SOUTH FLORIDA WATER MANAGEMENT DISTRICT

EAA Reservoir A-1 Preliminary Design Report for Pump Station, Control Structures and U.S. 27 Bridges

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1.0 INTRODUCTION

1.1 THE COMPREHENSIVE EVERGLADES RESTORATION PLAN (CERP)

The Comprehensive Everglades Restoration Plan (CERP) is charged with restoring the Everglades National Park, reviving habitat for more than sixty threatened and endangered species, restoring the natural water flows from Lake Okeechobee (LOK) to Florida Bay, and establishing a reliable environmental, urban, and agricultural water supply while providing improved flood protection. The CERP mission is:

Restoration of America's Everglades is the world's largest environmental project of its kind

CERP was designed to capture, store and redistribute fresh water previously lost to tide and to regulate the quality, quantity, timing, and distribution of water flows. CERP will be implemented over 30 years at an estimated cost of $8 billion. CERP is being funded, managed, and implemented through a unique 50-50 partnership between the state and federal governments.

Situated at a central point at the head of the Everglades, the Everglades Agricultural Area (EAA) Reservoir A-1 has been described as a keystone to the success of CERP by allowing the necessary control of water with a flexible delivery schedule.

1.2 EAA RESERVOIR A-1 PROJECT

1.2.1 General

The EAA Reservoir A-1 Project (Reservoir Project) is located in western Palm Beach County, generally in Township 46 and Range 37. It is situated in the EAA directly north of Stormwater Treatment Area 3/4 (STA-3/4), between the North New River Canal (NNRC) and Miami Canal, and west of U.S. Highway 27 (U.S. 27). It also adjoins the Holey Land Wildlife Management Area (WMA) to the southwest.

In accordance with CERP guidelines to capture, store and redistribute fresh water, the EAA Reservoir A-1 (Reservoir) facilities will be designed to improve the timing of environmental water supply deliveries to STA-3/4 and the Water Conservation Areas (WCA), reduce LOK regulatory releases to the estuaries, meet supplemental agricultural demands, and increase flood protection within the EAA.

1.2.2 Project Purposes, Goals, Objectives, and Benefits

Implementation of the Reservoir Project will meet objectives consistent with the ongoing work by the United States Army Corps of Engineers (USACE). The Project Implementation Report (PIR) being prepared by the USACE will provide the most current definition of the purpose and

benefits of the EAA Storage Reservoirs Project. In accordance with the USACE's PIR, the objectives of the Compartment A Reservoir, comprising EAA Reservoirs A-1 and A-2, include:

