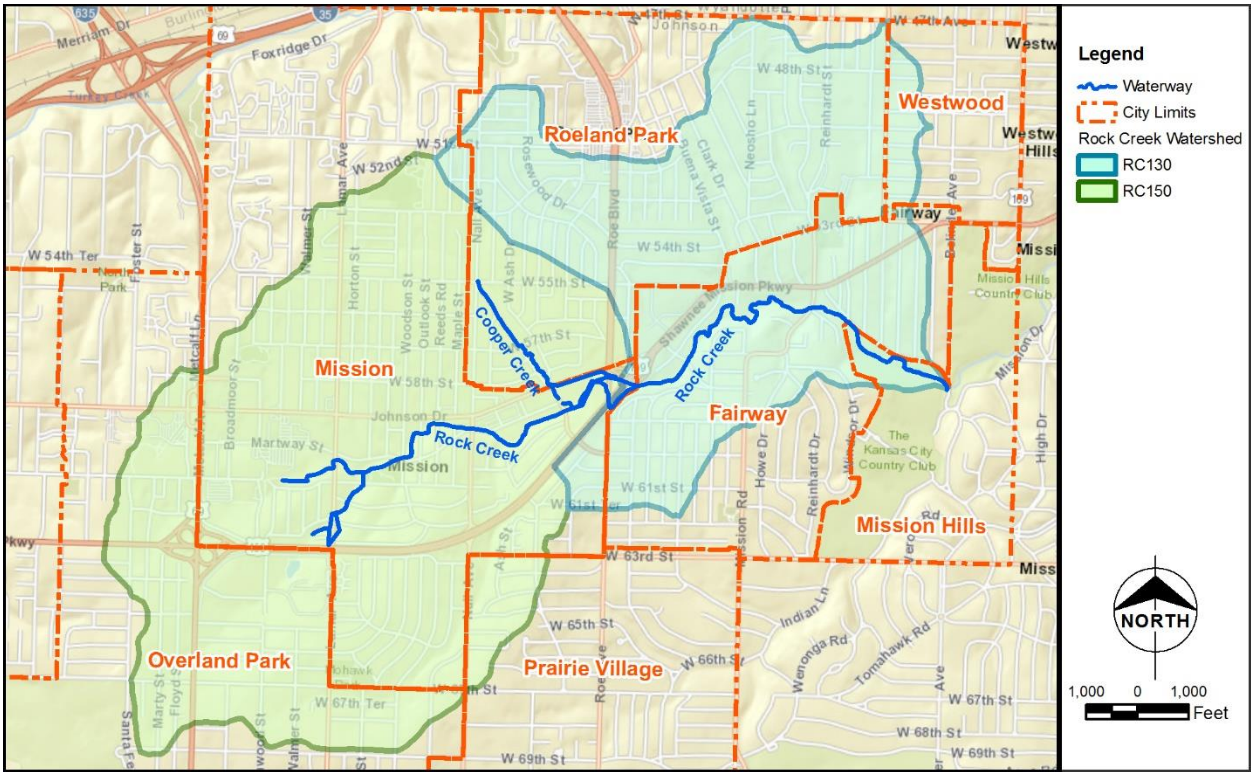



**Figure 2-1: Rock Creek Watershed and Neighboring Communities**

As a first step to identifying potential solutions to address flash flooding [1]concerns in Fairway, Burns & McDonnell, in 2015 as part of the Fairway Stormwater Level of Service Study (2), identified the level of service provided at the Windsor Box Culvert, Mission Road Bridge, and Sheridan Drive Bridge. Both the Windsor Box Culvert and the Mission Road Bridge are recently completed infrastructure projects, and the City contracted with CFS Engineers, P.A. in 2018 to design a replacement structure for the Sheridan Drive Bridge over Rock Creek that does not increase the level of service at that crossing (3). The 2015

[1] The term "flash flooding" is used ambiguously throughout this report. There was no specific rainfall event that defined flash flooding. This report considers a range of rainfall events from the Water Quality event to the 10-year, 24-hour rainfall event to capture those events that could be considered flash flooding, but not a major flood.

study (2) also looked at residential properties along Rock Creek within the 100-year floodplain as indicated by the 2009 LOMA list, in comparison to the provided lowest adjacent grade of the property.

## 2.1 Purpose

The City has contracted with Burns & McDonnell to evaluate the feasibility of additional alternatives to alleviate effects of flash flooding in Fairway along Rock Creek. Due to the recent capital investments made in the Windsor Box Culvert, Mission Road Bridge, and Sheridan Drive Bridge projects, this study did not consider modifications to these structures as alternatives. Since general perception in Fairway is that stormwater improvements at The Gateway site have exacerbated flash flooding issues in the City (1), Burns & McDonnell evaluated two alternatives in the upstream community. However, capital improvements in upstream communities are outside of the City of Fairway's jurisdiction. Therefore, a third alternative, one within City limits, was also evaluated.

## 2.2 Data

The following hydrology, hydraulics, and geographic data were utilized in the evaluation:

- FEMA LOMR for Rock Creek and Cooper Creek (Gateway), dated July 2011
- HEC-HMS model from Fairway Stormwater Level of Service Study, dated September 2015 (herein referred to as the HEC-HMS Model)
- HEC-RAS model for Rock Creek Main Channel Post Project Floodplain (09-07-1447P), dated February 2012 (herein referred to as the HEC-RAS Model)

The following software packages were utilized:

- U.S. Army Corps of Engineers Hydrologic Engineering Center, Hydrologic Modeling System HEC-HMS Version 4.2
- U.S. Army Corps of Engineers Hydrologic Engineering Center, River Analysis System HEC-RAS Version 5.0.5

The flows represented in the HEC-RAS Model could not be reproduced by the HEC-HMS Model. For River station 1.653 through 0.220 along reach RC 130, the HEC-HMS Model flows were between -1% and 2% different than the HEC-RAS Model flows for the 100-year event and -5% to -8% different for the 1-year event.

# 3.0 ALTERNATIVE ANALYSIS

Three alternatives were selected to evaluate opportunities to alleviate impacts of flash flooding in Fairway. The alternatives identified included potential solutions both within and outside of Fairway city limits. Since the perception in Fairway seems to be that stormwater improvements upstream have contributed to increased flash flooding impacts in Fairway, two alternatives evaluated storage within the City of Mission. The third alternative evaluated a potential solution within Fairway to relieve stormwater flooding issues. The three alternatives evaluated are as follows:

Alternative 1) Detention in the Rock Creek Watershed within the City of Mission, Kansas

Alternative 2) Inline storage in the existing box culverts at The Gateway project site

Alternative 3) Channel modifications to Rock Creek within the city limits of Fairway

The HEC-HMS and HEC-RAS models were utilized to evaluate impacts of the three (3) alternatives on the Rock Creek Watershed in Fairway, Kansas, and the feasibility of each alternative. Alternatives 1 and 2 were analyzed for the water quality, 1-year, 2-year, 5-year, and 10-year events. Alternative 3 was analyzed for the 10-year and 100-year events, based on the flow data presented in the HEC-RAS Model.

All rainfall events are represented as the NRCS Type II rainfall distribution over a 24-hour period. The precipitation depths for the rainfall events are noted in Table 3-1. Rainfall data for the 1-year through 100-year events were obtained from the Precipitation Frequency Estimates for the Kansas City Metropolitan Area (1) while the Water Quality event is defined in the Manual of Best Management Practices for Stormwater Quality (2).

**Table 3-1: Rainfall Depths**

| Rainfall Event | Rainfall Depth (inches) |
|---|---|
| Water Quality | 1.37 |
| 1-year | 2.86 |
| 2-year | 3.55 |
| 5-year | 4.50 |
| 10-year | 5.25 |
| 100-year | 7.94 |

# 4.0 ALTERNATIVE 1 – STORMWATER DETENTION

## 4.1 Introduction

The City of Fairway is considered a completely developed community. There are few opportunities within the City to add stormwater detention facilities to manage stormwater runoff and alleviate flooding in Rock Creek within Fairway limits to the extent required for substantial impact. In addition, a significant portion of the flow in Rock Creek originates in communities outside of Fairway, Kansas. As shown in Figure 4-1, approximately 1,782 acres of the total 2,960-acre watershed (60%) is upstream of the City. Therefore, the flooding along Rock Creek is greatly influenced by the stormwater management practices of upstream communities.

It has long been a perception within the Fairway community that the both the cause and the solution to the flooding problems is within the upstream communities. The purpose of this alternative is to quantify the amount of storage that would be required upstream of the City to have a significant impact on stream flows in Rock Creek.

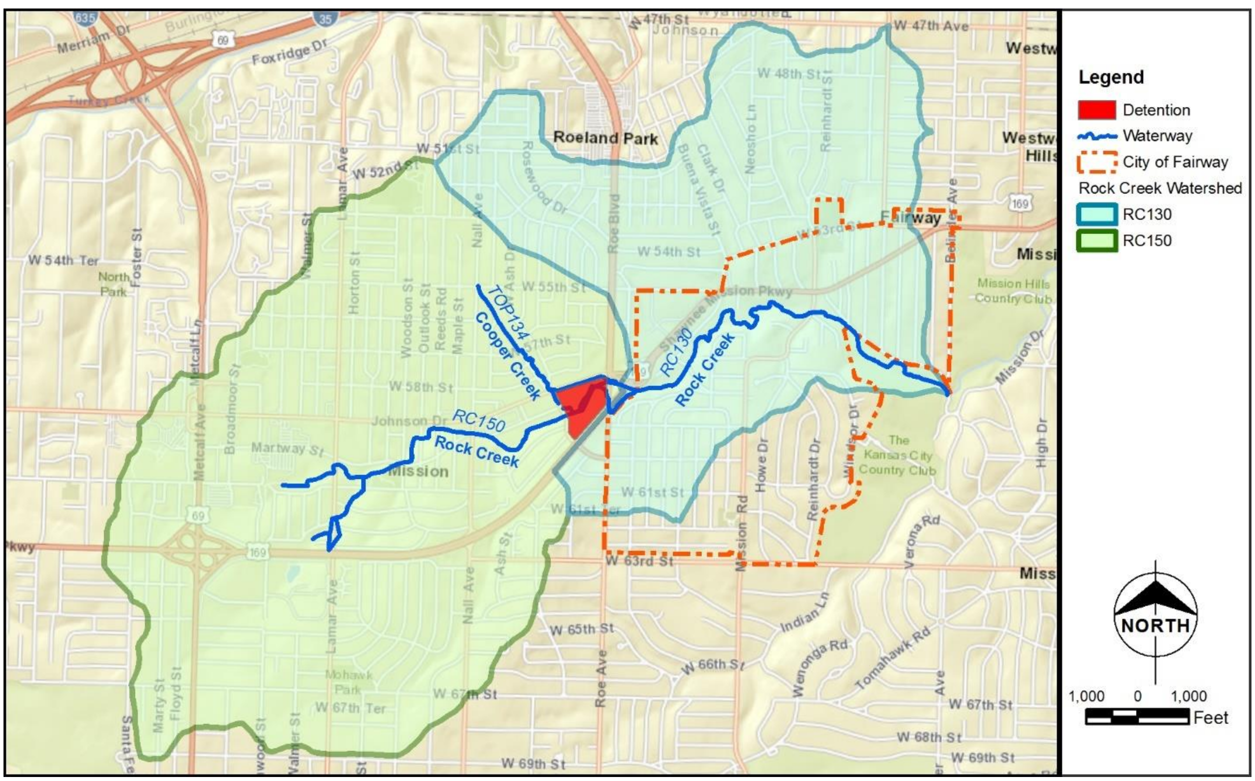



**Figure 4-1: Detention Basin Drainage Area**

## 4.2 Location

A theoretical detention basin was modeled at The Gateway project site. The Gateway is a large commercial development site in Mission, Kansas that is bounded on the north by Johnson Drive, on the east by Roe Avenue, on the south by Shawnee Mission Parkway, and on the west by Roeland Drive (see Figure 4-1 and Figure 4-2). The proposed detention basin would be located immediately west (upstream) of the City of Fairway. A detention facility at this location could help to regulate flows in Rock Creek downstream with the limits of Fairway.


**Figure 4-2: The Gateway Site**

The Gateway is a previously developed site that was highly impervious. At beginning of this study, The Gateway was the largest, undeveloped site within the Rock Creek Watershed. However, by the time this study was completed, development of the site was underway. The City of Fairway currently has no means of reserving The Gateway site for a detention facility.

## 4.3 Sizing

There was no set criterion for detention size, however, the plan area of the detention basin was loosely based on the approximate size of The Gateway site. Therefore, the analysis examines several combinations of storm events and levels of service to reduce flood impacts in Fairway along Rock Creek.

### 4.3.1 Design Storms

The purpose of the study was to focus on impacts to flash flood events. Flash flood has an ambiguous definition; this study considered rainfall events less than or equal to that generated by a 10-year, 24-hour rainfall event, though not all design storms considered necessarily produce flooding. Design storms analyzed included the following:

- Water quality event
- 1-year, 24-hour
- 2-year, 24-hour
- 5-year, 24-hour
- 10-year, 24-hour

Table 3-1 shows the relationship between the rainfall event and corresponding rainfall depth.

### 4.3.2 Reduction in Peak Discharge

For each design storm, the analysis targeted a 10, 20, and 30 percent reduction in peak flow rates. Table 4-1 shows the peak discharge estimated in Rock Creek at Roe Avenue from the HEC-HMS Model. This peak discharge is the inflow into the proposed detention basin. The values for the 10, 20, and 30 percent peak discharge reduction result in a range of outflows form the proposed detention basin.

**Table 4-1: Rock Creek Peak Discharges at Roe Avenue**

| Rainfall Event | Rainfall Depth (inches) | Peak Discharge (cfs) | Proposed Detention Basin Outflow | | |
|---|---|---|---|---|---|
| | | | 10% Peak Discharge Reduction (cfs) | 20% Peak Discharge Reduction (cfs) | 30% Peak Discharge Reduction (cfs) |
| Water Quality | 1.37 | 406 | 365 | 325 | 284 |
| 1-Year | 2.86 | 1334 | 1200 | 1067 | 934 |
| 2-Year | 3.55 | 1877 | 1689 | 1502 | 1314 |
| 5-Year | 4.50 | 2740 | 2466 | 2192 | 1918 |
| 10-Year | 5.25 | 3433 | 3090 | 2746 | 2403 |

### 4.3.3 Principal Outlet Structure Approximation

For modeling purposes, a principal outlet structure had to be incorporated into level pool routing information associated with the proposed detention basin. The unique principal outlet structure was sized for each combination of rainfall events and desired percent reduction in peak discharge. Modeled as a pipe, or combination of pipes, the principal outlet structure had to have the capacity to pass desired reduced peak discharge when the detention basin was at its maximum stage of 10 feet. Table 4-2 shows the principal outlet structure modeled for each condition. Principal outlet structure sizes were designed to meet desired peak flow reduction and may not represent standard precast structure sizes.

**Table 4-2: Principal Outlet Structure Sizes for Desired Reduction in Peak Discharge**

| Rainfall Event | 10% Peak Discharge | 20% Peak Discharge | 30% Peak Discharge |
|---|---|---|---|
| Water Quality | 1 – 5.5-foot | 1 – 5-foot by | 1 – 5.5-foot |
| 1-Year | 1 – 13-foot | 1 – 11.5-foot | 1 – 10-foot |
| 2-Year | 2 – 9-foot by | 2 – 8.5-foot | 2 – 8-foot by |
| 5-Year | 2 – 13.5-foot | 2 – 12-foot | 2 – 10.5-foot |
| 10-Year | 2 – 16-foot | 2 – 14-foot | 2 – 12-foot |

### 4.3.4 Required Detention Volume

With the Detention Basin Inflow estimated by the HEC-HMS Model and the Detention Basin Outflow established by a desired reduction in flow, then the required storage volume for each combination could be calculated. The required storage volume for a detention basin is given by the following equation:

$$\frac{\Delta S}{t} = Q_{in} - Q_{out}$$

Where

$\Delta S$ = Change in storage
$t$ = Time
$Q_{in}$ = Detention Basin Inflow
$Q_{out}$ = Detention Basin Outflow

For true design, the shape and depth of the detention basin would depend on site conditions. Since the detention basin considered in this study is theoretical, the details of grading and design were not given significant consideration. However, it was assumed that the maximum depth of a detention basin in this study would be about 10 feet, that the detention basin would have vertical walls, and that the detention basin would be square in shape. The use of square basin with vertical side walls greatly simplified the modeling.

The size of the detention basin was determined through an iterative process. A nominal size was selected, and input into the HEC-HMS model along with the appropriate principal outlet structure. The results of the model were examined to see how closely the detention basin stage was to the maximum of 10 feet. If the stage exceeded 10 feet, then size of the basin was too small and needed to be increased. If the stage was less than 10 feet, then the detention basin was too large, and the size needed to be decreased.

## 4.4 Results

The results of the analysis are shown in Table 4-3, Table 4-4, and Table 4-5. The results are also graphically depicted in Figure 4-3.

**Table 4-3: Required Storage Volumes for 10% Peak Discharge Reduction**

| Rainfall Event | Peak Inflow (cfs) | Peak Outflow (cfs) | Detention Area (acres) | Detention Volume (acre-feet) |
|---|---|---|---|---|
| Water Quality | 406 | 359 | 0.6 | 5.9 |
| 1-year | 1334 | 1195 | 3.0 | 21.3 |
| 2-year | 1877 | 1683 | 3.1 | 30.7 |
| 5-year | 2740 | 2463 | 4.1 | 39.4 |
| 10-year | 3433 | 3080 | 5.3 | 51.9 |

**Table 4-4: Required Storage Volumes for 20% Peak Discharge Reduction**

| Rainfall Event | Peak Inflow (cfs) | Peak Outflow (cfs) | Detention Area (acres) | Detention Volume (acre-feet) |
|---|---|---|---|---|
| Water Quality | 406 | 323 | 1.1 | 10.6 |
| 1-year | 1334 | 1062 | 3.6 | 35.1 |
| 2-year | 1877 | 1502 | 5.0 | 48.7 |
| 5-year | 2740 | 2192 | 6.7 | 64.5 |
| 10-year | 3433 | 2741 | 9.0 | 86.5 |

**Table 4-5: Required Storage Volumes for 30% Peak Discharge Reduction**

| Rainfall Event | Peak Inflow (cfs) | Peak Outflow (cfs) | Detention Area (acres) | Detention Volume (acre-feet) |
|---|---|---|---|---|
| Water Quality | 406 | 283 | 1.5 | 14.7 |
| 1-year | 1334 | 927 | 5.0 | 48.9 |
| 2-year | 1877 | 1314 | 6.7 | 63.3 |
| 5-year | 2740 | 1917 | 9.2 | 88.6 |
| 10-year | 3433 | 2385 | 12.0 | 117.2 |

The results show a range of possible solutions and various levels of service that can be achieved for this alternative. The higher the level of service, the bigger the detention basin would need to be. The lowest level of service considered as part of this study was the management of the water quality event and a 10 percent reduction of peak flow. To achieve this condition, approximately 5.9 acre-feet (1.9 million gallons) of storage would be needed immediately upstream of Roe Avenue. The highest level of service considered management of a 10-year rainfall event and a 30 percent reduction in peak flows. To achieve this, approximately 117 acre-feet (38.2 million gallons) of storage would be required.

