APPENDIX J.1

Drainage Study

The Ranch

Master Drainage Study

Third Submittal

April 30, 2019

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INTRODUCTION

OVERVIEW

The Ranch development project is a proposed 1,300 senior residential development over 530 acres within the City of Rancho Cordova. The proposed project is defined on the Small Lot Tentative Subdivision Map, THE RANCH, prepared by Wood Rodgers, dated February 2018. See **Figure 1**.

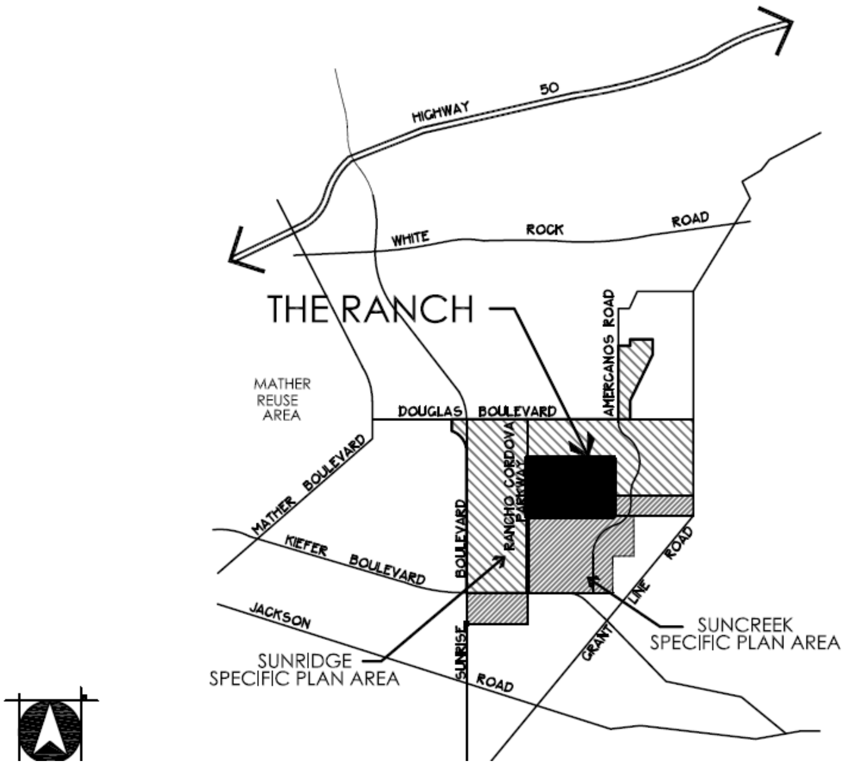

Figure 1. Vicinity Map

The project consists of two development areas at the northwest and southeast quadrants, with the remaining area as open space and an environmental corridor for the Lower Morrison Creek South. The northwest quadrant will drain to the Lower Morrison Creek South, and the southeast quadrant will drain to both the Lower Morrison Creek South and Kite Creek.

The open spaces will also include detention basins that will provide stormwater management. The management includes capture and treatment of summer irrigation flows, hydromodification of storm runoff, and attenuation of very large storms so that post-project flow rates are equal to or less than existing conditions. There will be three basins to manage runoff from the northwest quadrant development and two basins to manage the southeast quadrant stormwater runoff.

Current land use is cattle grazing. The topography is irregular and uneven, with gently rolling terraces, numerous hills, and depressions. The Lower Morrison Creek South meanders down the middle, generally from the northeast to southwest.

With the exception of a major road crossing (Crysanthy Boulevard) and four outflows from the respective detention basins, the South Branch of Morrison will remain as a meandering channel within an open space corridor. The outfall for the southern portion of the Southeast quadrant into Kite Creek is tentatively planned to be part of a larger outfall that will serve the proposed SunCreek Specific Plan.

Previous Studies

1. The "Drainage Study for The Preserve at Sunridge", County of Sacramento, March 2006, was prepared by Wood Rodgers. This study provided information for on-site and off-site drainage facilities for Ultimate Conditions and provided a solution for Interim Conditions. The development layout and environmental constraints have been significantly changed, and this study is no longer applicable.
2. The "Final Master Drainage Study, Sunrise-Douglas Community Plan Area, Sacramento, CA", dated October 16, 1998 by the Spink Corporation was available as a reference document for comparison of existing and developed conditions, flow volumes, and detention basin volumes.
3. The Montelena Drainage Study, including sections for Anatolia I and II, dated September 2007 by Wood Rodgers, is a compilation of drainage analyses prepared for several developments within the Sunrise-Douglas Community Plan. The studies focused on the Sunrise-Douglas Community Plan area but also included analyses of impacts to Laguna Creek.
4. The Master Drainage Study for Anatolia III, dated June 2004 by Wood Rodgers, provided the analysis and design information for the facilities to manage Anatolia III stormwater. The analysis and facilities information were used as presented for this study.
5. SunCreek Master Drainage Study, November 15, 2017, prepared by Watermark Engineering, Inc. for the SunCreek owners group. The study was for approximately 1,270 acres of mostly residential development east and mostly south of The Ranch property. The southeast quadrant of The Ranch drains to Kite Creek, which is also where most of the proposed SunCreek development drains.

This updated study relies on much of the basic data gathered and created by Wood Rodgers including land use information and topography mapping used for the cross-section data for the backwater analysis. It also relies on development information currently being prepared by CTA Engineering and Surveying.

Definitions

1. For this study, a shed or subshed, coupled with a number (#), is a portion of or an entire tributary area that drains to a specific location, either directly into a creek or into a basin (#).
2. A basin is the complete facility that will provide the stormwater management, including the permanent pool for water quality, storage for hydromodification and peak flow attenuation, and the outflow facilities.
3. Hydromodification is the change in watershed characteristics as a result of land use changes (development in this instance).
4. Lower Morrison Creek South Branch is identified as MCSB within this document.

