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ENERGY WATER INFORMATION GOVERNMENT

Calculation Record

Client Name: FLorida Municipal Power Agency Page 1 of 7

Project Name: Cane Island Power Park Unit 4 Project No.: 147651

Calculation Title: Dry Detention Basin and Discharge Structure Design

Calculation No./File No.: 52.5406.1101.03

Calculation Is: (check all that apply) ☐ Preliminary ☒ Final ☐ Nuclear Safety-Related

Objective To determine the treatment and pre-treatment volume. Show that pond is designed for both. To calculate the stage - discharge relationship for the dry detention basin and discharge structure.

Unverified Assumptions Requiring Subsequent Verification

No.	Assumption	Verified By	Date

See Page _____ of this calculation for additional assumptions.

This Section Used for Computer Generated Calculations

Program Name/Number: _____ Version: _____

Evidence of or reference to computer program verification, if applicable:

Bases or reference thereto supporting application of the computer program to the physical problem:

Review and Approval

Rev	Prepared By	Date	Verified By	Date	Approved By	Date
0	A.L. Morgan A.L. Morgan	03/07/08	J. M. Stanek JMStanek	3/12/08	M. J. Stanek	3/26/08

1.0 PURPOSE

The purpose of this calculation is to:
1.1) Determine the required treatment volume and show that detention basin is adequate for treatment volume.
1.2) Determine the stage-discharge relationship for detention basin

2.0 REFERENCES

2.1) South Florida Water Management District, Management and Storage of Surface Waters: Permit Information Manual, Volume IV,
2.2) Black & Veatch Drawings 147651-4STF-S3000 through 147651-4STF-S3002, Grading and Drainage.
2.3) Black & Veatch Drawing 147651-4STF-S3050, Grading and Drainage Details.
2.4) Black & Veatch Calculation, Project No. 147651, File No. 52.5406.1101.02, Title "Pre- and Post- Development Curve Numbers"
2.5) "Hydrology & Hydraulic Systems", Ram S. Gupta, 1989.

3.0 ASSUMPTIONS

No assumptions.

4.0 DEFINITIONS OF UNITS AND CONSTANTS

Due to the high number of units and constants, they are defined within Section 7.0 Analysis.

5.0 PROCEDURE/METHODOLOGY OF DESIGN

5.1) Calculate the treatment volume, Reference 2.1.
  5.1.1) Calculate the first inch of runoff from the entire site.
  5.1.2) Calculate the amount of 2.5 inches time the percentage of imperviousness.
  5.1.3) Compare the two values and determine which one governs.
    Reduce volume by 75% (Reference 2.1, dry detention).
5.2) Calculate stage for pond, Reference 2.2.
5.3) Calculate discharge for modified discharge structure, Reference 2.3 and 2.5.

6.0 CONCLUSIONS

6.1) The required treatment volume is 1.23 acre-ft. The actual treatment volume is 1.97 acre-ft. Therefore the detention basin is adequately sized for the required treatment volume.
6.2) The required pretreatment volume is 0.60 acre-ft.
6.2) The table of stage-discharge relationship for the pond is shown in Section 7.4.5 of this calculation.

7.0 ANALYSIS

7.1) Required Treatment Volume.
7.2) Required Pretreatment
7.3) Actual Treatment Volume.
7.4) Stage - Discharge

8.0 APPENDICES

8.1) Appendix A - Terramodel Output for Pond Volume.

7.1 Required Treatment Volume

7.1.1 Option A - Compute the first inch of runoff from the developed project: (Reference 2.1)

$A_{post.contributing} := 12.89acre$ (Reference 2.4)

$A_{post.pond} := 1.41 \cdot acre$ (Reference 2.4)

$A_{post.total} := A_{post.contributing} + A_{post.pond}$ $A_{post.total} = 14.3\,acre$

$V_{TreatA} := A_{post.total} \cdot 1in \cdot \frac{1 \cdot ft}{12 \cdot in}$ $V_{TreatA} = 1.19\,acre \cdot ft$

7.1.2 Option B - Compute 2.5 inches time the percentage of imperviousness: (Reference 2.1)

$A_{post.imp} := 7.89 \cdot acre$ (Reference 2.4)