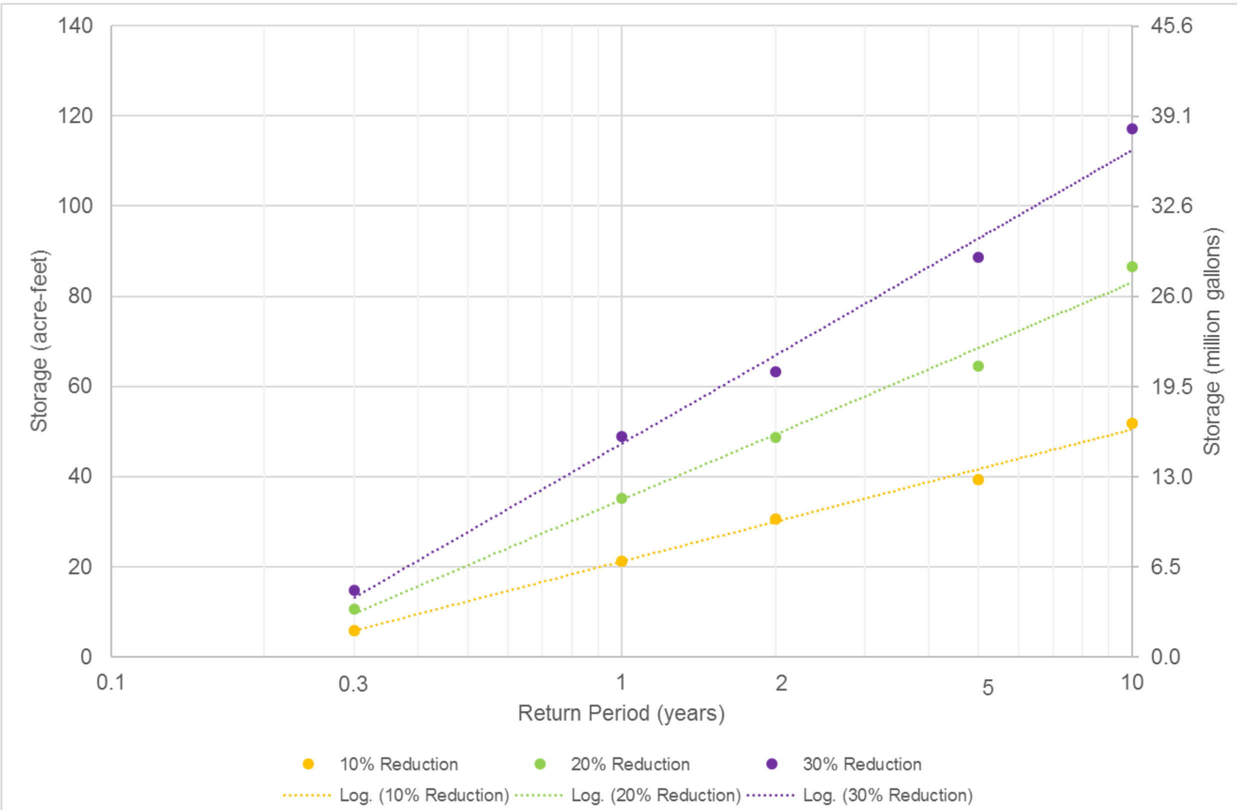



**Figure 4-3: Summary of Storage Requirements for Alternative 1**

For a detention basin that reduces peak flows of Rock Creek into Fairway by 20 percent for a 10-year event, the maximum decrease in water surface elevation was 2.54 feet and 0.64 feet for the 10-year and 100-year events, respectively. Model results for the 1-year event are provided in Appendix A and results for the 100-year event are in Appendix B. Water surface profile comparisons for the 10-year and 100-year events are included in Appendix C and Appendix D, respectively.

## 4.5 Conclusions

The primary purpose of this alternative was to quantify the scale of improvements that would be needed in the upstream watershed to affect flows in Rock Creek through Fairway. The analysis shows that the storage required is significant, and would require a facility that uses most, if not all, of The Gateway site. Though a detention basin of this size could lead to an increase in water surface elevation upstream of the proposed detention facility, upstream impacts were not analyzed for this alternative. Figure 4-4 shows the estimated sizes for 10-foot deep detention basins that will afford 20 percent reduction in peak discharges. As is shown in Figure 4-4, the volume of detention requires a significant amount of space.

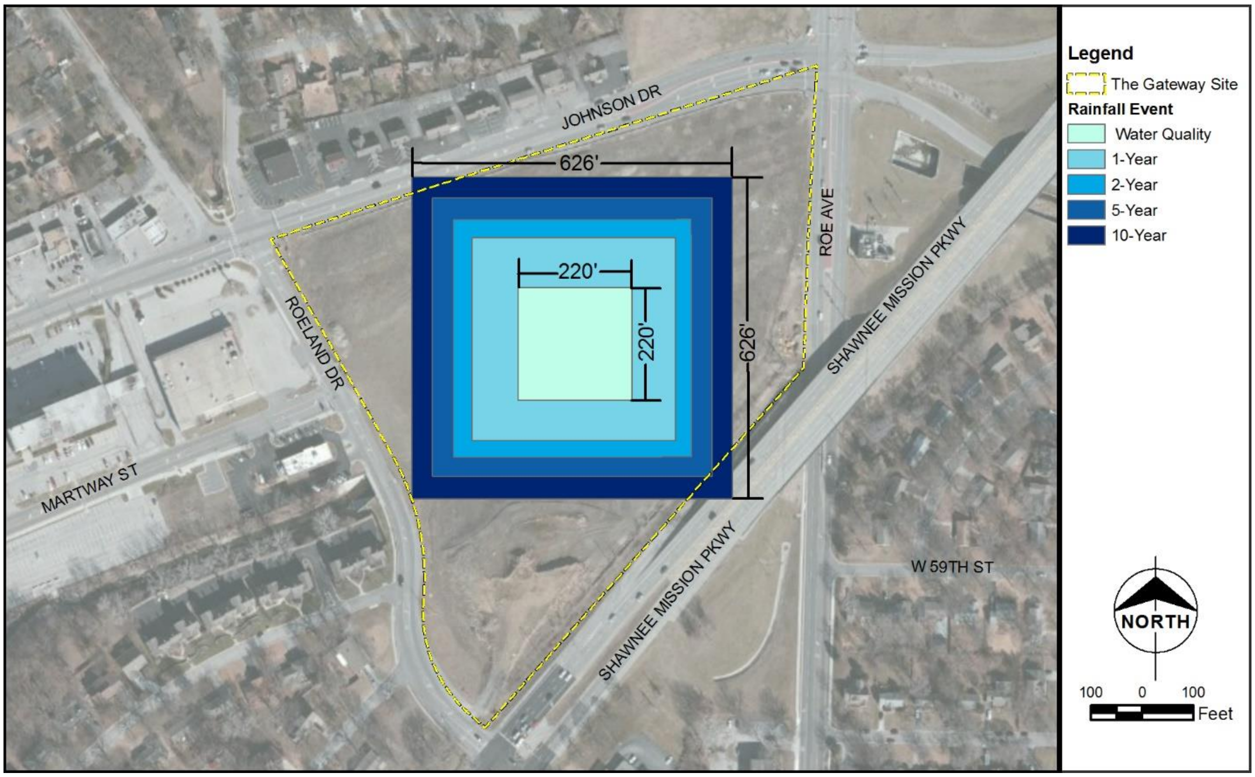



**Figure 4-4: Detention Basin Sizes Required for a 20% Reduction in Peak Discharges**

It should also be understood that The Gateway site is the ideal place for a storage facility because it is a large site in close proximity to the problem. If the site cannot be used for detention, the stormwater management strategy would need to shift to distributed storage throughout the Rock Creek Watershed. With distributed storage, multiple, smaller basins would be constructed throughout the cities of Mission and Fairway. This alternative defines the approximate storage volume required to provide the desired reduction for each design storm analyzed.

## 4.6 Opinion of Probable Cost

A conceptual level opinion of probable cost (OPC) was prepared for this alternative. The range of costs provided represents the lowest level of service considered (management of the water quality event and a 10 percent reduction of peak flow), as seen in Table 4-6, to the highest level of service considered (management of 10-year rainfall event and a 30-percent reduction in peak flow), as seen in Table 4-7. This alternative frames the probable cost for a stormwater detention solution ranging from approximately $5.7 million to $12.7 million.

**Table 4-6: Alternative 1 - Stormwater Detention (Water Quality Event)**

| ITEM | QUANTITY | UNIT | UNIT COST | COST |
|---|---|---|---|---|
| Excavation & Disposal | 18,000 | CY | $ 23 | $ 414,000 |
| Rock Excavation | 5 | % | | $ 21,000 |
| Existing Culvert Demo | 250 | LF | $ 800 | $ 200,000 |
| Primary Outlet Structure (Cast-in-Place 5.5' x 4' RCB) | 32 | CY | $ 1,200 | $ 39,000 |
| Inlet Energy Dissipation Structure | 2 | LS | $ 50,000 | $ 100,000 |
| Turf Seed | 1.1 | AC | $ 3,000 | $ 3,000 |
| | | | Subtotal | $ 777,000 |
| Erosion and Sediment Control | 5 | % | | $ 39,000 |
| Traffic Control | 2 | % | | $ 16,000 |
| Utility Relocation | 10 | % | | $ 78,000 |
| | | | Subtotal | $ 910,000 |
| Mobilization/Demobilization & Overhead | 9 | % | | $ 82,000 |
| | | | Subtotal | $ 992,000 |
| Engineering Design, Permitting, Administration, & Construction Administration | 20 | % | | $ 199,000 |
| Contingency | 30 | % | | $ 298,000 |
| | | | TOTAL | $ 1,489,000 |
| Property Acquisition | 1 | LS | $ 4,245,000 | $ 4,245,000 |
| | | | GRAND TOTAL | $ 5,734,000 |

Both the Water Quality Event and 10-Year Event opinions of probable cost assume some rock excavation, with rock excavation cost based on 5% of total excavation and disposal. Primary outlet structure costs were developed assuming a cast-in-place structure. Though not designed for this concept study, energy dissipation for each of the points of flow entering the proposed detention basin: Rock Creek and Cooper Creek. Property Acquisition costs were based on the 2018 appraised value of The Gateway site at 4801 Johnson Drive from the Johnson County Appraiser's Office website.

**Table 4-7: Alternative 1 - Stormwater Detention (10-Year Event)**

| ITEM | QUANTITY | UNIT | UNIT COST | COST |
|---|---|---|---|---|
| Excavation & Disposal | 146,000 | CY | $ 23 | $ 3,358,000 |
| Rock Excavation | 5 | % | | $ 168,000 |
| Existing Culvert Demo | 700 | LF | $ 800 | $ 560,000 |
| Primary Outlet Structure (Cast-in-Place 16' x 8.5' DBL RCB) | 150 | CY | $ 1,200 | $ 180,000 |
| Inlet Energy Dissipation Structure | 2 | LS | $ 50,000 | $ 100,000 |
| Turf Seed | 9.0 | AC | $ 3,000 | $ 27,000 |
| | | | Subtotal | $ 4,393,000 |
| Erosion and Sediment Control | 5 | % | | $ 220,000 |
| Traffic Control | 2 | % | | $ 88,000 |
| Utility Relocation | 10 | % | | $ 439,000 |
| | | | Subtotal | $ 5,140,000 |
| Mobilization/Demobilization & Overhead | 9 | % | | $ 463,000 |
| | | | Subtotal | $ 5,603,000 |
| Engineering Design, Permitting, Administration, & Construction Administration | 20 | % | | $ 1,120,000 |
| Contingency | 30 | % | | $ 1,680,000 |
| | | | TOTAL | $ 8,403,000 |
| Property Acquisition | 1 | LS | $ 4,245,000 | $ 4,245,000 |
| | | | GRAND TOTAL | $ 12,648,000 |

# 5.0 ALTERNATIVE 2 – INLINE STORAGE

## 5.1 Introduction

Alternative 2 evaluates the potential impact of inline storage in the existing storm sewers at The Gateway site. The existing storm sewers are large and were designed to convey a 100-year event underneath The Gateway development without surface flooding. Because the storm sewers were sized for such a large rainfall event, this alternative considered using the storage available during smaller rainfall events. The Gateway site is located at the confluence of Rock Creek and Cooper Creek. As shown in Figure 5-1, two separate storm sewer systems (Rock Creek System and Cooper Creek System) convey flows below The Gateway. The confluence of the two systems is located between Roe Avenue and Shawnee Mission Parkway (see Figure 5-2).

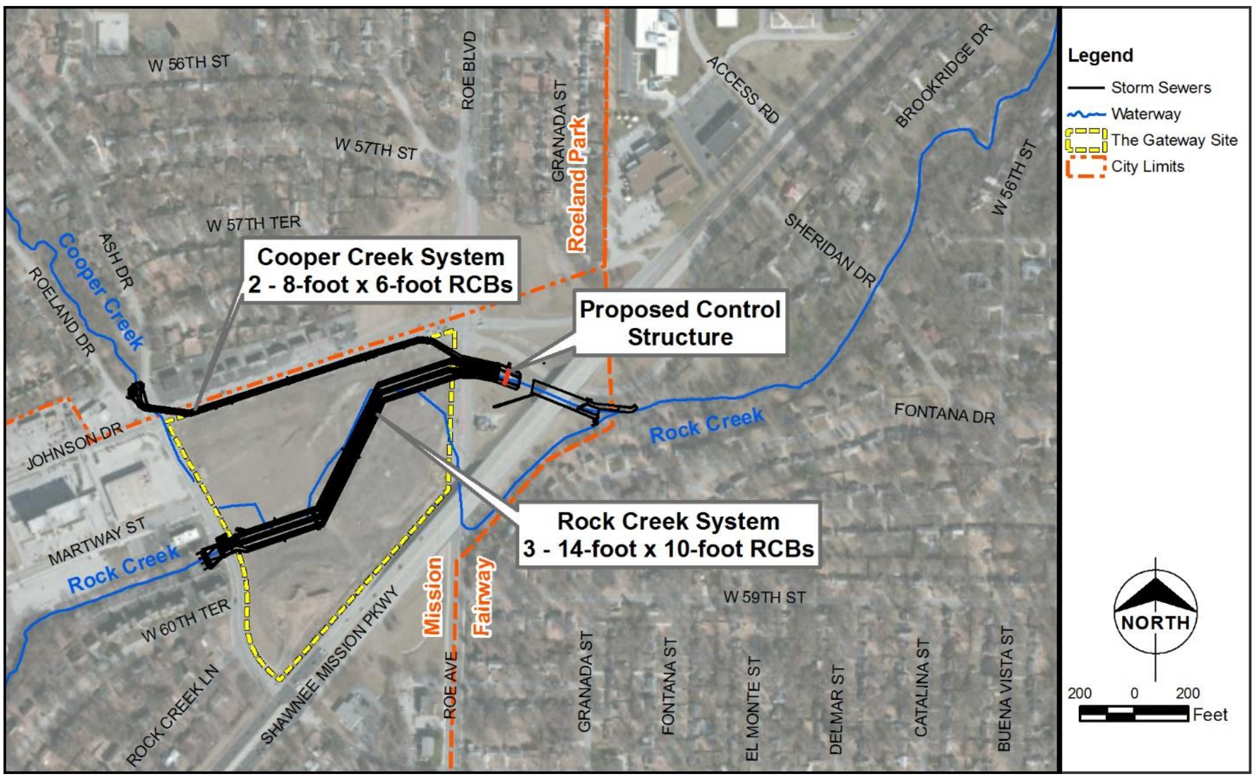



**Figure 5-1: Inline Storage at The Gateway**

## 5.2 Inline Storage

Characteristics of the Rock Creek and Cooper Creek Systems were obtained from the HEC-RAS model of the FEMA Letter of Map Revision (LOMR) for Rock Creek and Cooper Creek (Gateway), dated July 2011. In the LOMR, the Rock Creek System is modeled as three concrete boxes, each 14 feet wide by 10 feet tall. The upstream invert elevation was 915.14 feet and a downstream invert elevation was 909.46 feet.

The Cooper Creek System was modeled as two concrete boxes, 8 feet wide by 6 feet tall. The upstream invert elevation was 923.00 feet and the downstream invert elevation was 909.46 feet. Figure 5-2 shows the confluence of the Rock Creek and Cooper Creek Systems (looking west).

**Figure 5-2: Confluence of Rock Creek and Cooper Creek Systems**

## 5.3 Concept for Inline Storage

The analysis considered the use of inline storage with real-time controls. To create storage within the RCBs an obstruction to the flow must be introduced in the channel. The challenge with this concept is that the obstruction increases flood stages upstream and could increases the risk and frequency flooding to properties west of Roe Avenue. An increased flooding risk is not an acceptable outcome. Therefore, the following constraints were incorporated into the analysis:

- The conceptual plan could not cause an increase in base flood elevation
- Any raises in flood stages (for any rainfall event) had to be contained within the RCBs

With those two constraints, it was determined that the obstruction to create storage within the RCBs needed to be an adjustable control structure. The control structure would need to be raised during small rainfall events to create detention yet lowered during large rainfall events to allow flow to pass unobstructed. The adjustable control structure could also be lowered after the conclusion of a rainfall event, when downstream capacity within the channel section becomes available. Figure 5-3 shows the location of the proposed control structure with respect to the Rock Creek and Cooper Creek Systems.

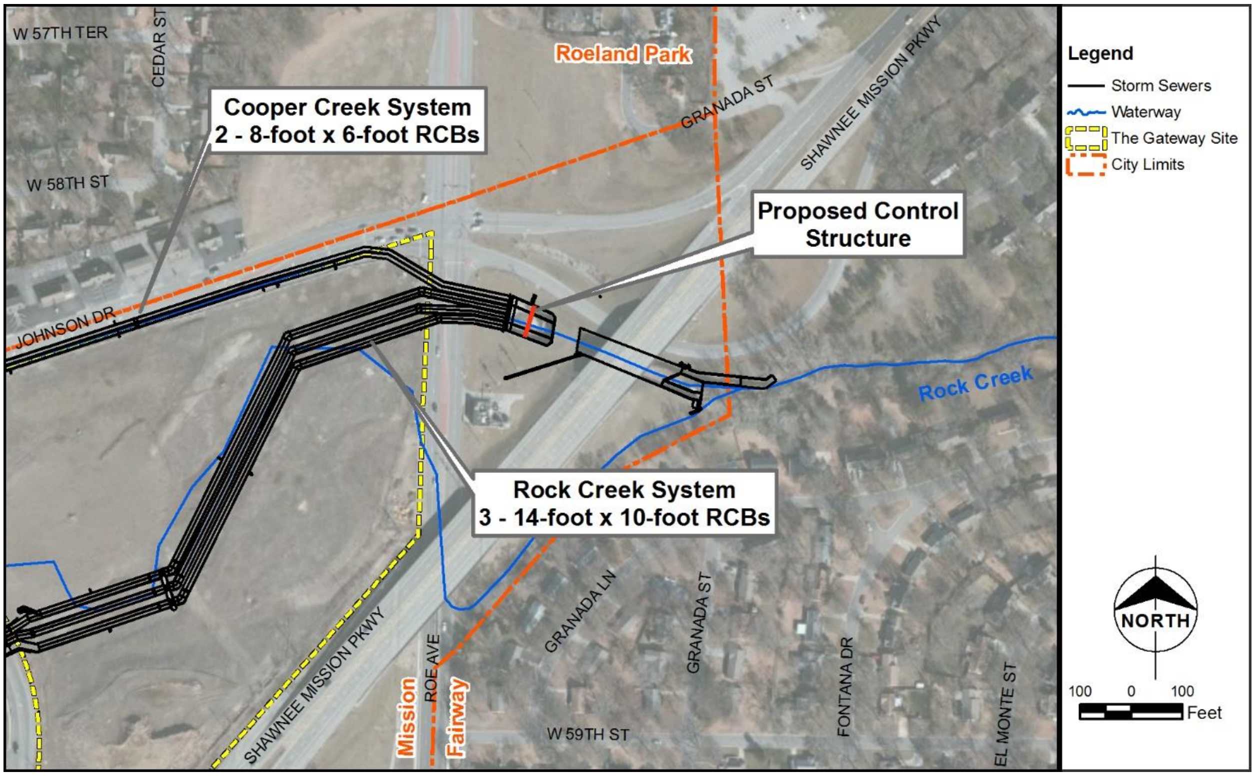



**Figure 5-3: Proposed Location of Control Structure**

## 5.4 Control Structure

To meet the constraints described above, the size of the obstruction was assumed to be a maximum height of 4 feet. It was reasoned that this was the height at which an adjustable structure could be raised and lowered during a flow event and withstand the hydrostatic forces of flow.

**Figure 5-4: Pneumatically Actuated Gate Example**

One option for the adjustable obstruction is a pneumatically actuated gate, which utilizes a series of pneumatically actuated panels to create an obstruction in flow. Flow rate through the gate and the corresponding increase in upstream stage is determined by the number of panels used to obstruct flow. The bottom-hinged steel panel gate is raised and lowered by control of an inflatable bladder or bladders. Figure 5-4 provides an example of a pneumatically actuated gate structure.

**Figure 5-5: Inflatable Dam Example**

Another option for the adjustable obstruction is an inflatable dam. An inflatable dam is a cylindrical bladder, made of synthetic fibers that raises the upstream water level when inflated. Generally, inflatable dams are anchored to the channel bottom and may be filled with air or water during deployment. Figure 5-5 provides an example of an inflatable dam structure.

## 5.5 Inline Storage Capacity

Static storage of the Rock Creek and Cooper Creek Systems was calculated based on a 4-foot control structure height and culvert characteristics described in paragraph 5.2. There is approximately 100,000 gallons of storage available in the Cooper Creek System and 560,000 gallons of storage available in the Rock Creek System. The combined total storage in both systems is 660,000 gallons.

## 5.6 Results and Conclusions

The available storage capacity within the two systems was compared to the estimated runoff volume for the rainfall event modeled. The 660,000 gallons of available storage capacity in The Gateway box culverts provided by a 4-foot control structure, installed at the downstream end of the box culverts, captures approximately 2.2% of the 29.7 million gallons of total runoff generated from a water quality event over the 1,782-acre drainage area tributary to The Gateway site. Table 5-1 shows the level of control that 660,000 gallons of inline storage would provide for varying rainfall events.

