# Appendix G

## Summary of Stormwater Quality and Peak Flow Control Infrastructure Modeling

Balance Hydrologics

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**RE: Summary of Stormwater Quality and Peak Flow Control Infrastructure Modeling, Brann Ranch Project, City of Rio Vista**

Dear David:

I would like to begin by thanking you for extending Balance Hydrologics the opportunity to assist with the modeling of the stormwater quality and peak flow control infrastructure for the proposed Brann Ranch Project ("Project") in the City of Rio Vista in Solano County. Specifically, you had requested support with hydrologic and hydraulic modeling of the proposed stormwater basins to confirm that the proposed facilities meet the pertinent City and State standards for stormwater quality and quantity controls.

Consistent with your objectives, we have completed pertinent modeling using documents from the City and County and your project plans. This letter report summarizes the modeling work completed and provides documentation to show that the proposed facilities are sized to control both runoff water quality and peak flow rates in a safe and efficient manner.

### *Pre- and Post-Project Drainage Patterns*

The Project lies within the much larger Watson Hollow watershed that encompasses areas along the south and west side of the City flowing east under Liberty Island and Airport Roads then past the airfield to eventually discharge to the Sacramento River north of downtown.

In terms of the Project area itself there are two drainage directions that need to be considered for comparison between pre-and post-project conditions. These are:

- Drainage to McCormack Road. The northern part of the Project, totaling approximately 120 acres, was previously programmed to drain to the northeast east where it will be picked up by an existing storm drain line in McCormack Road at Province Path. The existing line runs to the east and contributes to the detention basins designed as part of the Liberty Project. Those basins drain to the north branch of Watson Hollow at Airport Road. Therefore, total flow at Airport Road is a primary point of comparison for peak flow control.

- Drainage to Watson Hollow above Liberty Island Road. The southern portion of the Project, with overall post project developed area of roughly 149 acres, will include development both north and south of the Watson Hollow channel along and south of Canright Road. Runoff from this area will be discharged to the Watson Hollow channel at and above Liberty Island Road via an existing and three new storm drain outfalls.

The proposed land use for the Project area is described thoroughly in plans prepared by RJA and in related documents. Existing land use and soil types are depicted in the Web Soil Survey Report that is included as **Attachment 1**. The soil survey information compiled by the Natural Resources Conservation Service shows that the site is underlain by soils in Hydrologic Soil Groups C and D, indicative of clay rich soils that have a relatively high runoff potential.

### *Technical Approach and Modeling*

The proposed stormwater infrastructure was modeled using two separate hydrologic model platforms. Water quality control was assessed using a multi-decadal hydrologic model modified from the Bay Area Hydrologic Model platform. Hydrologic modeling for peak flow control was completed using the U.S. Army Corps of Engineers HEC-HMS software parameterized per Solano County Flood Water Agency guidelines.

The pertinent criteria for water-quality control compliance are those established in the Statewide MS-4 stormwater permit. Those requirements include the need for treating a minimum of 80 percent of the mean annual runoff from developed areas, noting that open space areas can be considered self-treating. The preferred treatment control is bioretention, and that is the treatment control applied throughout the Project area.

For peak flow control, the project objective is to not increase peak flow rates at downstream points of compliance for the 2-, 10-, and 100-year Solano County 24-hour design storms. Meeting this objective for the 2-year storm event shows compliance with the hydromodification requirements of the MS-4 permit, while control at the 10- and 100-year event level is consistent with City standards related to flood control considerations and avoiding impacts to downstream locations.

The need to meet both the water quality and quantity control requirements led to the need for five detention basin facilities identified as Detention Basins #1 through #5 on the Preliminary Stormwater Treatment Plan prepared by RJA. For Basins #1 through #4, these are used to detain and then meter runoff to adjacent bioretention facilities (BR #B-1 through #B-4). Treatment at Detention Basin #5 is provided upstream and therefore that basin only serves as a peak flow control facility. Each paired basin includes a low flow pipe in the detention portion that meters flow to the bioretention area and also a high flow riser for large events that bypasses the bioretention facility. In this manner the detention basins serve as “forebays” for the bioretention facilities allowing for debris and sediment to be retained there and improving the efficiency of the biotreatment. The high-flow riser in each case protects the bioretention facilities from high peak flows in very large storm events.