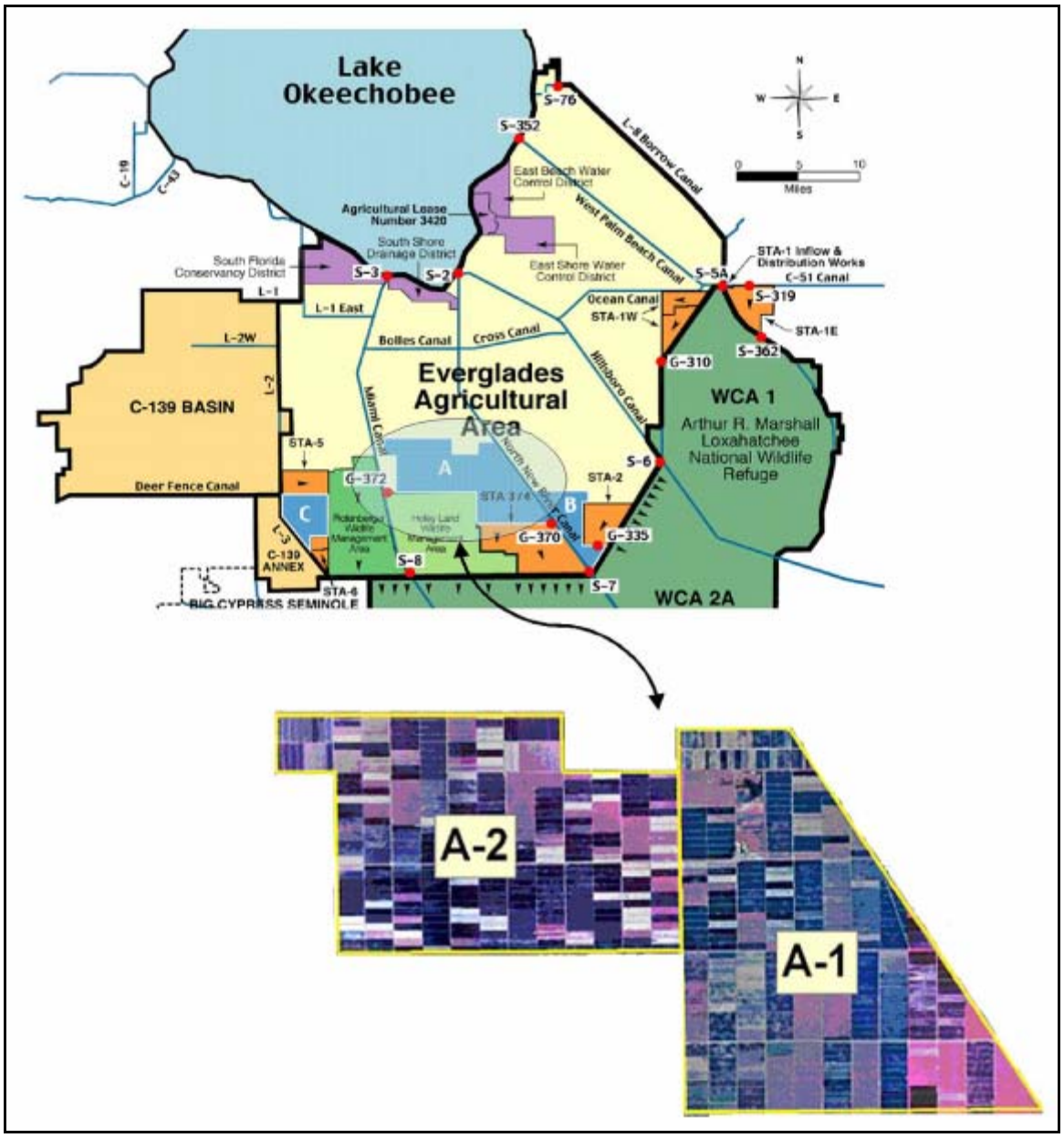
- Reduction of the LOK regulatory releases to the estuaries and backpumping from the Study Area (defined as that portion of the EAA that most influences its reservoir site) into the LOK by sending the water to the Reservoir
- Improved environmental releases through the storage of water and release to the Everglades during the dry season
- Flow equalization and optimization of treatment performance of STA by capturing peak storm event discharges within reservoirs for slow release to the STAs
- Improved regional water supply for the agricultural community currently served by the EAA canals and other areas served by LOK

The Reservoir Project covers approximately 17,000 acres and is designed to store stormwater originating within the S-2/7, S-3/8, S-236 and C-139 basins and releases from LOK, all located generally north of the Reservoir Project site. A schematic of the Reservoir and its relationship to the other EAA infrastructure is shown in Figure 1.2-1.

The EAA Reservoir A-1 is one of several reservoirs that are essential in fulfilling CERP's need to "capture, store and redistribute" fresh water. Further, it will improve the "quantity and timing" of delivery of fresh water to meet environmental and agricultural deliveries. Because of its critical place in the overall plan, the Reservoir's implementation was prioritized under the State of Florida's Acceler8 program. Projects in the Acceler8 program are implemented under an accelerated schedule with funding provided by the State of Florida. With the goal of providing maximum benefits for initial investment, the Acceler8 program will provide for construction of the EAA Reservoir A-1, with construction of EAA Reservoir A-2 to follow at a future date.

Project objectives and analysis of alternatives were covered in detail in the Basis of Design Report (BODR).

Figure 1.2-1 EAA Reservoir A-1 and Surrounding Infrastructure



1.2.3 Key Features

The key features of the Reservoir Project include the following:

- Approximately 190,000 acre-feet of storage with a perimeter embankment and seepage canal
- Northeast pump station that pumps from NNRC, estimated at 3,600 cubic feet per second (cfs) capacity, expandable to 5,000 cfs
- Connector canal from the NNRC to the new northeast pump station
- Seepage pump stations
- Gated discharge structures
- New four lane bridge on U.S. 27 across the new connector canal

Structure numbers, as shown on the Preliminary Drawings are as follows:

- S-602 Southeast Control Structure
- S-603 Southwest Control Structure
- S-609 Northeast Control Structure, Irrigation Pump Station, and Spillway
- S-610 Northeast Pump Station

The Reservoir is intended to store water from the S-2, S-6, and S-7 Basins, collected from the NNRC, and release it to STA-3/4 for treatment before release to WCA-3A.

1.2.4 Plans for Further Development

The Reservoir Project is the first phase of an ultimate EAA Reservoir Storage System that could store approximately 360,000 acre-feet of water over 30,000 acres of South Florida Water Management District (District) owned land between the NNRC and the Miami Canal. The USACE PIR process is currently evaluating Compartment A, which includes Reservoir A-1 and Reservoir A-2. Currently, only Reservoir A-1 is part of the Acceler8 program. It is anticipated that the design and construction of Reservoir A-2 will follow in a few years.