DESIGN CRITERIA

GENERAL REQUIREMENTS

This study is prepared under the same criteria used for the SunCreek drainage study. Specifically, a drainage study must be submitted to the City to demonstrate that:

a. The proposed detention basins are appropriately sized in compliance with the SSQP's NPDES Permit and Hydromodification Management Plan to mimic existing conditions;
b. The stormwater basins will drain by gravity;
c. The basins can be designed to minimize long-term maintenance, especially the outlet structures.

Per additional city requirements:

d. The existing-conditions 100-year floodplain of Lower Morrison Creek South Branch has to be defined;
e. Developed flows leaving The Ranch shall not create significant impacts to downstream properties.

Topographic mapping and this analysis are based on the National Geodetic Vertical Datum of 1929 (NGVD29).

WATER QUALITY

Through coordination with City officials, the proposed water quality treatment will utilize both dry basins and wet basins that include a permanent pool. The basins will be designed per the "Stormwater Quality Design Manual for the Sacramento and South Placer Regions, July 2018, Water Quality Detention Basins".

Three basins are designed with a permanent pool located below the lowest elevation of the outfall facilities. This configuration and the design were based on Table DB-1 of the Stormwater Manual. The remaining two basins are designed as dry basins because of their relatively small size. It would be difficult to keep a small permanent pool healthy, and one of the dry basins is under PG & E power lines where water bodies are not allowed.

HYDROMODIFICATION

The hydromodification was completed using the SAHM (Sacramento Area Hydrology Model) dated December 2013, developed by Clear Creek Solutions, Inc. The computer program provides pre-project peak flows for 2- through 25-year recurrence intervals storms. The program then analyzes the proposes facilities and compares pre-project and post-development flows, ranging from 25 to 40% of the 2-year peak flow through the 10-year peak flow, to demonstrate that post-project flows are similar to pre-project flows.

High Flow Attenuation

There is a requirement to attenuate the 100-year storm to approximate pre-project conditions. The XP-SWMM software was used for that analysis as well as for the selected lesser storms as described later. Both the SAHM and XP SWMM software were used to size and configure the basin and corresponding outfall facilities.

Methodology

Existing Conditions

The first major task was to select and analyze existing subsheds to determine runoff characteristics (hydrographs) and peak flows for the selected recurrence-intervals storms. SacCalc was used to generate the subshed hydrographs. The hydrographs were then added and routed using the XP-SWMM software. This software is approved by FEMA for Flood Insurance Studies and mapping revisions, so this information will also be used for the LOMR submittal.

Developed Conditions

The Ranch was subdivided into five drainage areas and five corresponding basins based on topographic constraints and proximity to Lower Morrison Creek South and Kite Creek.

Where appropriate, existing conditions subsheds were used for developed conditions. However, the post-project subsheds are based on both development boundaries and topography. Development grading will redirect a small portion of the southeast quadrant development area to Kite Creek rather than to MCS, mainly due to grading constraints.

The southwest portion of The Ranch will remain as open space. This area currently drains to MCS but will be directed south to Kite Creek as part of the nearby SunCreek development. This specific area is not part of this drainage study.

The decision to convey this area to Kite Creek was made as part of Appendix D, Regional Master Drainage Study for SunCreek Specific Plan, prepared by Makay and Somps, dated August 22, 2011. An excerpt of page 24 of that document is show below.

The 102.3+/- acre Open Space Preserve (Sub-shed KCOS-05) located east of Rancho Cordova Parkway and north of the SunCreek Plan Area has been modeled in a similar fashion as the Morrison Spill. The storm related runoff from this sub-shed is from an undeveloped open space area and does not require water quality treatment or detention within the SunCreek Plan Area. The runoff from sub-shed KCOS-05 naturally drains towards the northeast corner of the Rancho Cordova Parkway-North Campus Drive intersection. An inlet structure will be constructed at this location and the storm runoff from sub-shed KCOS-05 is routed through a 48-inch diameter pipe located in Rancho Cordova Parkway. The 48-inch diameter pipeline is sized to convey the higher peak flow of 84 +/- cfs generated by the 100-year, 24-hour storm rather than the peak flow rate of 50 +/- cfs generated by the 100-year, 10-day storm. The 48-inch pipeline will follow Rancho Cordova Parkway to the south where it drops into a 72-inch diameter pipe. The drop into the 72-inch diameter pipeline will help to dissipate the velocity energy generated in the 48-inch pipeline before discharging into the preserve/open space area just upstream of the Rancho Cordova Parkway box culverts. Additional energy dissipation measures prior may be needed to discharge into the preserve/open space to prevent erosion of the streambed.

Hydrologic Analysis

Land Use

The Ranch is undeveloped. The land may have been used for some dry farming in the past, but is currently used for cattle grazing.

Soils

The soil classifications for this study were based on information available from Natural Resources Conservation Service (NRCS). The soils are mostly classified as Hydrologic Soils Group D with the remaining classified within Group C. Selected soils information is provided as **Attachment A**.

Groundwater

Information from the nearby SunCreek Specific Plan Project DEIR/DEIS indicated that "groundwater is located from 20 to 100 feet below the ground surface depending on when and where the measurement was taken."

A preliminary geotechnical report prepared by WallaceKuhl entitled Jeager Ranch Property, dated Sept 26, 2016, stated that "groundwater is anticipated to vary between 150 and 240 feet below existing surface grades". As such, groundwater has not been considered in the analysis of the basins and drainage corridors.

There are two monitoring wells within The Ranch, but data collection and availability are not known at this time.

SURFACE WATER

The two sources of water that flow into the basins are rainfall runoff and runoff from excess landscaped irrigation. There are no other sources of surface water that could impact flows into and out of the proposed basins.

EXISTING CONDITIONS

MCSB generally flows from the northeast corner to the west central property boundary of The Ranch. The total tributary area of MCS entering The Ranch is 1,120 acres and the 100-year, 12-hour natural flow was estimated to be 678 cfs per Wood Rodgers (Reference 1). This hydrograph was used as model input at the northeast corner of the development site. Local inflow was added to the model at three locations along MCS as it meanders through The Ranch. Additional information of the flows along MCSB is provided later in this document.