Detention Basin #1/BR #B-1 and Detention Basin #2/BR #B-2 along with the future Commercial area will drain to McCormack Road and are modeling using an updated version of the Liberty Project hydrologic model with Airport Road as the point of compliance and the Liberty Project assumed to be part of the pre-project basis for Brann Ranch.

Detention Basin #3/BR #B-3, Detention Basin #4/BR #B-4, and Detention Basin #5, along an undetained but treated area along Canright Road will all flow to the Watson Hollow at or above Liberty Island Road. The modeling only includes the respective pre- and post-project areas impacted by the development and therefore should not be considered representative of the total peak flow rates in Watson Hollow if off-site areas were included.

### *Modeling Parameters*

Mean annual precipitation at the site per County isohyetal mapping is 17.0 inches. This values was used with the standard frequency storm to develop the design storm rainfall distribution for the 2-, 10-, and 100-year 24-hour events as consistent with the design basis used for the Liberty and Trilogy projects.

**Table 1** summarizes the hydrologic properties for each the various pre-project drainage areas, noting that the drainage to McCormack was taken from the Liberty Project drainage study for consistency with past project approvals.

*Table 1. Summary of Pre-project Drainage Area Hydrologic Parameters*

| | Land Area | | Impervious | Rainfall Losses | | Urbanization | Slope | Time Lag |
|---|---|---|---|---|---|---|---|---|
| **Drainage Area** | *(acres)* | *(sq miles)* | *(%)* | **Initial** *(inches)* | **Constant** *(feet)* | *(%)* | *(feet/feet)* | *(hours)* |
| ***To McCormack*** | | | | | | | | |
| 'Gibbs South Off-site" | 120.0 | 0.1875 | 0.5 | 0.2 | 0.02 | 0 | 0.006 | 1.076 |
| ***To Watson Hollow*** | | | | | | | | |
| #1 + #2 Pre | 12.9 | 0.0202 | 2 | 0.2 | 0.02 | 0 | 0.06 | 0.825 |
| #B-3 Pre | 100.8 | 0.1574 | 5 | 0.2 | 0.02 | 0 | 0.03 | 0.818 |
| #B-4 Pre | 68.4 | 0.1068 | 0 | 0.2 | 0.02 | 0 | 0.03 | 0.586 |
| *Total* | 182.0 | 0.2844 | | | | | | |

The corresponding parameters used for the post-project model runs are summarized in **Table 2**. It is important to note that the total area draining to Watson Hollow through the developed portions of Brann Ranch is substantially reduced as the northern areas shift into the McCormack drainage per the grading plan. That shift in drainage area boundaries was anticipated in the planning for the Liberty Project basins, and there is thus no significant change in the pre- versus post-project area draining to McCormack.

*Table 2. Summary of Post-project Drainage Area Hydrologic Parameters*

| Drainage Area | Land Area (acres) | Land Area (sq miles) | Impervious (%) | Rainfall Losses Initial (inches) | Rainfall Losses Constant (feet) | Urbanization (%) | Slope (feet/feet) | Time Lag (hours) |
|---|---|---|---|---|---|---|---|---|
| ***To McCormack*** | | | | | | | | |
| #B-1 Post | 29.9 | 0.0467 | 66.3 | 0.3 | 0.02 | 95 | 0.005 | 0.207 |
| #B-2 Post | 77.9 | 0.1217 | 61.9 | 0.3 | 0.02 | 100 | 0.005 | 0.289 |
| Commercial | 11.8 | 0.0184 | 89.8 | 0.3 | 0.02 | 100 | 0.005 | 0.172 |
| *Total* | 119.6 | 0.1869 | | | | | | |
| ***To Watson Hollow*** | | | | | | | | |
| #1 + #2 Post | 12.9 | 0.0202 | 65.8 | 0.3 | 0.02 | 100 | 0.005 | 0.175 |
| #B-3 Post | 100.8 | 0.1574 | 60.9 | 0.3 | 0.02 | 100 | 0.005 | 0.264 |
| #B-4 Post | 13.1 | 0.0204 | 66.3 | 0.3 | 0.02 | 100 | 0.005 | 0.176 |
| #B-4 Undetained | 22.7 | 0.0355 | 30.0 | 0.3 | 0.02 | 60 | 0.020 | 0.376 |
| *Total* | 149.4 | 0.2335 | | | | | | |

Iterative model runs were used to identify the required sizes of the detention basins in the project area and pertinent sizing values are presented in **Table 3**.

