APPENDIX M

DRAINAGE AND STORMWATER MASTER PLAN

Creekview Specific Plan

CITY OF ROSEVILLE, CA

DRAINAGE AND STORMWATER MASTER PLAN

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City of Roseville Permit Center
311 Vernon Street
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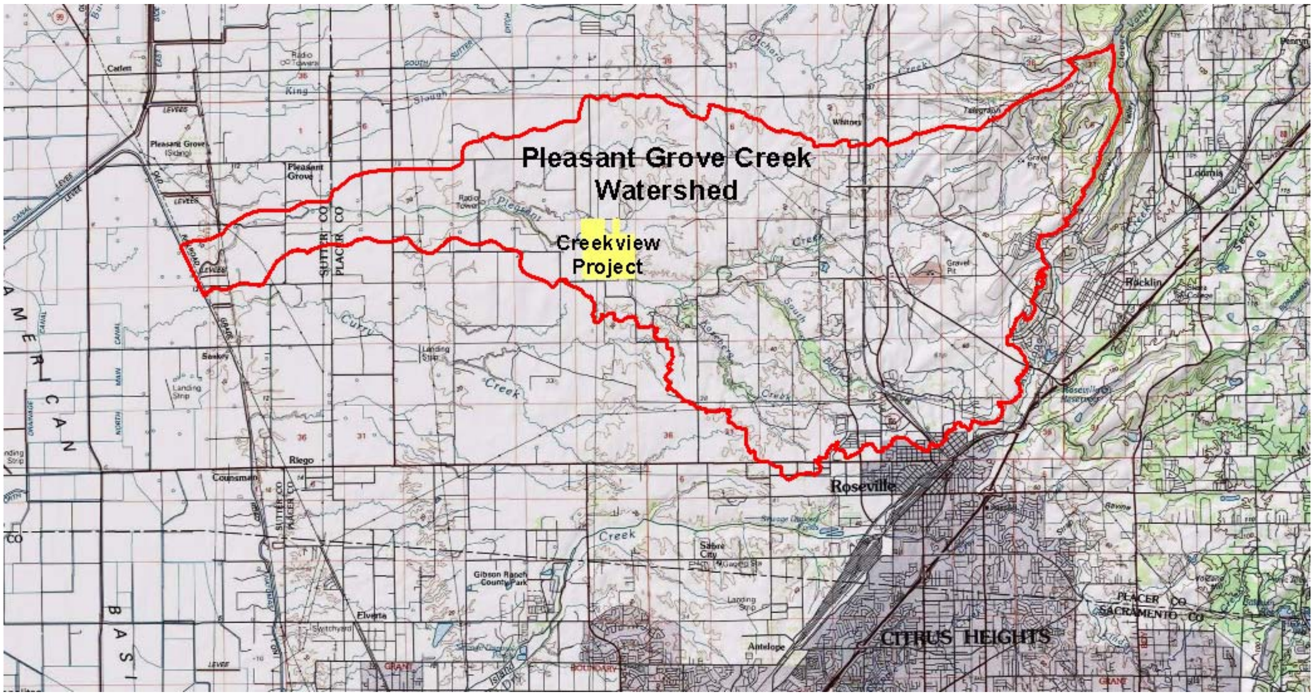


I. Introduction:

I.A Project Description

The Creekview Specific Plan (CSP) is wholly contained within the Pleasant Grove Creek (PGC) watershed, which is located within the larger Natomas Cross Canal watershed of northwestern Placer County and southeastern Sutter County. The PGC watershed drains to the Pleasant Grove Canal, to the Natomas Cross Canal, and then to the Sacramento River.

I.B Pleasant Grove Creek and University Creek

PGC, a perennial stream, traverses the site diagonally, entering in the southeast corner and extends northwesterly to the western edge of the Plan Area. The reach of PGC within the CSP flows year-round. Most of the CSP drains to PGC by overland flow or through the few wetland swales and ephemeral drainages on the site. The existing PGC floodplain extends nearly 1,500 feet south of the creek in the southwest portion of the CSP. Within the CSP, the main channel of PGC is within open space parcels C-53 and C-54.

University Creek, an intermittent stream tributary to PGC, enters the site in the northeast corner and extends westerly through the northern portion of the Plan Area and joins the main branch of PGC west of the Plan Area. University Creek is currently channeled with little riparian vegetation. The floodplain of University Creek is shallow and wide and extends onto the northwestern portion of the CSP. The northern third of the CSP drains toward University Creek. Within the CSP, University Creek is within open space parcels C-50, C-51 and C-52.

As a result of historic farming practices, both of these creeks, the main branch of PGC and University Creek, have experienced man-made manipulation downstream of the CSP. Field leveling resulted in the placement of fill materials within historical flood plains and re-channelization of the creek beds directed low flows around cultivation. These manipulations have direct correlations to the present floodplain limits.

The pre-project floodplains for Pleasant Grove Creek and University Creek are shown in Figures FP-1A and FP-1B.

I.C Reason Farms Retention Basin Project/Flood Control Project

The City of Roseville is undertaking development of a regional stormwater retention system (Reason Farms Flood Control Project) on the 1700-acre Reason Farms site, owned by the City and located immediately west and downstream of the CSP. Pursuant to the City's agreement with Sutter County, the Reason Farms site was purchased by the City for the purposes of constructing a flood control/retention basin project to mitigate the City's contribution to cumulative flooding impacts on downstream communities within the PGC watershed.

The retention facility is designed to provide the volumetric mitigation of stormwater development impacts for the 8-day 100-year runoff event from all developed properties within the Pleasant Grove Creek watershed, and the City of Roseville. The project is designed to provide retention storage of 2,530 acre-feet in two basins, one located on each side of PGC. South of PGC, 1850 acre-feet of storage will be provided in the south basin, and 680 acre-feet will be provided north of the creek in the north basin. During flood events effecting Sutter County, that coincide with the flow within the Sacramento River reaching its peak, the basin outlet gates would be in the closed position, water would accumulate and be held in the basins until flood conditions recede in the downstream floodplains (Natomas Cross Canal). Then, the basins would be allowed to dry and drain slowly. The Reason Farms project would also provide opportunities for other uses such as enhancement of riparian, wetland and upland habitat and recreational uses such as an equestrian center, pedestrian, bicycle and horse trails archery range, etc..

The Reason Farms Retention Basin Project EIR (SCH No. 2002072084) was certified by the City and the project was approved in January 2003. The City currently collects impact fees (Pleasant Grove Creek Watershed Mitigation Fee) from developing properties within the Pleasant Grove Creek watershed for the construction of these flood control improvements.

As presently designed, a bypass channel would divert water into the southern basin at an inlet point located immediately west of the western edge of the CSP, south of PGC, and extend to a point west and downstream, where flows would rejoin the creek.

I.D Pleasant Grove Creek Floodplain Condition

In the pre-project condition, immediately downstream of the CSP on the Reason Farms property, the PGC channel narrows abruptly as a result of past farming practices and land leveling from decades ago. The narrowing has created a man-made constriction.

This constriction creates a bottleneck in the conveyance of floodwaters resulting in an unnatural expanded 100-year floodplain which raises water surface elevations higher than pre-constriction conditions on the CSP. This condition has restricted downstream conveyance and affects flooding conditions on the CSP site.

The northern bank of PGC through the CSP is steep and extends well above the 100-year floodplain through most of the project reach. The southern bank is laid back at a gentler slope, allowing floodplain to extend in a southerly direction in several areas.

I.E Pleasant Grove Creek Bypass Channel

The CSP project includes construction of a bypass channel adjacent to PGC to provide additional conveyance and floodplain storage capacity within the PGC system through the CSP and on the downstream Reason Farms property (within the Off-Site Improvement Area). The system, created by the bypass channel and PGC together, will function to reclaim the historic floodplain of PGC within the CSP area and remove developable lands from the 100-year floodplain. The bypass channel will divert a portion of the high water flows from PGC upstream of the major channel constriction, and re-introduce the flows back into the existing channel downstream of the constriction.

The bypass channel would be constructed generally parallel to and south of the southern bank of the main channel of PGC. In the CSP, the bypass channel would be located within open space corridor (parcels C-53 and C-54). The bypass channel would begin at a point east of the Westbrook Boulevard crossing of PGC (north of parcel C-40) and continue west, off-site, onto the Reason Farms property where it will rejoin PGC downstream.

The northern bank of the bypass channel would be set back approximately 100 feet from the ordinary high water mark or 70 feet from the top of the southern bank of the existing main channel of PGC, whichever provides the greater distance from the top of bank.

The length of the bypass channel is approximately 6,650 feet. 4,150 feet of the bypass channel would be located on the CSP and 2,500 feet would be located on the Reason Farms property, off-site in the 58.6-acre Off-Site Improvement Area.

The bypass channel would be naturally vegetated, with a low flow channel, and provide for the creation of riparian habitat within depressed areas and stormwater treatment swales. Generally trapezoidal in shape, the soft contouring of the bypass channel will have a bottom width varying from 40 feet at the upstream end to 175 feet at the widest point near the CSP downstream boundary, and varying side slopes no steeper than 4:1 to tie into existing ground surface. The bypass channel would be constructed by excavation. Figures III.A.1 to III.A.11 are cross sections of the bypass channel. Once established with natural vegetations, minimal on-going maintenance of the by-pass channel is anticipated other then to remove the build up of sediment that may accumulate over time or to remove non-native invasive vegetation. Ramps will be designed in to the contours of the channel to allow maintenance vehicles access.

The western pedestrian bridge is designed to throttle flood flows and detain peak flows from the project site. The incremental 100-year peak flows created by the development of the CSP project will be mitigated by the impounded back water, which is contained within the project limits. Downstream releases for 100-year and greater events will overspill along the berm between the main channel and the by-pass channel which will be contoured and soft armored for this purpose. [SHOW MATCHING HYDRO-GRAPHS SOMEWHERE IN THE REPORT. SHOW A DETAILED EXHIBIT OF THE 100-YEAR FLOOD DETENTION FACILITY. WILL THERE BE DETENTION UPSTREAM OF THE OUTLET WIER? DESCRIBE AND SHOW.]

The floodplain improvements, including construction of the bypass channel and associated improvements will not adversely impact the proposed operation of the Reason Farms flood control facilities or reduce the available storage within the Reason Farms retention basin. The additional impounded backwater areas are contained within the project boundaries and do not extend upstream of the CSP.

The following describes components of the bypass channel:

I.E.1 Inlet Weir Structures

The bypass channel design includes seven engineered inlet weir connections to the main PGC channel. These weir connections enable transfers of storm waters from the main channel into the bypass channel. The first inlet structure is planned at the beginning of the bypass channel, at a point east of the Westbrook Boulevard crossing of PGC (north of Parcel C-40), shown on Figure 2. The first inlet structure will be constructed with concrete and consist of three gated structures (each 3' high and 6' wide) (or pipes of equivalent capacity with automated gates acceptable to the city) placed within a concrete frame, excavated into the existing earthen berm separating the main creek from the overbank floodplain. To reduce sediment transfer and deposition into the bypass channel, the transfer of storm waters into the channel is dispersed among six other inlet weirs located along the expanse of the bypass channel.

The proposed bypass channel improvement would modify the bypass channel easterly from its original planned location at the westerly boundary of the CSP to a location east of the Westbrook Boulevard crossing of the PGC.

The remaining six inlet weirs are designed for storm water flows in excess of the five-year storm and less frequent events to allow flow to exchange between the main creek and the bypass channel. The weirs will be passive transfer points located along the southern bank of the natural PGC channel and will avoid impacts to existing trees and riparian vegetation. The design of the inlet weirs will incorporate soft armoring with the use of geo-textile products designed to prevent erosion and allow vegetative growth. This slope protection will allow flows to move between the channels and maintain the integrity of the channel banks.

I.E.2 Outlet/Flow Control Structure

One outlet/flow control structure would be located approximately 2,000 feet west of the CSP boundary, on the Reason Farms property, within the 58.6-acre Off-Site Improvement Area.

The outlet/flow control structure would consist of a concrete weir and 2 – 36-inch low flow culverts each with a closeable gate. Flows would be either directed into the future flood control basin, or directed from the bypass channel into existing open channels to rejoin PGC. The open channels would be oriented to allow discharged flows to gently merge with the flows in PGC.

I.E.3 Low Flow Channel

The bypass channel would include a mild sloped meandering low flow channel to provide positive drainage. The low flow channel would split into two paths near weir locations to enhance energy dissipation. The splits and the ground between them would provide more area near the weirs and within the channel where dense vegetation would be allowed to establish to provide filtering of flows entering the bypass channel at the weirs, and to slow these flows to velocities consistent with the rest of the bypass channel. The low flow channel would be roughly trapezoidal, have a depth of one foot, and a bottom width of approximately ten feet and side slopes of four feet as shown on Figure 3. The low flow channel would be constructed by excavation and be designed so low flows meander through a naturally vegetated channel.

I.E.4 Berms/Embankments

On the Reason Farms property, earthen berms (embankments) would be constructed along the north and south sides of the bypass channel to a height greater than the 100-year flood elevations. The berms would function to isolate flows contained in the bypass channel from the main creek flows. In the pre-project condition, on the Reason Farms site, a berm exists along the southern bank of the PGC which currently effectively performs this function on the northern side of the proposed bypass channel location. The project proposes to enhance this existing berm to ensure bank protection.

Bypass channel construction would include several design features to stabilize portions of the existing bank on the southwestern side of PGC which have developed areas of instability as a result of historic creek modifications.

I.E.5 Excavation

Construction of the bypass channel and low flow channel would require approximately 233,700 cubic yards of cut and 28,500 cubic yards of fill.

	Cut	Fill
On-Site (Creekview)	131,400 cu yds	6,100 cu yds
Off-Site Improvement Area (Reason Farms)	102,300 cu yds	22,400 cu yds
Total	233,700 cu yds	28,500 cu yds

The excavated earthen material would be used on the respective properties and placed as either compacted fill on the CSP or for the construction of berms adjacent to the bypass channel on the Reason Farms property (Off-Site Improvement Area).

I.E.6 Erosion Control

Prior to the onset of construction activities, a Storm Water Pollution Prevention Plan (SWPPP) will be designed for the site and submitted to the Regional Water Quality Control Board (RWQCB). The SWPPP will detail the construction staging, fuel storage and containment and the erosion control element of the construction activities. No construction equipment would be allowed within PGC (below top of bank), except as needed for channel excavation at inlet/outlet structures. Silt fences would be installed at the top of the creek banks within the construction area to trap sediment, as well as to discourage entry. Limited excavation would be performed in PGC to excavate connector channels to inlet and outlet structures. Temporary check dams, constructed of drain rock or other suitable material may be installed within PGC for sediment trapping during construction, assuming creek flows are minimal. Depending on creek flow and groundwater conditions, floating silt curtains may also be used to enclose the excavation area.

As grading activities are completed, disturbed areas would be hydroseeded for erosion control. Additional measures, such as straw mulch or biodegradable erosion control fabrics, would be applied to slopes and along low-flow and bypass channels, which would be more susceptible to erosion. Stormwater treatment swales will be installed within the bypass channel to treat and minimize urban runoff impacts prior to introduction into PGC.

I.E.7 Riparian Corridor Habitat

A corridor of high-quality riparian habitat borders PGC. The bypass channel construction would preserve these habitats except for small encroachments at the inlet and outlet structures and at the locations where weirs are constructed. Locations of weirs were selected to minimize impacts to vegetation and trees. To protect riparian habitat along PGC, embankment structures would be set back approximately 100 feet from the ordinary high water mark or 70 feet from the top of bank, whichever provides the greater distance from the top of bank.

Within the setback area, riparian habitat area will be restored and new riparian wetlands would be created within and along the bypass channel. The design of the floodplain areas, low flow channel and attenuation features will create opportunities for riparian vegetation supported by nutrients and flows from the bypass channel.

Trees within the riparian corridor removed as a result of constructing the bypass and related improvements would be replaced on-site in accordance with the City of Roseville Tree Preservation Ordinance.

I.E.8 Construction Activities

Prior to excavation, the areas of excavation would be cleared of existing vegetation. Topsoil will be salvaged and stockpiled for later use. Given the scale of excavation, mass grading would be performed using scrapers or other large grading equipment. The scrapers would transport excavated material. Fine grading along the low flow and bypass channels would be performed with graders and bulldozers. Water trucks would be used for dust control during excavation. Soil would be hauled on-site and off-site within the Off-Site Improvement Area.

Limited excavation would be performed adjacent to PGC to connect the inlet and outlet structures with the main creek channel and to install weir structures. This excavation and construction would be performed during the summer low-flow period to minimize impacts to the creek. If required to complete the work near PGC, check dams could be installed, upstream and downstream of the work area, and submersible pumps used to direct water past the work area.

Earthen berms on the Reason Farms property would be constructed using material excavated from the bypass channel within the reach. Prior to fill placement, the subgrade of the berms would be prepared by clearing the area of vegetation and removing the stockpiled topsoil. For berm construction, excavated material would be placed in six to twelve-inch lifts, using either scrapers or bulldozers. Each lift of fill would be compacted using a sheepsfoot compactor. Water trucks would be used for dust control and managing the soil moisture content during backfill and compaction activities. All placement of engineered fills will be subject to the recommendations found within the CSP's Geotechnical Engineering Report and monitored by a licensed Geotechnical Engineer.

The inlet and outlet structures would be cast in place reinforced concrete structures. The structures would have their foundations embedded in undisturbed soil. The structures would be backfilled to create a firm and resistant seal with the adjacent embankment. The concrete structures would be formed and poured in sequential stages beginning with foundations and ending with above-ground walls.

I.F University Creek

Similar to Pleasant Grove Creek, in the pre-project condition, the University Creek channel narrows abruptly, immediately downstream of the CSP on the Reason Farms property. The narrowing is the result of past farming practices and has resulted in man-made constriction which restricts downstream conveyance and affects flooding conditions on the CSP site.

To address this condition on University Creek, the CSP will create a modified channel within open space parcels C-50 and C-50-a. The area around the channel would be enhanced with riparian plantings which will result in an enhanced environment over the pre-project condition. In the northwest portion of the CSP, University Creek would be restored to a more natural sinuous stream course with an adjacent floodplain. Fill materials would be placed up to the limits of the historic floodplain.

I.G Stormwater Quality

Development of the CSP including drainage improvements and proposed bypass channel improvements, has the potential to impact water quality in Pleasant Grove Creek and its tributaries. As a result, Best Management Practices (BMPs) and Low Impact Development (LID) measures will be implemented in the CSP to reduce potential impacts.

Several stormwater quality swales would be located within the bypass channel corridor to convey and treat stormwater prior to discharging into the creek. Some of these features are within the overbank areas of the creeks and would be within the floodplain, and therefore would contribute to the overall floodplain storage.

I.H Project Analysis

The master watershed modeling for Pleasant Grove Creek currently includes two studies which are in conflict with the predicted flow rates and the resulting floodplain elevations. The City is currently completing a restudy of Pleasant Grove Creek, in which various regional models for the watershed were combined into a single master model, and hydraulic routing using HEC-RAS unsteady flow simulations was added. The City models are based on the Placer County Stormwater Management Manual (SWMM) model development requirements and utilize the Placer County Flood Control and Conservation District's (PCFCWCD) PDP2 software for generating design event precipitation, and computing storm centering factors. The new City models include a superior calibration to previous modeling attempts for the watershed, but some areas of the hydraulic routing model are not based on terrain of sufficient accuracy to be used for floodplain mapping. This includes Creekview Specific Plan area, where project topography was added to these models to refine their results through the Creekview Specific Plan, Panhandle Properties and Reason Farms areas.

The other model is the latest FEMA Flood Insurance Study (FIS) evaluations and mapping for the DFIRM update. FEMA may release new flood map based on these updated studies. At the time of the writing of this document, FEMA and the City were in ongoing discussions about merging the methodologies of the two studies to come up with a single unified study. The main differences of the two studies are that storm centering was not applied to the FEMA analysis, the FEMA analysis did not include the routine effects of the stream floodplain attenuation, and that the FEMA analysis did not use the calibrated 'n' values of the City study.. The FEMA study did include a more advanced topography basis for the majority of the main Pleasant Grove Creek areas.

The CSP Drainage and Stormwater Master Plan (DSMP) presents hydrologic analyses based on the City's Pleasant Grove Drainage Study (RBF 2010), hereafter called the City Basis Model, and the FEMA DFIRM basis. The CSP DSMP demonstrates that the project impacts on peak flow rates would be mitigated per the SWMM requirements. For floodplain mapping analysis and impacts, both study bases were examined. For the Future Fully Developed Unmitigated and Historical floodplain mapping efforts, only the City basis hydrology was used.

A detailed hydraulic analysis (HEC-RAS) of Pleasant Grove Creek, is provided for the pre-project and post-project conditions. Hydrology (flows) are input into the hydraulic floodplain analysis models based on the Pre-project, and Post-project conditions. Post project mitigation will result from the construction of the proposed Creekview Bypass Channel as previously described. The analysis of the bypass channel includes the use of Manning's 'n' values for friction of 0.100 for the low flow channel and areas in-between low flow channels where they are split. This 'n' value accounts for the dense vegetation likely to develop within the low flow channel. The remaining bottom of the channel includes an 'n' value of 0.08 to account for vegetation that is likely to develop over time. The side slopes of the bypass channel include an 'n' value of 0.06 which accounts for the grasses and small shrubs and occasional tree's which may grow in this portion of the channel.

Floodplain Exhibits (FP-1, FP-2, and FP-3) delineate the pre-project, post-project mitigated, and post-project unmitigated conditions floodplain limits and base flood elevations for the 100-year events. A limited amount of detailed FEMA floodplain or floodway limits is currently defined within the CSP near the western plan boundary. These areas are shown on the "FP" drawings for reference, as Zone A (The proposed DFIRM floodplains are shown herein, and the project analysis demonstrates a "no adverse impact" solution despite encroachment within the proposed floodway along the south bank)..

All Drainage Improvements in the plan will comply with the City Design Standards, "Section 10 – Drainage". Stormwater Quality design elements will comply with the City Standards, "**Stormwater Quality Design Manual for the Sacramento and South Placer Regions".**

The CSP project proposes to mitigate potential impacts to peak flood rates for the 10-year and 100-year event as specified in these standards. The project proposes to mitigate peak flow impacts through the creation of additional on-stream and floodplain overbank attenuation at the Bypass Channel.

Additionally, the project will employ the use of Low Impact Development (LID) measures, which will reduce the directly connected imperviousness of the planned developments, and provide some offsets for the development impacts to peak flow, and runoff volumes for frequent events (and to a lesser amount, flood events). Attenuation benefits of the proposed bypass channel, and stormwater quality features are quantified on Figure AT-1, the "Attenuation Plan".

The project would include both: on-site LID, and treatment "Best Management Practices" (BMPs) to mitigate and treat the discharge of development constituents into the creeks and streams. Low Impact Development (LID) measures will be employed within the CSP to reduce the amounts of runoff and required treatment from the projects. This CSP Drainage and Stormwater Master Plan establishes LID required volumetric removal (RVR) targets/quotas for each type of land use as found in section IV.B of this report. The Master Plan also provides a sample plan identifying an example of how those targets will be obtained for each type of land use. The RVR's in conjunction with the proposed outfall vegetated swales, will obtain 100% mitigation of increased project runoff volumes for the 85^{th} percentile rainfall event. The LID RVR's will be the minimum threshold of LID elements allowed in the plan, although LID elements may be substituted, and greater levels of LID will be permitted, which could further reduce project impacts and BMP treatment sizing.

The proposed LID measures, and the flood storage volumes being added within the floodplain areas would assist in the reduction of the potential for hydrograph modification. Hydrograph Modification (otherwise known as Hydromodification or Hydromod) can impact stream systems causing them to move into a state of accelerated change. Hydromodification impacts can occur from non-mitigated development impacts, wherein added impervious areas can increase the total volume of runoff, and development storm drainage systems can accelerate the timing of the runoff, increasing the frequency of flows especially in smaller events. Hydromod is known, in some streams, to trigger stream evolution changes in a more rapid time scale than would have normally occurred. Sudden evolution of a stream can result in the removal of significant amounts of soils from the project streams, and deposition of those soils elsewhere in the watershed. Sudden evolution is therefore a significant concern for water quality regulated streams (see Clean Water Act, Waters of the US and other water bodies). The Pleasant Grove Creek stream includes areas identified as seasonal and perennial wetlands and therefore would be considered a water of the US. Migration is a more natural occurrence, as the "S" curves of all streams naturally migrate in the downstream direction. In our surveys of the Pleasant Grove Creek stream system we have seen evidence of scour and deposition which may be indicators of either migration and evolutionary issues. Because of the potential concerns over the Hydromodification impacts of CSP project, an analysis is provided in the DSMP which evaluates the hydromod related potential impacts of the project, and the benefits of the proposed project measures which are likely to mitigate most of the modification concerns.

Finally, as this development is contained within a watershed which discharges through the Natomas Cross Canal, it is subject to volumetric impacts analysis and potential mitigation requirements. A situation exists within Sutter County, within the sump areas upstream of the Natomas Cross Canal, wherein flooding is known to occur when the Sacramento River rises above a flood stage of 37.0 at the Verona Gage. This occurs as a result of the limited discharge capacity of the Natomas Cross Canal when the Sacramento River is flooding. As a result, the discharge of additional volumes of runoff during this type of event, could potentially increase the depth of flooding (per Cross Canal Watershed Study CH2MHILL – 1992-1994). Additionally, flooding of the sump area could occur from local runoff of the streams and watersheds which are tributary to the Natomas Cross Canal. As a result the City of Roseville collects a development fee, "The Pleasant Grove Watershed Mitigation Fee", which will ultimately construct facilities

(Reason Farms) to mitigate such impacts. This report will quantify the estimated volumetric impact of the project for a 8-day 100-year event.

II. Hydrology:

The Army Corps HEC-1 software was utilized to develop the hydrologic models for the Creekview Specific Plan project.

II.A Standards:

Master watershed modeling for Pleasant Grove Creek (PGC) has been adapted from the original "Cross Canal" models of 1992.. In 2009 RBF Consulting, Inc. under contract with the City Roseville, assembled these various studies, and added study data to prepare an updated watershed model for the City of Roseville (referred herein as "City Basis"). The City Basis models assembled the various data into a comprehensive PGC hydrology model (Kinematic Wave) per the Placer County Flood Control and Water Conservation District *"Stormwater Management Manual (SWMM)"* dated February 1994 and the SWMM Addendum 1, dated October 1997. The PGC update study is still ongoing at the time of the writing of this plan, and forms 1 of the 2 bases on which the project hydrology has been developed.

In 2010, FEMA presented their Flood Insurance Study (FIS) update intended to be included with the Digital Flood Insurance Rate Map (DFIRM) update for Placer County. The updated FIS(still in process) presents a new hydrologic and hydraulic basis for Pleasant Grove Creek. This hydrology basis is compatible with Placer County methodology except that storm centering, typically applied to a watershed this large, was not applied in any way. In addition, critical routing elements were omitted. As a result the local agencies believe the predicted flows of the FEMA analysis may be over-estimated. However, it has also been discovered that 'n' values less than those used in the City Basis analysis were used in the FEMA study, so similar floodplain elevations were reported in both studies. Also, the FEMA study includes land use based on the "existing" (2007) development conditions, while the City Study includes the "ultimate buildout" conditions of the watershed. The updated FIS hydrology and hydraulics forms the second basis presented in the DSMP..

II.A.1 Soils:

The soil type delineation was obtained from the "Soil Survey of Placer County, California Western Part". Hydrologic soil type "B" and "D" are the predominate soil types within the limits of the project boundary. Soils are classified into four hydrologic Categories:

> Group A: Consist of soils that have a high infiltration rate when thoroughly wet. These soils have a high rate of water transmission and low runoff potential. They are deep, well drained or excessively drained, and consist chiefly of sand, gravel, or both. No soils in this project are in Group A.
>
> Group B: Consist of soils having a moderate infiltration rate when thoroughly wet. These soils have a moderate runoff potential. They are moderately deep, well drained, and are medium in texture to moderately course in texture.

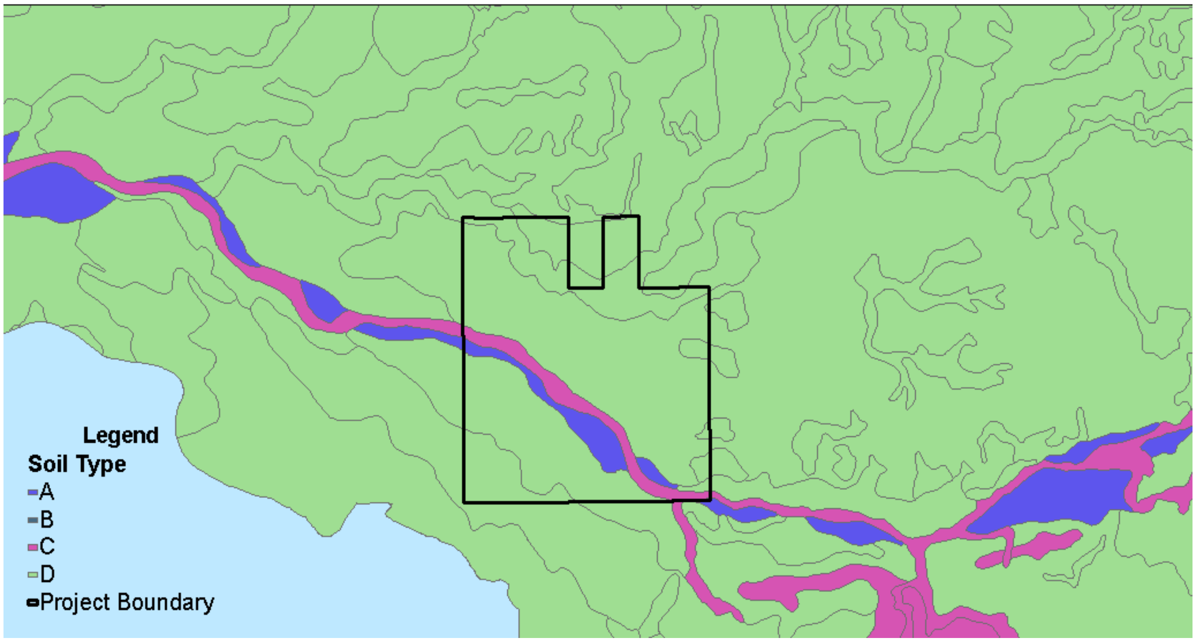
Group C: Consist of soils having a slow infiltration rate when thoroughly wet. These soils have a slow rate of water transmission and high runoff potential. The have soil layers that impede downward movement of water and have a slow infiltration rate.

Group D: Consist of soils having a slow infiltration rate when thoroughly wet. The rate of water transmission is very slow, and runoff potential is very high. This group includes:

a. clay soils that have high shrink-swell potential
b. soils that have a permanent high water table
c. soils that have a clay pan or clay layer at or near the surface and
d. soils that are shallow over nearly impervious material

Figure II.A.1 shows the hydrologic soils group delineations as provided by the National Resources Conservation Service (NRCS – Formerly Soils Conservation Service). As seen on this exhibit, all areas of the watershed model are predominantly Soils Group "D", which indicates low permeability of the soils and high runoff rates. The Placer County Flood Control and Water Conservation District's Storm Water Management Manual (SWMM) prescribes constant infiltration rates for various land uses. The DSMP defines the following values of use: 0.07 in/hour for native ground, 0.09 in/hr for developed landscaped areas, and 0.12 in/hr for developed park areas. Impervious surfaces are not considered to have infiltration, except for the LID related studies, where non-directly connected impervious areas, and LID treated areas were considered to be "non-impervious".

FIGURE II.A.1 – REGIONAL HYDROLOGIC SOILS GROUPS

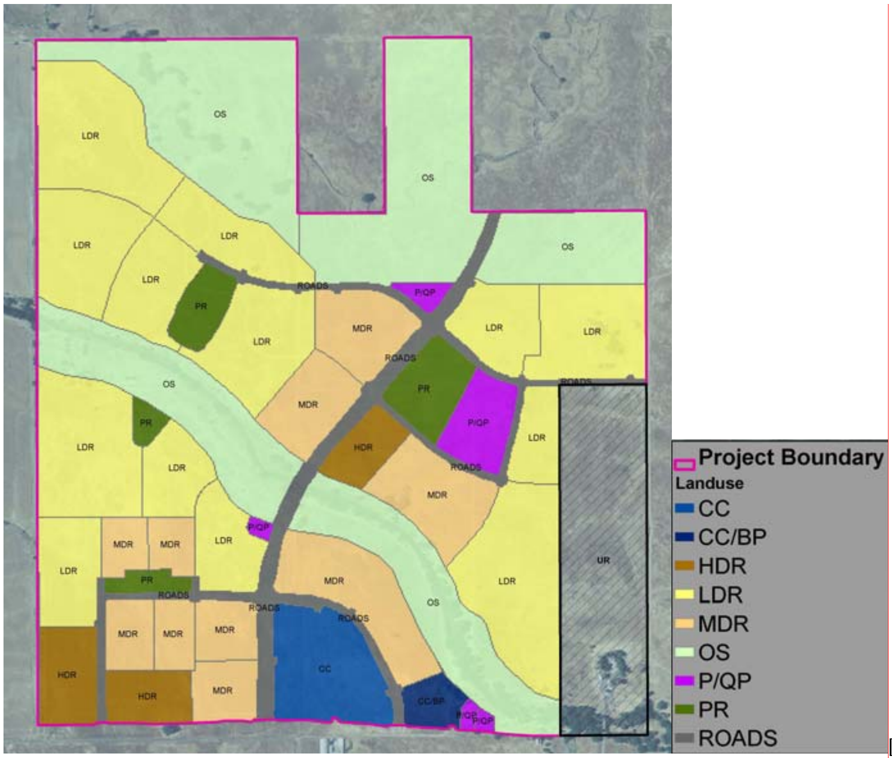


An oversized copy of this exhibit is provided as an attachment to this report as "SOIL-1".