DEVELOPED CONDITIONS

The Ranch was subdivided into five sheds: three sheds that represent the developed areas north of MCS; two development areas south of MCS; and the sixth shed representing the MCS corridor.
Drainage sheds were reconfigured based on land use, topography, and availability of suitable detention sites. The basins will be designed as wet basins except for the basins PG and SN. The permanent pool will be eight feet deep. The actual configuration of the basins has not been determined. Additional information about the basins is provided later in this document under Basin Details. The five sheds are shown on **Figure 2.**

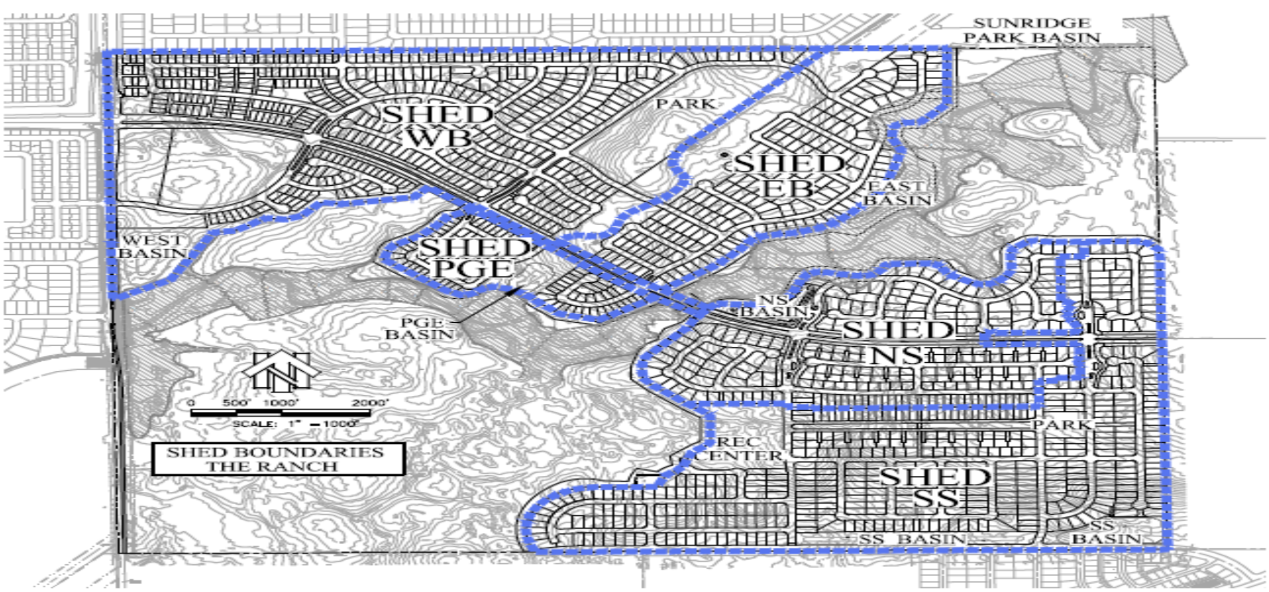

Figure 2. Sheds within The Ranch

A brief description of each shed and the corresponding detention basin facilities follows:

- **West Basin (WB):** The shed includes the northwest development area, and the basin is located just south of the tributary shed area and just east of Rancho Cordova Parkway. The outfall from this basin will enter MCS where it turns south and parallels the parkway in a man-made channel.

- **East Basin (EB)**: The EB shed includes the central and eastern portion of The Ranch development just north of MCS. The detention basin is adjacent to MCS near the middle of the development site. Outfall from this basin will be directly to MCS or conveyed south and discharged into the creek at the proposed Crysanthy Boulevard crossing.

- **PGE Basin (PGE):** This shed is located south of Crysanthy under the PG&E transmission lines. The shed area was minimized to comply with PG&E constraints for drainage facilities under their high-voltage power lines. The basin will be designed to create and maintain as much infiltration as can be reasonably achieved. An outflow will discharge south or west directly into MCS.

- **North South Basin (NS)** This shed is located along the left bank of MCS, generally along both sides of Crysanthy Boulevard east of the MCS crossing. The basin will be a dry-extended basin with an outflow to MCS upstream of the Crysanthy crossing. Note the modeling map shows SN rather than NS.

- **South-South Basin (SS):** All of the developed area south of MCS will drain to this linear basin that is located along the southern boundary of The Ranch. The permanent pool is at the southeast corner and will drain to Kite Creek. Its outfall will be part of a larger outfall that will also serve SunCreek and will become the new headwaters of Kite Creek.

  It is expected that the storm drains discharging into the wet basins will be below the water level of the permanent pool. This eliminates the need for access control at the outfalls. Manholes just upstream of the basin will include a slide gate so that the deep pipe can be isolated and cleaned as necessary.

Maps 1 and 2, folded in the back of this document, provide a detailed layout of the subshed areas, the proposed storm drain network, and the proposed detention basins. **Attachment B** provides a summary of imperviousness and peak flows for the 2-, 10-, and 100-year storms at the selected subsheds for post-project conditions. There is no comparative analysis for existing conditions because the subshed boundaries are not the same between existing and the post-project conditions.

HYDRAULIC ANALYSIS

OVERVIEW

The design of The Ranch of the three stormwater management wet basins can be described as three storage areas in a vertical stack. The lowest portion will be the permanent pool and will be below the lowest outfall. This permanent pool provides the water quality per the wet detention basin criteria.

The storage component to meet the hydromodification criteria is "stacked" in the middle and larger than the permanent pool. This hydromodification component also includes outflow facilities. For simplicity, the outflow facilities for each basin are designed to include a single orifice and a single weir.

The top area is the storage area needed to store and attenuate extreme storms up to the 100-year storm. The orifice and weir are designed to release flows to less than the pre-project flows. Trial and error model runs were used to determine the basin size, the size of the orifice, and the shape and size of the weir.

Each basin and corresponding outflow facility has to meet three distinct design criteria. The criteria were the size of a permanent pool for water quality, flow attenuation to meet the hydromodification protocol, and flow attenuation for extreme flows. To satisfy these criteria, a simple calculation and two computer models were used.

The basin under the PG&E transmission lines and the NS basin will be dry basins, designed to drain within 48 hours per water quality criteria. In addition, the basin bottom will be configured and constructed to improve and maintain infiltration. The design has not started, but concepts being considered to improve infiltration include pre-treatment areas, gravel beds, and excavation through the duripan layer, then backfilled with permeable material. Please note that infiltration has not been considered for sizing or flow control for these two dry basins. Rather, the design of the dry basins will include infiltration enhancements to reduce ponding time and reduce the chance of outflow from summer irrigation runoff.

MODELING

The computer model SAHM was used to determine the peak flows for the 2-, 5-, 10-, and 25-year events for each of the basins assuming existing conditions. These flows were used as "targets" within the XP-SWMM analysis. Peak 100-year target flows were available from the existing conditions subsheds but are not available because there are no "existing conditions" watershed parameters to use to compute flow. The developed conditions subshed boundaries are based on development boundaries, not watershed boundaries. As a result, basin parameters normally used to determine 100-year flows are not available.

A separate analysis was completed. The 100-year flows from the existing conditions subsheds were used to develop a regression equation to estimate 100-year flows from the man-made areas. The equation is:

$$Q_{100} = 3.06\ DA^{0.75}, \text{ where:}$$

Q_{100} = the 100-year flow in cubic feet per second (cfs), and
DA = drainage area in acres.

Table 1 provides a summary of the shed areas that includes estimates of natural flow from each shed. The flow estimates are used only as guides for the detention basin analyses.

Table 1. Summary of Existing Conditions Subsheds

Shed ID	Shed Area (ac)	100-yr Peak Flow (cfs)[a]
West	104.2	100
East	46.0	56
PGE	14.7	23
North-South	50.2	58
South-South	95.7	94
Remainder	218.7	na
Total	530	na

a: Estimated from regression equation developed for the SunCreek. See Modeling section for details.

The target flows were then used as a general guide to configure and evaluate various basin sizes and outfall facilities. They were used only as target flows and not specifically for design or compliance.

In addition to sizing the basin and outfall facilities, the upstream storm drain facilities were also modeled to provide preliminary pipe sizing based on containment of the 10-year flow. Note that the storm drain alignments are probably accurate but the pipe inverts and other design details are not yet available. As such, the hydraulic analysis of the pipe network is at the master drainage study level only. **Attachment C** provides additional information concerning design flows, preliminary pipe sizes, and information concerning basin and basin outfall parameters.

PERMANENT POOL

The permanent pool was sized based on the Sac County Water Quality manual (July 2018). While the actual design of the basins is not yet available, design guidelines and sizing information for each basin is provided later in this document. The wet basins are expected to be healthy, attractive, and maintain a fish population more than just mosquito fish.

All basins should be designed with side slopes of 4:1 or flatter. In addition, it is strongly recommended that soft curves be used for the shore line and basin perimeter. Clayey soils need to be stockpiled for the three wet ponds during excavation and nearby construction. Those soils will then be used to line the bottoms of the wet basins to minimize infiltration. The dry basins should not be lined.

The permanent pools will be eight feet deep or greater. The pan evaporation at the Folsom Lake weather station is about 52 inches for the months of May through October. Using a conversion of 0.75, the loss during the summer would be about 39 inches. Assuming a full pool in late April, no summer inflow, and minimum infiltration, the pools should have about four feet of water remaining at the end of the summer. As a minimum, the pools are expected to have sufficient volume and depth to maintain suitable temperature and habitat for mosquito fish. Note that summer inflows would also help maintain minimum water levels during the summer. Also note that summer inflows are not expected to exceed evapotranspiration, causing spill during the summer.

Hydromodification and High Flow Attenuation

The following steps were used to size and configure the basins and outflow facilities. The SAHM model was set up, starting with the footprint of the permanent pool. A trial and error procedure was then used to determine a storage basin, a single orifice, and a rectangular notch that met the hydromodification criteria.

That proposed facilities information was then used as input for the XP-SWMM (XP) model. An outfall to Kite Creek was added to the facilities to evaluate backwater conditions into the analysis. Note that the SAHM model is not dynamic, so backwater cannot be evaluated within that model.

Trial and error was again used to confirm and/or modify the proposed storage capacity and outflow facilities to meet the 100-year attenuation criteria. After the outflow requirements were met within the XP model, the revised facilities were then reloaded into the SAHM model to ensure that the hydromodification criteria were met.

The basin and outfall features were then reloaded into the SAHM model using the SSD Table option. If the hydromodification criteria were not met, then the XP model was reworked. This whole process was required to be able to include the outflow rating using different weir configurations, to be able to account for backwater, and accurately represent a basin that has varied side slopes. Typically, the generic basin has mild side slopes above the permanent pool that rapidly increase storage, then steeper slopes near the top. The SAHM is not designed for complex basin configurations.

The results of the SAHM analyses for the five basins are provided in **Attachment D**. Please note that the SAHM analysis focuses on flows from 25% of the 2-year storm through the 10-year storm and does not analyze storms smaller or larger than this range. Therefore, the permanent pool information and the upper portions of the storage and outfall facilities are not needed and have generally not been included in the data input. As such, the basin stage-area-storage information and outfall information do not represent the complete facility. Please refer to the Basin Details section for complete information.

The existing tributary area of Shed SS is less than the post-project area. The SAHM models for Shed SS reflect this relatively small increase and the capacity and outfall facilities for Basin SS reflect these differences. Also note that the SAHM analysis showed failure between 40 and 43 cfs but passed above and below this relatively small range.

DISCUSSION OF APPROACH

There were several reasons for the trial and error approach. Both models were needed to meet the design criteria, but either model could control the basin size and shape and the outflow facilities.