*Table 3. Detention Basin Sizing Parameters*

| Drainage Area | Volume at Riser Rim (acre-feet) | Riser Diameter (inches) | Riser Rim Elevation (feet) | Low Outlet Diameter (inches) | Low Outlet Elevation (feet) |
|---|---|---|---|---|---|
| Detention #1 | 1.61 | 18 | 34.5 | 8.0 | 32.0 |
| Detention #2 | 9.45 | 18 | 37.5 | 9.0 | 35.0 |
| Detention #3 | 7.25 | 30 | 25.0 | 9.0 | 20.5 |
| Detention #4 | 0.83 | 18 | 23.5 | 8.0 | 20.5 |
| Detention #5 | 1.03 | 18 | 32.0 | 8.3 | 29.0 |

The continuous simulation model was used to size the four bioretention facilities with upstream detention, noting that Detention #5 is downstream of its biotreatment. Additionally, the Commercial area water-quality basin was also sized using the continuous simulation model. It is important to note that the Commercial area could very readily be accommodated in the Detention Basin #2/BR #B-2 combined facility with a modest adjust in the treatment area in BR #B-2. In such a configuration, separate water-quality facilities would not be needed in the Commercial area. **Table 4** summarizes the water-quality facility parameters that were used.

*Table 4. Bioretention Facility Sizing Parameters*

| Drainage Area | Bioretention Area ($ft^2$) | Top of Biosoil (feet) | Riser Diameter (inches) | Riser Rim Elevation (feet) | Underdrain Orifice Diameter (inches) |
|---|---|---|---|---|---|
| DMA #B-1 | 16,030 | 31.5 | 12 | 32.5 | 6.0 |
| DMA #B-2 | 42,630 | 34.5 | 18 | 35.5 | 6.0 |
| DMA #B-3 | 37,820 | 20.0 | 18 | 21.0 | 8.0 |
| DMA #B-4 | 7,330 | 20.0 | 12 | 21.0 | 4.0 |
| Commercial | 18,000 | 41.5 | 18 | 42.5 | 6.0 |

## *Results*

The modeling output in terms of peak flow control is presented in **Table 5** and **Table 6** below. The modeling shows that the Brann Ranch infrastructure is appropriately sized to control peak flow rates for design storms spanning the range from the 2-year event (hydromodification) to the 100-year event (flood control).

*Table 5. Modeled Pre- and Post-project Peak Flow Rates to McCormack Road*

| Drainage Area | 2-year (cfs) | 10-year (cfs) | 100-year (cfs) |
|---|---|---|---|
| ***Pre-project*** | | | |
| 'Gibbs South Off-site" | 31.2 | 46.8 | 68.3 |
| at Airport Road | 98.0 | 129.0 | 168.8 |
| ***Post-project*** | | | |
| #B-1 Post | 21.2 | 31.2 | 44.5 |
| *With Detention* | *2.6* | 8.2 | 12.3 |
| #B-2 Post | 45.6 | 67.1 | 96.0 |
| Commercial | 9.3 | 13.7 | 19.4 |
| *With Detention* | 3.0 | 6.9 | 12.5 |
| Brann Ranch Total | 4.8 | 11.7 | 22.9 |
| at Airport Road | 93.0 | 128.2 | 157.9 |

