C-51 Reservoir Project Update

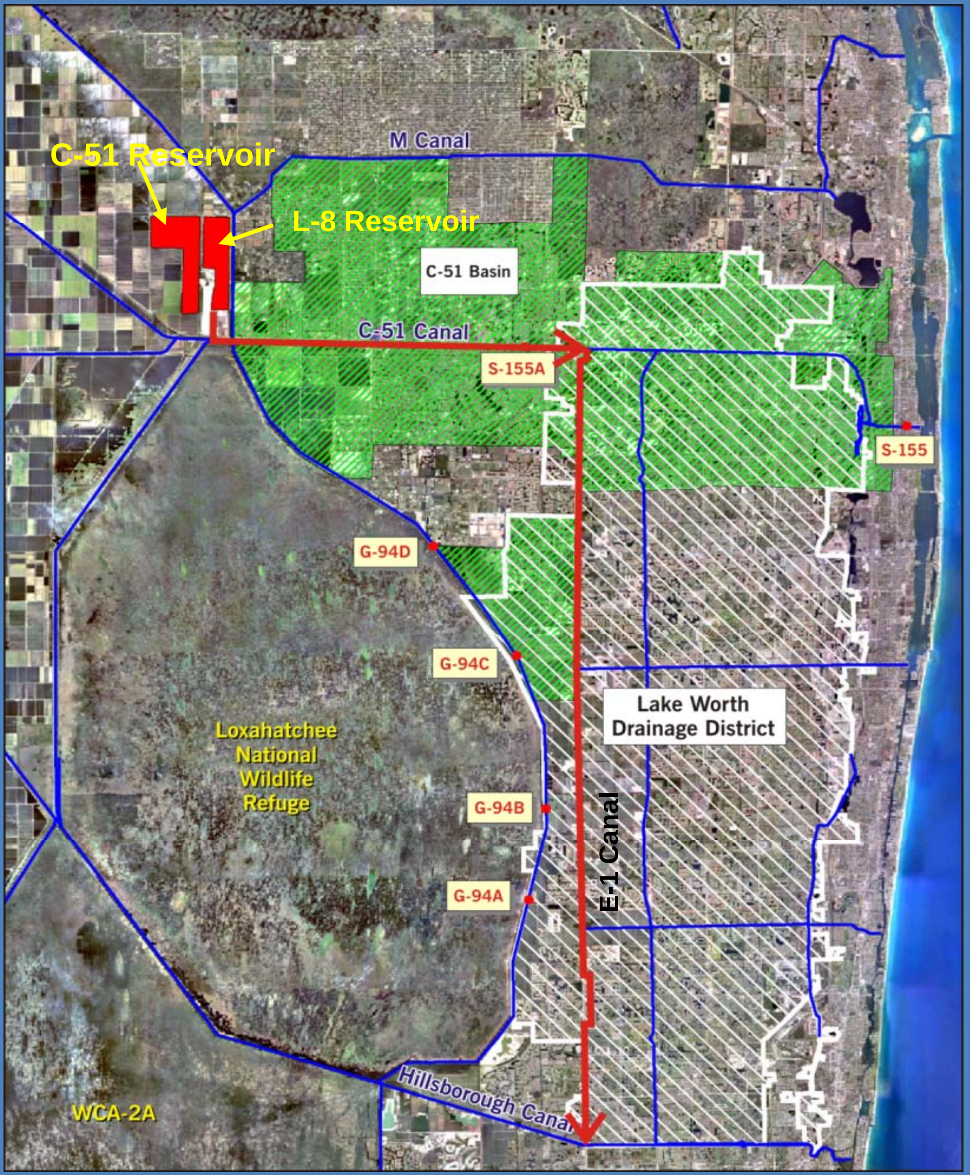
PBC League of Cities Board Presentation
July 23, 2014

David Swift
Vice-Chair, C-51 Reservoir
Finance and Governance
Work Group

Bevin Beaudet
Director
PBCWUD

C-51 Reservoir Project Summary

- Existing rock mine located north of West Palm Beach canal adjacent to L-8 Reservoir - same unique geology
- Captures excess flows in C-51 basin during wet times. Stored water released to canals during dry season.
- Increases regional availability of water for Lower East Coast
- Recharge wellfields
- Creates freshwater head to maintain fresh/saltwater interface along LEC
- Utilizes existing infrastructure (LWDD) for conveyance with some improvements



PALM BEACH COUNTY FLORIDA

BEST WATER, BEST SERVICE & BEST ENVIRONMENTAL STEWARDSHIP. Palm Beach County Water Utilities

What Has Been Done To Develop The C-51 Project?

- **November 2006** — BCC Funds Initial Study
- **February 2007** — SFWMD Places Project Into LECWSP
- **October 2008** — Phase I Feasibility Study Released
- **September 2009** — BCC Workshop
- **February 2010** — Phase II Feasibility Study Released
- **September 2010** — PBC-WRTF Endorses Concept
- **October 2011** — BCC Approves MOU

What Has Been Done To Develop The C-51 Project (Cont'd)?

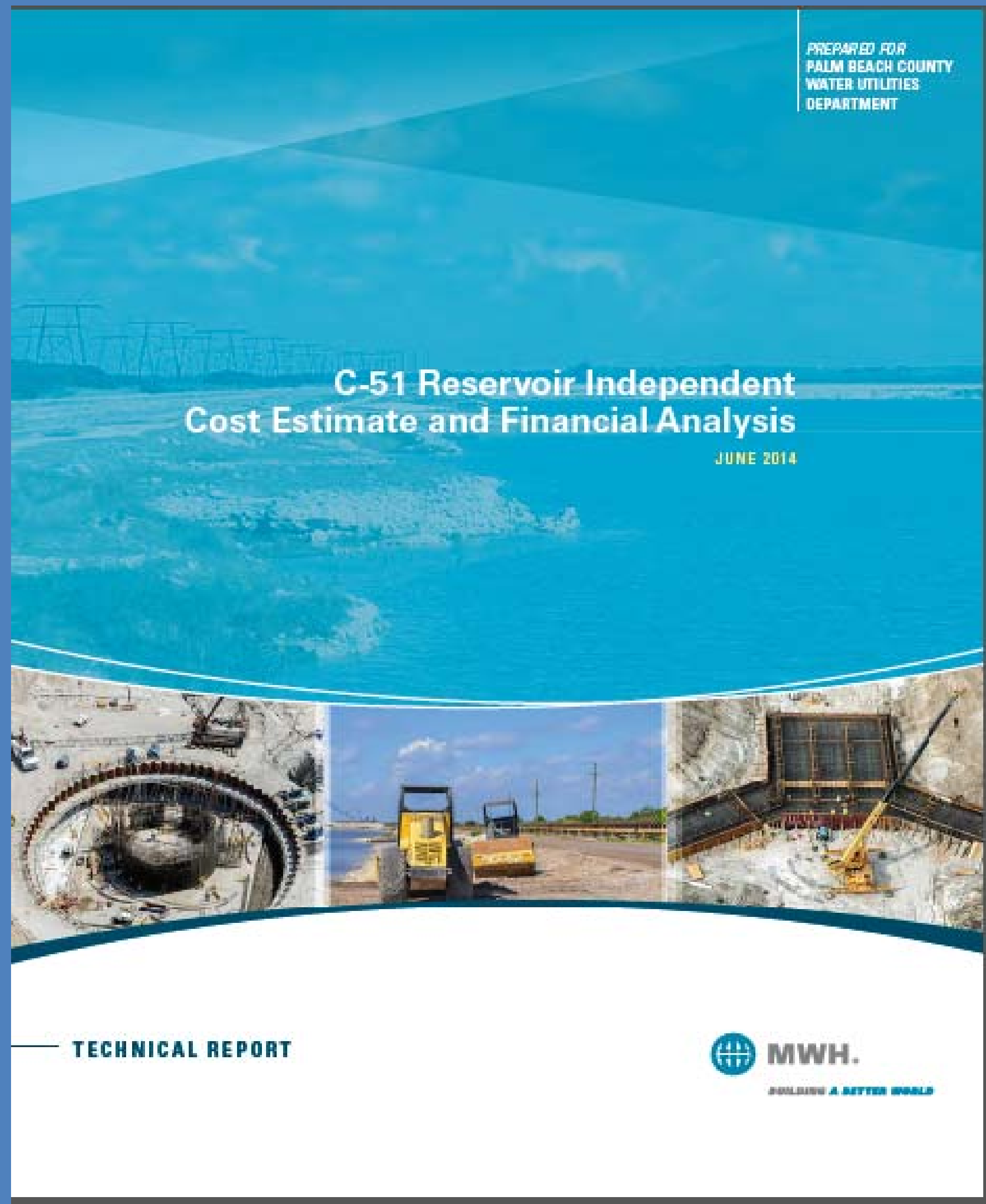
- **December 2011** — Draft SFWMD Report & Modeling
- **March 2012** — BCC Update
- **July 2012** — Preliminary Design and Cost Estimate Draft Report
- **November 2012** — SFWMD Presentation and GB Consideration
- **February 2013** — Preliminary Design and Cost Estimate Final Report
- **March 2013** — Palm Beach Aggregates Phases Project
- **April 2013** — PBC WRTF Approves Proposed Resolution

What Has Been Done To Develop The C-51 Project (Cont'd)?

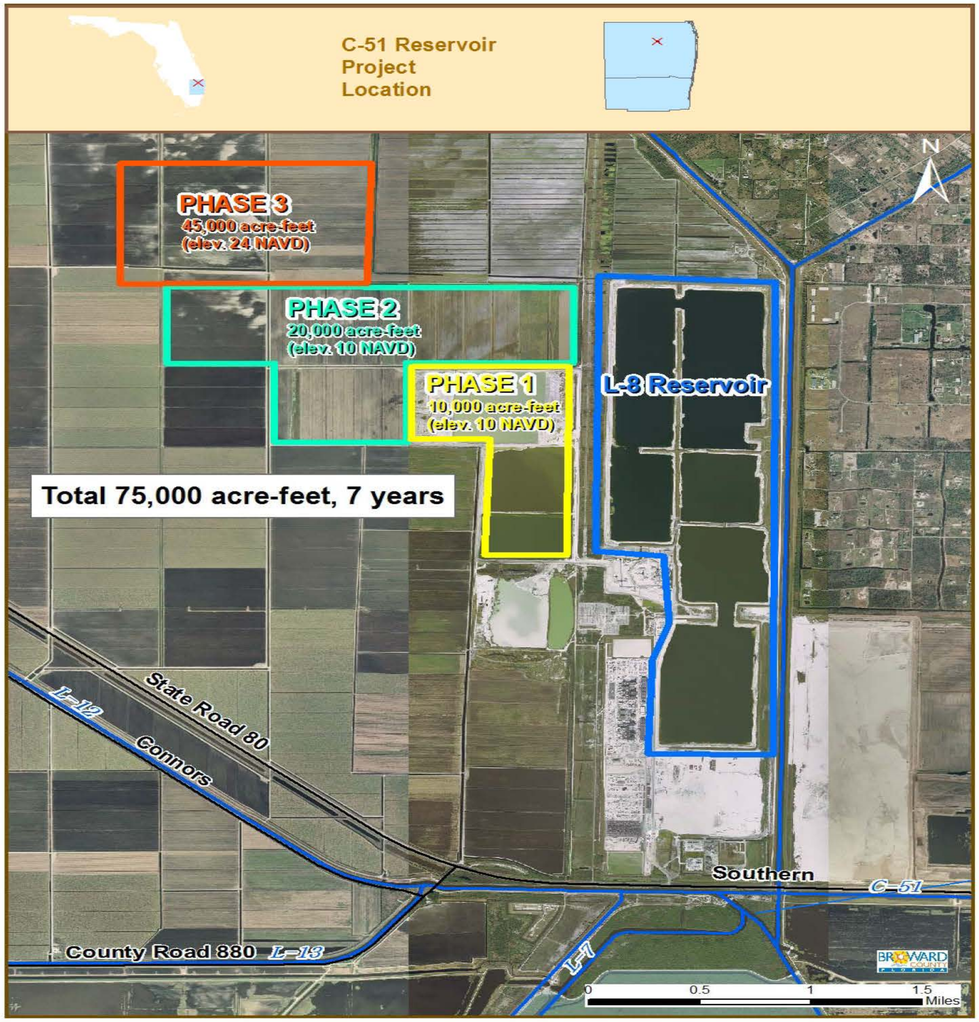
May 2013	September 2013	February 2014	PBC	Broward	June 2014	Late June 2014
BCC Update and Request to Approve Resolution	Finance and Governing Committee meets, recommends cost study.	BCC approves $150,000 for MWH to do an independent Coast estimate & Financial Analysis	Boca Raton Boynton Beach LWDD West Palm Beach	Broward Water & Wastewater Services Davie Ft. Lauderdale Hallandale Bch. Sunrise	MWH completes independent cost estimate and presents to the Finance and Governance Work group	Meeting with SFMWD Executive Staff to Negotiate Regulatory Aspects of C-51 Project

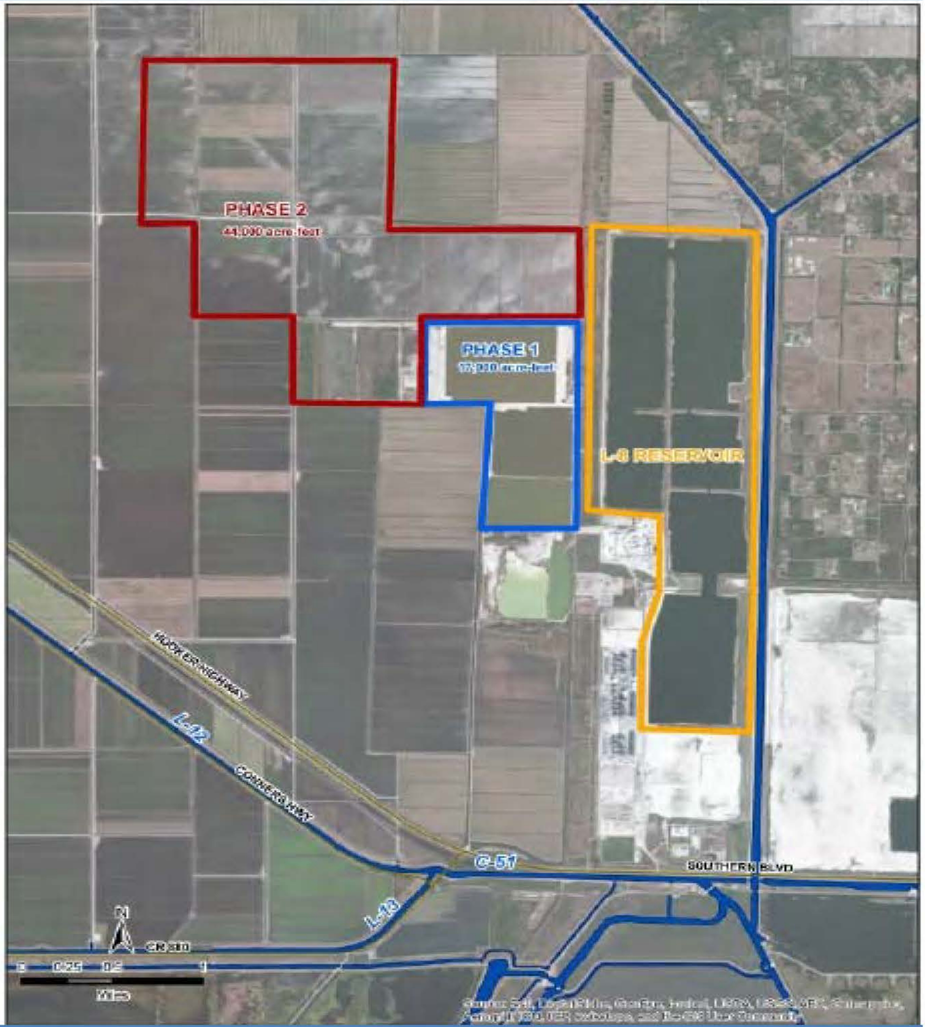
MWH Independent Cost Estimate Report

- Issued June 2014
- Updates Phased Project Approach and Presents Comparative Cost Analysis
- Presented at June 18 meeting of Finance and Governance Work Group



Updated C-51 Project Phases





Initial Configuration

Updated Configuration*

* Based on changed regulatory , scheduling and cost realities

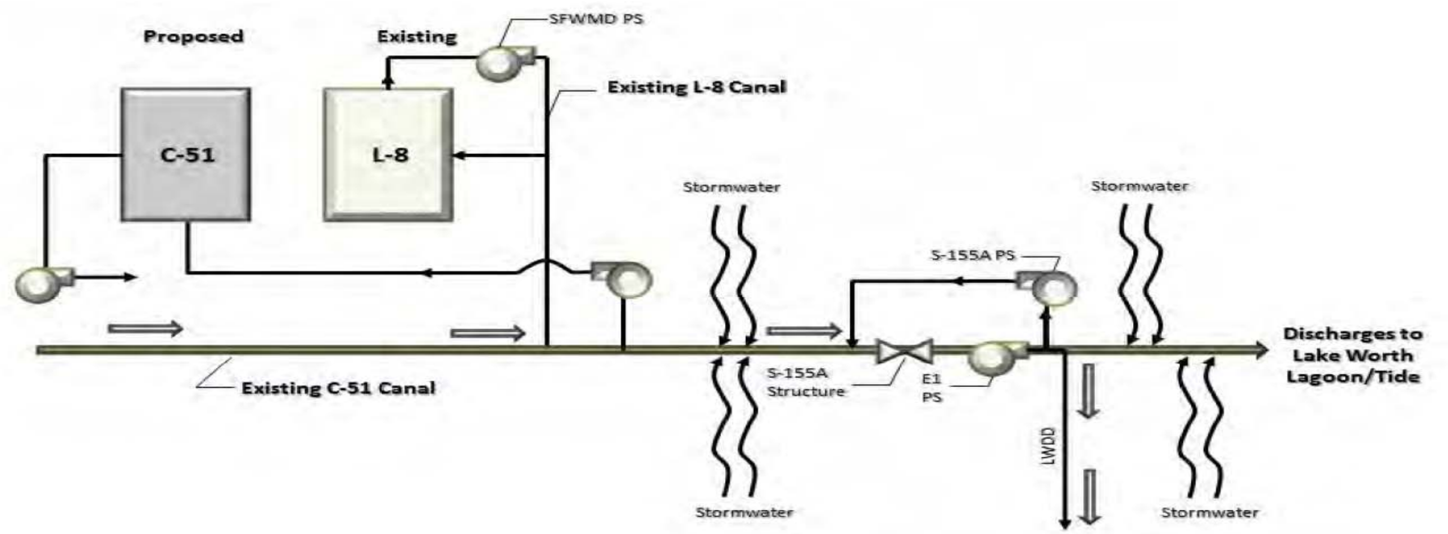


Figure 1. Design of Reservoir Facilities from 2013 C-51 Reservoir Design and Cost Estimate Report

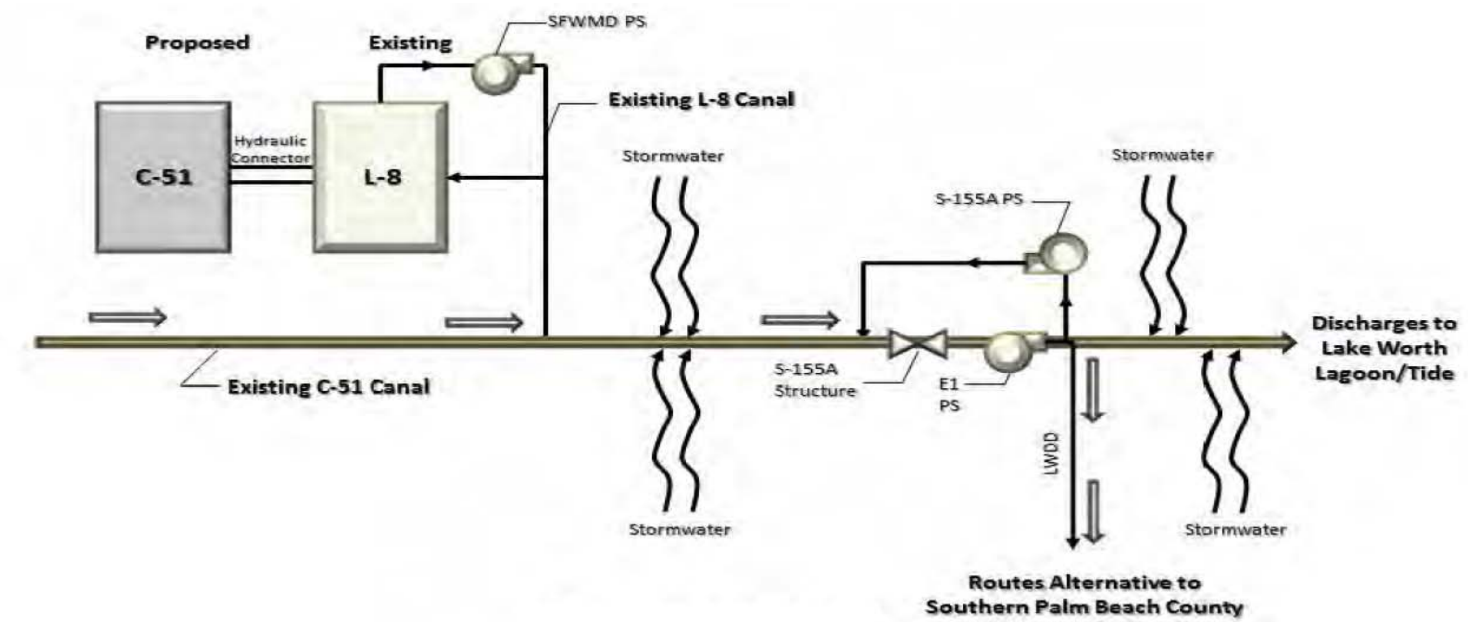


Figure 2. Revised Design of C-51 Reservoir Facilities from **2014 C-51 Reservoir Independent Cost Estimate and Financial Analysis Report** - (Includes hydraulic interconnect between L-8 and C-51 Reservoirs using the L-8 Pump station, eliminates the C-51 reservoir inflow and outlflow pump stations

Capital Costs for Phase 1, C-51 Reservoir

C-51 Phase 1 Construction Costs	$106,782,793
Land Costs	$0
Value at 12% Construction	$12,813,935
Project Management/Fees	$1,067,828
Engineering, Design, Permitting & Construction	$17,085,247
Interest during Construction @ 6%	$ 7,785,249
LWDD Projection Initiation Cost	$ 350,000
LWDD Canal User Fee	$ 380,160

Total Project Capital Costs (Phase 1) $146, 265, 212

Source: MWH, June 2014, C-51 Reservoir Independent Cost Estimate and Financial Analysis

Operations & Maintenance Costs (Phase 1)

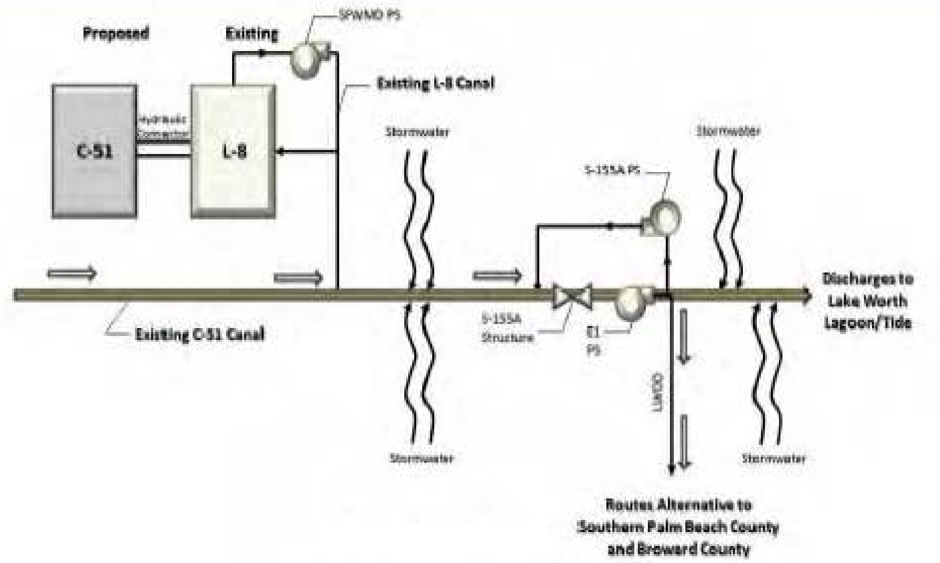


Figure 3-2 – Major Facilities Pursuant to Palm Beach Aggregates' Environmental Resource Permit Application. Modifications include a hydraulic interconnect between the L-8 and C-51 Reservoirs and using the L-8 pump stations to eliminate the C-51 Reservoir inflow and outflow pump stations.

C-51 & L8 Pumping Cost	$ 799
LWDD Pumping Cost	3,196
Total Phase 1 Annual Pumping Cost	3,995
C-51 Maintenance Expense	605,469
LWDD Maintenance Expense	76,032
Total Phase 1 Annual Maintenance Expense	$681,501
Total Phase 1 Operations and Maintenance Expense	$685,496

For purposes of this evaluation, it is assumed that the Phase 1 pumping and maintenance expenses would increase 3% annually to account for the effects of inflation.

Financing Considerations

Total Phase 1 Project Capital Costs	$146,265,212
Cost of Issuance at 2.0%	3,159,423
Debt Service Reserve Fund	11,705,963
Total Amount to be Financed	$161,130,598
Repayment Term (Years)	30
Interest Rate	6.0%
Annual Debt Service	$11,705,963

In developing the estimate of annual capital-related costs, it was also assumed that the cost recovery rate may need to include a provision for achieving a debt service coverage ratio of 1.15x annual debt service to enhance the credit position of the bond financing; however, since there are no significant renewal and replacement costs associated with the C-51 Reservoir facilities anticipated during the repayment term, it was further assumed that such amounts would be rebated to the project participants on an annual basis. The C-51 Reservoir cost recovery rates per thousand gallons (kgal), as set forth herein, include the calculation of unit costs both with and without the debt service coverage allowance.

Capital Costs for Phase 2*, C-51 Reservoir

C-51 Phase 2 Construction Costs	$182,019,449
Land Costs	$0
Value at 12% Construction	$21,842,334
Project Management/Fees	$ 1,820,194
Engineering, Design, Permitting & Construction	$29,123,112
Interest during Construction @ 6%	$51,552,482

Total Project Capital Costs (Phase 2) $286,357,571

* Phase 2 assumed to be operated in Year 16 and will take 7 years to construct.

Source: MWH, June 2014, C-51 Reservoir Independent Cost Estimate and Financial Analysis

Summary of Project Capital Costs

ERP* Phase 1………………..$ 146.2M

ERP Phase 2 ………………..$ 286.4M

Total ERP Phases 1 & 2…..$ 432.6M

* ERP = Environmental Resource Permit

Summary of Financial Costs and Comparison to Other Cost Estimate Studies

Project Phases/Report	OPCC (Opinion of Probable Construction Cost)	Total Project Costs	Storage Volume (Acre-feet)	Dry Season Water Availability (MGD)	Cost of Storage ($/Gallon)	Annual Costs ($/1000 gallons)	
						Dry Season Benefits Only	Year Round Benefit
PHASE 1 (MWH, 2014)	$106.8M	$146.2M	17,000	37	$3.96	$2.55	$1.05
PHASE 2 (MWH, 2014	$182M	$286.4M	44,000	96	$3.00	N/A	N/A
PHASES 1 & 2 COMBINED (MWH, 2014)	$288.8M*	$432.6M	61,000	132.5	$3.26	$2.11	$0.87
LWDD, PB County, Broward Co., SFWMD (2013) Phases 1,2,3	$695M**	$755.6M	74,000	132	$4.03	N/A	N/A
Hazen & Sawyer Feasibility Study for Total Project	$363M	$386M	75,000	120	$2.67	N/A	N/A

*Utilizes a proposed "Project Value Methodology" that addresses the unique location and geology of this site

**Assumed an unmined "greenfield site" that included excavation of material as part of the land costs

MWH Analysis of Financial Considerations

- Results showed costs to be less than, although in the range of, the original PBA cost estimate
- Land valuation accounts for the large portion of discrepancies in construction costs
- MWH (2014) report includes "Project Valuation Methodology" for land costs and risk assumed by PBA (12% of OPCC)
- Acceptable and Saleable ROI
- Affordable Cost Assumptions based on unit costs reserved on a take or pay basis

Next Steps

1. Negotiation Group to Meet With Representatives from Palm Beach Aggregates to Discuss Project Costs and Determine Final Cost Figures
2. Palm Beach Aggregates to apply for Diversion and Impoundment CUP (previously negotiated)
3. Finalization of Entities Interested in Initial Allocations from Phase I of the Project
4. Establishment of Governance Mechanism for Oversight and Management of Project
5. Entities Reserving Allocations to Modify Associated CUPs

QUESTIONS?

PREPARED FOR
PALM BEACH COUNTY WATER UTILITIES DEPARTMENT

C-51 Reservoir Independent Cost Estimate and Financial Analysis

JUNE 2014

TECHNICAL REPORT

MWH®

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BUILDING A BETTER WORLD

June 11, 2014

Mr. Bevin Beaudet, PE
Director
Palm Beach County Water Utilities Department
8100 Forest Hill Boulevard
West Palm Beach, FL 33416

RE: C-51 Reservoir Independent Cost Estimate and Financial Analysis – Final Report
PBCWUD CSA 14 (R2014-0204)
WUD Project No. 14-029
MWH Project No. 10504566

Dear Mr. Beaudet,

MWH is pleased to submit the enclosed report titled "C-51 Reservoir Independent Cost Estimate and Financial Analysis." This report reviews the developmental design information supplied to us by Palm Beach Aggregates to develop a Class IV Opinion of Probable Construction Cost and financial evaluation of the project with respect to capital, operations and maintenance, bonding and debt services, and reserves. The work was performed by MWH in association with ADA Engineering and Public Resources Management Group (PRMG). We also received significant input from Palm Beach Aggregates and their design engineers, the South Florida Water Management District, and the Lake Worth Drainage District.

We appreciate the opportunity to assist Palm Beach County and the participating utilities with this project. Should you have any questions or need additional information, please do not hesitate to call.

Sincerely,

MWH

Becky Hachenburg, PE, PMP
Vice President
Project Manager

C: Harold Aiken, MWH
Brent Whitfield, ADA
Rob Ori, PRMG

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C-51 RESERVOIR INDEPENDENT COST ESTIMATE AND FINANCIAL ANALYSIS

Prepared for:

Palm Beach County Water Utilities Department
8100 Forest Hill Boulevard
West Palm Beach, FL 33416

Participating Utilities:
Boca Raton, City of
Boynton Beach, City of
Broward County
Davie, Town of
Fort Lauderdale, City of
Hallandale Beach, City of
Sunrise, City of
West Palm Beach, City of

Prepared by:

MWH

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June 2014

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Glossary of Terms

Term	Definition
$M	Million Dollars
#H:#V	Horizontal to Vertical Ratio
AACE	Association for the Advancement of Cost Engineering
AADF	Annual Average Daily Flow
ACES	Automated Coastal Engineering System
Ac-ft	Acre feet
ASR	Aquifer Storage and Recovery
BG	Billion gallons
bls	Below land surface
BODR	Basis of Design Report
°C	Degrees Celsius
CERP	Comprehensive Everglades Restoration Plan
cfs	Cubic feet per second
cy	Cubic yard
DCM	Design Criteria Memorandum
EAA	Everglades Agricultural Area
El	Elevation
ERP	Environmental Resource Permit
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FP&L	Florida Power and Light
FS	Florida Statute
ft	feet
ft^2/day	Feet squared per day
gal	gallon
gpd	Gallons per day
gpd/ft	Gallons per day per foot
gpm/ft	Gallons per minute per foot
gpm	Gallons per minute

Term	Definition
HPC	Hazard Potential Classification
hr	hour
kgal	Thousand gallons
LEC	Lower East Coast
LECsR	Lower East Coast Water Supply MODFLOW model (SFMWD)
LWDD	Lake Worth Drainage District
MG	Million gallons
MGD	Million gallons per day
ML	Milliliter
mph	Miles per hour
MWSL	Maximum Water Storage Level
NAVD88	North American Vertical Datum of 1988
NGVD	National Geodetic Vertical Datum
NFSL	Normal Full Storage Level
NPV	Net present value
O&M	Operations and Maintenance
OD	Outside diameter
OPCC	Opinion of Probable Construction Cost
PBA	Palm Beach Aggregates, LLC.
PDCER	Preliminary Design and Cost Estimate Report (Lake Worth Drainage District, et al, 2014)
PS	Pump Station
RO	Reverse Osmosis
RCC	Roller-Compacted Concrete
sf	Square foot
SFWMD	South Florida Water Management District
SFWMM	South Florida Water Management Model
SPT	Standard Penetration Test

Term	Definition
STA	Stormwater Treatment Area
SWAN	Simulating Waves Near-shore
TM	Technical memorandum
UOM	Unit of Measure
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

1.0 - Acknowledgements

MWH acknowledges the project team involved in the research and adding to the collective technical resources for the preparation of this report. The work and reviews provided by the following firms and colleagues were critical to successful completion of this report.