Also, the criteria could have been easily met without the trial and error effort if the modeler did not consider basin size to be an important consideration. As an example, when backwater was considered in the XP model, the outflow was less compared to the SAHM model. In other words, the SAHM model overestimated the outflow. The backwater-controlled outflow was actually less which meant more storage (land) was needed if only the SAHM data were used. Hence the need to recycle the SAHM model with the XP data to gain a more efficient facility.

Another reason for the trial-and-error approach is the versatility of the XP-SWMM model. Any basin shape and configuration and a variety of outfall facilities can be quickly evaluated for compliance. In addition, the 100-year storm cannot be modeled within the SAHM model.

BASIN DETAILS

The stage-storage of each basin and the corresponding outfall facilities have been coordinated to meet water quality and hydromodification criteria as well as attenuation requirements along the creeks and downstream of the confluence of MCSB and Kite Creek.

Please note that the actual configuration can be modified without further analysis as long as the stage-storage-discharge relation remains similar to what is shown. If significant changes are proposed, then additional modeling may be needed to evaluate basin performance and downstream impacts. The entire basin may also be moved vertically, dependent on grading.

A basin might be reconfigured when the land use plan shows a larger footprint. That would accommodate a shallower basin with a larger, more freeform footprint. Conversely, a deeper basin may be desired. Either change could affect the size of the orifice, as well as the configuration and elevation of the weir. Any revised configuration or footprint would be addressed when there is more detailed development information.

Table 3 provides key parameters of each basin. The basins typically have an eight-foot depth for the permanent pool and an operating depth of 4 to 5 feet above the permanent pool. The top elevations of the basins are generally 1+ foot above the 100-year water surface elevation. An access road around each basin has not been included as part of the determination of needed basin area because there are too many unknowns at this time. However, the basin design will include access that is acceptable to the city. The additional area needed for a perimeter road would be in the range of up to one-half acre in addition to the basin areas shown in the summary table.

Detention/WQ basins and open channels shall be designed per Section I.8.5 of the SunCreek Specific Plan and per Section 7.4 and Section 8 of the City of Rancho Cordova Open Space Guidelines, dated December 2, 2013. Per the Open Space guidelines, consideration shall be given to designing detention basins to look natural with natural landscaping, to have gentle side-slopes, and to have terraced areas with a variety of plants and trees. Where feasible, basin perimeters shall incorporate trails and bike paths. These natural features shall not interfere with normal function and maintenance.

Table 3. Basin Parameters and Hydraulic Information					
Parameter	Basin ID				
	West	East	PG	NS	SS
Tributary Area (ac)	104.2	46.0	14.7	50.2	95.7
Land Use Percent Imperv (%)	52.9	42.4	53.9	54.6	50.3
Basin Surface Area (ac)	4.4	3.1	0.8	2.0	5.6
Req WQ Vol (Fig E-3) 48h(in)	0.38	0.32	0.39	0.40	0.37
Reg WQ Vol (af)	3.3	1.2	na	na	3.0
PP Surface area (ac)	1.4	1.5	na	na	1.0
Perm Pool (PP) Vol (af)	8.0	8.4	na	na	5.0
SAHM Trib Area (ac)	104.2	46.0	14.7	50.2	78.2
Top Elevation	175	188	183	187	180
Permanent Pool Elev (ft)	168	184	Dry	Dry	170
Bottom Elev. (ft)	160	176	176	181	162
Q2 In (cfs)	67	30	12	34	47
Q2 Out (cfs)	17	6	1.2	10	5
Q2 WSE (ft)	170.7	185.5	178.7	183.5	173.3
Q10 In (cfs)	116	61	24	70	82
Q10 Out (cfs)	54	26	1.6	27	18
Q10 WSE (ft)	172.7	185.9	180.0	184.4	174.5
Q100 In (cfs)	157	77	34	87	118
Q100 Out (cfs)	105	47	2.1	58	50
Q100 WSE (ft)	173.6	186.5	181.8	185.3	175.7
2-yr Storm WSE (ft) @ 24 hrs	170.2	185	177.4	182.0	172.8
Q100 WSE (ft) after 2yr, 24-hr	173.6	186.5	181.8	185.3	175.9

The proposed drainage facilities are shown on folded **Maps 1 and 2**. Hydraulic information and basin stage-area-volume information, taken from the XP model output, is provided in **Attachment C.** Copies of the SAHM output are provided at **Attachment D**.

The outflow facilities for the West, NS, and SS basins consisted of one orifice and one weir. The outflow for the PG&E basin is a single orifice. The outflow facility for the East Basin is a compound weir. **Table 4** provides a summary of the outfall facilities at each of the basins.

Table 4. Description of Basin Outfall Facilities

Basin ID	Orifice (in)	Flowline Elev (ft)[a]	Description of Weir	Flowline of Weir (ft)[b]	Comments
West	Rect- 0.5'h x 1.7'w	168	One foot wide at base (elev 170) and 6 ft wide at top at elev 175.	170	The weir is also considered the emergency spillway.
East	na	na	Compound weir, 0.6' BW @ elev 184, then 1.5' wide @elev 185.0, then 2.5'w @elev 185.01, and then sloping to 6' wide @ elev 188 (top).	184	The weir is also considered the emergency spillway.
PGE	6-in round	176	4' standpipe that will act as emergency weir. Open top will have Cooley type access cover.	182	Outfall pipe to be 12-in dia. Orifice connected to 4' standpipe.
NS	12" round	181	Weir: 1' w at base (elev 182.5), then 5.5' w at top at elev 187.	181	The weir is also the emergency spillway.
SS	12" round	170	Weir: 1' w at base (elev 172.5), then 4.0' w at top at elev 176.5.	172.5	The weir is also the emergency spillway.
a: All orifices assumed to be set 8 feet above basin bottom.					
b: All weirs assumed to be set 10 feet above basin bottom unless otherwise noted.					

Figures 2 and 3 provide a conceptual view of the basin configuration and proposed outfall facilities. These were taken from the SunCreek Drainage Study but are representative of the facilities planned for The Ranch.

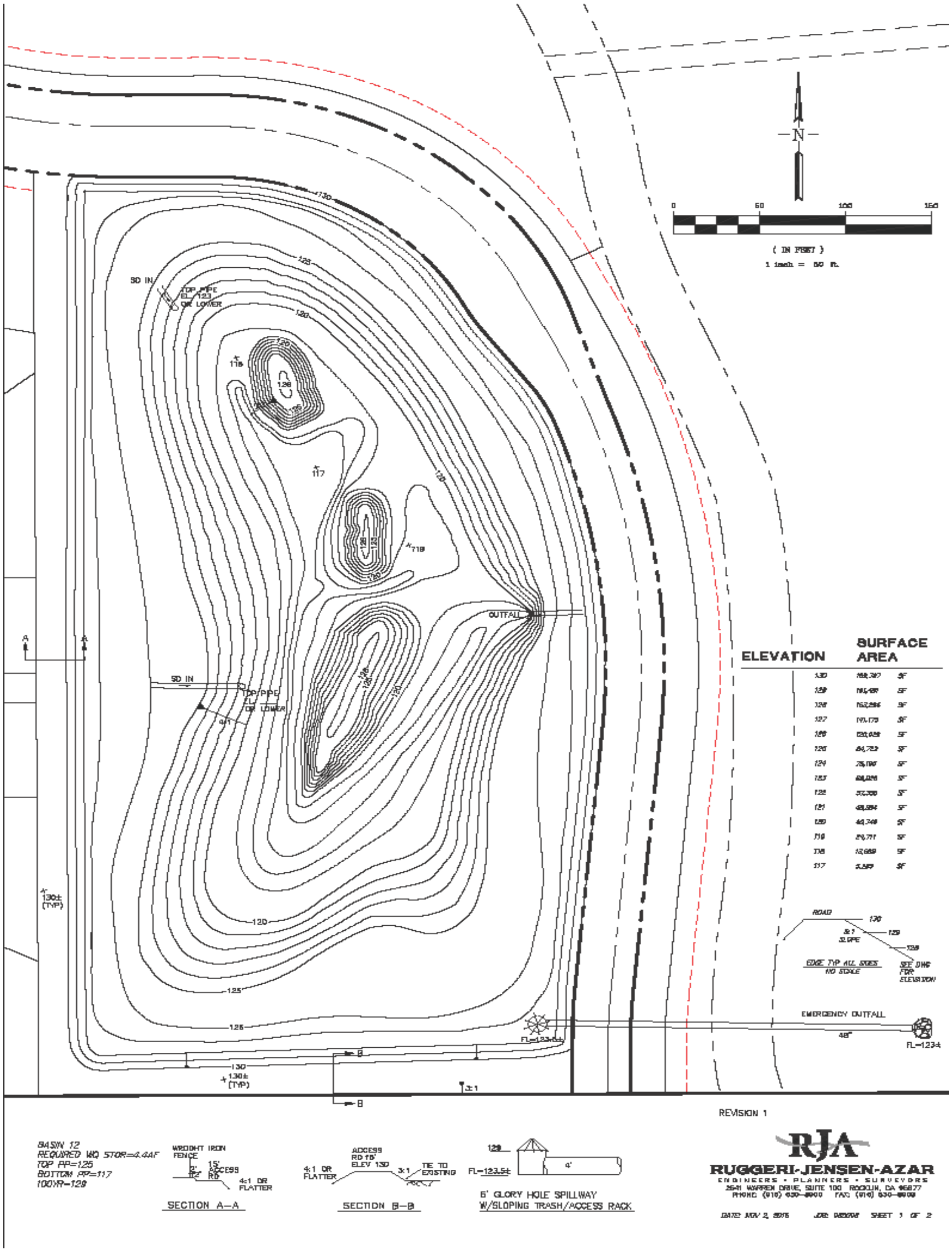

Figure 2. Preliminary Layout of Basin 9

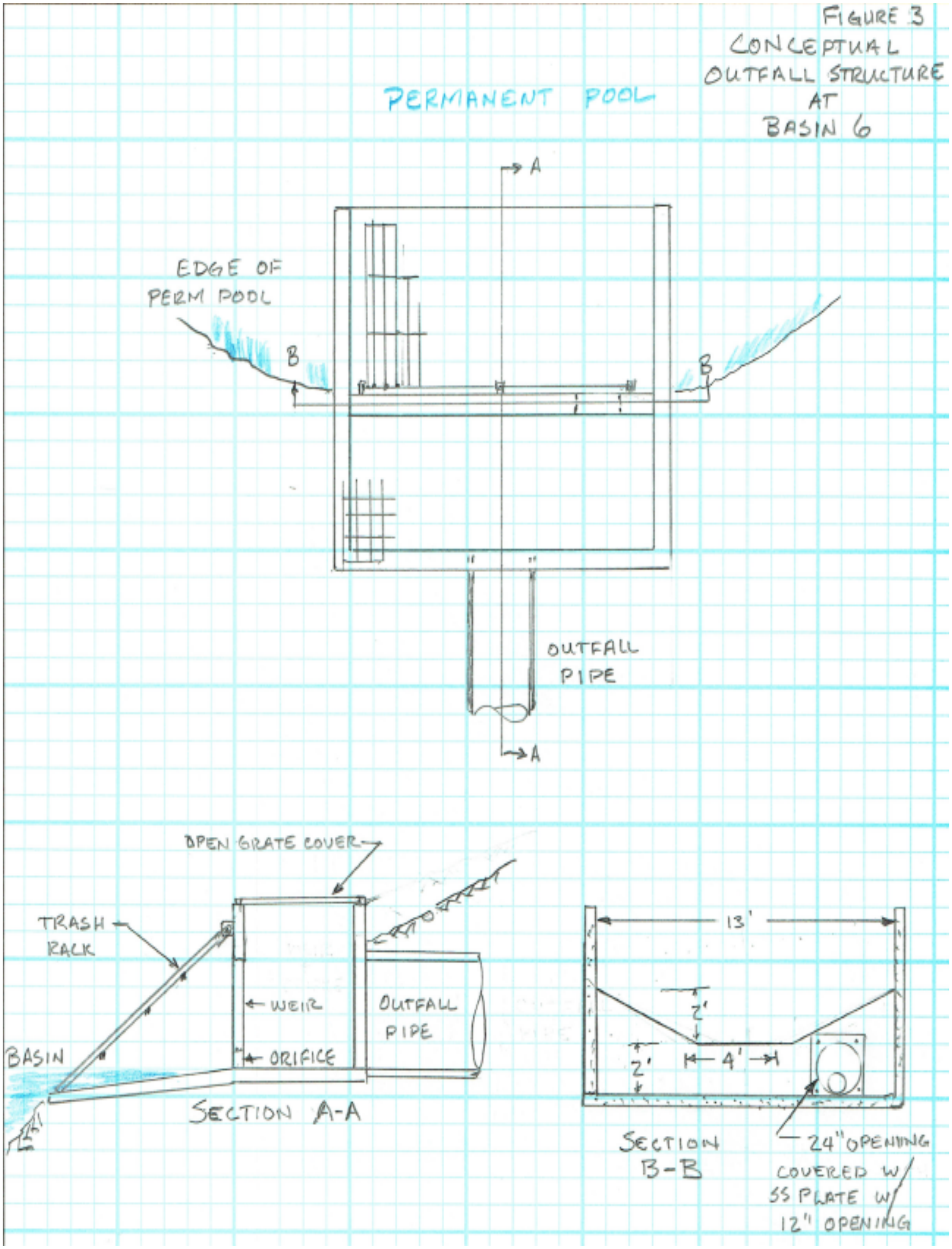

Figure 3. Preliminary Outfall from Basin 4, Typical of All Outfalls

OUTFALLS

The basins are sited up to several hundred feet from the channel with varied topography between the basin and the channel flow line. Releasing the basin outflow at the edge of the environmental corridor would generate erosion as a new channel would be cut into the native soils. This erosion is contrary to the purpose of attenuating peak flows.

For this study, it is recommended that an outfall pipe or armored channel be constructed so that runoff from the basins is released into or very near the stream flowline or thalweg. In addition, erosion protection at the outfalls is also recommended.

To minimize the disturbances within the preservation area, outfalls will be constructed as part of crossings where possible. **Table 5** provides a summary of existing and design flows and provides a preliminary description of the proposed outfalls.

Table 5. Locations of Basin Outfalls

Basin ID	Location and Description of Outfall
East	Outfall piped from the basin along Rancho Cordova Parkway right-of way and discharged into MCS at the constructed channel east of the parkway.
West	Discharged directly into MCS or piped southwest and discharged into MCS at the Chrysanthy Boulevard crossing.
PG	Discharged directly into MCS. Preliminary location west of Basin.
NS	Discharged to MCS upstream of Chrysanthy crossing
SS	Outfall piped to Kite Creek at the same location of the SunCreek Basin 2 outfall. The two or combined structure will become the headwaters of Kite Creek when that area of SunCreek is developed.

EXISTING AND POST-PROJECT FLOWS

Overview

A review comment from the first submittal was to include an analysis of potential impacts to upstream, adjacent, and downstream properties.

An XP model was used to evaluate the potential impacts along Morrison Creek South Branch (MCSB). To set up the analysis, the following steps were completed for the "existing conditions" model:

- Recreated the numerical hydrograph shown on Figure 4 provided by the Wood Rogers report entitled *Drainage Study for The Preserve at Sunridge*. The hydrograph with a peak flow of 678 cfs for the 100-year flow was applied at cross-section 96+00 near the upstream boundary of The Ranch.

- Forty cross-sections of the South Branch Morrison Creek were taken from available topographic information.
- Three existing sheds within The Ranch corridor and tributary to MCSB were then added to the existing conditions model.

The Post-Project (PP) information was then added to the model as a Scenario.   Key components of the PP scenario were as follows:

- The inflow hydrograph at the upstream end of MCSB was not changed.
- The natural tributary subsheds along MCSB were turned off.
- The four tributary sheds (WB, PG, EB, and NS) that represent The Ranch development were added.
- The local remaining natural subsheds along MCSB were added at five locations.
- Encroachment along the MCSB cross-sections was added per the proposed development.
- The proposed Contech arch at the Crysanthy Boulevard crossing was added.