II.A.2 Land Use:

Civil Solutions was provided with a proposed land use map for the Creekview Specific Plan project area as shown in Figure II.A.2 and on Exhibits SH-2 and FP-2. For the areas which are proposed for development with this project, separate watersheds were created in the post-project analysis. Factors for the Land Use were developed as shown in Table II.B.1.

FIGURE II.A.2 – CREEKVIEW SPECIFIC PLAN PROPOSED LAND USE



[w1]

II.A.3 Watershed Delineation:

The lands of the proposed project are wholly contained within the Pleasant Grove Creek watershed (see Exhibit SH-A). The “natural” watershed boundaries have been modified by the existing roadways and agricultural operations.

For the Pre-Project analysis, some minor shed limit boundaries were changed from the FEMA and City Basis studies and corresponding areas were re-calculated. The project watershed limits for the pre-project model are shown on exhibit SH-1A & SH-1B.

For the Post-Project analysis, watershed boundaries were adjusted to conform to the proposed development areas. Sub-watersheds were further subdivided to account for the proposed site alterations including: changes in impermeability due to roofs and paving, and changes in boundary locations due to the proposed piping and grading. Tributary areas to each watershed closely match the Pre-Project parameters, but minor adjustments were made for the above-mentioned purpose. Flow paths through and off the site for the Post-Project are identified on the shed map SH-2A and SH-2B

A portion of the area shown as Urban Reserve, east of the areas with designated land use, currently drains through the proposed CSP development areas. These areas do not have a land use type specified other than "urban reserve". Urban reserve areas which drain through the CSP site are assumed to have a "Medium Density Residential – MDR" land use for the design the size of storm drain trunks within the CSP (as if the urban reserve areas were a part of the project but with MDR land use). Mitigation alternatives also consider these urban reserve areas as developed MDR land use. The land use designation of the remaining "Urban Reserve" areas which drain to Pleasant Grove Creek directly, but not through the CSP, are not altered with this DSMP analyses..

II.A.4 Storm Centering:

The HEC-1 watershed model includes more than 1 square mile of area, and therefore, the effects of spatial distribution of a storm may have an impact on the computed peak flow rates. The Placer County Flood Control and Water Conservation District provides a software tool called "PDP", for use in generating HEC-1 precipitation for storm centering per the SWMM specifications. In late 2008 and early 2009, the district made adjustments to the PDP software generated a beta test version, "PDP2" of the program which makes adjustments including:

- The Area Reduction Coefficient is adjusted such that a minimum value is substituted so that precipitation values for the peak 1-hour will not drop below the precipitation rate at the edge of the peak 1-hour

- The 6-hour 100-year precipitation value from the SWMM tables is altered from 2.23 inches to 2.49 inches which is a statistically more normalized value with record data

- Log-linear interpolation is substituted for log-log interpolation

The test period for the Beta version of the PDP2 software will be complete when the Dry Creek Watershed Update Plan is adopted. No changes or issues have been found with this version. The analysis included in the DSMP utilized the PDP2 version of the district's software.

The FEMA analysis was also corrected for its use of the PDP software, to PDP2 (PDP Version 2). For example, the FEMA analysis included 24-hour precipitation for elevation 400 in the 100-year event totaling more than 5.1 inches, however, the SWMM indicates that the total depth of precipitation for this event should be 4.84 inches. PDP2 generates the correct amount of precipitation.

Storm centering will be computed for PL5F at 90 degrees in all events. A table provided by RBF (included on disk) summarizing various storm center results from a PULS routing version of the regional model, demonstrates that the PL5F at 90 storm centering generates the peak flows for Pleasant Grove Creek through the Creekview Specific Plan region of the watershed.

II.B Pre-Project Model:

II.B.1 Base Model

Two Base HEC-1 data files were created. The 1st base model was developed using the hydrologic base models provided with the City Pleasant Grove Watershed Study (RBF 2010). For the pre-project conditions RBF 2010 model was not altered. Table II.B.1A shows only those watershed elements for the CSP project area and the surrounding vicinity which were modified in the various post-project scenarios.

TABLE II.B.1A – Pre-project Base Model Hydrologic Factors(City Model)

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 1						
		Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
PL10B	0.4591	0.1	0.09	2	350	0.001	0.4	100
PL10C	0.8539	0.1	0.07	2	350	0.001	0.4	91
PL10D	0.9208	0.1	0.09	2	350	0.001	0.4	77
PL10E	0.5629	0.1	0.09	2	350	0.001	0.4	100
PL10M	0.4049	0.1	0.07	2	500	0.001	0.4	100

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 2						
		Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
PL10B	0.4591	0	0	0	0	0	0	0
PL10C	0.8539	0.1	0.13	56.456	94	0.0112	0.288	9
PL10D	0.9208	0.1	0.12	50.704	100	0.01	0.3	23
PL10E	0.5629	0	0	0	0	0	0	0
PL10M	0.4049	0	0	0	0	0	0	0

TABLE Note: A watershed may contain 2 overland routing planes in Kinematic Wave methodology. CESI uses plane 1 to represent the non-urbanized watershed area group, and plane 2 is used to represent the urbanized portion of the watershed area. We distinguish in this way because non-urbanized area tend to have much different runoff timing than urbanized areas. HEC-1 requires that Plane 1 always have values, so in some instances where no non-urban plane exist, the urban plane values are put solely into Plane 1.

The second base model uses the preliminary HEC-1 data files for the FEMA DFIRM update for Pleasant Grove Creek (work in process). For the pre-project analysis the values in the FEMA DFIRM model were not changed. Table II.B.1B shows only those watershed elements for the CSP project area and surrounding vicinity which were modified in the various post-project scenarios.

TABLE II.B.1B – Pre-project Base Model Hydrologic Factors(FEMA Model)

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 1						
		Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
PL10B	0.95	0	0.02	0	600	0.016	0.4	15
PL10C	1.94	0	0.08	0	600	0.016	0.4	100
PL10D	5.62	0	0.07	0	600	0.01	0.4	100
PL10E	0.35	0	0.07	0	600	0.01	0.4	100

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 2						
		Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
PL10B	0.95	0	0.08	0	600	0.016	0.4	85
PL10C	1.94	0	0	0	0	0	0	0
PL10D	5.62	0	0	0	0	0	0	0
PL10E	0.35	0	0	0	0	0	0	0

II.C Post-Project "Future, Fully Developed, Unmitigated" Model (FFDU):

Civil Solutions prepared a Post Project model based on the proposed CSP project land use information and the soils delineation boundaries. The Post Project model is based on the CSP plan information shown on Exhibits SH-2A and SH-2B. Factors for the developing watershed areas were added as shown in TABLE II.C.1A & II.C.1B in the Plane 2 watershed data (HEC-1 provides input for two overland planes, the secondary plane is used to quantify the urban factors related to development of the CSP project). Directly connected impervious area (percentage) was computed based on average coverage rates assumed for the various contributing area types as follows:

Land Use Type:	% Impervious
Low Density Residential (LDR)	40%
Medium Density Residential (MDR)	50%
High Density Residential (HDR)	60%
Commercial (Comm)	70%
Park	5%
Public/Quasi Public	50%
Roadway	85%

The above listed infiltration rates were adapted from the 2010 Dry Creek Watershed Update,,and the Pleasant Grove watershed studies.

Overland flow factors are also adjusted in the secondary (development) plane per typical values for the various development types. The adjustments were made in accordance with the calibrated rating tables generated in the "City Basis Study".

The CSP post-project hydrology(HEC-1) models were constructed using the City Basis model and are included on the CD-ROM in Appendix J of this DSMP. A complete listing of this file is provided in Appendix C. The CSP post-project hydrology model was used in the DSMP to examine all post-project scenarios. All post-project scenarios use the City Basis model modified to incorporate the results of the post-project hydraulic routing model results. CSP post-project model is also adapted to examine the "Future, Fully Developed, Unmitigated" scenario, which means that all existing offsite detention has been removed, that all offsite areas are assumed to be fully developed, and that project detention is also removed. Since Routing through the project limits is performed in the hydraulic models and is a part of the configuration of these models, inherently, the created attenuation of the bypass channel is included in all post project scenarios including the Future Fully Developed, Unmitigated scenario.

The factors shown in Table II.C.1A are for the CSP post-project model, and only those elements which have been modified from the City basis pre-project model are shown.

For the Future-Fully Developed Unmitigated scenario, the City Basis General Plan Buildout model is used as a base model. For the project area the factors shown in Table

II.C.1A are into the City Basis General Plan Buildout model.

TABLE II.C.1A – City Basis Post-Project Hydrologic Factors

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 1 Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
PL10B	0.4367	0.1	0.12	2.234	350	0.001	0.4	34
PL10C	0.853	0.1	0.1	3.722	350	0.0023	0.4	22
PL10D1	0.2006	0.1	0.09	2	350	0.001	0.4	49
PL10DA	0.0491	0.1	0.24	63.8	87	0.0126	0.274	100
P-WP5X	0.2274	0.1	0.09	2	350	0.001	0.4	77
PL10DB	0.0144	0.1	0.14	75.63	75	0.015	0.25	100
PL10DC	0.0528	0.1	0.12	5	350	0.005	0.4	6
CVPG3X	0.0399	0.1	0.09	2	350	0.001	0.4	77
PL10DD	0.0573	0.1	0.12	5	350	0.005	0.4	5
PL10DK	0.0271	0.1	0.12	40	130	0.01	0.3	100
PL10D5	0.0018	0.1	0.09	2	350	0.001	0.4	77
PL10DE	0.0394	0.1	0.15	47.71	109	0.01	0.3	100
PL10D4	0.0119	0.1	0.09	2	350	0.001	0.4	77
PL10DG	0.0392	0.1	0.12	43.98	121	0.01	0.3	100
PL10DF	0.0825	0.1	0.12	5	350	0.005	0.4	11
PL10D3	0.0396	0.1	0.09	2	350	0.001	0.4	77
PL10DI	0.0234	0.1	0.12	5	350	0.005	0.4	11
PL10D2	0.0387	0.1	0.09	2	350	0.001	0.4	77
PL10DJ	0.027	0.1	0.12	5	350	0.005	0.4	8
PL10E	0.5615	0.1	0.09	2	350	0.001	0.4	100
PL10M2	0.0114	0.1	0.07	2	350	0.001	0.4	100
PL10ML	0.0318	0.1	0.12	40	130	0.01	0.3	100
PL10M1	0.233	0.1	0.07	2	350	0.001	0.4	100
PL10MH	0.1076	0.1	0.12	5	350	0.005	0.4	5
PL10N	0.275	0.1	0.07	2	350	0.001	0.4	100

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 2 Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
PL10B	0.4367							
PL10C	0.853	0.1	0.12	46.449	112	0.01	0.3	78
PL10D1	0.2006	0.1	0.12	50.704	100	0.01	0.3	53
PL10DA	0.0491							
P-WP5X	0.2274	0.1	0.12	50.704	100	0.01	0.3	23
PL10DB	0.0144							
PL10DC	0.0528	0.1	0.12	48.7	106	0.01	0.3	94
CVPG3X	0.0399	0.1	0.12	50.704	100	0.01	0.3	23
PL10DD	0.0573	0.1	0.12	52.79	98	0.0104	0.296	95
PL10DK	0.0271							
PL10D5	0.0018	0.1	0.12	50.704	100	0.01	0.3	23
PL10DE	0.0394							
PL10D4	0.0119	0.1	0.12	50.704	100	0.01	0.3	23
PL10DG	0.0392							
PL10DF	0.0825	0.1	0.12	53.83	97	0.0106	0.294	89
PL10D3	0.0396	0.1	0.12	50.704	100	0.01	0.3	23
PL10DI	0.0234	0.1	0.12	43.2	121	0.01	0.3	89
PL10D2	0.0387	0.1	0.12	50.704	100	0.01	0.3	23
PL10DJ	0.027	0.1	0.12	40	130	0.01	0.3	92
PL10E	0.5615							
PL10M2	0.0114							
PL10ML	0.0318							
PL10M1	0.233							
PL10MH	0.1076	0.1	0.12	46.16	112	0.01	0.3	96
PL10N	0.275							

TABLE II.C.1B – FEMA Post-Project Un-mitigated Hydrologic Factors

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 1						
		Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
PL10B	0.9276	0	0.02	0	600	0.016	0.4	15
PL10C1	0.10777	0	0.08	0	600	0.016	0.4	100
PL10D1	0.1126	0.1	0.09	2	350	0.001	0.4	77
PL10D5	0.0018	0.1	0.09	2	350	0.001	0.4	77
PL10DE	0.0394	0.1	0.15	47.71	109	0.01	0.3	100
PL10D4	0.0119	0.1	0.09	2	350	0.001	0.4	77
PL10DG	0.0392	0.1	0.12	43.98	121	0.01	0.3	100
PL10DF	0.0825	0.1	0.12	5	350	0.005	0.4	11
PL10D3	0.0396	0.1	0.09	2	350	0.001	0.4	77
PL10DI	0.0234	0.1	0.12	5	350	0.005	0.4	11
PL10D2	0.0387	0.1	0.09	2	350	0.001	0.4	77
PL10DJ	0.027	0.1	0.12	5	350	0.005	0.4	8
PL10DA	0.0491	0.1	0.24	63.8	87	0.0126	0.274	100
P-WP5X	0.2274	0.1	0.09	2	350	0.001	0.4	100
PL10DB	0.0144	0.1	0.14	75.63	75	0.015	0.25	100
PL10DC	0.0528	0.1	0.12	5	350	0.005	0.4	6
CVPG3X	0.0399	0.1	0.09	2	350	0.001	0.4	100
PL10DD	0.0573	0.1	0.12	5	350	0.005	0.4	5
PL10DK	0.0271	0.1	0.12	40	130	0.01	0.3	100
PL10C2	0.98962	0	0.08	0	600	0.016	0.4	100
PL10D	5.4614	0	0.07	0	600	0.01	0.4	100
PL10ML	0.0318	0.1	0.12	40	130	0.01	0.3	100
PL10MH	0.1076	0.1	0.12	5	350	0.005	0.4	5
PL10E	0.35	0	0.07	0	600	0.01	0.4	100

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 2						
		Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
0.4	15	0	0.08	0	600	0.016	0.4	85
0.4	100	0	0	0	0	0	0	0
0.4	77	0.1	0.12	50.704	100	0.01	0.3	23
0.4	77	0.1	0.12	50.704	100	0.01	0.3	23
0.3	100	0	0	0	0	0	0	0
0.4	77	0.1	0.12	50.704	100	0.01	0.3	23
0.3	100	0	0	0	0	0	0	0
0.4	11	0.1	0.12	53.83	97	0.0106	0.294	89
0.4	77	0.1	0.12	50.704	100	0.01	0.3	23
0.4	11	0.1	0.12	43.2	121	0.01	0.3	89
0.4	77	0.1	0.12	50.704	100	0.01	0.3	23
0.4	8	0.1	0.12	40	130	0.01	0.3	92
0.274	100	0	0	0	0	0	0	0
0.4	100	0	0	0	0	0	0	0
0.25	100	0	0	0	0	0	0	0
0.4	6	0.1	0.12	48.7	106	0.01	0.3	94
0.4	100	0	0	0	0	0	0	0
0.4	5	0.1	0.12	52.79	98	0.0104	0.296	95
0.3	100	0	0	0	0	0	0	0
0.4	100	0	0	0	0	0	0	0
0.4	100	0	0	0	0	0	0	0
0.3	100	0	0	0	0	0	0	0
0.4	5	0.1	0.12	46.16	112	0.01	0.3	96
0.4	100	0	0	0	0	0	0	0

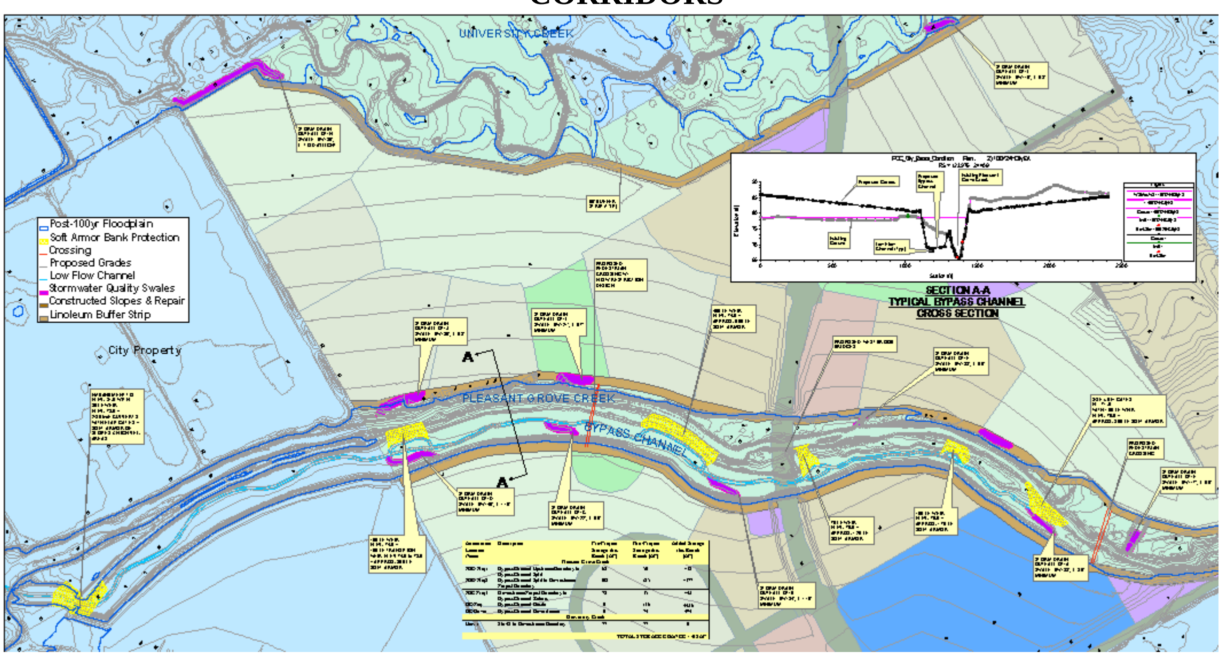
II.D Post-Project Mitigated Model:

Hydrologic (HEC-1) watershed factors for the post-project future fully developed, unmitigated and the post-project mitigated model are identical. The post-project models incorporate the effects of the Creekview Specific Plan Bypass Channel and other improvements as derived from the unsteady state HEC-RAS hydraulic analysis. Attenuation results from the proposed Bypass Channel, which would provide additional conveyance and storage capacity within the Pleasant Grove Creek system. Additionally, some attenuation results from small backwater effects which occur upstream of the proposed bridges. The added storage will function passively on the system, requiring no special operational maintenance.

The analysis and design of the floodplain areas, low flow channel and attenuation features accounts for the type of vegetation which may develop in these areas as a result of added nuisance waters and nutrients known to occur with types of development planned in this project. Exhibit AT-1 shows the proposed areas where improvements are proposed within the stream corridors. A reduced version of Exhibit AT-1 is provided here in Figure II.D.

Grading for the stormwater treatment swales at the main outfall locations was also included in the mitigation hydrology and hydraulics analysis.

FIGURE II.D – LOCATIONS OF IMPROVEMENTS PROPOSED IN STREAM CORRIDORS



An oversized plot of this exhibit is provided in the back of this report, as Exhibit AT-1. Proposed project facilities and wetland resources within the open space are also more easily identified on the larger exhibit.

The post project models for the Unmitigated and Mitigated conditions do not include adjustments for the proposed use of Low Impact Development measures that would be implemented by the CSP project. Those adjustments are only included in an additional model which is used to evaluate the Hydromodification impacts of the project, referred to as the "with LID" or "LID" model.

II.E Hydromodification Evaluation Post-Project Hydrology Model:

For the purposes of testing the potential hydrograph modification benefits of the proposed LID measures, an alternate hydrology (HEC-1 / HEC-HMS) analysis was performed which adjusts the imperviousness of the project for the LID components which will contribute to retention and infiltration of stormwater, which reduces runoff. This model includes the impervious area modifications for LID improvements by land use per TABLE II.E.1. Impervious area reductions are based on the Required Volume Reductions (RVR's) specified in section IV of this report. Timing of runoff passing through LID measures was not adjusted in this analysis compared to the other post-project hydrology models. Meaning that while a portion of area was converted to non-impervious type, it was retained in the urban plane of the watershed, and it is assumed that runoff coming from those areas will runoff in an urban timing. While changes in impervious area on type D soils are not a significant factor during the peak of flood events such as the 100-year, we have included these modifications so that impacts in smaller events such as stormwater quality (SWQ) and Hydromodification events (scientific evidence for events of significance for Hydromodofication does not exist for this watershed, however, in other areas of the state events between the 10-year and 10% or the 2-year are generally used) can be tested. Watershed HEC-1 factors are listed in Tables II.E.2A and II.E.2B. Sections IV.C and IV.D of this report show the results of the LID hydrologic analysis. Section IV.C.1 details how the Required Volume Reduction (RVR) are computed for this project and provide an example scenario of LID measures used to obtain these results. The Impervious Reduction factors identified in Table II.E.1 are discounted for only the LID elements that will produce improved infiltration and evapo-transpiration throughout the runoff events. The benefits of "Grassy Swales" and a portion of the benefit of "Soil Amendments" were not considered to derive the "Impervious Reduction for LID" used in the hydrologic analysis.

TABLE II.E.1 – IMPERVIOUS AREA REDUCTIONS FOR LID

Land Use Type	Non-modified Average Impervious %	Modified for LID Average Impervious %	Impervious Reduction for LID RVR's
LDR	40%	9%	31%
MDR	50%	12%	38%
HDR	60%	19%	41%
Commercial	70%	20%	50%
Public/Quasi Public	40%	9%	31%
Park	5%	2%	3%
Road	85%	26%	59%

TABLE II.E.2A – HYDROLOGIC WATERSHED FACTORS – LID REDUCED

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 1						
		Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
PL10B	0.4303	0.1	0.09	2	350	0.001	0.4	100
PL10C	0.8535	0.1	0.07	2	350	0.001	0.4	91
PL10D1	0.2006	0.1	0.09	2	350	0.001	0.4	47
PL10DA	0.0491	0.1	0.24	28.89	87	0.0126	0.274	100
P-WP5X	0.2274	0.1	0.09	2	350	0.001	0.4	100
PL10DB	0.0144	0.1	0.14	26.16	75	0.015	0.25	100
PL10DC	0.0528	0.1	0.12	2	350	0.005	0.4	6
CVPG3X	0.0399	0.1	0.09	2	350	0.001	0.4	100
PL10DD	0.0573	0.1	0.12	2	350	0.005	0.4	5
PL10DK	0.0271	0.1	0.12	9.4	130	0.01	0.3	100
PL10D5	0.0018	0.1	0.09	2	350	0.001	0.4	77
PL10DE	0.0394	0.1	0.15	17.18	109	0.01	0.3	100
PL10D4	0.0119	0.1	0.09	2	350	0.001	0.4	77
PL10DG	0.0392	0.1	0.12	10.6	121	0.01	0.3	100
PL10DF	0.0825	0.1	0.12	5	350	0.005	0.4	11
PL10D3	0.0396	0.1	0.09	2	350	0.001	0.4	77
PL10DI	0.0234	0.1	0.12	5	350	0.005	0.4	11
PL10D2	0.0387	0.1	0.09	2	350	0.001	0.4	77
PL10DJ	0.027	0.1	0.12	5	350	0.005	0.4	8
PL10E	0.5615	0.1	0.09	2	350	0.001	0.4	100
PL10M2	0.0114	0.1	0.07	2	350	0.001	0.4	100
PL10ML	0.0318	0.1	0.12	9	130	0.01	0.3	100
PL10M1	0.233	0.1	0.07	2	350	0.001	0.4	100
PL10MH	0.1076	0.1	0.12	5	350	0.005	0.4	5
PL10N	0.275	0.1	0.07	2	350	0.001	0.4	100

Shed Name	Area (Mi^2)	Hydrologic Data for Plane 2						
		Initial Infiltration (in/hr)	Constant Infiltration (in/hr)	% Impervious	Overland Length (ft)	Overland Slope (ft/ft)	Overland n' value	Percent of Watershed
PL10B	0.4303							
PL10C	0.8535	0.1	0.13	56.456	94	0.0112	0.288	9
PL10D1	0.2006	0.1	0.12	50.704	100	0.01	0.3	53
PL10DA	0.0491							
P-WP5X	0.2274							
PL10DB	0.0144							
PL10DC	0.0528	0.1	0.12	12.06	106	0.01	0.3	94
CVPG3X	0.0399							
PL10DD	0.0573	0.1	0.12	13.93	98	0.0104	0.296	95
PL10DK	0.0271							
PL10D5	0.0018	0.1	0.12	50.704	100	0.01	0.3	23
PL10DE	0.0394							
PL10D4	0.0119	0.1	0.12	50.704	100	0.01	0.3	23
PL10DG	0.0392							
PL10DF	0.0825	0.1	0.12	14.43	97	0.0106	0.294	89
PL10D3	0.0396	0.1	0.12	50.704	100	0.01	0.3	23
PL10DI	0.0234	0.1	0.12	10.58	121	0.01	0.3	89
PL10D2	0.0387	0.1	0.12	50.704	100	0.01	0.3	23
PL10DJ	0.027	0.1	0.12	9.5	130	0.01	0.3	92
PL10E	0.5615							
PL10M2	0.0114							
PL10ML	0.0318							
PL10M1	0.233							
PL10MH	0.1076	0.1	0.12	11.23	112	0.01	0.3	96
PL10N	0.275							

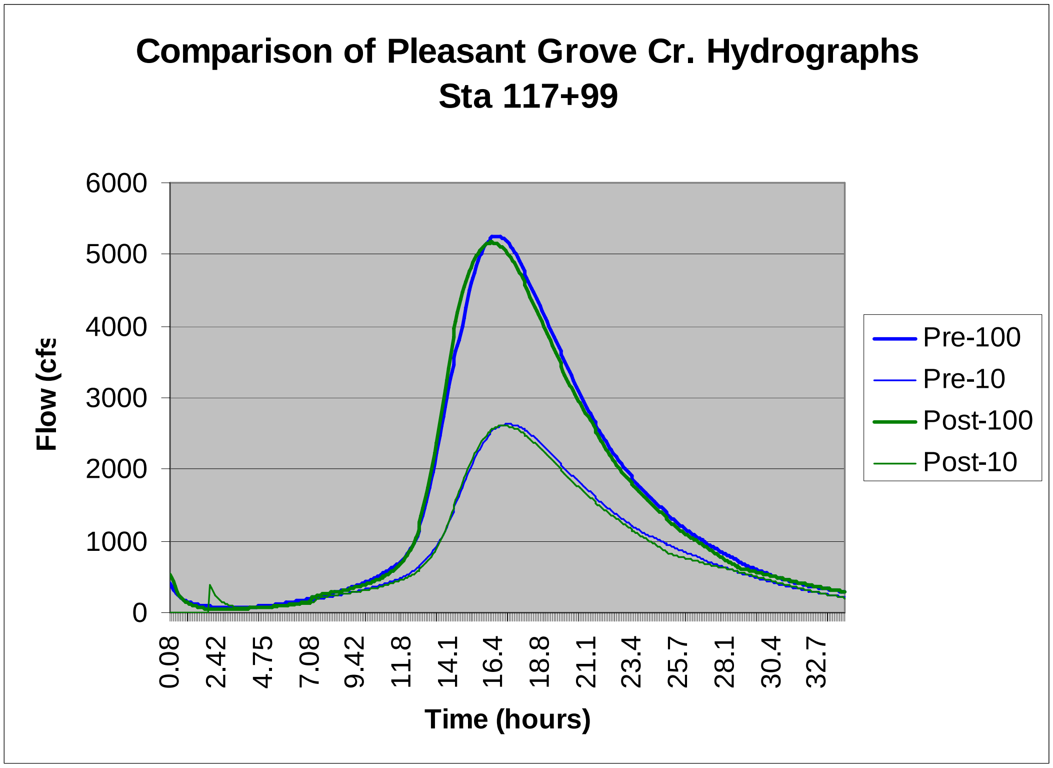
II.F Summary of Findings:

TABLE II.F.1A1 – City Basis 100-YEAR (& 10-YEAR) PEAK FLOW COMPARISON

Stream Station	Description	Pre-Project Peak Flow (cfs) (1)	Post-Project Future, Fully Developed, Unmitigated Peak Flow (cfs) (1)	Post-Project Mitigated Peak Flow (cfs) (1)	Post –Project Mitigated Net Peak Flow Reduction (cfs)
Pleasant Grove Creek – Main Channel					
172.3025	PGC-Upstream of Project	5252(2630)	5623(2982)	5247 (2627)	-5 (-3)
143.935	PGC-Upstream of Roadway Crossing (combined)	5298(2577)	5611(2968)	5216 (2615)	-82 (+38)
117.989	PGC-Downstream Project Boundary (combined)	5254(2630)	5617(2965)	5166 (2609)	-88 (-21)
94.24599	PGC-Bypass Channel Return	5034(2653)	5605(2958)	5065(2593)	+31 (-60) *
69.787	PGC-At Junction with University Creek	5013(2666)	5603(3004)	5062(2626)	+49 (-44) *
20.483	PGC at Reason Farms Return	5238(2871)	6055(3265)	5342(2840)	+104 (-31) *
University Creek					
56	UC-Upstream of Project flows	709(235)	809(313)	616 (201)	-93(-34)
43	UC-Leaving Project at North Boundary	675(225)	834(339)	667 (219)	-8(-6)
38	UC-Downstream of Project	654(205)	782(291)	649 (201)	-5(-4)

Note 1: values obtained from HEC-RAS Hydraulic Routing model results.
* Flows at the project boundary represent a net decrease in downstream flows as required, however modeling indicates a net increase at nodes downstream. The project modeling for the post project conditions includes obstructed overbank for a portion of the future fill at the south side of the bypass channel southerly berm at the panhandle property. The impact shown in the 100-year event resulting from this planned fill is considered less than significant because of the minor impact to water surface elevations see table III.A.3F

Figure II.F.1A – Comparison of Project Outflow Hydrographs



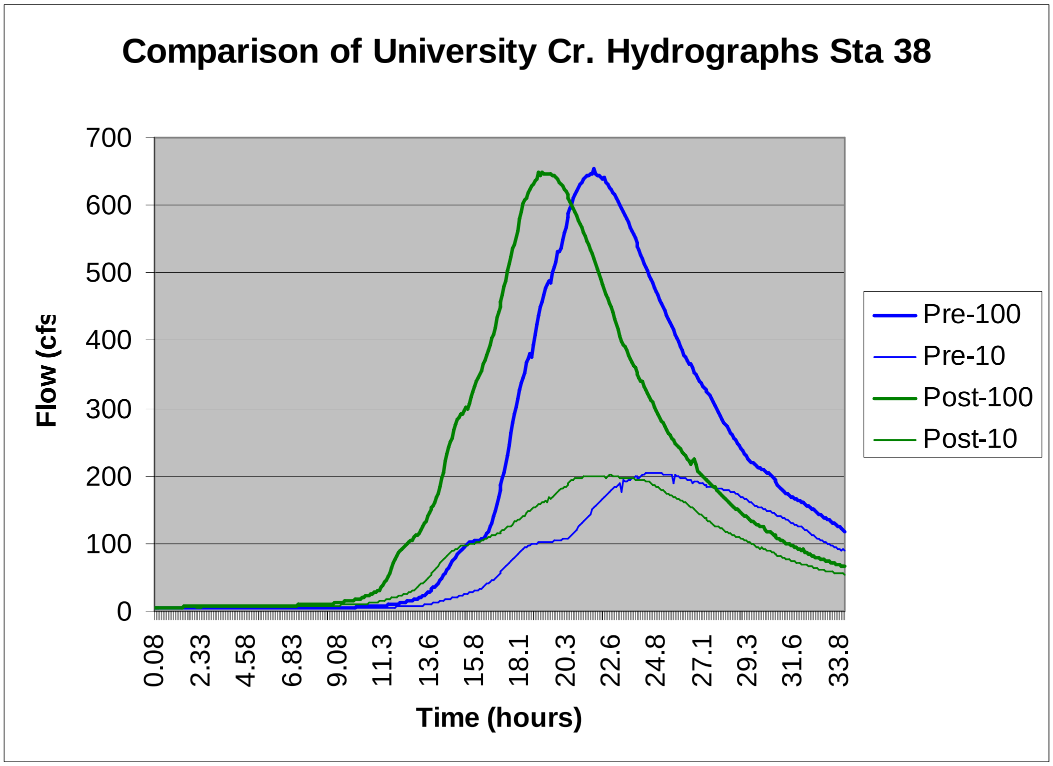


TABLE II.F.1A2 – FEMA Basis 100-YEAR (& 10-YEAR) PEAK FLOW COMPARISON

Stream Station	Description	Pre-Project Peak Flow (cfs) (1)	Post-Project Mitigated Peak Flow (cfs) (1)	Post –Project Mitigated Net Peak Flow Reduction (cfs)
Pleasant Grove Creek – Main Channel				
172.3025	PGC-Upstream of Project			
143.935	PGC-Upstream of Roadway Crossing	6949 (4032)	6825 (3997)	-124 (-35)
117.989	PGC-Downstream Project Boundary	6949 (4032)	6794 (3978)	-155 (-54)
94.24599	PGC-Bypass Channel Return	6949 (4032)	6770 (3965)	-179 (-67)
69.787	PGC-At Junction with University Creek	7745 (4488)	7622 (3964)	-123 (-524)
16.896	PGC at Reason Farms Return	7745 (4488)	7433 (3896)	-312 (-592)
University Creek				
56	UC-Upstream of Project flows	* 1572 (817)	1145 (592)	-427 (-225)
43	UC-Leaving Project at North Boundary	* 1572 (817)	1106 (571)	-466 (-246)
38	UC-Downstream of Project	* 1572 (817)	1062 (516)	-510 (-301)
2.1	US-Upstream of Confluence with PGC	* 1572 (817)	966 (637)	-566 (-180)

Note 1: values obtained from HEC-RAS model results. (Project unsteady state hydraulics model was used because, FEMA did not prepare an unsteady state model)
* - Includes all of PL10D watershed, which is more than University Creek.