*Table 6. Modeled Pre- and Post-project Peak Flow Rates to Watson Hollow*

| Drainage Area | 2-year *(cfs)* | 10-year *(cfs)* | 100-year *(cfs)* |
|---|---|---|---|
| ***Pre-project*** | | | |
| #1 + #2 Pre | 4.9 | 7.2 | 10.5 |
| #B-3 Pre | 30.9 | 45.9 | 66.9 |
| #B-4 Pre | 21.1 | 31.3 | 45.6 |
| at Liberty Island Road | 56.4 | 84.0 | 122.3 |
| ***Post-project*** | | | |
| #1 + #2 Post | 10.0 | 14.8 | 21.0 |
| *With Detention* | *2.3* | *2.8* | *7.3* |
| #B-3 Post | 62.2 | 91.6 | 130.9 |
| *With Detention* | *7.1* | *28.3* | *42.5* |
| #B-4 Post | 10.1 | 14.9 | 21.3 |
| *With Detention* | *2.2* | *2.7* | *8.0* |
| #B-4 Undetained | 11.3 | 16.7 | 24.1 |
| at Liberty Island Road | 16.2 | 44.1 | 74.4 |

The predicted performance of the bioretention facilities modeled using the continuous simulation model with 40 years of rainfall input is shown in **Table 7**. In call cases, treatment exceeds the minimum standard of 80 percent of mean annual runoff.

*Table 7. Summary of Predicted Bioretention Facility Performance*

| Drainage Area | Runoff Treated *(% of Total)* |
|---|---|
| #B-1 | 93.9 |
| #B-2 | 85.6 |
| #B-3 | 90.4 |
| #B-4 | 88.2 |
| Commercial | 100.0 |

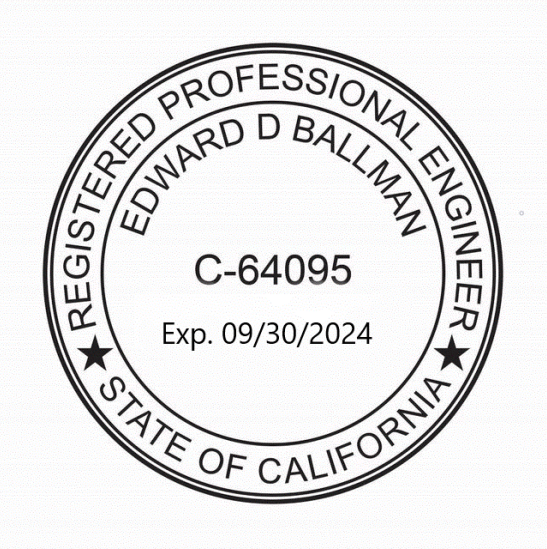
### *Closing*

The combined hydrologic work shows that the stormwater infrastructure proposed for the Brann Ranch Project can effectively meet the pertinent runoff water quality treatment requirements and also control peak flow rates consistent with hydromodification management and flood control criteria.

Please do not hesitate to contact Balance staff if you have any questions or comments related to this report or need further details regarding the work completed.

Sincerely,

BALANCE HYDROLOGICS, Inc.




Edward D. Ballman, P.E.
Principal Engineer

Attachment 1: Web Soil Survey Report

Hydrologic Soil Group—Solano County, California
(Brann Ranch, Rio Vista)


Map Scale: 1:9,910 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 100 200 400 600

Feet
0 450 900 1800 2700

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

## MAP LEGEND

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

**Soils**

**Soil Rating Polygons**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Lines**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Points**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Water Features**
- Streams and Canals

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

**Background**
- Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Solano County, California
Survey Area Data: Version 14, May 29, 2020

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

Date(s) aerial images were photographed: Data not available.

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

# Hydrologic Soil Group

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| AmC | Altamont-Diablo clays, 2 to 9 percent slopes | D | 170.2 | 44.9% |
| AoC | Antioch-San Ysidro complex, 2 to 9 percent slopes | D | 30.7 | 8.1% |
| CeA | Clear Lake clay, 0 to 2 percent slopes, MLRA 17 | C/D | 10.0 | 2.7% |
| DaC | Diablo-Ayar clays, 2 to 9 percent slopes | C | 113.5 | 30.0% |
| RoA | Rincon clay loam, 0 to 2 percent slope | C | 54.1 | 14.3% |
| **Totals for Area of Interest** | | | **378.6** | **100.0%** |

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher