SSCAFCA

Memo

To: Andres Sanchez, Design Services Director

From: Junko Boat, Drainage Engineer

Date: 10/3/2018

Re: Rainbow Pond Ported Riser Design

Due to anticipation for high sediment yield in the Rainbow Pond and the downstream culvert's likelihood for sediment issues (length approximately 200' and slope of 0.04%), a ported riser was considered for the pond.

Design criteria included:

- Likely square shaped ported riser to match the 2-cell 3' by 3' culverts.
- A few rows of reverse incline ports
- D = 6" ports
- A metal grate provided at the top. The top grate will be slanted for ease of maintenance.
- No low flow opening at the riser slab elevation (concern for sediment)

Based on these criteria and constructability for steel reinforcement in the walls, a rectangular ported riser with 3 rows of the reverse incline ports (ports at 30-degree angle from outside face to inside face) was designed.

1. Storage-Stage-Elevation

Storage-Stage-elevation relationship was developed using Civil3D elevation and contour area.

Elevation (ft)	Note
5670.57	Pond Invert
5670.66	Culvert Invert

Elevation (ft)	Note
5671.24	Invert of Bottom Row of Ports
5671.81	Top of Bottom Row of Ports
5672.39	Invert of Middle Row of Ports
5672.97	Top of Middle Row of Ports
5673.55	Invert of Top Row of Ports
5674.12	Top of Top Row of Ports
5674.51	Slanted Top Grate Lowest EL
5675.87	Slanted Top Grate Highest EL
5678.8	Original Emergency Spillway EL
5679.1	**Proposed** Emergency Spillway EL
5680.50	Top of Pond

Orifice equation was used for determining discharge through the ports, while weir equation was used for the top grate flow and emergency spillway flow. *Handbook of Hydraulics,* 6th Edition, by Brater and King was used to determine coefficients for orifice and weir conditions. The diameter of circular orifice being 0.5' and anticipated head between 0.4 – 10', a coefficient of discharge of 0.598 was selected using Table 4-3 Smith's Coefficients of Discharge for Circular and Square Orifice with Full Contraction in aforementioned reference. Table 5-3 was used for two different cases of weir condition; assuming average head in the table, weir coefficients of 3.0 and 2.6 were chosen based on the weir breaths of 1.0' and 12.0' for the top grate and the emergency spillway, respectively.

Discharges from each row of orifices were computed, and the combined discharges from all rows of ports & the grate were compared with the box culvert discharge of the pond outfall. Once the outfall culvert is fully submerged, the pond discharge will be governed by the pond outlet CBC, not by the ported riser. Discharge from the emergency spillway (for incoming flows in excess of the 100-year recurrence interval storm) was added to the overall rating curve in order to ensure that the 500-year water surface elevation (WSEL) remains at or below the top of the pond embankment.

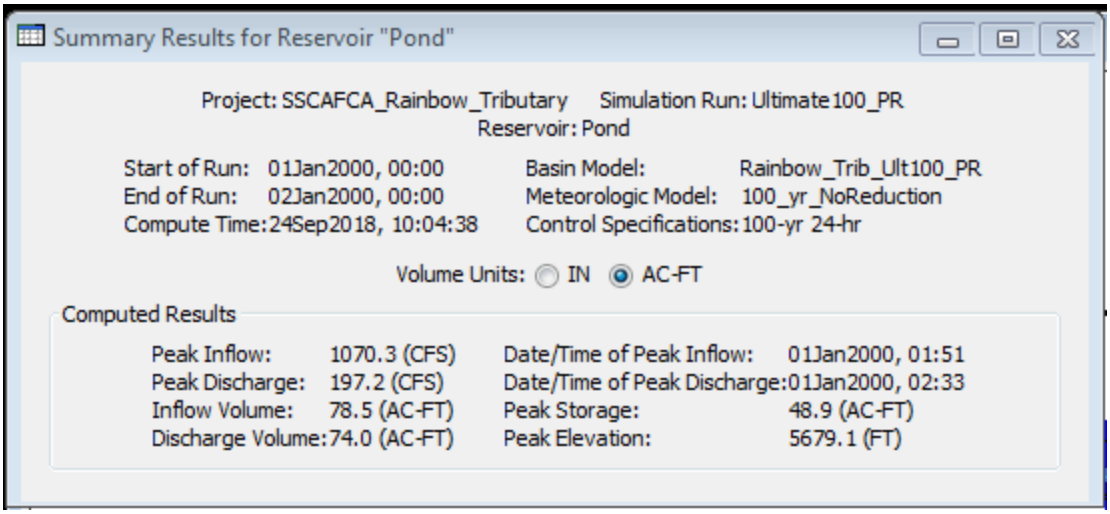
Elevation (ft)	Note	Cumulative Volume - conic (acre-ft)	Total Discharge Rating Curve (cfs)
5670.57	Pond Invert	0	0.0
5670.66	Culvert Invert	0.00	0.0
5671.00		0.02	0.0
5671.24	Invert of Bottom Row of Ports	1.16	0.0
5671.81	Top of Bottom Row of Ports	3.94	6.6
5672.00		4.91	8.0
5672.39	Invert of Middle Row of Ports	6.89	10.3
5672.97	Top of Middle Row of Ports	9.94	18.5
5673.00		10.12	18.8
5673.55	Invert of Top Row of Ports	13.11	23.7

Elevation (ft)	Note	Cumulative Volume - conic (acre-ft)	Total Discharge Rating Curve (cfs)
5674.00		15.65	31.6
5674.12	Top of Top Row of Ports	16.33	33.6
5674.51	Slated Top Grate Lowest EL (Top of Concrete)	18.60	38.9
5675.00		21.51	57.9
5675.66	Top of Side Face Slopes for Grate	25.58	132.5
5675.87	Slanted Top Grate Highest EL	26.90	144.9
5676.00		27.73	147.9
5677.00		34.25	167.8
5678.00		41.16	182.9
5678.90		47.61	194.7
5679.00		48.35	196.0
5679.10	Emergency Spillway EL	49.09	197.5
5680.00		55.89	456.1
5680.50	Top of Pond	59.78	696.6

2. HEC-HMS 100-year Model

Basin Model: Rainbow_Trib_Ult100_PR
Method at Pond: Outflow Curve
Storage Method: Elevation-Storage-Discharge
Storage-Discharge Function: Ported_Riser
Elevation-Storage Function: Ported_Riser
Run: Ultimate100_PR

The rating information was input in HEC-HMS, specifically Elevation-Storage Function (Ported_Riser) and Storage-Discharge Function (Ported_Riser) and run to check the 100-year 24-hour WSEL. After running the HEC-HMS model, it was identified that the 100-year WSEL would exceed the original emergency spillway elevation of 5678.8'. In order to contain the 100-year peak flow without spilling over the emergency spillway, the pond emergency spillway elevation was raised from 5678.8' to 5679.1'. This is 0.3' increase over the elevation provided in the original construction plans. It should be also noted that during final design phase of the original construction plans, the pond footprint was slighted modified. We now know it resulted in changes to the originally calculated WSEL. We accounted for the (previously unknown) change in the pond footprint in addition to the ported riser hydraulic analysis during the ported riser design & hydraulic re-analysis of the pond.



3. HEC-HMS 500-year model

Basin name: RainbowTrib_Ult_rev2
Method at Pond: Outflow Structures
Pond Storage Method: Elevation-Storage
Elevation-Storage Function: Ported_Riser
Run: Ultimate500_rev2