1800 Old Okeechobee Road
Suite 202
West Palm Beach, FL 33409

341 North Maitland Avenue
Suite 300
Maitland, FL 32751

Furthermore, MWH acknowledges the cooperative assistance offered by Palm Beach Aggregates throughout this project.

Cover photos provided by Palm Beach Aggregates.

2.0 - Executive Summary

The C-51 Reservoir is a proposed Public-Private Partnership under development by Palm Beach Aggregates, LLC, (PBA), with operational and maintenance support provided by the South Florida Water Management District (SFWMD) and the Lake Worth Drainage District (LWDD). This project has been under consideration since 2007 and of interest to numerous utilities since conception. The proposed C-51 Reservoir is located north of State Road 80 (Southern Boulevard) in Sections 17, 18 and 19 and Township 43 South, Range 40 East and Sections 11, 12, 13, 14 and Township 43 South, Range 39 East (Latitude: 26^{o} 43' 24.19" and Longitude: 80^{o} 22' 55.43"), in Palm Beach County (see **Figure 2-1**).

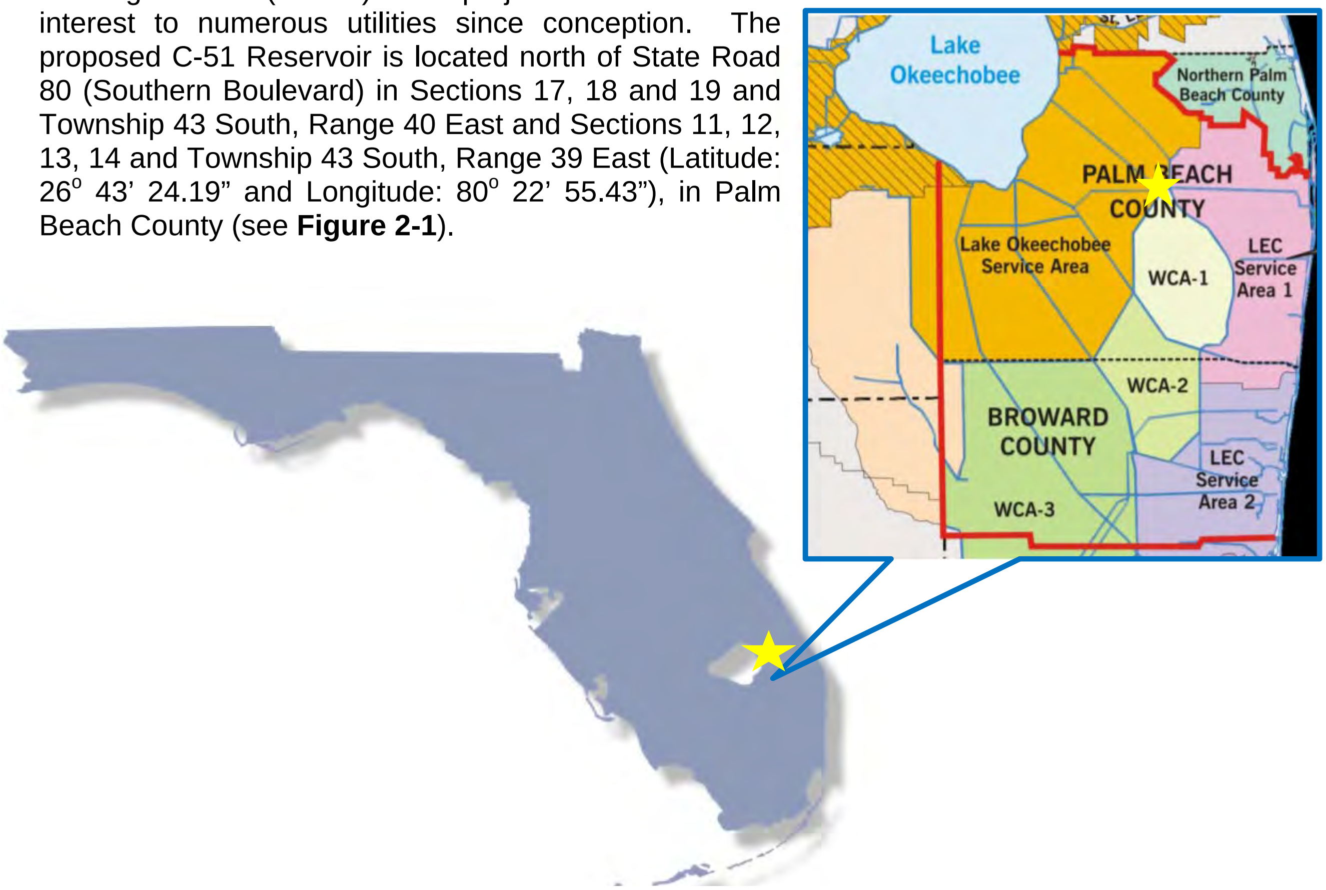

Figure 2-1 – C-51 Reservoir Location Map

The last published report describing features and cost for the project was the *C-51 Reservoir Preliminary Design and Cost Estimate*, Lake Worth Drainage District, et al. (February 2013). Since publication of that report, the project has progressed with some modifications that impact the construction and operating cost for the project. This report documents the changes from the last report as well as summarizes the progress made and remaining steps necessary to construct the reservoir.

PBA and the SFWMD signed a memorandum of understanding (May 2013) that provides cooperation by the parties in developing, operating and maintaining the reservoir. This cooperation results in a reduction of earlier projected costs by eliminating a dedicated pump station for the C-51 Reservoir. The parties have agreed to connect the C-51 and L-8 Reservoirs hydraulically, allowing the SFWMD to pump all water at its L-8 pump station. The SFWMD has further agreed to operate and maintain the reservoir at cost for the benefit of participating utilities.

The SFWMD conducted additional water resource modeling, confirming sufficient availability of stormwater to fill the Phase 1 reservoir in a 1-in-10 year drought without construction of a new pump station at the S-155A structure. At the time of this report, the SFWMD had not completed its analysis on the need for an S-155A pump station for Phase 2, so for this report costs have been included in Phase 2 to account for the pump station, if needed. Based on discussions with SFWMD staff, modeling has confirmed the feasibility of moving water from the C-51 canal through the LWDD using the E-1 canal though southern Palm Beach County to Broward County based on Phase 1 flows. Modeling to confirm conveyance of Phase 2 flows has not been finalized by SFWMD.

Additional and ongoing analysis is being conducted to determine the seepage loses (or gains) of water moved south into Broward County. The SFWMD will require each participating utility to modify its Consumptive Use Permit with modeling of the relative regional water system "lift" in the vicinity of its shallow aquifer wells. Further, the SFWMD will require participating utilities to submit a form of commitment for water before an equivalent amount of water will be permitted for consumptive use from the reservoir.

PBA has modified the design of the reservoir not only by eliminating a dedicated pumping station but also by removing Phase 3 of the reservoir as previously contemplated. Phase 3 required elevating the embankment walls to provide additional storage volume, but the associated dam safety criteria for the elevated sections would have increased the classification to high hazard level, rendering Phase 3 impractical. The project now envisioned includes a 17,000 ac-ft Phase 1, and a 44,000 ac-ft Phase 2. The first phase will be able to store 5,500 MG of water for distribution in the dry season. Phase 2 will add an additional 14,300 MG of water for a total of 19,800 MG of water when both phases are completed. **Figure 2-2** highlights the change in phasing configuration.

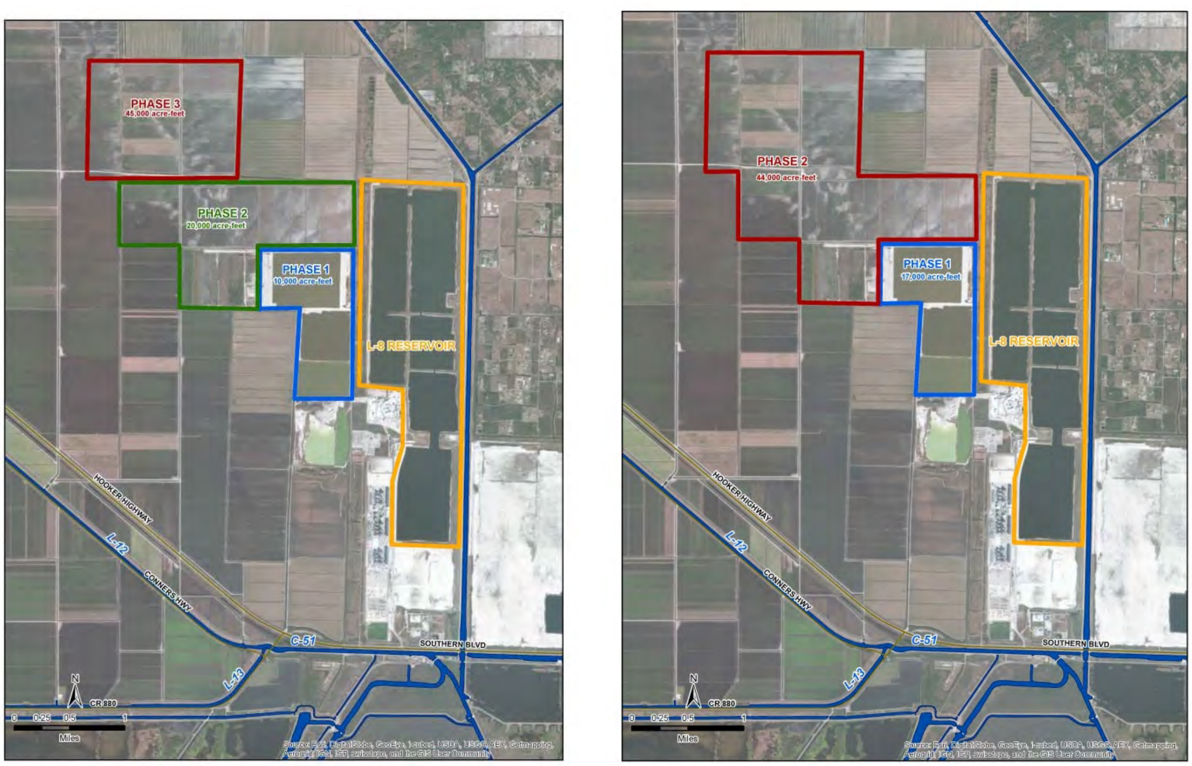

Figure 2-2 – C-51 Reservoir Project as Previously Envisioned with Three Phases (L) and Current Configuration with Two Phases (R)

The Florida Department of Environmental Protection (FDEP) issued PBA an Environmental Resource Permit (Permit No. EC 50-0301070-002, April 2014) that provides State authorization to construct both Phase 1 and Phase 2 of the reservoir. The permit duration for the construction of both phases is five years beginning in 2014. PBA is finalizing development of a Consumptive Use Permit Application that can be filed as soon as participants commit to specific quantities of water that will in turn support the volume of water that will be available annually from the reservoir.

An independent review of the reservoir features outlined in the 30% design documents was performed as part of this evaluation. The information provided to MWH at this stage of design follows the SFWMD and FDEP Design Criteria Memorandum (DCMs). A few potential cost savings suggestions, identified in Section 6, were shared with the design team, including reducing the embankment by at least one foot. The designer is reviewing these suggestions. However, for this analysis any potential cost savings associated with MWH's design suggestions have not been included in the Opinion of Probable Construction Cost (OPCC).

A new Class IV (AACE) OPCC was prepared by MWH based on the latest phasing and design plans provided by Palm Beach Aggregates. The January 2012 OPCC prepared by Burns and McDonnell included provisions for excavating rock from a "greenfield" site where no mining had occurred as well as dedicated inflow and outflow pumping stations. MWH's Phase 1 OPCC is based on the partial design information available for the reservoir improvements and assumes that no dedicated pump station is required. The twin 102-inch pipes connecting the L-8 and C-51 Reservoirs provide a hydraulic connection that allows shared use of the SFWMD L-8 pump station. The updated OPCC for Phase 1 also assumes the cells have been mined by PBA, but need additional work to convert from current state to a water storage reservoir. The January 2012 OPCC assumed the participants would bear the full cost of removing the limerock to a depth of approximately 20 feet bls. Since the Phase 2 cells are not yet mined, MWH approached this as a "greenfield" similar to Burns & McDonnell's approach. However, recognizing that PBA is in the mining business, MWH included not only the cost for excavation, but also assigned a value to the rock to give a more realistic value for the future mined condition.

In addition to the OPCC, additional costs were included to cover professional services, such as legal support, project management, engineering designs and studies, permit preparation, and construction coordination and oversight as well as other costs associated with obtaining a construction loan, cost of money, and profit.

The SFWMD provided budget estimates for maintenance of the L-8 Reservoir and historic pumping costs. This analysis assumed the additional cost to maintain the C-51 Reservoir as a function of the relative length of embankment added with each phase of development. A ratio of additional embankment was applied to the estimated annual maintenance costs. The SFWMD also provided the cost to pump water on a per acre foot basis, which, as applied, assumes one fill and empty cycle per year for the reservoir.

Although not part of the scope of work, MWH did include some cost consideration for the LWDD that will provide a more thorough analysis to future participants. The LWDD did not request capital improvements for Phase 1, but did request a one-time user fee of $3.00 per foot of canal used and 20% of that fee annually for maintenance of the system. A pumping cost equal to that provided by the SFWMD was applied to the LWDD for consistency. The LWDD also requested compensation for $350,000 spent by the agency in its efforts to progress development of the project. Phase 2 improvements to the LWDD as reported in the PDECR have been included in the Phase 2 financial analysis, but these costs should be re-visited in the future once future participation and flows are established.

Table 2-1 summarizes the financial calculations for the C-51 Reservoir project based on the OPCC, associated development costs to PBA, and the O&M cost estimates provided by the SFWMD and LWDD. Costs for modification to a participating utilities system, if required, are not included in this analysis. Annual costs as shown include annual debt service including reserves and O&M costs. The actual participants' ratio of dry season offset to average annual allocation will be a function of the Water Use Permitting process and may differ between participants.

Table 2-1 – Summary of Financial Calculations for the C-51 Reservoir Project

Project Phases per Environmental Resources Permit	OPCC ($M)[1]	Storage Volume (Ac-Ft)	Dry Season Water Availability (MGD)[2]	Cost of Storage[3] ($/gal)	Annual Costs[4] ($/1000 gal)	
					Dry Season Benefit Only[5, 6]	Year Round Benefit[7]
ERP Phase 1	106.8	17,000	37	3.96	2.55	1.05
ERP Phase 2	182	44,000	96	3.00	N/A[8]	N/A[8]
ERP Consolidated (Total)	**286.4**	**61,000**	**132.5**	**3.26**	**2.11**	**0.87**

1. Assumes the rock pit cells are mined and the capital cost represents the conversion to a reservoir. See Tables 7-1 and 7-2 excluding contingencies.
2. Assumes stated daily water availability over a 150 day dry period.
3. Capacity will be a function of the storage as permitted by the SFWMD through individual utility water use permits.
4. Annual cost includes O&M costs provided by SFWMD and the LWDD, Annual Debt Service, and Reserves.
5. Assumes the Dry Season Stored Water Benefit fully offsets regional impacts (e.g. for Phase 1 a 1:1 or 37 MG of alternative water provides 37 MGD of Biscayne/Surficial Aquifer allocation. This ratio may be dependent on regulatory constraints.
6. From Table 8-5, Avg. Cost per KGal: Year 1 represents Phase 1 and Year 16 represents Total.
7. From Table 8-7, Avg. Cost per KGal: Year 1 represents Phase 1 and Year 16 represents Total.
8. Not applicable - the Phase 2 annual operating costs cannot be separated from the total annual costs as they are integrated.

Table 2-2 provides a comparison of costs presented in previous reservoir configurations.

Table 2-2 – Alternative Reservoir Configuration Costs Comparison

C-51 Configuration	Dry Season Water Availability[1] (MGD)	Cost of Storage ($/gal)	Project Capital Costs ($M)	Annual Costs ($M)[5]
ERP Phase 1[2]	37	3.96	146.2[6]	14.1
ERP Phase 2[2]	96	3.00	286.4[7]	N/A
ERP Consolidated[2]	132.5	3.26	432.6	41.9
PDCER[3]	163	4.08	755.6	N/A
PBA	35	4.30[4]	158.9	14.9

1. Assumes stated daily water availability over a 150 day dry period.
2. Current configuration and basis of this independent evaluation.
3. The PDCER Project Costs does not include:

   Project management, Design, Permitting, Construction Management, Interest on money during construction, Land costs

   Project Value - Includes Project Value as established by Palm Beach Aggregates
4. From Palm Beach Aggregates (2013, January 18)
5. Assumes 30 yr. bond at 6% interest with 2% cost of issuance. Includes debt service reserves and issuance insurance. Values from Tables 8-5 and 8-7, Total Annual Cost: Year 1 represents Phase 1 and Year 16 represents Total.
6. Project capital costs from Section 8.2.1 herein.
7. Project capital costs from Section 8.3.1 herein.

The County understands and agrees that in the preparation of its work and opinions developed under this work assignment, MWH does not guarantee any outcome with respect to the availability, location or cost of water, or the cost of any facility that would provide water in any way.

3.0 - Background

The concept for the C-51 Reservoir was born from the development of the L-8 Reservoir. In 2007 the L-8 Reservoir was being constructed to provide an off-stream reservoir to capture stormwater that was flowing to tide at the Lake Worth Lagoon and had been impairing the lagoon ecological system with the large fresh-water discharges. The goal was to store the stormwater and retain it for dry weather augmentation of the Everglades system during times of excess drought. The L-8 Reservoir thus became part of the Comprehensive Everglades Restoration Plan (CERP). The timing of the reservoir development was coincidental with the projection of significant population increases in the southeast Florida region, requiring an increase in water supply.

In 2006 the Regional Water Availability Rule (2007) was enacted to avoid potential future cutbacks in shallow aquifer withdrawals, but it had mandated that no additional water would be permitted that impacted the Regional System. These guidelines essentially capped Biscayne/Surficial aquifer withdrawals to 2006 levels with additional water supplies to be provided by alternative water sources, such as reuse, treated brackish water, or captured stormwater. Each alternative water solution was a higher cost for water than the traditional Biscayne/Surficial aquifer source waters (supply capture and/or treatment). In addition, the cap on the Biscayne/Surficial aquifer supply stranded capacity already built by a number of utilities in anticipation of growth. Unfortunately, the rule included no exceptions for those utilities that had planned ahead; they simply lost the economic value of their investments to build capacity in advance of actual needs.

Making matters worse for the local utilities, projected water demands, fueled by a booming housing market, were skyrocketing. This increased demand put enormous pressure on utilities to determine new and, in some cases, very expensive alternative water sources. As the L-8 Reservoir took shape in 2007, discussions surfaced about expanding the reservoir to include flood protection and additional water for public supply. This concept resonated with utilities facing higher costs for alternative water supplies, consisting primarily of either brackish water reverse osmosis treatment of Floridan Aquifer water or reuse of wastewater effluent.

A consortium of utilities led by Fort Lauderdale and including Sunrise, Plantation, Hollywood, Pompano Beach, Broward County, and Palm Beach County contracted Hazen and Sawyer to evaluate options for alternative water supplies, especially to utilities with stranded capacity in systems designed to treat Biscayne/Surficial aquifer waters. The basic idea was simple – provide captured and stored stormwater to the regional system in the dry periods, allowing utilities to harvest this alternative water in the form of additional Biscayne/Surficial Aquifer withdrawals. This concept of capturing stormwater for use in dry periods had been developed by the South Florida Water Management District (SFWMD) and US Army Corps of Engineers (USACE). Their primary focus was to benefit the environment and improve water management in the Everglades Agricultural Area (EAA) using Aquifer Storage and Recovery (ASR) wells and reservoirs. The ASR wells' value was limited because of stormwater quality challenges and practical limitations of ASR capture of large stormwater flows. The reservoirs continued to be viewed as the preferred option, capable of capturing and storing large volumes at lower costs. The Hazen & Sawyer with MacVicar, Federico and Lamb report (2009) surveyed all utilities in the area requesting future demand data. From that analysis, they computed the unmet needs in Miami Dade, Broward, and Palm Beach Counties. The report also explored strategies for capturing stormwater that otherwise would be lost to tide and then using it to augment the Biscayne/Surficial aquifer in dry periods, thereby increasing the available water to be treated by existing (stranded) water plant infrastructure. The four technical memoranda developed and released in 2007 and 2008 by Hazen and Sawyer identified both a need for a potential source of water and a strategy for moving the water to utilities for public supply. By late 2008, consideration for an expanded L-8 Reservoir was replaced with a separate public supply reservoir known as the C-51 Reservoir. The modeled concept was straightforward—the reservoir would be filled with water that was historically lost to tide and then discharged into the regional system when flows to tide stopped and dry conditions prevailed. Water would be moved south through the Lake Worth Drainage District (LWDD) canal system to recharge the Biscayne/Surficial aquifers in Southern Palm Beach County and Broward County. The C-51 Reservoir would be used as a peaking supply, much like other alternative water sources. The addition of water from the reservoir would provide a water "lift" to the regional system commensurate with or exceeding additional surficial aquifer withdrawals granted to public supplies. Under the 1-in-10 year drought, the regional system would not be negatively impacted by the additional withdrawals since the canal elevations would be sufficient to recharge the aquifer and retard seepage from the water conservation areas. In fact, a benefit to the environment is that in most years more water could be made available from the reservoir than would be needed to offset demands allocated for public supply.

In 2008 the US was hit by a recession—stalling population growth in Florida—and utilities saw water use retract from the highs seen in 2005. During this same time, Broward County instituted year-round irrigation restrictions that encouraged water conservation, reducing demands in the County's utility sector even further. Similar reductions in water use were experienced in Palm Beach County. The lower water demands relieved the immediate pressure to develop alternative water supplies, providing time to further evaluate alternative options such as the C-51 Reservoir project.

In 2009, an additional report (Hazen and Sawyer, et al.) was commissioned by Fort Lauderdale and the Consortium of Utilities. This new report was to provide updates to and expand information provided in the three previous technical memoranda, focusing specifically on:

- Updating the water demands for the Lower East Coast (LEC) Water Supply Region.
- Developing a method to obtain regulatory certification for meeting the LEC alternative water supply objectives set forth in the Water Availability Rule using C-51 Reservoir water.
- Evaluating flow way routing from C-51 to points south using a route through the LWDD or through the Everglades Agricultural Area.
- Describing the geology and hydrology of the proposed C-51 Reservoir site to confirm suitability for a reservoir.
- Updating cost effectiveness analysis for development of the C-51 Reservoir.

Findings from the Phase 2A report (January 2010) stated that the unmet demands, discounted for brackish water reverse osmosis systems, still exceed the capacity of the proposed C-51 Reservoir. The report also made the case that by capturing stormwater that would otherwise be lost to the natural system, the C-51 Reservoir qualified as "Alternative Water" under the Water Availability Rule. The report confirmed that either southerly conveyance route technically worked, with the EAA route being the lower cost option. The report evaluated a series of soil borings and modeled flows to confirm the site geology to be representative of the low leakance characteristics found at the L-8

Reservoir. SFWMD provided verbal assurances that sufficient excess stormwater was available to fill the Phase 1 reservoir. Analysis is ongoing to complete seepage analysis of water routed south through the LWDD as well as confirmation of available excess stormwater for Phase 2. The updated cost analysis showed the C-51 Reservoir to be a cost-effective option to satisfy some of the future unmet water demands identified in Broward and Southern Palm Beach Counties.

In the Hazen and Sawyer Phase 2A report (2010, January), the cost analysis assumed a construction cost of $363M to produce 136 million gallons per day (MGD) during the 150-day dry season. This equates to a capital cost of $2.67/gallon of untreated water. Using an assumption of $0.02/1000 gallons for operations and maintenance, along with a 20-year 6% note, the total cost of the C-51 Reservoir options was reported to be approximately $0.66 per 1000 gallons of produced untreated water. This was reported to convert to an annualized cost of $1.58/1000 gallons when fully treated and finally incorporated into utility rates.

The property considered prime for development of an expanded L-8 reservoir (C-51 Reservoir) was an active mine owned and operated by Palm Beach Aggregates, LLC (PBA). In 2011, PBA secured the services of Burns & McDonnell to prepare preliminary cost analysis (2012) for developing a conceptualized C-51 Reservoir. While PBA was developing conceptual costs for C-51, the SFWMD was modeling the surface water system that might be tapped and subsequently serve utilities farther south. In December 2011, the SFWMD published a draft Water and Conveyance Analysis (2011, Appendix A). This study did not evaluate the regulatory aspects of the water availability, but rather the ability of the reservoir to provide water under two future options. One option provided the unmet needs as documented by the responding utilities in southern Palm Beach County and Broward County for a 2030 future time horizon which equated to 73.57 MGD. Option 2 looked at high demand population projections published by the Bureau of Economic & Business Research for 2010 to 2060 which was reported to convert to an unmet demand of 231.75 MGD. The analysis modeled 40 years of rainfall, between 1965 and 2005, to determine quantities of stormwater that had been seasonally lost to tide. Those flows provided a basis for filling the reservoir and a basis for providing supplemental supply to public water utility stakeholders. Based on this historical period of record, Option 1 demands were met all but one year and Option 2 demands could not be fully met. The report concluded that Option 2 demands would require additional sources as the reservoir would be dry on at least five occasions and unable to meet the full demands even in non-drought periods.

PBA continued work on the design and permitting of the C-51 Reservoir with the goal of creating a Public Private Partnership with SFWMD, whose flow ways would serve as the primary source of stormwater inflow and discharge routing once the reservoir was in operation. In May 2012, PBA entered into a Memorandum of Understanding with the SFWMD that set forth a cooperative environment for the operation and maintenance of the reservoir. In June of 2012, PBA released its Preliminary Design and Construction Report that outlined the three reservoir construction phases, 7-year plan for development of a 75,000 acre reservoir (total for all 3 phases), and preliminary cost estimates. **Figure 3-2** shows the Major Facilities envisioned at this time.

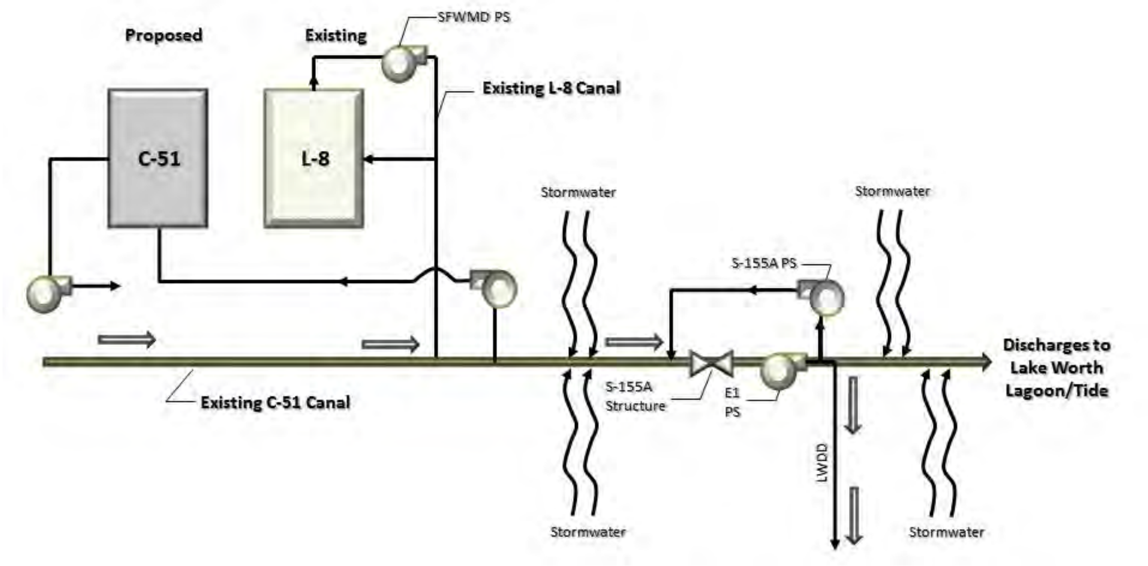

Figure 3-1 – Major Facilities from Preliminary Design and Cost Estimate Final Report (2013). At this time, the C-51 Reservoir had dedicated inflow and outflow pump stations and no interconnect with the L-8 Reservoir.

The opinion of probable cost for the reservoir was developed by Burns and McDonnell Engineering Company (2012). For all three phases, the total was $695M. This estimate assumed an unmined “greenfield” site that included excavation of material as part of the construction cost. Required improvements to the downstream flow ways needed to make the system functional included a new pump station at the S-155A structure located on the C-51 canal east of the project. This pump station would intercept and pump part of the stormwater that would normally flow to the Lake Worth Lagoon back to the west where it could be captured and stored in the C-51 Reservoir. Additionally, the LWDD estimated $33.3M in capital cost for E-1 canal and structures improvements. Broward County provided an estimate of $2.3M for improvements to their secondary canal system. The total cost for the entire project was reported to be $755.6M.

In October 2012, the LWDD offered to take on the role of project sponsor providing management oversight for the project and serving as the ultimate project owner. As project sponsor, the LWDD prepared, with assistance from Palm Beach County, Broward County, and the SFWMD, the C-51 Reservoir Preliminary Design and Cost Report (2013, February). This report followed a similar approach to the earlier work for the SFWMD by estimating unmet future water demands and determining the feasibility of the C-51 Reservoir project to satisfy all or some of that unmet demand. The recommendation was that participating stakeholders develop a detailed design report, further refine the cost estimates, and determine a plan for recovering capital and operations and maintenance costs for the reservoir.

In May 2013, following the release of the 2013 Preliminary Design and Cost Report, Broward and Palm Beach counties formed a joint task force – C-51 Governance and Finance Work Group. The specific purpose of the task force was to evaluate the financial feasibility for the C-51 Reservoir project and to explore governance models for the long-term management of the facility. An early action of the C-51 Governance and Finance Work Group was to hire a consultant, MWH, to provide an Opinion of Probable Construction Cost (OPCC) based on the latest refinements to the design and PBA’s Environmental Resource Permit application to the Florida Department of Environmental

Protection (FDEP) (Permit No. EC 50-0301070-002, April 2014). The latest configuration for the reservoir is to consolidate the project phases into two – eliminating the third phase, installing an interconnect between the C-51 and L-8 Reservoirs, eliminate the dedicated C-51 Reservoir inflow pump station and utilize the L-8 Reservoir Pump Station and interconnects instead (See **Figure 3-2**).