Table II.F.1A1 compares the findings of the City Basis pre-project and post-project hydrology analysis for the Peak 100-year flow rates at several key locations within the project. Flow rates reported in this table result from the hydraulic routing analysis, and are reported as the "Max" flows in the HEC-RAS files for these locations.

Table II.F.1A2 compares the findings of the FEMA Basis pre-project and post-project hydrology analysis studies for the Peak 100-year flow rates at several key locations within the project. Flow rates reported in this table result from the HEC-1 hydrologic analysis models. This demonstrates that for the FEMA basis analysis, the project will mitigate peak flow rates for the 100-year and 10-year events at all locations.

Tables II.F.1A1 and II.F.1A2 identify that for all flow exit points from the project, the peak flow rates will be equal to or less than the pre-project peak flow rates for the 100-year event.

TABLE II.F.1B – REQUIRED ATTENUATION CREATION AREAS (100-YEAR)

Attenuation Location Name	Description	Pre-Project Storage this Reach (AF)	Post-Project Storage this Reach (AF)	Added Storage this Reach (AF)
Pleasant Grove Creek				
PGC-Proj1	Bypass Channel Upstream Boundary to Bypass Channel Split	81	48	**-33 (1)**
PGC-Proj2	Bypass Channel Split to Downstream Project Boundary	230	121	**-109 (2)**
PGC Proj3	Downstream Project Boundary to Bypass Channel Return.	38	36	**-2 (3)**
BC-Proj	Bypass Channel Onsite	56	145	**+89 (4)**
BC-Down	Bypass Channel Downstream	121	151	**+30 (5)**
University Creek				
Univ1	Sta 48 to Downstream Boundary	73	73	0
TOTAL ONSITE STORAGE CHANGE = -53 AF **TOTAL OFFSITE STORAGE CHANGE = +28 AF**				

(1) reduction in passthrough peak storage volume results from reduced water surface elevations in the upstream end of the project at Pleasant Grove Creek . (2) results from project encroachments and improvements at bypass channel and some water surface lowering. (3) results from minor water surface elevation changes. (4) results from the construction of the bypass channel. (5) results from the bypass channelization and berms north and south of the bypass channel at the Panhandle property.

Table II.F.1B identifies the estimated change in the amount of 100-year floodplain storage volume that would occur through the project reaches shown on Exhibit AT-1. These added storage volumes at the bypass channel provides effective storage in the creek system that mitigates peak flow increases from the project as shown in Table II.F.1A1.

III. Hydraulics:

III.A Flood Plain Analysis:

A portion of the west end of the Creekview Specific Plan is shown on the proposed Digital FEMA Flood Insurance Rate Map (DFIRM) panel shown in Figure III-1, which is not yet effective as "Zone A". Zone A is defined by FEMA as:

> *Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.*

The City of Roseville will require the project to apply to FEMA for a Conditional Letter of Map Revision (CLOMR) and for a Letter of Map Revision (LOMR). A CLOMR is typically applied for once a project planning document is approved and the grading concept (for areas within the floodplain) is designed to a point where substantial revisions are not expected. A LOMR application is requested once all work within the floodplain is complete, and as-built information can be certified for FEMA. The CLOMR and LOMR applications provide FEMA with detailed hydraulic analyses, Base Flood Elevation Data and revised floodplain maps showing the new floodplain and floodway limits. The applications should also detail the proposed and completed modification made to the floodplain.

The project proposes to provide onsite attenuation within the over bank flow areas. The Creekview Specific Plan also proposes to cross the floodplain at several locations with bridge/culvert crossings for roadways and pedestrian trails as shown on exhibit AT-1..

The results of the detailed hydraulic study of the pre-project floodplains for all tributaries of Pleasant Grove Creek within the project is shown on exhibit FP-1A and FP-1B. The estimated Post-project floodplains for the mitigated condition are shown on exhibit FP-2A and FP-2B. FP-3 identifies the "future fully developed, unmitigated" floodplains for the project which is the assumed post-project floodplain for design purposes. Exhibit FP-4 shows the differences between the pre-project and post-project 100-year floodplains for the City Basis analysis.

In addition to the pre-project floodplain analysis, two additional analysis were performed to determine what the floodplains would have been through the project before lands downstream of the project were altered for farming. A historic analysis was prepared for the historic topography with the pre-project 100-year flow rates, and a historic analysis was prepared for the historic topography with the Future Fully Developed, Unmitigated flow rates.

Floodway analysis was not performed for the CSP Drainage and Stormwater Master Plan but will be performed with the FEMA CLOMR and LOMR application studies.

The Army Corps HEC-RAS software version 4.1.0 was utilized to develop the included hydraulic models for the project. Floodplain elevations were determined for the 100-year event, for the Pre-Project and Post-Project conditions. The HEC-RAS base models were obtained from the new City Study and from the DFIRM FEMA study. Detailed cross sections within the project areas, the Panhandle property, and the Reason Farms property were re-cut based on the project topography. Where grading is proposed for the Bypass Channel, roadway and pedestrian trails, and stormwater quality improvements, the post-project models were updated accordingly. Figures III.A-1 to III.A-11 show the cross sections of Pleasant Grove Creek and University Creek where modifications are proposed.

Hydraulic models have been prepared for post-project conditions for both City Basis and the FEMA basis. For the FEMA basis pre project analysis, the FEMA steady state HEC-RAS analysis was used.. For the City Basis analysis, a pre-project unsteady state HEC-RAS model was used.

The City Basis and FEMA Basis models were developed independent of each other. The City Basis Hydrology includes a comprehensive inclusion of all project updates to the Pleasant Grove master watersheds and HEC-1 files. The City Basis hydrology models include analysis per the methodologies required by the City and meets the requirements of the Stormwater Management Manual, including the use of PDP software and the application of storm centering methodologies. The FEMA hydrology, includes a limited update to the HEC-1 base files for two projects in the upstream watersheds. The FEMA Basis hydrology incorporates the use of PDP software, but does not include the storm centering methodology. Both the City Basis and FEMA Basis models include hydraulic modeling of Pleasant Grove Creek. The City Basis hydraulic model includes a comprehensive compilation of models prepared by various projects in the watershed and the main intent of this model is to be used to perform hydraulic routing of the flows from the hydrology model. The model include hydraulic factors such as Manning's 'n' value which were determined by performing a calibration analysis. However, this model can be enhanced at local projects with detailed topography to be used for flood mapping purposes as well. The FEMA Basis hydraulic model includes only the main stem and main tributaries. The FEMA Basis hydraulics model cross sections were determined from LiDAR obtained specifically for this model, which in many locations is better information than the City Basis models were developed with. Hydraulic factors such as Manning's 'n' value were determined for the FEMA Basis model using engineering judgement, and no calibration to gage values in storm events was performed. The hydrology for the FEMA Basis model was compared to Regional values for a consistency check.

In General, the City Basis modeling produces lower, more attenuated flow rates, but with higher friction (Manning's 'n' values). The FEMA Basis model uses higher flow rates, but with less friction, and the timing of the flows are much quicker to respond than the City Basis analysis. Water surface elevations of each model are higher than the other in some places and lower in other places, so no direct conclusion can be made that one model is more conservative than the other for the prediction of Flow Rates. As such both model base methodologies are being analyzed in this project in order to "bookend" the potential range of hydrology and hydraulics that may ultimately be employed by the City to analyze Pleasant Grove Creek.

At the time of the writing of this document, the City of Roseville and FEMA had committed to work together to try to establish a uniform model that both agencies would be able to work with before any FEMA remapping of the watershed occurs. The details of what principles will be applied to the uniform model are still unknown.

III.A.1 Pre-Project Hydraulic Model Parameters:

The HEC-RAS version 4.1.0 software was utilized to perform an unsteady state hydraulic analysis of the existing floodplains. A site visit was performed to evaluate the stream conditions and estimate 'n' values for channel friction at the low flow and overbank areas. For the existing conditions, the 'n' values were not altered from those used in the City Basis analysis for the creek areas. Manning's 'n' values for the bypass channel were set per the City's requirements, such that values of 0.10 were used for the low flow paths, 0.08 were used for the channel bottom, and 0.06 was used at the side slopes of the channel. A small low flow crossing bridge exists near the upstream end of the project, which will be converted to a pedestrian crossing with the project, the bridge crossing was modeled the same for both the pre-project and post-project conditions.

The pre-project floodplain, mapped on the FP-1 shows the 100-year flood limits for the existing conditions through the Creekview Specific Plan. The pre-project HEC-RAS City Basis model also generates the pre-project peak flow hydrology for the City Basis of comparison with post-project conditions peak flows.

III.A.2 Post-Project Mitigated Hydraulic Model Parameters:

The post-project mitigated condition hydraulic model includes all bridges, culverts, and attenuation features planned for the project within the creek corridors. 'n' values are adjusted for this model to account for nuisance flow contributions to vegetation growth along the Bypass Channel. 'n' values of 0.10 are assumed in the low flow channel and 0.080 was applied to the remaining channel bottom, and an 'n' value of 0.06 was applied at the side slopes of the bypass channel.

Hydrology produced from the combined hydrology and hydraulic analysis is compared to the pre-project combined hydrology and hydraulic analysis to demonstrate mitigation objectives are being achieved by project improvements.

III.A.3 Future, Fully Developed, Unmitigated Hydraulic Model Parameters:

For this scenario, 'n' values from the post-project mitigated scenario are used. Wetland Creation areas were removed from the hydraulic model, so that the attenuation resulting from the floodplain volumes created by these features would not be counted. The model removes the routing within the hydrology models for detention basins within the Westpark subdivision, and assumes that mitigation is no longer functioning. The Westpark subdivision is a large approved specific plan development area south of the CSP. Several hundred acres of the Westpark plan area drain to Pleasant Grove Creek and approximately 150 acres of the Westpark plan will drain through the CSP via the proposed storm drain system.

Within the model, the edges of the channel were obstructed approximately 5 feet horizontally into the floodplain to account for future variability in the design of the edge features.

This scenario identifies the design basis floodplain for use in design of the various project elements. The floodplain limits identified by this model will be used in the project CLOMR when that is submitted to FEMA. The base flood elevations established in the Future Fully Developed, Unmitigated analysis are used for determining the elevations of structures to be constructed on the project. Depth of flow at Pleasant Grove Creek Varies from 12 feet to 18 feet at Pleasant Grove Creek in the 100-year event, and within the bypass will vary from 9 feet to 12 feet for the 100-year event. The floodplains of the bypass and main branch of Pleasant Grove Creek are connected and flows freely exchange through the project limits at the 100-year water surface elevation. At the downstream areas of the bypass channel, depths are roughly 11 feet.

At University Creek, 100-year depths vary from 6 feet to 8 feet along the project frontage.

The City Standards require that 2 feet of freeboard be applied where 100-year depths exceed 8 feet, and where 100-year depths do not exceed 8 feet, 3 feet of freeboard is applicable. The difference in the freeboard requirements is attributable to the potential for Beavers to cause impediments which could raise water surface elevations. For this project, all areas fronting on Pleasant Grove Creek and the Bypass Channel would be subject to the 2 feet minimum freeboard criteria. All areas fronting onto University Creek will be subject to the 3 feet minimum freeboard criteria.

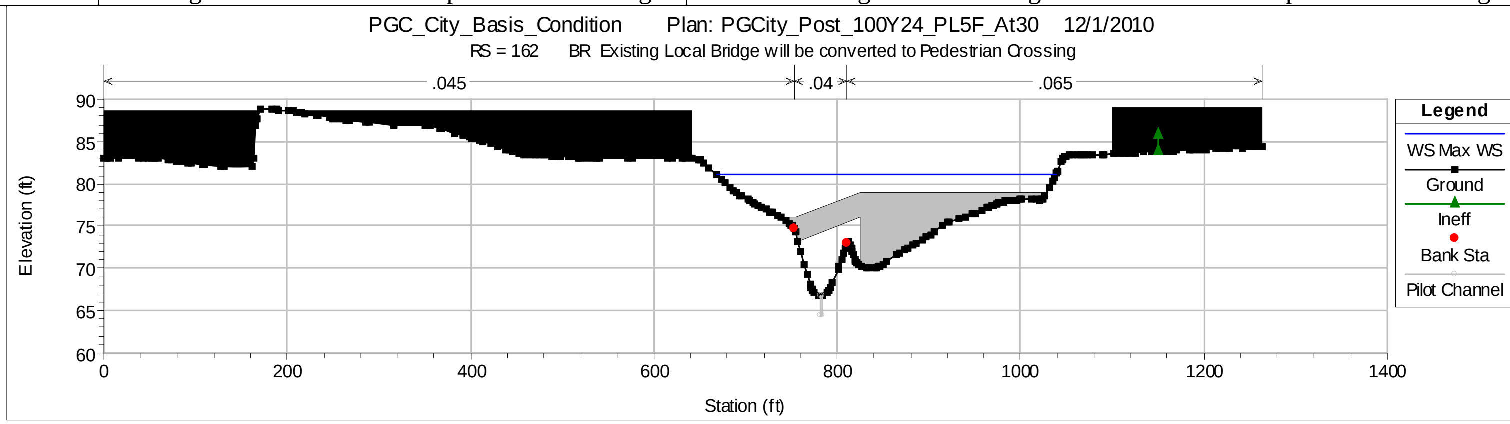
The Creekview Specific Plan Bypass Channel improvements are included in this model scenario. The Bypass Channel element is a mitigation measure to provide additional conveyance and attenuation volume through the project, however this element is also critical to the project function, so in this instance it is also being included in the "unmitigated" scenario.

Final design of the proposed Creekview Specific Plan bridges will require detailed hydraulic analysis demonstrating that the hydraulic elevations and peak flow attenuation levels proposed in the DSMP would be maintained for post-project mitigated and post-project unmitigated, 10-year and for 150% of the 100-year event.. The City requires that a 150% “clogging factor” be applied to the 100-year event flow rates at bridges to verify that they will continue to perform as designed at an elevated flow rates (area reduction methodology is not acceptable). The final design instream attenuation levels must be verified in these conditions, such that peak flows are not increase at the downstream project boundary.

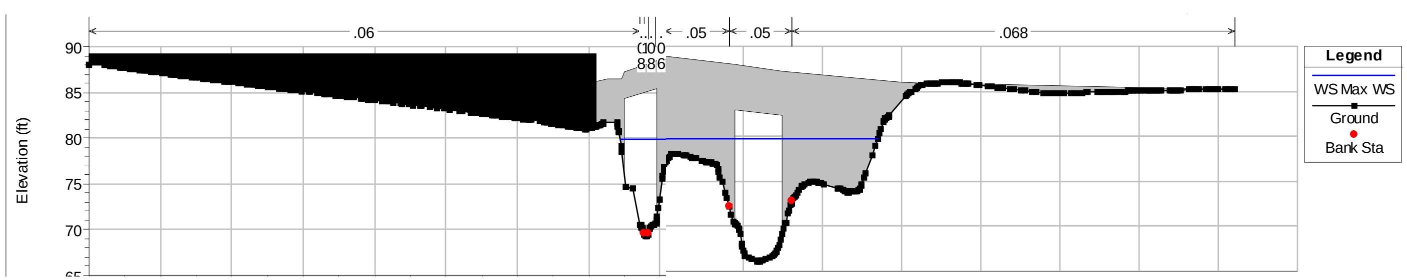
A special arch culvert was added to the proposed Creekview Specific Plan roadway crossing of the Bypass Channel. The culvert would provide a pedestrian undercrossing of the roadway. The pedestrian trail would be set at an elevation above the bypass channel invert elevation, such that the trail would not be expected to flood in a 2-year event and such that it provides 9 feet of vertical clearance.

TABLE III.A.3A – PROPOSED BRIDGE CROSSINGS 162 & 142

Station	Description	Approx. Crossing Length and Description
	PLEASANT GROVE CREEK	
162	Near upstream end of project, the existing access crossing will be converted to a pedestrian crossing	70' Rail Car Bridge (EX) the existing access crossing will be converted to a pedestrian crossing



Station	Description	Approx. Crossing Length and Description
142	Main Roadway Crossing	60' Span at PGC Main & 90' Span at Bypass Channel, Bike Trail Crossing is included in Bypass Channel Bridge Section



Note: the above design bridge and culvert sizes may be modified in final design, with alternate bridge and culvert types with equivalent capacity.

TABLE III.A.3B – PROPOSED BRIDGE CROSSING 131

Station	Description	Approx. Crossing Length and Description
	PLEASANT GROVE CREEK	
131	Near downstream end of project, a proposed pedestrian crossing	42' Bridge at Bypass + 33' Span Bridge at Pleasant Grove Creek

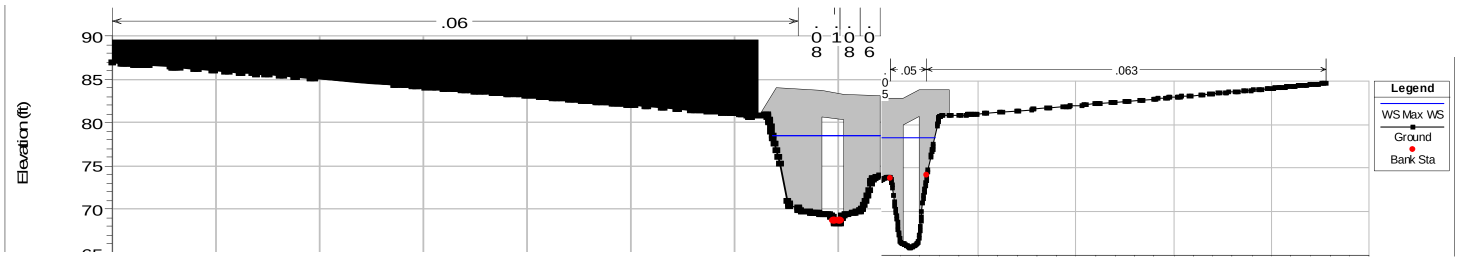
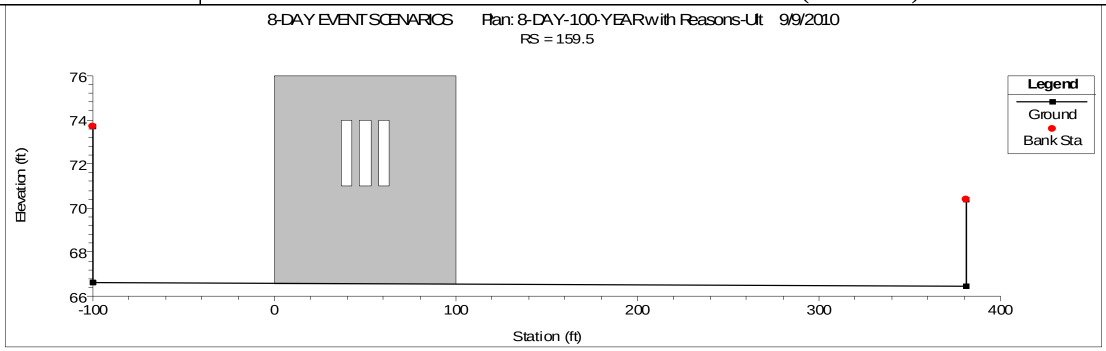


TABLE III.A.3C – OTHER SPECIAL STRUCTURES - WEIRS 159.5 & 153.5

Station	Description	Approx. Crossing Length and Description
	PLEASANT GROVE CREEK	
159.5	Diversion Weir and Gates to CSP Bypass Channel	3 – 3'h x 6'w gates with 100' overtopping weir at elevation 76.0 + approximately 300 feet of soft armor stabilization. (Incl. weir)



Station	Description	Approx. Crossing Length and Description
153.5	Flow Exchange Weir (PGC to Bypass Channel)	100' overtopping weir at elevation 75.5 + approximately 175 feet of soft armor stabilization (incl. weir)

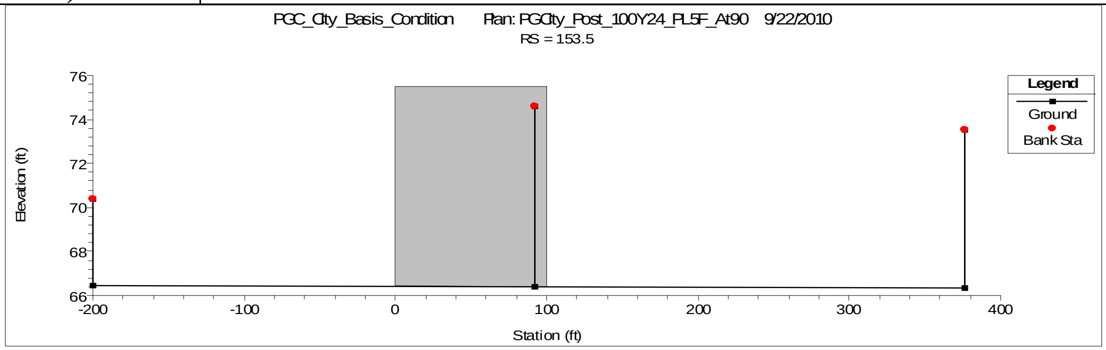


TABLE III.A.3D – OTHER SPECIAL STRUCTURES - WEIRS 145.92 & 139.5

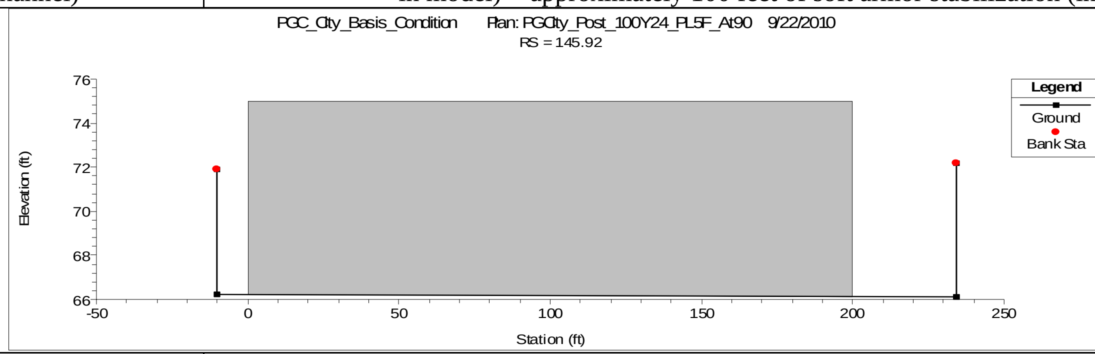
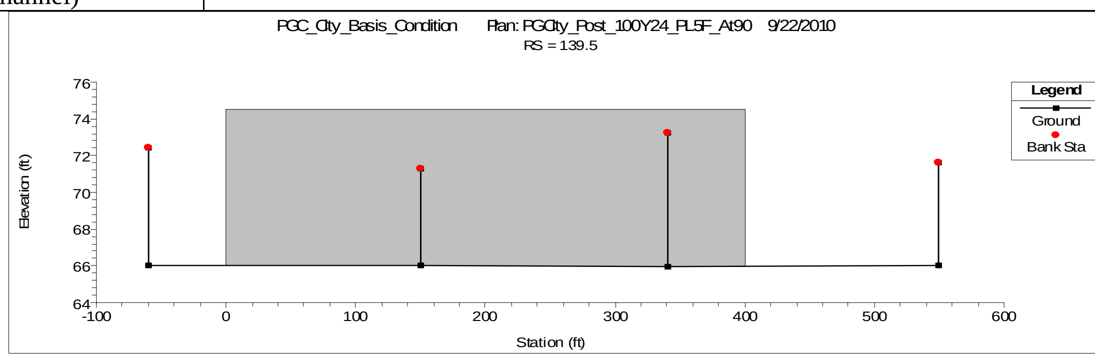
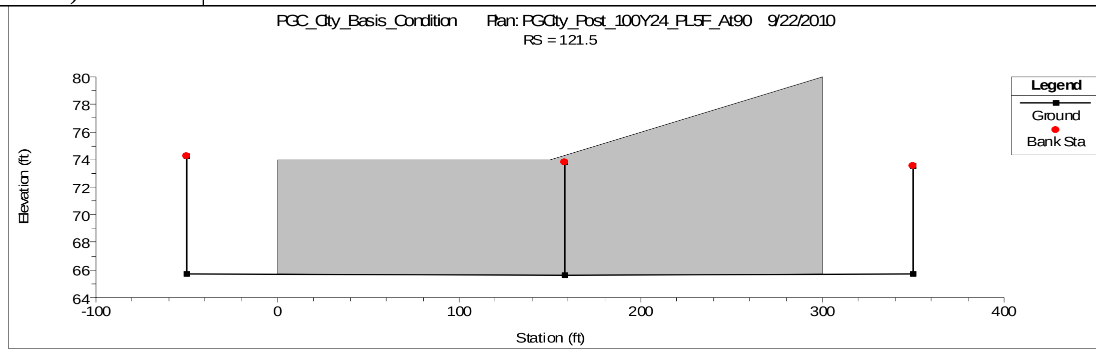
Station	Description	Approx. Crossing Length and Description
	PLEASANT GROVE CREEK	
145.92	Flow Exchange Weir (PGC to Bypass Channel)	75' Constructed weir at elevation 75.0 (+ approximately 125 feet of existing top of bank weir represented in model) + approximately 100 feet of soft armor stabilization (incl. weir)
		
139.5	Flow Exchange Weir (PGC to Bypass Channel)	400' overtopping weir at elevation 74.5 + approximately 500' soft armor stabilization (incl. weir)
		

TABLE III.A.3E – OTHER SPECIAL STRUCTURES – WEIR 121.5 & 99.5

Station	Description	Approx. Crossing Length and Description
	PLEASANT GROVE CREEK	
121.5	Flow Exchange Weir (PGC to Bypass Channel)	150’ overtopping weir at elevation 74.0 + 150’ of variable elevation weir (74.0 to 78.0) + approximately 350 feet of soft armor stabilization



Station	Description	Approx. Crossing Length and Description
99.5	Bypass Channel Return Structure	35’ Constructed overtopping weir at elevation 73.0 + approximately 300 feet of embankment to elevation 81.5 + 2-36 inch pipe culverts with flap gates on Pleasant Grove Creek side to prevent backflow into the bypass channel

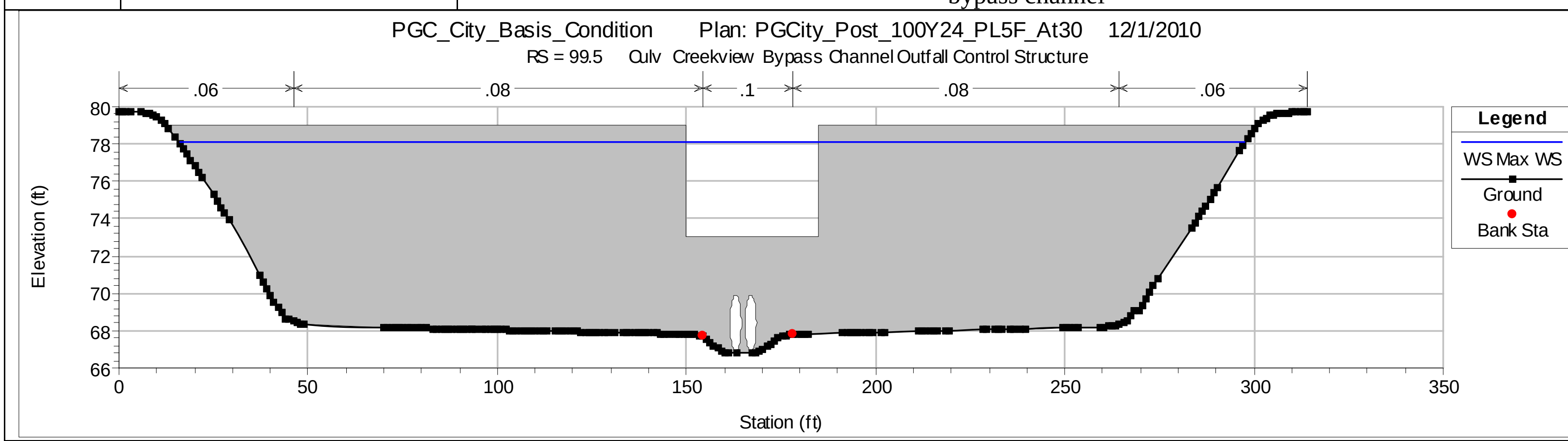


Table III.A.3F compares the hydraulic modeling results for the pre-project and post-project mitigated conditions at various project boundary locations for the peak flowrates of the 100-year event. The Table also demonstrates the project will not be adversely impacting offsite peak 100-year water surface elevations.

TABLE III.A.3F –Water Surface Elevations (WSE) Comparison for Pre- and Post-Project Mitigated Conditions

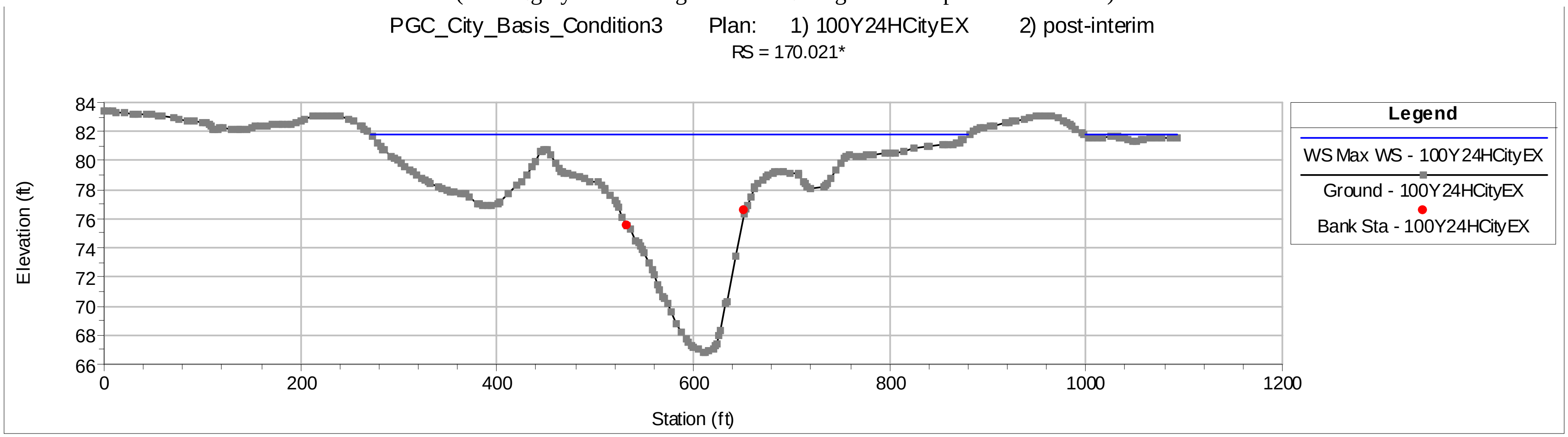
Station	Description:	Pre-project 100-year WSE	Post-project 100-year WSE	Reduction (ft)
	PLEASANT GROVE CREEK			
172.3025	PGC-Upstream of Project	81.98	81.59	**-0.39**
143.935	PGC-Upstream of Roadway Crossing	80.16	79.86	**-0.30**
143.935	Bypass Channel-Upstream of Roadway Crossing	79.87	79.89	**+0.02**
117.989	PGC-Downstream Project Boundary	78.35	77.73	**-0.38**
117.989	Bypass Channel-Downstream Project Boundary	77.59	78.27	**+0.68**
94.24599	PGC-Bypass Channel Return	72.71	72.32	**-0.39**
69.787	PGC-At Junction with University Creek	71.09	71.13	**-+0.04**
	UNIVERSITY CREEK			
56	UC-Upstream of Project flows	84.02	83.81	**-0.21**
43	UC-Leaving Project at North Boundary	78.65	78.65	**0**
38	UC-Downstream of Project	78.52	78.51	**-0.01**
2.1	US-Upstream of Confluence with PGC	71.29	70.88	**-0.41**

- Note: Elevations for the post-project shown in this table are not intended for design. Post-project future unmitigated elevations should be used for design (see Exhibit FP-3)

FIGURE III.A-3G1 – HEC-RAS CROSS SECTIONS PGC 170 & 167 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



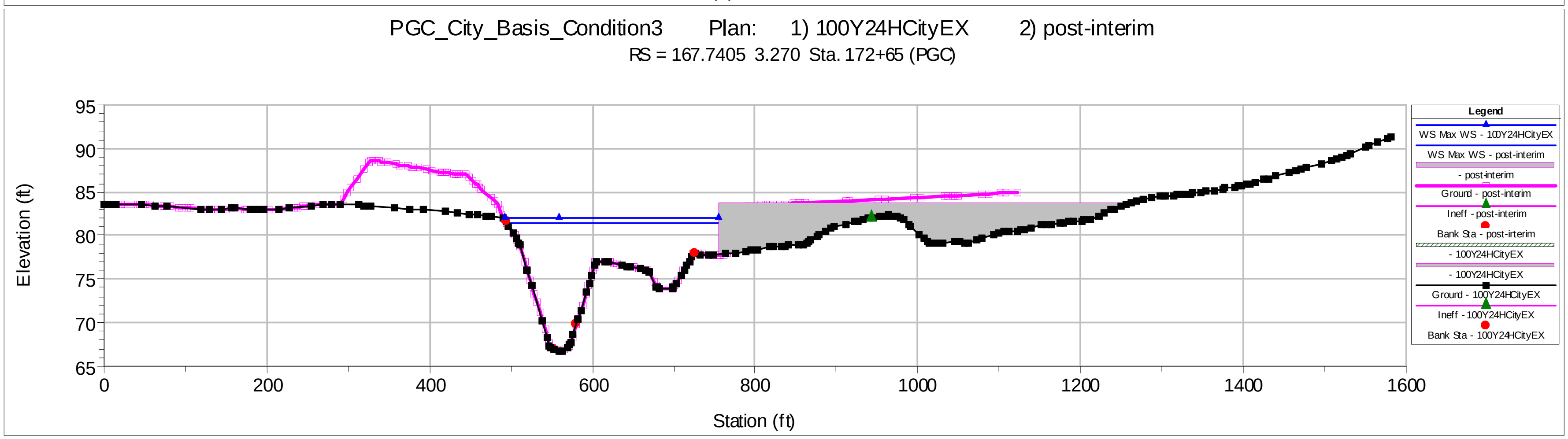
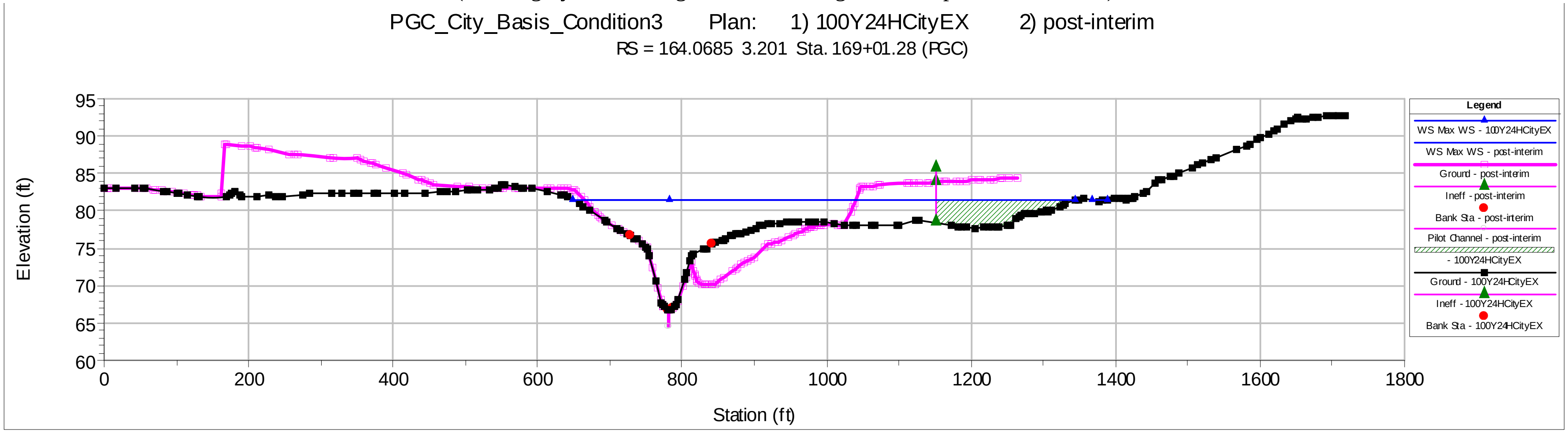


FIGURE III.A-3G2 – HEC-RAS CROSS SECTIONS PGC 164 & 162U (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream
(Black/.grey are existing conditions: Magenta = Proposed Conditions)



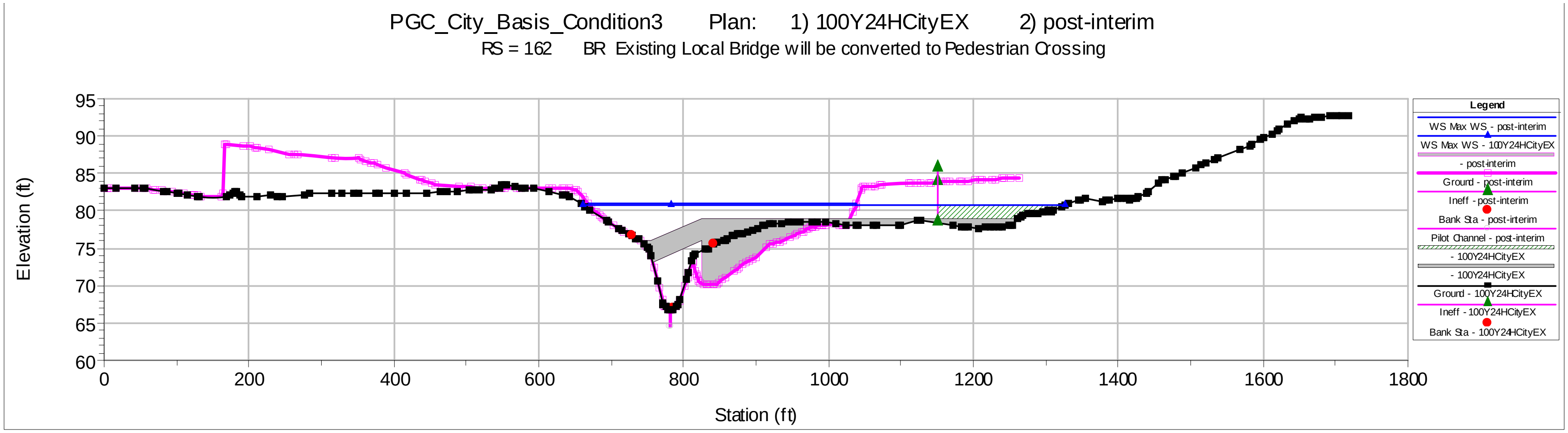
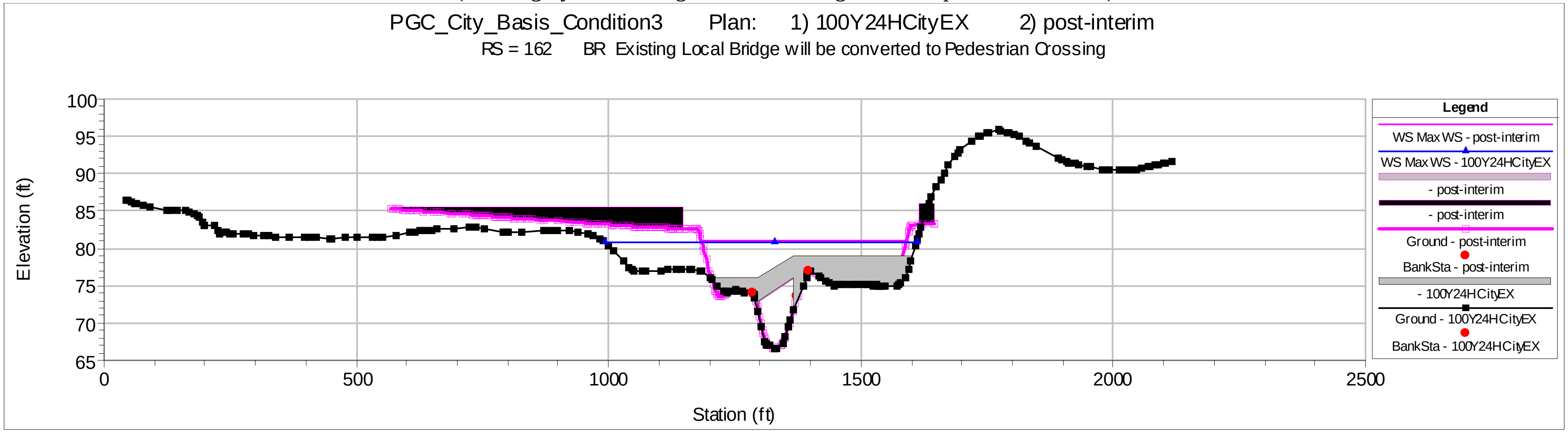


FIGURE III.A-3G3 – HEC-RAS CROSS SECTIONS PGC 162D & 160 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



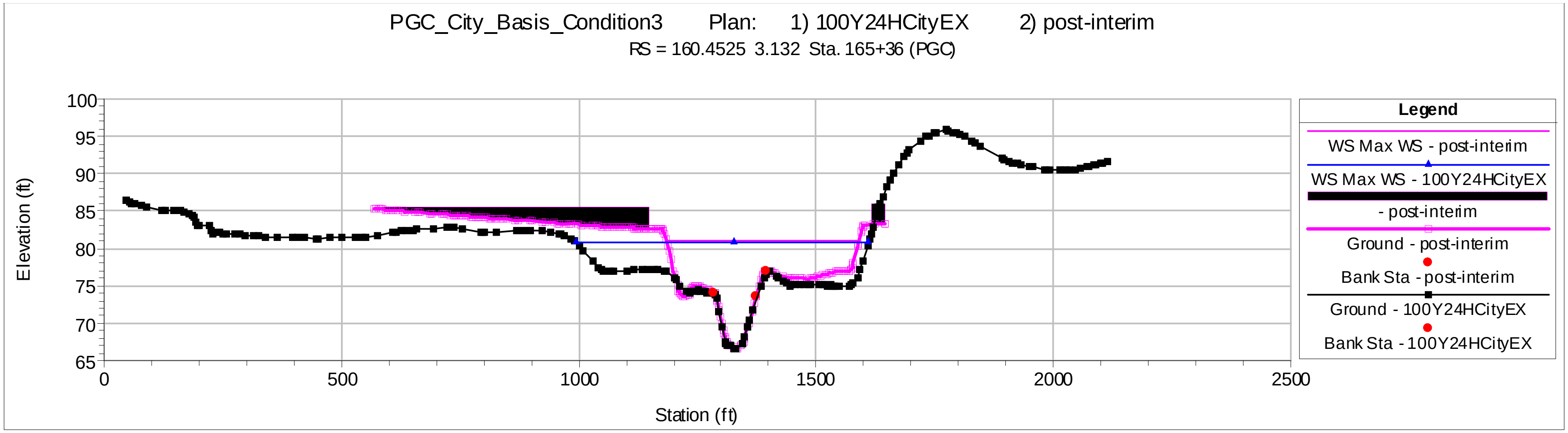
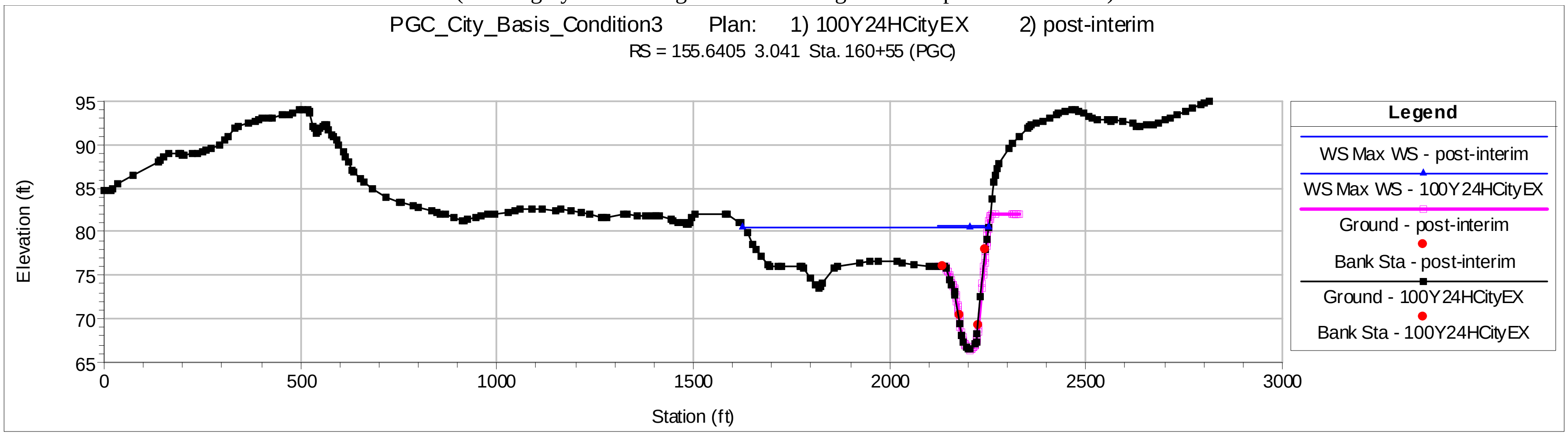


FIGURE III.A-3G4 – HEC-RAS CROSS SECTIONS PGC 156 & 153 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



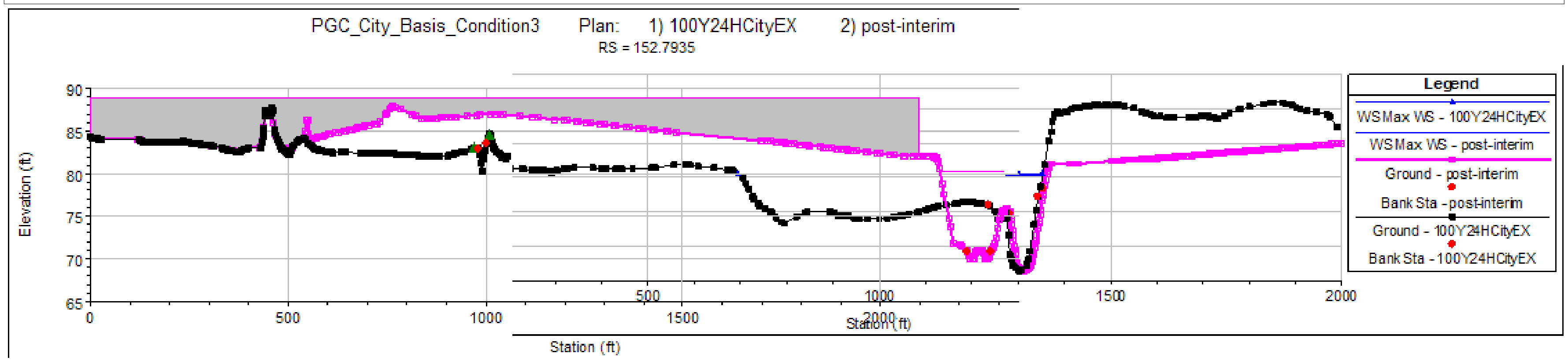
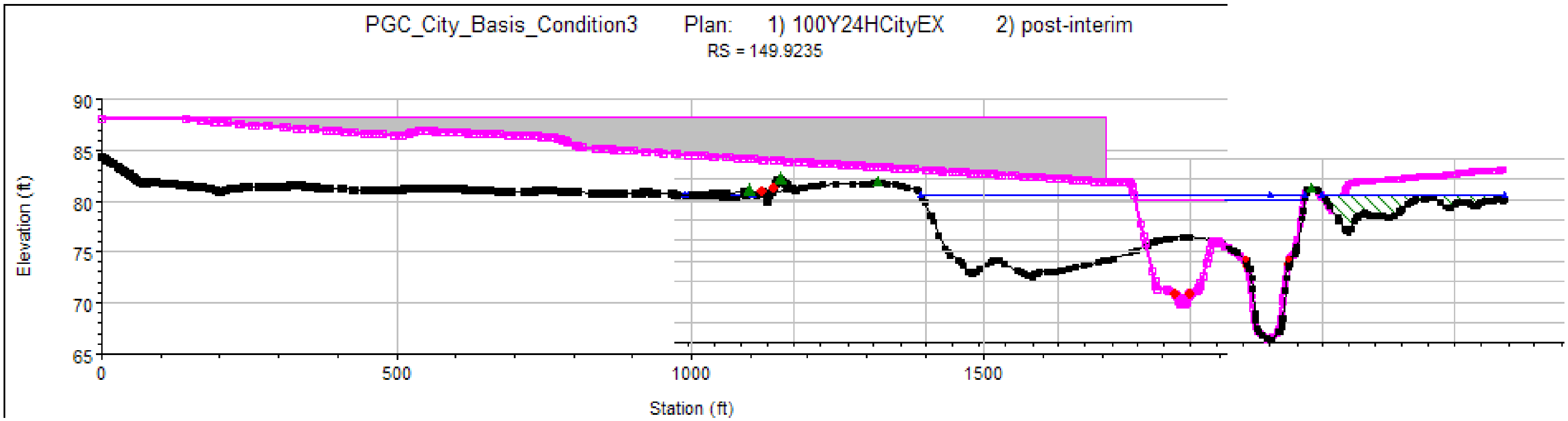


FIGURE III.A-3G5 – HEC-RAS CROSS SECTIONS PGC 150 & 148 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



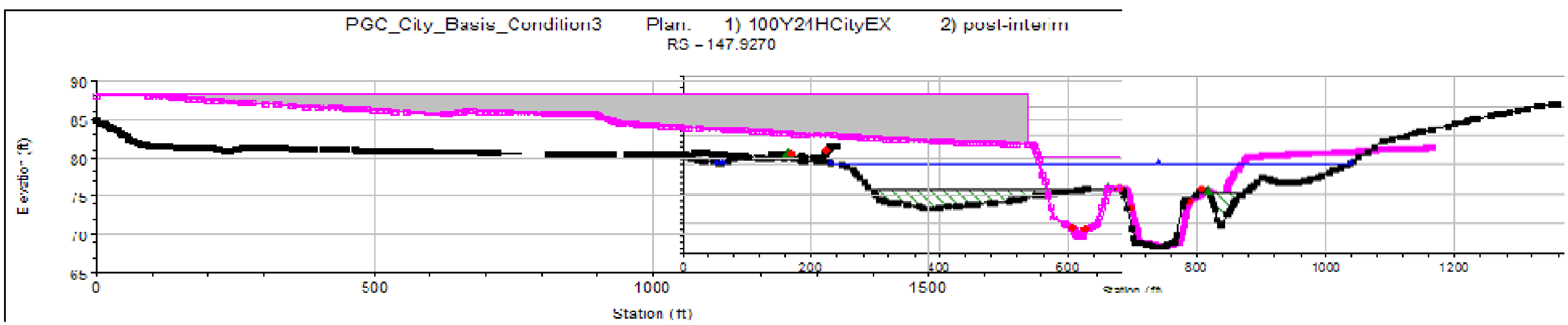
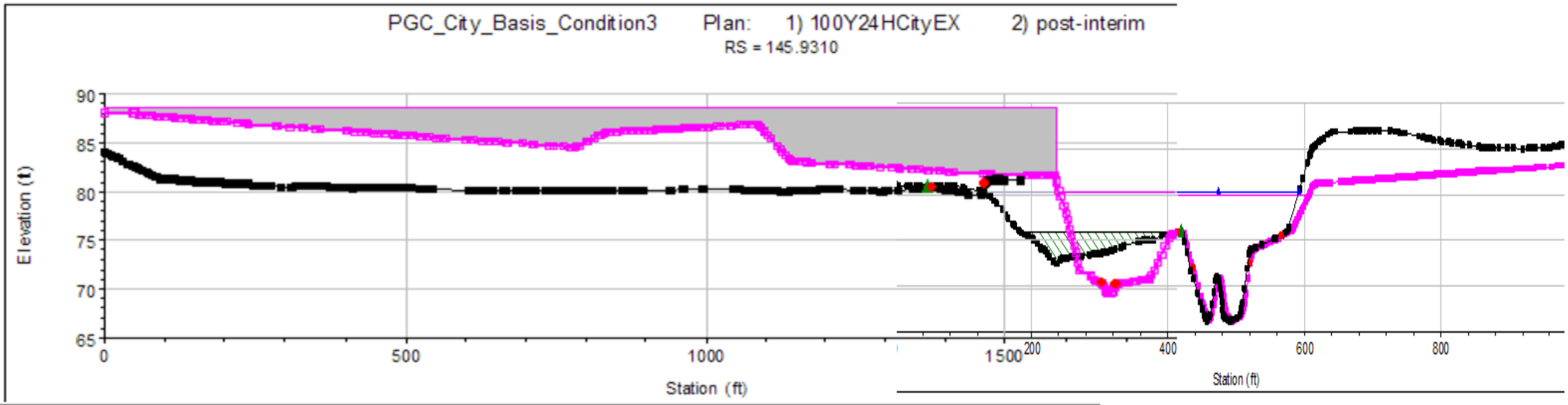


FIGURE III.A-3G6 – HEC-RAS CROSS SECTIONS PGC 146 & 144 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



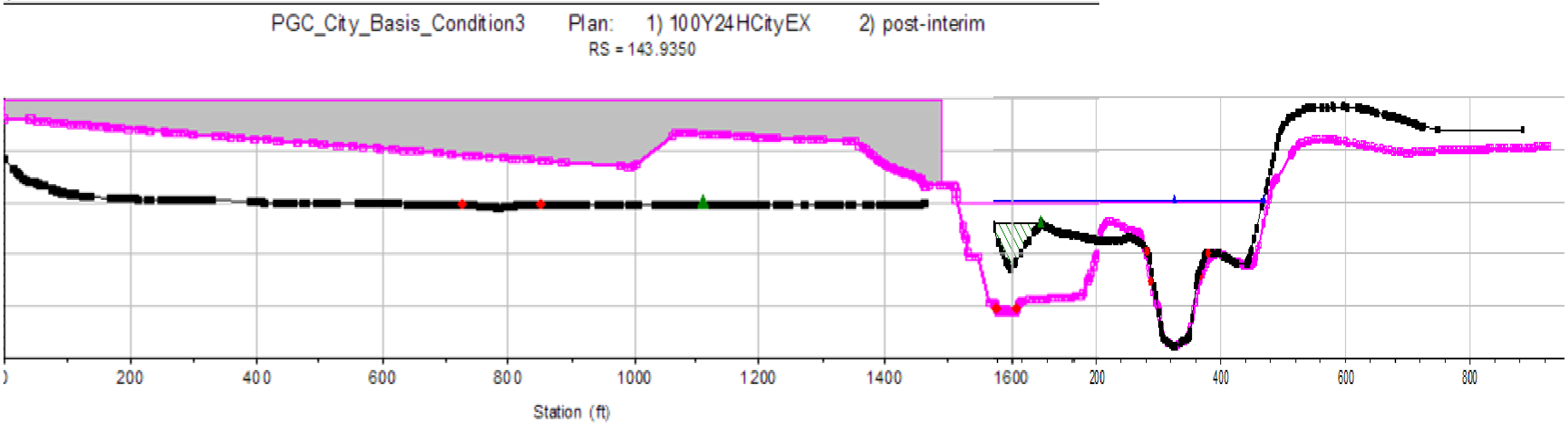
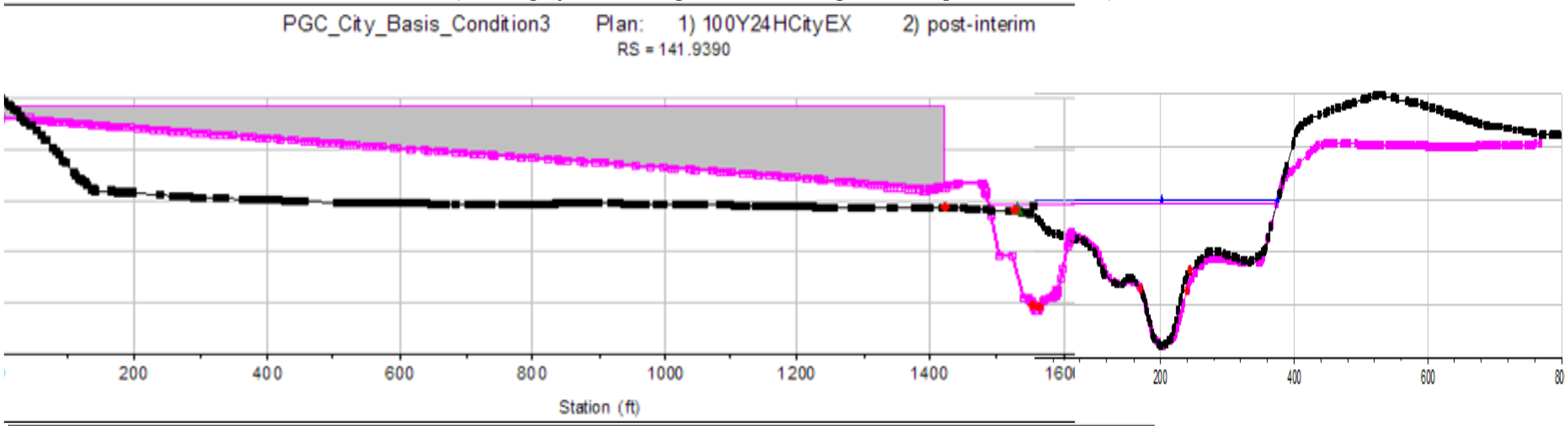


FIGURE III.A-3G7 – HEC-RAS CROSS SECTIONS PGC 143 & 142 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



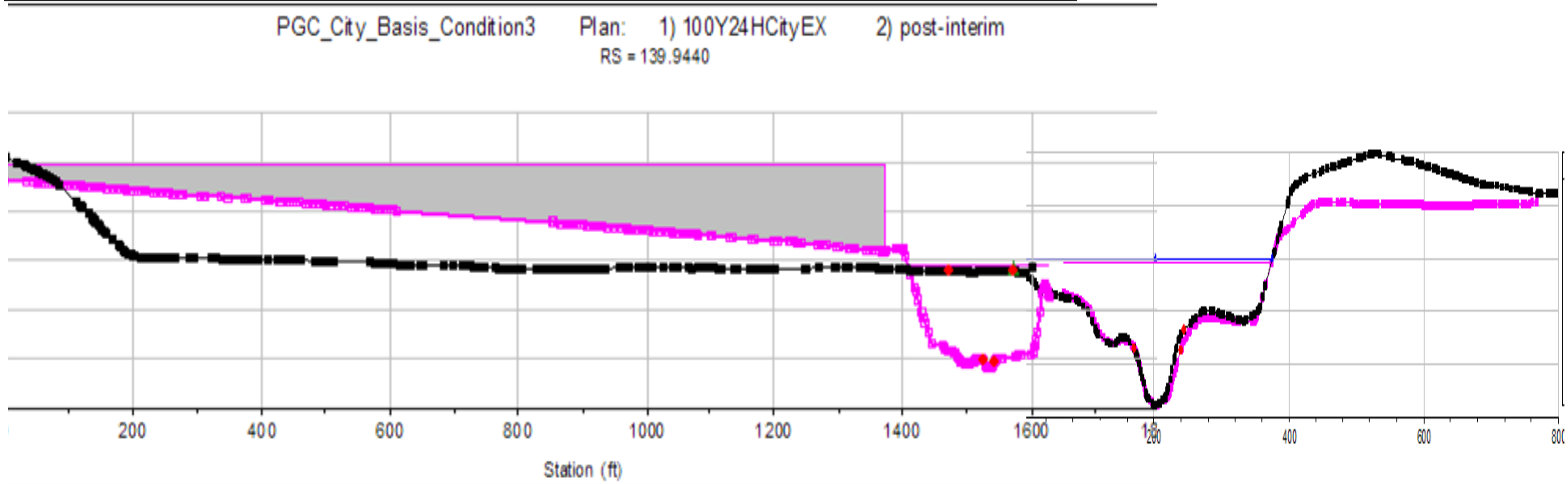
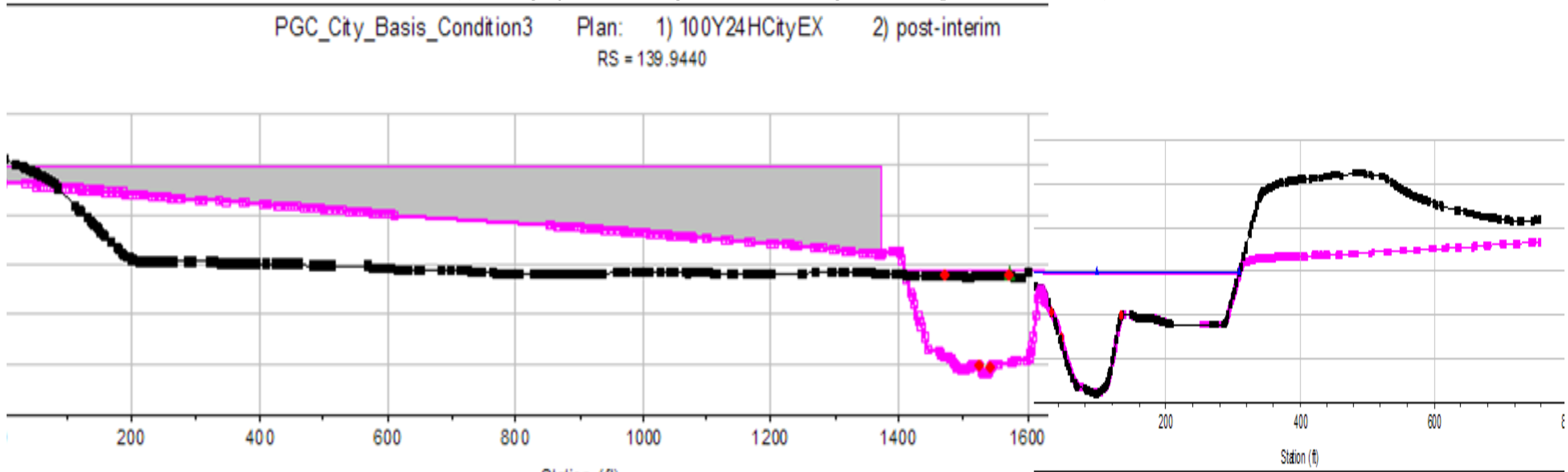


FIGURE III.A-3G8 – HEC-RAS CROSS SECTIONS PGC 140 & 138 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



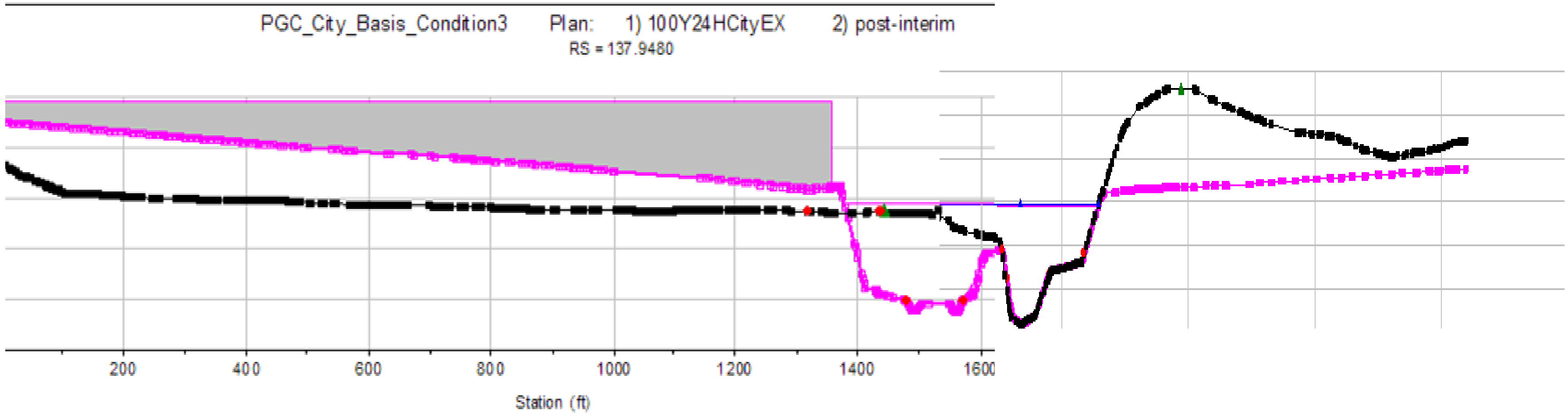
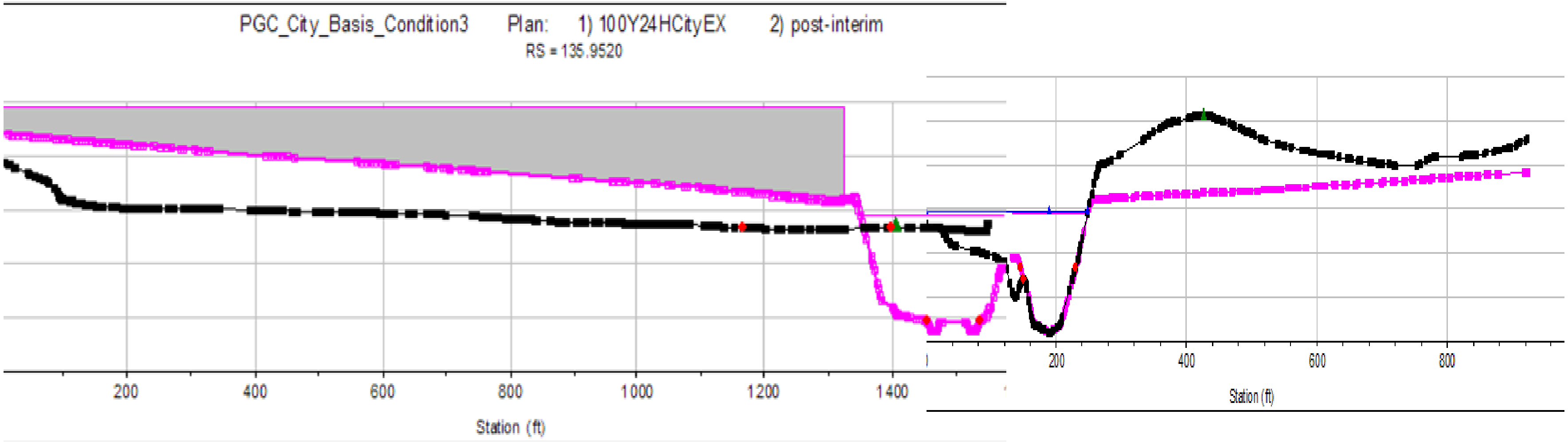


FIGURE III.A-3G9 – HEC-RAS CROSS SECTIONS PGC 136 & 134 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



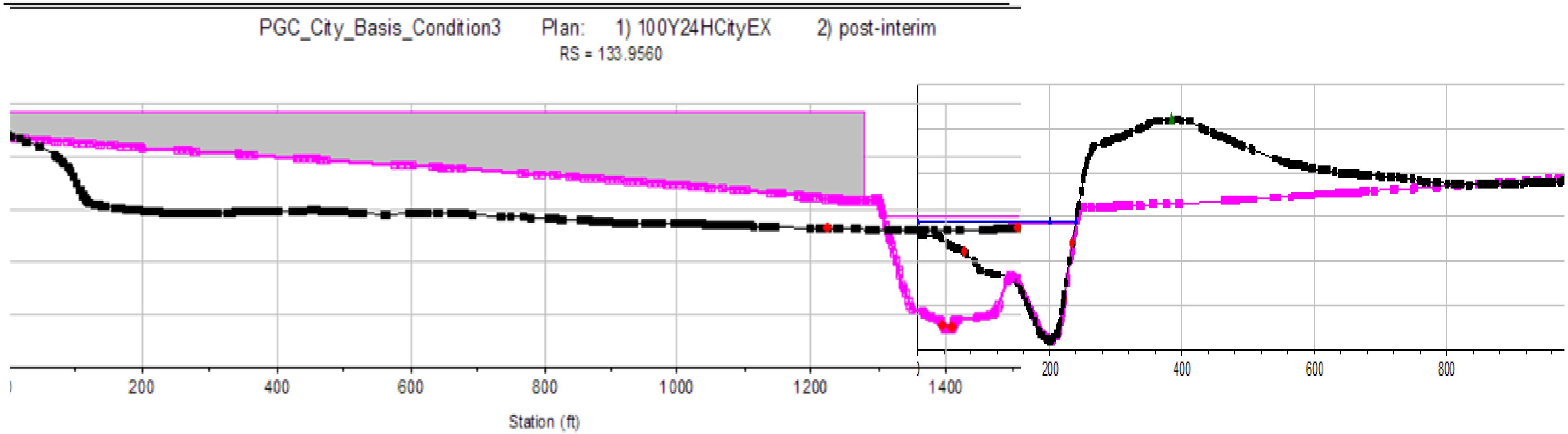
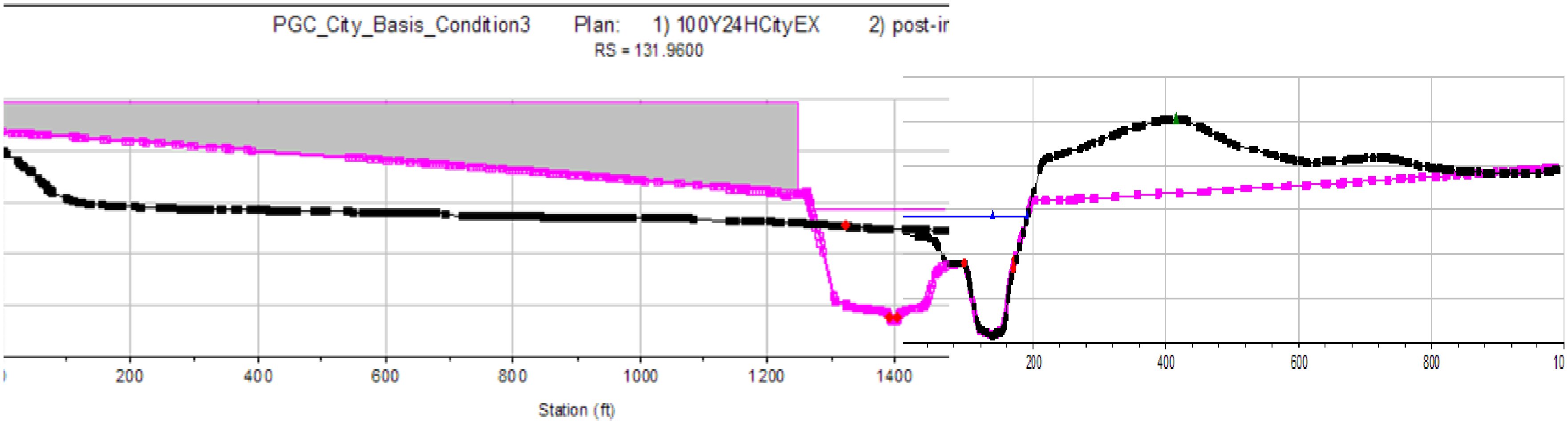


FIGURE III.A-3G10 – HEC-RAS CROSS SECTIONS PGC 132 & 130 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



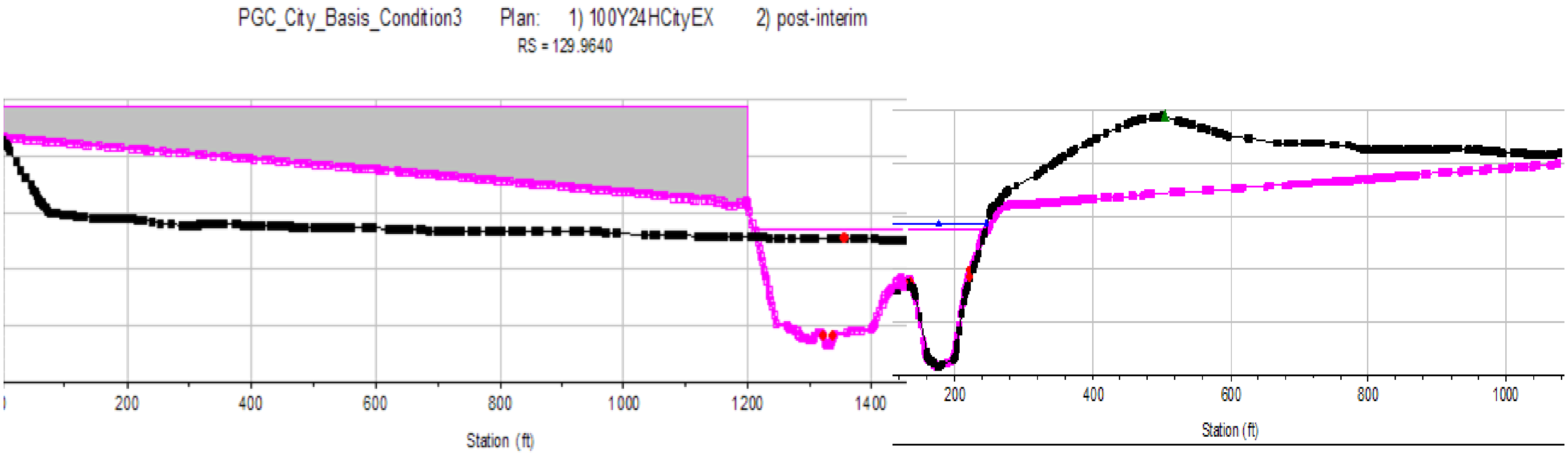
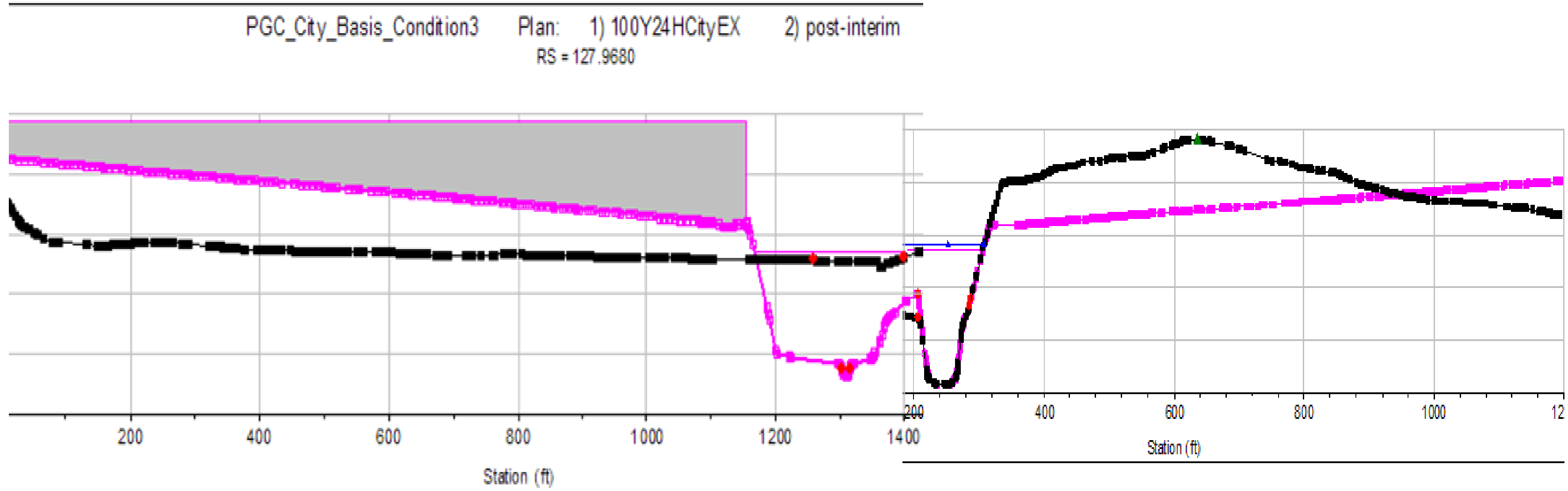


FIGURE III.A-3G11 – HEC-RAS CROSS SECTIONS PGC 128 & 126 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



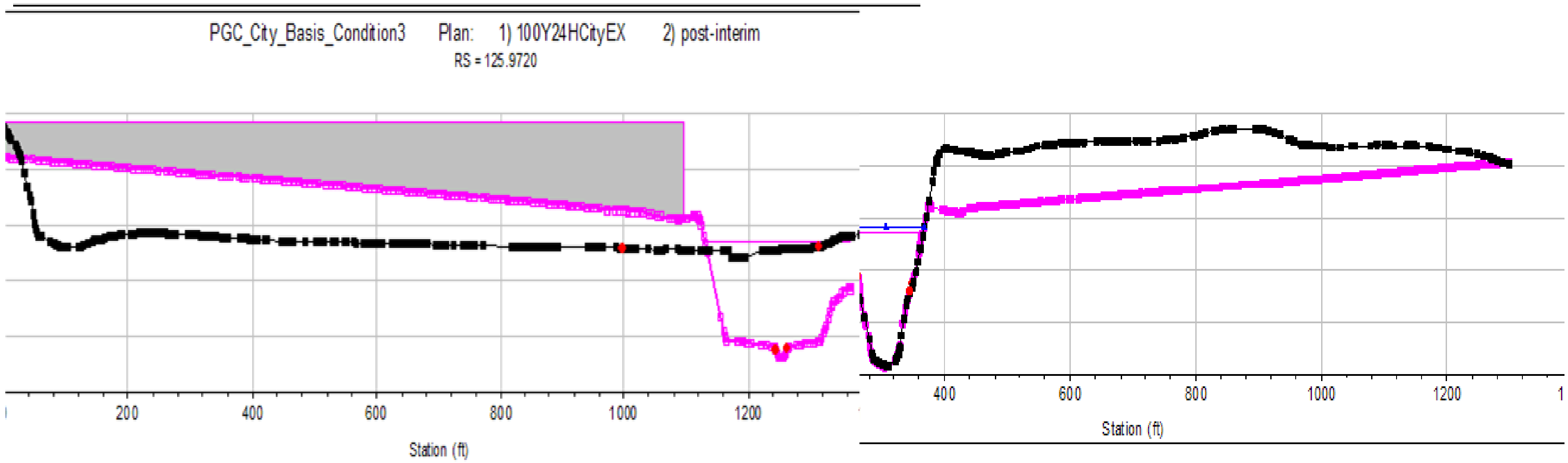
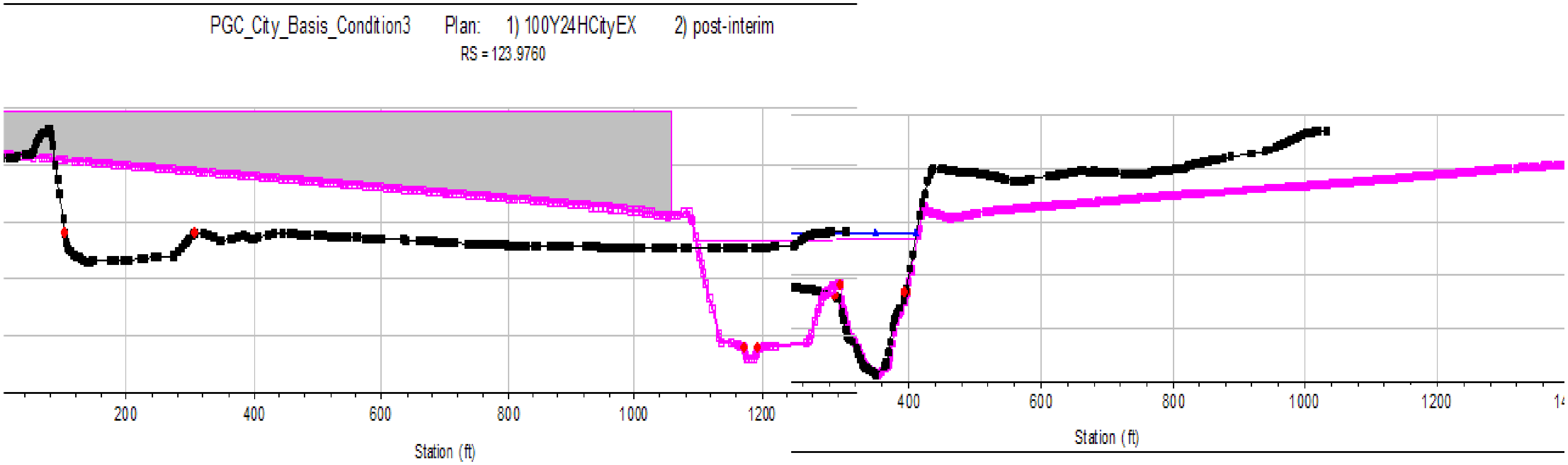


FIGURE III.A-3G12 – HEC-RAS CROSS SECTIONS PGC 124 & 122 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



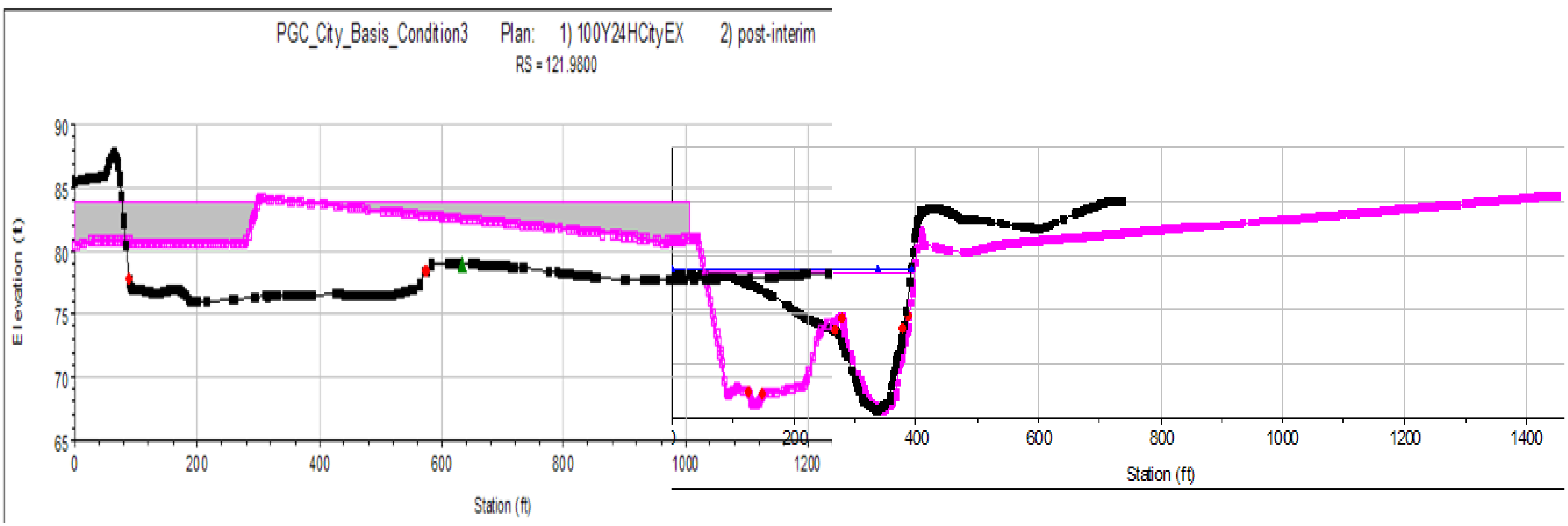


FIGURE III.A-3G13 – HEC-RAS CROSS SECTIONS PGC 120 & 118 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)

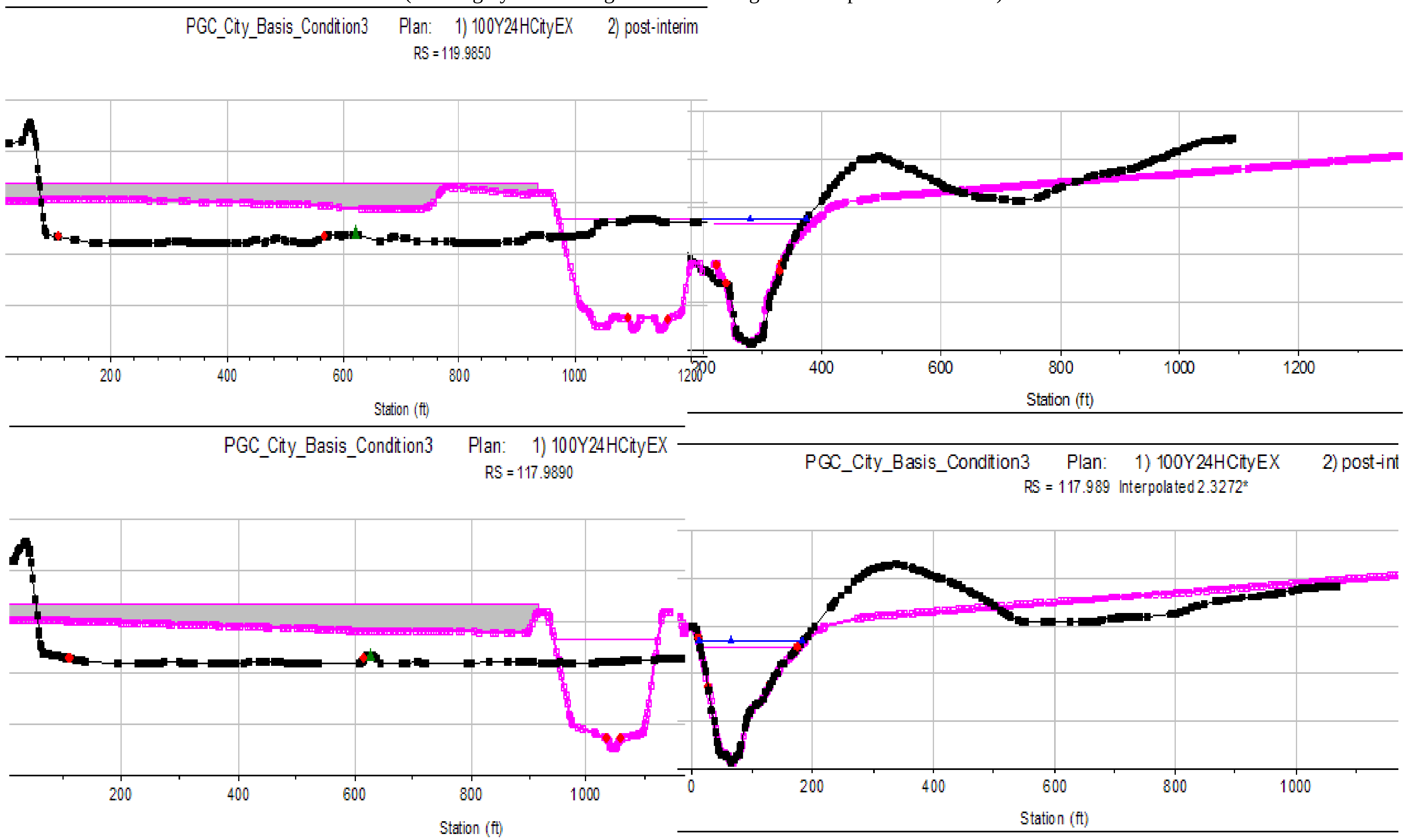
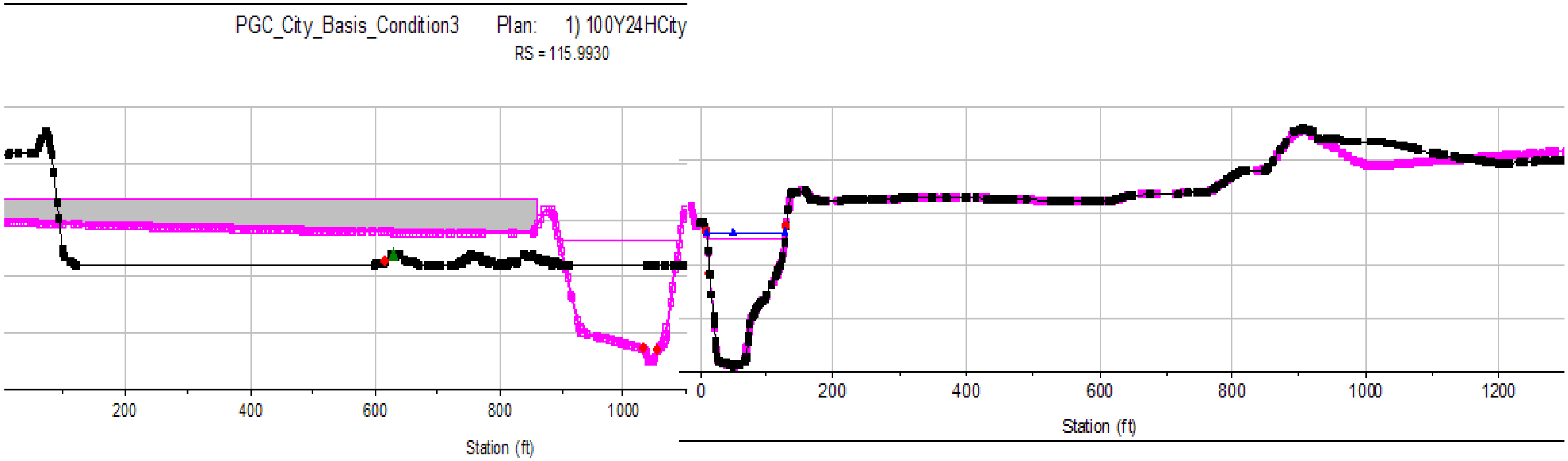


FIGURE III.A-3G14 – HEC-RAS CROSS SECTIONS PGC 116 & 114 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



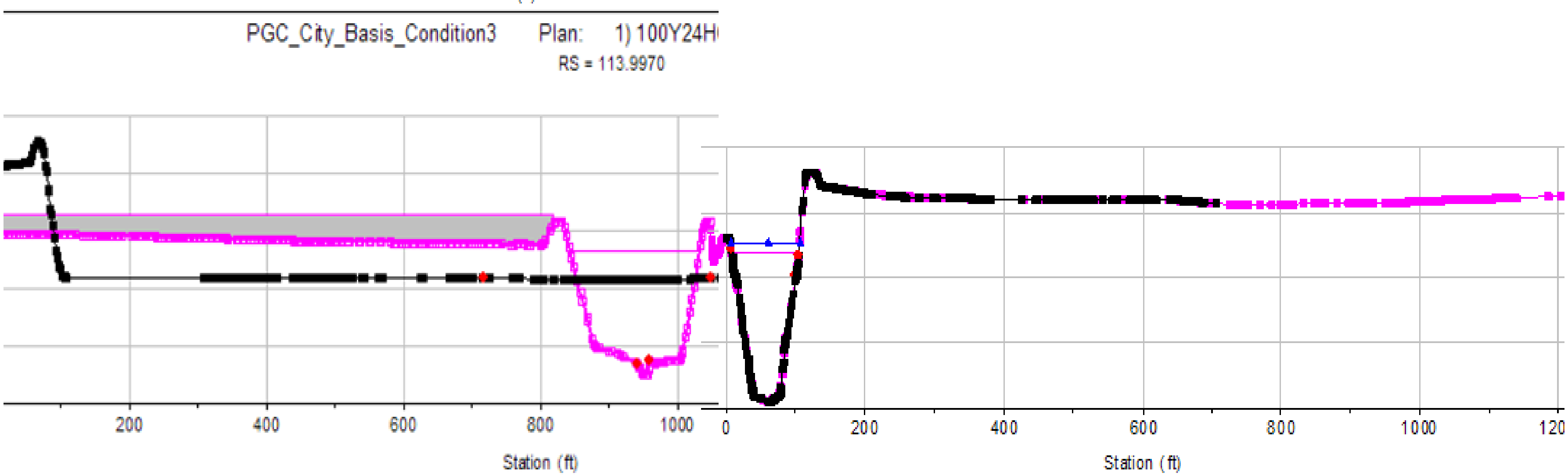
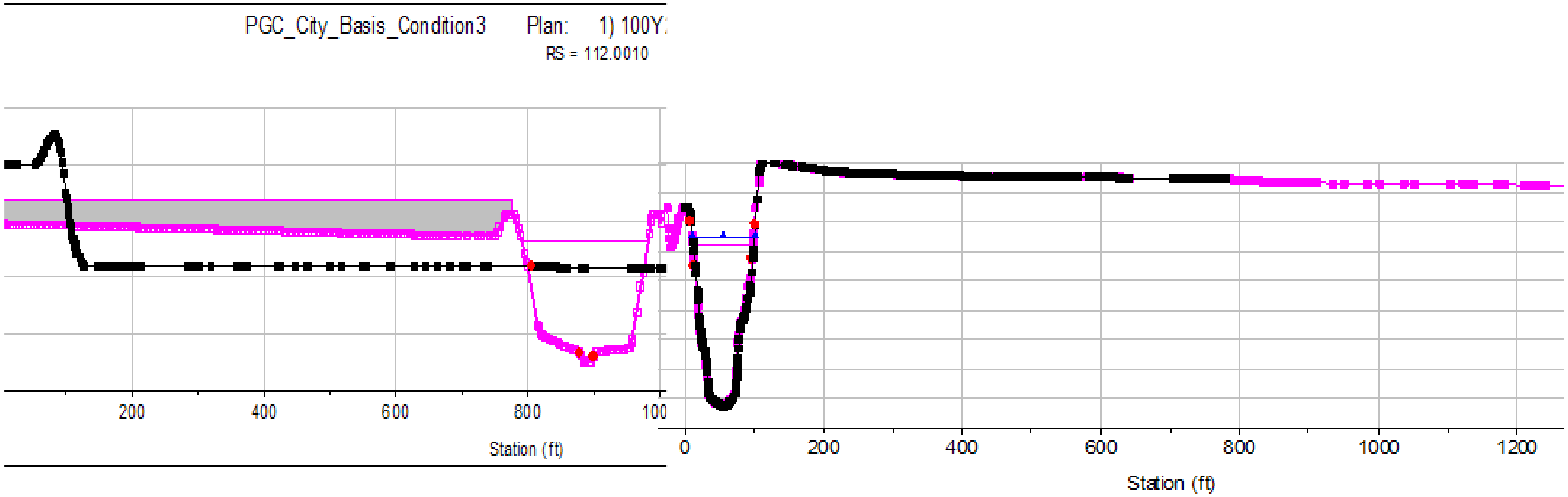


FIGURE III.A-3G15 – HEC-RAS CROSS SECTIONS PGC 112 & 110 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



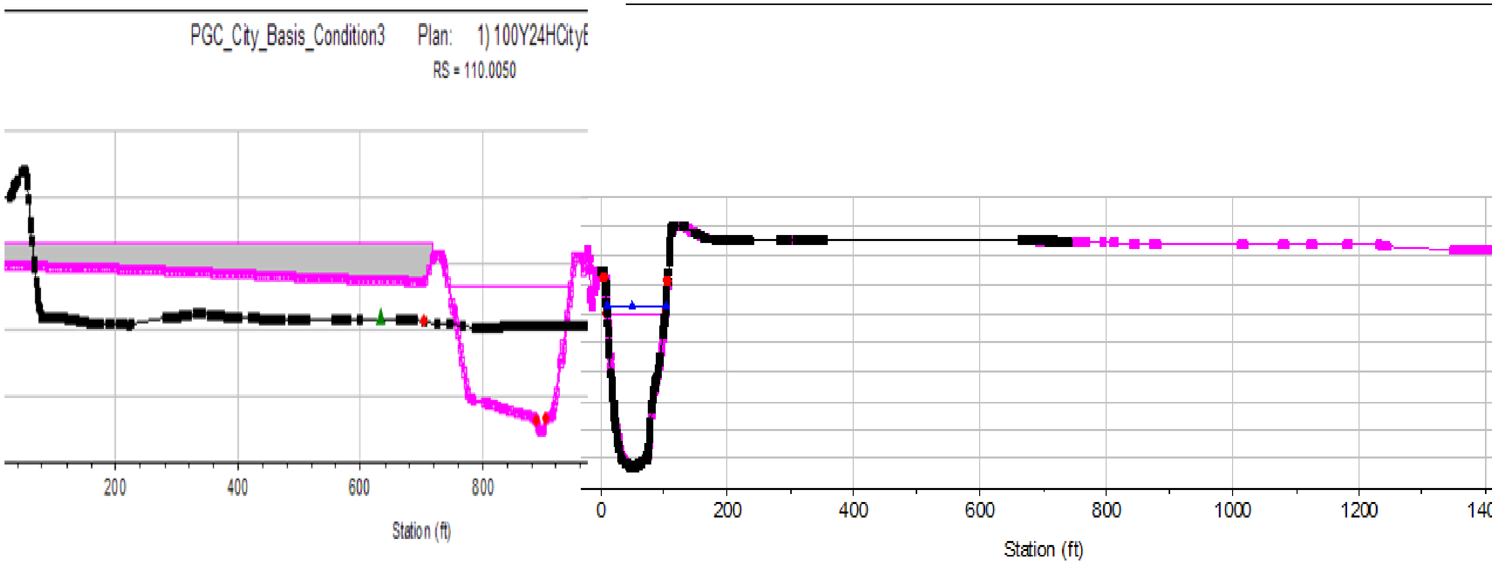


FIGURE III.A-3G16 – HEC-RAS CROSS SECTIONS PGC 108 & 106 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)