**Table 5-1: Comparison of Available Storage to Total Runoff**

| Rainfall Event | Rainfall Depth (inches) | Total Runoff Volume (million gallons) | Percent Capture |
|---|---|---|---|
| Water Quality | 1.37 | 29.7 | 2.2% |
| 1-Year | 2.86 | 78.7 | 0.8% |
| 2-Year | 3.55 | 104.8 | 0.6% |
| 5-Year | 4.50 | 142.8 | 0.5% |
| 10-Year | 5.25 | 174.0 | 0.4% |

Results of the analysis suggest that the inline storage volume available in the Rock Creek and Cooper Creek Systems is not enough to significantly impact flows in Rock Creek. Figure 5-6 shows the runoff hydrograph for the water quality event (the smallest storm modeled) for Rock Creek at Roe Avenue.

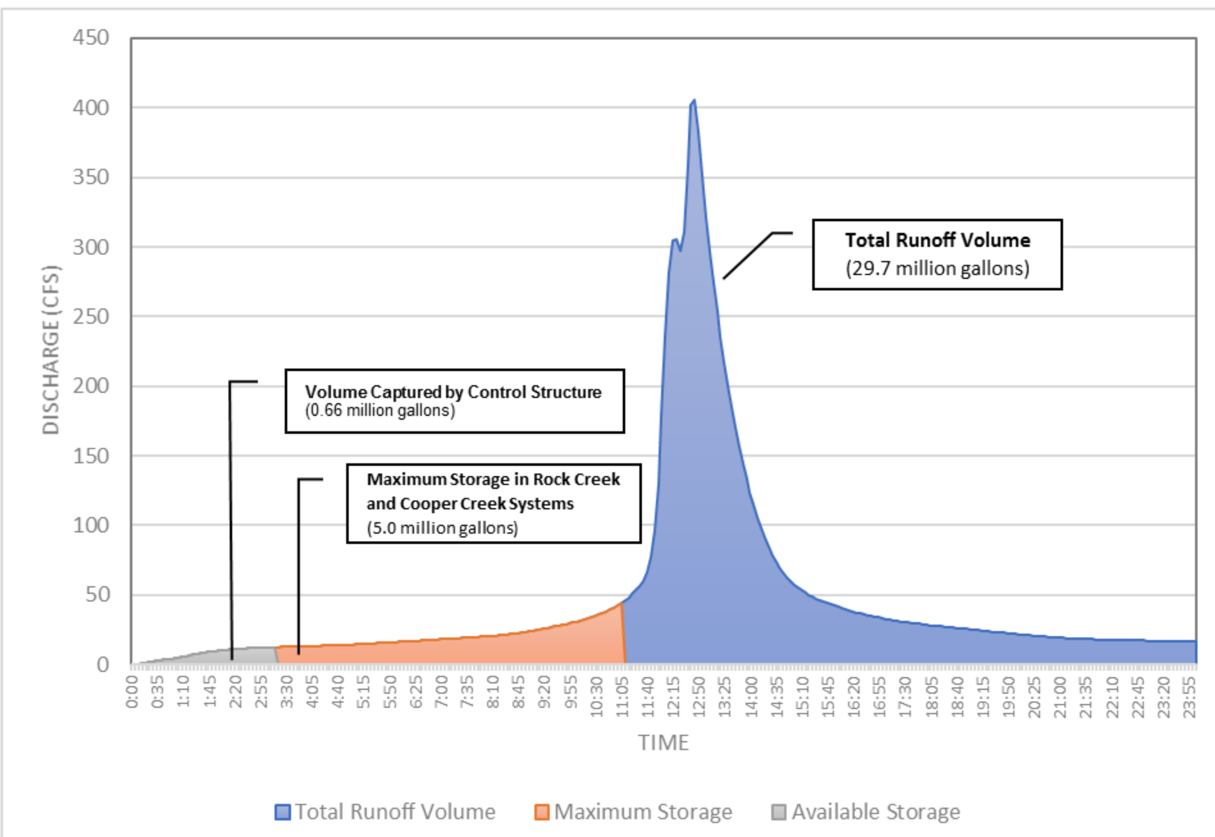



**Figure 5-6: Comparison Volumes for the Water Quality Event**

The figure shows a comparison of the runoff hydrograph to the available volume that could be captured by a control structure. If a 4-foot structure was in-place when the rainfall begins, the systems could store approximately 2.2% of the total runoff volume from the water quality event. It would take approximately 3 hours for the water in the system to fill behind the control structure and start overtopping. When the structure is overtopped, the attenuation impacts would be diminished, and the system would no longer function as a detention basin. As can be seen from Figure 5-6, the volume controlled by the control structure is proportionally small compared to the total runoff volume. The inline storage volume would be filled prior to the flood crest in Rock Creek. Therefore, the peak discharge would not be attenuated with no noticeable impact to the City of Fairway.

The limitation of using a control structure with a maximum height of 4 feet was self-imposed. It could be argued that this constraint and the simplified analysis that was conducted, understates the available storage. Comprehensive modeling using dynamic wave routing and a simulation of real-time controls on the control structure would yield a different, and more precise evaluation of how the system could be operated.

However, this additional effort may not compensate for the lack of available volume. A second comparison was made using the total volume of the RCBs. This would assume that the RCBs could be completely filled and used for storage. For both the Rock Creek and Cooper Creek systems, this maximum storage volume is estimated to be 5.0 million gallons, or 16.8 percent of the total runoff for the water quality event. Figure 5-6 suggests that even if the maximum storage capacity could be utilized, the inline storage is still inconsequential. The RCBs would be full before the flood crest, and there would be no significant attenuation of the peak flow.

The discussion presented above relates to expected system performance during the water quality event, a 1.37-inch rainfall distributed over a 24-hour period. This event is well below the rainfall depths and intensities associated with a flash flood event; which was the focus of the study.

The results of Alternative 2 corroborate the results of Alternative 1 which also conclude that the storage volume required was significant. To afford a sizeable impact on flow rates in Rock Creek, the storage requirements must be more than 30 acre-feet (10 million gallons), which would reduce peak flows by 20 percent for a 1-year rainfall event.

## 5.7 Opinion of Probable Cost

The conceptual level OPC, prepared for this alternative, includes an adjustable control structure, anchoring for control structure, electrical and control systems, and power source. Detailed information regarding this OPC is provided in Table 5-2. The probable cost of this alternative is significantly less than Alternative 1, mostly due to the scale of the project and property acquisition. Alternative 1 provides 1.9 to 38.2 million gallons of storage for approximately $5.7 million to $12.7 million, whereas this alternative provides only 0.66 million gallons of storage for approximately $0.6 million.

**Table 5-2: Alternative 2 - Inline Storage**

| ITEM | QUANTITY | UNIT | UNIT COST | COST |
|---|---|---|---|---|
| Demolition | 1 | LS | $ 25,000 | $ 25,000 |
| Reinforced Concrete Anchoring for Control Structure | 35 | CY | $ 1,000 | $ 35,000 |
| Control Structure | 1 | LS | $ 200,000 | $ 200,000 |
| Power Source - Hardline (3-Phase, 480V Service) | 1 | LS | $ 50,000 | $ 50,000 |
| Electrical and Control Systems | 1 | LS | $ 40,000 | $ 40,000 |
| | | | Subtotal | $ 350,000 |
| Mobilization/Demobilization & Overhead | 9 | % | | $ 32,000 |
| | | | Subtotal | $ 382,000 |
| Engineering Design, Permitting, Administration, & Construction Administration | 20 | % | | $ 77,000 |
| Contingency | 30 | % | | $ 115,000 |
| | | | TOTAL | $ 574,000 |

# 6.0 ALTERNATIVE 3 – CHANNEL MODIFICATIONS

## 6.1 Introduction

Alternative 3 evaluates the impact of channel modifications along Rock Creek within Fairway. Two scenarios of channel modifications include overbank clearing and grubbing and channel excavation. These modifications anticipate the impacts of increasing channel capacity with vegetation management and minor channel improvement along the creek. Channel modifications were considered where feasible and were limited to the portion of Rock Creek between river stations 1.653 and 0.608 (see Figure 6-1).

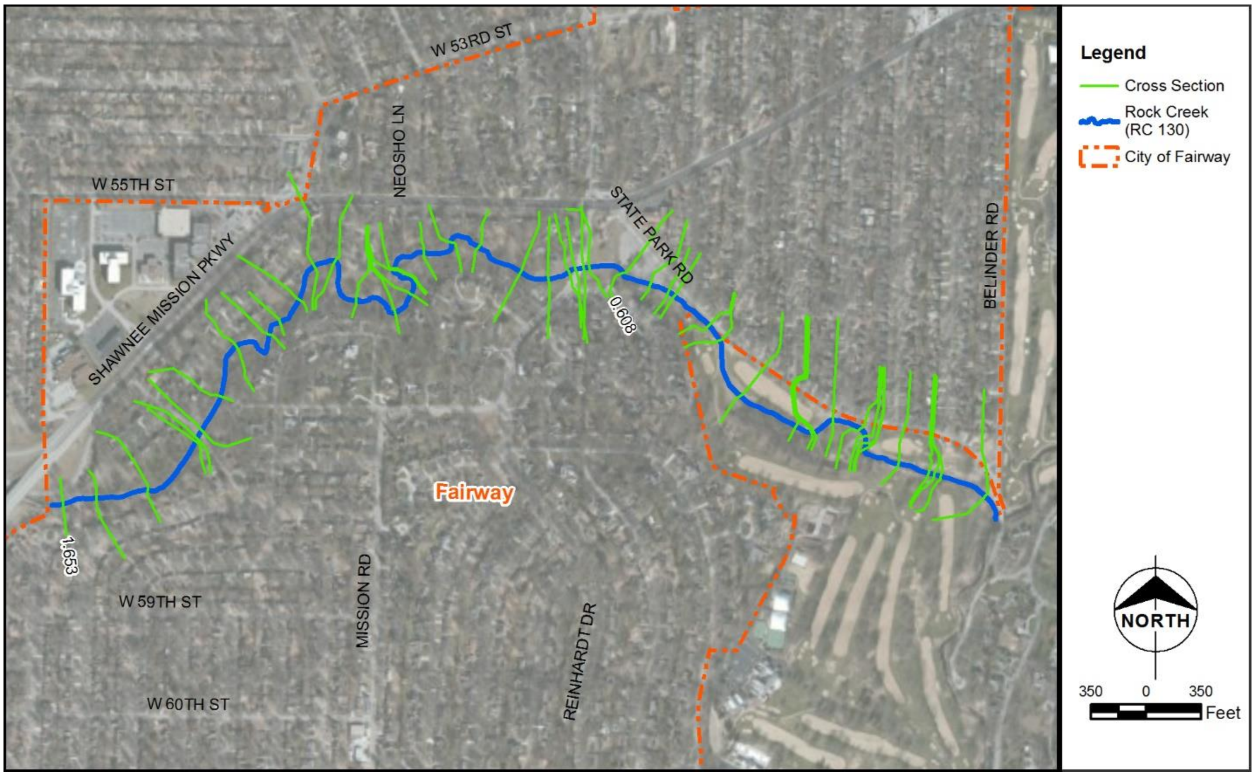



**Figure 6-1: HEC-RAS Cross Sections for Rock Creek**

## 6.2 Limitations of the Analysis

Because this study was conceptual in nature, consideration was only given to channel hydraulics. Other concerns such as easements, slope stability, construction access, permitting requirements, environmental impacts, and downstream impacts were not considered.

Impacts to existing structures, foundations, fences and other existing features were not considered in detail. In general, an attempt was made to develop channel improvements that avoided houses. However, should the City select channel modification as the preferred alternative, the design would need to be verified.

The proposed modifications did not consider improvements to any of the existing bridges along Rock Creek within the City of Fairway. Bridges, culverts and roadway embankments were not changed.

Implementation of Alternative 3 may result in a drastic change to the character of Rock Creek. Vegetation management to improve capacity would result in selective clearing of existing trees and underbrush along the creek. This strategy is contrary to the City's commitment to plant and maintain trees. If this alternative is selected, the channel improvements and vegetation management strategies should be coordinated with the Fairway Tree Board.

## 6.3 Concept for Channel Modifications

Proposed channel modifications were modeled using HEC-RAS (3) and the Effective Model for Rock Creek obtained from the Federal Emergency Management Agency (FEMA) (4). The Effective Model did not include the bridge replacement project for Sheridan Drive. Therefore, the HEC-RAS model for the Sheridan Bridge Project (5) was incorporated into the Effective Model. The new model created is herein referred to as the Corrected Effective Model.

Proposed channel modifications modeled two scenarios:

- Proposed Conditions (n-Values) Model: Vegetation Management
- Proposed Conditions (30-foot Trapezoidal Channel) Model: Channel Improvements

## 6.4 Vegetation Management

The Proposed Conditions (n Values) Model, altered Manning's roughness coefficients in the model to reflect clearing and grubbing within the Rock Creek overbank areas. As shown in Figure 6-2, the roughness coefficients in the overbanks are high to represent the presences of trees, brush and other conditions that act to impede flow. To predict how vegetation management could improve channel hydraulics, the Manning's roughness coefficients were changed to 0.04 to reflect a combination of grasses with limited amount of brush (6) in the overbanks for a 40 to 80-foot swath on either side of the channel, where clearing and grubbing was feasible. Figure 6-3 shows how Manning's roughness coefficients were changed at a given cross section.

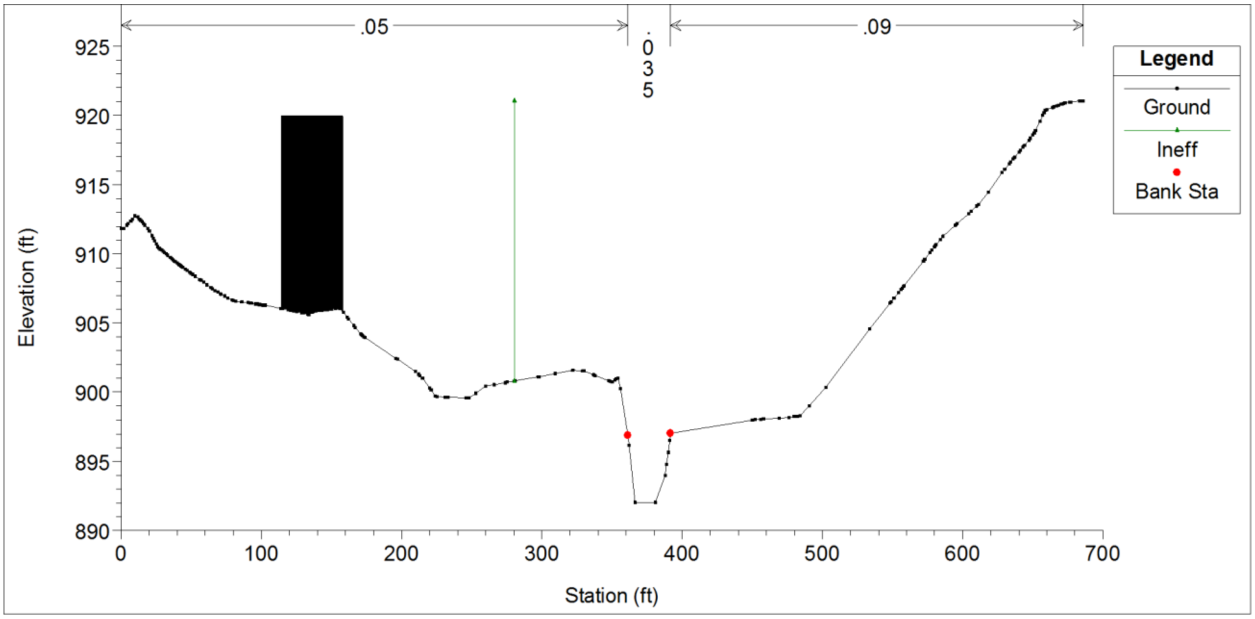



**Figure 6-2: Manning's Roughness Coefficient for Existing Conditions**

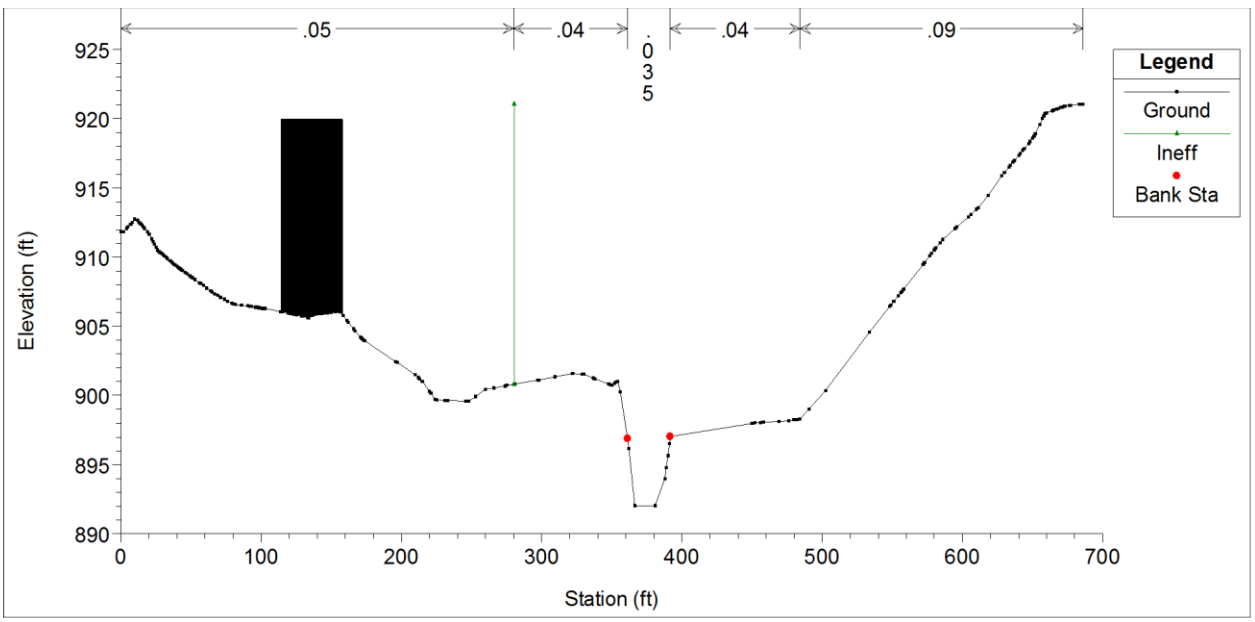



**Figure 6-3: Manning's Roughness Coefficient for Proposed Conditions**

## 6.5 Channel Improvements

The second scenario, Proposed Conditions (30-foot Trapezoidal Channel) Model, reflects a grading strategy to create a more uniform and hydraulically efficient channel. The channel section modeled for this study was a trapezoidal channel with a typical bottom width of 30 feet and 3:1 side slopes. When existing channel bottom width exceeded 30-feet, channel bottom width was not modified. Where 3:1 side slopes were not feasible, 2:1 side slopes were used. Channel sections directly upstream and downstream of bridge structures were not altered. To account for the efficiency of an engineered channel, a Manning's roughness coefficient of 0.035 was used within the channel. Figure 6-4 provides an example of proposed channel modification.

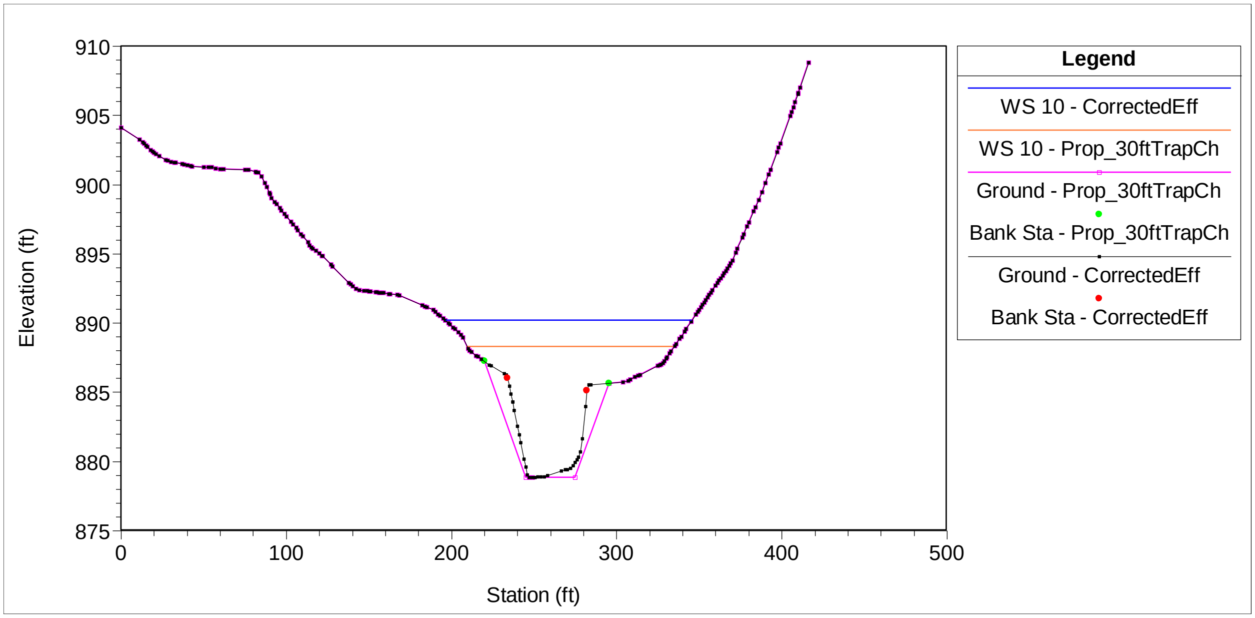
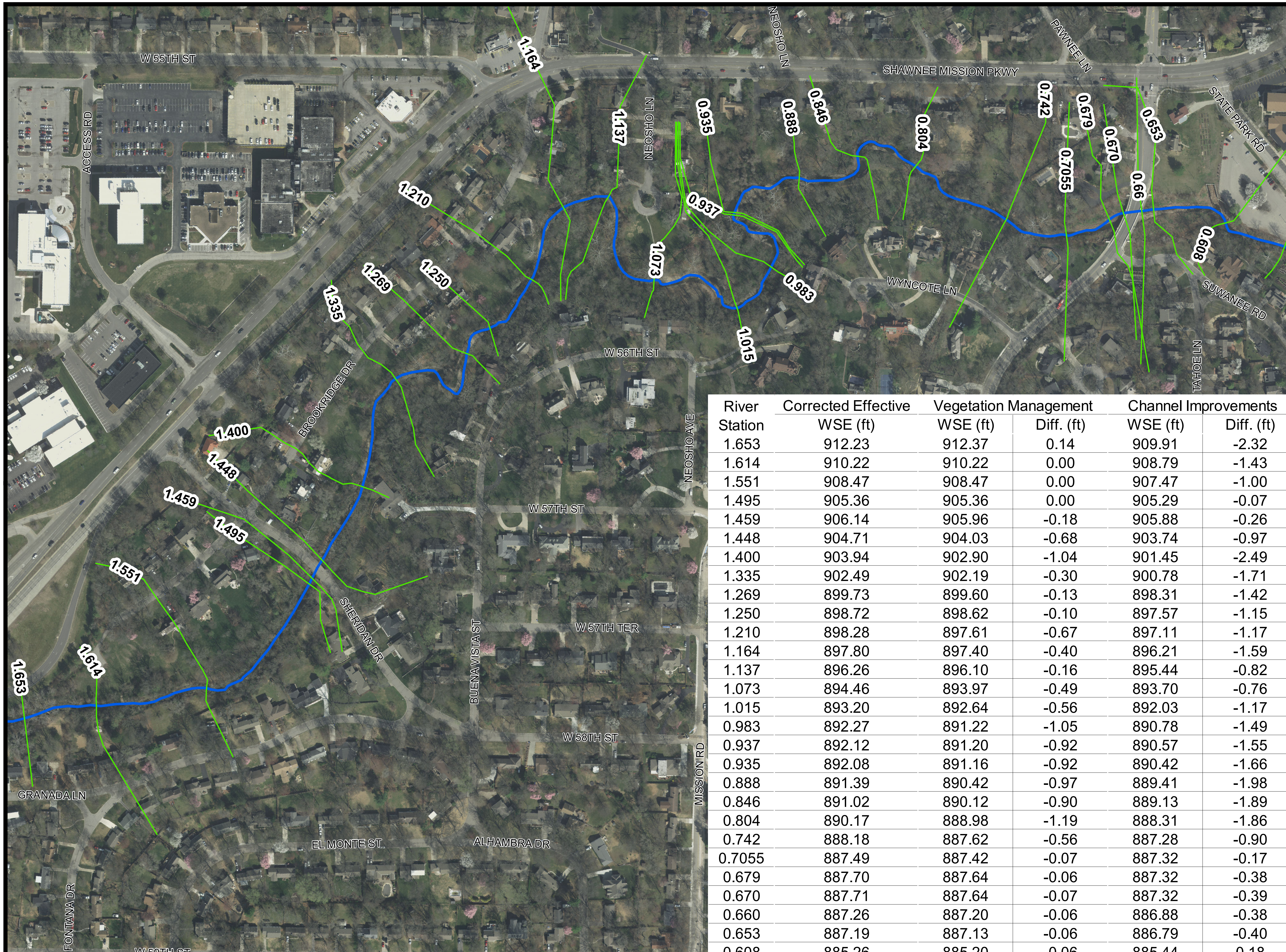



**Figure 6-4: Example of Proposed Channel Excavation**

## 6.6 Results and Conclusions

Water surface elevations were computed for both scenarios and results were compared to the Corrected Effective Model. Model results are provided in Appendix A and Appendix B. Both scenarios lowered the water surface elevation of Rock Creek. For the vegetation management scenario, the maximum decrease in water surface elevation was 1.19 feet and 1.53 feet for the 10-year and 100-year rainfall events, respectively. For the channel improvement scenario, the maximum decrease in water surface elevation was 2.49 feet and 2.74 feet for the 10-year and 100-year events, respectively. Figure 6-5 quantifies the difference in water surface elevation for the 10-year event. Water surface profile comparisons for the 10-year and 100-year events are included in Appendix C and Appendix D, respectively.




| River Station | Corrected Effective WSE (ft) | Vegetation Management WSE (ft) | Vegetation Management Diff. (ft) | Channel Improvements WSE (ft) | Channel Improvements Diff. (ft) |
|---|---|---|---|---|---|
| 1.653 | 912.23 | 912.37 | 0.14 | 909.91 | -2.32 |
| 1.614 | 910.22 | 910.22 | 0.00 | 908.79 | -1.43 |
| 1.551 | 908.47 | 908.47 | 0.00 | 907.47 | -1.00 |
| 1.495 | 905.36 | 905.36 | 0.00 | 905.29 | -0.07 |
| 1.459 | 906.14 | 905.96 | -0.18 | 905.88 | -0.26 |
| 1.448 | 904.71 | 904.03 | -0.68 | 903.74 | -0.97 |
| 1.400 | 903.94 | 902.90 | -1.04 | 901.45 | -2.49 |
| 1.335 | 902.49 | 902.19 | -0.30 | 900.78 | -1.71 |
| 1.269 | 899.73 | 899.60 | -0.13 | 898.31 | -1.42 |
| 1.250 | 898.72 | 898.62 | -0.10 | 897.57 | -1.15 |
| 1.210 | 898.28 | 897.61 | -0.67 | 897.11 | -1.17 |
| 1.164 | 897.80 | 897.40 | -0.40 | 896.21 | -1.59 |
| 1.137 | 896.26 | 896.10 | -0.16 | 895.44 | -0.82 |
| 1.073 | 894.46 | 893.97 | -0.49 | 893.70 | -0.76 |
| 1.015 | 893.20 | 892.64 | -0.56 | 892.03 | -1.17 |
| 0.983 | 892.27 | 891.22 | -1.05 | 890.78 | -1.49 |
| 0.937 | 892.12 | 891.20 | -0.92 | 890.57 | -1.55 |
| 0.935 | 892.08 | 891.16 | -0.92 | 890.42 | -1.66 |
| 0.888 | 891.39 | 890.42 | -0.97 | 889.41 | -1.98 |
| 0.846 | 891.02 | 890.12 | -0.90 | 889.13 | -1.89 |
| 0.804 | 890.17 | 888.98 | -1.19 | 888.31 | -1.86 |
| 0.742 | 888.18 | 887.62 | -0.56 | 887.28 | -0.90 |
| 0.7055 | 887.49 | 887.42 | -0.07 | 887.32 | -0.17 |
| 0.679 | 887.70 | 887.64 | -0.06 | 887.32 | -0.38 |
| 0.670 | 887.71 | 887.64 | -0.07 | 887.32 | -0.39 |
| 0.660 | 887.26 | 887.20 | -0.06 | 886.88 | -0.38 |
| 0.653 | 887.19 | 887.13 | -0.06 | 886.79 | -0.40 |
| 0.608 | 885.26 | 885.20 | -0.06 | 885.44 | 0.18 |

**Legend**
- Cross Section
- Rock Creek

NORTH

200 0 200 Feet

**City of Fairway, Kansas**

**STORMWATER LEVEL OF SERVICE STUDY - PHASE 2 FLOODING ADJACENT TO ROCK CREEK**

## Figure 6.5

## Water Surface Comparison by Cross Section for 10-Year Event

**12/6/2018**

BURNS & McDONNELL
9400 Ward Parkway
Kansas City, MO. 64114

Path: Z:\Clients\WTR\FairwayKS\108200_LOSStudyPh2\Studies\Geospatial\DataFiles\ArcDocs\Figure6.5_XS-WSE_11x17.mxd

## 6.7 Opinion of Probable Cost

A conceptual level opinion of probable cost (OPC) was prepared each scenario of this alternative: vegetation management and channel improvements. The probable costs for the vegetation management and channel improvement scenarios are provided in Table 6-1 and Table 6-2, respectively.

**Table 6-1: Alternative 3 - Channel Modifications (Vegetation Management Scenario)**

| ITEM | QUANTITY | UNIT | UNIT COST | COST |
|---|---|---|---|---|
| Clearing & Grubbing, Disposal, & Cleanup | 10.2 | AC | $ 20,000 | $ 204,000 |
| Turf Seed | 10.2 | AC | $ 3,000 | $ 31,000 |
| | | | Subtotal | $ 235,000 |
| Erosion and Sediment Control | 5 | % | | $ 12,000 |
| Traffic Control | 2 | % | | $ 5,000 |
| Utility Relocation | 3 | % | | $ 7,000 |
| | | | Subtotal | $ 259,000 |
| Mobilization/Demobilization & Overhead | 9 | % | | $ 23,000 |
| | | | Subtotal | $ 282,000 |
| Engineering Design, Permitting, Administration, & Construction Administration | 20 | % | | $ 56,000 |
| Contingency | 30 | % | | $ 84,000 |
| | | | TOTAL | $ 422,000 |
| Permanent Easements | 1 | LS | $ 1,155,000 | $ 1,155,000 |
| Easement Acquisition | 62 | EA | $ 8,000 | $ 496,000 |
| | | | GRAND TOTAL | $ 2,073,000 |

The vegetation management scenario assumes clearing and grubbing a 40-foot swath on either side of the channel within the overbanks and reseeding. The OPC also includes permanent easements on the aforementioned 40-foot swath for regular vegetation maintenance and easement acquisition costs for the 62 properties impacted by this scenario.

**Table 6-2: Alternative 3 - Channel Modifications (Channel Improvements Scenario)**

| ITEM | QUANTITY | UNIT | UNIT COST | COST |
|---|---|---|---|---|
| Excavation & Disposal | 18,000 | CY | $ 23 | $ 414,000 |
| Clearing & Grubbing, Disposal, & Cleanup | 6.4 | AC | $ 20,000 | $ 128,000 |
| Temporary Road (Construction/Deconstruction) | 8,000 | SY | $ 16 | $ 128,000 |
| Turf Sod of Temporary Easement | 19,000 | SY | $ 7 | $ 133,000 |
| Rip Rap | 31,000 | TON | $ 48 | $ 1,488,000 |
| | | | Subtotal | $ 2,291,000 |
| Erosion and Sediment Control | 5 | % | | $ 115,000 |
| Traffic Control | 2 | % | | $ 46,000 |
| Utility Relocation | 3 | % | | $ 69,000 |
| | | | Subtotal | $ 2,521,000 |
| Mobilization/Demobilization & Overhead | 9 | % | | $ 227,000 |
| | | | Subtotal | $ 2,748,000 |
| Engineering Design, Permitting, Administration, & Construction Administration | 20 | % | | $ 550,000 |
| Contingency | 30 | % | | $ 825,000 |
| | | | TOTAL | $ 4,123,000 |
| Temporary Easements | 1 | LS | $ 191,000 | $ 191,000 |
| Permanent Easements | 1 | LS | $ 895,000 | $ 895,000 |
| Easement Acquisition | 62 | EA | $ 8,000 | $ 496,000 |
| | | | GRAND TOTAL | $ 5,705,000 |

The channel improvements scenario includes earthwork within the main channel section. Rip rap bank stabilization was assumed for the side slopes for up to 5-foot flow depth. To access the main channel the construction and deconstruction of a temporary construction access road as well as temporary construction easements were included. The OPC assumes sodding disturbed areas within the temporary construction easement. The OPC also includes a permanent easement over the entire length of Rock Creek within Fairway for reoccurring maintenance of the main channel section and easement acquisition costs related to the 62 adjacent properties.

# 7.0 CONCLUSIONS

While none of the alternatives considered as part of the study afforded a definitive solution, the alternatives for stormwater detention within the City of Mission have been dismissed as viable strategies for stormwater management. The recommended strategy (Alternative 3) is a continued focus on conveyance in Rock Creek.

It is the conclusion of this study that stormwater detention project in the upstream community(s) would not be a practical solution for management of flows in Rock Creek. The results of Alternative 1, which considered a large detention basin at The Gateway site, is not a viable solution with the site under development (7). Detention facilities in the upstream watershed would need to be distributed throughout the watershed would likely utilize small, undeveloped areas. Both Mission and Fairway are long-established, highly-urbanized communities. Like Fairway, Mission affords few opportunities for these new detention facilities.

The use of the existing storm sewers at The Gateway site for inline storage does not provide storage in amount that would result in a meaningful reduction in flow rates. The volume of runoff generated by the 1,782 acres tributary to Rock Creek at Roe Avenue is proportionally large to the storage available in the Rock Creek and Copper Creek Systems. This study predicts that inline storage capacity would fill well before a flood crest (even for small rainfall events) and would provide only minimal attenuation during the peak of the event.

During the Public Works Committee meeting on November 29, 2018, it was requested that the study include a description of flooding impacts for each alternative in relation to both residential properties and public infrastructure. Access to Brookside Drive and State Park Road for emergency situations during rainfall events was expressed as a concern.

The low point on Brookside Drive was identified and a plot was developed to determine the existing level of service at this location. Based on Figure 7-1, Brookside Drive is estimated to have less than a 10-year level of service. To bring Brookside Drive up to a 10-year level of service either the road would need to be raised or the water level lowered up to 3 feet at this location. A detention basin that provides a 20 percent reduction in peak flows for the 10-year event, described in Alternative 1, only reduces the water surface elevation by 1.36 feet at this location. Neither of the channel modification scenarios evaluated in Alternative 3, Vegetation Management and Channel Improvements, were estimated to reduce the water surface elevation by 3 feet.

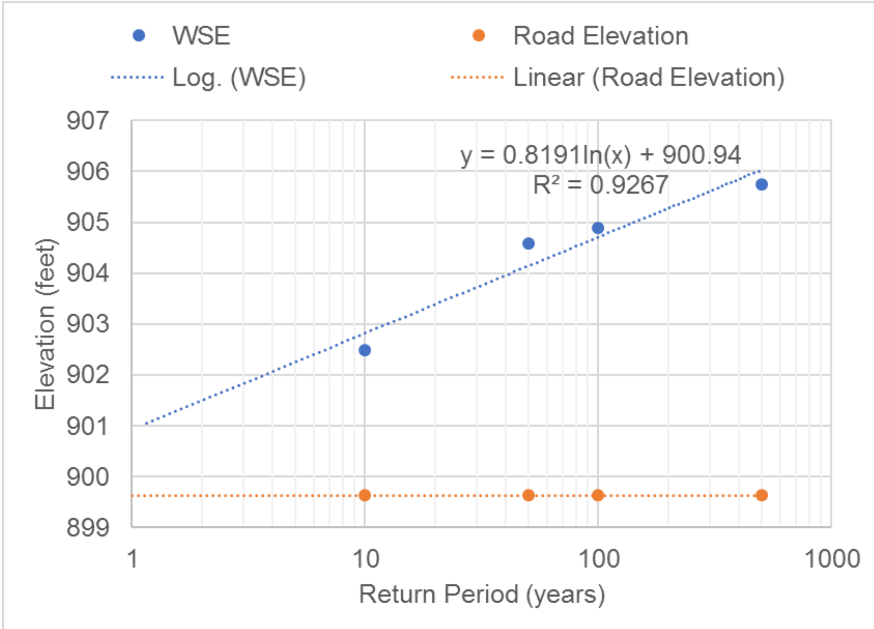



**Figure 7-1: Brookside Drive Existing Level of Service**

A similar evaluation was conducted for State Park Road, which estimated State Park Road to have less than a 10-year level of service. The level of service plot for State Park Road is provided in Figure 7-2. Based on modeling efforts, there is potential to bring State Park Road up to a 10-year level of service by reducing peak flows, however, further study would be required.

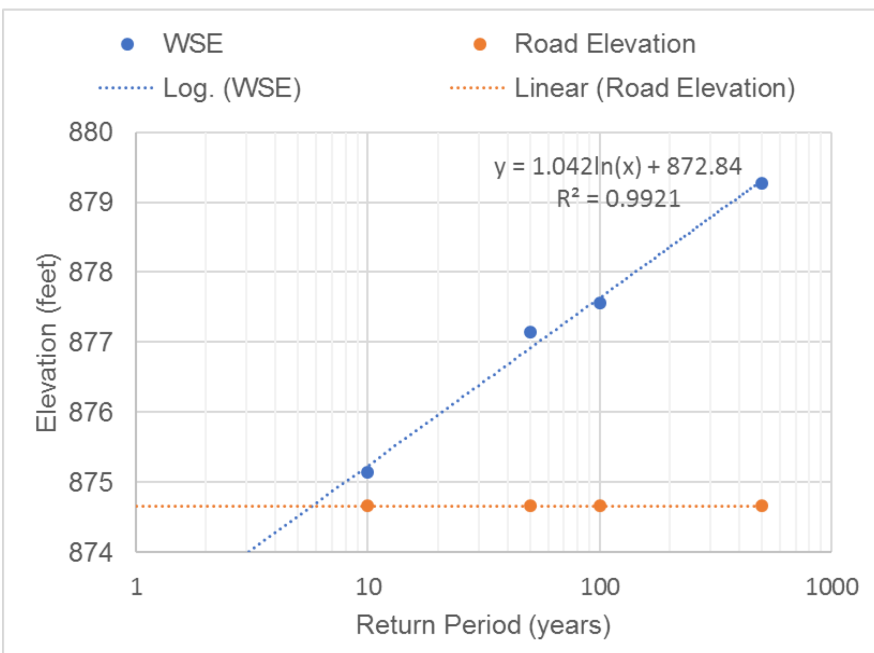



**Figure 7-2: State Park Road Existing Level of Service**

The level of service to residential properties was also evaluated based on lowest adjacent grades provided in the 2009 LOMA list. Table 7-1 summarizes the modeled impacts to level of service to residential properties for Alternative 1, stormwater detention that provides a 20% reduction in peak flows for the 10-year rainfall event, and the two scenarios evaluated in Alternative 3, vegetation management and channel improvements.

**Table 7-1: Maximum Number of Residential Properties Impacted**

| | Stormwater Detention | Vegetation Management | Channel Improvements |
|---|---|---|---|
| **Removed from the 100-year Floodplain** | 0 | 1 | 4 |
| **Improved Level of Service** | 6 | 4 | 7 |

## 7.1 Near-Term Goals

With few options available in the Rock Creek watershed for new detention facilities, the recommended near-term solution is the management of the Rock Creek channel to maintain and maximize conveyance. The channel should be treated as an asset like other City-owned utilities. Steps that could be taken include the following:

- Acquire easements along the creek to shift ownership and maintenance responsibility from private property owner to the City.
- Control unwanted vegetation along the creek to the greatest extent practical. Clear brush and other low-lying growth to enhance capacity.
- The City should consider a public outreach program for the property owners along Rock Creek. The program could explain the need to maintain vegetation and encourage homeowners to remove fences, out buildings, and other private structures that may obstruct flow. Property owners also need to be informed of the consequence of disposing yard debris and other waste materials in the floodplain.
- The City could also develop routine maintenance practices to clear the existing culverts and bridges of sediment and debris. Efforts should be made to keep these structures at maximum capacity.

- Develop a capital improvements plan for channel modifications. The plan should develop projects to improve channel conveyance and promote bank stability.

## 7.2 Long-Term Goals

It is generally recognized that flooding along Rock Creek is one of the biggest challenges facing the City of Fairway. It is also recognized that there is not a single, cost effective solution. The underlying problem is that urbanization, which has contributed to the flooding problem, has occurred beyond the jurisdictional boundaries of Fairway. In many respects, the solutions that involve stormwater management are beyond the City's direct control. To affect a significant reduction of the flooding problem in Fairway, the cities of Mission and Roeland Park would need to construct stormwater management facilities and/or require developments to do so.

Each city within the Rock Creek Watershed has a responsibility to manage stormwater runoff. These efforts are done independently, and there is not a comprehensive approach to watershed management. Until such a plan is agreed upon by all cities, then Fairway, being at the downstream end of the watershed, will continue to bear the burden of flooding, without regulatory authority to control or alleviate the problem.

However, there may be some regulatory justification for a comprehensive watershed strategy. First, APWA 5600 (8), which is the stormwater design manual adopted by most communities in the Kansas City metropolitan area, allows communities to adopt specific management strategies based on the needs for the community. In coordination with the County and all communities in the Rock Creek Watershed, Specific Locally-Defined Strategies for stormwater management could be developed for the watershed. Paragraph 5601.5.A.4.b states the following:

***Special Locally-Defined Strategies:*** *The City/County may develop alternative strategies that are tailored to the unique circumstances of their watersheds. Such strategies may apply globally to the City/County or only to certain designated areas. The City/County will identify each alternative strategy with a unique descriptor and publish the requirements for each.*

*Such alternative strategies may involve increased or decreased allowable release rates, relaxed or more stringent controls for certain storm return intervals, reliance on infiltration or low-impact development practices for added volume control, planning and open space controls, and/or special requirements to participate in regional control facilities instead of development-scale facilities.*

*Stormwater management for site development may include structural facilities and/or nonstructural solutions. Where runoff controls are required, low-impact development practices or, off-site control of runoff in addition to or instead of the standard wet or dry bottom basins may be used.*

The special locally-defined strategy could include the following:

- Require all new developments and redevelopments to include stormwater detention. It would be important to include redevelopments that have not historically been required to provided stormwater detention facilities.
- Require that detention facilities provide a specified reduction in peak discharges. Most regulations require stormwater to be managed to a level of "no adverse effect." With this requirement, conditions would not worsen in Rock Creek, but neither would they improve. Because the Rock Creek Watershed was largely developed prior to current stormwater management requirements, management to the status quo may not be of long-term benefit. The goal of a stormwater management strategy should be to develop an urban drainage system that mimics predevelopment hydrology conditions.
- Development of a detailed and comprehensive hydrologic model for the watershed. The model would establish the base conditions for the watershed. When a new development is proposed, the model would be revised to account for the changes in land use and proposed stormwater infrastructure. Models could be regulatory similarly to how the HEC-RAS models are used to determine the impacts to floodplains.
- Establish a procedure to allow all cities to participate in the review and approval of development plans.
- Promote or require the use of low impact development techniques.

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# APPENDIX A HEC-RAS MODEL RESULTS FOR 10-YEAR EVENT

## Appendix A - HEC-RAS Results for 10-Year Event

| Reach | River Sta | Profile | Plan | Q Total (cfs) | Min Ch El (feet) | W.S. Elev (feet) | Crit W.S. (feet) | E.G. Elev (feet) | E.Q. Slope (ft/ft) | Vel Chnl (feet/sec) | Flow Area (sq ft) | Top Width (feet) | Froude # Chl | Delta WS (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RC130 | 1.653 | 10 | CorrectedEff | 3673 | 903.45 | 912.23 | | 913.45 | 0.00323 | 9.05 | 473.95 | 94.43 | 0.58 | |
| RC130 | 1.653 | 10 | Prop_nValues | 3673 | 903.45 | 912.37 | | 913.42 | 0.00279 | 8.52 | 487.54 | 99.14 | 0.54 | 0.14 |
| RC130 | 1.653 | 10 | Prop_30ftTrapCh | 3673 | 903.45 | 909.91 | 909.66 | 912 | 0.00921 | 11.62 | 324.47 | 75.98 | 0.92 | -2.32 |
| RC130 | 1.653 | 10 | PropDetBasin | 2741 | 903.45 | 911.34 | | 912.25 | 0.00283 | 7.79 | 394.24 | 84.19 | 0.53 | -0.89 |
| RC130 | 1.614 | 10 | CorrectedEff | 3871 | 900.94 | 910.22 | 910.22 | 912.25 | 0.006 | 12.03 | 420.14 | 145.19 | 0.77 | |
| RC130 | 1.614 | 10 | Prop_nValues | 3871 | 900.94 | 910.22 | 910.22 | 912.25 | 0.006 | 12.03 | 420.14 | 145.19 | 0.77 | 0.00 |
| RC130 | 1.614 | 10 | Prop_30ftTrapCh | 3871 | 900.94 | 908.79 | | 910.24 | 0.00497 | 9.66 | 406.68 | 78.54 | 0.69 | -1.43 |
| RC130 | 1.614 | 10 | PropDetBasin | 2801.5 | 900.94 | 908.49 | 908.49 | 910.81 | 0.0089 | 12.34 | 247.82 | 72.34 | 0.9 | -1.73 |
| RC130 | 1.551 | 10 | CorrectedEff | 3871 | 899.79 | 908.47 | 907.63 | 909.18 | 0.00241 | 8.17 | 881.03 | 309.69 | 0.5 | |
| RC130 | 1.551 | 10 | Prop_nValues | 3871 | 899.79 | 908.47 | 907.63 | 909.18 | 0.00241 | 8.17 | 881.03 | 309.69 | 0.5 | 0.00 |
| RC130 | 1.551 | 10 | Prop_30ftTrapCh | 3871 | 899.79 | 907.47 | 907.11 | 908.64 | 0.00417 | 9.49 | 621.98 | 260.43 | 0.65 | -1.00 |
| RC130 | 1.551 | 10 | PropDetBasin | 2801.5 | 899.79 | 907.29 | 906.73 | 908.19 | 0.00315 | 8.43 | 551.69 | 249.32 | 0.56 | -1.18 |
| RC130 | 1.495 | 10 | CorrectedEff | 3871 | 898 | 905.36 | 905.36 | 907.34 | 0.00759 | 11.51 | 388.53 | 144.4 | 0.83 | |
| RC130 | 1.495 | 10 | Prop_nValues | 3871 | 898 | 905.36 | 905.36 | 907.34 | 0.00759 | 11.51 | 388.53 | 144.4 | 0.83 | 0.00 |
| RC130 | 1.495 | 10 | Prop_30ftTrapCh | 3871 | 898 | 905.29 | 903.92 | 906.6 | 0.00498 | 9.29 | 457.16 | 140.12 | 0.68 | -0.07 |
| RC130 | 1.495 | 10 | PropDetBasin | 2801.5 | 898 | 904.44 | 903.7 | 906.04 | 0.00744 | 10.18 | 282.56 | 87.01 | 0.8 | -0.92 |
| RC130 | 1.459 | 10 | CorrectedEff | 3871 | 895.97 | 906.14 | 901.95 | 906.47 | 0.00116 | 5.32 | 1158.76 | 372.52 | 0.3 | |
| RC130 | 1.459 | 10 | Prop_nValues | 3871 | 895.97 | 905.96 | 901.95 | 906.33 | 0.00131 | 5.58 | 1093.27 | 365.92 | 0.32 | -0.18 |
| RC130 | 1.459 | 10 | Prop_30ftTrapCh | 3871 | 895.97 | 905.88 | 901.95 | 906.27 | 0.00138 | 5.69 | 1064.81 | 362.66 | 0.33 | -0.26 |
| RC130 | 1.459 | 10 | PropDetBasin | 2801.5 | 895.97 | 905.3 | 900.81 | 905.6 | 0.00107 | 4.8 | 862.41 | 336.1 | 0.29 | -0.84 |
| RC130 | 1.454 | | | Culvert | | | | | | | | | | |
| RC130 | 1.448 | 10 | CorrectedEff | 3871 | 894.58 | 904.71 | 900.78 | 905.14 | 0.00129 | 5.75 | 923.02 | 272.57 | 0.34 | |
| RC130 | 1.448 | 10 | Prop_nValues | 3871 | 894.58 | 904.03 | 900.78 | 904.64 | 0.00192 | 6.65 | 729.22 | 192.67 | 0.41 | -0.68 |
| RC130 | 1.448 | 10 | Prop_30ftTrapCh | 3871 | 894.58 | 903.74 | 900.78 | 904.43 | 0.00225 | 7.02 | 681.31 | 185.57 | 0.44 | -0.97 |
| RC130 | 1.448 | 10 | PropDetBasin | 2801.5 | 894.58 | 903.41 | 899.75 | 903.96 | 0.00171 | 5.94 | 471.37 | 177.74 | 0.38 | -1.30 |
| RC130 | 1.400 | 10 | CorrectedEff | 3871 | 894.02 | 903.94 | | 904.64 | 0.00261 | 8.29 | 855.96 | 285.02 | 0.5 | |
| RC130 | 1.400 | 10 | Prop_nValues | 3871 | 894.02 | 902.9 | | 903.89 | 0.0041 | 9.52 | 602.5 | 197.19 | 0.61 | -1.04 |
| RC130 | 1.400 | 10 | Prop_30ftTrapCh | 3871 | 894.02 | 901.45 | 901.29 | 903.24 | 0.00637 | 11.12 | 428.07 | 141.44 | 0.78 | -2.49 |
| RC130 | 1.400 | 10 | PropDetBasin | 2801.5 | 894.02 | 902.68 | | 903.38 | 0.00288 | 7.83 | 561.07 | 186.51 | 0.51 | -1.26 |
| RC130 | 1.335 | 10 | CorrectedEff | 4422 | 892.02 | 902.49 | 901.37 | 903.58 | 0.00332 | 10.17 | 919.37 | 322.78 | 0.59 | |
| RC130 | 1.335 | 10 | Prop_nValues | 4422 | 892.02 | 902.19 | 900.6 | 902.83 | 0.00217 | 8.04 | 848.9 | 316.17 | 0.47 | -0.30 |
| RC130 | 1.335 | 10 | Prop_30ftTrapCh | 4422 | 892.02 | 900.78 | 898.35 | 901.71 | 0.00242 | 8.01 | 713.32 | 214.22 | 0.5 | -1.71 |
| RC130 | 1.335 | 10 | PropDetBasin | 3089.9 | 892.02 | 901.13 | 900.07 | 902.22 | 0.00361 | 9.55 | 614.1 | 252.3 | 0.59 | -1.36 |
| RC130 | 1.269 | 10 | CorrectedEff | 4422 | 890.94 | 899.73 | 899.73 | 901.88 | 0.00682 | 12.8 | 489.37 | 124.53 | 0.83 | |
| RC130 | 1.269 | 10 | Prop_nValues | 4422 | 890.94 | 899.6 | 899.6 | 901.5 | 0.00638 | 12.24 | 473.73 | 123.17 | 0.8 | -0.13 |
| RC130 | 1.269 | 10 | Prop_30ftTrapCh | 4422 | 890.94 | 898.31 | 898.05 | 900.24 | 0.00759 | 11.32 | 426.04 | 109.06 | 0.85 | -1.42 |
| RC130 | 1.269 | 10 | PropDetBasin | 3089.9 | 890.94 | 898.53 | 898.53 | 900.44 | 0.00711 | 11.63 | 348.13 | 110.62 | 0.82 | -1.20 |
| RC130 | 1.250 | 10 | CorrectedEff | 4422 | 890 | 898.72 | 898.72 | 900.63 | 0.00591 | 12.05 | 541.62 | 162.6 | 0.79 | |
| RC130 | 1.250 | 10 | Prop_nValues | 4422 | 890 | 898.62 | 898.62 | 900.28 | 0.00546 | 11.47 | 524.78 | 160.6 | 0.75 | -0.10 |
| RC130 | 1.250 | 10 | Prop_30ftTrapCh | 4422 | 890 | 897.57 | 897.07 | 899.43 | 0.00652 | 11.08 | 445.91 | 132.78 | 0.8 | -1.15 |
| RC130 | 1.250 | 10 | PropDetBasin | 3089.9 | 890 | 897.41 | 897.41 | 899.29 | 0.0069 | 11.41 | 347.83 | 126.92 | 0.82 | -1.31 |
| RC130 | 1.210 | 10 | CorrectedEff | 4422 | 888.6 | 898.28 | 896.69 | 899.1 | 0.00287 | 8.89 | 786.13 | 227.46 | 0.54 | |
| RC130 | 1.210 | 10 | Prop_nValues | 4422 | 888.6 | 897.61 | 896.44 | 898.46 | 0.00327 | 8.98 | 687.24 | 220.8 | 0.57 | -0.67 |
| RC130 | 1.210 | 10 | Prop_30ftTrapCh | 4422 | 888.6 | 897.11 | 896.18 | 898.24 | 0.00397 | 9.7 | 659.12 | 205.86 | 0.63 | -1.17 |
| RC130 | 1.210 | 10 | PropDetBasin | 3089.9 | 888.6 | 897.3 | 895.85 | 897.92 | 0.00247 | 7.59 | 641.74 | 214.07 | 0.49 | -0.98 |
| RC130 | 1.164 | 10 | CorrectedEff | 4515 | 888.07 | 897.8 | | 898.39 | 0.00245 | 7.12 | 1148.83 | 283.9 | 0.49 | |
| RC130 | 1.164 | 10 | Prop_nValues | 4515 | 888.07 | 897.4 | | 897.76 | 0.00173 | 5.73 | 1038.8 | 263.72 | 0.41 | -0.40 |
| RC130 | 1.164 | 10 | Prop_30ftTrapCh | 4515 | 888.07 | 896.21 | | 897.27 | 0.00386 | 8.83 | 826.12 | 256.86 | 0.62 | -1.59 |
| RC130 | 1.164 | 10 | PropDetBasin | 3160.1 | 888.07 | 896.82 | | 897.3 | 0.00229 | 6.29 | 886.51 | 258.45 | 0.47 | -0.98 |

## Appendix A - HEC-RAS Results for 10-Year Event

| Reach | River Sta | Profile | Plan | Q Total (cfs) | Min Ch El (feet) | W.S. Elev (feet) | Crit W.S. (feet) | E.G. Elev (feet) | E.Q. Slope (ft/ft) | Vel Chnl (feet/sec) | Flow Area (sq ft) | Top Width (feet) | Froude # Chl | Delta WS (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RC130 | 1.137 | 10 | CorrectedEff | 4515 | 887 | 896.26 | 896.26 | 897.78 | 0.00725 | 11.69 | 701.26 | 274.43 | 0.82 | |
| RC130 | 1.137 | 10 | Prop_nValues | 4515 | 887 | 896.1 | 895.95 | 897.3 | 0.0062 | 10.66 | 657.16 | 258.67 | 0.76 | -0.16 |
| RC130 | 1.137 | 10 | Prop_30ftTrapCh | 4515 | 887 | 895.44 | 894.63 | 896.69 | 0.00425 | 9.48 | 647.29 | 208.12 | 0.65 | -0.82 |
| RC130 | 1.137 | 10 | PropDetBasin | 3160.1 | 887 | 895.4 | 895.4 | 896.73 | 0.00673 | 10.46 | 496.71 | 206.34 | 0.78 | -0.86 |
| RC130 | 1.073 | 10 | CorrectedEff | 4515 | 885.95 | 894.46 | 893.39 | 895.39 | 0.00496 | 8.74 | 657.51 | 203.7 | 0.56 | |
| RC130 | 1.073 | 10 | Prop_nValues | 4515 | 885.95 | 893.97 | 893.39 | 895.17 | 0.00674 | 9.75 | 574.47 | 171.45 | 0.65 | -0.49 |
| RC130 | 1.073 | 10 | Prop_30ftTrapCh | 4515 | 885.95 | 893.7 | 893.18 | 895.1 | 0.0053 | 10.28 | 549.6 | 155.82 | 0.69 | -0.76 |
| RC130 | 1.073 | 10 | PropDetBasin | 3160.1 | 885.95 | 893.6 | 892.32 | 894.32 | 0.00429 | 7.5 | 515.38 | 152.92 | 0.51 | -0.86 |
| RC130 | 1.015 | 10 | CorrectedEff | 4515 | 883.82 | 893.2 | 892.09 | 893.89 | 0.00523 | 8.11 | 943.29 | 317.73 | 0.52 | |
| RC130 | 1.015 | 10 | Prop_nValues | 4515 | 883.82 | 892.64 | 891.96 | 893.41 | 0.00512 | 8.43 | 771.34 | 282.87 | 0.56 | -0.56 |
| RC130 | 1.015 | 10 | Prop_30ftTrapCh | 4515 | 883.82 | 892.03 | 891.6 | 893.33 | 0.0067 | 9.91 | 678.63 | 235.4 | 0.67 | -1.17 |
| RC130 | 1.015 | 10 | PropDetBasin | 3160.1 | 883.82 | 892.09 | 891.39 | 892.86 | 0.00617 | 7.94 | 629.18 | 239.42 | 0.55 | -1.11 |
| RC130 | 0.983 | 10 | CorrectedEff | 4515 | 882.91 | 892.27 | 891.31 | 893.17 | 0.00464 | 8.91 | 871.07 | 260.04 | 0.57 | |
| RC130 | 0.983 | 10 | Prop_nValues | 4515 | 882.91 | 891.22 | 891.22 | 892.59 | 0.00571 | 10.67 | 617.3 | 223.51 | 0.73 | -1.05 |
| RC130 | 0.983 | 10 | Prop_30ftTrapCh | 4515 | 882.91 | 890.78 | 890.01 | 892.37 | 0.00529 | 10.59 | 598.26 | 201.36 | 0.73 | -1.49 |
| RC130 | 0.983 | 10 | PropDetBasin | 3160.1 | 882.91 | 890.82 | 889.93 | 891.89 | 0.00626 | 9.01 | 531.53 | 204.17 | 0.64 | -1.45 |
| RC130 | 0.937 | 10 | CorrectedEff | 4515 | 880.75 | 892.12 | 889.16 | 892.45 | 0.00143 | 5.64 | 1244.85 | 234.96 | 0.32 | |
| RC130 | 0.937 | 10 | Prop_nValues | 4515 | 880.75 | 891.2 | 889.32 | 891.57 | 0.00158 | 5.84 | 1030.59 | 230.16 | 0.34 | -0.92 |
| RC130 | 0.937 | 10 | Prop_30ftTrapCh | 4515 | 880.75 | 890.57 | 888.66 | 891.25 | 0.00249 | 7.44 | 916.95 | 226.99 | 0.45 | -1.55 |
| RC130 | 0.937 | 10 | PropDetBasin | 3160.1 | 880.75 | 890.72 | 887.45 | 891.04 | 0.00142 | 5.28 | 921.49 | 227.75 | 0.32 | -1.40 |
| RC130 | 0.935 | 10 | CorrectedEff | 4515 | 880.71 | 892.08 | | 892.44 | 0.00154 | 5.97 | 1231.59 | 240.47 | 0.34 | |
| RC130 | 0.935 | 10 | Prop_nValues | 4515 | 880.71 | 891.16 | | 891.56 | 0.00169 | 6.16 | 1011.69 | 235.34 | 0.37 | -0.92 |
| RC130 | 0.935 | 10 | Prop_30ftTrapCh | 4515 | 880.71 | 890.42 | | 891.21 | 0.00282 | 8.08 | 872.34 | 231.24 | 0.49 | -1.66 |
| RC130 | 0.935 | 10 | PropDetBasin | 3160.1 | 880.71 | 890.67 | | 891.03 | 0.00156 | 5.71 | 896.82 | 232.62 | 0.35 | -1.41 |
| RC130 | 0.888 | 10 | CorrectedEff | 4515 | 880.37 | 891.39 | 889.15 | 891.99 | 0.00237 | 7.3 | 1004.77 | 196.8 | 0.42 | |
| RC130 | 0.888 | 10 | Prop_nValues | 4515 | 880.37 | 890.42 | 889.03 | 891.07 | 0.00253 | 7.6 | 816.19 | 188.66 | 0.46 | -0.97 |
| RC130 | 0.888 | 10 | Prop_30ftTrapCh | 4515 | 880.37 | 889.41 | 887.76 | 890.44 | 0.00352 | 8.7 | 724.91 | 180.59 | 0.56 | -1.98 |
| RC130 | 0.888 | 10 | PropDetBasin | 3160.1 | 880.37 | 890.02 | 887.35 | 890.56 | 0.00244 | 6.67 | 742.77 | 185.52 | 0.41 | -1.37 |
| RC130 | 0.846 | 10 | CorrectedEff | 4515 | 879.06 | 891.02 | | 891.51 | 0.00192 | 7.42 | 1204.8 | 240.18 | 0.4 | |
| RC130 | 0.846 | 10 | Prop_nValues | 4515 | 879.06 | 890.12 | | 890.6 | 0.00161 | 7.28 | 991.57 | 233.74 | 0.41 | -0.90 |
| RC130 | 0.846 | 10 | Prop_30ftTrapCh | 4515 | 879.06 | 889.13 | | 889.81 | 0.00173 | 7.06 | 919.2 | 224.9 | 0.43 | -1.89 |
| RC130 | 0.846 | 10 | PropDetBasin | 3160.1 | 879.06 | 889.56 | | 890.07 | 0.00214 | 7.11 | 861.13 | 229.45 | 0.41 | -1.46 |
| RC130 | 0.804 | 10 | CorrectedEff | 4515 | 878.86 | 890.17 | | 890.96 | 0.0037 | 7.76 | 773.04 | 149.03 | 0.44 | |
| RC130 | 0.804 | 10 | Prop_nValues | 4515 | 878.86 | 888.98 | | 890.09 | 0.00326 | 9.11 | 605.24 | 131.66 | 0.55 | -1.19 |
| RC130 | 0.804 | 10 | Prop_30ftTrapCh | 4515 | 878.86 | 888.31 | | 889.31 | 0.00278 | 8.13 | 618.34 | 125.4 | 0.54 | -1.86 |
| RC130 | 0.804 | 10 | PropDetBasin | 3160.1 | 878.86 | 888.88 | | 889.51 | 0.00336 | 6.74 | 592.99 | 130.77 | 0.41 | -1.29 |
| RC130 | 0.742 | 10 | CorrectedEff | 4515 | 878.4 | 888.18 | | 889.32 | 0.00704 | 9.82 | 666.36 | 143.47 | 0.58 | |
| RC130 | 0.742 | 10 | Prop_nValues | 4515 | 878.4 | 887.62 | | 888.9 | 0.00414 | 10.35 | 587.48 | 136.6 | 0.63 | -0.56 |
| RC130 | 0.742 | 10 | Prop_30ftTrapCh | 4515 | 878.4 | 887.28 | | 888.25 | 0.00381 | 8.37 | 696.39 | 154.78 | 0.56 | -0.90 |
| RC130 | 0.742 | 10 | PropDetBasin | 3160.1 | 878.4 | 886.93 | | 887.94 | 0.00712 | 8.92 | 495.28 | 130.43 | 0.57 | -1.25 |
| RC130 | 0.7055 | 10 | CorrectedEff | 4515 | 875 | 887.49 | | 888.31 | 0.00389 | 7.45 | 703.85 | 146.47 | 0.46 | |
| RC130 | 0.7055 | 10 | Prop_nValues | 4515 | 875 | 887.42 | | 888.22 | 0.00228 | 7.39 | 693.62 | 144.63 | 0.46 | -0.07 |
| RC130 | 0.7055 | 10 | Prop_30ftTrapCh | 4515 | 875 | 887.32 | | 887.77 | 0.00098 | 5.45 | 927.01 | 165.41 | 0.33 | -0.17 |
| RC130 | 0.7055 | 10 | PropDetBasin | 3160.1 | 875 | 886.41 | | 886.99 | 0.00311 | 6.19 | 559.71 | 119.73 | 0.4 | -1.08 |
| RC130 | 0.679 | 10 | CorrectedEff | 4515 | 874.8 | 887.7 | | 887.96 | 0.00066 | 4.06 | 1169.53 | 206.49 | 0.24 | |
| RC130 | 0.679 | 10 | Prop_nValues | 4515 | 874.8 | 887.64 | | 887.9 | 0.00067 | 4.1 | 1156.94 | 203.41 | 0.24 | -0.06 |
| RC130 | 0.679 | 10 | Prop_30ftTrapCh | 4515 | 874.8 | 887.32 | | 887.6 | 0.00077 | 4.27 | 1093.53 | 187.11 | 0.26 | -0.38 |
| RC130 | 0.679 | 10 | PropDetBasin | 3160.1 | 874.8 | 886.55 | | 886.72 | 0.00052 | 3.3 | 964.46 | 148.51 | 0.21 | -1.15 |
| RC130 | 0.670 | 10 | CorrectedEff | 4515 | 874.68 | 887.71 | 881.06 | 887.91 | 0.00041 | 3.59 | 1257.47 | 124.79 | 0.2 | |
| RC130 | 0.670 | 10 | Prop_nValues | 4515 | 874.68 | 887.64 | 881.06 | 887.85 | 0.00041 | 3.61 | 1249.86 | 124.79 | 0.2 | -0.07 |
| RC130 | 0.670 | 10 | Prop_30ftTrapCh | 4515 | 874.68 | 887.32 | 881.06 | 887.54 | 0.00046 | 3.73 | 1209.57 | 124.79 | 0.21 | -0.39 |
| RC130 | 0.670 | 10 | PropDetBasin | 3160.1 | 874.68 | 886.55 | 880.35 | 886.68 | 0.00029 | 2.84 | 1113.47 | 124.79 | 0.17 | -1.16 |

## Appendix A - HEC-RAS Results for 10-Year Event

| Reach | River Sta | Profile | Plan | Q Total (cfs) | Min Ch El (feet) | W.S. Elev (feet) | Crit W.S. (feet) | E.G. Elev (feet) | E.Q. Slope (ft/ft) | Vel Chnl (feet/sec) | Flow Area (sq ft) | Top Width (feet) | Froude # Chl | Delta WS (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RC130 | 0.667 | | | Bridge | | | | | | | | | | |
| RC130 | 0.660 | 10 | CorrectedEff | 4515 | 874.59 | 887.26 | 880.44 | 887.41 | 0.00029 | 3.05 | 1480.3 | 150 | 0.17 | |
| RC130 | 0.660 | 10 | Prop_nValues | 4515 | 874.59 | 887.2 | 880.44 | 887.35 | 0.0003 | 3.07 | 1471.06 | 150 | 0.17 | -0.06 |
| RC130 | 0.660 | 10 | Prop_30ftTrapCh | 4515 | 874.59 | 886.88 | 880.44 | 887.03 | 0.00033 | 3.17 | 1422.07 | 150 | 0.18 | -0.38 |
| RC130 | 0.660 | 10 | PropDetBasin | 3160.1 | 874.59 | 886.12 | 879.8 | 886.21 | 0.00021 | 2.42 | 1308.19 | 150 | 0.14 | -1.14 |
| RC130 | 0.653 | 10 | CorrectedEff | 4211 | 874.5 | 887.19 | 881.07 | 887.38 | 0.0004 | 3.49 | 1231.96 | 220.61 | 0.21 | |
| RC130 | 0.653 | 10 | Prop_nValues | 4211 | 874.5 | 887.13 | 881.07 | 887.32 | 0.00041 | 3.52 | 1218.38 | 206.98 | 0.21 | -0.06 |
| RC130 | 0.653 | 10 | Prop_30ftTrapCh | 4211 | 874.5 | 886.79 | 881.07 | 887 | 0.00046 | 3.67 | 1157.05 | 170.52 | 0.23 | -0.40 |
| RC130 | 0.653 | 10 | PropDetBasin | 3103.2 | 874.5 | 886.05 | 880.42 | 886.18 | 0.00034 | 2.98 | 1040.98 | 139.85 | 0.19 | -1.14 |
| RC130 | 0.608 | 10 | CorrectedEff | 4590 | 876.04 | 885.26 | 884.82 | 886.75 | 0.00451 | 10.64 | 560.86 | 319.47 | 0.69 | |
| RC130 | 0.608 | 10 | Prop_nValues | 4590 | 876.04 | 885.2 | 884.8 | 886.69 | 0.00452 | 10.6 | 551.98 | 307.28 | 0.69 | -0.06 |
| RC130 | 0.608 | 10 | Prop_30ftTrapCh | 4590 | 876.04 | 885.44 | 883.26 | 886.51 | 0.00267 | 8.72 | 659.42 | 324.69 | 0.54 | 0.18 |
| RC130 | 0.608 | 10 | PropDetBasin | 3274 | 876.04 | 884.72 | 883.27 | 885.73 | 0.00323 | 8.57 | 472.19 | 291.37 | 0.58 | -0.54 |
| RC130 | 0.571 | 10 | CorrectedEff | 4590 | 874.43 | 884.5 | 884.5 | 885.83 | 0.00472 | 10.22 | 542.77 | 225.82 | 0.64 | |
| RC130 | 0.571 | 10 | Prop_nValues | 4590 | 874.43 | 884.52 | 884.52 | 885.82 | 0.00405 | 10.35 | 545.39 | 225.99 | 0.65 | 0.02 |
| RC130 | 0.571 | 10 | Prop_30ftTrapCh | 4590 | 874.43 | 884.5 | 884.5 | 885.83 | 0.00472 | 10.22 | 542.77 | 225.82 | 0.64 | 0.00 |
| RC130 | 0.571 | 10 | PropDetBasin | 3274 | 874.43 | 883.96 | 883.96 | 885.02 | 0.00417 | 9.16 | 444.14 | 219.07 | 0.59 | -0.54 |
| RC130 | 0.547 | 10 | CorrectedEff | 4590 | 871.04 | 884.19 | | 884.79 | 0.00185 | 6.99 | 896.77 | 189.55 | 0.37 | |
| RC130 | 0.547 | 10 | Prop_nValues | 4590 | 871.04 | 884.19 | | 884.79 | 0.00185 | 6.99 | 896.77 | 189.55 | 0.37 | 0.00 |
| RC130 | 0.547 | 10 | Prop_30ftTrapCh | 4590 | 871.04 | 884.19 | | 884.79 | 0.00185 | 6.99 | 896.77 | 189.55 | 0.37 | 0.00 |
| RC130 | 0.547 | 10 | PropDetBasin | 3274 | 871.04 | 883.27 | | 883.75 | 0.00156 | 6.06 | 726.36 | 181.59 | 0.33 | -0.92 |
| RC130 | 0.538 | 10 | CorrectedEff | 4590 | 870.61 | 883.76 | | 884.61 | 0.00236 | 8.91 | 740.11 | 189.45 | 0.46 | |
| RC130 | 0.538 | 10 | Prop_nValues | 4590 | 870.61 | 883.76 | | 884.61 | 0.00236 | 8.91 | 740.11 | 189.45 | 0.46 | 0.00 |
| RC130 | 0.538 | 10 | Prop_30ftTrapCh | 4590 | 870.61 | 883.76 | | 884.61 | 0.00236 | 8.91 | 740.11 | 189.45 | 0.46 | 0.00 |
| RC130 | 0.538 | 10 | PropDetBasin | 3274 | 870.61 | 882.84 | | 883.58 | 0.0021 | 7.97 | 581.23 | 160.59 | 0.43 | -0.92 |
| RC130 | 0.482 | 10 | CorrectedEff | 4590 | 871.2 | 883.65 | 880.55 | 883.94 | 0.00083 | 4.14 | 1104.41 | 259.26 | 0.21 | |
| RC130 | 0.482 | 10 | Prop_nValues | 4590 | 871.2 | 883.65 | 880.55 | 883.94 | 0.00083 | 4.14 | 1104.41 | 259.26 | 0.21 | 0.00 |
| RC130 | 0.482 | 10 | Prop_30ftTrapCh | 4590 | 871.2 | 883.65 | 880.55 | 883.94 | 0.00083 | 4.14 | 1104.41 | 259.26 | 0.21 | 0.00 |
| RC130 | 0.482 | 10 | PropDetBasin | 3274 | 871.2 | 882.74 | 877.89 | 882.98 | 0.00075 | 3.73 | 890.24 | 211.86 | 0.2 | -0.91 |
| RC130 | 0.463 | | | Bridge | | | | | | | | | | |
| RC130 | 0.460 | 10 | CorrectedEff | 4590 | 870.63 | 882.68 | | 883.34 | 0.00171 | 7.38 | 778.69 | 185.74 | 0.4 | |
| RC130 | 0.460 | 10 | Prop_nValues | 4590 | 870.63 | 882.68 | | 883.34 | 0.00171 | 7.38 | 778.69 | 185.74 | 0.4 | 0.00 |
| RC130 | 0.460 | 10 | Prop_30ftTrapCh | 4590 | 870.63 | 882.68 | | 883.34 | 0.00171 | 7.38 | 778.69 | 185.74 | 0.4 | 0.00 |
| RC130 | 0.460 | 10 | PropDetBasin | 3274 | 870.63 | 881.9 | 878.08 | 882.4 | 0.00137 | 6.28 | 638.31 | 173.8 | 0.36 | -0.78 |
| RC130 | 0.385 | 10 | CorrectedEff | 4590 | 870.6 | 880.65 | 880.65 | 882.08 | 0.00455 | 10.34 | 638.92 | 292.99 | 0.65 | |
| RC130 | 0.385 | 10 | Prop_nValues | 4590 | 870.6 | 880.65 | 880.65 | 882.08 | 0.00455 | 10.34 | 638.92 | 292.99 | 0.65 | 0.00 |
| RC130 | 0.385 | 10 | Prop_30ftTrapCh | 4590 | 870.6 | 880.65 | 880.65 | 882.08 | 0.00455 | 10.34 | 638.92 | 292.99 | 0.65 | 0.00 |
| RC130 | 0.385 | 10 | PropDetBasin | 3274 | 870.6 | 878.11 | 878.11 | 880.63 | 0.01064 | 12.76 | 261.39 | 56.51 | 0.96 | -2.54 |
| RC130 | 0.308 | 10 | CorrectedEff | 4590 | 867.96 | 878.82 | | 879.34 | 0.00145 | 6.74 | 970.02 | 291.52 | 0.38 | |
| RC130 | 0.308 | 10 | Prop_nValues | 4590 | 867.96 | 878.82 | | 879.34 | 0.00145 | 6.74 | 970.02 | 291.52 | 0.38 | 0.00 |
| RC130 | 0.308 | 10 | Prop_30ftTrapCh | 4590 | 867.96 | 878.82 | | 879.34 | 0.00145 | 6.74 | 970.02 | 291.52 | 0.38 | 0.00 |
| RC130 | 0.308 | 10 | PropDetBasin | 3274 | 867.96 | 878.14 | | 878.52 | 0.0011 | 5.59 | 791.87 | 235.39 | 0.33 | -0.68 |
| RC130 | 0.287 | 10 | CorrectedEff | 4590 | 867.87 | 878.7 | 876.9 | 879.16 | 0.00141 | 6.36 | 1001.7 | 307.08 | 0.37 | |
| RC130 | 0.287 | 10 | Prop_nValues | 4590 | 867.87 | 878.7 | 876.9 | 879.16 | 0.00141 | 6.36 | 1001.7 | 307.08 | 0.37 | 0.00 |
| RC130 | 0.287 | 10 | Prop_30ftTrapCh | 4590 | 867.87 | 878.7 | 876.9 | 879.16 | 0.00141 | 6.36 | 1001.7 | 307.08 | 0.37 | 0.00 |
| RC130 | 0.287 | 10 | PropDetBasin | 3274 | 867.87 | 878.03 | 874.46 | 878.39 | 0.00116 | 5.49 | 804.21 | 265.21 | 0.33 | -0.67 |

## Appendix A - HEC-RAS Results for 10-Year Event

| Reach | River Sta | Profile | Plan | Q Total (cfs) | Min Ch El (feet) | W.S. Elev (feet) | Crit W.S. (feet) | E.G. Elev (feet) | E.Q. Slope (ft/ft) | Vel Chnl (feet/sec) | Flow Area (sq ft) | Top Width (feet) | Froude # Chl | Delta WS (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RC130 | 0.286 | | | Bridge | | | | | | | | | | |
| RC130 | 0.285 | 10 | CorrectedEff | 4590 | 867.87 | 878.52 | | 879.04 | 0.00146 | 6.85 | 987.3 | 314.19 | 0.39 | |
| RC130 | 0.285 | 10 | Prop_nValues | 4590 | 867.87 | 878.52 | | 879.04 | 0.00146 | 6.85 | 987.3 | 314.19 | 0.39 | 0.00 |
| RC130 | 0.285 | 10 | Prop_30ftTrapCh | 4590 | 867.87 | 878.52 | | 879.04 | 0.00146 | 6.85 | 987.3 | 314.19 | 0.39 | 0.00 |
| RC130 | 0.285 | 10 | PropDetBasin | 3274 | 867.87 | 877.83 | | 878.24 | 0.00118 | 5.86 | 786.99 | 262.71 | 0.34 | -0.69 |
| RC130 | 0.256 | 10 | CorrectedEff | 4590 | 867.87 | 877.56 | 877.56 | 878.61 | 0.00508 | 10.1 | 669.78 | 257.93 | 0.59 | |
| RC130 | 0.256 | 10 | Prop_nValues | 4590 | 867.87 | 877.56 | 877.56 | 878.61 | 0.00508 | 10.1 | 669.78 | 257.93 | 0.59 | 0.00 |
| RC130 | 0.256 | 10 | Prop_30ftTrapCh | 4590 | 867.87 | 877.56 | 877.56 | 878.61 | 0.00508 | 10.1 | 669.78 | 257.93 | 0.59 | 0.00 |
| RC130 | 0.256 | 10 | PropDetBasin | 3274 | 867.87 | 875.81 | 875.81 | 877.7 | 0.00949 | 12 | 338.44 | 106.24 | 0.77 | -1.75 |
| RC130 | 0.220 | 10 | CorrectedEff | 4684 | 865.93 | 875.14 | 874.35 | 876.34 | 0.00362 | 9.95 | 619.58 | 200.54 | 0.6 | |
| RC130 | 0.220 | 10 | Prop_nValues | 4684 | 865.93 | 875.14 | 874.35 | 876.34 | 0.00362 | 9.95 | 619.58 | 200.54 | 0.6 | 0.00 |
| RC130 | 0.220 | 10 | Prop_30ftTrapCh | 4684 | 865.93 | 875.14 | 874.35 | 876.34 | 0.00362 | 9.95 | 619.58 | 200.54 | 0.6 | 0.00 |
| RC130 | 0.220 | 10 | PropDetBasin | 3327.9 | 865.93 | 873.69 | 873.38 | 875.05 | 0.00478 | 10.1 | 396.25 | 115.74 | 0.67 | -1.45 |

# APPENDIX B HEC-RAS MODEL RESULTS FOR 100-YEAR EVENT

## Appendix B - HEC-RAS Results for 100-Year Event

| Reach | River Sta | Profile | Plan | Q Total (cfs) | Min Ch El (feet) | W.S. Elev (feet) | Crit W.S. (feet) | E.G. Elev (feet) | E.Q. Slope (ft/ft) | Vel Chnl (feet/sec) | Flow Area (sq ft) | Top Width (feet) | Froude # Chl | Delta WS (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RC130 | 1.653 | 100 | CorrectedEff | 5894 | 903.45 | 913.15 | 912.21 | 915.54 | 0.00553 | 12.78 | 577.68 | 130.09 | 0.77 | |
| RC130 | 1.653 | 100 | Prop_nValues | 5894 | 903.45 | 913.46 | 912.21 | 915.31 | 0.00428 | 11.52 | 619.78 | 140.24 | 0.68 | 0.31 |
| RC130 | 1.653 | 100 | Prop_30ftTrapCh | 5894 | 903.45 | 912.18 | 911.6 | 914.47 | 0.00702 | 12.3 | 523.17 | 99.45 | 0.84 | -0.97 |
| RC130 | 1.653 | 100 | PropDetBasin | 6883.7 | 903.45 | 913.52 | 913.23 | 916.42 | 0.0064 | 14.14 | 628.3 | 142.32 | 0.84 | 0.37 |
| | | | | | | | | | | | | | | |
| RC130 | 1.614 | 100 | CorrectedEff | 6237 | 900.94 | 912.14 | 912.14 | 914.21 | 0.00523 | 13.06 | 761.78 | 208.54 | 0.75 | |
| RC130 | 1.614 | 100 | Prop_nValues | 6237 | 900.94 | 912.14 | 912.14 | 914.21 | 0.00523 | 13.06 | 761.78 | 208.54 | 0.75 | 0.00 |
| RC130 | 1.614 | 100 | Prop_30ftTrapCh | 6237 | 900.94 | 909.4 | 909.4 | 912.47 | 0.0093 | 14.09 | 458.45 | 90.99 | 0.97 | -2.74 |
| RC130 | 1.614 | 100 | PropDetBasin | 7161.2 | 900.94 | 912.55 | 912.55 | 914.8 | 0.00554 | 13.83 | 849.44 | 217.74 | 0.77 | 0.41 |
| | | | | | | | | | | | | | | |
| RC130 | 1.551 | 100 | CorrectedEff | 6237 | 899.79 | 909.57 | | 910.49 | 0.00298 | 9.9 | 1265.58 | 387.76 | 0.57 | |
| RC130 | 1.551 | 100 | Prop_nValues | 6237 | 899.79 | 909.57 | | 910.49 | 0.00298 | 9.9 | 1265.58 | 387.76 | 0.57 | 0.00 |
| RC130 | 1.551 | 100 | Prop_30ftTrapCh | 6237 | 899.79 | 909.23 | 908.43 | 910.17 | 0.00301 | 9.42 | 1161.67 | 362.29 | 0.57 | -0.34 |
| RC130 | 1.551 | 100 | PropDetBasin | 7161.2 | 899.79 | 909.99 | | 910.9 | 0.00295 | 10.14 | 1430.85 | 397.61 | 0.57 | 0.42 |
| | | | | | | | | | | | | | | |
| RC130 | 1.495 | 100 | CorrectedEff | 6237 | 898 | 907.37 | 907.37 | 908.91 | 0.00482 | 11.15 | 891.15 | 326.36 | 0.7 | |
| RC130 | 1.495 | 100 | Prop_nValues | 6237 | 898 | 907.37 | 907.37 | 908.91 | 0.00482 | 11.15 | 891.15 | 326.36 | 0.7 | 0.00 |
| RC130 | 1.495 | 100 | Prop_30ftTrapCh | 6237 | 898 | 906.62 | 906.62 | 908.4 | 0.0055 | 11.22 | 736.97 | 286.84 | 0.74 | -0.75 |
| RC130 | 1.495 | 100 | PropDetBasin | 7161.2 | 898 | 907.73 | 907.73 | 909.33 | 0.00494 | 11.63 | 1010.43 | 336.77 | 0.71 | 0.36 |
| | | | | | | | | | | | | | | |
| RC130 | 1.459 | 100 | CorrectedEff | 6237 | 895.97 | 907.32 | 904.73 | 907.74 | 0.00142 | 6.36 | 1615.59 | 395.92 | 0.34 | |
| RC130 | 1.459 | 100 | Prop_nValues | 6237 | 895.97 | 907.04 | 904.73 | 907.53 | 0.00168 | 6.79 | 1506.58 | 389.93 | 0.37 | -0.28 |
| RC130 | 1.459 | 100 | Prop_30ftTrapCh | 6237 | 895.97 | 907.03 | 904.73 | 907.52 | 0.00169 | 6.81 | 1503.15 | 389.82 | 0.37 | -0.29 |
| RC130 | 1.459 | 100 | PropDetBasin | 7161.2 | 895.97 | 907.58 | 905.7 | 908.06 | 0.00161 | 6.89 | 1721.07 | 405.07 | 0.36 | 0.26 |
| | | | | | | | | | | | | | | |
| RC130 | 1.454 | | | Culvert | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| RC130 | 1.448 | 100 | CorrectedEff | 6237 | 894.58 | 906.54 | 902.64 | 906.97 | 0.00118 | 6.24 | 1558.04 | 379.03 | 0.34 | |
| RC130 | 1.448 | 100 | Prop_nValues | 6237 | 894.58 | 905.33 | 902.64 | 906.21 | 0.00247 | 8.32 | 1112.98 | 357.53 | 0.48 | -1.21 |
| RC130 | 1.448 | 100 | Prop_30ftTrapCh | 6237 | 894.58 | 905.25 | 902.64 | 906.15 | 0.00257 | 8.44 | 1082.37 | 345.76 | 0.49 | -1.29 |
| RC130 | 1.448 | 100 | PropDetBasin | 7161.2 | 894.58 | 906.67 | 903.77 | 907.2 | 0.00144 | 6.95 | 1607.55 | 382.19 | 0.37 | 0.13 |
| | | | | | | | | | | | | | | |
| RC130 | 1.400 | 100 | CorrectedEff | 6237 | 894.02 | 906.12 | | 906.63 | 0.00171 | 7.81 | 1534.89 | 352.54 | 0.42 | |
| RC130 | 1.400 | 100 | Prop_nValues | 6237 | 894.02 | 904.75 | | 905.55 | 0.00296 | 9.37 | 1092.41 | 298.82 | 0.54 | -1.37 |
| RC130 | 1.400 | 100 | Prop_30ftTrapCh | 6237 | 894.02 | 903.76 | 903.06 | 905.22 | 0.00405 | 10.9 | 884.2 | 274.41 | 0.65 | -2.36 |
| RC130 | 1.400 | 100 | PropDetBasin | 7161.2 | 894.02 | 906.05 | | 906.74 | 0.00234 | 9.1 | 1509.4 | 349.39 | 0.49 | -0.07 |
| | | | | | | | | | | | | | | |
| RC130 | 1.335 | 100 | CorrectedEff | 7194 | 892.02 | 904.89 | 903.18 | 905.85 | 0.00259 | 10.45 | 1512.7 | 370.7 | 0.54 | |
| RC130 | 1.335 | 100 | Prop_nValues | 7194 | 892.02 | 904.05 | 902.16 | 904.71 | 0.00195 | 8.62 | 1300.98 | 357.1 | 0.46 | -0.84 |
| RC130 | 1.335 | 100 | Prop_30ftTrapCh | 7194 | 892.02 | 902.92 | 900.38 | 904.08 | 0.00237 | 9.31 | 1181.83 | 332.21 | 0.52 | -1.97 |
| RC130 | 1.335 | 100 | PropDetBasin | 7204.8 | 892.02 | 904.9 | 903.18 | 905.86 | 0.00259 | 10.45 | 1514.39 | 370.8 | 0.54 | 0.01 |
| | | | | | | | | | | | | | | |
| RC130 | 1.269 | 100 | CorrectedEff | 7194 | 890.94 | 901.75 | 901.75 | 904.34 | 0.00654 | 14.73 | 789.3 | 261.08 | 0.85 | |
| RC130 | 1.269 | 100 | Prop_nValues | 7194 | 890.94 | 901.36 | 901.36 | 903.48 | 0.00589 | 13.59 | 721.83 | 221.59 | 0.8 | -0.39 |
| RC130 | 1.269 | 100 | Prop_30ftTrapCh | 7194 | 890.94 | 899.88 | 899.87 | 902.55 | 0.00802 | 13.57 | 611.38 | 126.19 | 0.91 | -1.87 |
| RC130 | 1.269 | 100 | PropDetBasin | 7204.8 | 890.94 | 901.76 | 901.76 | 904.34 | 0.00653 | 14.73 | 790.89 | 261.47 | 0.85 | 0.01 |
| | | | | | | | | | | | | | | |
| RC130 | 1.250 | 100 | CorrectedEff | 7194 | 890 | 900.5 | 900.5 | 902.55 | 0.00546 | 13.39 | 877.11 | 288.47 | 0.78 | |
| RC130 | 1.250 | 100 | Prop_nValues | 7194 | 890 | 900.08 | 900.08 | 901.97 | 0.00541 | 12.92 | 795.66 | 255.26 | 0.77 | -0.42 |
| RC130 | 1.250 | 100 | Prop_30ftTrapCh | 7194 | 890 | 899.08 | 899 | 901.67 | 0.00713 | 13.47 | 678.99 | 174.37 | 0.87 | -1.42 |
| RC130 | 1.250 | 100 | PropDetBasin | 7204.8 | 890 | 900.5 | 900.5 | 902.56 | 0.00546 | 13.4 | 878 | 288.84 | 0.78 | 0.00 |
| | | | | | | | | | | | | | | |
| RC130 | 1.210 | 100 | CorrectedEff | 7194 | 888.6 | 899.44 | 898.08 | 900.84 | 0.0043 | 11.87 | 960.31 | 240.54 | 0.68 | |
| RC130 | 1.210 | 100 | Prop_nValues | 7194 | 888.6 | 898.61 | 897.7 | 900.09 | 0.00488 | 11.91 | 835.09 | 230.99 | 0.71 | -0.83 |
| RC130 | 1.210 | 100 | Prop_30ftTrapCh | 7194 | 888.6 | 898.69 | 897.63 | 900.29 | 0.00456 | 11.85 | 891.31 | 231.82 | 0.7 | -0.75 |
| RC130 | 1.210 | 100 | PropDetBasin | 7204.8 | 888.6 | 899.23 | 898.08 | 900.74 | 0.00474 | 12.28 | 928.76 | 238.08 | 0.71 | -0.21 |
| | | | | | | | | | | | | | | |
| RC130 | 1.164 | 100 | CorrectedEff | 7386 | 888.07 | 898.74 | | 899.76 | 0.00374 | 9.63 | 1429.91 | 312.2 | 0.63 | |
| RC130 | 1.164 | 100 | Prop_nValues | 7386 | 888.07 | 898.54 | | 899.08 | 0.0021 | 7.07 | 1367.07 | 307.15 | 0.47 | -0.20 |
| RC130 | 1.164 | 100 | Prop_30ftTrapCh | 7386 | 888.07 | 897.89 | | 899.16 | 0.00398 | 10.18 | 1270.51 | 288.86 | 0.65 | -0.85 |
| RC130 | 1.164 | 100 | PropDetBasin | 6992.1 | 888.07 | 898.62 | | 899.59 | 0.00359 | 9.33 | 1392.63 | 309.21 | 0.61 | -0.12 |

## Appendix B - HEC-RAS Results for 100-Year Event

| Reach | River Sta | Profile | Plan | Q Total (cfs) | Min Ch El (feet) | W.S. Elev (feet) | Crit W.S. (feet) | E.G. Elev (feet) | E.Q. Slope (ft/ft) | Vel Chnl (feet/sec) | Flow Area (sq ft) | Top Width (feet) | Froude # Chl | Delta WS (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RC130 | 1.137 | 100 | CorrectedEff | 7386 | 887 | 897.62 | 897.61 | 899.09 | 0.00656 | 12.53 | 1119.1 | 345.66 | 0.8 | |
| RC130 | 1.137 | 100 | Prop_nValues | 7386 | 887 | 897.96 | 897.2 | 898.73 | 0.00335 | 9.23 | 1226.22 | 346.7 | 0.58 | 0.34 |
| RC130 | 1.137 | 100 | Prop_30ftTrapCh | 7386 | 887 | 897.46 | 896.8 | 898.65 | 0.00343 | 9.96 | 1209.86 | 345.16 | 0.6 | -0.16 |
| RC130 | 1.137 | 100 | PropDetBasin | 6992.1 | 887 | 897.5 | 897.49 | 898.93 | 0.00646 | 12.3 | 1079.45 | 345.28 | 0.79 | -0.12 |
| RC130 | 1.073 | 100 | CorrectedEff | 7386 | 885.95 | 895.88 | 894.98 | 897.05 | 0.00548 | 10.31 | 978.06 | 402.24 | 0.61 | |
| RC130 | 1.073 | 100 | Prop_nValues | 7386 | 885.95 | 894.98 | 894.98 | 896.88 | 0.0096 | 12.73 | 762.01 | 323.18 | 0.79 | -0.90 |
| RC130 | 1.073 | 100 | Prop_30ftTrapCh | 7386 | 885.95 | 894.94 | 894.94 | 897.01 | 0.00675 | 12.96 | 772.56 | 315.63 | 0.8 | -0.94 |
| RC130 | 1.073 | 100 | PropDetBasin | 6992.1 | 885.95 | 895.67 | 894.75 | 896.87 | 0.00573 | 10.38 | 923.93 | 400.25 | 0.62 | -0.21 |
| RC130 | 1.015 | 100 | CorrectedEff | 7386 | 883.82 | 895.19 | 893.58 | 895.71 | 0.00344 | 7.67 | 1607.4 | 471.59 | 0.44 | |
| RC130 | 1.015 | 100 | Prop_nValues | 7386 | 883.82 | 894.09 | 893.24 | 894.81 | 0.00411 | 8.56 | 1237.2 | 368.24 | 0.52 | -1.10 |
| RC130 | 1.015 | 100 | Prop_30ftTrapCh | 7386 | 883.82 | 894.11 | 893.31 | 895.11 | 0.00445 | 9.64 | 1309.39 | 369.19 | 0.57 | -1.08 |
| RC130 | 1.015 | 100 | PropDetBasin | 6992.1 | 883.82 | 894.92 | 893.44 | 895.46 | 0.00364 | 7.75 | 1516.96 | 461.65 | 0.45 | -0.27 |
| RC130 | 0.983 | 100 | CorrectedEff | 7386 | 882.91 | 894.73 | 892.95 | 895.32 | 0.00261 | 8.04 | 1663.28 | 443.72 | 0.44 | |
| RC130 | 0.983 | 100 | Prop_nValues | 7386 | 882.91 | 893.27 | 892.72 | 894.28 | 0.00358 | 10.11 | 1176.12 | 325.9 | 0.6 | -1.46 |
| RC130 | 0.983 | 100 | Prop_30ftTrapCh | 7386 | 882.91 | 893 | 892.18 | 894.46 | 0.00385 | 10.96 | 1167.9 | 316.65 | 0.65 | -1.73 |
| RC130 | 0.983 | 100 | PropDetBasin | 6992.1 | 882.91 | 894.42 | 892.81 | 895.04 | 0.00278 | 8.14 | 1560.12 | 393.24 | 0.46 | -0.31 |
| RC130 | 0.937 | 100 | CorrectedEff | 7386 | 880.75 | 894.49 | 890.6 | 894.85 | 0.00133 | 6.12 | 1984.49 | 424.2 | 0.31 | |
| RC130 | 0.937 | 100 | Prop_nValues | 7386 | 880.75 | 893.2 | 890.45 | 893.61 | 0.00145 | 6.06 | 1550.99 | 330.4 | 0.33 | -1.29 |
| RC130 | 0.937 | 100 | Prop_30ftTrapCh | 7386 | 880.75 | 892.87 | 890.4 | 893.53 | 0.00233 | 7.88 | 1474.52 | 307.46 | 0.43 | -1.62 |
| RC130 | 0.937 | 100 | PropDetBasin | 6992.1 | 880.75 | 894.19 | 890.44 | 894.54 | 0.00136 | 6.08 | 1873.7 | 389.19 | 0.31 | -0.30 |
| RC130 | 0.935 | 100 | CorrectedEff | 7386 | 880.71 | 894.48 | | 894.84 | 0.00137 | 6.3 | 2062.55 | 421.07 | 0.33 | |
| RC130 | 0.935 | 100 | Prop_nValues | 7386 | 880.71 | 893.19 | | 893.6 | 0.00148 | 6.15 | 1554.87 | 368.02 | 0.34 | -1.29 |
| RC130 | 0.935 | 100 | Prop_30ftTrapCh | 7386 | 880.71 | 892.8 | | 893.51 | 0.0025 | 8.26 | 1448.96 | 322.97 | 0.45 | -1.68 |
| RC130 | 0.935 | 100 | PropDetBasin | 6992.1 | 880.71 | 894.17 | | 894.53 | 0.00141 | 6.29 | 1933.5 | 412.71 | 0.33 | -0.31 |
| RC130 | 0.888 | 100 | CorrectedEff | 7386 | 880.37 | 893.68 | 890.64 | 894.4 | 0.00239 | 8.45 | 1486.36 | 239.76 | 0.43 | |
| RC130 | 0.888 | 100 | Prop_nValues | 7386 | 880.37 | 892.43 | 890.26 | 893.17 | 0.00228 | 8.31 | 1212.16 | 205 | 0.45 | -1.25 |
| RC130 | 0.888 | 100 | Prop_30ftTrapCh | 7386 | 880.37 | 891.64 | 889.78 | 892.82 | 0.00312 | 9.75 | 1148.57 | 198.79 | 0.55 | -2.04 |
| RC130 | 0.888 | 100 | PropDetBasin | 6992.1 | 880.37 | 893.38 | 890.46 | 894.09 | 0.0024 | 8.32 | 1416.79 | 228.69 | 0.43 | -0.30 |
| RC130 | 0.846 | 100 | CorrectedEff | 7386 | 879.06 | 893.39 | | 893.91 | 0.0018 | 8.18 | 1795.61 | 258.96 | 0.4 | |
| RC130 | 0.846 | 100 | Prop_nValues | 7386 | 879.06 | 892.25 | | 892.74 | 0.00133 | 7.52 | 1507.53 | 249.69 | 0.38 | -1.14 |
| RC130 | 0.846 | 100 | Prop_30ftTrapCh | 7386 | 879.06 | 891.44 | | 892.23 | 0.0016 | 8.01 | 1461.69 | 243.43 | 0.43 | -1.95 |
| RC130 | 0.846 | 100 | PropDetBasin | 6992.1 | 879.06 | 893.08 | | 893.6 | 0.00182 | 8.1 | 1715.91 | 256.45 | 0.4 | -0.31 |
| RC130 | 0.804 | 100 | CorrectedEff | 7386 | 878.86 | 892.27 | | 893.34 | 0.00424 | 9.45 | 1128.73 | 205.02 | 0.48 | |
| RC130 | 0.804 | 100 | Prop_nValues | 7386 | 878.86 | 890.74 | | 892.24 | 0.00366 | 10.94 | 860.57 | 157.6 | 0.6 | -1.53 |
| RC130 | 0.804 | 100 | Prop_30ftTrapCh | 7386 | 878.86 | 890.2 | | 891.69 | 0.00315 | 10.12 | 875.97 | 149.44 | 0.59 | -2.07 |
| RC130 | 0.804 | 100 | PropDetBasin | 6992.1 | 878.86 | 892 | | 893.03 | 0.00417 | 9.23 | 1076.2 | 188.03 | 0.48 | -0.27 |
| RC130 | 0.742 | 100 | CorrectedEff | 7386 | 878.4 | 890.19 | | 891.58 | 0.00715 | 11.34 | 976.81 | 164.87 | 0.61 | |
| RC130 | 0.742 | 100 | Prop_nValues | 7386 | 878.4 | 889.52 | | 891.01 | 0.00398 | 11.64 | 868.45 | 157.93 | 0.64 | -0.67 |
| RC130 | 0.742 | 100 | Prop_30ftTrapCh | 7386 | 878.4 | 889.23 | | 890.47 | 0.00406 | 9.77 | 1014.96 | 171.71 | 0.6 | -0.96 |
| RC130 | 0.742 | 100 | PropDetBasin | 6992.1 | 878.4 | 889.79 | | 891.22 | 0.00766 | 11.44 | 911.1 | 160.67 | 0.62 | -0.40 |
| RC130 | 0.7055 | 100 | CorrectedEff | 7386 | 875 | 889.33 | | 890.53 | 0.00475 | 9.26 | 1032.3 | 235.14 | 0.53 | |
| RC130 | 0.7055 | 100 | Prop_nValues | 7386 | 875 | 889.26 | | 890.34 | 0.00268 | 8.89 | 1016.8 | 229.88 | 0.51 | -0.07 |
| RC130 | 0.7055 | 100 | Prop_30ftTrapCh | 7386 | 875 | 889.18 | | 889.92 | 0.00136 | 7.06 | 1280.76 | 223.66 | 0.4 | -0.15 |
| RC130 | 0.7055 | 100 | PropDetBasin | 6992.1 | 875 | 888.82 | | 890.07 | 0.00529 | 9.41 | 923.16 | 194.2 | 0.56 | -0.51 |
| RC130 | 0.679 | 100 | CorrectedEff | 7386 | 874.8 | 889.67 | | 890.06 | 0.0008 | 5.13 | 1632.12 | 244.96 | 0.27 | |
| RC130 | 0.679 | 100 | Prop_nValues | 7386 | 874.8 | 889.54 | | 889.94 | 0.00085 | 5.22 | 1600.07 | 244.14 | 0.28 | -0.13 |
| RC130 | 0.679 | 100 | Prop_30ftTrapCh | 7386 | 874.8 | 889.23 | | 889.67 | 0.00095 | 5.43 | 1525.15 | 242.21 | 0.29 | -0.44 |
| RC130 | 0.679 | 100 | PropDetBasin | 6992.1 | 874.8 | 889.17 | | 889.57 | 0.00087 | 5.18 | 1510.19 | 241.83 | 0.28 | -0.50 |
| RC130 | 0.670 | 100 | CorrectedEff | 7386 | 874.68 | 889.65 | 882.4 | 890.02 | 0.00061 | 4.9 | 1561.69 | 464.99 | 0.25 | |
| RC130 | 0.670 | 100 | Prop_nValues | 7386 | 874.68 | 889.51 | 882.4 | 889.9 | 0.00064 | 4.98 | 1483.18 | 429.71 | 0.25 | -0.14 |
| RC130 | 0.670 | 100 | Prop_30ftTrapCh | 7386 | 874.68 | 889.21 | 882.4 | 889.62 | 0.0007 | 5.11 | 1445.29 | 299.09 | 0.26 | -0.44 |
| RC130 | 0.670 | 100 | PropDetBasin | 6992.1 | 874.68 | 889.15 | 882.22 | 889.52 | 0.00064 | 4.86 | 1437.99 | 250.76 | 0.25 | -0.50 |

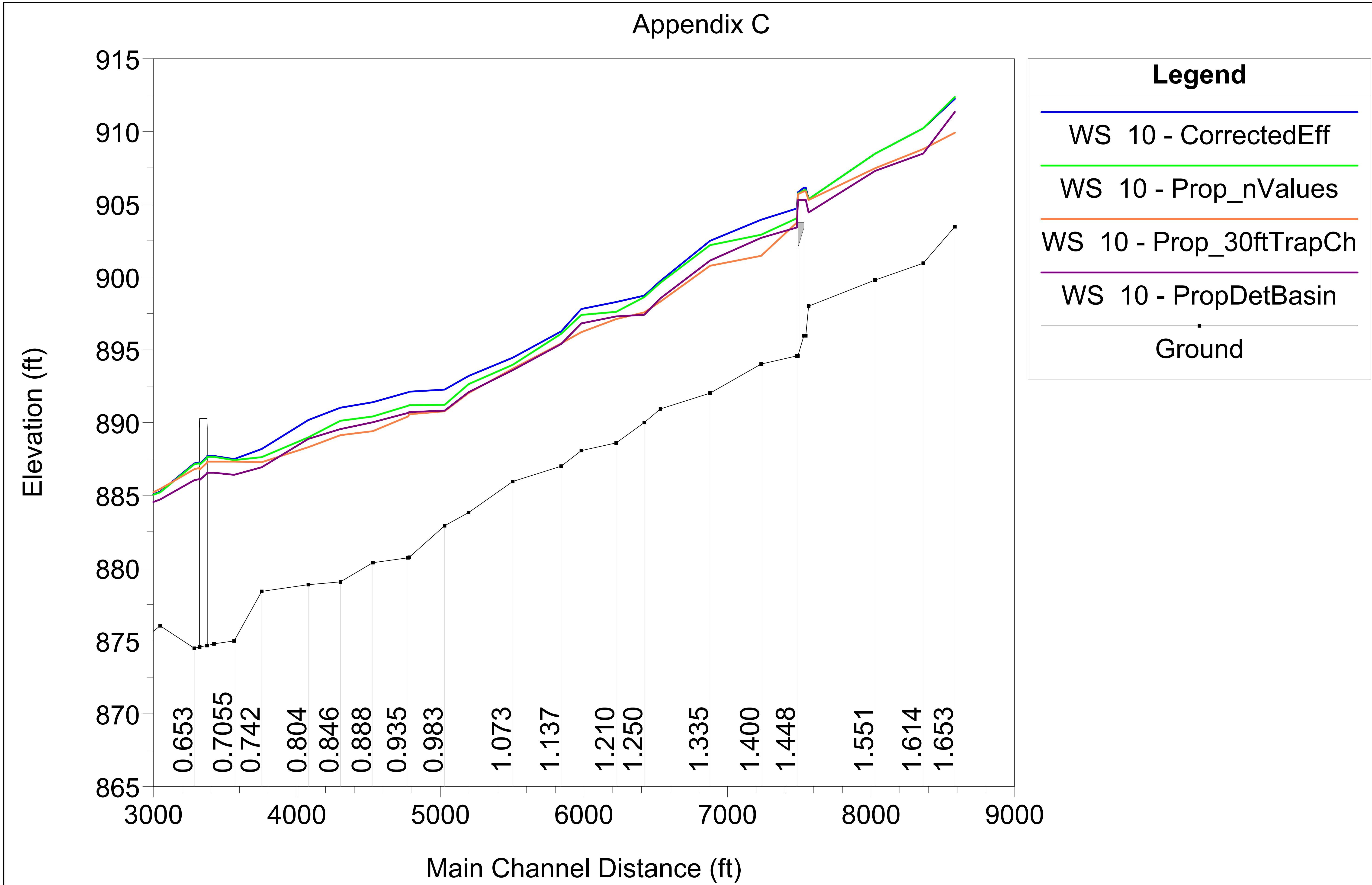
**Appendix B - HEC-RAS Results for 100-Year Event**

| Reach | River Sta | Profile | Plan | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.Q. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl | Delta WS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (cfs) | (feet) | (feet) | (feet) | (feet) | (ft/ft) | (feet/sec) | (sq ft) | (feet) | | (feet) |
| RC130 | 0.667 | | | Bridge | | | | | | | | | | |
| RC130 | 0.660 | 100 | CorrectedEff | 7386 | 874.59 | 889.52 | 881.63 | 889.78 | 0.0004 | 4.06 | 1829.49 | 519.39 | 0.21 | |
| RC130 | 0.660 | 100 | Prop_nValues | 7386 | 874.59 | 889.41 | 881.63 | 889.67 | 0.00041 | 4.1 | 1809.53 | 481.93 | 0.21 | -0.11 |
| RC130 | 0.660 | 100 | Prop_30ftTrapCh | 7386 | 874.59 | 889.1 | 881.63 | 889.38 | 0.00045 | 4.21 | 1757.75 | 250.9 | 0.22 | -0.42 |
| RC130 | 0.660 | 100 | PropDetBasin | 6992.1 | 874.59 | 889.05 | 881.48 | 889.3 | 0.00041 | 4 | 1749.73 | 204.03 | 0.21 | -0.47 |
| RC130 | 0.653 | 100 | CorrectedEff | 7066 | 874.5 | 889.48 | 882.52 | 889.76 | 0.00046 | 4.32 | 1775.4 | 318.8 | 0.23 | |
| RC130 | 0.653 | 100 | Prop_nValues | 7066 | 874.5 | 889.36 | 882.52 | 889.64 | 0.00048 | 4.38 | 1745.05 | 312.78 | 0.24 | -0.12 |
| RC130 | 0.653 | 100 | Prop_30ftTrapCh | 7066 | 874.5 | 889.04 | 882.52 | 889.35 | 0.00054 | 4.57 | 1666.42 | 297.02 | 0.25 | -0.44 |
| RC130 | 0.653 | 100 | PropDetBasin | 6589 | 874.5 | 889.01 | 882.29 | 889.28 | 0.00047 | 4.28 | 1659.26 | 295.57 | 0.24 | -0.47 |
| RC130 | 0.608 | 100 | CorrectedEff | 7855 | 876.04 | 886.64 | 886.64 | 888.88 | 0.00589 | 13.63 | 809.2 | 348.28 | 0.81 | |
| RC130 | 0.608 | 100 | Prop_nValues | 7855 | 876.04 | 886.59 | 886.59 | 888.78 | 0.00578 | 13.45 | 800.05 | 347.81 | 0.8 | -0.05 |
| RC130 | 0.608 | 100 | Prop_30ftTrapCh | 7855 | 876.04 | 886.49 | 886.06 | 888.52 | 0.00456 | 12.34 | 848.41 | 346.89 | 0.72 | -0.15 |
| RC130 | 0.608 | 100 | PropDetBasin | 7091.7 | 876.04 | 886.29 | 886.29 | 888.43 | 0.0058 | 13.17 | 746.41 | 345.09 | 0.8 | -0.35 |
| RC130 | 0.571 | 100 | CorrectedEff | 7855 | 874.43 | 885.7 | 885.61 | 887.6 | 0.00492 | 11.46 | 772.62 | 260.04 | 0.67 | |
| RC130 | 0.571 | 100 | Prop_nValues | 7855 | 874.43 | 885.73 | 885.63 | 887.52 | 0.00427 | 11.67 | 777.54 | 260.69 | 0.68 | 0.03 |
| RC130 | 0.571 | 100 | Prop_30ftTrapCh | 7855 | 874.43 | 885.7 | 885.61 | 887.6 | 0.00492 | 11.46 | 772.62 | 260.04 | 0.67 | 0.00 |
| RC130 | 0.571 | 100 | PropDetBasin | 7091.7 | 874.43 | 885.4 | 885.36 | 887.2 | 0.00508 | 11.39 | 713.22 | 251.47 | 0.68 | -0.30 |
| RC130 | 0.547 | 100 | CorrectedEff | 7855 | 871.04 | 885.75 | | 886.68 | 0.00257 | 9 | 1204.23 | 207.22 | 0.44 | |
| RC130 | 0.547 | 100 | Prop_nValues | 7855 | 871.04 | 885.75 | | 886.68 | 0.00257 | 9 | 1204.23 | 207.22 | 0.44 | 0.00 |
| RC130 | 0.547 | 100 | Prop_30ftTrapCh | 7855 | 871.04 | 885.75 | | 886.68 | 0.00257 | 9 | 1204.23 | 207.22 | 0.44 | 0.00 |
| RC130 | 0.547 | 100 | PropDetBasin | 7091.7 | 871.04 | 885.46 | | 886.3 | 0.00238 | 8.53 | 1144.72 | 203.03 | 0.43 | -0.29 |
| RC130 | 0.538 | 100 | CorrectedEff | 7855 | 870.61 | 885.32 | | 886.48 | 0.00299 | 10.89 | 1055.55 | 210.93 | 0.53 | |
| RC130 | 0.538 | 100 | Prop_nValues | 7855 | 870.61 | 885.32 | | 886.48 | 0.00299 | 10.89 | 1055.55 | 210.93 | 0.53 | 0.00 |
| RC130 | 0.538 | 100 | Prop_30ftTrapCh | 7855 | 870.61 | 885.32 | | 886.48 | 0.00299 | 10.89 | 1055.55 | 210.93 | 0.53 | 0.00 |
| RC130 | 0.538 | 100 | PropDetBasin | 7091.7 | 870.61 | 885.03 | | 886.11 | 0.00281 | 10.41 | 995.83 | 207.54 | 0.51 | -0.29 |
| RC130 | 0.482 | 100 | CorrectedEff | 7855 | 871.2 | 885.2 | 881.97 | 885.64 | 0.00099 | 4.93 | 1534.63 | 288.6 | 0.24 | |
| RC130 | 0.482 | 100 | Prop_nValues | 7855 | 871.2 | 885.2 | 881.97 | 885.64 | 0.00099 | 4.93 | 1534.63 | 288.6 | 0.24 | 0.00 |
| RC130 | 0.482 | 100 | Prop_30ftTrapCh | 7855 | 871.2 | 885.2 | 881.97 | 885.64 | 0.00099 | 4.93 | 1534.63 | 288.6 | 0.24 | 0.00 |
| RC130 | 0.482 | 100 | PropDetBasin | 7091.7 | 871.2 | 884.92 | 881.71 | 885.32 | 0.00094 | 4.72 | 1453.79 | 284.16 | 0.23 | -0.28 |
| RC130 | 0.463 | | | Bridge | | | | | | | | | | |
| RC130 | 0.460 | 100 | CorrectedEff | 7855 | 870.63 | 884.14 | | 885.13 | 0.0023 | 9.33 | 1075.42 | 250.15 | 0.48 | |
| RC130 | 0.460 | 100 | Prop_nValues | 7855 | 870.63 | 884.14 | | 885.13 | 0.0023 | 9.33 | 1075.42 | 250.15 | 0.48 | 0.00 |
| RC130 | 0.460 | 100 | Prop_30ftTrapCh | 7855 | 870.63 | 884.14 | | 885.13 | 0.0023 | 9.33 | 1075.42 | 250.15 | 0.48 | 0.00 |
| RC130 | 0.460 | 100 | PropDetBasin | 7091.7 | 870.63 | 883.92 | | 884.8 | 0.00209 | 8.79 | 1022.7 | 226.87 | 0.45 | -0.22 |
| RC130 | 0.385 | 100 | CorrectedEff | 7855 | 870.6 | 882.17 | 882.17 | 883.73 | 0.00465 | 11.78 | 1081.75 | 357.54 | 0.68 | |
| RC130 | 0.385 | 100 | Prop_nValues | 7855 | 870.6 | 882.17 | 882.17 | 883.73 | 0.00465 | 11.78 | 1081.75 | 357.54 | 0.68 | 0.00 |
| RC130 | 0.385 | 100 | Prop_30ftTrapCh | 7855 | 870.6 | 882.17 | 882.17 | 883.73 | 0.00465 | 11.78 | 1081.75 | 357.54 | 0.68 | 0.00 |
| RC130 | 0.385 | 100 | PropDetBasin | 7091.7 | 870.6 | 881.78 | 881.78 | 883.4 | 0.0049 | 11.76 | 959.41 | 351.7 | 0.69 | -0.39 |
| RC130 | 0.308 | 100 | CorrectedEff | 7855 | 867.96 | 880.11 | | 880.78 | 0.00179 | 8.13 | 1430.03 | 405.63 | 0.43 | |
| RC130 | 0.308 | 100 | Prop_nValues | 7855 | 867.96 | 880.11 | | 880.78 | 0.00179 | 8.13 | 1430.03 | 405.63 | 0.43 | 0.00 |
| RC130 | 0.308 | 100 | Prop_30ftTrapCh | 7855 | 867.96 | 880.11 | | 880.78 | 0.00179 | 8.13 | 1430.03 | 405.63 | 0.43 | 0.00 |
| RC130 | 0.308 | 100 | PropDetBasin | 7091.7 | 867.96 | 879.81 | | 880.48 | 0.00178 | 7.97 | 1313.59 | 390.51 | 0.43 | -0.30 |
| RC130 | 0.287 | 100 | CorrectedEff | 7855 | 867.87 | 879.97 | 878.55 | 880.56 | 0.00169 | 7.6 | 1482.49 | 421.44 | 0.42 | |
| RC130 | 0.287 | 100 | Prop_nValues | 7855 | 867.87 | 879.97 | 878.55 | 880.56 | 0.00169 | 7.6 | 1482.49 | 421.44 | 0.42 | 0.00 |
| RC130 | 0.287 | 100 | Prop_30ftTrapCh | 7855 | 867.87 | 879.97 | 878.55 | 880.56 | 0.00169 | 7.6 | 1482.49 | 421.44 | 0.42 | 0.00 |
| RC130 | 0.287 | 100 | PropDetBasin | 7091.7 | 867.87 | 879.67 | 878.23 | 880.26 | 0.0017 | 7.49 | 1359.48 | 408.69 | 0.42 | -0.30 |

**Appendix B - HEC-RAS Results for 100-Year Event**

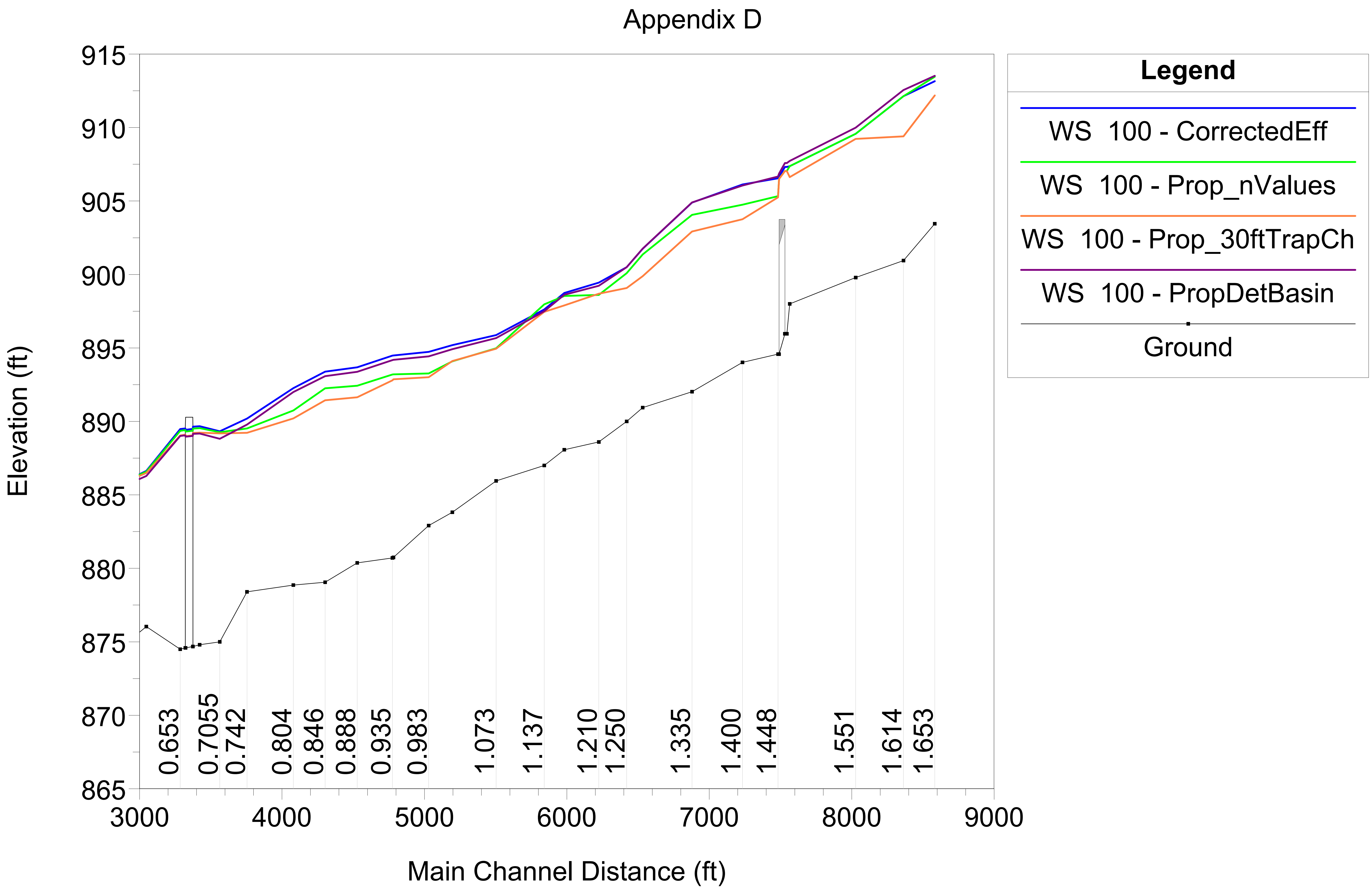
| Reach | River Sta | Profile | Plan | Q Total (cfs) | Min Ch El (feet) | W.S. Elev (feet) | Crit W.S. (feet) | E.G. Elev (feet) | E.Q. Slope (ft/ft) | Vel Chnl (feet/sec) | Flow Area (sq ft) | Top Width (feet) | Froude # Chl | Delta WS (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RC130 | 0.286 | | | Bridge | | | | | | | | | | |
| RC130 | 0.285 | 100 | CorrectedEff | 7855 | 867.87 | 879.77 | | 880.43 | 0.00177 | 8.17 | 1458.58 | 415.11 | 0.43 | |
| RC130 | 0.285 | 100 | Prop_nValues | 7855 | 867.87 | 879.77 | | 880.43 | 0.00177 | 8.17 | 1458.58 | 415.11 | 0.43 | 0.00 |
| RC130 | 0.285 | 100 | Prop_30ftTrapCh | 7855 | 867.87 | 879.77 | | 880.43 | 0.00177 | 8.17 | 1458.58 | 415.11 | 0.43 | 0.00 |
| RC130 | 0.285 | 100 | PropDetBasin | 7091.7 | 867.87 | 879.48 | | 880.13 | 0.00178 | 8.04 | 1338.55 | 407.37 | 0.43 | -0.29 |
| RC130 | 0.256 | 100 | CorrectedEff | 7855 | 867.87 | 878.45 | 878.45 | 879.88 | 0.00646 | 12.12 | 909.85 | 281.57 | 0.67 | |
| RC130 | 0.256 | 100 | Prop_nValues | 7855 | 867.87 | 878.45 | 878.45 | 879.88 | 0.00646 | 12.12 | 909.85 | 281.57 | 0.67 | 0.00 |
| RC130 | 0.256 | 100 | Prop_30ftTrapCh | 7855 | 867.87 | 878.45 | 878.45 | 879.88 | 0.00646 | 12.12 | 909.85 | 281.57 | 0.67 | 0.00 |
| RC130 | 0.256 | 100 | PropDetBasin | 7091.7 | 867.87 | 878.3 | 878.3 | 879.61 | 0.00601 | 11.57 | 867.75 | 276.72 | 0.65 | -0.15 |
| RC130 | 0.220 | 100 | CorrectedEff | 8103 | 865.93 | 877.56 | | 878.46 | 0.00226 | 9.28 | 1212.54 | 324.42 | 0.49 | |
| RC130 | 0.220 | 100 | Prop_nValues | 8103 | 865.93 | 877.56 | | 878.46 | 0.00226 | 9.28 | 1212.54 | 324.42 | 0.49 | 0.00 |
| RC130 | 0.220 | 100 | Prop_30ftTrapCh | 8103 | 865.93 | 877.56 | | 878.46 | 0.00226 | 9.28 | 1212.54 | 324.42 | 0.49 | 0.00 |
| RC130 | 0.220 | 100 | PropDetBasin | 7195.3 | 865.93 | 876.92 | | 877.91 | 0.0026 | 9.57 | 1025.08 | 268.57 | 0.53 | -0.64 |

# APPENDIX C WATER SURFACE COMPARISON FOR 10-YEAR EVENT



Appendix C
Legend
WS 10 - CorrectedEff
WS 10 - Prop_nValues
WS 10 - Prop_30ftTrapCh
WS 10 - PropDetBasin
Ground
Elevation (ft)
Main Channel Distance (ft)
915
910
905
900
895
890
885
880
875
870
865
3000
4000
5000
6000
7000
8000
9000
0.653
0.7055
0.742
0.804
0.846
0.888
0.935
0.983
1.073
1.137
1.210
1.250
1.335
1.400
1.448
1.551
1.614
1.653

# APPENDIX D WATER SURFACE COMPARISON FOR 100-YEAR EVENT


Appendix D
Legend
WS 100 - CorrectedEff
WS 100 - Prop_nValues
WS 100 - Prop_30ftTrapCh
WS 100 - PropDetBasin
Ground
Elevation (ft)
915
910
905
900
895
890
885
880
875
870
865
0.653
0.7055
0.742
0.804
0.846
0.888
0.935
0.983
1.073
1.137
1.210
1.250
1.335
1.400
1.448
1.551
1.614
1.653
3000
4000
5000
6000
7000
8000
9000
Main Channel Distance (ft)

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