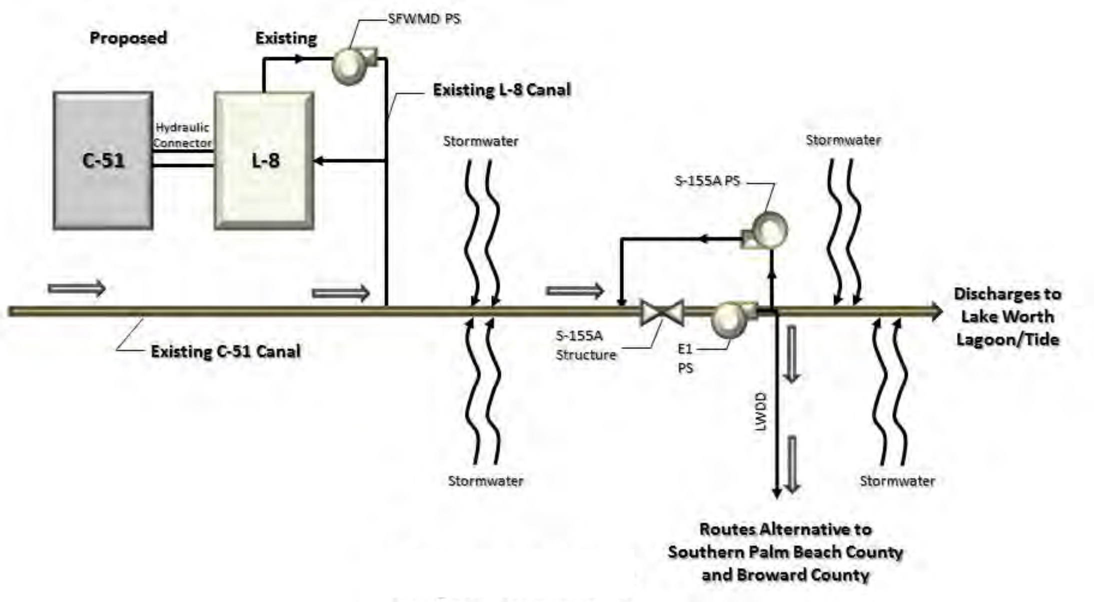

Figure 3-2 – Major Facilities Pursuant to Palm Beach Aggregates' Environmental Resource Permit Application. Modifications include a hydraulic interconnect between the L-8 and C-51 Reservoirs and using the L-8 pump stations to eliminate the C-51 Reservoir inflow and outflow pump stations.

MWH's report presents an independent look at the OPCC for the two-phase reservoir configuration, as well as the latest information from the SFWMD and the LWDD for ancillary improvements and operating and maintenance costs for the C-51 Reservoir and ancillary facilities. This report will also summarize findings from review of the SFWMD's plans for capture of dry season supply of stormwater to provide unmet needs for Phase 1 and Phase 2 of the Reservoir as currently configured.

4.0 - Literature/Data Review

A literature review was performed using all available sources and data. This literature review included not only existing reports but also regulatory documentation available from State agencies with applicable jurisdiction. Section 9 provides a complete reference list of documents reviewed by MWH.

Table 4-1 provides a summary of the reviewed documents and their application to the C-51 Reservoir Project expansion study.

Table 4-1 - Summary of Documents Reviewed

Item	Report	Scope / Overview	Application to C-51 Reservoir
1	Memorandum No. 3 (M-3) – Final Hydrological Modeling / Water Budget Evaluations. Conceptual Feasibility of a Sub-Regional Lower East Coast Water Supply Solution (October, 2008; MacVicar, Federico and Lamb)	SFWMD analysis using the Lower East Coast Water Supply MODFLOW model (LECsR) to determine the feasibility of C-51 reservoir.	• Assumes 225 MGD of additional water needed by 51 utilities in 2025 • Assumes 300 MGD of surface water deliveries would be needed to meet utilities 225 MGD in groundwater withdrawals • The C-51 reservoir would supply 120 MGD, while reclaimed water would provide 140 MGD • Modeling showed that the C-51 reservoir is capable of providing 120 MGD without depleting at any time between 1965 and 2000 • Modeling does not incorporate Restoration Strategies water management assumptions, includes provision of supply to the Loxahatchee River from L-8 Reservoir
2	Conceptual Feasibility of a Sub-Regional Lower East Coast Water Supply Solution. (February 2009; Hazen & Sawyer with MacVicar, Federico and Lamb)	Analysis of raw water requirements, hydrologic modeling and conveyance analysis, and conceptual facilities. Prepared for City of Fort Lauderdale and several Broward County utilities	• Raw water projections were based on 2007 surveys of all utilities, requesting existing and projected withdrawals for 2010, 2015, 2020, and 2025 • Modeling of water availability was based on Memorandum No. 3 (October, 2008; MacVicar, Federico and Lamb) • Assumes several conveyance facilities implemented: C-51 Reservoir (48,000 ac-ft) / S155A Pump Station (500 cfs to back pump from C-51 East) / Southern Blvd Box Culvert / S5AE Pump Station / L-8 Canal Crossing / C-51 Reservoir Conveyance Canal and Inflow Structure / C-51 Water Supply Pump Station (371 cfs) • Includes detailed evaluation of available sources of reclaimed water • Estimates C-51 Reservoir implementation cost at $363 million in 2007 dollars

Item	Report	Scope / Overview	Application to C-51 Reservoir
3	Conceptual Feasibility of a Sub-Regional Lower East Coast Water Supply Solution. Phase 2A, Task 2a – Proposed Certification Process FINAL (January 2010; MacVicar, Federico and Lamb)	Supplementary information to the February 2009 Report. Evaluation of ability of the C-51 Reservoir to meet the requirements of the LEC Regional Water Availability Rule	• Shows that the C-51 Reservoir meets the definition of an alternative water supply project and/or development • Shows that there is sufficient demand projected to justify the C-51 Reservoir • Shows that the C-51 Reservoir fits the definition of a project that will provide surficial water to offset groundwater withdrawals • Shows that the C-51 Reservoir fits the definition of a project that will use wet season surface water to meet future water demand within the same hydrologic area where the available surface water is identified
4	Conceptual Feasibility of a Sub-Regional Lower East Coast Water Supply Solution. Phase 2A, Task 2b – Direct Conveyance Alternatives FINAL (January 2010; MacVicar, Federico and Lamb)	Supplementary information to the February 2009 Report. Evaluation of ability to convey the C-51 Reservoir water to LEC utilities via (1) LWDD Canals or (2) EAA Canals	• Proposed moving water in the L-40 Borrow Canal at costs ranging from $41M to $118M, potential water quality concerns are noted • Proposed moving water down the LWDD E-1 Canal with the addition of 3 gated pump stations and 2 control structure retrofits at an estimated cost of $49.6M • Proposed moving water through G-371 and around STA 3/4 to reach Broward County through the North New River Canal using existing facilities
5	Conceptual Feasibility of a Sub-Regional Lower East Coast Water Supply Solution. Phase 2A, Task 3 – Geologic and Hydrologic Investigation FINAL (January 2010; MacVicar, Federico and Lamb)	Supplementary information to the February 2009 Report. Evaluation of geologic field test data for suitability of reservoir construction.	• Found geologic conditions were similar to the adjacent L-8 Reservoir, with sandy and coquina limestone that grade to sand and shell at 34 to 38 feet below the ground surface • Field permeability tests were run on the L-8 Reservoir only, and showed significantly lower permeability than the EAA • Chloride levels in three wells varied from 76 to 3,000 mg/L in a trend increasing with depth. Recent experience was noted as diluting the chlorides by cycling fresh water in the reservoir

Item	Report	Scope / Overview	Application to C-51 Reservoir
6	Conceptual Feasibility of a Sub-Regional Lower East Coast Water Supply Solution. Phase 2A, Task 4 – Cost Effectiveness Analysis FINAL (January 2010, Hazen & Sawyer)	Supplementary information to the February 2009 Report. Update to cost estimates.	• Updated cost of C-51 Reservoir ($308M) • Total updated cost with LWDD conveyance ($451M) • Total updated cost with EAA conveyance ($401M) • Provides Total Cost per 1,000 Gallons for each conveyance alternative • Provides Unit Costs based on Phasing of Reservoir Construction • Provides Unit Costs based on Level of Utility Participation
7	Conceptual Feasibility of a Sub-Regional Lower East Coast Water Supply Solution. Phase 2A – Additional Investigations Compilation of Technical Memoranda (January 2010, Hazen & Sawyer with MacVicar, Federico and Lamb)	Supplementary information to the February 2009 Report. Summary of Combined Technical Memorandum.	• Compilation of the findings and conclusions of all previous technical memoranda
8	C-51 Reservoir – Preliminary Design and Cost Estimate. Appendix A: Water Availability & Conveyance Analysis (December 2011, SFWMD Hydrologic and Environmental Systems Modeling Section as included with the Lake Worth Drainage District, et al 2014 PDCER)	Documents the modeling approach and findings associated with the SFWMD's analysis of the C-51 Reservoir	• Uses the South Florida Water Management Model (SFWMM or 2 x 2) to evaluated the water budget for the C-51 Reservoir • Uses HEC-RAS/HEC-HMS to evaluate moving water into the reservoir along the C-51 Canal • Uses MODFLOW to evaluate seepage with LWDD canals • Assumes two scenarios for future water demands from utilities: (1) Future Scenario 2060 with Utility Projections, (2) Future Scenario 2060 with Population Projections • Reservoir storage assumed at 75,000 ac-ft. • Simulation showed there is sufficient water to fill the reservoir during

Item	Report	Scope / Overview	Application to C-51 Reservoir
			most simulated years (1965-2005) • For Option 1 demands, the reservoir would have delivered 85 MGD or more to the region while not exceeding the storage capacity of the reservoir • For Option 2 demands, the reservoir would have dried out in two periods (1989-90 and 1971-72). Dry season deliveries during highest volume years exceeded 145 MGD • Modeling includes proposed 7,914 ac-ft Lake Point Reservoir in the north end of the L-8 Basin • Modeling includes Loxahatchee River Watershed Restoration Deliveries from L-8 Reservoir • Modeling does not include Restoration Strategies assumptions for water management • Assumes flows from C-51 East Basin with a new pump at S-155A
9	L8 Divide Structure HEC-HMS and HEC-RAS Modeling – Phase 2 Final Report (July 2013; SFWMD)	Modeling of the L-8 Basin and channel hydraulics in L-8 Canal to determine design criteria for proposed G-541 structure	• Includes calibration of L-8 Basin hydrology and hydraulics for Tropical Storm Isaac (August 26-29, 2012) • Uses Soil Moisture Accounting method for hydrology. • Steady-state HEC-RAS analysis for 2,000 cfs and 3,000 cfs design flows • Pre-vs-Post hydraulic analysis of 10-yr, 25-yr and 100-yr design storms
10	Conveyance of Water from C-51 Reservoir to Broward County – DRAFT REPORT.	Modeling analyses using HEC-RAS and MODFLOW for three conveyance	• Assumes only Phase I of C-51 reservoir is constructed (only C-51 West is available for runoff capture), such that only 35 MGD is conveyed as a constant 54 cfs • Uses HEC-RAS to simulate movement in C-51 Canal from reservoir

Item	Report	Scope / Overview	Application to C-51 Reservoir
	(January 2014; SFWMD)	segments: (1) C-51 canal from reservoir to CS-2 pump; (2) the E-1 Canal Segment from CS-2 to CS-14; (3) Hillsboro Canal from CS-14 to L-36 Borrow Canal to C-13 Basin.	to CS-2 pump station • Uses combination of HEC-RAS and LWDD groundwater model to simulate conveyance and seepage rates in E-1 Canal • Uses HEC-RAS model to simulate conveyance of additional 54 cfs in L-36 Borrow Canal • Recommends additional cross-sectional surveys along E-1 Canal being collected • Recommends field test along canal route to verify conveyance findings
11	Palm Beach Aggregates, C-51 Reservoir Phase 1 and C-51 Reservoir Phase 2 (Conceptual) Stormwater Management System Calculations and Plans (February 2014; Federico, Lamb and Associates)	Documentation accompanying ERP application for C-51 Reservoir development	• The current mine operations have zero offsite discharge during 100-yr, 3-day storm • Proposed 138 acre wet retention pond proposed south of mine cell 8 to maintain full onsite retention • OPCC Development
12	Palm Beach Aggregates, LLC C-51 Reservoir Basis of Design Report AMEC, February 2014	Refinements to preliminary design to develop a reservoir embankment design that would meet the requirements of SFWMD and USACE for a low hazard dam as defined in the SFWMD DCM-2 guidelines.	• Engineering analyses of selected reservoir embankment cross sections for stability and seepage performance • Analyses of required freeboard for proposed operating conditions and characterization as a low hazard structure per SFWMD DCM-2. • Reported results represent an approximately 30% level of design completion. Recommendations were provided for advancing the design toward a biddable level with the generation of construction level drawings and specifications • OPCC development.

Item	Report	Scope / Overview	Application to C-51 Reservoir
13	Palm Beach Aggregates, LLC C-51 Reservoir Hydraulic Facilities, Final Design, Construction Drawings, WRS Compass Infrastructure and Environment, February 2014	Construction drawings for hydraulic facilities within the C-51 Reservoir including connections to the L-8 Reservoir	• Final design of hydraulic structures for C-51 reservoir. • Drawings 5-26 of 132 used for OPCC development
14	Palm Beach Aggregates, LLC C-51 Reservoir Hydraulic Facilities, Final Design, Specifications WRS Compass Infrastructure and Environment, February 2014	Specifications for construction of modifications to C-51 reservoir	• Final design of hydraulic structures for C-51 reservoir.
15	Palm Beach Aggregates, LLC C-51 Reservoir Hydraulic Facilities, Final Design, Hydraulic Facilities Design Synopsis, WRS Compass Infrastructure and Environment, February 2014	Summary of design for hydraulic facilities within and between the C-51 Reservoir and the L-8 Reservoir	• Final design of hydraulic structures for C-51 reservoir.
16	Palm Beach Aggregates, LLC, Opinion of Probable Construction Cost, C-51 Reservoir, Burns and McDonnell Engineering Company, September 2011	Engineering estimate of construction cost for development of C-51 Reservoir in three phases	• Reference only for take-offs in OPCC development

Item	Report	Scope / Overview	Application to C-51 Reservoir
17	Palm Beach Aggregates, LLC, Revised Opinion of Probable Construction Cost, C-51 Reservoir, Phase 1,Burns and McDonnell Engineering Company, January 2013	Engineering estimate of construction cost for development of C-51 Reservoir – Phase 1 only.	• Reference only for take-offs in OPCC development

5.0 - Source Water and Conveyance

5.1 Surface Water Availability in L-8 & C-51 Basins

To provide a viable source of water for consumptive use, the proposed reservoir must capture excess water that is available in the wet season and be able to store a sufficient volume to meet the demand in the dry season. In addition to environmental factors, such as seepage and evaporation, the effectiveness of the reservoir is based on three primary factors:

- The volume of water available in the wet season that is not committed to other uses, such as the environment or consumptive use,
- The volume of the storage reservoir, and
- The demand in the dry season.

Because the meteorological conditions vary from year to year, the volume of water available for storage in the wet season and for consumption in the dry season can vary significantly. The inherent variability of the weather complicates any attempt to perform a simple water budget to determine if the proposed water will be able to meet future demands. Currently, the only tools that can provide insight into water availability are computer models that re-create historic conditions to simulate the effect of changes in available water and demand with time. The models described in Section 4.0 - Literature and Data Review, provide the only simulations available to review this type of analysis.

5.1.1 1-in-10 Year Drought Water Balance

In accordance with the SFWMD Basis of Review for Water Use Permits (2012), the annual and the maximum monthly allocations are based on the assumed 1-in-10 year drought condition. Since no monitoring data exists for a reservoir that has not been constructed, the only tool available for providing the necessary technical evaluations for permitting is a hydrologic and hydraulic model of the region.

As described in Section 4.0, there are three primary model types that have been utilized, the LECsR (Simulation Period: 1986 – 2000), the SFWMM (Simulation Period: 1965 – 2005) and HEC-HMS/HEC-RAS (Steady State Simulation Period). The best modeling tool for determining the available source water is the SFWMM because of the regional nature of the model and the longer simulation period that captures more meteorological variability. The most recent documentation for a simulation using SFWMM to represent the C-51 Reservoir is in the Preliminary Design and Cost Estimate Report (PDCER) (Lake Worth Drainage District, et al, 2013, Appendix A).

The PDCER documents the performance of a 75,000 ac-feet C-51 Reservoir (Lake Worth Drainage District, et al, 2013, Appendix A). As noted in Section 4.0, there are several assumptions inherent in the PDCER analysis that are not congruent with the current or anticipated future conditions, including elements of CERP that send water from the L-8 Reservoir to the Loxahatchee River and the back-pumping station at the S-155A structure that would connect the C-51 East and West basins. With respect to consumptive uses, the simulation compares the results of two sets of demand conditions:

- Option 1 - Projected 2060 Demand Reported by Stakeholders

- Option 2 - Projected 2060 Demand from High Population Growth reported by the University of Florida

The PDCER (Lake Worth Drainage District, et al, 2013, Appendix A) states that the proposed C-51 Reservoir would provide 85 MGD or more during the four driest years without exceeding the storage capacity of the reservoir. Since the period simulated is 41 years in length, the performance in the four driest years therefore reflects the 1-in-10 year drought condition. Assuming Option 1 demands, the model indicates that a 75,000 ac-feet reservoir could provide supplemental water during a 1-in-10 year drought without drying out. Since Option 2 demands are greater, the reservoir is unable to store enough water from the wet season to meet all dry-season demands in the driest years. In the simulation of Option 2, the C-51 Reservoir is dry for an extended period in both 1971-1972 and 1989-1990. **Figure 5-1** below are taken from the PDCER and illustrate the C-51 Reservoir performance for both conditions (Lake Worth Drainage District, et al, 2013).

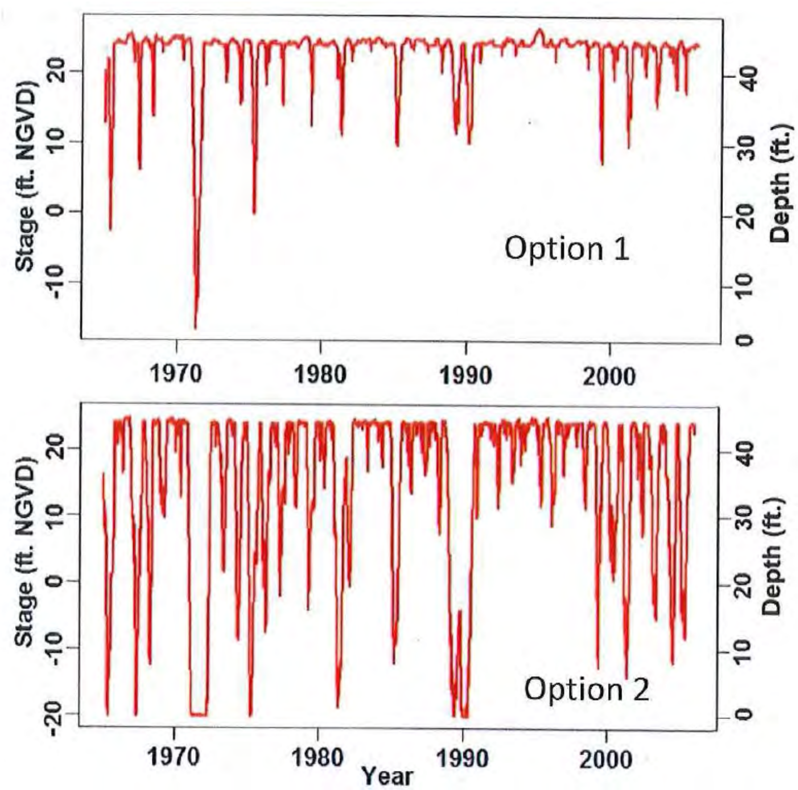

Figure 5-1 – Water levels in the C-51 reservoir simulated by the regional model based on Option 1 and Option 2 water demands (LWDD, 2013)

Although the results of the SFWMM suggest that there is sufficient availability in the four driest years during the study period under the Option 1 assumptions, the analysis in the PDCER is not congruent with the current implementation plan where the full build-out of the proposed C-51 Reservoir is 61,000 ac-feet. This build-out is nearly 20% less storage than what was simulated in the PDCER. In addition, the Restoration Strategies plan modifies the regional water management operations. Due to these differences, there the SFWMM simulation currently available does not re-create the proposed condition.

The SFWMD has developed a spreadsheet that allows for manipulation of the SFWMM results to reflect changes in the regional operations and changes in the volume of the reservoir. This spreadsheet tool is currently being used by Federico, Lamb and Associates to estimate the performance of the latest reservoir configuration and assumptions with respect to drought conditions. When this updated analysis is available, the results will provide additional insight into water availability in the 1-in-10 year drought condition.

5.1.2 1-in-100 Year Drought Water Balance

The longest available period of record simulation for the regional water management system is 41 years, making the 1-in-100 year performance more difficult to infer from the simulation. As with return frequencies for rainfall, it is possible to develop a statistical prediction of a 1-in-100 year recurrence probabilities without 100 years of data; however no estimate of the 1-in-100 year performance has been prepared to date. The current Basis of Review for Consumptive Use Permits does not require an evaluation of impacts for the 1-in-100 year drought condition. During these extreme dry years, severe water shortage cutbacks would be in place which would change the model assumptions with respect to demand.

5.2 Regional System Storage and Deliveries

The delivery of water from the full build-out of the C-51 Reservoir to the utilities has not yet been studied in depth. As noted in Section 4.0, a draft report is available from the SFWMD titled, *Conveyance of Water from C-51 Reservoir to Broward County* (2014, January). This report is a detailed investigation of the hydraulics associated with moving the volume of water available from Phase I of the C-51 Reservoir implementation through the LWDD canals and into Broward County. The Phase I storage volume is assumed to be 17,000 ac-feet and will provide 35 MGD of dry season water supply, which is equivalent to an additional flow rate of 54 cfs. For the Phase 2 full build-out condition, the anticipated additional flow rate will be roughly 194 cfs, which is significantly higher than what has been simulated previously.

The SFWMD will not provide a hydraulic simulation of the conveyance considerations for the Phase 2 full-build out of the reservoir until a permit for Phase 2 of the reservoir is submitted. It is a fair assumption, however, that during a drought condition there will be more available capacity within the conveyance canal network as the canals will be at a lower stage.

5.3 Conveyance Features

The planned conveyance of water from the C-51 Reservoir south is to flow east through the C-51 Canal then south through LWDD's E-1 Canal into Broward County (See **Figure 5-2**).

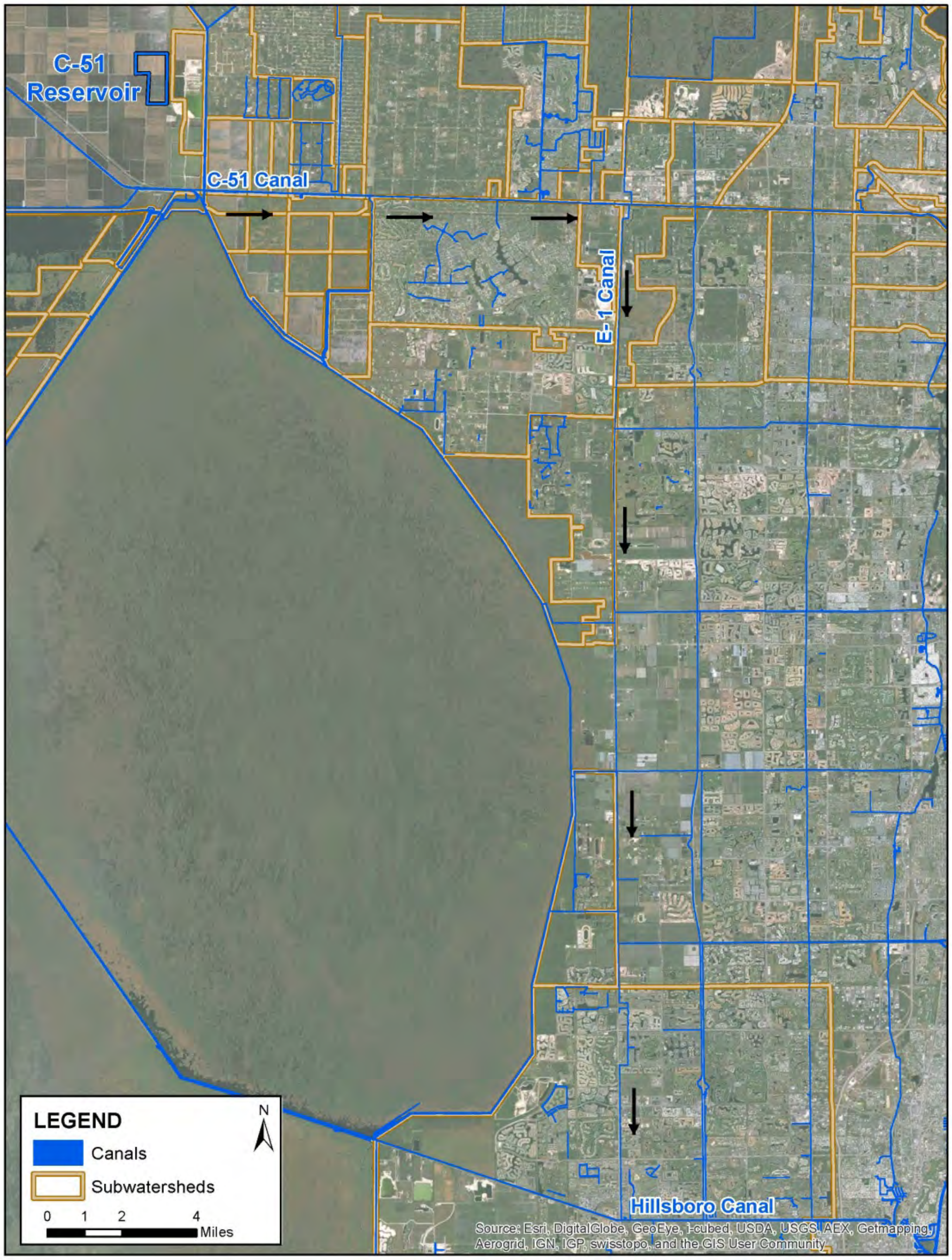

Figure 5-2 – Conveyance from C-51 Reservoir through LWDD to Southern Palm Beach County and Broward County

Water flows north in LWDD's E-1 Canal to the C-51 Canal and then east out to tide. To reverse the flow south, LWDD has identified the need for four pump stations and a series of weirs as shown in **Figure 5-3**.

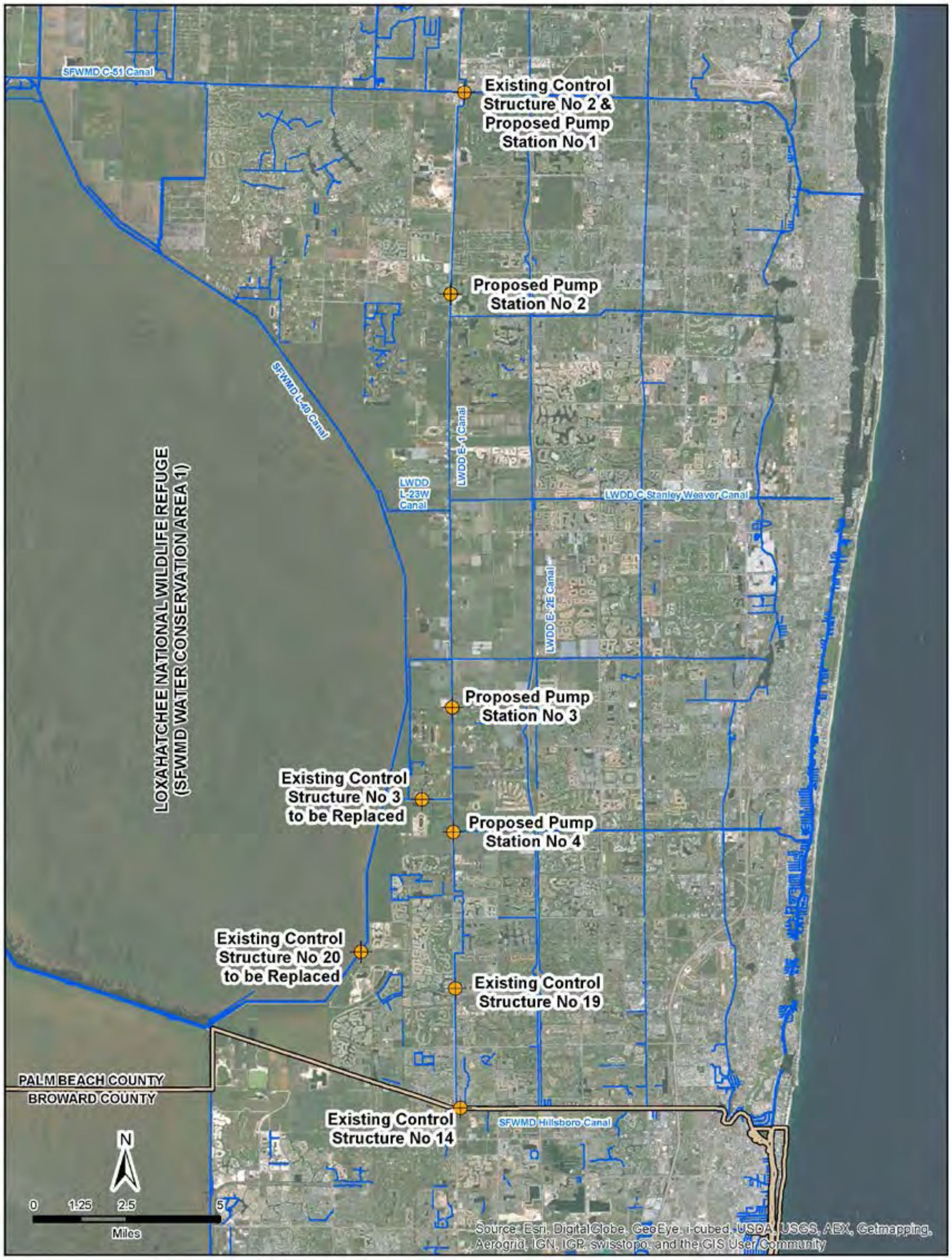

Figure 5-3 – Proposed Structures in LWDD's E-1 Canal to Reverse the Flow from North to South

6.0 - Basis of Design Features

The following sections provide a summary of information contained within the design documents provided to MWH on behalf of Palm Beach Aggregates by AMEC, WRS Compass and Burns and McDonnell. Technical memoranda providing the detailed geotechnical review comments by MWH staff are included as Appendix A. Table 4-1 lists the documents reviewed and the review subjects covered for each. An independent review of the reservoir features outlined in the 30% design documentation was performed as part of this evaluation. MWH utilized the Design Criteria Memorandum developed jointly by the SFWMD, FDEP, and USACE for reservoir dam safety in Florida as the basis for these reviews.

6.1 C-51/L-8 Reservoir Interaction and Operation Scheme Overview

The C-51/L-8 system is intended to receive excess stormwater from the C-51 Canal basin via the L-8 Canal during wet periods and release the water back to the L-8 Canal during dry periods. According to WRS Compass' *Hydraulic Facilities Design Synopsis,* dated March 4, 2014, water will enter the L-8 Reservoir from the L-8 Canal through a proposed 3,000 cfs water control structure (G-538) operated by the SFWMD. Further, the proposed C-51 hydraulic facilities are designed to deliver and return 500 cfs of stored water at one foot of head loss to the C-51 Reservoir from the L-8 Reservoir. This rate conflicts with a previous WRS Compass description (2014, February 12) of the hydraulic facilities included with the ERP application that states a 1,000 cfs flow rate through the water control structure. From both reports, we note that stage levels for both of the reservoirs will vary based on environmental and water supply deliveries. The proposed hydraulic facilities allow for gravity drainage of the C-51 Reservoir, while a proposed 450 cfs pump station will draw down the L-8 Reservoir into the L-8 Canal.

The C-51 Reservoir hydraulic facilities include a nominal 500 cfs, below-grade connection between the existing L-8 Reservoir to the proposed C-51 Reservoir and associated water control structures and spillways to transfer stormwater between the two reservoirs. A future pump station located in L-8 will pump water into C-51 facilitating water storage in C-51 above the L-8 Maximum Water Storage Level of 16.5 ft (all elevations reference the NAVD88 datum).

The hydraulic elements included by WRS Compass as part of the system were the following:

a) L-8 Canal

b) L-8 Reservoir with a surface area of 1,240 acre, with Normal Full Storage Level (NFSL) and Maximum Water Storage Level (MWSL) of 14.5 feet and 16.5 feet, respectively

c) C-51 Reservoir with surface area of 1,740 acre (total Phase 1 and Phase 2), with a NFSL and MWSL of 16.5 feet and 17.7 feet, respectively

d) Two 102-in diameter steel pipes with 1-in thick walls connecting L-8 and C-51 Reservoirs

e) East gated hydraulic structure with two 9x9-foot slide gates to control the flow through the steel pipes. The north slide gate and the steel pipe is referenced as G-59N and the south slide gate and the steel pipe is referenced as G-59S

f) Gated spillway G-538 that inflows water from L-8 Canal to L-8 Reservoir

g) G-59 east inflow/outflow canal and scour apron, that connects the East outlet (L-8 side) of the two steel pipes to L-8 Reservoir

h) G-59 west discharge headwall structure and scour apron, that connects the west outlet (C-51 side) of the two steel pipes to C-51 Reservoir

i) Future Pump Station PS-59 that pumps water from L-8 to C-51 under operation requirements

j) Pumping station G-539 that pumps water from L-8 Reservoir to L-8 Canal

6.2 Reservoir Development Scheme and Phasing Information

The proposed C-51 Reservoir facilities are located on lands that have been or are now used for mining operations. These lands are currently owned by either Palm Beach Aggregates, LLC (PBA), Florida Power and Light, Inc. (FP&L), or the SFWMD. PBA mines the site in rectangular cells as shown on **Figure 6-1**.

Figure 6-1 - Mining Operations in Cell 12 of C-51 Reservoir (photo courtesy of Google©)

Phasing of the project has been in flux and the AMEC and WRS Compass design documents and the ERP application materials currently do not match. The project was originally envisioned as three construction phases as depicted on the construction drawing site maps provided by AMEC and WRS Compass while there are two phases detailed in the ERP application materials. MWH has confirmed with Palm Beach Aggregates that the project has been reconfigured into two phases as shown in the ERP submittal and will be reflected as such in future construction drawing sets. The current two phase approach is depicted in **Figure 6-2**.

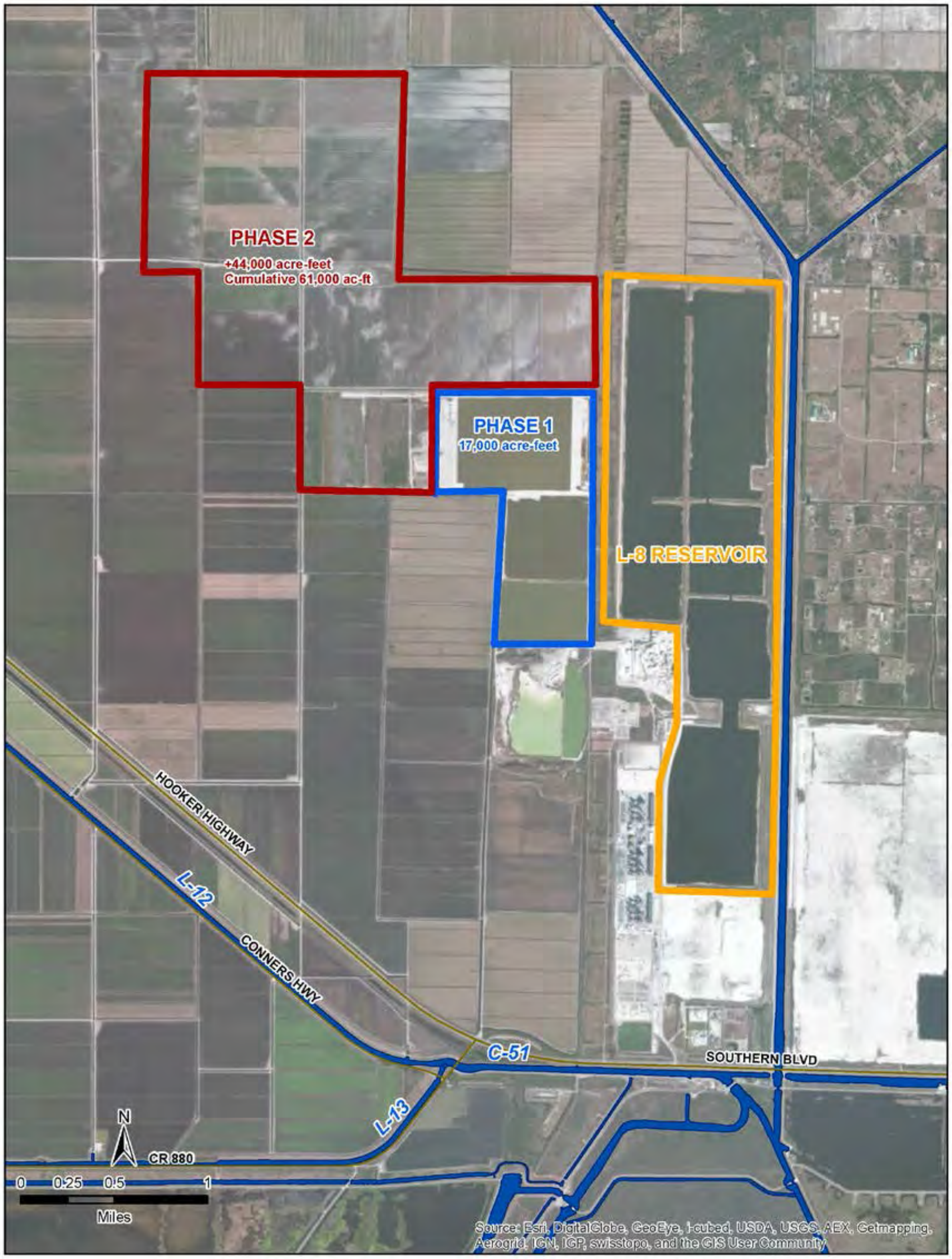

Figure 6-2 - C-51 Reservoir Phasing Plan

6.3 Hydrologic / Hydraulic Design Information

This section summarizes design parameters provided by the designers in the following documents:

- AMEC (2014, February). *C-51 Reservoir, Basis of Design Report*.
- WRS Compass (2014, March 4). *C-51 Reservoir, Hydraulic Facilities Design Synopsis*.
- Grandusky, K. D. (2014, February). *Stormwater Management System Calculations and Plans*.
- WRS Compass (2014, February 28). Final Design Drawings. *C-51 Reservoir Hydraulic Facilities*.

6.3.1 Inflow Design Flood (IDF)

The selected design storm rainfall and wind-speed parameters were based on a low hazard potential classification (HPC) for the C-51 Reservoir. The 72-hour, 100-year rainfall of 14 inches was selected as the design storm. A one-hour wind speed of 60 mph was selected for freeboard design (AMEC, 2014, pg. 16).

6.3.2 Storm Routing for IDF and Rainfall

The normal full storage level (NFSL) for the C-51 Reservoir is at El 16.5 feet (NAVD88). The maximum drawdown level for C-51 Reservoir is at El -20 feet (NAVD88) (WRS Compass, 2014, Mar 4).

With an initial reservoir level at El 16.5 ft (NAVD 88) and a 14 inch rainfall, the maximum water surface level after the 100-year rainfall was at El 17.67 feet. The C-51 Reservoir is designed for zero discharge during the 100-year storm. The C-51 embankment sections are composed of earth embankments with a crest level at El 25.5 feet (NAVD88) and a roller-compacted concrete (RCC) section designated to be a spillway with a crest level at El 23.0 feet (NAVD88). The 100-year storm static water level would be over five feet below the crest of the designated RCC spillway section. The designated RCC spillway section was not designed to function as an overflow spillway as the RCC section crest level was based on overwash criteria as used for non-overflow dam sections.

6.4 Hazard Potential Classification and Dam Breach Studies (DCM-1)

No formal hazard potential classification report of the type described in DCM-1 has been prepared for the C-51 Reservoir (SFWMD, 2005). The only written basis for hazard potential classification is provided in the BODR (AMEC, 2014, pg. 15):

> "With a maximum normal pool elevation of 16.5 feet (NAVD88), the C-51 Reservoir is considered to be a low hazard potential classification (Low HPC) impoundment facility, similar to the adjacent L-8 Reservoir."

MWH was advised by SFWMD that discussions were held between SFWMD and PBA regarding the hazard potential classification for the C-51 Reservoir that resulted in a reduction in maximum water level to achieve a low hazard potential classification. However, no documents have been made available to MWH that provide a basis for a low hazard potential classification for L-8 Reservoir. DCM-1 provides a format for information from which to determine a hazard potential classification, but this type of information has not been made available to MWH. The low hazard potential classification for the C-51 Reservoir cannot be confirmed by MWH.

6.5 Design Flood and Freeboard Review (DCM-2)

AMEC's freeboard calculations were based on the larger Phase 2 configuration of the C-51 Reservoir. The 100-year rainfall and 60 mph wind speed values selected for freeboard design of the C-51 Reservoir correspond to the low hazard potential criteria values provided in Section 2.2.2 of DCM-2 (SFWMD, 2006). MWH performed a check calculation to estimate the freeboard requirements using the manual calculation method in DCM-2 (SFWMD, 2006) based on the Shore Protection Manual (USACE, 1984). During this review, MWH identified an unnecessary adjustment of the 60 mph wind speed (over land) to 72 mph (over water) was made (AMEC, 2014, Table 5). The 60 mph wind speed is already considered to be over water.

6.5.1 Reservoir Set-up and Set Down

Wind setup was calculated to be 0.27 feet based on a 72 mph wind speed (AMEC, 2014, Table 5). Based on the DCM-2 manual calculation referenced above, wind setup would be slightly lower if the 60 mph wind speed was used.

6.5.2 Wave Runup

Wave heights and wave runup were determined by AMEC with the computer models SWAN and ACES. An approximate check of these values by MWH, using the spreadsheet method included in DCM-2, showed reasonable conformance with the 8.9-foot freeboard value determined for the embankment section when an input wind speed of 72 mph was used (AMEC, 2014, Table 6). The approximate spreadsheet method indicated that the embankment freeboard requirement would be over 1.0 foot lower if a 60 mph input wind speed was used.

The AMEC freeboard analysis results show a design freeboard of 6.1 feet for the 2,000 foot-long RCC spillway section, resulting in a design crest level at El 23.0 feet (NAVD88). The concept of applying an overwash limitation design criterion to a spillway section appears to mix design criteria for dams and spillways. Spillways are normally designed for prolonged continuous overflows. MWH believes that a narrower overflow spillway with a lower crest elevation should be considered. This spillway would be designed to overflow during the 100-year storm.

6.6 Spillway and Outlet Works Criteria (DCM-3)

This section reviews design parameters provided by the designers in the following documents:

- WRS Compass (2014, March 4). *C-51 Reservoir Hydraulic Facilities Design Synopsis.*
- WRS Compass (2013, December 10). *Preliminary Drawings. C-51 Hydraulic Facilities.*
- WRS Compass, (2014, February 12). *C-51 Reservoir Project Description of Hydraulic Facilities*.

The C-51 Reservoir project has two hydraulic components—the interconnected control structure to the L-8 Reservoir and the overflow spillway.

The interconnected control structure between the L-8 and C-51 Reservoirs consists of twin 102-inch diameter pipes, a sluice gate on each pipe, and a 225 cfs pumping station. The pipes are designed to pass at least 500 cfs between the reservoirs by gravity under one foot of head differential. The pumping station is arranged to move water from L-8 to C-51 using the same pipes. Flow in the pipes, under gravity flow, is controlled by the sluice gates.

The overflow spillway also connects the two reservoirs via a concrete weir located along the east side of the C-51 Reservoir and a stepped spillway to convey the flow down into the L-8 Reservoir.

6.6.1 Spillway Structural Evaluations

Portions of the overflow spillway intended to handle overflows from the C-51 Reservoir into the L-8 Reservoir were constructed as part of the original L-8 Reservoir. The soil cement steps on the side slopes of the L-8 Reservoir, Cell 4 comprises the downstream limit of the overflow spillway system. To construct the overflow spillway system, a segment of the side slope protection steps will need to be removed and replaced in kind. Design calculations related to the overflow volume from the C-51 to the L-8 Reservoir are not yet available and, therefore, MWH was unable to provide review and comment.

6.6.2 Interconnected Control Structure Outlet Works Sizing and Discharge Capacity

The calculations state that the maximum velocity from the 102-inch pipes at the maximum differential of 36.5 feet is 9 ft/sec at the end of the spillway, but no calculations are shown to confirm this number. At full gate opening, the flow is about 2,750 cfs and the velocity exiting the pipes is about 24 ft/sec; for small gate openings the velocity could be as high as 48 ft/sec. These high velocities could carry well beyond the end of the concrete apron and on to the rip-rap lining. There are no computations shown for the sizing of the rip rap, but the WRS Compass *Hydraulic Facilities Design Synopsis* report states that the rip rap is designed for a velocity of 5.5 ft/sec. This is adequate for normal operation (500 cfs through wide open gates), but will not withstand higher velocities under larger differentials. It is assumed that differential water levels greater than one foot are unusual, but there is no description of the various operating scenarios in the documents available for review.

6.6.3 Rate of Drawdown Analyses

No drawdown calculations were provided, but based on the size of the culverts and the amount of reservoir storage above ground there should be little problem meeting the requirements in DCM-3 (SFWMD, 2006).

6.7 Embankment Dimensions (DCM-4)

The proposed C-51 Reservoir includes earthfill and RCC embankment sections. The earthfill embankments consist of 3H:1V upstream and downstream slopes with a 14-foot wide crest at El 25.5 feet. The embankment upstream slope and crest are protected with a 12-inch thick slab of RCC for erosion protection. The RCC embankment, serving as spillway, has a vertical upstream face, a 1H:1V downstream slope, and a 14-foot wide crest at El 23.0 foot. The downstream foundation of the RCC embankment is protected with a 1- to 2-feet thick RCC slab that connects to a RCC-lined channel.

A number of requirements of the SFWMD's DCM-4 were either unmet or unaddressed when compared to the embankment geometry presented in the AMEC basis of design report (BODR) (2014) and WRS Compass final design drawings (2014):

a) The crest of the embankment is flat but should be sloped to the interior at a 2% grade.

b) The location and details of access ramps, pull outs, turn around areas, and site access roads were not available from the AMEC BODR (2014).

c) The AMEC BODR (2014, pg. 12) indicates that the internal and external corridor may be less than 50-feet wide at some locations, but does not give further details. It is also noted that the WRS Compass final design drawings (2014, Drawing No. C012) show a 10-foot wide internal corridor section at the location of the inlet/outlet structure. The minimum width required is 50 feet and 40 feet from high/significant and low hazard potential impoundments, respectively.

d) The proposed exterior maintenance road width of 14 feet shown in the AMEC BODR (2014, Figures 11 through 13) is less than the minimum required of 16 feet.

e) The exterior maintenance road is located between El 12 feet (NAVD 88) and El 16 feet (NAVD 88) (AMEC, 2014, Figures 11 through 13). Information verifying that these elevations are above the 100-year, 24-hour flood level was not available in the report.

The AMEC BODR (2014, pg. 12) indicates that the deviations from DCM-4 listed under Items c) and d) above, have been accepted by the SFWMD. However, it is recommended to provide SFWMD with plans, sections, and details of the internal and external corridors and perimeter external roads to verify acceptance of any deviation from DCM-4.

6.8 Seepage, Slope Stability, and Settlement Review

The seepage analysis methods and results available in the documents were reviewed. It is recommended to display boundary conditions and permeability values for the different materials on seepage figures to facilitate the evaluation or interpretation of analysis outputs. Below are observations made from the seepage analysis review:

a) The seepage analyses for the RCC dam do not include the boundary condition set by having L-8 Reservoir at maximum normal pool level and C-51 Reservoir empty.

b) The design proposes a slurry wall with the tip at El -30 feet; however, in some of the seepage analysis results, the tip of the slurry cutoff appears to be below El -30 feet (AMEC, 2014, Appendix G) which appears to be a discrepancy

The stability analyses performed on the RCC and earthfill sections presented in the design documents were reviewed. In general, the comments generated from the review suggested additional evaluations would be appropriate for the RCC dam structure, including the following:

a) Coupled stress-deformation analyses performed to verify the stability and integrity of the dam founded on limestone of variable thickness and depth and the impact of the inlet/outlet headwall excavations and narrowing of the internal corridor of the RCC dam to 10 feet as shown in the WRS Compass drawings (2014, Drawing C012).

b) Stability analysis including the tailing water in downstream relief drain for the computation of uplift pressures (AMEC, 2014, Appendix F) and accounting for the accumulation of sediments on the internal corridor by including horizontal silt pressure.

c) Stability sliding analyses for the RCC slab over the upstream slopes of the earthfill embankments using the geocomposite-soil interface friction angle and uplift hydrostatic pressures generated in the underdrainage system.

d) Evaluation of the structurally-controlled failure mechanism for the limestone reservoir wall.

During the review of the settlement analyses for RCC and earthfill embankments, no defined acceptable levels of deformation and differential settlements for RCC embankment were identified. A stress-deformation analysis should be performed and include the site foundation conditions consisting of a limestone "rock cap" (stiffer unit) with variable thickness and depth underlain by sand deposits (softer unit). Also, it seems standardized material properties were used for the limestone in the available settlement analysis. The limestone in South Florida is not typical and material parameters for the limestone on-site should be developed for use in design analyses.

Stress-deformation analysis should be performed to evaluate the connection of the seepage collar wall with the RCC dam and the 12-feet wide soil-bentonite cutoff wall shown in the WRS Compass drawings (2014, Drawings C011 through C013). The wide slurry trench under the RCC structure imposes a high risk of cracking the rigid structure and an alternative solution may need to be developed. Evaluate settlement of the slurry wall to take into account the consolidation of the soil-bentonite backfill material.

Construction joints and measures to control leakage at joints are required for an RCC gravity dam on uniform foundation conditions. Considering the site foundation conditions, a more appropriate design for this structure would likely be an earth dam with an RCC overtopping section to serve as the spillway or a faced symmetrical hardfill dam (constructed with cemented sand and gravel material) to reduce bearing stresses on the foundation and provide a more flexible structure.

6.9 Seepage Barriers, Seepage Collection Systems, and Potential Seepage Losses Resulting from Operating Levels

6.9.1 Review of site investigation data for selection of engineering properties

In general the stratigraphy at the project site consists of the following materials based on the boring logs included in the BODR (AMEC, 2014, Appendices B and C) (from top to bottom):

- Fill comprised of sand, silty and clayey sand, clay and silt with thickness varying typically from 2 feet to 10 feet.
- Fibrous peat with some sand and silts. This material was encountered at local areas. Thickness of this unit varies from less than 1 foot to about 4 feet.
- Overburden comprised of sand, silty and clayey sand, with occasional roots and sand to gravel size shell and limestone fragments. The earthfill embankments will be founded on overburden.

- Poorly cemented calcareous limestone interbedded with deposits of sand, silty sand and clayey sand, with sand to gravel size shell and limestone fragments. Some boring logs report voids in the limestone that may be the result of the dissolution of the limestone (AMEC, 2014, Figure Appendix C1-2 through C1-3). The proposed RCC embankment is founded on the upper limestone layer (“rock cap”). Within the RCC dam footprint, the thickness and top elevation of the “rock cap” varies from 3 feet to 15 feet and from El -5.0 feet to El 5.0 feet NAVD 88, respectively.

The AMEC BODR (2014) includes a description of the exploration, field testing, and laboratory testing completed for the C-51 and L-8 Reservoirs. In general, the field testing programs included borings with Standard Penetration Tests (SPTs) and constant and falling head permeability tests performed in overburden and the underlying sequence of limestone and sand deposits. Laboratory tests included index properties (moisture content, grain size analysis, and organic content) and compaction and triaxial tests on compacted specimens. No in-situ or laboratory testing were available to evaluate strength and deformability properties of the limestone foundation.

In general, the review comments for the AMEC report pertaining to the site investigation data and selection of design parameters for analysis and design of the embankments included the following:

a) A description of geologic structural features of limestone including joints and cavities and their impact of the various structures was not included.

b) No in-situ or laboratory testing data of strength and deformability of limestone was included.

c) No detailed description of the basis used for the selection of permeability, strength, and deformation parameters for the foundation materials was provided.

d) The permeability of the RCC is assumed to be 0.0 ft/day (AMEC, 2014, Table 7). Permeability values of 1.5x10-9 to 1.5x10-7 cm/s reported for well-compacted, workable RCC mixtures by USACE (2000) should be considered for seepage analysis.

e) The permeability for the soil-bentonite cutoff wall used in the seepage analyses should be provided and coordinated with the Technical Construction Specification of the soil-bentonite cutoff wall.

f) No input parameters for the foundation and engineering fill materials used in the transient seepage analysis described in the AMEC BODR (2014, Section 6.4.3) are provided. This information should be included in the design calculation report to document the calculated piezometer levels through the embankments and foundation materials during and immediately after rapid drawdown.

6.9.2 Seepage studies and stability evaluation analyses (for each phase of reservoir life – construction, operation, and drawdown)

The seepage and stability evaluations and analyses presented in the AMEC BODR (2014) were reviewed. The analyses scenarios should include each phase of reservoir life (construction, operation, and drawdown) as well as address project specific features. The following comments pertain to documentation and selection of loading cases for seepage, stability, and settlement analyses:

a) The selection of the loading cases for seepage, slope stability, and settlement analysis should be supported with a detailed description of the operation of the C-51 and L-8 Reservoirs. This information, including reservoir operating drawdown rates, should be part of the BODR (AMEC, 2014), and should be used to verify that all controlling loading conditions associated with the reservoir operation are being analyzed.

b) Seepage analyses with pool level at the spillway crest, El 23 feet (NAVD88), should be included to evaluate impacts on the design for this extreme condition.

c) Slope stability analysis for earthfill dams should be performed for during-construction (considering load of equipment and materials for construction of the slurry wall), end-of-construction, long-term, maximum surcharge pool, and rapid drawdown conditions in accordance with USACE EM 1110-2-1902 (2003). Pseudo-static analysis should also be included.

d) Loading case selection should take into account the above-grade impoundment of stored water. The maximum normal pool level at El 16.5 feet (NAVD88) is above the foundation level of the earthfill embankment.

e) Stability of RCC embankment section should be performed in accordance with the USACE EM 1110-2-2200, *Gravity Dam Design* (1995). This document identifies seven loading conditions that cover end-of-construction and several service loading cases (i.e. usual, unusual and extreme). If specific loading conditions do not apply to the C-51 Reservoir, the stability calculation should document and justify the deviation from the design guideline.

6.9.3 Exit gradient evaluations

The evaluation of exit hydraulic gradients presented in the AMEC BODR (2014) was reviewed and hydraulic gradient output results from SEEP/W software were not found. A detailed verification of seepage hydraulic gradients in the overburden (sand) foundation below the downstream slopes of the earthfill dam and at the overburden slope toe (along the perimeter drainage ditch) should be performed.

The BODR includes safety factors for exit gradients by assuming a critical gradient of 1.0 (AMEC, 2014). For the evaluation of the potential internal erosion of foundation materials and embankment fills, it should be considered that critical hydraulic gradients for internal erosion are often significantly lower than 1.0 (that is typically associated with heave, blowout, quick-condition, liquefaction, and boiling of sand). The critical hydraulic gradient to initiate internal erosion in coarser to medium sand is generally in the order of 0.3 and less (Perzlmaier et al., 2007; Wan et al., 2008).

6.9.4 Seepage barrier design

The primary seepage barrier shown in the design documents is a soil-bentonite cutoff wall within and beneath the embankment. A review of the AMEC BODR (2014) and the WRS Compass final design drawings (2014) generated the following comments:

a) Design measures to maintain the seepage protection in the earthfill embankment, as the embankment and soil-bentonite slurry settles, should be detailed.

b) Provisions to prevent the formation of a gap at the contact of the soil-bentonite cutoff wall and the RCC dam were not provided. Also, taking into account that the elevation of the top of the rock varies, design measures to ensure complete filling of the slurry trench with low permeability fill along the RCC foundation were not included.

c) Technical Specification Section 02260, 3.03.H (AMEC, 2014) requires that upon completion of the slurry trench, it is to be immediately capped with fill material with minimum thickness of two feet and extending up to two feet beyond the outside edge of the slurry trench. A layer of geotextile is specified to be installed prior to placing the cap material. It is assumed this is a temporary capping (to be removed before construction of RCC) for the 12-foot wide and 48-foot long slurry wall shown in the WRS final design drawings (2014, Drawings C011 through C013) but the temporary nature of this geotextile should be specified. The properties of the geotextile are not included. This requirement and the stability of the cap for the 12-foot span of the slurry wall should be verified.

6.9.5 Seepage collection system design

The seepage collection system design presented in the AMEC BODR (2014) was reviewed and the following comments generated:

a) A method for accessing and cleaning the perforated drainage piping located under the spillway splash pad and along the earthfill embankment toe should be discussed.

b) The filter/transition materials for the drainage trench under the spillway splash pad require more detail.

c) A perforated pipe with drain aggregate material wrapped with non-woven geotextile is proposed under and along the downstream toe of the earthfill dam. Geotextile is susceptible to installation damage and may clog over time. Consider eliminating the pipe and geotextile and lower the drain blanket into the overburden.

d) A coarse aggregate is specified for the drain blanket. Much of the foundation material is sand and will require a soil filter to prevent migration of the sand into the gravel. The final design should include detailed filter analysis, and filter fabric should not be used in areas that would not be readily accessible in the future if repairs are required.

6.9.6 Potential Seepage Loses Resulting from Operating Levels

For the proposed RCC dam there is a high potential of leakage for reservoir water levels above the foundation level of the RCC dam, as noted below:

a) Given the variable foundation conditions for the RCC dam, as described in previous sections, there is a risk of inducing differential settlements that could crack and impair the water tightness of the dam.

b) Soil-bentonite slurry will settle over time due to consolidation, thus, the soil-bentonite backfill will detach from the base of the RCC dam.

For the proposed earthfill dam there is a high potential of leakage for reservoir water levels near the maximum normal pool level and above, as noted below:

a) The proposed top of the soil-bentonite cutoff wall is right at the maximum normal pool level (El 16.5 feet NAVD88). The cutoff wall should have an overbuilt to accommodate the long-term settlements of the soil-bentonite slurry that will take place during the service life of the facility. The cutoff wall should also be designed to control seepage for reservoir water level at El 17.7 feet NAVD88 (maximum normal pool level + 100-year rainfall (14 inches)).

b) There is a risk of leakage if the top of the cutoff wall is set below RCC spillway crest located at El 23 feet NAVD88.

6.10 Review of Proposed Embankment Penetrations

6.10.1 Review of filter design to prevent piping at soil-structure interface

Design details of the connection between the cutoff wall, within the earthfill dam, and with the RCC dam were not found in the documents provided. It is recommended to implement measures to enhance the water tightness of this connection, including widening of the slurry wall at the contact with the spillway structure and shaping of the spillway side walls with 1H:8V slopes to allow the compression of the slurry backfill against the spillway side walls as the slurry consolidates.

Design calculations for the 102-inch diameter steel conduits were not available at the time of the review. The same level of documentation on loading cases required for the embankments and detailed descriptions of external and internal loads should be included in the design of the steel conduits to verify that the controlling internal and external loads are being analyzed.

Details of the type of pipe connections should also be included. The pipe connections and conduits should remain watertight under the operating internal pressures.

6.10.2 Review of settlement

There were several settlement concerns identified from the review of the WRS final design drawings (2014). Welded to the 102-inch conduits are two-sheet pile seepage collars extending into the RCC Dam fill (WRS Compass, 2014, Drawing C012). Placement, compaction, and self-weight of the RCC fill will transfer load to the sheet pile walls and, subsequently, to the 102-inch conduits creating a loading condition that will induce concentrated stress and differential settlements in the conduits. Detailed evaluations and calculations should be included in the design, verifying that the integrity of the conduits is not compromised.

The connection of the seepage collar to the RCC Dam includes a 12-ft wide trench filled with bentonite slurry under the RCC dam (WRS Compass, 2014, Drawings C011 through C013). Stress-deformation analyses discussed previously should include an evaluation of this connection. There is a high risk of cracking the RCC dam due to differential settlement induced in the RCC structure given the lack of bearing capacity of the wide, soft slurry trench and variability of the subsurface which requires details for transverse cracks and construction joints in the RCC section.

In addition, a limestone strata ranging in depth from 2 to 36-feet deep is indicated beneath the RCC section of the embankment. The variable foundation conditions, along with normal stress distribution within a concrete dam, also require stress analysis for design. Construction joints are required for an RCC gravity dam on uniform foundation conditions, and measures to control leakage at joints is required. A more appropriate design for this structure would likely be an earth dam with an RCC overtopping section to serve as the spillway

6.10.3 Review of constructability and operability

From the review of the design documents, there is a concern for constructability of the inlet/outlet conduits. Placement of the proposed 12-foot wide slurry wall at the connection of the seepage collar of the 102-inch inlet/outlet conduits with the RCC dam should be re-evaluated. Placing fill over the slurry trench would need to be performed after consolidation of the slurry takes place. Otherwise, the stability and integrity of RCC or hardfill structures placed over this wide, soft slurry trench will be compromised.

6.11 Review of Slope Protection Design

As previously described, the embankment consists of an earthfill section with a 12-inch layer of RCC slope protection and a RCC section functioning as a spillway. The slope protection design is included in the AMEC 30% construction drawing set (2012), the AMEC BODR (2014), and the WRS Compass RCC for Hydraulic Structures (2014, Section 02520). The comments and questions generated from the review included the following:

a) The installation of a geocomposite drain beneath the RCC slope protection can be difficult due to its stiffness and the thin layer is prone to reductions in capacity or blinding by the compacted RCC. It is recommended that a drawdown stability analyses of the section be performed, assuming no drain layer and achieving a minimum safety factor of 1.0. Test sections should also be required to confirm appropriate construction techniques.

b) A more thorough definition and testing of the aggregate proposed for the RCC should be included in the construction documents. The WRS Compass and AMEC documents conflict on the aggregate properties required.

c) Concerns exist for the construction methods employed and constructability of an RCC layer on a 2H:1V slope. It is unlikely that the required compaction can be achieved if not placed in horizontal lifts.

d) RCC thickness, compaction requirements, and mix design are covered generally but should be specifically addressed and consider the different configurations in which it is being applied (e.g. varying slopes, horizontal vs. vertical lifts, types of equipment use for installation, etc.). If these items are left for the design-builder to further develop, the specifications need more specific performance criteria, and conditions to be analyzed need to be provided.

e) The location and extent of the RCC are not consistent between the construction drawings and the specifications.

f) More specific details are recommended for RCC mixing, mill selection, measurement, compaction equipment, placement control, and material testing for the specifications.

Additional details are presented in the Technical Memorandums included in Appendix A.

6.12 Design Observations

Upon review of the preliminary design documentation with the DCMs, the following observations were made during the design review that may impact the design and cost of the project. It is recommended that the design engineers for the C-51 Reservoir project review and incorporate as appropriate. These observations are included herein for information and were not addressed or included in the Opinion of Probable Construction Costs that follow in Section 7.

a) Stability and seepage control performance of the RCC embankment is a concern in the proposed design. The design proposes a RCC dam founded on a limestone “rock cap” (stiffer unit) with variable thickness and depth that is underlain by sand deposits (softer unit) (AMEC, 2014, Figure 4 and Figures 7 through 9). This foundation condition imposes a high risk of inducing differential settlements that could crack the RCC dam. Additionally, given the shape of the structure (with vertical upstream face), the high concentration of stress at the dam toe could overstress the foundation. The RCC dam may punch through foundation areas with a thin “rock cap,” or the thin “rock cap” could fail in either buckling or bending. A faced symmetrical hardfill dam, constructed with cemented sand and gravel material, should be considered to reduce bearing stresses on the foundation and to provide a more flexible structure.

b) Since borings only provide very punctual information, the exact location of the top of the limestone is unknown between borings. Thus, it is recommended to reword/remove note 3 of Document #2 (AMEC, 2014, Drawing G003) that could lead to contract claims. Pertinent borings should be included in the contract package as part of a Geotechnical Data Report and Geotechnical Baseline Report.

c) Revisit the rip rap sizing at the outlet works under higher velocity conditions (e.g. greater than one foot water differentials).

d) Revisit the wind speed used (72 mph over water vs. 60 mph over water) and the impact on wind setup, wave runup, and ultimately required freeboard height. Potentially the freeboard and corresponding embankment height can be reduced by over 1.0 foot.

e) Revisit the overflow spillway design based on an overflow during a 100-year storm. Potentially the spillway can be lowered and the width decreased.

The following items are recommended to be closely coordinated between AMEC and WRS Compass:

a) Design of the connections of the seepage collar at the C-51 Reservoir by WRS Compass with the embankment and soil-bentonite cutoff wall by AMEC (2014, Drawing C011).

b) Design of the excavation in the C-51 Reservoir for the construction of the inlet/outlet headwall by WRS Compass, and design of the adjacent foundation and perimeter embankment by AMEC. The excavation for the headwall structure is locally encroaching in the embankment internal corridor. The excavation is within less than 30 ft from the RCC embankment proposed by AMEC (2014, Drawing No. C012).

c) Quality control by the engineer is referenced to specification section 02381, which was not included. The QC program, or QA/QC if this is a design-build, needs to be detailed to ensure the design requirements are met.

7.0 - Opinion of Probable Construction Cost

7.1 Estimating Methodology

The project design is still underway with different levels of completion by feature. Palm Beach Aggregates reports the status of the civil and mechanical portions of the project completed by WRS Compass to be 100% complete. The interior of the reservoir being designed by AMEC is currently under design and is likely between 60 and 100 % complete at this time. Additional information for the remaining project features has been provided by AMEC in their Basis of Design Report (BODR) which represents approximately 30% completion. After review of this information, MWH believes the concepts presented are sufficiently detailed to permit a Class 4 Opinion of Probable Construction Cost (OPCC) estimate pursuant to the scope of work. Expected accuracy ranges are from -15% to -30% on the low side and +20% to 50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

MWH prepared this estimate in accordance with AACE International and SFWMD's DCM-7. The take-offs and resulting OPCC were developed using the documents as outlined in Table 4-1. MWH provided rates for labor, equipment, and crews. Estimates are represented in 2014 US dollars with no escalation. As the project is envisioned to occur over many years, costs will need to be escalated as appropriate. Unit rates are provided in Appendix C.

7.2 Estimating Assumptions

The following assumptions were used to develop the OPCC.

a) The site is NOT a green field site, but rather fully mined

b) No work will disturb existing wetlands

c) Cost allocated to PBA and NOT considered a direct cost to the reservoir includes, mining Phase I rock (Cells 9, 10 and 11), stockpiling rock and overburden, site mitigation, stormwater management off the reservoir site, and mine related permitting

d) The twin 102-inch pipes and appurtenances associated with the reservoirs Interconnect Control Structure will be installed while the L-8 Reservoir is dewatered during construction of the L-8 Pump Station. If not the case, the cofferdam and dewatering needs will need to be evaluated likely increasing the costs.

e) Cells 9, 10, & 11 will require dewatering for bottom and side wall earthwork.

f) All embankment fill can be obtained from PBA on-site materials

g) Clay bentonite will be purchased and trucked to the site

h) Concrete will be purchased and trucked to the site

i) Based on the mining operations completed for Cells 9, 10 and 11, 1 foot of material from the bottom of each cell is needed to obtain a smooth contour. This excavation will be necessary to prepare the cells for use as a reservoir.

j) Side slopes will require minor slope preparation. Assume mining will leave side walls within the overburden soils at 2H:1V. Site preparation will require reducing that slope angle to 3H:1V.

k) Rock excavation from the rock bench (at elevations between +5 to +2 NAVD88) to the base of the cell are assumed to be vertical.

l) Base of excavation in the cells is per the ERP permit at -20 feet NAVD88.

m) Bottom material will require removal by drilling and blasting. The excavated material will be hauled to onsite stockpiles. All rock material is processed onsite.

n) A conveyor is located on the north boundary of Cells 11 and 12. The conveyor cannot move due to long-term mine operations. The berm to be constructed on that boundary (Section D) will require installation of sheet piles and two phases of embankment construction to accommodate the conveyor location prior to removal. The sheet piles are assumed to be removed when excavation in Phase 2 is complete and the conveyor is removed.

7.3 Project Features

7.3.1 Phase 1

The capital cost of the C-51 Reservoir Phase 1 and ancillary facilities are comprised of the following:

a) Work and materials including dewatering, required to dress the mined acreage (cells 9, 10 &11) by removing remnant material left on the bottom of the pit following rock mining activities and dressing the side wall to a stable repose.

b) Work and materials required to install bentonite clay seepage barriers per design

c) Work and materials to build embankments per design

d) Work and materials to armor embankments per design

e) Work and materials to install twin 102-inch pipes and ancillary seepage barriers, control structures, and jockey pump system that hydraulically connects the C-51 and L-8 Reservoirs.

f) Work and materials to install armored overflow spillway per design

g) Work to install seepage collection system and collection swale at the toe of the embankment

h) Work to install drainage ditch to route seepage and stormwater runoff to the stormwater containment pond.

i) Work to construct stormwater catchment pond

j) Planning, surveys, design, geotechnical investigations, and analysis and permitting (beyond that required to characterize & mine Phase I)

k) Cost to install cofferdam within L-8 Reservoir to a depth of -40ft NAVD88, sufficient to install the twin 102-inch pipes that tie the L-8 to the C-51 Reservoir (Interconnected Control Structure).

7.3.2 Project Features

The capital cost of the C-51 Reservoir Phase 2 and ancillary facilities are comprised of the following:

a) Work and materials including dewatering, required to dress the mined acreage by removing remnant material left on the bottom of the pit following rock mining activities and dressing the side wall to a stable repose.

b) Work and materials required to install bentonite clay seepage barriers per design

c) Work and materials to build embankments per design

d) Work and materials to armor embankments per design

e) Work and materials to install armored overflow spillway per design

f) Work to install seepage collection system and collection swale at the toe or the embankment

g) Work to expand stormwater catchment pond to accommodate Phase 2 runoff.

h) Planning, surveys, design, geotechnical investigations, and analysis and permitting (beyond that required to characterize & mine Phase 2)

i) Cost to excavate cells 12,13,14,16,18 to a depth of -20 ft NAVD88

j) Cost to stockpile material.

k) Supplemental costs for site mining have been provided for Phase 2, but are not included as part of the OPCC.

7.4 Summary of Capital Costs

Table 7-1 provides the OPCC for Phase 1 and **Table 7-2** provides the OPCC for Phase 2 of the reservoir project. Table 7-2 also includes an analysis of supplemental costs to mine the site from a greenfield condition and the resulting value of the aggregate. These supplemental costs are not included as part of the OPCC, but instead for information should users of the Phase 2 reservoir require its development in advance of the aggregate demand.

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Table 7-1- C - 51 Reservoir OPCC Phase 1

Currency: USD-United States April - 2014 Dollars

Item	Description	Quantity	UOM	Unit Price	Total Price	Comments
	Grand Total Price:				$ 127,071,738	
	Phase 1 Supplemental Costs					
1	Costs of mining basins 9,10,11 to -20 feet by PBA	1	LS	by others	$0	
2	Haul & stockpile by PBA	1	LS	by others	$0	
	Phase 1 Direct Costs					
	Misc. Roads, Haul Roads, Erosion control and Fencing					
1	Remove fencing	600	LF	$10.00	$6,000	
2	Install construction fencing	1,600	LF	$21.00	$33,600	
3	Install Temporary fencing	500	LF	$21.00	$10,500	
4	Grade existing Roads	1	LS	$24,000.00	$24,000	20hr at $1200 per hour
5	Improve, widen some haul roads	7,000	LF	$4.60	$32,200	Remove peat, 800cy of road base, grade
6	Grading, ditches etc. Erosion control	19,561	LF	$2.25	$44,012	Labor crew, small backhoe, $1.00/LF material
7	Silt fence type lll	7,000	LF	$2.00	$14,000	$1.45/LF material
8	Silt fence type lV	11,500	LF	$2.60	$29,900	$2.00/LF material
9	Maintain Erosion control	24	mo.	$2,250.00	$54,000	
10	Remove construction fencing and grade site	1	LS	$20,000.00	$20,000	
11	Temporary Floating Turbidity Barrier	1,000	LF	$70.00	$70,000	
12	Clean-out cross channel in cells	1	LS	$20,000.00	$20,000	
	Total				**$358,212**	
	Embankment section A, C, D					
1	Earth Embankment areas remove peat	117,388	cy	$5.22	$612,765	Load and haul to stockpile
2	Earth Embankment areas remove sand above clay/sand	403,529	cy	$5.22	$2,106,421	Load and haul to stockpile
3	Earth Embankment areas remove clay/sand areas	263,654	cy	$5.22	$1,376,274	Load and haul to stockpile
4	Install grade beams basin 9,10 for soil bentonite wall	14,981	LF	$182.00	$2,726,542	
5	Install basin soil bentonite wall	63,808	cy	$135.00	$8,614,080	
6	Dewater basin 9,10 and 11 rent pumps and buy pipe	2	sets	$10,000.00	$20,000	Rent 8-inch pump, buy suction, pipe, etc.
7	Set-up the dewatering system cell 9/10	1	LS	$8,000.00	$8,000	
8	Dewater basin 9/10	460	HR	$30.00	$13,800	
9	Set-up the dewatering system cell 11	1	LS	$8,000.00	$8,000	
10	Dewater basin 11	530	HR	$30.00	$15,900	
11	Maintain basins dewatered	12	mo.	$4,750.00	$57,000	Maintenance crew 37.5hr per month, 40hr pump oper.
12	Remove sandy/shell material basin 9,10 bottom 2ft to 7ft	929,300	cy	$8.71	$8,094,203	Drill, shoot, load and haul to stockpile
13	Remove sandy/shell material basin 11 bottom 2ft to 7ft	1,070,700	cy	$8.71	$9,325,797	Drill, shoot, load and haul to stockpile
14	Excavate basin 9,10 side slopes to 3 on 1.	252,636	cy	$10.83	$2,736,048	Drill, shoot, load and haul to embankment
15	Excavate basin 11 side slopes to 3 on 1.	268,620	cy	$10.83	$2,909,155	Drill, shoot, load and haul to embankment
16	Earth Embankment toe concrete foundation	2,774	cy	$295.00	$818,330	
17	Earth Embankment compacted fill A, C, D from 3 to1 ex	521,000	cy	$1.10	$573,100	from 3 to 1 excavation in cell sides
18	Earth Embankment compacted fill A, C, D buy	110,421	cy	$24.10	$2,661,146	buy from PBA
19	Earth Embankment U/S toe 6" inch PVC outlet pipe	60	ea.	$30.00	$1,800	
20	Earth Embankment U/S toe 6" inch PVC slotted pipe	14,981	LF	$5.00	$74,905	
21	Earth Embankment geocomposite drainage layer	1,105,597	SF	$1.25	$1,381,996	
22	Earth Embankment U/S 12" RCC facing	44,277	cy	$65.52	$2,901,029	Make RCC on site $60.52, place $5.00
23	Earth Embankment D/S blanket drain	21,084	cy	$32.10	$676,796	
24	Earth Embankment D/S toe 6" inch PVC outlet pipe	15	ea.	$70.00	$1,050	
25	Earth Embankment D/S toe 6" inch PVC slotted pipe	14,981	LF	$10.00	$149,810	
26	Earth Embankment D/S Toe road	8,878	cy	$24.10	$213,960	
27	Earth Embankment turnouts	8	ea.	$8,000.00	$64,000	
28	Earth Embankment access roads	2	ea.	$6,000.00	$12,000	
	Total				**$48,153,908**	
	RCC Spillway section B					
1	Remove peat spillway areas	16,259	cy	$5.22	$84,872	Load and haul to stockpile
2	Remove sand and clay/sand above rock spillway areas	171,651	cy	$5.22	$896,018	Load and haul to stockpile
3	Install grade beams RCC spillway for soil bentonite wall	4,580	LF	$182.00	$833,560	
4	Install RCC spillway soil bentonite wall	12,722	cy	$135.00	$1,717,470	
5	Buy Forms U/S Face RCC spillway	5,750	SF	$35.00	$201,250	
6	Set & Strip Forms U/S Face	105,340	SF	$3.62	$381,331	
7	Install RCC spillway concrete	93,296	cy	$63.03	$5,880,447	Make RCC on site $60.52cy, place $2.50cy
8	Trim with hoe D/S Face of RCC spillway	151,140	SF	$1.00	$151,140	
9	Install compacted earth fill spillway area	36,640	cy	$24.10	$883,024	
10	Install relief drain and pipe	4,580	LF	$5.00	$22,900	
11	Install energy dissipation RCC concrete slab	3,732	cy	$63.03	$235,228	
12	Install 12" RCC splash pad	9,160	cy	$63.03	$577,355	
13	Install 12" road base	1,696	cy	$24.10	$40,874	
	Total				**$11,905,468**	
	Twin 102-inch Pipes					
1	Basin 11 platform, stilling well, staff gauge	1	LS	$5,000.00	$5,000	
2	West spillway Riprap apron scour protection (E)	2,132	cy	$46.10	$98,285	
3	West spillway geotextile fabric	19,508	SF	$1.25	$24,385	
4	West spillway 6" bedding stone	418	cy	$24.10	$10,074	Buy at $18/cy plus haul and place
5	West spillway excavate for wing walls and Headwall	400	cy	$5.79	$2,316	
6	West spillway concrete wing walls and Headwall	597	cy	$800.00	$477,600	
7	West spillway backfill wing walls and Headwall	100	cy	$2.50	$250	
8	East spillway Riprap apron scour protection (A) underwater	4,182	cy	$70.00	$292,740	Buy at $50/cy plus haul and place
9	East spillway geotextile fabric under water work	52,440	SF	$2.50	$131,100	
10	East spillway 6" bedding stone underwater work	1,249	cy	$35.00	$43,715	
11	East channel wing walls in cofferdam	538	cy	$850.00	$457,300	
12	East channel Riprap (A) In cofferdam	215	cy	$46.10	$9,912	
13	East channel 9" bedding stone in cofferdam	23,456	SF	$24.10	$565,290	Buy at $18/cy plus haul and place
14	East TBM Tunneling launch pit 40ft by 30ft by 36ft deep	5,040	SF	$30.00	$151,200	
15	West TBM extraction pit, add ex. 27ft by 40ft by 4ft deep	160	cy	$10.00	$1,600	
16	Buy Permalok 102" x 1" pipe	1,650	LF	$900.00	$1,485,000	
17	Install the 102" x 1" pipe and grout	1,470	LF	$590.00	$867,300	
18	Remove TBM launch and extraction Pits	1	LS	$2,500.00	$2,500	
19	Install pipe cathode protection system	1	LS	$3,000.00	$3,000	
20	Install sheet pile bentonite cut-off wall pit	3,224	SF	$30.00	$96,720	
21	Install steel pipe collars 105" +/-	2	ea.	$4,000.00	$8,000	
22	Install bentonite material in cut-off pit	220	cy	$110.00	$24,200	
	Total				**$4,757,486**	
	Inflow/outflow control structure					
1	Cofferdam sheet pile 600ft by 333ft by 47ft	87,702	SF	$30.00	$2,631,060	Use PZ27 with a top soil anchor tie
2	Tie - backs soil and rock anchors	385	ea.	$1,100.00	$423,500	

Table 7-1- C - 51 Reservoir OPCC Phase 1

Currency: USD-United States April - 2014 Dollars

3	Move over East Haul road	1	LS	$8,000.00	$8,000	
4	Remove cofferdam	87,702	sf	$20.00	$1,754,040	
5	Rebuild East Haul Road	1	LS	$10,000.00	$10,000	
6	Demo existing concrete	1,300	cy	$200.00	$260,000	
7	Excavate for control structure and channel	15,800	cy	$6.00	$94,800	
8	Backfill around control structure and wing walls	7,000	cy	$3.00	$21,000	
9	East channel geotextile fabric	16,482	SF	$1.25	$20,603	
10	East channel 6" bedding stone	305	cy	$24.10	$7,351	Buy at $18/cy plus haul and place
11	East channel 18" riprap	920	cy	$50.00	$46,000	
12	Control structure concrete slabs	228	cy	$200.00	$45,600	
13	Control structure concrete walls	897	cy	$400.00	$358,800	
14	Control structure Rebar	106	ton	$2,000.00	$212,000	
15	Install 102" pipe - jacking pit to control structure	180	LF	$60.00	$10,800	
16	Buy and install access steel ladders	18	LF	$250.00	$4,500	
17	Buy and install handrails	184	LF	$75.00	$13,800	
18	Bulletproof Door	1	ea.	$1,000.00	$1,000	
19	Vent system	1	LS	$500.00	$500	
20	Bollards	7	ea.	$150.00	$1,050	
21	Welded Bar Grating 5 gratings for a total of 522SF	522	SF	$175.00	$91,350	
22	Stop logs	4	ea.	$20,100.00	$80,400	
23	control structure electrical and instrumentation	1	LS	$20,000.00	$20,000	
	Total				**$6,116,153**	
	Storm water Catchment Pond					
1	Grade and level bottom 138 AC	601,128	SF	$0.25	$150,282	
2	Embankment 6 ft +/-	3,600	LF	$42.00	$151,200	Material from stockpile
3	Install grade beams for soil bentonite wall	4,600	LF	$182.00	$837,200	
4	Install soil bentonite wall	5,120	cy	$100.00	$512,000	
5	RCC spillway	1,000	LF	$1,590.00	$1,590,000	Make RCC on site $60.52cy, place $2.50cy
6	36-inch HDP 2 lines	4,000	LF	$260.00	$1,040,000	
	Total				**$4,280,682**	
	Total Direct Costs				**$75,571,909**	
	Project Site Indirect Costs					
	Project Management			3%	**2,267,157**	
	Safety			1%	**755,719**	
	Administration, Office, Shops etc.			5%	**3,778,595**	
	Construction Equipment Plant Costs			1%	**755,719**	
				Sub Total Indirects:	**7,557,191**	
			Sub Total Directs + Indirects:		**$83,129,100**	
	Markups					
	Prime Contractor OH&P on Subs	20 million		5.0%	**$1,000,000**	
	Prime Contractor OH&P on Self-Perform	75 million		10.0%	**$7,500,000**	
	Prime Contractor Home office costs	105 million		5.0%	**$5,250,000**	
	Contractor Insurance Program	110 million		2.5%	**$2,493,873**	Performance/Payments Bonds, Gel Liability, & Bldr's Risk
	State Sales Taxes	36 million		6.0%	**$2,160,000**	Sales Tax on 40%
	Escalation			0.0%	**$0**	Excluded
	Estimating Accuracy Contingency	105 million		5.0%	**$5,250,000**	
				Sub Total Markups:	**$23,653,873**	
			Total Estimated Capital Costs:		**$106,782,973**	Total Estimated Construction Costs w/o Contingency
	Project Administration & Management					
	Construction Oversight & Management			0.0%		Captured in economic evaluations presented in Section 8.0
	Engineering			0.0%		Captured in economic evaluations presented in Section 8.0
	Engineering During Construction			0.0%		Captured in economic evaluations presented in Section 8.0
	Misc. Owner's Soft Costs (All)			0.0%		Captured in economic evaluations presented in Section 8.0
	Land Acquisition			0.0%		Captured in economic evaluations presented in Section 8.0
	Scope Contingency On Civil			15.0%	**$16,017,446**	Quantity Growth & Scope Growth on civil work+
	Scope Contingency On Equipment			0.0%		
	Interest During Construction			0.0%		Captured in economic evaluations presented in Section 8.0
	Owner's Construction Contingency/Management Reserve			4.0%	**$4,271,319**	Excluded, allowance for changed field conditions
		Sub Total Project Administrative Expenses:			**$20,288,765**	
					$ 127,071,738	Total Estimated Construction Costs w/ Contingency
			Cost Range:	**$ 108,010,977**	**$ 158,839,673**	Per AACE cost estimate guidelines

Notes:

1) This OPCC is classified as a Class 4 cost estimate per AACE guidelines. Stated accuracy range = -15% to + 25%.
2) Pricing basis = escalation to midpoint of construction is not included.
3) Pricing assumes competitive market conditions at time of tender (+3 bidders/trade).
4) Owner soft costs and project management expenses excluded.

Estimating Disclaimer - Engineer's Opinion of Probable Construction Cost

The estimate of costs shown and any resulting conclusions on the project financial, economic feasibility or funding requirements have been prepared from guidance in the project evaluation and implementation from the information available at the time the estimate was prepared. The final Costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions and other variable factors. Accordingly, the final project costs may vary from the estimate. Project feasibility, benefit/cost analysis, risk and funding must be reviewed prior to making specific funding decisions and establishment of the project budget.

AACE International CLASS 4 Cost Estimate - Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. Typically, engineering is 10% to 40% complete. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Virtually all Class 4 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -15% to -30% on the low side and +20% to 50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 20 hours or less to perhaps more than 300 hours may be spent preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

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4/25/2014

Table 7-2 C - 51 Reservoir OPCC Phase 2

Currency: USD-United States April - 2014 Dollars

Grand Total Price:					$ 216,603,145	
Item	**Description**	**Quantity**	**UOM**	**Unit Price**	**Total Price**	**Comments**
	Phase 2 Supplemental Costs					Presented for information only.
1	Improve, widen some haul roads.	13,000	LF	$4.60	$59,800	
2	Grading, ditches etc. Erosion control	34,764	LF	$2.25	$78,219	
3	Silt fence type lll	30,000	LF	$2.00	$60,000	
4	Silt fence type lV	39,000	LF	$2.60	$101,400	
5	Maintain Erosion control	144	mo.	$2,000.00	$288,000	Min of 2 draglines
6	Excavate Peat	1,719,600	cy	$5.22	$8,976,312	
7	Excavate Sand and sand/clay to top of limestone	16,278,800	cy	$5.22	$84,975,336	
8	Drill and shoot limestone	45,320,700	cy	$2.50	$113,301,750	
9	Excavate limestone with Manitowoc dragline, 7 cy bucket	45,320,700	cy	$0.83	$37,616,181	production about 360 cy per hour
10	Load limestone on to conveyor	45,320,700	cy	$0.65	$29,458,455	
11	convey limestone to proceeding plant	45,320,700	cy	$0.25	$11,330,175	
12	Process the limestone	45,320,700	cy	$6.40	$290,052,480	about 400 ton per hour plant
13	Excavate sand/shell below limestone	12,051,000	cy	$8.71	$104,964,210	
14	Overhead etc. 10%	1	LS	$68,000,000.00	$68,000,000	
	Costs of mining basins 12, 13, 14, 16 & 18 -20+/- feet by PBA	45,320,700	cy	$16.53	$749,262,318	Presented for information only. Not included in OPCC.
	Sell Limestone product 95%, 5% is waste, use 1.6 ton per cy	68,887,464	ton	$12.00	$826,649,568	Presented for information only. Not included in OPCC.
	profit				$77,387,250	Presented for information only. Not included in OPCC.
	Phase 2 Direct Costs					
	Misc. Roads, Haul Roads and Fencing					
1	Install construction fencing	1,600	LF	$21.00	$33,600	
2	Install permanent fencing	500	LF	$21.00	$10,500	
3	Grade existing Roads	1	LS	$30,000.00	$30,000	
4	Improve, widen some haul roads.	7,000	LF	$4.60	$32,200	
5	Grading, ditches etc. Erosion control	34,764	LF	$2.25	$78,219	
6	Silt fence type lll	10,000	LF	$2.00	$20,000	
7	Silt fence type lV	24,764	LF	$2.60	$64,386	
8	Maintain Erosion control	36	mo.	$2,250.00	$81,000	
9	Remove Construction fence and grade	1	LS	$30,000.00	$30,000	
11	Temporary Floating Turbidity Barrier	1,000	LF	$70.00	$70,000	
12	Clean-out cross channel in cells	5	ea.	$20,000.00	$100,000	
	Total				**$549,905**	
	Embankment section A, C, D					
1	Earth Embankment areas remove peat	288,117	cy	$5.22	$1,503,971	Load and haul to stockpile
2	Earth Embankment areas remove sand above clay/sand	1,390,092	cy	$5.22	$7,256,280	Load and haul to stockpile
3	Earth Embankment areas remove clay/sand areas	461,578	cy	$5.22	$2,409,437	Load and haul to stockpile
4	Install grade beams for soil bentonite walls	34,764	LF	$182.00	$6,327,048	
5	Install soil bentonite walls	148,068	cy	$135.00	$19,989,180	
6	Dewater basin, Rent pumps and buy pipe etc.	3	sets	$10,000.00	$30,000	Rent 8-inch pump, buy suction, pipe, etc.
7	Set-up the dewatering system	5	ea.	$8,000.00	$40,000	
8	Dewater basins	2,650	HR	$30.00	$79,500	
9	Maintain basins dewatered	24	mo.	$4,750.00	$114,000	
10	Remove sandy/shell material from basin bottom 2ft to 7ft	6,417,600	cy	$8.71	$55,897,296	Drill, shoot, load and haul to stockpile
11	Excavate basins side slopes to 3 on 1.	1,549,560	cy	$10.83	$16,781,735	Drill, shoot, load and haul to embankment
12	Earth Embankment toe concrete foundation	6,438	cy	$295.00	$1,899,210	
13	Earth Embankment compacted fill A, C, D	1,465,238	cy	$1.10	$1,611,762	from the 3 to 1 excavation in the cells sides
14	Earth Embankment U/S toe 6" inch PVC outlet pipe	139	ea.	$30.00	$4,170	
15	Earth Embankment U/S toe 6" inch PVC slotted pipe	34,764	LF	$5.00	$173,820	
16	Earth Embankment geocomposite drainage layer	2,565,583	SF	$1.25	$3,206,979	
17	Earth Embankment U/S 12" RCC facing	102,746	cy	$65.52	$6,731,918	Make RCC on site $60.52, place $5.00
18	Earth Embankment D/S blanket drain	48,927	cy	$32.10	$1,570,557	
19	Earth Embankment D/S toe 6" inch PVC outlet pipe	35	ea.	$70.00	$2,450	
20	Earth Embankment D/S toe 6" inch PVC slotted pipe	34,764	LF	$10.00	$347,640	
21	Earth Embankment D/S Toe road	20,600	cy	$24.10	$496,460	
22	Earth Embankment access roads	4	ea.	$6,000.00	$24,000	
23	Earth Embankment turnouts	13	ea.	$8,000.00	$104,000	
	total				**$126,601,412**	
	Breach cell 11 and bridge breach					
1	Excavate embankment	1	LS	$30,000.00	$30,000	
2	Excavate Breach	1	LS	$40,000.00	$40,000	
3	Rack ends of embankment	1	LS	$10,000.00	$10,000	
4	Bridge over the Breach	1	LS	$750,000.00	$750,000	
					$830,000	
	Total Direct Costs				**$127,981,318**	
	Project Indirect Costs					
	Project Management			3%	**3,839,440**	
	Safety			1%	**1,279,813**	
	Administration, Office, Shops etc.			5%	**6,399,066**	
	Construction Equipment Plant Costs			1%	**1,279,813**	

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Table 7-2 C - 51 Reservoir OPCC Phase 2

Currency: USD-United States April - 2014 Dollars

				Sub Total Indirects:	**12,798,132**	
				Sub Total Directs + Indirects:	**$140,779,449**	
	Markups					
	Prime Contractor OH&P on Subs	30 million		5.0%	**$1,500,000**	
	Prime Contractor OH&P on Self-Perform	149 million		10.0%	**$14,900,000**	
	Prime Contractor home office cost	180 million		5.0%	**$9,000,000**	
	Contractor Insurance Program	180 million		2.5%	**$4,500,000**	Performance/Payments Bonds, General Liability, & Bldr's Risk
	State Sales Taxes	39 million		6.0%	**$2,340,000**	Sales Tax on 40%
	Escalation			0.0%	**$0**	Excluded
	Estimating Accuracy Contingency	180 million		5.0%	**$9,000,000**	
				Sub Total Markups:	**$41,240,000**	
				Total Estimated Capital Costs:	**$182,019,449**	Total Estimated Construction Costs w/o Contingency
	Project Administration & Management					
	Construction Oversight & Management			0.0%		Captured in economic evaluations presented in Section 8.0
	Engineering			0.0%		Captured in economic evaluations presented in Section 8.0
	Engineering During Construction			0.0%		Captured in economic evaluations presented in Section 8.0
	Misc. Owner's Soft Costs (All)			0.0%		Captured in economic evaluations presented in Section 8.0
	Land Acquisition			0.0%		Captured in economic evaluations presented in Section 8.0
	Scope Contingency On Civil			15.0%	**$27,302,917**	Quantity Growth & Scope Growth on civil work+
	Scope Contingency On Equipment			0.0%		
	Interest During Construction			0.0%		Financing costs excluded
	Owner's Construction Contingency/Management Reserve			4.0%	**$7,280,778**	Excluded, allowance for changed field conditions
				Sub Total Project Administrative Expenses:	**$34,583,695**	
					$ 216,603,145	Total Estimated Construction Costs w/ Contingency
				Cost Range: **$ 184,110,000**	**$ 270,750,000**	Per AACE cost estimate guidelines

Notes:

1) This OPCC is classified as a Class 4 cost estimate per AACE guidelines. Stated accuracy range = -15% to + 25%.
2) Pricing basis = escalation to midpoint of construction is not included.
3) Pricing assumes competitive market conditions at time of tender (+3 bidders/trade).
4) Owner soft costs and project management expenses excluded.
5) Supplemental costs provided above for mining site are not included, but provided as justification for excluding land costs from Phase 2 OPCC.

Estimating Disclaimer - Engineer's Opinion of Probable Construction Cost

The estimate of costs shown and any resulting conclusions on the project financial, economic feasibility or funding requirements have been prepared from guidance in the project evaluation and implementation from the information available at the time the estimate was prepared. The final Costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions and other variable factors. Accordingly, the final project costs may vary from the estimate. Project feasibility, benefit/cost analysis, risk and funding must be reviewed prior to making specific funding decisions and establishment of the project budget.

AACE International CLASS 4 Cost Estimate - Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. Typically, engineering is 10% to 40% complete. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Virtually all Class 4 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -15% to -30% on the low side and +20% to 50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 20 hours or less to perhaps more than 300 hours may be spent preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

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Table 7-3 - C - 51 Reservoir OPCC Summary Phases 1 and 2

Currency: USD-United States April - 2014 Dollars

Grand Total Price:					$ 343,674,883	
Item	**Description**	**Quantity**	**UOM**	**Unit Price**	**Total Price**	**Comments**
	Phase 1 Project Costs				$127,071,738	without contingency = $106.8M (used in Section 8 for financial analysis based on alternative delivery methodology)
	Phase 2 Project Costs				$216,603,145	without contingency = $182M (used in Section 8 for financial analysis based on alternative delivery methodology)
	Total Project Costs				$343,674,883	
	Project Administration & Management					
	Construction Oversight & Management			0.0%		Captured in economic evaluations presented in Section 8.0
	Engineering			0.0%		Captured in economic evaluations presented in Section 8.0
	Engineering During Construction			0.0%		Captured in economic evaluations presented in Section 8.0
	Misc. Owner's Soft Costs (All)			0.0%		Captured in economic evaluations presented in Section 8.0
	Land Acquisition			0.0%		Captured in economic evaluations presented in Section 8.0
	Scope Contingency On Civil			0.0%		Quantity Growth & Scope Growth on civil work+
	Scope Contingency On Equipment			0.0%		
	Interest During Construction			0.0%		Captured in economic evaluations presented in Section 8.0
	Owner's Construction Contingency/Management Reserve			0.0%		Excluded, allowance for changed field conditions
		Sub Total Project Administrative Expenses:				
					$ 343,674,883	Total Estimated Construction Costs w/ Contingency
				Cost Range: $ 292,120,000	$ 429,590,000	Per AACE cost estimate guidelines

Notes:

1) This OPCC is classified as a Class 4 cost estimate per AACE guidelines. Stated accuracy range = -15% to + 25%.
2) Pricing basis = escalation to midpoint of construction is not included.
3) Pricing assumes competitive market conditions at time of tender (+3 bidders/trade).
4) Owner soft costs and project management expenses excluded.

Estimating Disclaimer - Engineer's Opinion of Probable Construction Cost

The estimate of costs shown and any resulting conclusions on the project financial, economic feasibility or funding requirements have been prepared from guidance in the project evaluation and implementation from the information available at the time the estimate was prepared. The final Costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions and other variable factors. Accordingly, the final project costs may vary from the estimate. Project feasibility, benefit/cost analysis, risk and funding must be reviewed prior to making specific funding decisions and establishment of the project budget.

AACE International CLASS 4 Cost Estimate - Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. Typically, engineering is 10% to 40% complete. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Virtually all Class 4 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -15% to -30% on the low side and +20% to 50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 20 hours or less to perhaps more than 300 hours may be spent preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

8.0 - Economic Evaluation

This section summarizes the economic evaluation of the C-51 Reservoir project. The economic evaluation is based on project cost estimates for capital costs related to the initial project investment, including planning, engineering, design, permitting, construction and financing costs, as well as annual operation and maintenance expense. It is assumed that the project will be developed in two phases. The preliminary analysis set forth herein is based on the evaluation of both phases of the project.

8.1 Project Valuation Methodology

In discussions with Palm Beach County, MWH concluded that attempting to place a fair market value on the mined property was subject to a variety of opinions if we approached this from a comparable sales approach as direct comparable sales are not available. This is a unique parcel, in a unique location, and engaging in a debate on the land's value misses the objective. Rather than focus on land appraisals, MWH with Palm Beach County's concurrence decided to refer to a Project Value Assessment that encompasses a full range of features that are not easily defined through a traditional land appraisal.

In this feasibility analysis, MWH assumed the Project Value was associated with a unique opportunity presented by Palm Beach Aggregates in maximizing the mined site's value to the region as an alternative water source and potential flood mitigation structure. The location – adjacent to the L-8 reservoir with a passive hydraulic interconnect – provides storage for flood waters that can be diverted from the L-8 basin into the combined L-8 and C-51 Reservoirs. The flood mitigation opportunity costs are not directly accounted for in the analysis and have been included within the Project Value Assessment. Additionally, the ecosystem benefits resulting from reduced fresh water discharges into the Lake Worth Lagoon are not quantified except in the Project Value Assessment.

When evaluating a project such as this, it is reasonable to assign value to the risk undertaken by Palm Beach Aggregates in moving ahead with the concept and providing a permitted, constructed, and operational facility to the region for future water supply. The Project Value Assessment is an attempt to capture the risk of this project not progressing, but with significant investments made to date. Also, the cost analysis assumed no direct value for the land. Again, rather than debate the value of a mined property in a unique geologic area, MWH categorized compensation for the land as a value proposition and not an appraised feature.

After consultation on May 30, 2014 with the participating utilities, MWH was directed to apply a Project Value Assessment of 12 percent of the OPCC to complete this analysis. Alternatively, using the same assumptions and cost elements with the published capacity charge of $4.30/gal proposed by Palm Beach Aggregates results in a Project Value Assessment of approximately 23.8 percent of the OPCC. The difference in the capacity charge resulting from the two Project Value Assessments is $0.34 per gallon or approximately $12.6M.

8.2 Phase 1

8.2.1 Capital Costs

The project capital costs for the first phase of the C-51 Reservoir are as follows:

C-51 Phase 1 Construction Costs (OPCC) [1]	$106,782,793
Land Costs	0
Project Management / Fees [2]	1,067,828
Engineering, Design, Permitting and Construction Mgt. [3]	17,085,247
Interest During Construction at 6% [4]	7,785,249
Value at 12% of Construction Cost [5]	12,813,935
LWDD Projection Initiation Cost [6]	350,000
LWDD Canal User Fee [7]	380,160
Total Project Capital Costs (Phase 1)	$146,265,212

Footnotes:

[1] Costs from Table 7-1 excluding contingencies due to design-build method.

[2] Palm Beach Aggregates has invested in a skilled project team working at risk for the benefit of developing the reservoir project, coordinating with multiple State agencies, multiple municipalities, and stakeholders. The Project Manager has been actively working on this effort for the past four years and will continue managing this effort until the reservoir is operational and transferred to the member utilities. The Project Management Fees this effort was set at 1% of the OPCC.

[3] Estimate based on 16% of Construction Cost.

[4] Assumes 24 month construction period.

[5] Project Value represents the value of the turn-key project including the unique geologic features, unique location adjacent to the L-8 reservoir, the pre-project investment risk, the ownership risk during construction and land value. The project value as a percent of the OPCC was offered by the participating utilities.

[6] Reflects one time payments to Lake Worth Drainage District.

For purposes of this analysis, it is assumed that the Phase 1 project capital costs would be financed using tax-exempt revenue bonds based on the following financing assumptions.

Total Phase 1 Project Capital Costs	$146,265,212
Cost of Issuance at 2.0%	3,159,423
Debt Service Reserve Fund	11,705,963
Total Amount to be Financed	$161,130,598
Repayment Term (Years)	30
Interest Rate	6.0%
Annual Debt Service	$11,705,963

In developing the estimate of annual capital-related costs, it was also assumed that the cost recovery rate may need to include a provision for achieving a debt service coverage ratio of 1.15x annual debt service to enhance the credit position of the bond financing; however, since there are no significant renewal and replacement costs associated with the C-51 Reservoir facilities anticipated during the repayment term, it was further assumed that such amounts would be rebated to the project participants on an annual basis. The C-51 Reservoir cost recovery rates per thousand gallons (kgal), as set forth herein, include the calculation of unit costs both with and without the debt service coverage allowance.

8.2.2 Operations and Maintenance Costs

The cash flow analysis also includes certain annual operating and maintenance expenses associated with Phase 1 of the C-51 project. These expenses were based off of historical information provided by SFWMD and projected costs from LWDD. The assumptions utilized for this component of the analysis includes the following annual expenses:

C-51 & L8 Pumping Cost	$ 799
LWDD Pumping Cost	3,196
Total Phase 1 Annual Pumping Cost	3,995
C-51 Maintenance Expense	605,469
LWDD Maintenance Expense	76,032
Total Phase 1 Annual Maintenance Expense	$681,501
Total Phase 1 Operations and Maintenance Expense	$685,496

For purposes of this evaluation, it is assumed that the Phase 1 pumping and maintenance expenses would increase 3% annually to account for the effects of inflation.

Table 8-1 summarizes the projected annual project costs for Phase 1 of the C-51 Reservoir.

Table 8- 1

C-51 Phase 1 - Reservoir Project Costs

Line No.	Description	Annual Debt Service [1]	Debt Service Coverage (15%)	Debt Service Coverage Rebate	Net Capital Related Costs	Annual Pumping Costs [2]	Annual Maint. Costs [2]	Total Annual O&M	Total Annual Cost
1	Year 1	$11,705,963	$1,755,894	$1,755,894	$11,705,963	$3,995	$681,501	$685,496	$12,391,458
2	Year 2	11,705,963	1,755,894	1,755,894	11,705,963	4,115	701,946	706,061	12,412,023
3	Year 3	11,705,963	1,755,894	1,755,894	11,705,963	4,238	723,004	727,242	12,433,205
4	Year 4	11,705,963	1,755,894	1,755,894	11,705,963	4,365	744,694	749,060	12,455,022
5	Year 5	11,705,963	1,755,894	1,755,894	11,705,963	4,496	767,035	771,532	12,477,494
6	Year 6	11,705,963	1,755,894	1,755,894	11,705,963	4,631	790,046	794,677	12,500,640
7	Year 7	11,705,963	1,755,894	1,755,894	11,705,963	4,770	813,748	818,518	12,524,480
8	Year 8	11,705,963	1,755,894	1,755,894	11,705,963	4,913	838,160	843,073	12,549,036
9	Year 9	11,705,963	1,755,894	1,755,894	11,705,963	5,061	863,305	868,366	12,574,328
10	Year 10	11,705,963	1,755,894	1,755,894	11,705,963	5,213	889,204	894,416	12,600,379
11	Year 11	11,705,963	1,755,894	1,755,894	11,705,963	5,369	915,880	921,249	12,627,212
12	Year 12	11,705,963	1,755,894	1,755,894	11,705,963	5,530	943,356	948,886	12,654,849
13	Year 13	11,705,963	1,755,894	1,755,894	11,705,963	5,696	971,657	977,353	12,683,316
14	Year 14	11,705,963	1,755,894	1,755,894	11,705,963	5,867	1,000,807	1,006,674	12,712,636
15	Year 15	11,705,963	1,755,894	1,755,894	11,705,963	6,043	1,030,831	1,036,874	12,742,836
16	Year 16	11,705,963	1,755,894	1,755,894	11,705,963	6,224	1,061,756	1,067,980	12,773,943
17	Year 17	11,705,963	1,755,894	1,755,894	11,705,963	6,411	1,093,609	1,100,019	12,805,982
18	Year 18	11,705,963	1,755,894	1,755,894	11,705,963	6,603	1,126,417	1,133,020	12,838,983
19	Year 19	11,705,963	1,755,894	1,755,894	11,705,963	6,801	1,160,209	1,167,011	12,872,973
20	Year 20	11,705,963	1,755,894	1,755,894	11,705,963	7,005	1,195,016	1,202,021	12,907,984
21	Year 21	11,705,963	1,755,894	1,755,894	11,705,963	7,215	1,230,866	1,238,082	12,944,044
22	Year 22	11,705,963	1,755,894	1,755,894	11,705,963	7,432	1,267,792	1,275,224	12,981,187
23	Year 23	11,705,963	1,755,894	1,755,894	11,705,963	7,655	1,305,826	1,313,481	13,019,443
24	Year 24	11,705,963	1,755,894	1,755,894	11,705,963	7,884	1,345,001	1,352,885	13,058,848
25	Year 25	11,705,963	1,755,894	1,755,894	11,705,963	8,121	1,385,351	1,393,472	13,099,434
26	Year 26	11,705,963	1,755,894	1,755,894	11,705,963	8,365	1,426,911	1,435,276	13,141,238
27	Year 27	11,705,963	1,755,894	1,755,894	11,705,963	8,616	1,469,719	1,478,334	13,184,297
28	Year 28	11,705,963	1,755,894	1,755,894	11,705,963	8,874	1,513,810	1,522,684	13,228,647
29	Year 29	11,705,963	1,755,894	1,755,894	11,705,963	9,140	1,559,224	1,568,365	13,274,327
30	Year 30	11,705,963	1,755,894	1,755,894	11,705,963	9,414	1,606,001	1,615,416	13,321,378
31	Year 31	0	0	0	0	9,697	1,654,181	1,663,878	1,663,878
32	Year 32	0	0	0	0	9,988	1,703,807	1,713,794	1,713,794
33	Year 33	0	0	0	0	10,287	1,754,921	1,765,208	1,765,208
34	Year 34	0	0	0	0	10,596	1,807,568	1,818,165	1,818,165
35	Year 35	0	0	0	0	10,914	1,861,796	1,872,709	1,872,709
36	Year 36	0	0	0	0	11,241	1,917,649	1,928,891	1,928,891
37	Year 37	0	0	0	0	11,579	1,975,179	1,986,757	1,986,757
38	Year 38	0	0	0	0	11,926	2,034,434	2,046,360	2,046,360
39	Year 39	0	0	0	0	12,284	2,095,467	2,107,751	2,107,751
40	Year 40	0	0	0	0	12,652	2,158,331	2,170,984	2,170,984
41	Year 41	0	0	0	0	13,032	2,223,081	2,236,113	2,236,113
42	Year 42	0	0	0	0	13,423	2,289,774	2,303,196	2,303,196
43	Year 43	0	0	0	0	13,825	2,358,467	2,372,292	2,372,292
44	Year 44	0	0	0	0	14,240	2,429,221	2,443,461	2,443,461
45	Year 45	0	0	0	0	14,667	2,502,097	2,516,765	2,516,765

Footnotes:

[1] Annual debt service costs are based on the assumptions below:

Term (Years)	30
Interest Rate	6.00%
Cost of Issuance	2.00%
Project Capital Cost	$146,265,212
Debt Service Reserve	$11,705,963
Costs of Issuance	3,159,423
Total Principal	**$161,130,598**
Annual Debt Service	$11,705,963

[2] Annual maintenance expenses are escalated by a factor of 3.00% per year.

8.3 Phase 2

8.3.1 Capital Costs

Phase 2 of the C-51 Reservoir Project is assumed to be operational in year 16 and will take 7 years to construct. The project capital cost for the second phase of the C-51 Reservoir is as follows:

C-51 Phase 2 Construction Costs (OPCC) [1]	$182,019,449
Land Costs	0
Project Management / Fees [2]	1,820,194
Engineering, Design, Permitting and Construction Mgt. [3]	29,123,112
Interest During Construction at 6% [4]	51,552,482
Value at 12% of Construction Cost [5]	21,842,334
Total Project Capital Costs (Phase 2)	$286,357,572

Footnotes:

[1] Costs from Table 7-2 excluding contingencies due to design-build method.

[2] Palm Beach Aggregates has invested in a skilled project team working at risk for the benefit of developing the reservoir project, coordinating with multiple State agencies, multiple municipalities, and stakeholders. The Project Manager has been actively working on this effort for the past four years and will continue managing this effort until the reservoir is operational and transferred to the member utilities. The Project Management Fees this effort was set at 1% of the OPCC.

[3] Estimate based on 16% of Construction Cost.

[4] Assumes 84 month construction period.

[5] Project Value represents the value of the turn-key project including the unique geologic features, unique location adjacent to the L-8 reservoir, the pre-project investment risk, the ownership risk during construction and land value. The project value as a percent of the OPCC was offered by the participating utilities.

For purposes of this analysis, it is assumed that the Phase 2 project capital costs would be financed using tax-exempt revenue bonds based on the following financing assumptions.

Total Phase 2 Project Capital Costs	$286,357,572
Cost of Issuance at 2.0%	6,185,509
Debt Service Reserve Fund	22,917,897
Total Amount to be Financed	$315,460,978
Repayment Term (Years)	30
Interest Rate	6.0%
Annual Debt Service	$22,917,897

In developing the estimate of Phase 2 annual capital-related costs, it was also assumed that the cost recovery rate may need to include a provision for achieving a debt service coverage ratio of 1.15x annual debt service to enhance the credit position of the bond financing; however, since there are no significant renewal and replacement costs associated with the C-51 Reservoir facilities anticipated during the repayment term, it was further assumed that such amounts would be rebated to the project participants on an annual basis consistent with the cost recovery assumptions for Phase 1. The C-51 Reservoir cost recovery rates per thousand gallons, as set forth herein, include the calculation of unit costs both with and without the debt service coverage allowance.

8.3.2 Operations and Maintenance Costs

The cash flow analysis also includes certain annual operating and maintenance expenses associated with Phase 2 of the C-51 project. The assumptions utilized for this component of the analysis includes the following annual expenses:

C-51 & L8 Pumping Cost	$2,068
LWDD Pumping Cost	8,272
Total Phase 2 Annual Pumping Cost	$10,340
C-51 Maintenance Expense	$917,969
LWDD Maintenance Expense	76,032
Total Phase 2 Annual Maintenance Expense	$994,001
Total Phase 2 Operations and Maintenance Expense	$1,004,341

For purposes of this evaluation, it is also assumed that the Phase 2 pumping and maintenance expenses would increase a 3% annually to account for the effects of inflation.

Table 8-2 summarizes the projected annual project costs for Phase 2 of the C-51 Reservoir. **Table 8-3** summarizes the projected annual project costs for the combined Phases 1 and 2 of the C-51 Reservoir.

Table 8-2

C-51 Phase 2 - Reservoir Project Costs

Line No.	Description	Annual Debt Service [1]	Debt Service Coverage (15%)	Debt Service Coverage Rebate	Net Capital Related Costs	Annual Pumping Costs [2]	Annual Maint. Costs [2]	Total Annual O&M	Total Annual Cost
1	Year 1	$22,917,897	$3,437,684	$3,437,684	$22,917,897	$10,340	$994,001	$1,004,341	$23,922,238
2	Year 2	22,917,897	3,437,684	3,437,684	22,917,897	10,650	1,023,821	1,034,471	23,952,368
3	Year 3	22,917,897	3,437,684	3,437,684	22,917,897	10,970	1,054,536	1,065,505	23,983,402
4	Year 4	22,917,897	3,437,684	3,437,684	22,917,897	11,299	1,086,172	1,097,471	24,015,367
5	Year 5	22,917,897	3,437,684	3,437,684	22,917,897	11,638	1,118,757	1,130,395	24,048,291
6	Year 6	22,917,897	3,437,684	3,437,684	22,917,897	11,987	1,152,320	1,164,306	24,082,203
7	Year 7	22,917,897	3,437,684	3,437,684	22,917,897	12,347	1,186,889	1,199,236	24,117,132
8	Year 8	22,917,897	3,437,684	3,437,684	22,917,897	12,717	1,222,496	1,235,213	24,153,109
9	Year 9	22,917,897	3,437,684	3,437,684	22,917,897	13,098	1,259,171	1,272,269	24,190,166
10	Year 10	22,917,897	3,437,684	3,437,684	22,917,897	13,491	1,296,946	1,310,437	24,228,334
11	Year 11	22,917,897	3,437,684	3,437,684	22,917,897	13,896	1,335,854	1,349,750	24,267,647
12	Year 12	22,917,897	3,437,684	3,437,684	22,917,897	14,313	1,375,930	1,390,243	24,308,139
13	Year 13	22,917,897	3,437,684	3,437,684	22,917,897	14,742	1,417,208	1,431,950	24,349,847
14	Year 14	22,917,897	3,437,684	3,437,684	22,917,897	15,185	1,459,724	1,474,909	24,392,805
15	Year 15	22,917,897	3,437,684	3,437,684	22,917,897	15,640	1,503,516	1,519,156	24,437,053
16	Year 16	22,917,897	3,437,684	3,437,684	22,917,897	16,109	1,548,621	1,564,731	24,482,627
17	Year 17	22,917,897	3,437,684	3,437,684	22,917,897	16,593	1,595,080	1,611,672	24,529,569
18	Year 18	22,917,897	3,437,684	3,437,684	22,917,897	17,090	1,642,932	1,660,023	24,577,919
19	Year 19	22,917,897	3,437,684	3,437,684	22,917,897	17,603	1,692,220	1,709,823	24,627,720
20	Year 20	22,917,897	3,437,684	3,437,684	22,917,897	18,131	1,742,987	1,761,118	24,679,015
21	Year 21	22,917,897	3,437,684	3,437,684	22,917,897	18,675	1,795,276	1,813,952	24,731,848
22	Year 22	22,917,897	3,437,684	3,437,684	22,917,897	19,235	1,849,135	1,868,370	24,786,267
23	Year 23	22,917,897	3,437,684	3,437,684	22,917,897	19,813	1,904,609	1,924,421	24,842,318
24	Year 24	22,917,897	3,437,684	3,437,684	22,917,897	20,407	1,961,747	1,982,154	24,900,050
25	Year 25	22,917,897	3,437,684	3,437,684	22,917,897	21,019	2,020,599	2,041,618	24,959,515
26	Year 26	22,917,897	3,437,684	3,437,684	22,917,897	21,650	2,081,217	2,102,867	25,020,764
27	Year 27	22,917,897	3,437,684	3,437,684	22,917,897	22,299	2,143,654	2,165,953	25,083,850
28	Year 28	22,917,897	3,437,684	3,437,684	22,917,897	22,968	2,207,963	2,230,932	25,148,828
29	Year 29	22,917,897	3,437,684	3,437,684	22,917,897	23,657	2,274,202	2,297,860	25,215,756
30	Year 30	22,917,897	3,437,684	3,437,684	22,917,897	24,367	2,342,428	2,366,795	25,284,692

Footnotes:

[1] Annual debt service costs are based on the assumptions below:

Term (Years)	30
Interest Rate	6.00%
Cost of Issuance	2.00%
Project Capital Cost	$286,357,572
Debt Service Reserve	$22,917,897
Costs of Issuance	6,185,509
Total Principal	**$315,460,978**
Annual Debt Service	$22,917,897

[2] Annual maintenance expenses are escalated by a factor of 3.00% per year.

Table 8-3

C-51 Phase 1 & 2 - Reservoir Combined Project Costs

Line No.	Description	Annual Debt Service	Debt Service Coverage (15%)	Debt Service Coverage Rebate	Net Capital Related Costs	Annual Pumping Costs	Annual Maint. Costs	Total Annual O&M	Total Annual Cost
1	Year 1	$11,705,963	$1,755,894	$1,755,894	$11,705,963	$3,995	$681,501	$685,496	$12,391,458
2	Year 2	11,705,963	1,755,894	1,755,894	11,705,963	4,115	701,946	706,061	12,412,023
3	Year 3	11,705,963	1,755,894	1,755,894	11,705,963	4,238	723,004	727,242	12,433,205
4	Year 4	11,705,963	1,755,894	1,755,894	11,705,963	4,365	744,694	749,060	12,455,022
5	Year 5	11,705,963	1,755,894	1,755,894	11,705,963	4,496	767,035	771,532	12,477,494
6	Year 6	11,705,963	1,755,894	1,755,894	11,705,963	4,631	790,046	794,677	12,500,640
7	Year 7	11,705,963	1,755,894	1,755,894	11,705,963	4,770	813,748	818,518	12,524,480
8	Year 8	11,705,963	1,755,894	1,755,894	11,705,963	4,913	838,160	843,073	12,549,036
9	Year 9	11,705,963	1,755,894	1,755,894	11,705,963	5,061	863,305	868,366	12,574,328
10	Year 10	11,705,963	1,755,894	1,755,894	11,705,963	5,213	889,204	894,416	12,600,379
11	Year 11	11,705,963	1,755,894	1,755,894	11,705,963	5,369	915,880	921,249	12,627,212
12	Year 12	11,705,963	1,755,894	1,755,894	11,705,963	5,530	943,356	948,886	12,654,849
13	Year 13	11,705,963	1,755,894	1,755,894	11,705,963	5,696	971,657	977,353	12,683,316
14	Year 14	11,705,963	1,755,894	1,755,894	11,705,963	5,867	1,000,807	1,006,674	12,712,636
15	Year 15	11,705,963	1,755,894	1,755,894	11,705,963	6,043	1,030,831	1,036,874	12,742,836
16	Year 16	34,623,859	5,193,579	5,193,579	34,623,859	16,564	2,055,757	2,072,321	36,696,180
17	Year 17	34,623,859	5,193,579	5,193,579	34,623,859	17,061	2,117,430	2,134,491	36,758,350
18	Year 18	34,623,859	5,193,579	5,193,579	34,623,859	17,573	2,180,953	2,198,525	36,822,385
19	Year 19	34,623,859	5,193,579	5,193,579	34,623,859	18,100	2,246,381	2,264,481	36,888,340
20	Year 20	34,623,859	5,193,579	5,193,579	34,623,859	18,643	2,313,773	2,332,416	36,956,275
21	Year 21	34,623,859	5,193,579	5,193,579	34,623,859	19,202	2,383,186	2,402,388	37,026,247
22	Year 22	34,623,859	5,193,579	5,193,579	34,623,859	19,778	2,454,681	2,474,460	37,098,319
23	Year 23	34,623,859	5,193,579	5,193,579	34,623,859	20,372	2,528,322	2,548,693	37,172,553
24	Year 24	34,623,859	5,193,579	5,193,579	34,623,859	20,983	2,604,171	2,625,154	37,249,014
25	Year 25	34,623,859	5,193,579	5,193,579	34,623,859	21,612	2,682,297	2,703,909	37,327,768
26	Year 26	34,623,859	5,193,579	5,193,579	34,623,859	22,261	2,762,765	2,785,026	37,408,885
27	Year 27	34,623,859	5,193,579	5,193,579	34,623,859	22,929	2,845,648	2,868,577	37,492,436
28	Year 28	34,623,859	5,193,579	5,193,579	34,623,859	23,616	2,931,018	2,954,634	37,578,493
29	Year 29	34,623,859	5,193,579	5,193,579	34,623,859	24,325	3,018,948	3,043,273	37,667,133
30	Year 30	34,623,859	5,193,579	5,193,579	34,623,859	25,055	3,109,517	3,134,572	37,758,431
31	Year 31	22,917,897	3,437,684	3,437,684	22,917,897	25,806	3,202,802	3,228,609	26,146,505
32	Year 32	22,917,897	3,437,684	3,437,684	22,917,897	26,580	3,298,886	3,325,467	26,243,364
33	Year 33	22,917,897	3,437,684	3,437,684	22,917,897	27,378	3,397,853	3,425,231	26,343,128
34	Year 34	22,917,897	3,437,684	3,437,684	22,917,897	28,199	3,499,789	3,527,988	26,445,885
35	Year 35	22,917,897	3,437,684	3,437,684	22,917,897	29,045	3,604,782	3,633,827	26,551,724
36	Year 36	22,917,897	3,437,684	3,437,684	22,917,897	29,917	3,712,926	3,742,842	26,660,739
37	Year 37	22,917,897	3,437,684	3,437,684	22,917,897	30,814	3,824,314	3,855,128	26,773,024
38	Year 38	22,917,897	3,437,684	3,437,684	22,917,897	31,738	3,939,043	3,970,781	26,888,678
39	Year 39	22,917,897	3,437,684	3,437,684	22,917,897	32,691	4,057,214	4,089,905	27,007,802
40	Year 40	22,917,897	3,437,684	3,437,684	22,917,897	33,671	4,178,931	4,212,602	27,130,499
41	Year 41	22,917,897	3,437,684	3,437,684	22,917,897	34,682	4,304,299	4,338,980	27,256,877
42	Year 42	22,917,897	3,437,684	3,437,684	22,917,897	35,722	4,433,428	4,469,149	27,387,046
43	Year 43	22,917,897	3,437,684	3,437,684	22,917,897	36,794	4,566,430	4,603,224	27,521,121
44	Year 44	22,917,897	3,437,684	3,437,684	22,917,897	37,897	4,703,423	4,741,321	27,659,217
45	Year 45	22,917,897	3,437,684	3,437,684	22,917,897	39,034	4,844,526	4,883,560	27,801,457

Footnotes:

[1] Amounts shown based on the combined values from Table 8-1 & Table 8-2.

8.4 Water Availability/Demand

The economic evaluation is based on the assumption that Phase 1 of the C-51 Reservoir, when full, is capable of storing approximately 5.5 billion gallons (17,000 acre-feet) of water and the assumption that Phase 2 of the C-51 Reservoir, when full, is capable of storing an additional 14.5 billion gallons (44,000 acre-feet) of water for a total storage volume of approximately 20 billion gallons (61,000 ac-ft) of water.. In order to evaluate the cost of water provided by the C-51 Reservoir, the analysis shown on **Tables 8-4** and **8-5** calculates the unit cost of water based on 100% utilization of the reservoir storage capability based on reservoir usage during the dry season only (assumed to be 150 days). **Tables 8-6** and **8-7** reflect the same information but based on 100% utilization of the reservoir storage capability year round. The actual reservoir usage will likely vary by utility as negotiated with the SFWMD through the water use permit process.

8.5 Summary

Table 8-8 provides a summary of the financial calculations for the project showing the OPCC, Total Principal, and Annual Costs for both dry season and year round benefit.

Table 8-8 – Summary of Financial Calculations for the C-51 Reservoir Project

Project Phases per Environmental Resources Permit	Storage Volume (MG)	OPCC ($M)[1]	Total Principal ($M)[2]	Annual Costs ($M)[3]	Annual Costs[4] ($/1000 gal)[4]	
					Dry Season Benefit Only[4]	Year Round Benefit[5]
ERP Phase 1	5,500	106.8	161	14.1	2.55	1.05
ERP Phase 2	14,000	182	315.5	N/A[6]	N/A[6]	N/A[6]
ERP Consolidated (Total)	**19,950**	**286.4**	**476.5**	**41.9**	**2.11**	**0.87**

1. Assumes the rock pit cells are mined and the capital cost represents the conversion to a reservoir. From Tables 7-1 and 7-2, excluding contingencies.
2. From Tables 8-1 and 8-2.
3. From Tables 8-5 and 8-7, Total Annual Cost: Year 1 represents Phase 1 and Year 16 represents Total.
4. From Table 8-5, Avg. Cost per KGal: Year 1 represents Phase 1 and Year 16 represents Total.
5. From Table 8-7, Avg. Cost per KGal: Year 1 represents Phase 1 and Year 16 represents Total
6. Not applicable - the Phase 2 annual operating costs cannot be separated from the total annual costs as they are integrated.

Based on the assumption discussed above, a summary of the cost recovery rate for water supplied by the C-51 Reservoir per thousand gallons based on dry season benefit only is set forth in Tables 8-4 and 8-5. Table 8-4 shows the estimated cost of water supplied by the C-51 Reservoir net of any debt service coverage allowance where Table 8-5 assumes that C-51 Project is financed by a single entity representing the project participants. In order to enhance the credit position of the financing, it is assumed that the participants would be charged a rate including an allowance for a debt service coverage ratio of 1.15 x debt service, which would ultimately be returned to the participants**.** Tables 8-6 and 8-7 provide a summary of the cost recovery rate for water supplied by the C-51 Reservoir per thousand gallons based on year round benefits. **Figure 8-1** show the cost recovery rate, including the debt service coverage allowance while **Figure 8-2** shows the cost recovery rate without debt service coverage included.

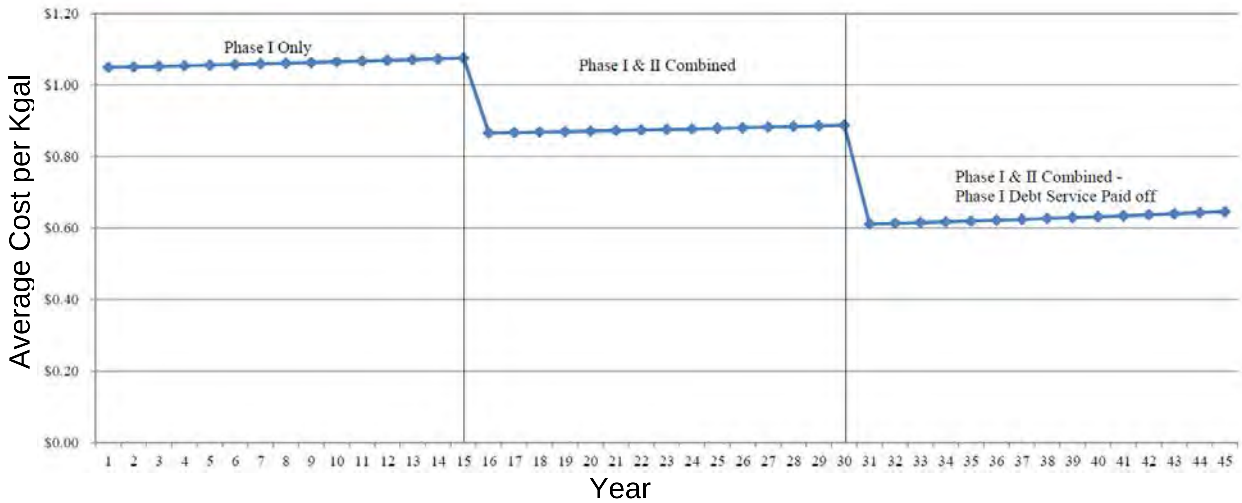

Figure 8-1 Cost Recovery Rate with Debt Service Coverage Included

(Year Round Reservoir Benefit)

Figure 8-2 - Cost Recovery Rate without Debt Service Coverage Included

(Year Round Reservoir Benefit)

Table 8-4

C-51 Phase 1 & 2 - Reservoir Project Cost Recovery Rate
Without Debt Service Coverage Included - Dry Season Benefit Only

		Project Cost Recovery Rate		
Line No.	Description	Total Annual Cost [1]	Annual Water Available (Kgals)	Average Cost Per Kgal
1	Year 1	$12,391,458	5,539,467	$2.24
2	Year 2	12,412,023	5,539,467	2.24
3	Year 3	12,433,205	5,539,467	2.24
4	Year 4	12,455,022	5,539,467	2.25
5	Year 5	12,477,494	5,539,467	2.25
6	Year 6	12,500,640	5,539,467	2.26
7	Year 7	12,524,480	5,539,467	2.26
8	Year 8	12,549,036	5,539,467	2.27
9	Year 9	12,574,328	5,539,467	2.27
10	Year 10	12,600,379	5,539,467	2.27
11	Year 11	12,627,212	5,539,467	2.28
12	Year 12	12,654,849	5,539,467	2.28
13	Year 13	12,683,316	5,539,467	2.29
14	Year 14	12,712,636	5,539,467	2.29
15	Year 15	12,742,836	5,539,467	2.30
16	Year 16	36,696,180	19,876,911	1.85
17	Year 17	36,758,350	19,876,911	1.85
18	Year 18	36,822,385	19,876,911	1.85
19	Year 19	36,888,340	19,876,911	1.86
20	Year 20	36,956,275	19,876,911	1.86
21	Year 21	37,026,247	19,876,911	1.86
22	Year 22	37,098,319	19,876,911	1.87
23	Year 23	37,172,553	19,876,911	1.87
24	Year 24	37,249,014	19,876,911	1.87
25	Year 25	37,327,768	19,876,911	1.88
26	Year 26	37,408,885	19,876,911	1.88
27	Year 27	37,492,436	19,876,911	1.89
28	Year 28	37,578,493	19,876,911	1.89
29	Year 29	37,667,133	19,876,911	1.90
30	Year 30	37,758,431	19,876,911	1.90
31	Year 31	26,146,505	19,876,911	1.32
32	Year 32	26,243,364	19,876,911	1.32
33	Year 33	26,343,128	19,876,911	1.33
34	Year 34	26,445,885	19,876,911	1.33
35	Year 35	26,551,724	19,876,911	1.34
36	Year 36	26,660,739	19,876,911	1.34
37	Year 37	26,773,024	19,876,911	1.35
38	Year 38	26,888,678	19,876,911	1.35
39	Year 39	27,007,802	19,876,911	1.36
40	Year 40	27,130,499	19,876,911	1.36
41	Year 41	27,256,877	19,876,911	1.37
42	Year 42	27,387,046	19,876,911	1.38
43	Year 43	27,521,121	19,876,911	1.38
44	Year 44	27,659,217	19,876,911	1.39
45	Year 45	27,801,457	19,876,911	1.40

Footnotes:

[1] Amounts shown based on the combined values from Table 8-1 & Table 8-2.

Table 8-5

C-51 Phase 1 & 2 - Reservoir Project Cost Recovery Rate
With Debt Service Coverage Included - Dry Season Benefit Only

		Project Cost Recovery Rate		
Line No.	Description	Total Annual Cost [1]	Annual Water Available (Kgals)	Average Cost Per Kgal
1	**Year 1**	**$14,147,353**	**5,539,467**	**$2.55**
2	Year 2	14,167,918	5,539,467	2.56
3	Year 3	14,189,099	5,539,467	2.56
4	Year 4	14,210,917	5,539,467	2.57
5	Year 5	14,233,388	5,539,467	2.57
6	Year 6	14,256,534	5,539,467	2.57
7	Year 7	14,280,375	5,539,467	2.58
8	Year 8	14,304,930	5,539,467	2.58
9	Year 9	14,330,222	5,539,467	2.59
10	Year 10	14,356,273	5,539,467	2.59
11	Year 11	14,383,106	5,539,467	2.60
12	Year 12	14,410,743	5,539,467	2.60
13	Year 13	14,439,210	5,539,467	2.61
14	Year 14	14,468,531	5,539,467	2.61
15	Year 15	14,498,731	5,539,467	2.62
16	**Year 16**	**41,889,759**	**19,876,911**	**2.11**
17	Year 17	41,951,929	19,876,911	2.11
18	Year 18	42,015,963	19,876,911	2.11
19	Year 19	42,081,919	19,876,911	2.12
20	Year 20	42,149,854	19,876,911	2.12
21	Year 21	42,219,826	19,876,911	2.12
22	Year 22	42,291,898	19,876,911	2.13
23	Year 23	42,366,132	19,876,911	2.13
24	Year 24	42,442,592	19,876,911	2.14
25	Year 25	42,521,347	19,876,911	2.14
26	Year 26	42,602,464	19,876,911	2.14
27	Year 27	42,686,015	19,876,911	2.15
28	Year 28	42,772,072	19,876,911	2.15
29	Year 29	42,860,711	19,876,911	2.16
30	Year 30	42,952,010	19,876,911	2.16
31	Year 31	29,584,190	19,876,911	1.49
32	Year 32	29,681,048	19,876,911	1.49
33	Year 33	29,780,812	19,876,911	1.50
34	Year 34	29,883,569	19,876,911	1.50
35	Year 35	29,989,409	19,876,911	1.51
36	Year 36	30,098,423	19,876,911	1.51
37	Year 37	30,210,709	19,876,911	1.52
38	Year 38	30,326,363	19,876,911	1.53
39	Year 39	30,445,486	19,876,911	1.53
40	Year 40	30,568,183	19,876,911	1.54
41	Year 41	30,694,561	19,876,911	1.54
42	Year 42	30,824,731	19,876,911	1.55
43	Year 43	30,958,805	19,876,911	1.56
44	Year 44	31,096,902	19,876,911	1.56
45	Year 45	31,239,141	19,876,911	1.57

Footnotes:

[1] Amounts shown based on the combined values from Table 8-1 & Table 8-2.

Table 8-6

C-51 Phase 1 & 2 - Reservoir Project Cost Recovery Rate
Without Debt Service Coverage Included - Year Round Benefit

		Project Cost Recovery Rate		
Line No.	Description	Total Annual Cost [1]	Annual Water Available (Kgals)	Average Cost Per Kgal
1	Year 1	$12,391,458	13,479,370	$0.92
2	Year 2	12,412,023	13,479,370	0.92
3	Year 3	12,433,205	13,479,370	0.92
4	Year 4	12,455,022	13,479,370	0.92
5	Year 5	12,477,494	13,479,370	0.93
6	Year 6	12,500,640	13,479,370	0.93
7	Year 7	12,524,480	13,479,370	0.93
8	Year 8	12,549,036	13,479,370	0.93
9	Year 9	12,574,328	13,479,370	0.93
10	Year 10	12,600,379	13,479,370	0.93
11	Year 11	12,627,212	13,479,370	0.94
12	Year 12	12,654,849	13,479,370	0.94
13	Year 13	12,683,316	13,479,370	0.94
14	Year 14	12,712,636	13,479,370	0.94
15	Year 15	12,742,836	13,479,370	0.95
16	Year 16	36,696,180	48,367,150	0.76
17	Year 17	36,758,350	48,367,150	0.76
18	Year 18	36,822,385	48,367,150	0.76
19	Year 19	36,888,340	48,367,150	0.76
20	Year 20	36,956,275	48,367,150	0.76
21	Year 21	37,026,247	48,367,150	0.77
22	Year 22	37,098,319	48,367,150	0.77
23	Year 23	37,172,553	48,367,150	0.77
24	Year 24	37,249,014	48,367,150	0.77
25	Year 25	37,327,768	48,367,150	0.77
26	Year 26	37,408,885	48,367,150	0.77
27	Year 27	37,492,436	48,367,150	0.78
28	Year 28	37,578,493	48,367,150	0.78
29	Year 29	37,667,133	48,367,150	0.78
30	Year 30	37,758,431	48,367,150	0.78
31	Year 31	26,146,505	48,367,150	0.54
32	Year 32	26,243,364	48,367,150	0.54
33	Year 33	26,343,128	48,367,150	0.54
34	Year 34	26,445,885	48,367,150	0.55
35	Year 35	26,551,724	48,367,150	0.55
36	Year 36	26,660,739	48,367,150	0.55
37	Year 37	26,773,024	48,367,150	0.55
38	Year 38	26,888,678	48,367,150	0.56
39	Year 39	27,007,802	48,367,150	0.56
40	Year 40	27,130,499	48,367,150	0.56
41	Year 41	27,256,877	48,367,150	0.56
42	Year 42	27,387,046	48,367,150	0.57
43	Year 43	27,521,121	48,367,150	0.57
44	Year 44	27,659,217	48,367,150	0.57
45	Year 45	27,801,457	48,367,150	0.57

Footnotes:

[1] Amounts shown based on the combined values from Table 8-1 & Table 8-2.

Table 8-7

C-51 Phase 1 & 2 - Reservoir Project Cost Recovery Rate
With Debt Service Coverage Included - Year Round Benefit

		Project Cost Recovery Rate		
Line No.	Description	Total Annual Cost [1]	Annual Water Available (Kgals)	Average Cost Per Kgal
1	**Year 1**	**$14,147,353**	**13,479,370**	**$1.05**
2	Year 2	14,167,918	13,479,370	1.05
3	Year 3	14,189,099	13,479,370	1.05
4	Year 4	14,210,917	13,479,370	1.05
5	Year 5	14,233,388	13,479,370	1.06
6	Year 6	14,256,534	13,479,370	1.06
7	Year 7	14,280,375	13,479,370	1.06
8	Year 8	14,304,930	13,479,370	1.06
9	Year 9	14,330,222	13,479,370	1.06
10	Year 10	14,356,273	13,479,370	1.07
11	Year 11	14,383,106	13,479,370	1.07
12	Year 12	14,410,743	13,479,370	1.07
13	Year 13	14,439,210	13,479,370	1.07
14	Year 14	14,468,531	13,479,370	1.07
15	Year 15	14,498,731	13,479,370	1.08
16	**Year 16**	**41,889,759**	**48,367,150**	**0.87**
17	Year 17	41,951,929	48,367,150	0.87
18	Year 18	42,015,963	48,367,150	0.87
19	Year 19	42,081,919	48,367,150	0.87
20	Year 20	42,149,854	48,367,150	0.87
21	Year 21	42,219,826	48,367,150	0.87
22	Year 22	42,291,898	48,367,150	0.87
23	Year 23	42,366,132	48,367,150	0.88
24	Year 24	42,442,592	48,367,150	0.88
25	Year 25	42,521,347	48,367,150	0.88
26	Year 26	42,602,464	48,367,150	0.88
27	Year 27	42,686,015	48,367,150	0.88
28	Year 28	42,772,072	48,367,150	0.88
29	Year 29	42,860,711	48,367,150	0.89
30	Year 30	42,952,010	48,367,150	0.89
31	Year 31	29,584,190	48,367,150	0.61
32	Year 32	29,681,048	48,367,150	0.61
33	Year 33	29,780,812	48,367,150	0.62
34	Year 34	29,883,569	48,367,150	0.62
35	Year 35	29,989,409	48,367,150	0.62
36	Year 36	30,098,423	48,367,150	0.62
37	Year 37	30,210,709	48,367,150	0.62
38	Year 38	30,326,363	48,367,150	0.63
39	Year 39	30,445,486	48,367,150	0.63
40	Year 40	30,568,183	48,367,150	0.63
41	Year 41	30,694,561	48,367,150	0.63
42	Year 42	30,824,731	48,367,150	0.64
43	Year 43	30,958,805	48,367,150	0.64
44	Year 44	31,096,902	48,367,150	0.64
45	Year 45	31,239,141	48,367,150	0.65

Footnotes:

[1] Amounts shown based on the combined values from Table 8-1 & Table 8-2.

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10.0 -APPENDIX A – GEOTECHNICAL DESIGN REVIEW MEMORANDUM

MEMORANDUM

TO: B. Hachenburg, Gary Wantland, G. Tate, H. Aiken **DATE**: 04/05/14

FROM: C. Zambrano

SUBJECT: C-51 Technical Review – Geotechnical Analysis and Design Aspects

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1. Introduction

This memorandum presents the review of the available geotechnical analyses and design aspects of C-51 Reservoir Project, addressing the items requested in the document "C-51 Independent Cost Estimate and Finanical Analysis_MWH Report Outline_v4A.pdf", and listed below.

- Item g. Embankment Dimensions (DCM-4)
- Item h. Slope Stability and Seepage Analysis
- Item i. Seepage Barriers, Seepage Collection Systems, and Potential Seepage Losses Resulting from Operating Levels
    - i. Review of site investigation data for selection of engineering properties
    - ii. Seepage studies
    - iii. Stability evaluation analyses (for each phase of reservoir life – construction, operation and drawdown)
    - iv. Exit gradient evaluations
    - v. Reservoir embankment design geometry and cross sections
    - vi. Seepage barrier design
    - vii. Seepage collection system design
- Item j. Evaluation of Proposed Embankment Penetrations
    - i. Evaluation of filter design to prevent piping at soil-structure interface
    - ii. Evaluation of settlement
    - iii. Evaluation of constructability and operability
- Item l. Discussion of Design Observations

2. Organization of the Report

To facilitate the presentation of this technical review, comments on analysis and design aspects are presented in separate sections following the typical sequence of the executions of analysis and design tasks (i.e. starting with review of subsurface exploration data for selection of engineering properties). The titles of the sections and subsections of this memorandum include the items of Section 1.0 being covered. The remainder of this document is organized in the following sections:

- Section 3.0 – General Project Description & List of Reviewed Documents
- Section 4.0 – Embankment Dimensions (DCM-4)

- Section 5.0 – Stability, Seepage and Settlement Analyses
- Section 6.0 – Design of Seepage Control Measures
- Section 7.0 – Evaluation of Proposed Embankment Penetrations
- Section 8.0 – Discussion of Design Observations
- Section 9.0 – References

3. General Project Description & List of Reviewed Documents

The following documents were reviewed:

- Document # 1: AMEC (2014), C-51 Reservoir – Basis of Design Report, February 2014.
- Document # 2: WRS (2014), C-51 Reservoir Hydraulic Facilities – Final Design Drawings, February 2014. General, Demolition and Civil Work Drawings (Sheet 1 through 18 of 132).
- Document #3: WRS (2014), C-51 Reservoir Hydraulic Control Facilities – Final Design, Technical Specification Section 02260 Slurry Trench – Slurry Wall Construction.

Document #1 by AMEC pertains to the intermediate analysis and design of the C-51 earthfill and Roller Compacted Concrete (RCC) embankments, and a 2.5-ft wide soil-bentonite cutoff wall (slurry wall) provided to control seepage under the RCC embankment and under and through the earthfill embankment.

Documents #2 and #3 by WRS pertains to the final design of the C-51 Hydraulic Control Structures that will connect the existing L-8 Reservoir with the proposed C-51 Reservoir. This connection consists of two 102-inch diameter steel conduits with a gated control structure at the L-8 reservoir side, and scour protection riprap aprons protecting the C-51 and L-8 reservoir floors at the inlet/outlet areas. The conduits are spaced at 4 ft between pipe walls. Per Document #2 (Drawings C031), the length of each conduit is about 817 ft +/-. About 700 ft +/- of each conduit will be installed via microtunneling. The remaining 117 ft +/- long conduit sections will be installed using the traditional open excavation and backfill methods. The tunneling will be perform from a temporary launching pit, located at about 117 ft +/- from the existing L-8 reservoir embankment, and be advanced toward the C-51 reservoir. After completion of the tunneling operation, the open cut pipe installation will begin. Seepage collars for the two conduits are proposed at the C-51 and L-8 reservoir sides and consist of steel sheet pile walls with openings welded to the conduits. The Microtunneling Technical Specification was not available at the time of this review.

4. Embankment Dimensions (DCM-4) (Item g.)

The proposed C-51 Reservoir includes earthfill and RCC embankment sections. The earthfill embankments consist of 3H:1V upstream and downstream slopes with a 14-m wide crest at El. +25.5 ft. The embankment upstream slope and crest are protected with a 12-inch thick slab of RCC for erosion protection. The RCC embankment, serving as spillway, has a vertical upstream face, a 1H:1V downstream slope and a 14-m wide crest at El. +23.0 ft. The downstream foundation of the RCC embankment is protected with a 1-ft to 2-ft thick RCC slab that connects to a RCC-lined channel.

The following geometry/dimension requirements of the Design Criteria Memorandum DCM-4 – Minimum Dimensions of Embankment (Levees or Dams), Ramps, Pull Outs, and Access Roads (DCM-4) are not met, and for some items as noted below, information was not available to assess compliance with DCM-4.

a) The crest of the embankment is flat. The crest should be sloped to the interior (at a 2% grade).

b) Location and details of access ramps, pull outs, turn around areas, site access roads were not available in Document #1.

c) Document # 1 indicates that the internal corridor may be less than 50 ft wide at some locations (Section 6.1.1, Page 12). Details, dimensions and extent of these narrower corridor sections were not available in Document #1.

   It is also noted that Document #2 shows a 10-ft wide internal corridor section at the location of the inlet/outlet structure (See Document #2, Drawing No. C012). The minimum width required is 50 ft and 40 ft from high/significant and low hazard potential impoundments, respectively.

d) Document # 1 indicates that the external corridor may be less than 50 ft at some locations (Section 6.1.1, Page 12). Details, dimensions and extent of these narrower corridor sections were not available in Document #1.

e) The width of the proposed exterior maintenance road (14-ft wide) is less than the minimum required of 16 ft (See Document #1, Figures 11 through 13).

f) The exterior maintenance road is located between El. +12 ft and El. +16 ft (See Document #1, Figures 11 through 13). Information verifying that these elevations are above the 100-year, 24 hour flood level was not available in Document #1.

Document #1 indicates that the deviations from DCM-4 listed under Items **c)** through **e)** above, have been accepted by South Florida Water Management District (SFWMD) (Section 6.1.1, Page 12, 4th paragraph). However, it is recommended to provide SFWMD with plans, sections and details of the internal and external corridors and perimeter external roads to verify acceptance of any deviation from DCM-4.

5. Stability, Seepage and Settlement Analyses

5.1. Review of Available Site Investigation Data for Selection of Design Parameters (**Item i. i.**)

In general, the stratigraphy at the project site consists of the following materials based on the boring logs included in Document #1 (Figures 5 through 9, and Appendices B and C) (from top to bottom):

- Fill comprised of sand, silty and clayey sand, clay and silt with thickness varying typically from 2 ft to 10 ft.
- Fibrous peat with some sand and silts. This material was encountered at local areas. Thickness of this unit varies from less than 1 ft to about 4 ft.
- Overburden comprised of sand, silty and clayey sand, with occasional roots and sand to gravel size shell and limestone fragments. The earthfill embankments will be founded on overburden.
- Poorly cemented calcareous limestone interbedded with deposits of sand, silty sand and clayey sand, with sand to gravel size shell and limestone fragments. Some boring logs report voids in the limestone that may be the result of the dissolution of the limestone (See Document #1, Figure Appendix C1-2 through C1-3). The proposed RCC embankment is founded on the upper limestone layer ("rock cap"). Within the RCC dam footprint, the thickness and top elevation of the "rock cap" varies from 3 ft to 15 ft and from El. -5.0 ft to El. 5.0 ft NAVD 88, respectively.

Document # 1 includes a description of the exploration, field testing and laboratory testing completed for the C-51 and L-8 Reservoirs. In general, the field testing programs included borings with Standard Penetration Tests (SPTs), and constant and falling head permeability tests performed in overburden and the underlying sequence of limestone and sand deposits. Laboratory testing included index properties (moisture content, grain size analysis and organic content), and compaction and triaxial tests on compacted specimens. No in-situ or laboratory testing were available to evaluate strength and deformability properties of the limestone foundation.

The following review comments for Document #1 pertain to review of site investigation data and selection of design parameters for analysis and design of the embankments.

a) A description of geologic structural features of limestone was not included in Document #1. Presence of joints (if any) and cavities should be discussed in the design report, including their potential impact on the different structures (i.e. potential loss of slurry into the reservoir through cavities in the limestone).

b) No in-situ or laboratory testing data of strength and deformability of limestone was included in Document #1. Considering the variable thickness and depth of the limestone "rock cap", evaluation of the strength and deformation properties of this rock unit is warranted for the evaluation of stability and stress-deformation conditions of the spillway structure founded on this material.

c) A detail description of the basis used for the selection of permeability, strength and deformation parameters for the foundation materials is not provided in Document #1. The selection of strength and deformation parameters should be documented and supported with testing data. Please consider to include in the design report charts showing the variation with elevation (instead of depth) of the different parameters of the foundation materials. This information will facilitate the assessment of the variability of the ground conditions, for sensitivity analyses, and the evaluation of the selected design parameters.

d) The permeability of the RCC is assumed to be 0.0 ft/day (Document # 1, Table 7). Permeability values of $1.5x10^{-9}$ to $1.5x10^{-7}$ cm/s reported for well-compacted, workable RCC mixtures by USACE (2000) should be considered for seepage analysis.

e) Provide the permeability for the soil-bentinote cutoff wall used in the seepage analyses. The design permeability value should be coordinated with the Technical Construction Specifications of the Soil-Bentonite cutoff wall.

f) Input parameters for the foundation and engineering fill materials used in the transient seepage analysis described in Document #1 (Section 6.4.3) are not provided. This information should be included in the design calculation report to document the calculated piezometer levels through the embankments and foundation materials during and immediately after rapid drawdown. These calculated piezometric levels should be incorporate in the slope stability analyses.

5.2. Loading Cases (**Item i. ii. & Item i. iii.**)

The following comments pertain to documentation and selection of loading cases for seepage, stability and settlement analyses:

a) The selection of the loading cases for seepage, slope stability and settlement analysis should be supported with a detailed description of the operation of the C-51 and L-8 Reservoirs. This information, including reservoir operating drawdown rates, should be part of the Basis of Design Report (Document #1), and should be used to verify that all controlling loading conditions associated with the reservoir operation are being analyzed.

b) Include seepage analyses with pool level at the spillway crest, El. +23 ft, to evaluate impacts on the design for this extreme condition.

c) Slope stability analysis for earthfill dams should be performed for during-construction (considering load of equipment and materials for construction of the slurry wall), end-of-construction, long-term, maximum surcharge pool and rapid drawdown conditions in accordance with USACE (2003). Pseudo-static analysis should also be included.

d) Document #1 (Section 6.5, Page 22, third paragraph), includes the following statement "*…Since the reservoir is predominately a below-grade facility, there is no possibility of a rapid drawdown conditions….*". Please clarify this statement. There should not be ambiguity in the classification of this facility. C-51 reservoir is an above-grade facility. The maximum normal pool level at El. +16.5 ft is above the foundation level of the earthfill embankment.

e) Stability of RCC embankment section should be performed in accordance with the USACE (1995). This document identifies seven (7) loading conditions that cover end-of-construction and several service loading cases (i.e. usual, unusual and extreme). If the designer considered that one of the loading conditions does not apply to C-51 Reservoir, the stability calculation should document and justify the deviation from the design guideline.

f) The development of loading cases for settlement analysis should consider the evaluation of differential settlements for the RCC dam.

5.3. Seepage Analysis

5.3.1. Groundwater Seepage Analysis (**item h.**)

The following review comments pertain to seepage analysis for earthfill and RCC embankment sections:

a) Seepage analysis for the RCC dam do not include the boundary condition set by having L-8 reservoir at maximum normal pool level and C-51 reservoir empty.

b) The design proposed a slurry wall with tip at El. -30 ft. However, in some of the seepage analysis results the tip of the slurry cutoff appears to be below El. -30 (Document #1, Appendix G, Figure G-1, G-6, G-7, G-8 and G-10). Please confirm the model geometry.

c) To facilitate the evaluation/interpretation of SEEP/W analysis outputs, it is recommended to include in each output figure, the boundary conditions and the permeability values used in the analysis for the different materials.

5.3.2. Exit Gradient Evaluations (**item i. iv.**)

The following review comments pertain to evaluation of exit hydraulic gradient:

a) Hydraulic gradient output results from SEEP/W software were not included in Document #1, Appendix G. Please include this information to allow the evaluation of the location and overall distribution of high hydraulic gradient zones within the embankment and foundations.

b) Include a detailed verification of seepage hydraulic gradients in the overburden (sand) foundation below the downstream slopes of the earthfill dam, and at the overburden slope toe (along the perimeter drainage ditch).

c) Document #1 (Table 8) includes safety factors for exist gradients by assuming a critical gradient of 1.0. For the evaluation of the potential internal erosion of foundation materials and embankment fills, it should be considered that critical hydraulic gradients for internal erosion are often significantly lower than 1.0 (that is typically associated with heave, blowout, quick-condition, liquefaction, boiling of sand). Critical hydraulic gradient to initiate internal erosion in coarser to medium sand are generally in the order of 0.3 and less (Perzlmaier, S.et al., 2007 and Wan, et al, 2008).

5.4. Stability Analysis (**Item h.**)

The following review comments pertain to the evaluation of slope stability analysis for RCC and earthfill embankments:

a) Stability and seepage control performance of the RCC dam is controlled by the concentration of stresses in the foundation "rock cap" and associated differential settlements induced in RCC structure. Thus, coupled stress-deformation analyses should be performed to verify the stability and integrity of the dam founded on the "rock cap" that has variable thickness and depth. In addition, same type of analyses should be performed to evaluate the impact of the inlet/outlet headwall excavations and narrowing of the internal corridor of the RCC dam to 10 ft as shown in Document #2 (Drawings C012). For the site foundation conditions, a faced symmetrical hardfill dam (constructed with cemented sand and gravel material) should be considered to reduce bearing stresses on the foundation and provide a more flexible structure.

b) The downstream relief drain behind the RCC (near the drainage ditch) is above the foundation level of the RCC dam (Document #1, Figure 11). Thus, the limit equilibrium stability analysis should include the tailing water for the computation of uplift pressures (Document #1, Appendix F, Page 1 of 6 and 4 of 4). To account for the accumulation of sediments on the internal corridor, horizontal silt pressure should also be considered in the computation of sliding safety factors.

c) Include stability sliding analyses for the RCC slab over the upstream slopes of the earthfill embankments using the geocomposite-soil interface friction angle. As part of this stability analysis, include calculations performed for the design of the underdrainage system (geocomposite with piping and valves system) provided to prevent uplift hydrostatic pressures below the RCC slab.

d) Structurally-controlled failure mechanism should be evaluated for the limestone reservoir wall. If no controlling joint sets are present in this rock unit, this geologic condition should be documented in the design report.

5.5. Settlement Analysis (**item h.**)

The following review comments pertain to the evaluation of settlement analysis for RCC and earthfill embankments:

a) Define acceptable levels of deformation and differential settlements for RCC embankment and perform stress-deformation analysis to verify that the integrity of the structure is not compromised. The analysis should include the site foundation conditions consisting of a limestone "rock cap" (stiffer unit) with variable thickness and depth underlay by sand deposits (softer unit).

b) Stress-deformation analysis should be performed to evaluate the connection of the seepage collar wall with the RCC dam and the 12-ft wide soil-bentonite cutoff wall shown in Document #2 (Drawings C011 through C013). The wide slurry trench under the RCC structure imposes a high risk of cracking the rigid structure.

c) Evaluate settlement of the slurry wall to take into account the consolidation of the soil-bentonite backfill material.

6. Design of Seepage Control Measures

6.1.1. Seepage Barrier (**item i. & item i. vi.**)

a) Provide design measures (i.e. overbuilt) to maintain the seepage protection in the earthfill embankment after the soil-bentonite slurry settles. Document #1 (Figures 11 through 13) shows the top of the soil-bentonite cutoff wall at El. 16.5 ft. This is right at the maximum normal pool level and below the maximum normal pool level + 100-year rainfall (14 inches) (Document #1, Figures 11 through 13).

b) Provide details and provisions to prevent the formation of a gap at the contact of the soil-bentonite cutoff wall and the RCC dam. Soil-bentonite cutoff wall will settle overtime mainly due to consolidation of the soil-bentonite slurry and in a lesser degree due to potential water loss from the slurry through coarser soil layers. Also, taking into account that the elevation of the top of the rock varies, include design measures to ensure complete filling of the slurry trench with low permeability fill along the RCC foundation (Document #1, Figures 11 through 13).

c) Document #3 (See Technical Specification Section 02260, 3.03.H) requires the capping of the slurry trench immediately upon completion of the slurry trench with fill material with minimum thickness of 2 ft and extending up to 2 ft beyond the outside edge of the slurry trench. A layer of geotextile is specified to be installed prior to placing the cap material. Since, this document by WRS pertains to the construction of C-51 Reservoir Hydraulic Control Facilities, it is understood that this is a temporary capping (to be removed before construction of RCC) for the 12-ft wide and 48-ft long slurry wall shown in Document #2 (Drawings C011 through C013). The properties of the geotextile are not included. Please verify this requirement and the stability of the cap for the 12-ft span of the slurry wall.

6.1.2. Seepage Collection Systems (**item i. vii.**)

a) Include manholes access for cleaning the perforated drainage piping located under spillway splash pad and along the earthfill embankment toe (Document #1, Figure 11 through Figure 13).

b) Detail the filter/transition materials for the drainage trench under the spillway splash pad.

c) A French drain (perforated pipe with drain aggregate material wrapped with non-woven geotextile) is proposed under and along the downstream toe of the earthfill dam (Document #1, Figure 11 through Figure 13). Geotextile is susceptible to installation damage and may clog over time. Consider eliminating the French drain and lower the drain blanket into the overburden. If deemed necessary, the drainage capacity of the blanket could be increased by increase its thickness and/or by installing slotted drainage pipe with compatible gravel envelope. These pipes could discharge in the perimeter drainage ditch.

6.1.3. Potential Seepage Looses Resulting from Operating Levels (**item i.**)

For the proposed RCC dam there is a high potential of leakage for reservoir water levels above foundation level of the RCC dam as noted below:

a) Given the variable foundation conditions for the RCC dam, as described in previous sections, there is a risk of inducing differential settlements that could crack and impair the watertightness of the dam.

b) Soil-bentonite slurry will settle over time due to consolidation. Thus, the soil-bentonite backfill will detach from the base of the RCC dam.

For the proposed earthfill dam there is a high potential of leakage for reservoir water levels near the maximum normal pool level and above as noted below:

c) The proposed top of the soil-bentonite cutoff wall is right at the maximum normal pool level (El. 16.5 ft). The cutoff wall should have an overbuilt to accommodate the long-term settlements of the soil-bentonite slurry that will take place during the service life of the facility. The cutoff wall should also be designed to control seepage for reservoirs water level at El. + 17.7 ft [maximum normal pool level + 100-year rainfall (14 inches)].

d) There is a risk of leakage if the top of the cutoff wall is set below RCC spillway crest located at El. +23 ft.

7. Evaluation of Proposed Embankment Penetrations

The following sections pertain to review comments for the connection of the earthfill dam to the RCC dam and the penetration of the soil-bentonite cutoff wall by the two 102-inch conduits of the Inlet/Outlet Control Structure G-59.

7.1.1. Design Measures to prevent piping at soil-structure interface (**item j. i.**)

a) Design details of the connection between the cutoff wall, within the earthfill dam, with the RCC dam are not provided. It is recommended to implement measures to enhance the watertightness of this connection, including widening of the slurry wall at the contact with the spillway structure and, shaping of the spillway side walls with 1H:8V slopes to allow the compression of the slurry backfill against the spillway side walls as the slurry consolidates.

b) Design calculations for the 102-in diameter steel conduits were not available at the time of the review. The same level of documentation on loading cases required for the embankments should be included in the design of the steel conduits to verify that the controlling internal and external loads are being analyzed. Detail description of external and internal loads should be included.

c) Provide details of the type of pipe connections. The pipe connections and conduits should remain watertight under the operating internal pressures.

7.1.2. Evaluation of Settlements (**item j. ii.**)

a) The two sheet pile seepage collars are extended into the RCC dam fill (Document #2, Drawings C012). Placement, compaction and self-weight of the RCC fill will transfer load to the sheet pile walls and subsequently to the 102-inch conduits that are welded to the sheet piles. This loading condition will induce concentrated stress and differential settlements in the conduits. Detail evaluations and calculation should be included in the design verifying that the integrity of the conduits is not compromised.

b) The connection of the seepage collar to the RCC Dam shown in Document #2 (Drawings C011 through C013) includes a 12-ft wide trench filled with bentonite slurry under the RCC dam. Stress-deformation analysis should be performed to evaluate this connection. There is a high risk of cracking the RCC dam due to differential settlement induced in the RCC structure given the lack of bearing capacity of the wide soft slurry trench.

7.1.3. Evaluation of Constructability and Operability (**item j. iii.**)

a) The proposed 12-ft wide slurry wall at the connection of the seepage collar of the 102-inch inlet/outlet conduits with the RCC dam should be re-evaluated. Placing fill over the slurry trench would need to be done after some consolidation of the slurry takes place. Stability and integrity of RCC or Hardfill structure placed over this wide soft slurry trench will be compromised.

8. Discussion of Design Observations (item l.)

a) Stability and seepage control performance of the RCC embankment is of major concern in the proposed design. The design proposes a RCC dam founded on a limestone “rock cap” (stiffer unit) with variable thickness and depth that is underlain by sand deposits (softer unit) (See Document #1, Figure 4 and Figures7 through 9). This foundation condition imposes a high risk of inducing differential settlements that could crack the RCC dam. Additionally, given the shape of the structure (with vertical upstream face), high concentration of stress at the dam toe could overstress the foundation. The RCC dam may punch through foundation areas with a thin “rock cap” or the thin “rock cap” could fail in either buckling or bending. A faced symmetrical hardfill dam (constructed with cemented sand and gravel material) should be considered to reduce bearing stresses on the foundation and provide a more flexible structure.

b) Since borings only provide very punctual information, the exact location of the top of the limestone is unknown between borings. Thus, it is recommended to reword/remove note 3 of Document #2 (Drawing G003) that could lead to contract claims. Pertinent borings should be included in the contract package as part of a Geotechnical Data Report and Geotechnical Baseline Report.

The following items are recommended to be closely coordinated between AMEC and WRS:

i. Design of the connections of the seepage collar at the C-51 reservoir by WRS with the embankment and soil-bentonite cutoff wall by AMEC (See Document #2, Drawing C011).

ii. Design of the excavation in the C-51 reservoir for the construction of the inlet/outlet headwall by WRS and design of the adjacent foundation and perimeter embankment by AMEC. The excavation for the headwall structure is locally encroaching in the embankment internal corridor. The excavation is within less than 30 ft from the RCC embankment proposed by AMEC (See Document #2, Drawing No. C012).

9. References

U.S. Army Corps of Engineers (USACE) (1995). Engineering and Design – Gravity Dam Design, EM 1110-2-2200.

U.S. Army Corps of Engineers (USACE) (2000). Engineering and Design - Roller-Compacted Concrete, EM 1110-2-2006.

U.S. Army Corps of Engineers (USACE) (2003). Engineering and Design - Slope Stability, EM 1110-2-1902.

Perzlmaier, S., Muckenthaler, P., and Koelewijn, A.R. (2007). Hydraulic Criteria for Internal Erosion in Cohesionless Soil, in Proceedings Assessment of the Risk of Internal Erosion of Water Retaining Structures: Dams, Dykes and Levees – Intermediate Report of the European Working Group of ICOLD, Contributions to the Symposium in Freising, Germany, September 2007.

Wan, C.F., Fell, R. (2008). Assessing the Potential of Internal Instability and Suffusion in Embankment Dams and Their Foundation, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 134., No. 3., March 1, 2008.

MWH

BUILDING A BETTER WORLD

MEMORANDUM

TO:	Becky Hachenburg Gary Wantland	DATE:	14 March 2014
FROM:	Terry Arnold	CC:	
SUBJECT:	Review of Preliminary Design Reports, C-51 Reservoir	REF:	

I have reviewed the following reports. I have several questions and comments which are summarized below.

1. *Amec C-51 Reservoir, Engineering Plans For Palm Beach Aggregates, LLC, April 10, 2012*
2. *Amec C-51 Reservoir Basis of Design Report, Palm Beach Aggregates LLC, February 2014.*
3. *WRS Final Design, Final Design, Specification Section 02520 Roller Compacted Concrete (RCC)*
4. *WRS, Phase Two, North Storage Area Dam Construction, Palm Beach Aggregates, Inc. (41 drawings, undated).*

REVIEW COMMENTS

AMEC April 2012 Engineering Plans.

1. In this report, details regarding design of RCC for an RCC over topping section and RCC gravity section for a spillway. The details are rather general and many needed specifics are not included or unclear. Some questions/concerns at this stage of design:
2. Drawing 2.
    a. The aggregate for RCC is specified as limerock. More specific details of the properties that are required to meet design requirements for the structure need to be provided.
    b. A coarse aggregate is specified for the drain blanket. Much of the foundation material is sand. Final design should include detailed filter analysis. And filter fabric should not be used in areas that would not be readily accessible in the future if repairs are required.
    c. Quality control by the engineer is referenced to specification section 02381 which was not included. The QC program, or QA/QC if this is a design-build, needs to be detailed to ensure the design requirements are met.
    d. Placement of RCC is specified for a 12 inch lift compacted to 98% ASTM D558. The ability to get this full depth in a lift is dependent on the material gradation, workability (vebe time or other measure) equipment and the type of placement (horizontal versus sloping lifts). The specifications will need to address both types of placement conditions and likely different.

3. Drawing 4.
    a. The detail references (Section B) do not match with Sheet 9 (Section A3) and are not clear. Coordinate with Plan details on Sheet 10 and Section on Sheet 12.
4. Drawing 12.
    a. The contact between the slurry wall and base of the RCC dam section will not be in full contact when the slurry settles. This contact needs to be further developed.
    b. The design needs details for transverse cracks and construction joints. A RCC gravity dam is probably not appropriate for the site conditions.
    c. The details of the energy dissipater blocks need further design analysis. The y do not look sufficient. And the connection to the RCC apron will need to be designed.
    d. The runout apron does not include anchorage, or drainage. Hydrostatic uplift and/or negative pressure at the toe of the dam should be expected to occur. The design needs further development.
5. Flat plate soil cement is shown as 12 inch thick. Stability during drawdown will be an important design consideration. The planned geocomposite drain is very thin, and the continuity and drainage capacity after compacting RCC on top of it could be reduced or blinded off. Recommend that a "worst case" design analysis be performed assuming no under-drainage and a factor of Safety of 1.0.
    a. Placement of the relatively stiff geocomposite is difficult over large areas. Wrinkling and/or tearing are strong possibilities. Field trail placement and test pits to confirm suitable placement should be including in the construction documents

AMEC February 2014 Basis of Design Report.

1. The design report describes perimeter embankment berms (3H:1V) along with interior embankment divider dikes (2H:1V). Slope protection for both is described as flat plate soil-cement. Flat-plate soil-cement cannot be compacted on a 2H:1V slope. Soil-cement/RCC placed on slopes steeper than 3H:1V are to be placed in horizontal lifts.
2. RCC design analysis described on page included overturning, sliding stability and base pressures. These are important conditions. However, they are not the only conditions that require analysis. Stress analysis of the dam and foundation are required for this type of dam. In particular in these foundation conditions. Stratum ¾ (limestone ranges in depth from 2 to 36 feet deep. The variable foundation conditions, along with normal stress distribution within a concrete dam, requires stress analysis for design. Construction joints are required for an RCC gravity dam on uniform foundation conditions, and measures to control leakage at joints is required. With the variable foundation depth, properties and conditions a stress analysis should be considered mandatory. A more appropriate design for this structure would likely be an earth dam with an RCC overtopping section to serve as the spillway. (It should be noted that an RCC dam was considered for the EAA Reservoir A-1 but was not selected for some of the reasons noted above).
3. Section 6.7 Describes settlement. However, settlement, or more importantly deformation of the

foundation beneath the RCC dam needs to be analyzed. Soil logs describe the depth to Stratum 3/4 (limestone) ranging from 2 to 36 foot deep. This variable condition will have a major impact on the design and performance of a rigid RCC Dam.

4. The bearing capacity report in the analysis is based on a published text book value for limestone. Limestone in South Florida is not a typical limestone and the general reference used should not be considered applicable.

WRS Design Drawings, Dated February 2014.

1. The drawing file consists of 28 drawings but the numbering implies there are 132 drawings. This is very confusing.
2. Sheet 20 shows a double row sheet pile with soil bentonite between them. This foundation is unsatisfactory for the foundation of a RCC dam. The foundation conditions at the site are not very suitable for an RCC dam without excavating a wide soft area beneath the dam. This detail is not likely suitable for an earthfill dam with RCC over-topping protection.
3. The wide slurry wall section for the tunneling option looks like it presents a lot of problems for any type of dam. Recommend developing another method and details to achieve design objective.
4. Specification Section 02520 RCC for Hydraulic Structures.
    a. RCC only goes to Elevation +19. Why not to the crest. Wave runup and erosion protection is needed to the crest of the earth dam sections.
    b. It appears that the thickness of the RCC is being left to the design-builder. Very specific performance and conditions to be analyzed must be provided if this is going to be left to a design builder.
    c. Section 1.05A2-Describes flat plate but there is none shown on drawings. Specification need to cover both flat-plate and RCC for a gravity dam. The requirements will be different for both types of structures. And two different specifications section may be easier depending on the different requirements.
    d. Section 1.05B2 implies that the drawdown analysis is to be determined by a design-builder. The Owner should providing operating criteria that would provide the designer the required drawdown rates and operating conditions. In addition, a maximum of 8 inch lifts is specified with the potential for 12 inch thick lifts if shown to be satisfactory in a test section. This is a good approach as obtaining full depth compaction is a 12 inch thick lift can be difficult. Recommend providing specific details of conditions to be met in a test fill to avoid arguments over full depth density, average density etc.
    e. Section 1.05C describes RCC for interior berms. No interior berms are shown in the drawing set, and the AMEC drawings show 2H:1V slopes for interior berms which are not constructable.
    f. Section 1.06 describes mixing plant requirements. Pugmill and compulsory mixers have

been shown to have satisfactory performance for the types of materials typically used in RCC and soil-cement. Other plant types have been less successful or had significant problems. Both pugmills and compulsory mixers are widely available and the designer should consider specifying mixer types that have been shown to be most successful.

  i. In addition, the Uniformity Test CRD-C55 is usually modified for applications involving soil-cement/RCC mixes with significantly less cement and water in the mixes. The reference to a plant having a track record is too vague to be enforceable. If track history is too be used as a specified means for plant usage, specific criteria of what kind of history is needed should be specified.
  ii. Measurement of cementitious material volumetrically has allowed problems to develop in RCC/soil-cement applications. Weight measurement of cementitious material is preferred, in particular since the quantity of cement being added is relatively low. If volumetric is to be allowed, check measures to ensure that the expected volume of cement is being added, should be provided.

g. Section 1.06 B6. The reference to “weight” following the table should clearly describe “dry weight” or the specific value of measurement.
h. Section 1.06D describes spreading but does not include the method of lift thickness control. Typically laser level/thickness control is specified.
i. Section 1.06E describes compaction equipment. The description is very limited. It does not describe minimum weight of equipment or a requirement for variable frequency and amplitude. The ability to adjust the frequency and amplitude is desirable. Different combination performing better for different materials.
j. Section 2.01B specifies the water quality. It is desirable to require mix designs with the planned mixing water.
k. Section 2.01C allows use of aggregate from interior levees. What type of material is available? The natural deposits available can vary widely and a much more extensive testing and mix design program would be required. The gradation listed in the table is “extremely broad”. More detailed specifications are needed. In particular, for a design-build contract. Note the AMEC design report described a different RCC aggregate. What is this project using?
l. Section 3.01B describes mix design development. The details are insufficient for a design-build contract. In addition, a reference to ASTM D1557 is included. Testing by ASTM D1557 is not compatible with some of the gradations listed in the Table in 2.012C. There are no established procedures for RCC mix design in ASTM 1557. Specific procedures or performance criteria must be provided. Strength, durability, and other important properties should be specified.
m. The rest of the specification section is too vague and insufficient for this project.

11.0 - APPENDIX B - SFWMD and Palm Beach Aggregates Memorandum of Understanding

C-51 RESERVOIR MEMORANDUM OF UNDERSTANDING BETWEEN THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT AND PALM BEACH AGGREGATES, LLC

This C-51 Reservoir Memorandum of Understanding on Project Protocol ("**MOU**") is entered into as of last date executed below by and between the South Florida Water Management District, a public corporation of the State of Florida existing by virtue of Chapter 25270, Laws of Florida, 1949, and operating pursuant to Chapter 373, Florida Statutes, and Chapter 40E, Florida Administrative Code, as a multipurpose water management district ("**SFWMD**") and Palm Beach Aggregates, LLC, a Florida limited liability company ("**PBA**") (each a "**Party**" and collectively, the "**Parties**").

A. WHEREAS, PBA owns or controls certain agricultural and mining properties in Palm Beach County upon which it has proposed to develop, design, finance construction and construct the C-51 Reservoir as an alternative water supply and water management project which would provide benefits to areas in South Florida under the jurisdiction of the SFWMD ("**Region**"). The C-51 Reservoir at full completion would comprise a series of interconnected Storage Cells capable of storing up to 75,000 acre-feet of water producing approximately 185 MGD of water availability for the Region. In addition, the project would incorporate affiliated pumping, inflow and outflow structures, and network of canals, waterways, and other water bodies ("**Conveyance Systems**") including those owned and operated by Chapter 298 Districts (" **298 Districts**"). This MOU addresses Phase 1 of the C-51 Reservoir, which would include Storage Cells capable of storing approximately 14,000 acre feet of water at control elevation 16.5 feet, NAVD 88, producing approximately 35 MGD of water availability for the Region.

The remaining storage capacities in the C-51 Reservoir would be completed in other phases, which would be the subject of future memoranda of understanding which would provide the development approach and structure for those other phases.

B. WHEREAS, the goal of Phase 1 of the C-51 Reservoir would be for the SFWMD to capture and divert excess stormwater that would otherwise flow into the Lake Worth Lagoon estuarine habitat or other water bodies to the C-51 Reservoir, where it would be stored for later re-introduction by the SFWMD for the benefit of the Region during periods of low rainfall, for the purpose of maintaining water levels within the Region and re-charging natural systems, surface water bodies and the surficial aquifer systems, to enhance protection against salt water intrusion, and to benefit water supply utilities and other water users that wish to participate in Phase 1 of the project ("**Participants"**).

NOW, THEREFORE, in consideration of the foregoing recitals and the covenants and agreements set forth herein, the Parties hereby agree as follows:

1. PROJECT IMPLEMENTATION

1.1 PBA proposes to design, develop, permit, finance construction and construct Phase 1 of the C-51 Reservoir in accordance with this MOU. PBA will assume and bear all risks related to the design, development, permitting, construction financing, construction, and completion of Phase 1 of the C-51 Reservoir, and will provide for payment of the agreed upon costs for necessary improvements to the Conveyance System attributable to Phase 1 water flows.

1.2 Upon completion of Phase 1 of the C-51 Reservoir, PBA proposes to transfer ownership of the completed Phase 1 to a not-for-profit corporation. The intent is for the not-for-profit corporation to qualify for charitable tax-exempt status under Internal Revenue Code Section 501(c)(3) so that the Participants in the Phase will receive the lowest possible operating and potential financing costs on a going forward basis. Upon transfer of the completed Phase 1, the governance of the not-for-profit corporation would be determined by the Participants and any involved 298 Districts that wished to participate in governance.

1.3 PBA will request pre-application permit meetings with the SFWMD on the preparation of one or more long duration permits for the C-51 Reservoir. PBA will then submit the permit application(s) to the SFWMD, subject to compliance with the Basis of Review ("BOR") and Chapter 373, Florida Statutes, and subject to the regulatory approval of the SFWMD.

2. PERMITS AND REGULATORY PROCEEDINGS

2.1 This MOU does not grant any permit approvals or commit SFWMD to grant any approvals.

2.2 Pursuant to Section 373.2234, Florida Statutes, and the BOR, and as determined during the permitting process, the SFWMD may consider: designating the C-51 Reservoir as a preferred water supply source for consumptive uses; certifying that additional water from the Regional System is available through implementation of the C-51 Reservoir as an alternative water supply; determining the relationship between water flows from the C-51 Reservoir to allocable water availability for Participants; other authorization mechanisms to provide long duration permits to Participants who enter into capacity allocation agreements for the C-51 Reservoir; and establishment of an area served by the Project in accordance with the needs of the Region, SFWMD water supply planning areas, and the Participants.

2.3 The SFWMD will provide operational analysis and evaluation of the connections between Phase 1 of the C-51 Reservoir and the Conveyance Systems to efficiently and effectively move water into and out of the C-51 Reservoir.

2.4 The SFWMD will provide conceptual operational and regulatory analyses of the regional Conveyance System infrastructure and other circumstances as may be useful for making the C-51 Reservoir available to Participants or projects in the Region. The SFWMD will also consider including the C-51 Reservoir in the 2013 Update to the Lower East Coast Regional Water Supply Plan.

2.5 The SFWMD agrees to use it best efforts at efficiently processing Project-related permit applications.

3. PARTICIPANT ALLOCATIONS

3.1 PBA will be solely responsible to undertake, at its expense, solicitations of interest for Phase 1 of the C-51 Reservoir to seek sufficient capacity allocation agreements to economically support commencement of construction of Phase 1 of the C-51 Reservoir. The SFWMD will have no responsibility with respect to securing capacity allocation agreements.

3.2 No Participant will be required to use the C-51 Reservoir as a water supply source nor be obligated to enter into a capacity allocation agreement with PBA. Each Participant will make its own technical and financial feasibility analysis and public interest finding as to whether entering into a capacity allocation agreement is superior technically and/or financially to other alternative water supply options available to the Participant.

3.3 Participants will submit water use permit applications to the SFWMD together with a copy of an executed capacity allocation agreement. The SFWMD will confirm the allocation relationship between water outflows and water availability for each permit application through the permitting process, which may be different from the proposed allocation in the capacity allocation agreement and subject to reconciliation. Each Participant shall be required to maintain a capacity allocation agreement in full force and effect during the duration of the water use permit.

3.4 Nothing in this MOU will require or obligate the SFWMD to issue any water use permits. Execution of a capacity allocation agreement by a Participant does not guarantee the Participant will receive a water use permit from the SFWMD.

3.5 The SFWMD will have no responsibility or obligation for the management or administration of any capacity allocation agreement.

4. CONVEYANCE SYSTEM COORDINATION

4.1 PBA will be responsible for entering into such Conveyance System agreements with the 298 Districts as may be necessary, with input from the SFWMD, to implement the provisions of this Section 4. The Conveyance System agreements would provide a basis, (i) for construction of and payment of any improvements needed for the Conveyance System, (ii) for any operational protocols necessary to convey water for the implementation of the Phase and for flood control purposes, and (iii) for the payment of any incremental operation and maintenance costs, other costs to be incurred, and any fees by the 298 Districts.

4.2 The SFWMD agrees to consider Conveyance System permit applications that may be submitted in conjunction with the C-51 Reservoir by 298 Districts, with the intent that such Conveyance System permits be supplemental or additional to the current 298 District permits and impose no harm on existing permit allocations and conditions due to conveying water through a 298 District's portion of the Conveyance System in the Project.

4.3 The SFWMD will be responsible for operating its components of the Regional System as necessary or useful, including inflow structures, outflow structures and pumping facilities, to (i) divert water from the Regional System to the C-51 Reservoir, (ii) convey water from the C-51 Reservoir to the Regional System, (iii) convey water from the C-51 Reservoir through the Regional System, and (iv) and coordinate with 298 Districts for the conveyance of water from the Regional System through their portions of the Conveyance System.

5. COMMENCEMENT OF CONSTRUCTION

5.1 PBA will commence the completion of construction of Phase 1 of the C-51 Reservoir upon the attainment of the following Conditions Precedent:

5.1.1 Issuance of the reservoir permit(s) to PBA;

5.1.2 Execution by Participants of capacity allocation agreements allocating the storage capacity of the Phase to be constructed by PBA;

5.1.3 Issuance of water use permits to the Participants for the phase;

5.1.4 Receipt by PBA of all other governmental approvals necessary to commence construction of the Phase;

5.1.5 Receipt by PBA of construction financing to fund the commencement and complete construction of the Phase.

5.1.6 Receipt of Conveyance System agreements as necessary for the conveyance of water through the Conveyance Systems for the Phase.

5.1.7 Completion of an O&M Agreement pursuant to Section 6.2 below.

6. OPERATIONS AND MAINTENANCE OF THE C-51 RESERVOIR

6.1 In order to assure the seamless integration of the C-51 Reservoir with the SFWMD's operation of the Regional System and to implement the availability of the C-51 Reservoir as an Alternative Water Supply for the Participants, the Parties believe it to be in the best interest of the public for the SFWMD to operate the C-51 Reservoir, as part of the SFWMD's Regional System, to maintain stages sufficient to meet the needs of each Phase.

6.2 During the permitting process, the SFWMD and the PBA intend to develop a written operations agreement (**"O&M Agreement")**. The Parties anticipate that the O&M Agreement would provide for (i) the SFWMD to operate and maintain the C-51 Reservoir with O&M funding on an annual basis from the Participants, (ii) coordination between SFWMD and the 298 Districts in accordance with Section 4.3(iv), and (iii) would provide for standard SFWMD liability protection, indemnifications and insurance coverage.

7. MISCELLANEOUS PROVISIONS

7.1 Either party may terminate this MOU by providing the other Party 30 days written notice of termination.

7.2 Nothing in this MOU nor any action taken hereunder shall be construed (a) to create any duty, liability or standard of care to any person that is not a Party to the MOU, (b) no person that is not a party to the MOU shall have any rights or interest, direct or indirect, in this MOU and (c) this MOU is intended solely for the benefit of the Parties hereto, and the Parties expressly disclaim any intent to create any rights in any other third party as a third-party beneficiary to this MOU.

7.3 Notwithstanding anything in this MOU to the contrary, nothing in this MOU shall require the SFWMD to lend or use its taxing power or credit to aid PBA, nor will the SFWMD become a joint owner with or stockholder of PBA.

7.4 No modification or amendment of this MOU shall be binding upon the Parties unless the same is in writing and signed with the same authorization originally given by the Party to be bound.

7.5 This MOU and the rights and obligations of the Parties are to be governed by, construed, and interpreted in accordance with the laws of the State of Florida, and shall be binding upon and inure to the benefit of the Parties hereto and their respective legal representatives, successors and assigns.

7.6 This MOU shall not constitute a lien, cloud, or encumbrance upon on real property, or actual or constructive notice of any such lien, cloud or encumbrance.

7.7 This MOU shall not limit or restrict the SFWMD's or any other governmental authority's discretion in the exercise of their governmental or police powers and shall not constitute a delegation of such entity's governmental authority or police powers.

IN WITNESS WHEREOF, the Parties have set their hands and seals.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
By Its Governing Board

By: [signature]
Name: DANIEL T. O'KEEFE
Title: Chairman

Legal Form Approved:

By: [signature]
Name: Jennifer Bokankowitz, Esq.
Title Attorney

SEAL
BOARD OF SOUTH FLORIDA WATER MANAGEMENT DISTRICT GOVERNING
STATE OF FLORIDA
Established 1949

Attested:

By: [signature]
Name: Brenda E. Low
Title: District Clerk/Assistant Secretary
Date: 5/22, 2013

PALM BEACH AGGREGATES, LLC

By: [signature]
Its: Authorized Representative

Date: 5/16, 2013

12.0 -APPENDIX C – Unit Rates Used in OPCC

Labor Rates			13%	11%	8 hrs
CLASS	**BASE RATE**	**FRINGE**	**TAXES**	**WC**	**TOTAL**
Carpenter	$17.00	$2.31	$2.21	$1.87	**$23.39**
Pile Driver	$18.00	$2.31	$2.34	$1.98	**$24.63**
Cement Mason	$16.93	$0.00	$2.20	$1.86	**$20.99**
Electrician	$29.98	$10.86	$3.90	$3.30	**$48.04**
Crane Operator, over 150 TN	$29.09	$8.80	$3.78	$3.20	**$44.87**
Oilier	$22.99	$8.80	$2.99	$2.53	**$37.31**
Bulldozer Operator	$14.95	$8.80	$1.94	$1.64	**$27.34**
Blade Operator	$16.00	$8.80	$2.08	$1.76	**$28.64**
Loader Operator	$15.33	$3.60	$1.99	$1.69	**$22.61**
Grade checker	$14.50	$4.67	$1.89	$1.60	**$22.65**
Iron Worker	$21.87	$7.65	$2.84	$2.41	**$34.77**
Laborer	$10.64	$0.00	$1.38	$1.17	**$13.19**
Pipe layer	$14.00	$0.00	$1.82	$1.54	**$17.36**
Truck Driver, highway	$9.60	$0.00	$1.25	$1.06	**$11.90**
Truck Driver off-road	$12.27	$1.97	$1.60	$1.35	**$17.18**

Equipment Rates		
Pickup 4x4	**$12.00**	hr.
Cat D-8 dozer/ripper	**$140.00**	hr.
Cat 12 Blade	**$64.00**	hr.
Cat backhoe 330	**$98.00**	hr.
Cat 980 H 7.5 cy bucket	**$140.00**	hr.
Cat 35 ton Art truck	**$143.00**	hr.
Compacter 66"	**$65.00**	hr.
Off-highway water truck 5000	**$65.00**	hr.
Hydro rock drill	**$116.00**	hr.

Hydro crane 20 ton	**$65.00**	hr.
Hydro crane 40 ton	**$90.00**	hr.
Air compressor 750cfm	**$52.00**	hr.
Rented concrete pump	**$7.50**	per cy

Material Rates

Ready - Mix concrete to site 3000-psi	**$105.00**	cy
Ready - Mix concrete to site 4000-psi	**$111.00**	cy
Concrete sand	**$10.28**	ton
Road base	**$11.30**	ton
Sub-contract soil Bentonite 30" cut-off wall	**$134.00**	cy
6" perforated HDPE pipe	**$6.15**	lf
6" slotted plc. pipe	**$6.15**	lf
Rebar cut-bend and place	**$1.10**	lb

RCC mix and deliver

	quantity per cy		**Unit cost**	**total per cy**
coarse aggregate	1122	lb	$0.0075	$8.42
3/4 size aggregate	1276	lb	$0.0065	$8.29
sand	110	lb	$0.0100	$1.10
cement	123	lb	$0.0625	$7.69
pozzand	198	lb	$0.0375	$7.43
admmix	0.099	gal	$6.00	$0.59
Plant cost	1	cy	$10.00	$10.00
operate plant	1	cy	$5.00	$5.00
Deliver	1	cy	$12.00	$12.00
				$60.52

Load and Haul Soil, Peat, Sand/clay

Loader, cat 980	1	hr	$110.00	$110.00

dozer/rippers D-8 Pit	1		$140.00		$140.00
dump	1		$140.00		$140.00
35 ton act trucks	3		$110.00		$330.00
Cat blade 12	1		$64.00		$64.00
Water truck 4000 gal	1		$65.00		$65.00
Grade checker	1		$22.65		$22.65
operators	3		$27.34		$82.02
teamsters	3		$17.18		$51.54
Labor	1		$13.19		$13.19
4-men	0.5		$40.00		$20.00
Pickup	0.5	hr	$12.00		$6.00
					$1,044.40

Production 200 cy/hour		**$5.22**	**cy**
1.3 +/- mile haul			

Excavate 3H:1V slope in Limestone

Loader, cat hoe 330	1	hr	$98.00		$98.00
dozer/rippers D-8 Pit	2		$140.00		$280.00
35 ton act trucks	2		$115.00		$230.00
Cat blade 12	1		$64.00		$64.00
Water truck 4000 gal	1		$65.00		$65.00
Grade checker	1		$22.65		$22.65
operators	3		$27.34		$82.02
teamsters	2		$17.18		$34.36
Labor	1		$13.19		$13.19
4-men	1		$40.00		$40.00
Pickup	1	hr	$12.00		$12.00
Rock drills	4		$116.00	80%	$371.20
Labors	8		$15.00		$120.00
Power truck	1		$35.00		$35.00
Powerman lead	2		$17.00		$34.00

Production 175 cy/hour			**$8.58**	**cy**	$1,501.42
Powder cost					
			$10.83	**cy**	

Load and Haul Bottom sandy/shell material

Loader, cat 980	1	hr	$110.00	$110.00
dozer/rippers D-8 Pit	1.5		$140.00	$210.00
dump	1		$140.00	$140.00
35 ton act trucks	3.5		$110.00	$385.00
Cat blade 12	1		$64.00	$64.00
Water truck 4000gal	1		$65.00	$65.00
Grade checker	1		$22.65	$22.65
operators	3.5		$27.34	$95.69
teamsters	3.5		$17.18	$60.13
Labor	1		$13.19	$13.19
4-men	0.5		$40.00	$20.00
Pickup	0.5	hr	$12.00	$6.00
				$1,191.66

Production 200 cy/hour	**$5.96**	**cy**
Drill and shoot	**$2.75**	**cy**
1.3 +/- mile haul	**$8.71**	**cy**

Compact embankment

Fill foreman	1	$40.00		$40.00
Grade checker	1	$22.65		$22.65
Cat blade 12	1	$64.00		$64.00
Compacter 66"	1	$65.00		$65.00
				$191.65
Production 175 cy/hour		**$1.10**	**cy**	

U/S Toe Concrete

concrete	1	cy	$105	$105.00
fine grade	25	sf	$15	$15.00
side forms	10	sf	$37	$37.00
Pour and finish	1	cy	$5.50	$5.50
cure				$1.00
Rebar	#6 at 12"			$132.00
	cost	cy		**$295.50**

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BUILDING A BETTER WORLD

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