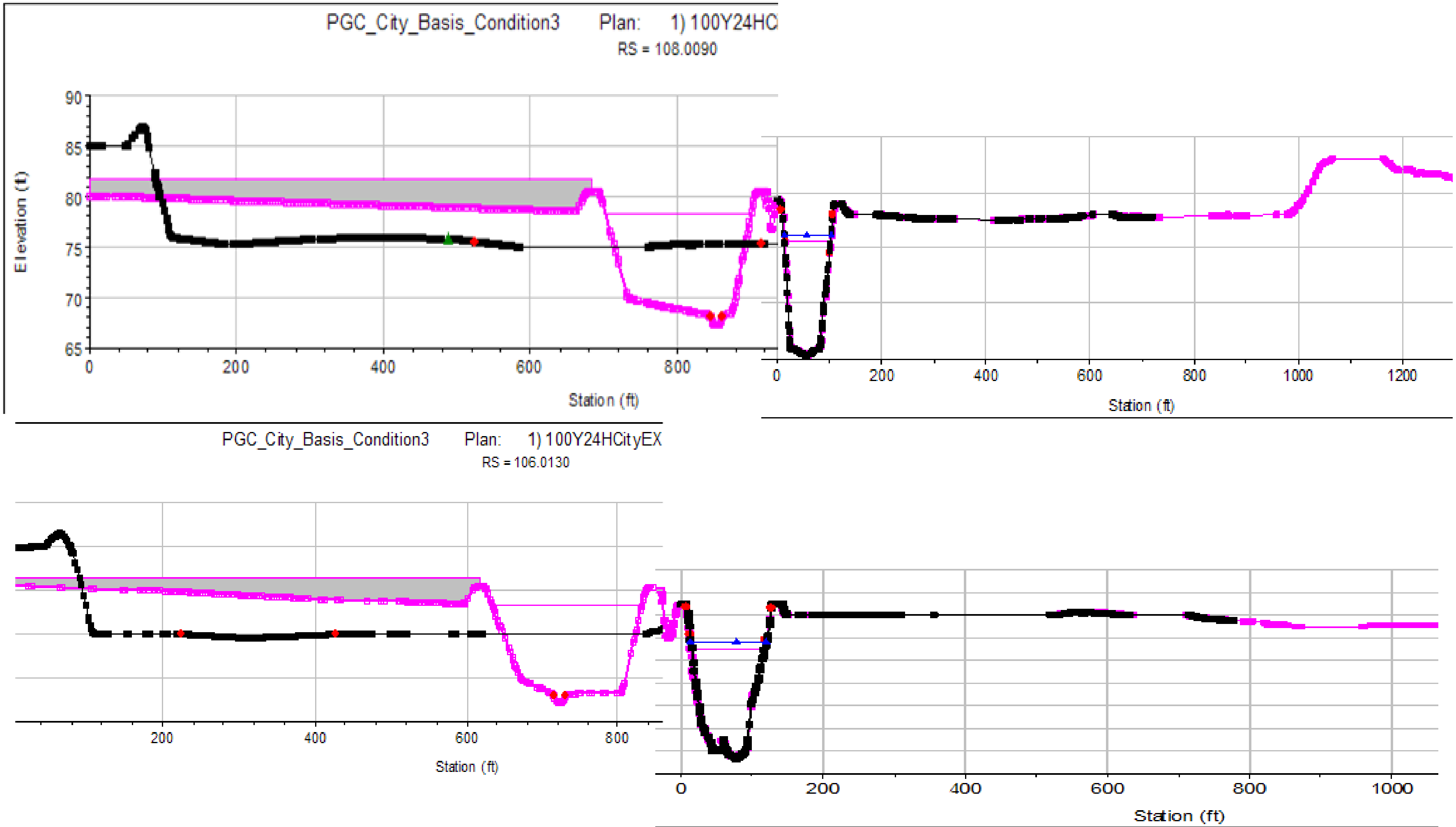


FIGURE III.A-3G17 – HEC-RAS CROSS SECTIONS PGC 104 & 102 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)

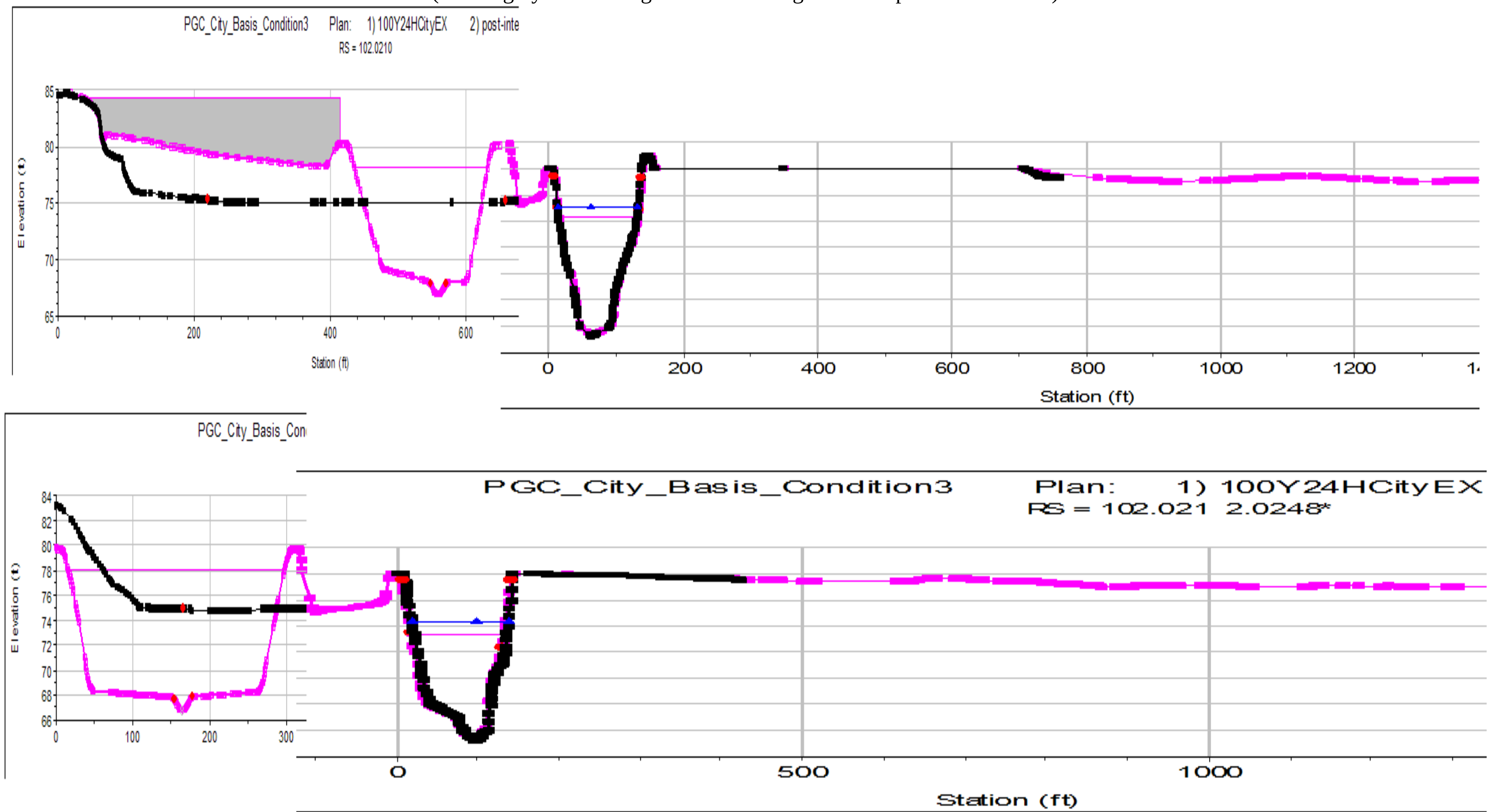


FIGURE III.A-3G18 – HEC-RAS CROSS SECTIONS PGC 100 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)

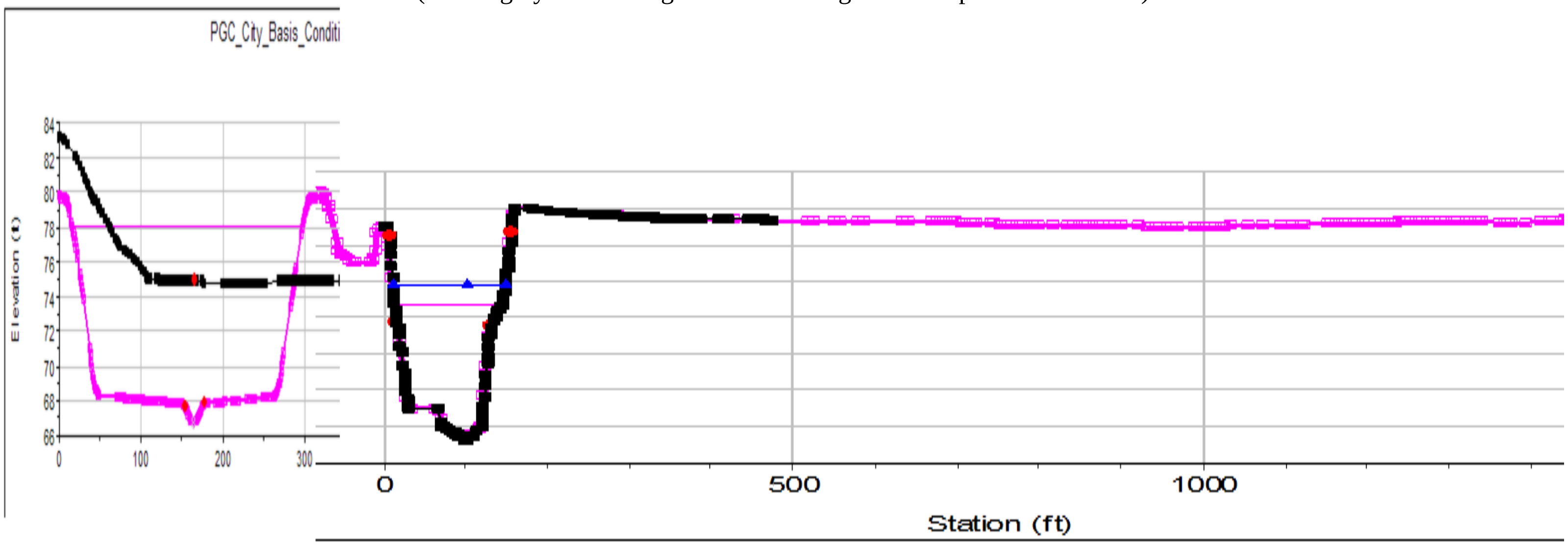
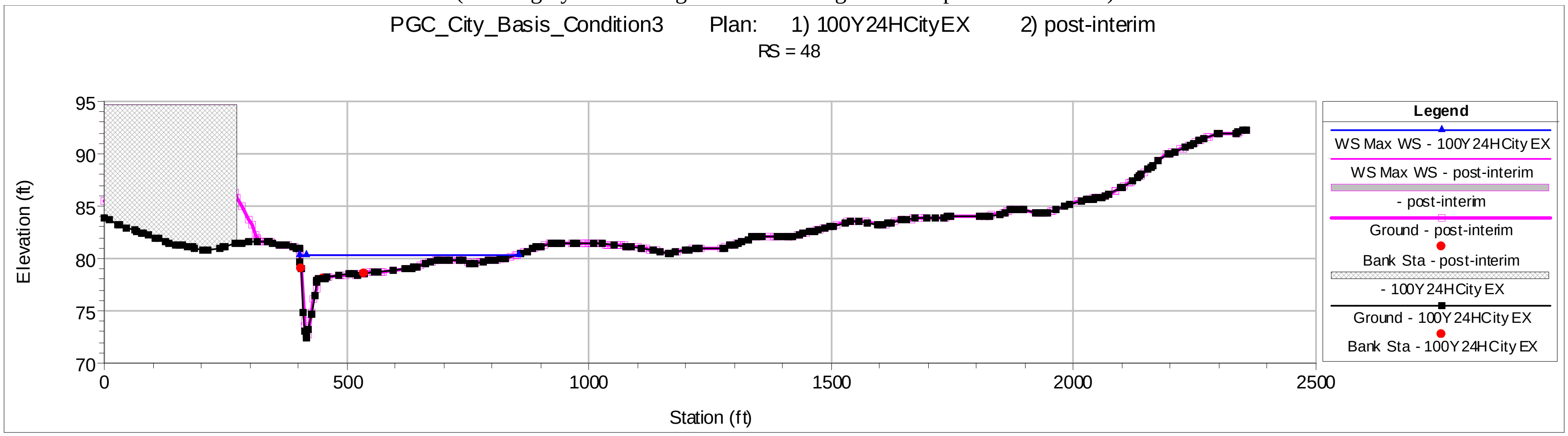


FIGURE III.A-3H1 – HEC-RAS CROSS SECTIONS UNIVERSITY CR 48 & 47 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



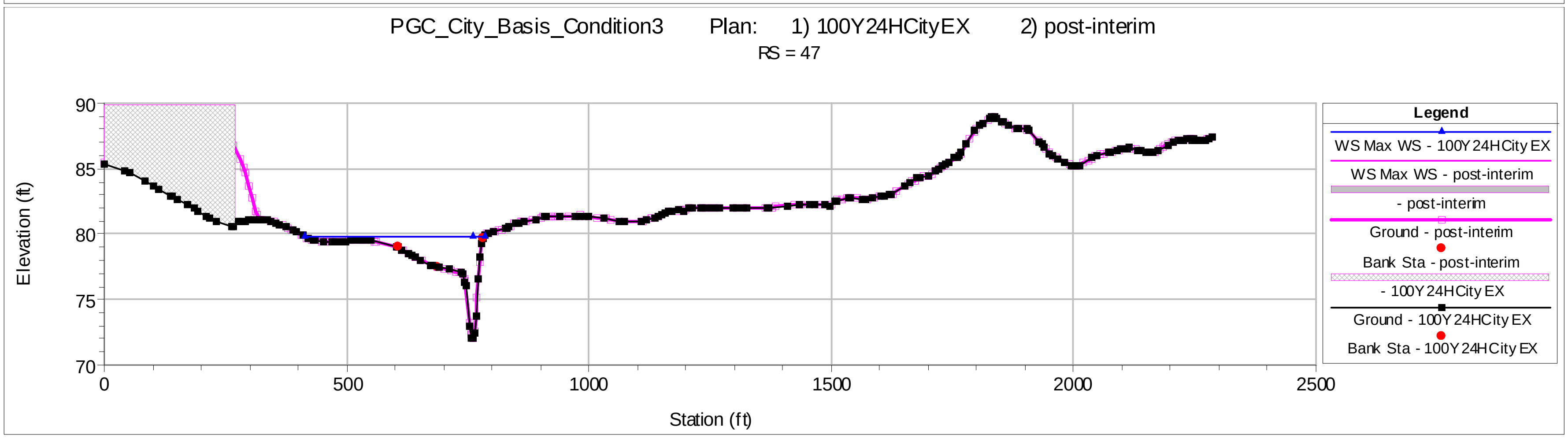
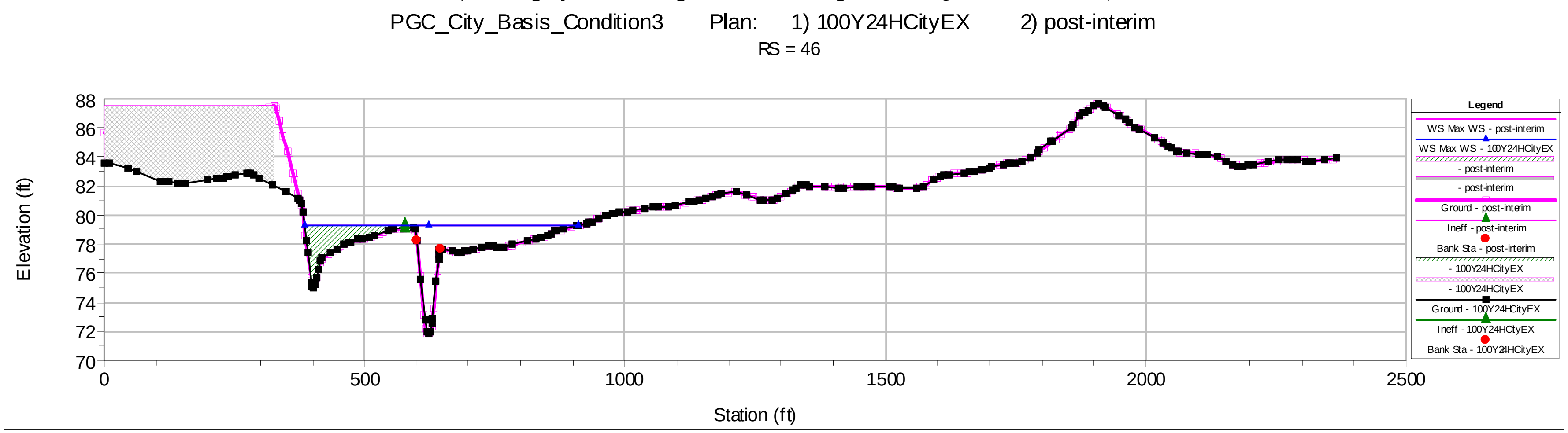


FIGURE III.A-3H2 – HEC-RAS CROSS SECTIONS UNIVERSITY CR 46 & 45 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



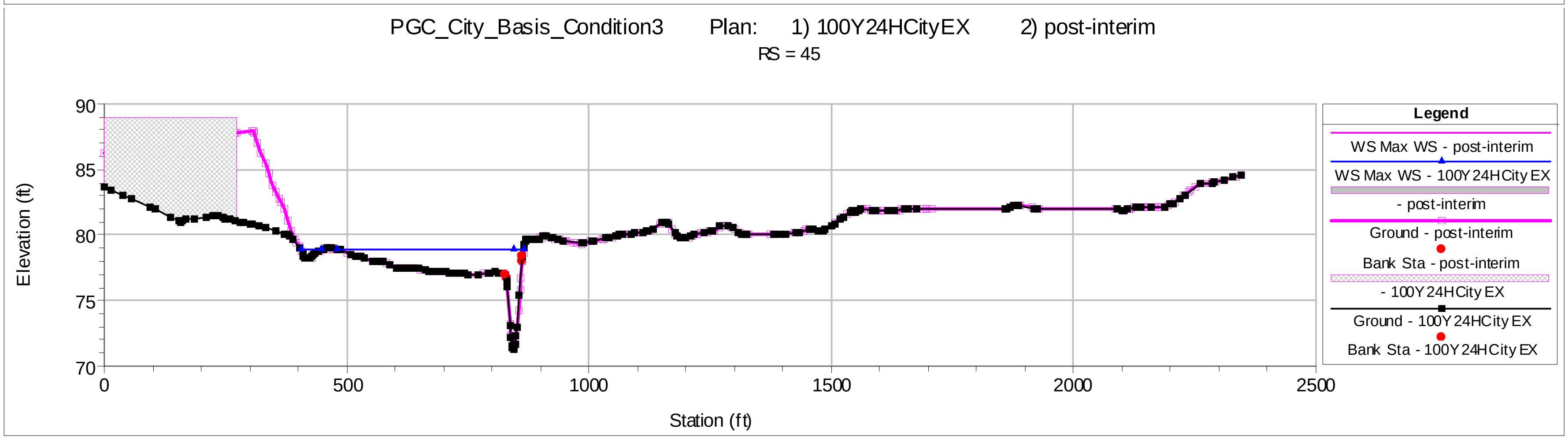
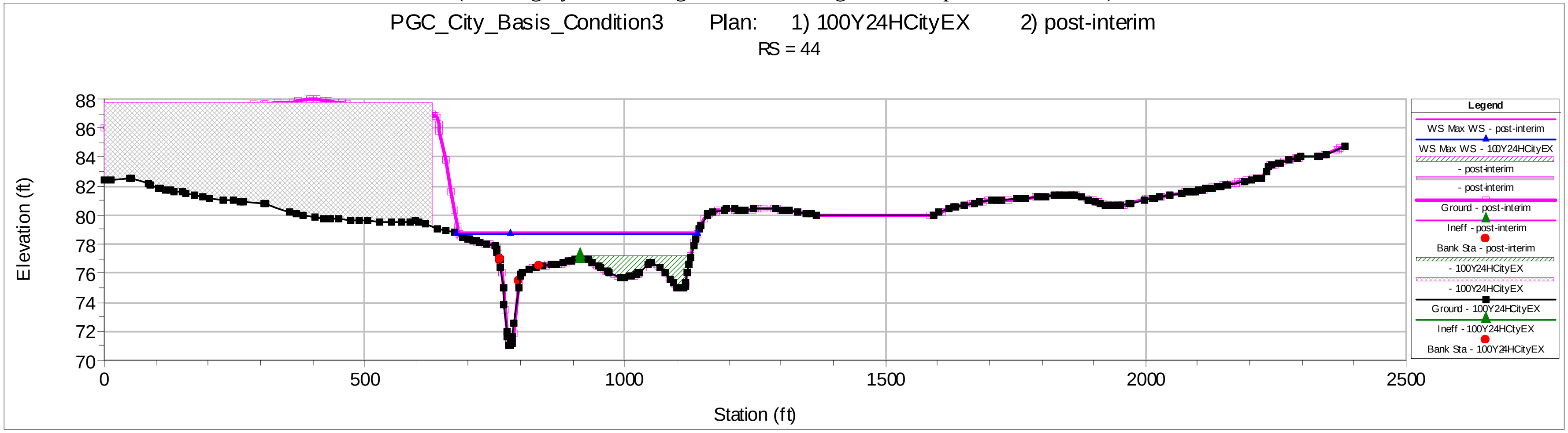


FIGURE III.A-3H3 – HEC-RAS CROSS SECTIONS UNIVERSITY CR 44 & 43 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



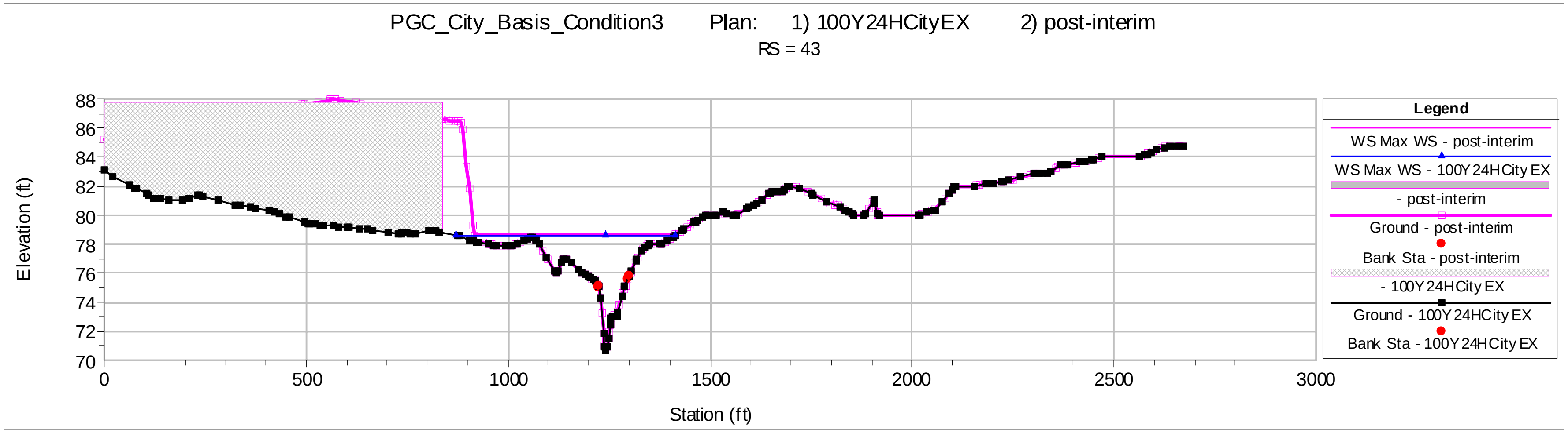
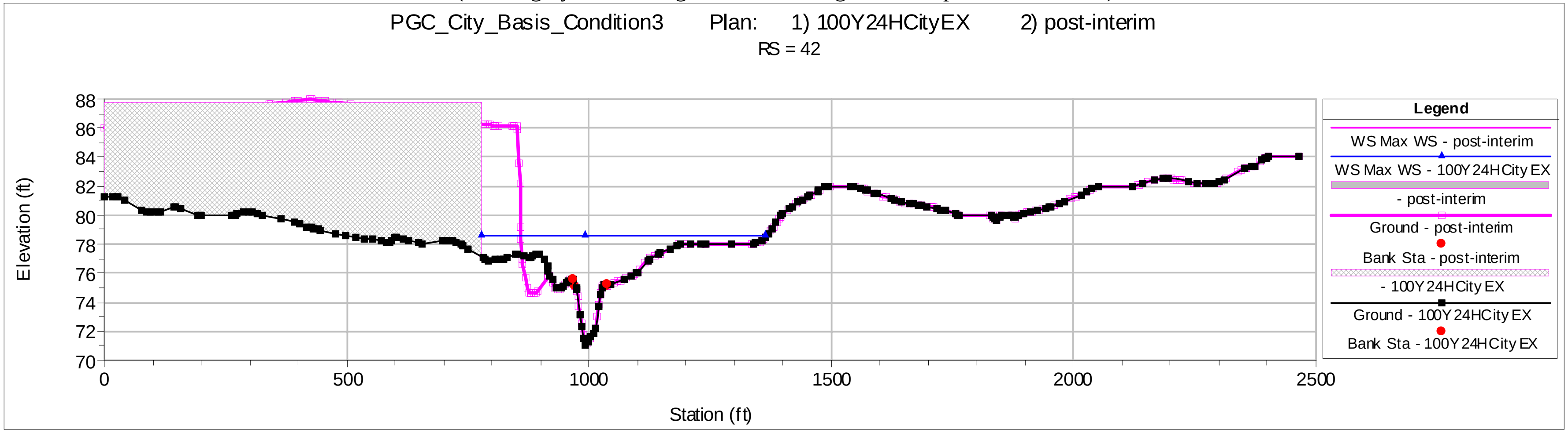


FIGURE III.A-3H4 – HEC-RAS CROSS SECTIONS UNIVERSITY CR 42 & 41 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



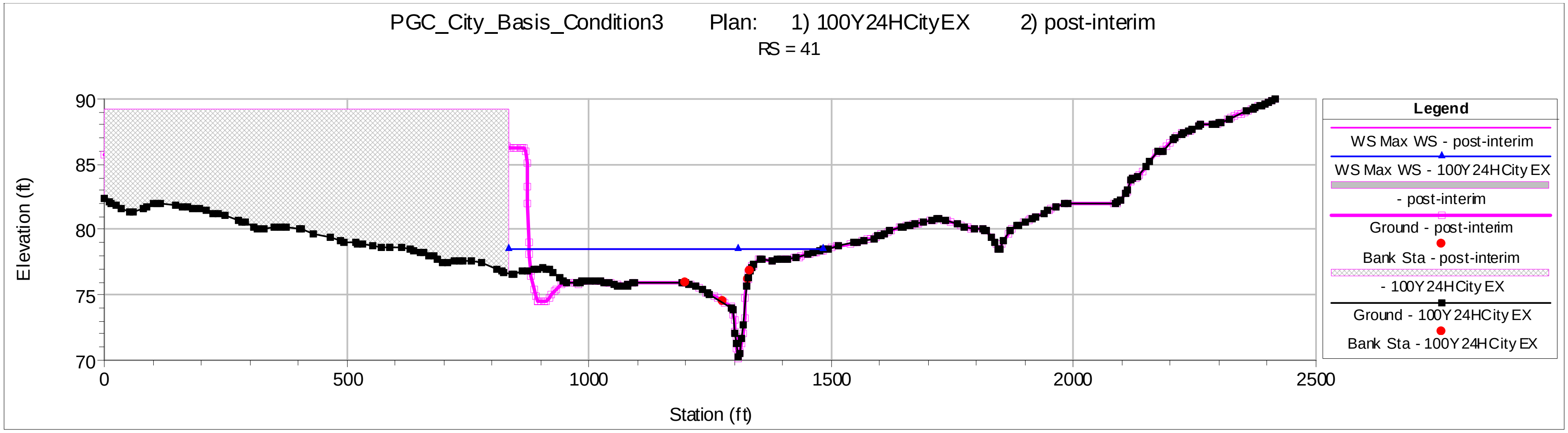
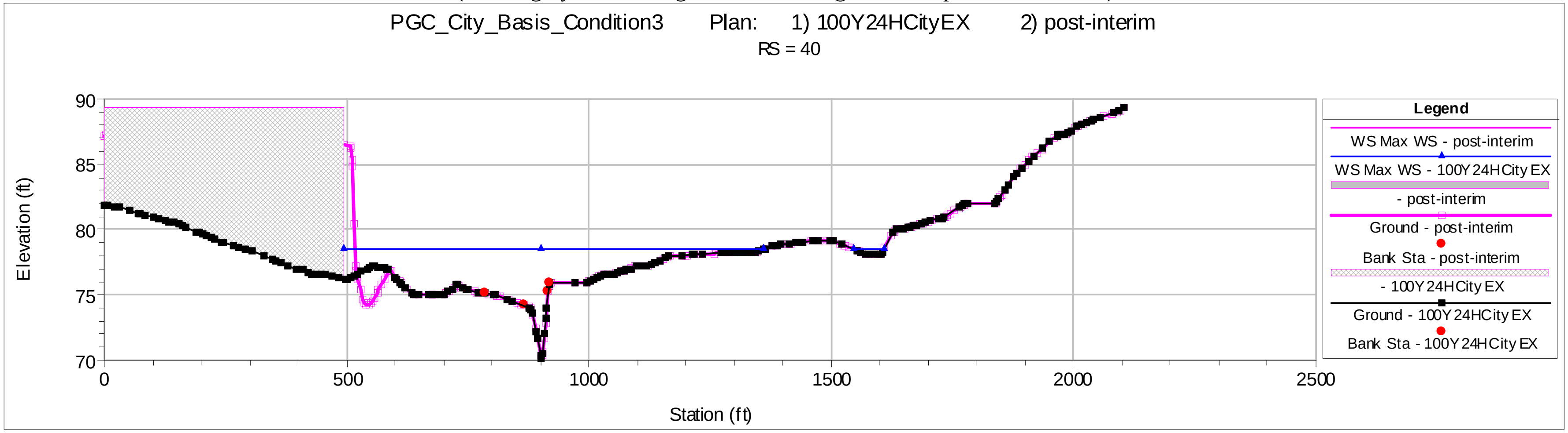


FIGURE III.A-3H5 – HEC-RAS CROSS SECTIONS UNIVERSITY CR 40 & 39 (Pre- and Post-Project Modified)

Pleasant Grove Creek Onsite, From Upstream to Downstream… Looking Downstream

(Black/.grey are existing conditions: Magenta = Proposed Conditions)



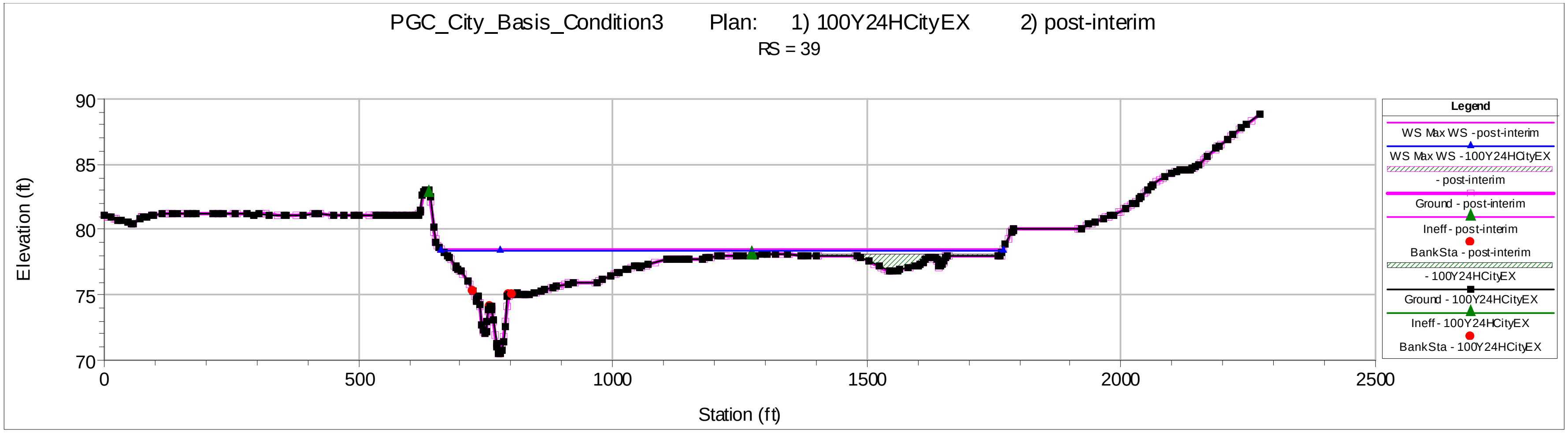
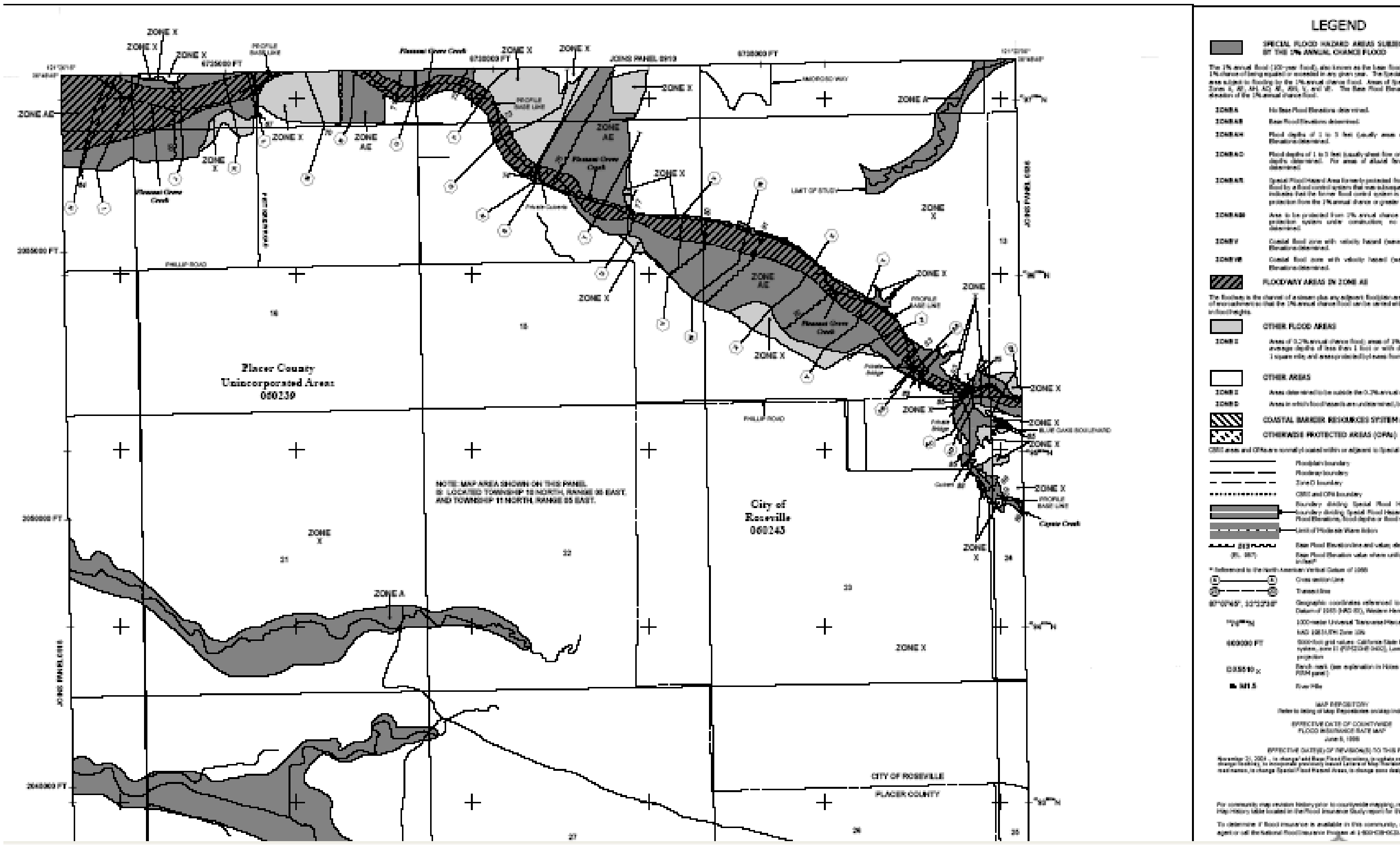


FIGURE III.1 – DFIRM (DRAFT 2010)



III.B Storm Drain System:

A preliminary storm drainage system is shown on Exhibit SD-1. This system has been analyzed using the CS-DRAINAGE STUDIO software program. The optimized pipe sizing is provided in the summary calculations provided in Appendix G for the 10-year and 100-year storm events. The pipes have been sized for one foot of freeboard below manhole and drain inlet rim elevations in the 10-year event.

At Arterial and major collector streets, flood waters are not allowed to encroach into vehicle lanes during the 100-year event. Storm drain pipes have been sized to convey the 100-year flow without surface flow.

Preliminary site grading was used to establish manhole rim elevations as shown on the exhibit. These grades were also used to model surface flow channels. For both the 10-year and 100-year events, downstream floodplain elevations were specified per the post-project unmitigated floodplain analysis (see Exhibit FP-3), as the downstream "known water surface elevations".

The storm drainage pipes discharge at several locations into the Pleasant Grove Creek corridors. Generally, vegetated swales are proposed at these discharge locations. The length of each swale would be based on the storm water quality contact time calculations identified in appendix H.

When the project reaches the point in processing at which the City is reviewing plan documents, a final Master Drainage Plan will be required which updates this plan for the final planned improvements. In addition, a detailed analysis of the proposed permanent and construction activities Best Management Practices shall be included either in the Final Master Drainage Plan, or as a separate "Water Quality BMP Plan". The BMP Plan shall identify expected pollutants, the expected activities, the effectiveness of the proposed BMPs and the maintenance plans for the BMP improvements.

IV. Water Quality:

The Creekview Specific Plan project would install improvements that comply with the City of Roseville's Stormwater Quality criteria. The City of Roseville is a Phase II community and has developed, jointly with the regions Phase I communities, the "Stormwater Quality Design Manual for the Sacramento and South Placer Regions"(SQDM). This document was adopted by the City of Roseville on July 18, 2007.

The State Water Quality Control Board is beginning to draft new requirements for storm water management permits administered under the Nationwide Pollution Discharge Elimination System (NPDES) regulations. At the time the Creekview Specific Plan is constructed it is anticipated that the NPDES permit will include requirements that hydrograph modification impacts be addressed. The DSMP includes a section addressing the potential hydrograph modification impacts of the Creekview Specific Plan, and the net impacts of the project with the proposed mitigation measures.

IV.A Stormwater Management During Construction Activities

The release of on-site stormwater runoff during Construction activities is regulated by the State General Construction Permit issued by the Regional Water Quality Control Board for all commercial and residential construction sites greater than one acre. The General Construction permit requires that a Storm Water Pollution Prevention Plan (SWPPP) be developed and implemented to prevent the transport of pollution and sediments from the site by runoff.

The SWPPP identifies the Best Management Practices (BMPs) that will be implemented during the construction process. Erosion and sediment control BMPs typically include such things as applying straw mulch to disturbed areas, the use of fiber rolls and silt fences, sedimentation basins, drain inlet protection, stabilized construction accesses, and construction equipment fuel and maintenance requirements. The final sizing and selection of BMPs will consider requirements specific to the Pleasant Grove Creek watershed and proposed construction activities.

A Stormwater Pollution Prevention Plan (SWPPP) will be required to describe the BMPs which will be used to prevent erosion and to clean site discharge waters before entering State Waters. A permit with the Central Valley Regional Water Quality Control Board of the State of California will be obtained for the proposed construction activities. If construction occurs during the wet season, additional winterization improvements will be required to stabilize the disturbed areas of the site, prevent erosion, and clean discharge waters. All construction related BMP improvements must comply with the "NPDES General Permit for Storm Water Discharges Associated with Construction Activities, NPDES No. CAS000002, Order No. 99-08DWQ".

IV.B Post Construction Stormwater Management

Post construction stormwater management is intended to treat in perpetuity the urban runoff generated on-site. The BMP techniques within the CSP area will reduce and/or eliminate the pollutants from the urban stormwater runoff and prevent the contamination of receiving waters. Creekview will work with the then current permit criteria applicable at the time of development and in conformance with the City of Roseville Improvement Standards, the City's Stormwater Quality Design Manual, the Placer County Flood Control Agency's Stormwater Management Manual, the open space preserve Operations and Maintenance (O&M) Plan, to design and address post construction stormwater treatment.

Post construction stormwater treatment is composed of three general elements: source control, runoff reduction and treatment of runoff. All three elements will be used in the Creekview stormwater management plan. The basic practice of source control is to minimize the potential for constituents to enter runoff at the source. An example of a source control BMP would be stamping of drainage inlets to inform residents that waters flow to the Creeks.

The tool the project will employ towards the goal of runoff reduction, is the use of Low Impact Development(LID) measures. Implementation of LID includes the construction of decentralized small scale improvements that provide for local infiltration and treatment opportunities that reduce the quantity of runoff which enters the storm drain systems during a rainfall event. LID will be implemented to offset runoff increases that occur when development converts native ground to impervious cover.

Additional Treatment control BMPs will be located at the end of the pipe and provide further treatment of the stormwater before it enters into the natural creek system, including:

- Grassy swales; and,
- Structural BMPs

The final selection of Best Management Practices (BMPs) shall consider requirements specific to the Pleasant Grove Creek watershed.

IV.C Low Impact Development Measures

Low impact development (LID) is an approach to stormwater management that emphasizes the use of small-scale, natural, constructed and proprietary drainage features integrated throughout a development site. The intent of LID measures is to slow, clean, infiltrate and evapo-transpire runoff, to reduce the quantity of urban runoff entering the storm drain systems. The added opportunities for infiltration offered by the use of LID can add water to local aquifers, increasing water reuse. It is a sustainable practice that benefits water quality protection, stream stability and can contribute to water supply. Unlike traditional storm water management, which collects and conveys storm water runoff through storm drains, pipes, or other conveyances to a centralized storm water facility, LID within Creekview will use site design elements to minimize changes to the site's pre-development runoff rates and volumes. Creekview's LID elements will assist with the goal of optimizing to the site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to where it originates.

Key principles of low impact development include:

- Decentralize and manage urban runoff to integrate storm water management throughout the watershed

- Preserve the ecosystem's natural hydrological functions and cycles.

- Account for a site's topographic features in its design.

- Reduce directly connected impervious surfaces to slow runoff and provide additional infiltration opportunities.

- Reduce impervious ground cover and maximize infiltration on-site.

It is also likely that the State Water Resources Control Board will adopt a new General Construction Permit before this project starts construction. Part of that permit addresses requirements for the use of permanent LID measures to mitigate runoff volume increases from development for the 85th percentile runoff event. The currently anticipated guidelines of the permit are presented at:

http://www.swrcb.ca.gov/water_issues/programs/stormwater/constpermits.shtml

The "Stormwater Quality Design Manual for the Sacramento and South Placer Regions" (SWDM), adopted by the City of Roseville, also specifies criteria for the design and analysis of LID measures for use in the City of Roseville. Computation methods are very similar for this manual as those presented in the final construction permit implemented July 1, 2010, however, the construction permit computational methodology generates slightly lower volume reductions from some individual measures, and offers computational criteria for a greater diversity of LID measures, and therefore has been used for the LID calculations included with this project. The CSP will have to meet the design guidelines specified in the SWDM, and it is very likely that the project will also have to meet the guidelines of the General Permit. The Post-construction LID worksheets from Appendix 4_1 of the Draft General Permit #2 are used herein to estimate these factors.

IV.C.1 Volume Reductions from LID measures:

LID measures provide treatment opportunities at or near the source of the runoff, and can substantially reduce the amount of treatment required. The Creekview Specific Plan will incorporate the use of LID throughout the development areas, and herein prescribes certain minimum Required Volume Reductions (RVR) attributed to LID performance within each land use as shown in Table IV.C.1A. The amount listed in TABLE IV.C.1A are minimum thresholds required for each outfall location throughout the project, and the achievement of higher RVR through the use of LID measures is encouraged if possible. The values indicated in TABLE IV.C.1A represent the amount of LID which will be applied to all product types expected for each of the land use types shown below.

TABLE IV.C.1A – LID Required Volume Reductions (RVR)

Land Use Type:	**LID 85th Percentile Event Volume Reduction from all measures except Vegetated Swales**
Low Density Residential (LDR)	80.5%
Medium Density Residential(MDR)	78.6%
High Density Residential (HDR)	70.8%
Commercial	74.2%
Park	100%
Public/Quasi Public	81.6%
Roadway	71.4%

Additional project design elements within the open space areas will also provide hydrograph modification benefits. The created wetland elements will provide additional floodplain storage capacity which is factored into the project hydrology analysis. The created wetlands also provide LID and treatment potential which has not been factored into the project mitigation, which include: added infiltration opportunities, evapo-transpiration opportunities, nutrient uptake, biological filtering, and stream buffers.

Examples of LID measures which may be used in this project are described in TABLE IV.C.1B. This is only a partial list of the types of measures which may be selected.

TABLE IV.C.1B – Applicable LID Measures By Development Type:

LID Measure Descriptions	**Benefits Description**	**Development Land Use Type which is applicable to LID Measure**
Disconnected roof drains	Water running off of the impervious roof system is treated by biological filtration, and the runoff gains an opportunity to partially infiltrate.	Low Density Residential Medium Density Residential High Density Residential Commercial, Public/Quasi Public, Parks
* Pervious or partially paved driveways & Porous pavement areas, and soil confinement	Pavement alternatives offer the opportunity for partial or complete infiltration of runoff.	Low Density Residential Medium Density Residential High Density Residential Commercial, Public/Quasi Public, Park Roadway
Separated sidewalks & Pavement Disconnection and eliminated pavement	Runoff from the impervious sidewalk, driveway, and pavement areas can be treated and infiltrated in landscape areas before entering the gutter pan and storm drain systems. (including residential walkways) In some areas of the development, un-necessary pavement may also be eliminated for stormwater benefit.	Low Density Residential Medium Density Residential High Density Residential Commercial, Public/Quasi Public, Park Roadway
Tree Planting and Canopy Preservation	The creation and preservation of tree canopy reduces the rate and amount of total runoff which enters the storm drain systems.	Low Density Residential Medium Density Residential High Density Residential Commercial, Public/Quasi Public, Park Roadway
Soil amendments in landscaped areas and Storm water planters.	The addition of organic material to impervious soils can add voids which can absorb runoff preventing it from entering storm drain systems. In residential areas, this may include amending a landscape strip adjacent to the street or pavement areas where large amounts of runoff can be intercepted from the lots. In commercial areas this is likely to be limited to stormwater planter areas. At roadways this will be used where roadway flows are diverted into the landscape areas.	Low Density Residential Medium Density Residential High Density Residential Commercial, Public/Quasi Public, Park Roadway
Stream Buffer	Sheet flows can be discharged into the stream corridors (at the surface overbank) directly providing significant treatment and infiltration opportunity prior to entering the streams.	High Density Residential ** Commercial ** Park Public/Quasi Public **
Vegetated Swales	*** Discharge of runoff into vegetated swales provides additional treatment in the in the treatment train, and opportunities for additional infiltration of runoff waters	Required at all storm drain outlet locations.
Stormwater Retention	These measures remove stormwater from the system, and trap constituents at the stormwater retention location such that it is not discharged.	Not currently anticipated within this plan area, however, with appropriate supporting documentation could be used in individual projects to achieve the RVR criteria.

* The use of pervious pavement and other infiltration oriented paving systems are dependant on infiltration capacity of the underlying soils, and may not be used everywhere. Geotechnical investigations are necessary to support the use of these systems. ** Opportunities for the use of this measure and land use combination are extremely limited within the Specific Plan. *** Because infiltration potential of this measure is not directly computable without geotechnical investigations, this measure is not applicable in this plan towards the RVR criteria, however, this element is required at all storm drainage outfall locations to make up the shortfall of the RVR to the 100% criteria of the "Appendix 2 - Post-Construction Water Balance Performance Standard".

TABLE IV.C.1C demonstrates an alternative for the quantity of individual LID measures needed to obtain each land uses RVR standard for this Specific Plan, using the Appendix 2 - Post-Construction Water Balance Performance Standard. Individual projects are not required to use these alternative measures and quantities exactly, and can change the selected measures by providing computations for alternate selections meeting the RVR's established for this Specific Plan. It will be required with the submittal of design plans and specifications that calculations supporting the achievement of the minimum RVR will be submitted for each outfall of the Specific Plan. Attachment F worksheets supporting the RVR's for sample development areas of each type are provided in Appendix H.

TABLE IV.C.1C – Alternative LID Use to Achieve Minimum RVR

Land Use Type	Disconnected roof drains	Pervious or partially paved driveways & Porous pavement areas, and soil confinement	Separated sidewalks, Pavement Disconnection, and eliminated impervious paving areas (including sidewalks)	Tree Planting and Canopy Preservation ***	Soil amendments in landscaped areas & Planters (est. acreage of amendments per 100 acres of dev.)	Stream Buffer	Vegetated Swales	Required Volume Reduction (RVR) ****
LDR	* 95%	-	8%	3 per lot	1.5 ac.	-	**	80.5%
MDR	* 80%	-	8%	1 per lot	1.5 ac.	-	**	78.6%
HDR	* 50%	-	15%	1 per unit	1.5 ac.	-	**	70.8%
COM	* 50%	-	15%	20 per acre	2.0 ac.	-	**	74.2%
PARK	* 50%	-	20%	5 per acre	0.5 ac.	10%	**	100%
PQP	* 50%	-	20%	10 per acre	1.5 ac.	-	**	81.6%
ROAD	-	-	50%	10 per acre	1.0 ac.	-	**	71.4%

* Disconnected Roof Drains will likely be implemented 100% for developments that use this measure, however some development product types are incompatible with this measure, and post construction adjustments to these systems do sometimes occur. For these reasons, the project wide average assumed usage of this measure has been reduced to the amount shown. ** Vegetated Swales will be used at each outfall and the minimum design will be per the width and length needed to generate a RVR of 100% for each outfall location per Appendix 4 criteria. *** Tree planting is assumed to be 50% evergreen and 50% deciduous in this example. **** Extensive LID practices are proposed in lieu of Structural BMP Treatment Requirement in City Standards, and Structural BMP's will not be provided at/near storm drain outfall locations with this project.

IV.C.2 End of Pipe Treatment:

The schematic Post-Project Drainage Systems Map is shown in Exhibits SD-1. The maps identify storm drain outfall locations. Treatment Facilities (BMPs) will be required upstream of discharge to Pleasant Grove Creek or any other Regulated Water of the State such as wetlands. Based on the plan shown in SD-1, treatment consisting of a section of Vegetated Swale will be the most common form of outfall BMP. The minimum design length of Vegetated grassy swale will be computed as the minimum length needed to achieve an RVR of 100%. When space constraints prevent the construction of a 100% RVR vegetated swale, , a supplemental treatment BMP will be used in combination with the swale to achieve 100% treatment per the City's requirements, assuming LID is ineffective.

The optimum design length of Vegetated grassy swale and the associated calculations are provided in TABLE IV.C.2A. The design lengths represented in this table assume complete treatment via the Vegetated Grassy Swale, as if LID and source control measures were ineffective.

To comply with the requirements of the local Mosquito/Vector Abatement District, all BMP's will be required to be designed to discharge all waters within 96-hours of the completion of runoff from a storm event. All graded areas must drain so that no standing water could accumulate for more than 96-hours within water quality facilities.

Information regarding the storm drain watershed areas tributary to each outfall location are included in exhibit SD-1.

TABLE IV.C.2A – BMP SIZING AT OUTFALLS – Non Reduced for LID

	NON-REDUCED - SWQ VOLUME/FLOWRATE DESIGN - PRSCG FACTORS										
Outfall Location	Total Area	Total % Imperv	C Value	Volume Ft^3	Reserve Volume Ft^3	**Total Volume Ft^3**	**Design Flowrate cfs**	**Min. Swale Length ft**	**Min. Swale Width ft**	**Velocity (fps)**	**Slope ft/ft**
OT-A	31.4	60.38%	0.41	33805	1690	**35496**	**2.59**	**117**	**27.0**	**0.28**	0.01
OT-B	116.7	51.03%	0.35	105532	5277	**110809**	**8.07**	**119**	**84.5**	**0.28**	0.01
OT-C	33.4	43.82%	0.30	26329	1316	**27646**	**2.01**	**116**	**21.0**	**0.28**	0.01
OT-D	66.5	34.71%	0.25	43552	2178	**45730**	**3.33**	**118**	**35.0**	**0.28**	0.01
OT-E	25.9	40.00%	0.28	18937	947	**19884**	**1.45**	**115**	**15.0**	**0.27**	0.01
OT-F	52.8	43.54%	0.30	41400	2070	**43470**	**3.17**	**117**	**33.0**	**0.28**	0.01
OT-G	25.1	43.12%	0.30	19534	977	**20511**	**1.49**	**115**	**15.5**	**0.27**	0.01
OT-H	83.8	32.46%	0.24	52203	2610	**54813**	**3.99**	**118**	**42.0**	**0.28**	0.01
OT-I	15.0	33.93%	0.25	9660	483	**10143**	**0.74**	**111**	**7.5**	**0.26**	0.01
OT-J	17.3	35.75%	0.26	11587	579	**12166**	**0.89**	**112**	**9.0**	**0.27**	0.01
OT-K	17.4	40.00%	0.28	12722	636	**13358**	**0.97**	**113**	**10.0**	**0.27**	0.01

TABLE IV.C.2B – MINIMUM VEGETATED SWALE SIZING AT OUTFALLS for RVR=100 in LID

	REDUCED for LID - SWQ VOLUME/FLOWRATE DESIGN - PRSCG FACTORS												
Outfall Location	Total Area ac	Imperv. Area ac	**LID Mit. Imp. Area ac**	Reduced % Imperv	C Value	Volume Ft^3	Reserve Volume Ft^3	**Total Volume Ft^3**	**Design Flowrate cfs**	**Min. Swale Length ft**	**Min. Swale B. Width ft**	Velocity < 1 fps Check	Design Slope ft/ft
OT-A	31.4	19.0	**4.6**	45.86%	0.31	25746	1287	**27034**	**1.97**	**115**	**20.5**	0.27	0.010
OT-B	116.7	59.6	**12.9**	39.95%	0.28	85263	4263	**89526**	**6.52**	**119**	**68.0**	0.28	0.010
OT-C	33.4	14.6	**3.0**	34.71%	0.25	21874	1094	**22968**	**1.67**	**114**	**17.5**	0.27	0.010
OT-D	66.5	23.6	**6.4**	25.92%	0.20	35315	1766	**37081**	**2.70**	**117**	**28.0**	0.28	0.010
OT-E	25.9	10.4	**2.0**	32.21%	0.24	16049	802	**16852**	**1.23**	**111**	**13.0**	0.26	0.010
OT-F	52.8	23.0	**5.0**	34.01%	0.25	34061	1703	**35764**	**2.61**	**115**	**27.5**	0.27	0.010
OT-G	25.1	10.8	**2.2**	34.41%	0.25	16346	817	**17163**	**1.25**	**113**	**13.0**	0.27	0.010
OT-H	83.8	27.2	**5.6**	25.79%	0.20	44322	2216	**46538**	**3.39**	**117**	**35.5**	0.28	0.010
OT-I	15.0	5.1	**1.0**	27.49%	0.21	8298	415	**8713**	**0.63**	**107**	**6.5**	0.25	0.010
OT-J	17.3	6.2	**1.2**	28.90%	0.22	9915	496	**10410**	**0.76**	**106**	**8.0**	0.25	0.010
OT-K	17.4	7.0	**1.4**	32.20%	0.24	10780	539	**11319**	**0.82**	**109**	**8.5**	0.26	0.010

* Vegetated Swales built to this minimum length complete the RVR to 100% for LID, but do not complete the total treatment requirements of the project, and additional BMP's will be required to obtain the treatment objectives.

IV.D.1 Hydrograph Modification Benefits from LID:

The development of the Specific Plan has the potential to modify the hydrologic response for given storm recurrences within the Pleasant Grove Creek Watershed. It is commonly understood that development generally increases runoff volume and peak flows by increasing the amount of impervious areas within the watershed and by reducing the amount of time over which runoff occurs.

Streams naturally migrate and evolve. Migration is the progression of the stream meanders in a downstream direction. Migration can naturally occur over short time periods or long geological periods, depending on stream factors such as soil types, amount of and type of vegetation present, hydrologic conditions and land use conditions. Evolution is the modification of the stream type or classification, into another stream type or classification. Evolution naturally occurs in streams over long geological periods. Modifications to the hydrologic response of a watershed has the potential in some watersheds to result in downstream modifications to the stream, referred to as an evolutionary response. An evolutionary response can result in considerable additional sediment load within a stream corridor, and ultimately can result in the degradation of water quality, environmental resources, recreational resources, and navigable resources.

The City of Roseville regulates stormwater discharge in compliance with the U.S. Environmental Protection Agency National Pollutant Discharge Elimination System (NPDES) MS4 permit. Pursuant to this permit, the City requires new projects to mitigate stormwater quality impacts to the "Maximum Extent Practicable". The CSP project has reviewed the potential for hydrograph modification, resulting from the proposed development measures and has incorporated mitigation measures which will reduce the potential as follows:

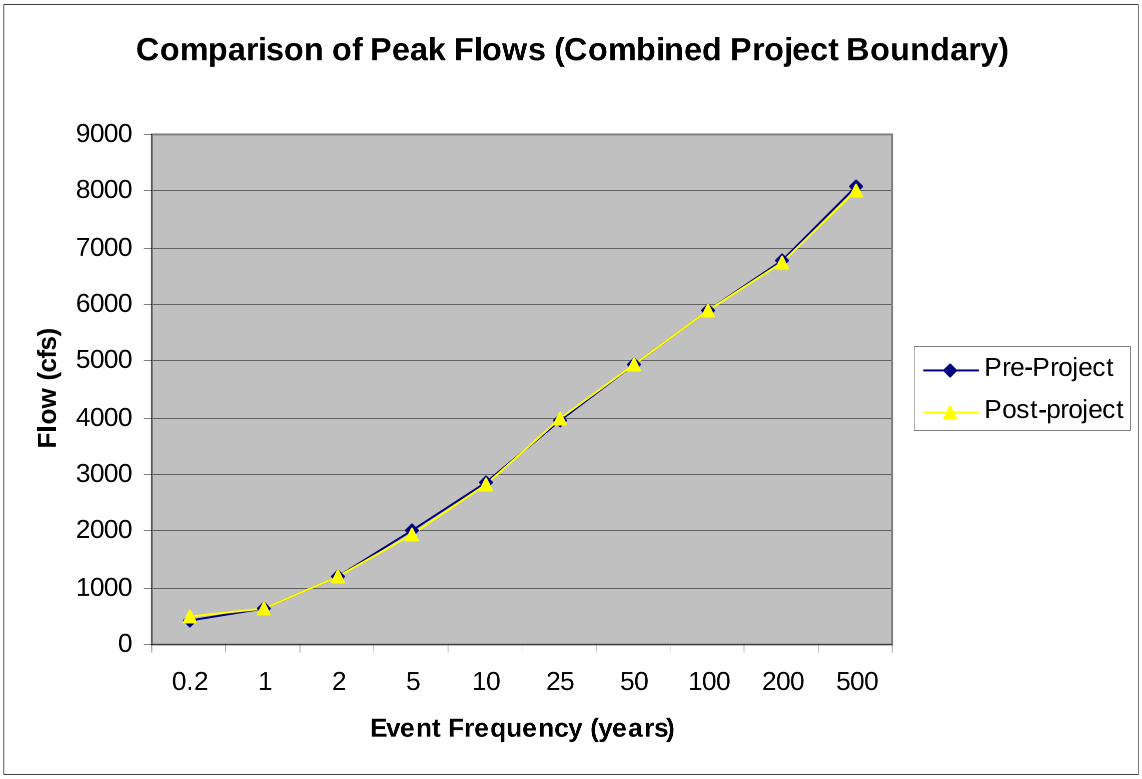
- The project will incorporate the use of extensive Low Impact Development measures to reduce runoff impacts at the source of runoff from impervious surfaces.

- The project has developed a peak flow mitigation plan within the creek corridors which will provide attenuation (for the development impacts to peak flow rates) for all storm events from 10% of the peak 2-year to the 100-year event when combined with the reductions in runoff from the use of LID.

IV.D.2 Peak Flow Response:

In figure IV.D.2A we have plotted peak flow responses at the combination of the project boundary flow points, where all project flows are included, for the Pre-Project and Post-Project Mitigated with LID scenarios. The response for the following events is compared in the graph: 10% of 2-year, 50% of 2-year, 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, 200-year and 500-year. The graph demonstrates that peak flow increases from the project area will not occur and are fully mitigated for the full range of events, by the proposed project mitigation plan.

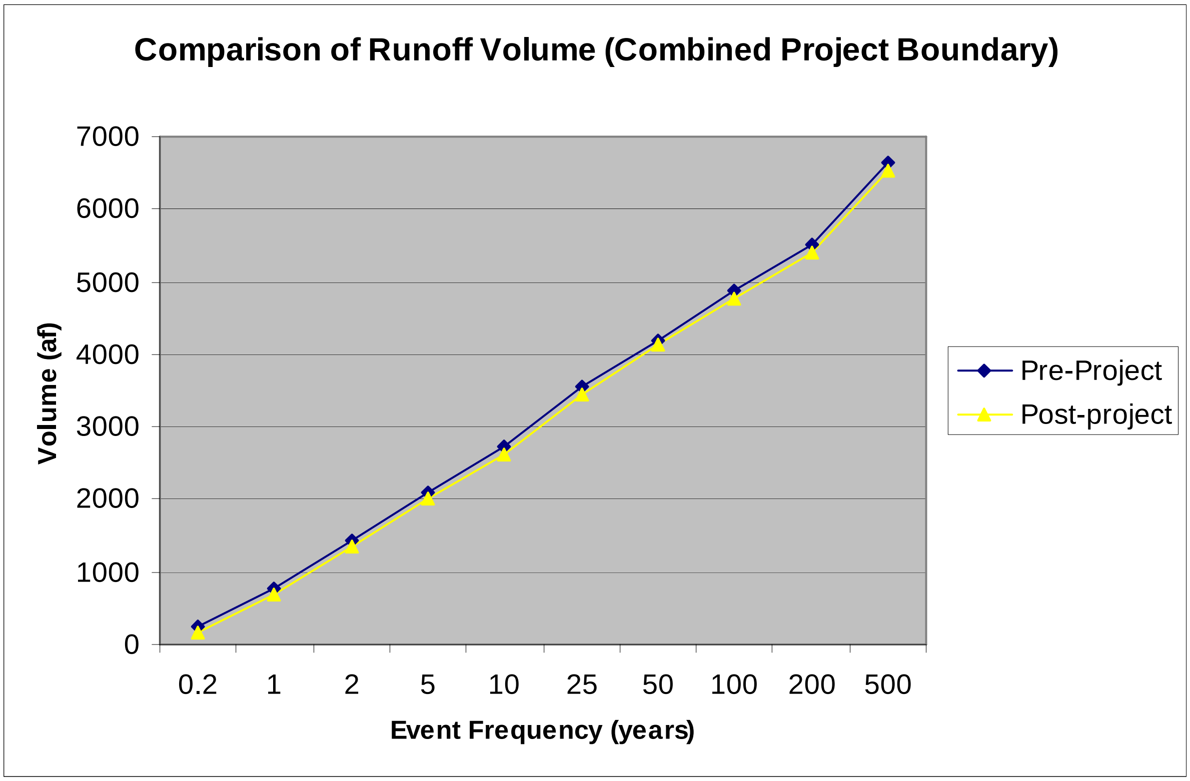
FIGURE IV.D.2A – Peak Flowrate Comparisons At Project Boundary



IV.D.3 Volumetric Response:

Figure IV.D.3A – plots the comparison of the resulting runoff hydrograph volumes at the same location, just downstream of the confluence of Pleasant Grove Creek and University Creek. The plot shows that runoff volume for the 24-hour event are reduced in the post project analysis.