1.2.5 Scope of Work for Work Order 15

The scope of work for Work Order 15 is for preliminary engineering design services (30 percent design) for the northeast pump station, discharge structures, and U.S. 27 bridges at the Reservoir. Preliminary design services for the embankment and associated canals are not included in this Work Order. However, preliminary site layout showing locations of embankments, canals, access roads, and structures will be included.

The task will include preliminary design and layout of the pump station structure, equipment, and appurtenant systems; the Reservoir spillway; discharge structures; and bridges.

The design will be based on the conclusions from the BODR (dated January 2006), District Standards, and technical memoranda developed during previous work orders. A discussion of the Basis of Design is included in Section 5 of this report, and Lists of Drawings and Technical Specifications are included in Sections 8 and 9, respectively.

2.0 SITE CONDITIONS

The site conditions discussed in this Section were developed for the entire EAA Reservoir A-1 site and were presented in the BODR. Many of the environmental conditions included below will not be encountered at the specific structure sites.

The planned Reservoir Project is located about 16 miles south of Lake Okeechobee in western Palm Beach County, Florida. It is in the Everglades physiographic area, an area of low relief with the natural ground surface of the Reservoir Project site lying generally between elevations 8 and 11 feet NAVD88.

The Reservoir site is an agricultural area primarily used for growing sugarcane. The area is drained by a system of canals constructed largely during the second half of the last century under the United States Army Corps of Engineers' (USACE) Central and Southern Florida Project. Flooding and draining these canals is used by the local sugar producers to regulate the groundwater level during planting and harvesting of the primary crop (sugarcane).

2.1 *CLIMATE*

The climate of southeast Florida is characterized as subtropical. The average annual temperature in Palm Beach County, Florida is approximately 73 degrees Fahrenheit. According to the Southeast Regional Climate Center (one of six regional climate centers in the United States directed by the National Oceanic and Atmospheric Administration [NOAA]), the average maximum daily temperature for the Belle Glade Experimental Station (No. 080611) was 83.5 degrees Fahrenheit for the period of record May 1, 1924 through February 29, 2004. The average minimum temperature for the same period of record was 61.7 degrees Fahrenheit. Average total precipitation at the Belle Glade Experimental Station for this period of record was 55.32 inches. The Belle Glade Experimental Station is approximately 10 miles north of the Reservoir Project site.

Approximately 75 percent of the annual precipitation occurs during the wet season months of June through October. During this season, scattered and isolated convective thunderstorms occur frequently over land. Tropical storms and hurricanes also occur during the wet season and can provide significant rainfall and extreme winds in a short period of time. Rainfall from November through May (the dry season) is usually the result of large frontal systems from the north and are broadly distributed rather than localized. According to the Southeast Regional Climate Center, the wettest average month for the period of record is June (8.52 inches), while the driest average month for the period of record is December (1.71 inches).

2.2 *LAND USE DURING CONSTRUCTION*

The EAA was designated by the United States Congress in 1948. It is bounded by Lake Okeechobee on the north and the Everglades National Park on the south. The EAA was created

as a result of draining the northern Everglades for agricultural use. It encompasses about 27 percent of the historic Everglades and consists of an area of approximately 700,000 acres of farmland. The major crop in the EAA is sugarcane, but winter vegetables are also grown.

Nearly the entire Reservoir Project site, as well as adjoining lands to the north, northwest, and east, is designated for sugarcane production. A small rectangular-shaped parcel in the northern portion of the Reservoir Project site is designated industrial land use, and was occupied by the Talisman Sugar Corporation processing facility. The Holey Land tract is southwest of the Reservoir Project site and is designated as freshwater marshes with sawgrass. The southern adjoining property is occupied by STA-3/4.

Much of the acreage currently designated for sugarcane production is to remain in production during construction of the Reservoir and associated facilities. In conjunction with this use, the existing interior canals, access roads, pumping stations, and electrical power lines serving the area need to remain in service. A land use plan showing the areas and facilities to remain in service during the construction period was included in the Preliminary Drawings for the Embankments and Canals (Work Order 13).