$A_{post.agg} := 5acre$ (Reference 2.4)

$A_{quality.site} := A_{post.total} - (A_{post.pond} + A_{post.imp})$

$A_{quality.site} = 5\,acre$

$A_{pervious} := 0 \cdot acre$

$A_{quality.imp} := A_{quality.site} - A_{pervious}$ $A_{quality.imp} = 5\,acre$

$P_{imp} := \frac{A_{quality.imp}}{A_{quality.site}}$ $P_{imp} = 100\,\%$

$D_{quality} := P_{imp} \cdot 2.5 \cdot in$ $D_{quality} = 2.5\,in$

$V_{TreatB} := D_{quality} \cdot A_{post.imp} \cdot \frac{1 \cdot ft}{12 \cdot in}$ $V_{TreatB} = 1.64\,ft\,acre$

7.1.3 Reduce controlling Treatment Volume by 75%

Option B governs because the required treatment volume is greater than Option A.

$V_{Treatment.Required} := .75 \cdot V_{TreatB}$ (Reference 2.1)

$V_{Treatment.Required} = 1.23\,ft\,acre$ (Conclusion 6.1)

7.2 Required Pretreatment Volume

Determine 0.5 inch of pretreatment, $D_{pretreat}$. (Reference 2.1)

$D_{pretreat} := A_{post.total} \cdot 0.5 \cdot in$

$D_{pretreat} = 0.60\,ft\,acre$ (Conclusion 6.2)

7.3 Actual Treatment Volume

Pond surface area and storage were determined using Terramodel Version 10.43. Pond storage output from Terramodel is included in Appendix A. Pond surface area can be verified by Reference 2.2.

Stage	Pond Area (SF)	Total Area (Acres)	Pond Incremental Detention volume (CY)	Accumulative Detention volume (CY)	Accumulative Detention volume (ac-ft)
74	38,490	0.88	0	0	0
75	42,793	0.98	1,504	1,504	0.94
76	47,210	1.08	1,665	3,169	1.97
77	51,778	1.19	1,833	5,002	3.11
78	57,478	1.32	2,003	7,004	4.35
78.25	58,952	1.35	550	7,555	4.69
78.5	61,251	1.41	577	8,131	5.04
78.75	63,682	1.46	604	8,735	5.42
79	72,255	1.66	633	9,368	5.81

The control elevation is at 76.00 feet, Reference 2.3. Therefore the actual treatment volume is 1.97 acre-ft.

$V_{treatment.actual} := 1.97 \cdot acre \cdot ft$ (Conclusion 6.1)

7.4 Stage vs. Discharge

The existing Unit 3 stormwater pond discharge structure will be modified for new pond. The existing structure has an 8" diameter orifice at elevation 76.00 feet and a broad crested weir with top elevation at 78.00 feet. The structure will be modified to add four - 10" diameter orifices at elevation 76.17 feet and modified weir top elevation at 78.75 feet. These changes can be seen on Detail 5, Reference 2.3.

7.4.1 Example discharge calculation for 8" Orifice with water elevation at 79.00 feet.

$D_{8in} := 8 \cdot in$ (Reference 2.3)

$A_{8in} := \pi \cdot \frac{D_{8in}^2}{4}$ $A_{8in} = 0.35\,ft^2$

$c := 0.6$ (Reference 2.5)

$h_{control.8in} := 76.00 \cdot ft$ $h := 79.00 \cdot ft$

$\Delta h_{8in} := h - \left(\frac{D_{8in}}{2} + h_{control.8in} \right)$ $\Delta h_{8in} = 2.67\,ft$

$n := 1$ (Reference 2.3, Number of orifices)

$Q_{8in} := n \cdot c \cdot A_{8in} \cdot \sqrt{(2 \cdot g \cdot \Delta h_{8in})}$ $Q_{8in} = 2.74 \frac{ft^3}{sec}$ (Reference 2.5)

7.4.2 Example discharge calculation for 10" Orifice with water elevation at 79.00 feet.

(Reference 2.3)

$D_{10in} := 10 \cdot in$

$A_{10in} := \pi \cdot \frac{D_{10in}^2}{4}$ $\quad A_{10in} = 0.55\,ft^2$

$c := 0.6$ (Reference 2.5)

$h_{control.10in} := 76 \cdot ft + 2 \cdot in$ $\quad h := 79.00 \cdot ft$

$\Delta h_{10in} := h - \left(\frac{D_{10in}}{2} + h_{control.10in} \right)$ $\quad \Delta h_{10in} = 2.42\,ft$

(Reference 2.3, Number of orifices)

$n := 4$

$Q_{10in} := n \cdot c \cdot A_{10in} \cdot \sqrt{(2 \cdot g \cdot \Delta h_{10in})}$ $\quad Q_{10in} = 16.32 \frac{ft^3}{sec}$ (Reference 2.5)

7.4.3 Example discharge calculation for sharp crested weir with top elevation at 78.75 ft.

(Reference 2.3)

$L_{weir} := 10 \cdot ft$

$h_{control.weir} := 78.75 \cdot ft$ $\quad h = 79\,ft$

$\Delta h_{weir} := h - h_{control.weir}$ $\quad \Delta h_{weir} = 0.25\,ft$

$c_{weir} := .97$ $\quad c_d := c_{weir} \cdot \sqrt{2 \cdot g}$ (Reference 2.5)

$Q_{weir} := 0.385 c_d \cdot L_{weir} \cdot (\Delta h_{weir})^{\left(\frac{3}{2}\right)}$ $\quad Q_{weir} = 3.74 \frac{ft^3}{sec}$ (Reference 2.5)

7.4.4 Total discharge calculation for water elevation at 79.00 ft.

$Q_{total} := Q_{8in} + Q_{10in} + Q_{weir}$ $\quad Q_{total} = 22.81 \frac{ft^3}{sec}$

7.4.5 Stage vs Discharge Relationship Table (Conclusion 6.3)

Stage (ft)	1- 8" Φ and 4- 10" Φ Orifice Discharge (cfs)	Weir Discharge (cfs)	Total Discharge (cfs)
74	0	-	0
75	0	-	0
76	0	-	0
77	8.15	-	8.15
78	14.67	-	14.67
78.25	15.89	-	15.89
78.5	17.02	-	17.02
78.75	18.08	0.00	18.08
79	19.08	3.75	22.83

APPENDIX A
Terramodel Output for Pond Volume

SURFACE TO DATUM VOLUME REPORT

Project: C:\Documents and Settings\mor45202\My Documents\FMPA\2-28-08 Updated Pond Contours.pro

Report Generated: Monday, March 03, 2008 11:12:04 AM

DTM Surface Layer Name	Number of Points	Datum Elevation
DTM POND	286	79.00

Volume limited to that within the constraining boundary - Object 1116
Area within boundary: 882,101.61 Sq. Ft. (20.2503 Acres)
Total triangulated area: 72,257.26 Sq. Ft. (1.6588 Acres)

	Depth Range (ft)	Cut Volume (Cu. Yd.)	Accumulative Volume (Cu. Yd.)
74.00	-5.00 > -4.75	361.1	
	-4.75 > -4.50	370.8	
	-4.50 > -4.25	380.7	
75.00	-4.25 > -4.00	391.0	1503.6
	-4.00 > -3.75	401.1	
	-3.75 > -3.50	411.1	
	-3.50 > -3.25	421.3	
76.00	-3.25 > -3.00	431.8	3168.9
	-3.00 > -2.75	442.4	
	-2.75 > -2.50	452.8	
	-2.50 > -2.25	463.4	
77.00	-2.25 > -2.00	474.1	5001.6
	-2.00 > -1.75	484.7	
	-1.75 > -1.50	495.3	
	-1.50 > -1.25	505.9	
78.00	-1.25 > -1.00	516.7	7004.2
78.25	-1.00 > -0.75	550.3	7554.5
78.50	-0.75 > -0.50	576.5	8131.0
78.75	-0.50 > -0.25	604.0	8735.0
79.00	-0.25 > 0.00	632.8	9367.8

Excavation Volume Beneath Datum (Cu. Yd.)	Fill Volume Above Datum(Cu. Yd.)
9,367.8	0.0

Net Difference: 9,367.8 Cu. Yd. excess volume beneath datum