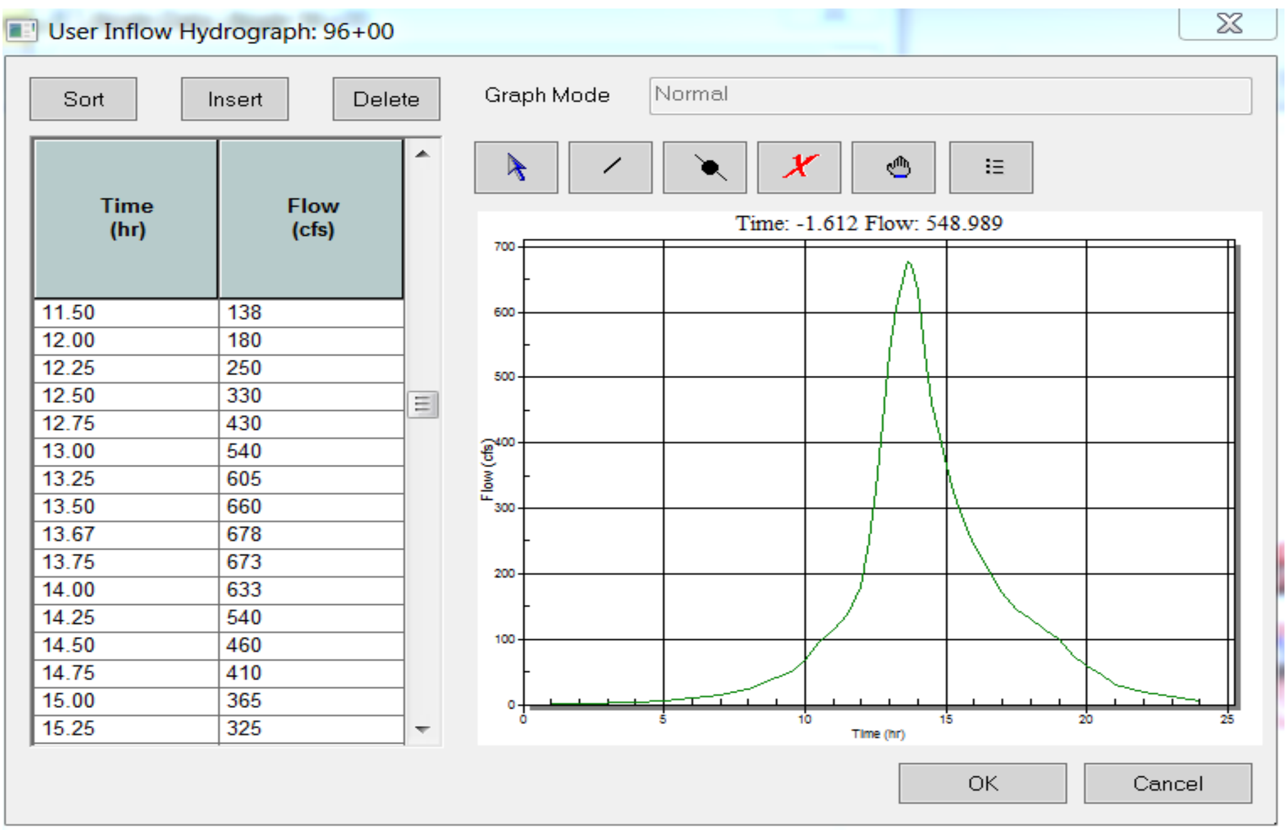

Figure 4. Inflow Hydrograph of Morrison Creek South Branch into The Ranch

Upstream Impacts

There is encroachment that will raise the water level within The Ranch property. However, the backwater effect is insignificant (0.02 ft) at Section 96+00 which is near the upstream property line. The impact is less at the property line.

Adjacent Property Impacts

Both the flow and water level along MCSB varied because of the changed conditions and the slight changes where local flows were added to the model. There are impacts along MCS where there will be encroachment from development. The maximum changes were + 15 cfs and -18 cfs. Maximum water elevation changes were +0.03 and -0.48 feet. The Ranch development is on both sides of the South Branch of Morrison Creek, so no other properties are affected. It is the responsibility of developers to protect their own property and is part of the design considerations.

Downstream Impacts

At the downstream end, downstream of Rancho Cordova Parkway, the model results indicate a slight decrease in flow (15 cfs) and a slight decrease of the water level (-0.06 ft) for post-project conditions compared to existing conditions. **Figures 5** and **6** show the flows and water surface elevations just downstream of Rancho Cordova Parkway. **Attachment E** provides additional modeling details for the comparative analysis. The cross-section locations are shown on **Maps 1** and **2**. **Attachment E** provides more detailed information from the comparative analysis.

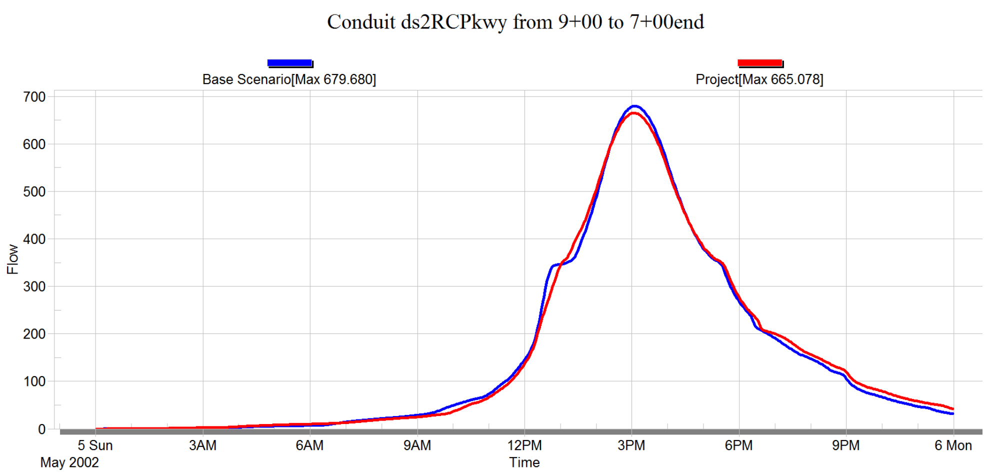

Figure 5. Existing and Post-project 100-yr Flows DS of Rancho Cordova Parkway

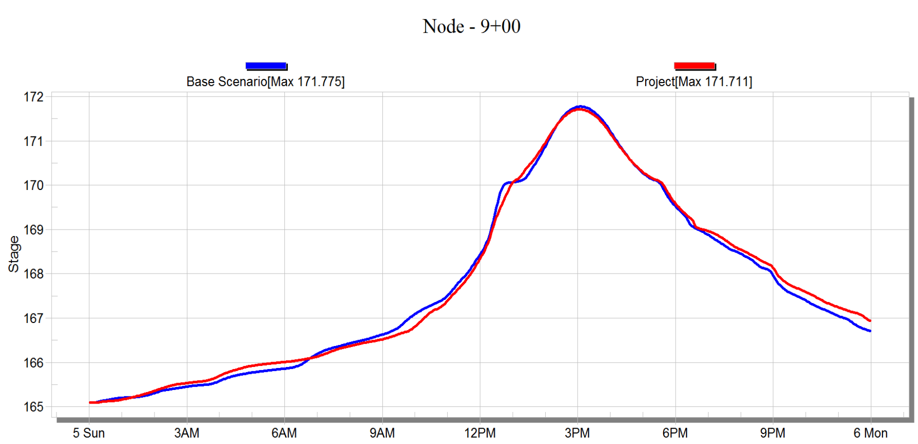

Figure 5. Existing and Post-project 100-yr Water Levels DS of Rancho Cordova Parkway

PDF of appendices has been requested from project applicant to include with drainage study