FIGURE IV.D.3A – Comparison of Pre-project and Post-project Runoff Volumes (24-hour)



IV.D.4 Hydrograph Characteristics:

TABLE IV.D.4A: HYDROGRAPH CHARACTERISTICS AT PROJECT DISCHARGE

Event	36-hour Runoff Volume (AF)		Peak Flow (CFS)	
	PRE-	POST MIT LID	PRE-	POST MIT LID
500-YEAR	6651	6522	8090	8029
200-YEAR	5509	5395	6761	6738
100-YEAR	4879	4776	5901	5881
50-YEAR	4198	4130	4939	4938
25-YEAR	3544	3441	3966	3984
10-YEAR	2725	2625	2856	2807
5-YEAR	2101	2010	2025	1940
2-YEAR	1423	1354	1188	1204
50% of 2-YEAR	762	694	621	650
10% of 2-YEAR	236	158	414	481

It is important to note that the mitigated with LID hydrograph is similar in overall timing and demonstrates a reduction in peak flow rate. The Future, Fully Developed, without mitigation hydrograph demonstrates an accelerated timing in the 2-year event, and a substantial increase in both peak flow and volume, which is summarized in TABLE IV.D.4A.

IV.D.5 Hydrograph "Flow Duration":

The duration of flow of certain flow rates over time will change the sediment load requirements of the channel. Traditionally, "Flow Duration analysis" involves preparing some continuous simulation models for the alternative project conditions, and running 30-years of gage records through the simulation, and compiling and comparing the results of flow exceedance verses time. Similarly we can use design events to chart the relative impact of the project. To do this, the hydrographs for the various project scenarios and design events are measured to determine the duration of exceedance of certain flow rates. For this analysis we selected flow rates of:

Flow Rates for Flow Duration Analysis	Design Events Studied
90 cfs	10% of the 2-year
100 cfs	50% of the 2-year
200 cfs	2-year
300 cfs	5-year
400 cfs	10-year
500 cfs	25-year
750 cfs	50-year
1000 cfs	100-year
2000 cfs	200-year
3000 cfs	500-year
4000 cfs	
5000 cfs	
6000 cfs	

Data was assembled for comparison of the Pre-project conditions, Post-project conditions with mitigation and LID. Flows are compared at the confluence point of Pleasant Grove Creek and University Creek where all project flows are combined with the other creek flows. Figure III.C.4 shows the comparison of these scenarios for flow duration where a log scale is used on the duration axis. The Duration Axis plots the total summation of duration for which flowrates are exceeded for the analyzed events for a normalized 100-year period.

Figure IV.D.5A – Flow-Duration Relative Comparison (logarithmic)

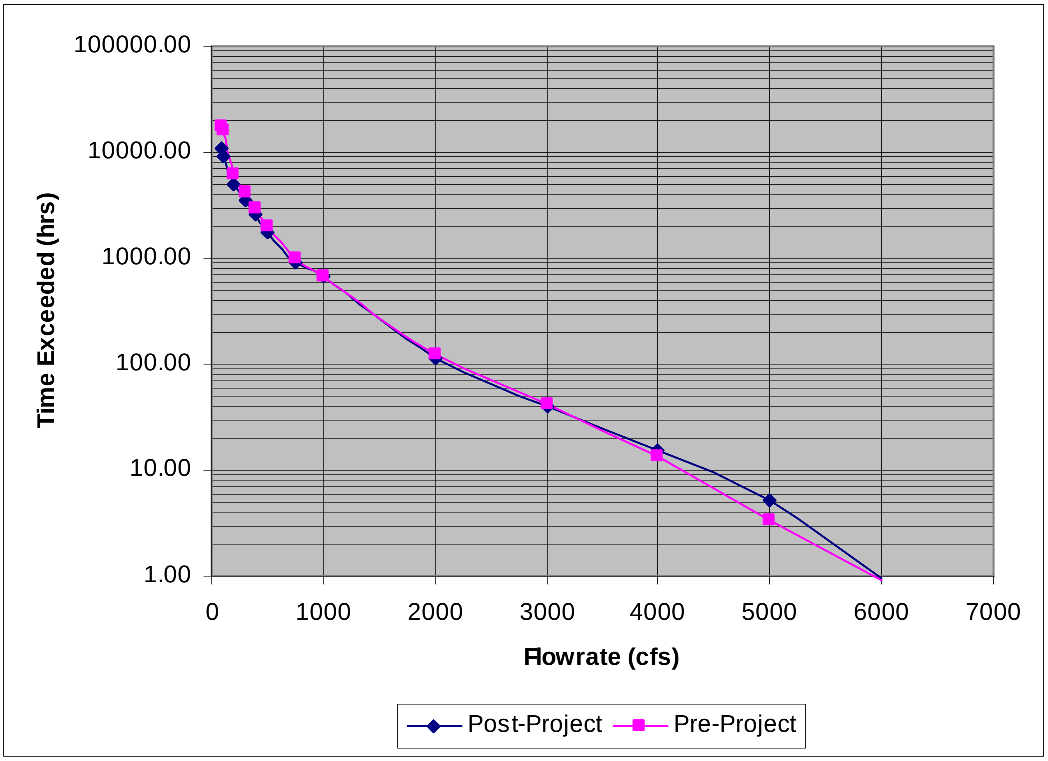
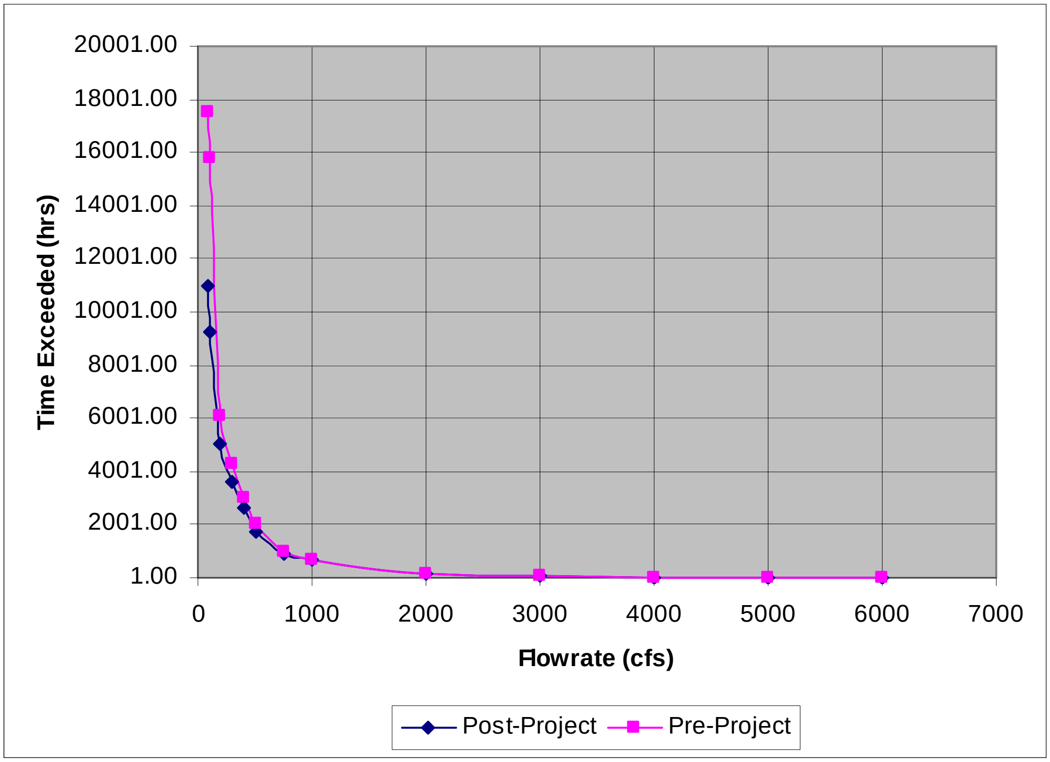


Figure IV.D.5A shows that the project with LID and mitigation is expected to lessen or equal the flow duration amounts from the pre-project for all flows less than 3,000 cfs.

Figure IV.D.5B shows the same correlation but on a non-logarithmic scale. On this figure it is easy to see the substantial relative benefits for the smaller and more frequently occurring flow rates, that the project with mitigation would have. The duration impacts for the higher flow rate events are not even visable on this scale.

Figure III.D.5B – Flow Duration Relative Comparison (non logarithmic)



Note: the above charts plot relative impacts for the storm events analyzed in this document. Adding storm event frequencies to this analysis would make the curves smoother (less jagged), but would not alter the results of the relative comparisons demonstrated.

V. Volumetric Impacts:

The Creekview Specific Plan drains via Pleasant Grove Creek. Runoff from the CSP area ultimately drains to the Natomas Cross Canal before entering the Sacramento River. The Cross Canal Watershed Study (CH2MHILL 1992-1994) identified that development within these watershed could make a flooding problem that exists within Sutter County, worse, by increasing the volume of runoff. The City of Roseville has implemented a drainage fee to collect funds and to ultimately build a mitigation facility, currently planned at the Reason Farms site. The Pleasant Grove Watershed Mitigation Fee recently established the parameters shown in Table V.A for development in Type D soils.

TABLE V.A – VOLUMETRIC IMPACT RATES IN TYPE D SOILS

LAND USE TYPE	LAND USE DESCRIPTION	% IMPERVIOUS	TYPE "D" SOIL IMPACT RATE (AF/ACRE)	LAND USE AREA (ACRE)	LAND USE IMPACT (ACRE FT)
LDR	Low Density Residential	40	0.072	155.8	11.22
MDR	Medium Density Residential	50	0.126	64.3	8.10
HDR	High Density Residential	60	0.206	17.1	3.52
COMM	Commercial	70	0.233	19.3	4.50
Park	Park	5	-0.115	15.7	-1.81
PQP	Public/Quasi Public	50	0.126	9.6	1.21
ROAD	Roadways	85	0.313	43.4	13.58
UR	Urban Reserve	2	0	0	0.00
OS	Open Space	2	0	136.2	0.00
				TOTAL=	40.33

The total computed impact of the CSP project is 44.2 acre feet of volumetric storage for a 8-day 100-year event. This impact will be mitigated at the City of Roseville's Reason Farms Facility, once it is constructed.

VI. Sediment Transport and Weir Stability Analysis:

This section discusses the potential sediment transport and weir stability issues related to the bypass channel design, and the analyses that have been performed for this project.

VI.A Sediment Transport:

A sediment transport analysis (PWA 2009) was prepared for Pleasant Grove Creek, the Creekview Bypass Channel, and the future extension of the bypass channel to the Reason Farms Retention Basin. is the sediment transport study is included in Appendix A.

The bypass channel design presented in the DSMP is largely the same as the bypass channel design that was analyzed in the "CREEKVIEW DEVELOPMENT PLEASANT GROVE CREEK SEDIMENT TRANSPORT ANALYSIS OF: (1) THE CREEKVIEW BYPASS CHANNEL AND (2) BYPASS CHANNEL CONNECTION TO THE REASON FARMS RETENTION BASIN", prepared by Phillip Williams and Associates, 12/15/2009 ("PWA 2009"), except that a few design changes have been made to increase the stability of the existing separator berm between the bypass channel and Pleasant Grove Creek; Other changes would reduce the risk of changing the groundwater conditions around the existing PGC channel, and increase the longevity, durability and stability of the bypass channel. In many cases the results presented in "PWA 2009" were used to guide these design modification which are summarized below:

- Bypass Channel Invert: the invert of the bypass channel was raised to an elevation several feet above the invert of the Pleasant Grove Creek channel, to avoid dewatering issues.
- Meandering Low Flow Channel: a low flow channel with a base width of 10 feet, depth of 1 foot and 4:1 side slopes was added to the bypass channel throughout the length of the channel. The low flow channel will contain nuisance flows and small event rainfall, , and assist with controlling the amount of dense vegetation growth expected in the bypass channel. The low flow channel will require regular maintenance to keep plant growth under control and to assure positive flows.
- Double low flow channel and widened vegetation zone: The low flow channel is split at weir flow exchange areas, such that one low flow channel approaches the toe of the weir. The area in-between the two low flow channels is assumed in the analysis to also include dense vegetation. Dense vegetation will be allowed to grow in the low flow channels and the areas between the split low flow channels. Dense vegetation growth will assist in slowing of velocities passing over the flow exchange weirs, as well as isolating most of the sediment fallout within these areas. These area's will have to be maintained to remove any excessive sediment loads.
- Flow Exchange Weirs: 5 flow exchange weirs have been added to the project design. The weirs will be slightly excavated (6 inches to 24 inches) into the existing berm which will separate the bypass channel from the main channel of Pleasant Grove Creek. These areas will include provisions for erosion protection in the form of soft armor fabrics.. These weirs are intended to isolate the highest velocity exchanges where erosion is most

likely to occur, between the bypass channel and Pleasant Grove Creek in order to prevent erosion of the separator berm. There will be flow exchange along the entire length of the berm in high flow events, but the highest velocities will be concentrated at the weir locations, where armoring will be installed with the project.

- Flow Isolation Berm: Downstream of the CSP site, a berm will be constructed between the bypass channel and Pleasant Grove Creek which will eliminate the potential for flow exchange between the creek and the bypass channel. The flow isolation berm would extend through this reach to the flow return location approximately 2500 feet west of the project.

The combined effect of these modifications is that depth of sediment deposition in PGC is likely to be reduced from the amounts shown in the PWA 2009 Sediment Transport Study. It is also likely that total sediment load to the CSP bypass channel will be reduced below the estimates presented in PWA 2009.

For the purpose of evaluating the impact of the potential sediment accumulations in the bypass channel, an alternate version of the post-project analysis for the Future Fully Developed and unmitigated (FFDU) flow conditions was developed to include the sediment depths per Chapter 3 of the "PWA 2009" study. Locations of scour reported in the analysis were not modified for this sensitivity analysis. The analysis basically includes 700 CY of deposited material near the upstream weir (approximately 35 feet wide x 2.5 feet deep by 200 feet of sediment is placed in the model) then approximately 300 CY of deposited material is inserted for each 100 feet of proposed weir (roughly 35 wide by 2.5 feet deep is added near the weir toe). An example of how the sediment was applied ot the cross sections as obstructed area is shown in FIGURE VI.A.1.

FIGURE VI.A.1 – Example of Sediment Obstructed Area added to Cross Sections

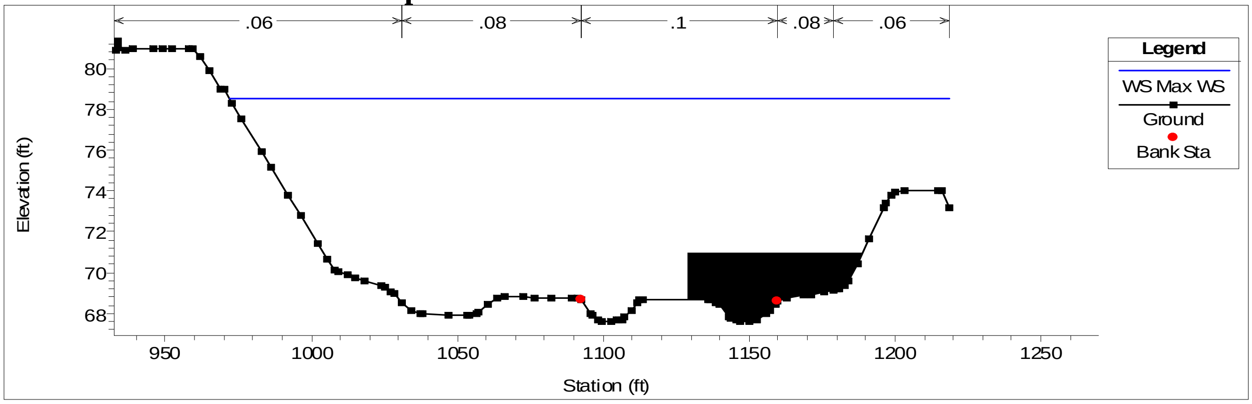


FIGURE VI.A.2 – Profile Comparison for FFDU 100-year, with and without Sediment

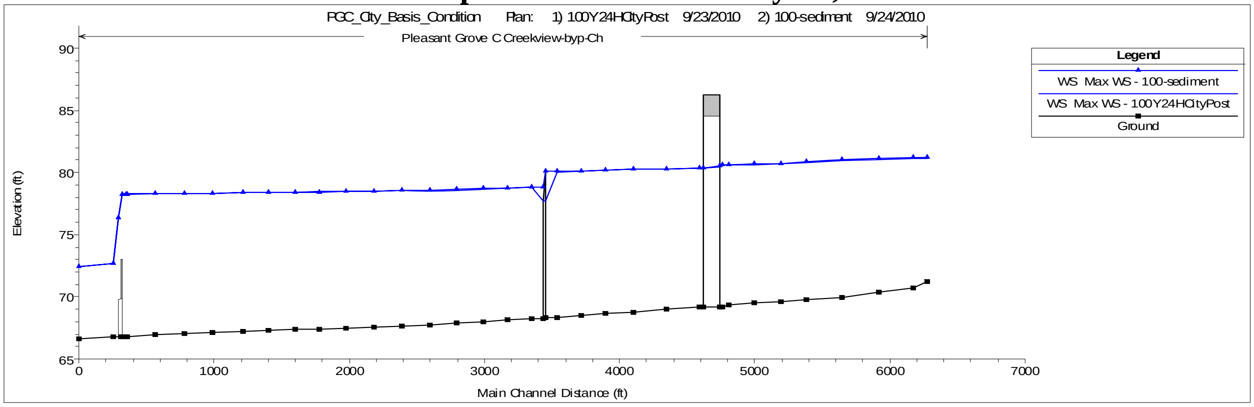


Figure IV.A.2 – Compares the resulting water surface changes for the 100-year event FFDU analysis. At the upstream end of the bypass channel water surface elevations are increased by 0.06 feet for the with sediment condition. The sediment would also have the potential to change the flow split between the main channel and the bypass channel. The results show that the peak flow for this scenario in the 100-year event leaving the project in the bypass channel would be reduced by 4 cfs to 1421 cfs.

VI.B Weir Stability Analysis:

The construction of the Creekview Specific Plan Bypass Channel has the potential to impact the stability of the southwest bank of Pleasant Grove Creek through the project. A 2-dimensional unsteady state analysis of Pleasant Grove Creek and the Bypass Channel was performed using the FLO-2D software. A 25 foot grid sizing was selected to model the project detail fully.

The software can identify flow direction and speed in two dimensions. The results of this analysis for velocity distribution are plotted for each weir location on figures VI.B.1 to VI.B.6.

FIGURE VI.B.1 – BYPASS CHANNEL SPLIT WEIR LOCATION VELOCITIES (100-year Peak)

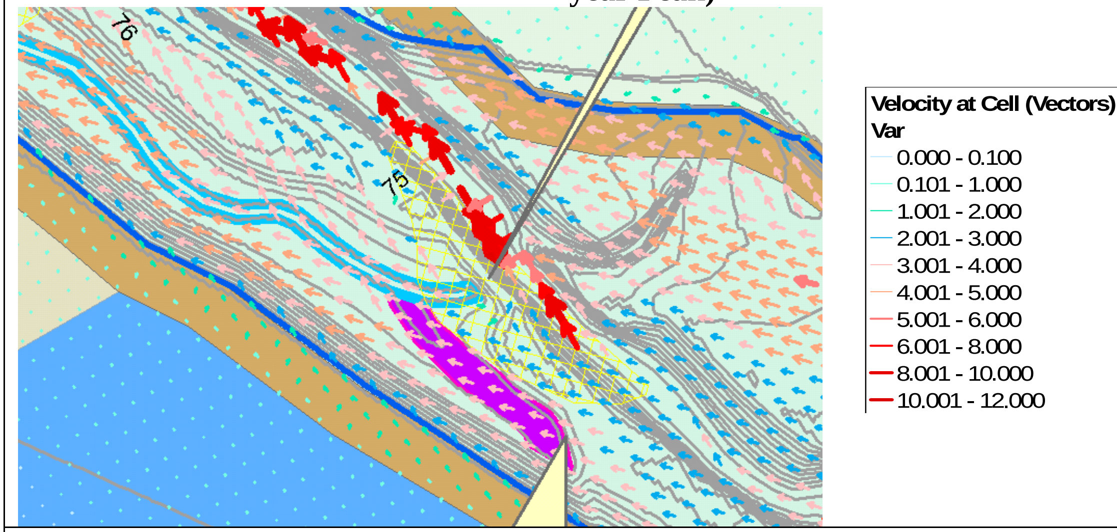


FIGURE VI.B.2 – BYPASS CHANNEL WEIR LOCATION 2 VEL. (100-year Peak)

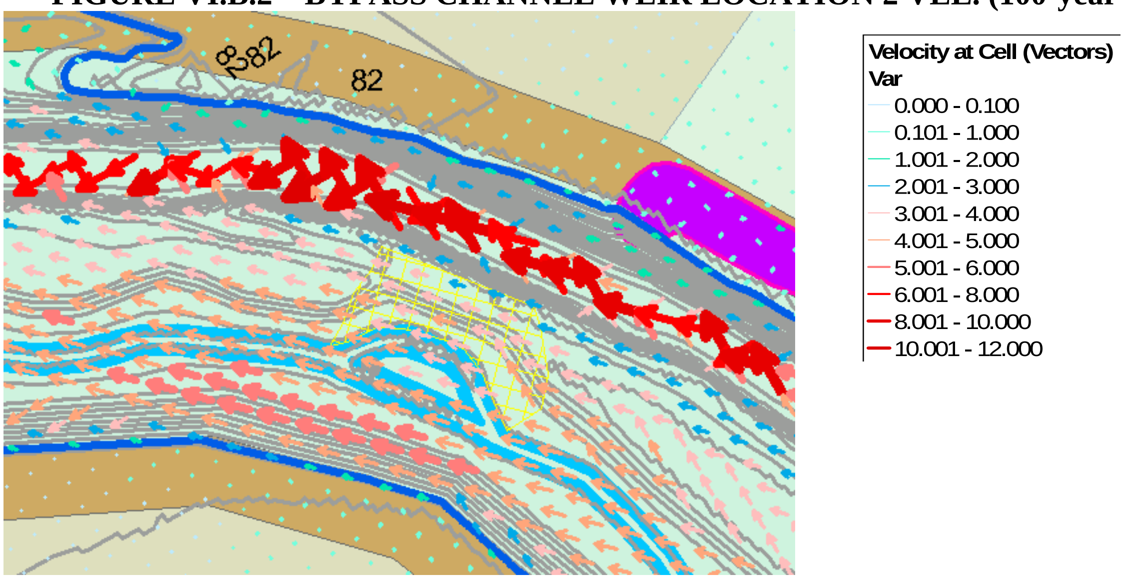


FIGURE VI.B.3 – BYPASS CHANNEL WEIR LOCATION 3 VEL. (100-year Peak)

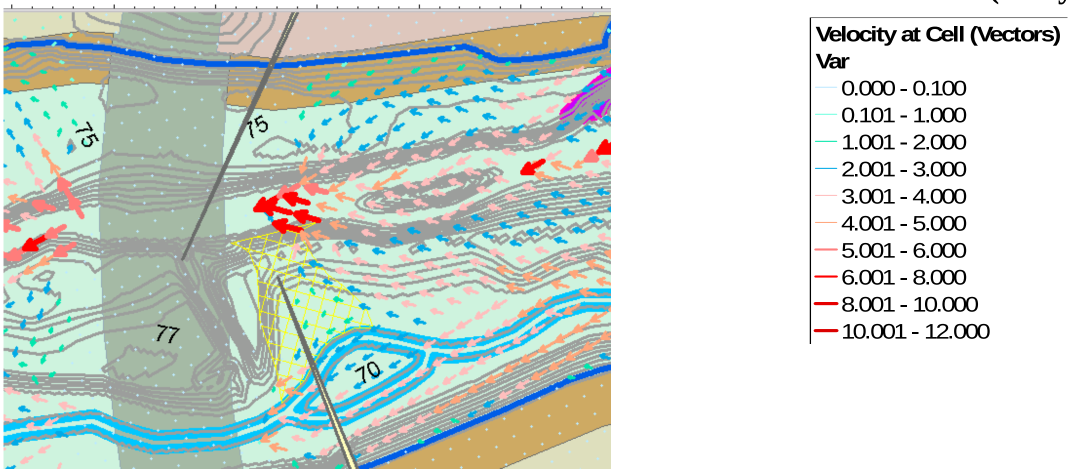


FIGURE VI.B.4 – BYPASS CHANNEL WEIR LOCATION 4 VEL. (100-year Peak)

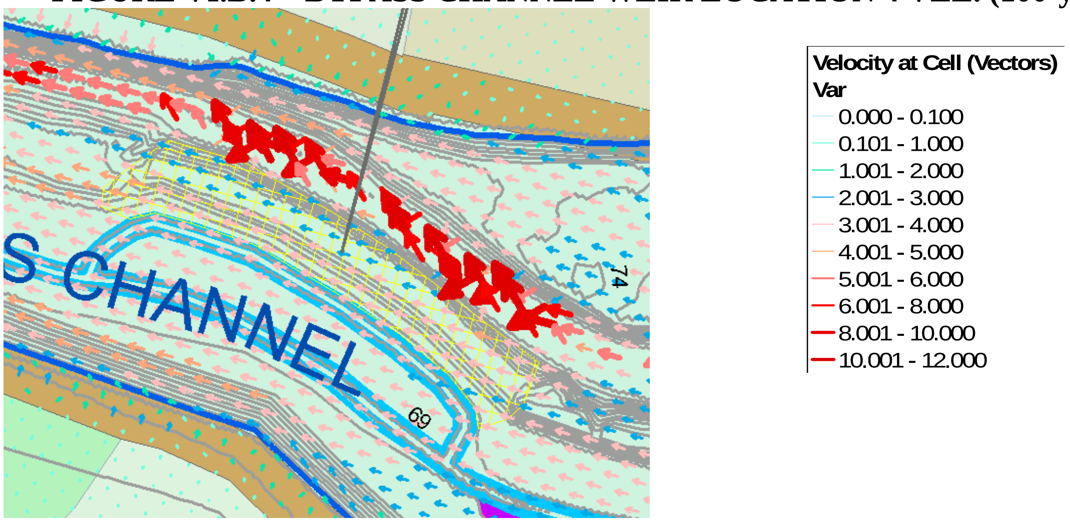


FIGURE VI.B.5 – BYPASS CHANNEL WEIR LOCATION 5 VEL. (100-year Peak)

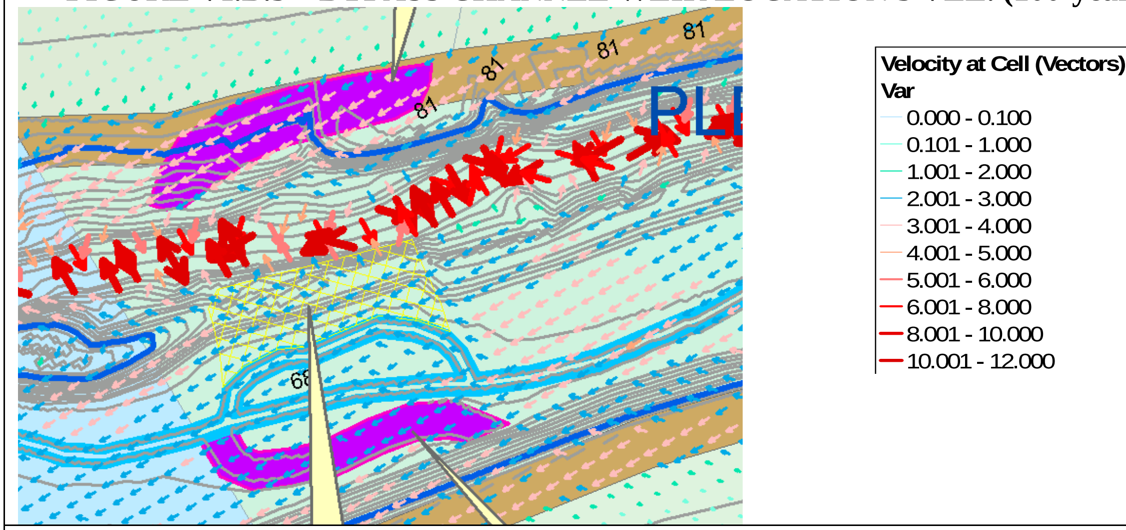
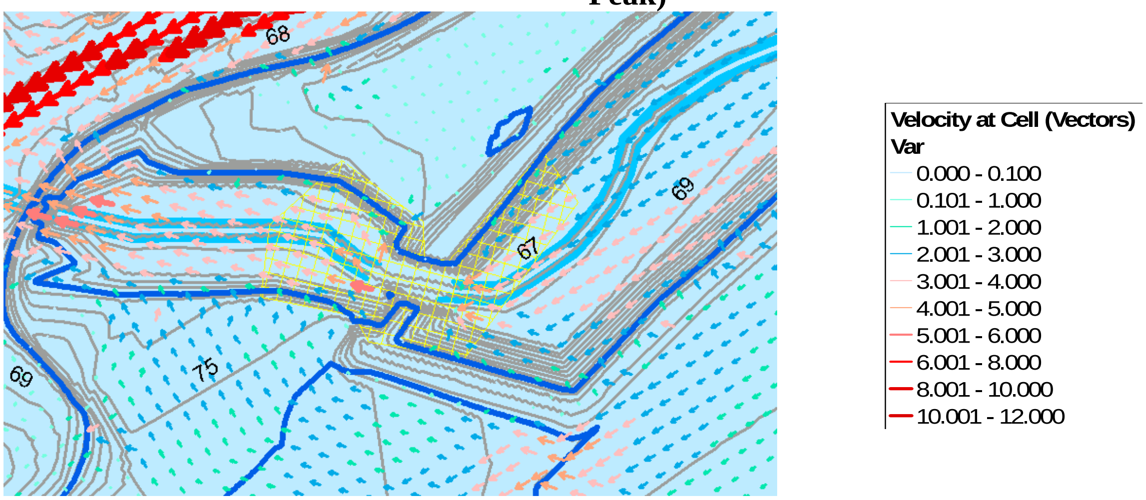


FIGURE VI.B.6 – BYPASS CHANNEL RETURN WEIR LOCATION 2 VEL. (100-year Peak)



(Once the FLO-2D analysis is stabilized, more discussion wil be placed here including references to 2D animations, the oversized exhibit, and the results of the analysis)

VII. Conclusions:

The DSMP demonstrates that with implementation of the CSP project:

- The project hydrology and hydraulics were evaluated for two potential regulatory hydrologic studies, The City Basis and the FEMA basis models.
- Peak flows for the range of events studied will be slightly lower than those that would be expected without the CSP improvements at the project boundaries.
- Flood elevations upstream of the CSP project will rreduce slightly (-.4 feet at Pleasant Grove Creek and 0 feet at University Creek), but this is within a range acceptable to the City and consistent with the City's Floodplain Management Ordinance.
- Flood elevations below the confluence of Pleasant Grove Creek would be unchanged by the project improvements.
- Runoff volumes for the range of events studied would be reduced as a result of the proposed CSP LID measures.
- The drainage elements of the project are designed to accommodate and mitigate for potential future increased stormwater permit requirements. Advanced use of LID, and impacts to hydromodification are evaluated within the report.
- The project will have an 8-day 100-year volumetric impact of 40.3 acre feet, and will be required to pay the Pleasant Grove Watershed Mitigation Fee.

APPENDICES

APPENDIX A
BYPASS CHANNEL SEDIMENT TRANSPORT ANALYSIS (PWA – 12/2009)

APPENDIX B
HEC-1 PRE-PROJECT INPUT FILE

APPENDIX C
HEC-1 POST-PROJECT
FUTURE FULLY DEVELOPED UNMITIGATED INPUT FILE

APPENDIX D
HEC-1 POST-PROJECT
MITIGATED SCENARIO
INPUT FILE

APPENDIX E
HEC-RAS PRE-PROJECT
SUMMARY TABLE

APPENDIX F
HEC-RAS POST-PROJECT
MITIGATED AND
FUTURE, FULLY DEVELOPED, UNMITIGATED
SUMMARY TABLE

APPENDIX G
PROPOSED ONSITE PROJECT
STORM DRAIN ANALYSIS
10-YEAR and 100-YEAR
CSDS REPORT

APPENDIX H
STORMWATER QUALITY CALCULATIONS
LID CALCULATIONS

APPENDIX I
Support for the Land Use Imperviousness Computations (Not in this Draft)

APPENDIX J

CD-ROM of Project Files

APPENDIX K
Oversized Exhibits