2.3 *GEOLOGY AND SOILS*

The Reservoir Project site has been investigated in a progressive sequence of borings spaced throughout the site area. One hundred forty-five borings were completed for the District around the Reservoir perimeter in 2003 and early 2004. Twenty borings to a depth of 50 feet below ground surface (bgs) were completed at the Reservoir Project Test Cell site for the Test Cell Project design in December 2004, and an additional eight borings to 100 feet depth were completed during the Test Cell construction in early 2005. During the summer of 2005, 158 conventional rotary borings and 5 rotosonic borings were completed bringing the boring spacing to roughly 1000 feet around the site perimeter and 2000 to 4000 feet across most of the site interior. Twenty-eight of the rotary borings extended to a depth of 100 feet, while the remainder were drilled to depths ranging between 8 and 42.5 feet. The depths of the rotosonic borings ranged between 220 and 250 feet.

The borings generally penetrated through about 1/2 to 2 feet of surficial peat/muck and marl, then through 18 to 35 feet of primarily carbonate sand and limestone, and then into primarily shelly quartz sand with sparse limestone to a depth between 61 and 89 feet. The marl beneath the peat and muck is known by some authors as the Lake Flirt Marl, but is undifferentiated from the peat and muck layer for this report. The upper carbonate sand and limestone constitutes the Fort Thompson Formation at the site. Below this, the shelly sand and sparse limestone constitutes the Caloosahatchee Formation and the underlying Pinecrest Sand Member of the Tamiami Formation.

Below 61 to 89 feet depth, the 100-foot rotary borings and the rotosonic borings penetrated into primarily shelly, carbonate sand again but mixed with varying proportions of fine, quartz sand and sandy limestone gravel, the Ochopee Limestone Member of the Tamiami Formation. The rotosonic borings penetrated through the Ochopee Limestone and a shelly, silty, fine quartz sand, and then into a distinct olive gray unit to their completed depths. The top of the shelly, silty sand, referred to as the Unnamed Sand was at between 140 and 177 feet depth. Between 191 and 200 feet depth they penetrated into olive gray Peace River Formation, the upper

formation of the Hawthorne Group, that grades downward from very fine quartz sand to sandy clay.

The top of the Fort Thompson Formation consists of a limestone layer generally about 4.5 to 5 feet thick, which is locally called caprock. The caprock is generally white, light gray, tan, or yellowish brown with variable amounts of weathering; it is jointed and contains solution cavities and weakly cemented, porous zones. The caprock is underlain by silty carbonate sand with localized hard limestone layers extending down to the Caloosahatchee Formation. Another hard limestone layer 1.5 to 3 feet thick is often encountered along the contact between the Fort Thompson and the Caloosahatchee. A thinner, hard limestone layer about 1/2 to 1 foot thick is sometimes encountered at around 16 to 17 feet deep. The sand and lower limestone layers are generally white to very pale brown. Laboratory testing of the sand sampled in the borings averaged 83.6 percent calcium carbonate content with an average of 19.9 percent passing the #200 sieve in gradation tests. The Unified Soil Classification (ASTM D422) for the SPT samples tested (90 tests) were mostly SM (53) with some SW-SM (12), SP-SM (6), and GP-GM (4) and with occasional GM (3), SP (3), GW (1), GW-GM (2), CL-ML (2), ML (2), and SW (1). Visual inspection of the sand samples from the borings reveals that they include shell fragments, and tend to be angular and platy.

The top of the Caloosahatchee Formation is composed of fine grained, subrounded, shelly quartz sand. The Caloosahatchee Formation and the underlying Pinecrest Sand Member of the Tamiami Formation cannot be differentiated in the borings. At the site, the two average a total of about 41 feet thick. Samples sent for laboratory testing were assigned Unified Soil Classifications of mostly SP-SM (43), SM (23), and SW-SM (15) and occasionally SP (8), GP-GM (5), GP 1)), and GM (1). The proportions of carbonate to quartz sand vary. The sampled sand indicated an average calcium carbonate content of 36.1 percent, and an average 10.7 percent of material passing the #200 sieve. The primary color of the geologic material in the Caloosahatchee Formation and the Pincrest Sand is light greenish gray.

Samples tested from the Ochopee Limestone Member of the Tamiami Formation averaged 65.8 percent carbonate and 11.7 percent passing the #200 sieve. The samples were assigned Unified Soil Classifications of mostly SP-SM (38), SM (24), and SW-SM (17) with a few GP-GM (4) and GW-GM (2). The Ochopee Limestone is generally light gray in color.

The Unnamed Sand is generally light yellow-gray. Samples tested averaged 47.6 percent carbonate and 24.4 percent passing the #200 sieve. The samples were assigned Unified Soil Classifications of SM (8), SP-SM (4), and CL-ML (1)

The Peace River Formation is olive gray in color. Samples tested averaged 27.2 percent carbonate and 52.2 percent passing the #200 sieve. The samples were classified as SM (7), ML (3), CL (2), and CH (1)

2.4 *SEISMICITY*

The Uniform Building Code Seismic Zone Map (USACE 1995), shows that the entire state of Florida is in seismic Zone 0. There are no known active or capable faults in Florida, and no capable faults or recent earthquake epicenters are known to exist near the Project site. The United States Geological Survey (USGS) Earthquake Hazards Program website lists 28

earthquake epicenters within 300 kilometers of the EAA Reservoir A-1 test cell site. Of these, 20 are associated with a January 1942 event in the Everglades area attributable to blasting.

The National Oceanic and Atmospheric Administration (NOAA) database shows there have been 136 recorded instances of felt ground motion in Florida since 1879, the first year in the record. Of these, many are the result of earthquakes centered outside of Florida, most notably the September 1886 earthquake at Charleston, South Carolina but also earthquakes centered in Cuba. Of the rest, many are of doubtful seismic origin, some are attributable to blasting such as the 1942 event noted above.

Of the historical ground motion events reliably attributable to seismic events in Florida, only one produced damage. This was a Modified Mercalli VI series of two shocks on January 13, 1879. Each lasted about 30 seconds and was felt from Savannah, Georgia on the north to Daytona Beach, Florida on the south. Damage was minor, including cracked and fallen plaster and articles thrown from shelves.

An inquiry at the USGS website for the latitude and longitude (N26.46301 and W80.68098) of the EAA Reservoir A-1 Test Cell site returned a probabilistic peak ground acceleration of 3.28 percent for a 2 percent possibility of exceedance in 50 years. De-aggregation plots of the probabilistic seismic hazard for the test cell site showed that the largest contributor to the hazard for long period (1 and 2 second period) seismic ground motion was from a M_W 7.3 earthquake (1886, Charleston, South Carolina). For short period (PGA and 0.2 second period) seismic ground motion the largest contributor is an earthquake of about M_W 5 within 50 kilometers of the site.

Based on available data, the seismic hazard and the risk of damage due to seismic events in Florida and at the Reservoir site are considered to be low.

2.5 *SURFACE WATER HYDROLOGY*

Lake Okeechobee provides water south to the EAA through the NNRC and the Miami Canal. The Miami Canal flows south to the G-372 pump station, and then continues south into the Everglades Protection Area. The G-372 pump station pumps water into the STA-3/4 Supply Canal which currently feeds the Holey Land WMA and STA-3/4. The NNRC flows south to G-370 pump station and continues on south into the Everglades Protection Area. The NNRC will be used to supply the new northeast pump station located at the northeast end of the Reservoir. The G-370 pump station currently feeds the east end of the STA-3/4 Supply Canal.

There are numerous secondary agriculture canals that connect to the major canals along with seepage ditches common outside the levees. The secondary agriculture canals are responsible for north-south water movement.

The Reservoir embankment will be designed to withstand the wind and precipitation design conditions identified in draft DCM-2 (Haapala Et Al., 2005a). The conditions were 1) 100 year wind with probable maximum precipitation, 2) category five hurricane with 100-year storm, 3) probable maximum wind (200 mph), and 4) a storm specific wind and precipitation (Hurricane Easy). These conditions are described in Section 5.3 of the BODR.

Design conditions affecting the Reservoir include:

- 100-year wind speed 103 mph
- Probable Maximum Precipitation 54 inches
- Design wave height 6.65 feet
- Wind setup 2.1 feet
- Wave run-up 6.0 feet
- Maximum water level 24.6 feet

2.6 *GROUNDWATER HYDROLOGY*

Since the intermediate groundwater confining unit is located approximately 200 to 250 feet below ground surface and will restrict any seepage from Reservoir that might reach this depth, only the surficial aquifer system lying above the confining unit is of concern for this project. With the high degree of communication between groundwater and surface water in the area, the groundwater gradient in the surficial aquifer system is controlled to a large extent by the operation of the hundreds of canals throughout the region. Therefore, even though the general regional gradient in the surficial aquifer system is believed to be southward, localized gradients may actually be in other directions in portions of the area surrounding the Reservoir site due to the operation of canals and wells in the region. Future seepage from the Reservoir, the operation of the seepage canal, and modifications to the operation of the NNRC will also change these groundwater gradients in the surficial aquifer system near the Reservoir

To interpret the groundwater pressure profile in the surficial aquifer system when seepage occurs, a series of more than 70 piezometers were installed for the Test Cell Project. The pressure readings from the piezometers were used to determine both the horizontal and vertical hydraulic conductivity (K_h and K_v, respectively) for each of the geologic units comprising the surficial aquifer system using both three-dimensional and two-dimensional groundwater models. The K_h and K_v values (derived by calibrating each of the groundwater models to the measurements taken during the Test Cell Project) are shown in Table 2.6-1.

Table 2.6-1 Hydraulic Conductivity Values Determined by Test Cell MODFLOW Model

Layer	K_h (feet/day)	K_v (feet/day)
Muck/peat and marl[1]	100	100
Caprock	500	1.1
Fort Thompson Formation	400	10
Caloosahatchee Formation	400	8
Tamiami Formation [2]	36	18

[1] Muck was removed from Test Cells, so calibration of the K values for the muck was not possible. The listed values were determined by the United States Army Corps of Engineers (USACE) through laboratory/field testing of the muck which were K_h = 40 feet/day and K_v = 9 feet/day (USACE, 2005). These values were increased as shown to account for the significant area where muck does not exist (Seepage Evaluation, Groundwater Model Memorandum, Black & Veatch, July 11, 2005).

[2] The Test Cell piezometers did not penetrate the deeper portions of the surficial aquifer system, so calibration to the published K values for the Tamiami Formation was not possible. The above conductivities reflect the USACE's values determined from laboratory/field testing.

2.7 *ENVIRONMENTAL CONDITIONS*

Under CERP, an area of land called Parcel A in the center of the EAA south boundary was designated as the site for a storage reservoir. Parcel A consists of about 30,000 acres including approximately 583 acres of open water, 97 acres of shrub and brushland, 206 acres of wetlands, and the remaining acres in agricultural use. Under the Acceler8 program, Parcel A was divided into two portions: A-1 and A-2. EAA Reservoir A-1 is approximately the Eastern half of Parcel A over an area of close to 17,000 acres. Historically, the project area was predominantly sawgrass marsh but in the mid-1900s it was drained for agricultural production.

The discussion of environmental conditions focuses on two specific issues: 1) vegetation and wetlands and 2) endangered species. A summary of the information follows and more detailed information is contained in the BODR (Appendix 2-1). Environmental Site Assessments are described in Section 2.7.3.

2.7.1 Vegetation and Wetlands

2.7.1.1 Existing Conditions

The Reservoir Project area contains five verified wetlands, totaling 205.88 acres. The habitat quality of the five verified wetlands was determined as one Category 1 wetland (13.07 acres), one Category 3 wetland (1.73 acres), one Category 5 wetland (3.45 acres), and two Category 6 wetlands (187.63 acres).

USFWS (Slack, 2005) issued a Planning Aid Letter (PAL) to USACE on March 11, 2005, in which they provided guidance and recommendations on resource conservation issues for the EAA Reservoir Storage Project. USFWS recommended including a habitat buffer on the north

and west sides, and littoral shelves along the seepage canals and on the internal sides of the embankment. USFWS recognized that littoral shelves on the interior sides of the Reservoir may be cost-prohibitive.

2.7.1.2 Potential Impacts

Due to the presence of extensive sugarcane farming and limited acreage of natural habitats on the Reservoir Project site, adverse effects to native vegetation are limited to wetland areas. As a result of the proposed Reservoir Project, approximately 206 acres of emergent and scrub-shrub wetland will be converted to open water aquatic habitat. All impacts to upland areas are to lands in active agricultural use.

The existing wetlands (205.88 acres) within the Reservoir Project are considered to be disturbed wetlands due to the sugarcane farming practices that comprise the majority of the surrounding area. Most of the wetlands are dominated by nuisance and/or exotic vegetation as identified by the Florida Exotic Pest Plant Council on the List of Invasive Species and appear to be isolated and surrounded by sugarcane farming. Although the habitat is predominately exotic, the wetlands still provide habitat and foraging for medium and small sized animals. The wetlands also provide water storage and promote water quality.

The proposed Reservoir will replace the wetland habitat with an aquatic habitat that will be approximately 16,000 acres in size. The area is projected to re-vegetate through natural recruitment with aquatic plants and wetland plants particularly around the edge of the water. The aquatic habitat will provide habitat and foraging for medium and small sized mammals, reptiles, amphibians, birds, fish and invertebrates. The increase in open water will specifically provide an optimal location for migratory birds for habitat and foraging, and increased utilization by fish and other aquatic species. The water storage function will increase due to the large capacity of the Reservoir. There will be deep water refugia that will be approximately three to five percent of the total acreage. The Reservoir will also provide a filter to “polish” water, improving water quality.

Littoral benches along seepage canals (approximately eight acres) will also be constructed around the exterior of the embankment. There may be intermittent littoral shelves within the canals, depending on the characteristics of the cap rock at specific locations. These littoral shelves will depend on natural vegetative recruitment from surrounding seed sources. The littoral shelves will also provide habitat and foraging for a variety of species, as well as water storage and increased water quality.

2.7.2 Fish and Wildlife

Prior to the agricultural alterations to this area, wildlife was similar to that found on the adjacent Holey Land WMA. Wildlife species typically seen at the Holey Land WMA include white-tailed deer, common snipe, marsh rabbit, blue-winged teal, mottled ducks, and other waterfowl.

2.7.2.1 Existing Conditions

The proposed Reservoir Project area is dominated by sugarcane production interspersed with isolated emergent wetlands and drainage canals dissecting the property. The USFWS stated that native habitats for fish and wildlife are not a significant component of the area due to alterations for agriculture that have removed most native vegetation. The quality of habitat provided by the existing canal and wetlands is low. However, these wetland habitats do provide foraging habitat for birds, and the canals provide habitat for fish, reptiles, and invertebrates.

The Florida Natural Areas Inventory (FNAI) was consulted to identify the elemental occurrences of protected species within the Reservoir Project area, and none was found. Potential habitat for the wood stork and Florida panther was identified southwest of the Reservoir Project area that is in the Holey Land WMA. The FWC Potential Habitat Model was used by the USFWS to identify and calculate potential habitat areas for those wildlife species that may occur in the Reservoir Project area. Out of 33 possible species, potential habitat was identified for 14. One of these is federally endangered (wood stork) and two are federally threatened (American alligator and eastern indigo snake).

2.7.2.2 Potential Impacts

Due to the limited natural habitat within the Reservoir Project area, long-term adverse impacts to fish and wildlife, including state and federal protected species, are not anticipated. Waterfowl, fish, and reptiles may experience temporary impacts due to the elimination of existing agricultural ditches and isolated wetlands. Impacts to all wildlife species can be minimized by gradually flooding the area, thereby allowing the terrestrial wildlife to vacate the area. However, following construction, new habitat will be created that will afford similar foraging opportunities for these species. Potential habitat in the adjacent Holey Land WMA will be impacted indirectly by the control of water levels and improved water quality at the WMA. Additionally, temporary impacts from the noise from construction activities are anticipated.

2.7.3 Environmental Site Assessments

Under the Talisman Exchange, the Talisman Sugar Corporation (Talisman) in conjunction with The St. Joe Company (SJC), conveyed approximately 55,000 acres of land utilized for sugarcane farming and milling to the United States Department of Interior (DOI), the District and The Nature Conservancy (TNC). The farmland is located in Palm Beach and Hendry Counties, and consists of the Talisman Farm (approximately 36,000 acres) and several smaller, non-contiguous satellite farms.

The southern portion of the Talisman Farm will become the Reservoir. The northern portion of the Talisman Farm, along with the satellite farms, has been exchanged by the District for land owned by other local sugarcane growers in order to secure a contiguous block of land necessary for creation of the Reservoir and to assist in restoring water quality in the Everglades.

Prior to conveyance of the Talisman property, Dames and Moore (D&M), on behalf of the District, performed Phase I and Phase II Environmental Site Assessments on the Talisman owned/leased properties. The Environmental Site Assessments were part of the due diligence effort associated with the potential purchase of the property. The Phase I Environmental Site Assessment was performed to identify potential point source areas of concern. A Phase II Environmental Site Assessment was later performed to determine the status of potential constituents of concern (COC) at each of the areas of concern identified in Phase I. It was not within the scope of work of the Phase II Environmental Site Assessment to fully delineate any potential impacts to soil and/or groundwater.

Based on the Phase I and Phase II Environmental Site Assessments, D&M identified 11 areas at which COC were detected in soil, groundwater, sediment, or surface water at concentrations exceeding regulatory cleanup target levels or guidance concentrations. Transference of ownership of each of the Exclusion Areas was deferred until a Site Rehabilitation Completion Order (SRCO) for each Exclusion Area was issued by the FDEP.

The list of Exclusion Areas included:

- Five pump stations
- Two pesticide mix load areas
- A former labor camp and crop duster landing strip
- A former borrow pit/agricultural landfill
- The former sugar processing mill
- The surface water management areas adjacent to the sugar mill

These areas were primarily impacted with organochlorine pesticides (e.g., DDT), petroleum products, and arsenic.

Professional Services, Inc. (PSI) performed assessment and remediation on all of the Exclusion Areas on behalf of Talisman Sugar Corp. and the SJC. The cleanup objectives for each Exclusion Area within the proposed Reservoir area were based on the proposed end land use for water storage areas. As such, cleanup target levels were chosen to be protective of potential ecological receptors which are likely to inhabit the area once a reservoir is constructed. Since the cleanup target levels for protection of wildlife for most of the chemicals found on the Talisman property are more stringent than the cleanup standards for human health, a cleanup to ecological standards is also inherently protective of agricultural workers during the interim period prior to Reservoir construction, and Reservoir construction workers.

The FDEP has issued SRCOs for the majority of the Exclusion Areas. These parcels can be conveyed immediately with no restrictions. On the remaining parcels, the remediation work has been completed to the satisfaction of the FDEP and the FDEP has issued memoranda of technical concurrence. However, a deed restriction is necessary in order to convey the property to the District.

The cleanup of the mill site involved assessment and remediation of a number of point source discharge areas. Areas of concern at the mill site included numerous leaking petroleum storage tanks, pesticide and/or arsenic impacted soils in the sediments of two drainage canals, an ash pit, a water storage retention area, and metals-impacted soils adjacent to several building slabs.

In general, the petroleum impacted areas were handled through excavation and on-site treatment of soils in ex-situ bioremediation piles. Once the treatment was verified by confirmation sampling, the treated soils were returned to their respective excavations. PSI excavated, treated, and backfilled approximately 16,000 cubic yards of petroleum impacted soil at the mill site.

PSI was instructed that the canals and surface depressions at the mill are to be filled as part of the EAA Reservoir A-1 construction. Therefore, rather than excavating impacted sediments from the drainage canals, PSI elected to cover these slightly impacted soils with a 2-foot cover. The cover is intended to prevent exposure of potential receptor species to these sediments. Pesticide and arsenic impacted soil was also excavated from other areas of concern at the mill site and consolidated in the ash pit. The ash pit was a low lying excavated area that accepted effluent from the boilers. The ash in the pit was lightly impacted with heavy metals and polynuclear aromatic hydrocarbons (PAHs). Additional soils from other areas of concern were

also filled into the pit and the ash pit was covered with two feet of clean soil to prevent future exposure.

These three areas within the mill site where contaminated soils have been left and capped will also require restrictions on excavation activities. These parcels are identified as the South Rock Canal, the Ash Pit, and the Waste Lake Discharge Ditch. An additional area of capped, impacted soil is present approximately three miles west of the mill at the former borrow pit/agricultural landfill. These areas contain pesticide, PAH and metal impacted soils which are buried beneath a clean soil cover. The excavation restrictions are necessary to prevent disturbance of these areas. These areas have been surveyed by a professional land surveyor and the coordinates have been provided to District personnel to ensure that no disturbance of these areas occurs.

In summary, all of the physical assessment and remediation intended by District has been completed on all of the Exclusion Area parcels and all of the technical documents relating to the cleanup have been reviewed and accepted by FDEP. Remaining outstanding activities are to record the appropriate deed restrictions on a few of the parcels. Once these activities are completed, it is expected that the FDEP will issue SRCOs on the remaining parcels and all of the parcels can be conveyed to the District.

The Talisman Exchange and the environmental remediation described in the preceding paragraphs occurred before Black & Veatch's involvement with the project. The District has verified that the variable water levels resulting from reservoir operation and subsequent resuspension of sediments were taken into account in the remediation assessment. Black & Veatch has been instructed that the District has accepted the standard of protection offered by the remediation. No further investigations into contamination are intended at this time. The Preliminary Design Report does not address any of these risks, and Black & Veatch accepts no responsibility of existing conditions as directed by the District.

3.0 DESIGN REQUIREMENTS AND CRITERIA

3.1 PROJECT LIMITS AND SITE DATUM

The EAA Reservoir A-1 Project is bounded by U.S. 27 on the east, STA-3/4 on the south, the Holey Land WMA on the southwest, and farmland in the EAA on the northwest and north.

The horizontal datum for this report is North American Datum of 1983 (NAD83); and vertical datum is North American Vertical Datum of 1988 (NAVD88). Some other studies and designs use the National Geodetic Vertical Datum of 1929 (NGVD29) as a vertical datum. The relationship between them is NAVD88 = NGVD29 – 1.4 feet.

3.2 FUNCTIONAL AND OPERATIONAL

3.2.1 Inflow to Reservoir

Reservoir inflows will consist of flows from the NNRC, Miami Canal, seepage collection canals, and precipitation. A more detailed description of each inflow is provided in Section 6.2.4 of the BODR.

Inflow will be accomplished through the use of the new northeast pump station, the new control structure S-609 adjacent to the northeast pump station and the new control structures S-602 and S-603 from the STA-3/4 Inflow Canal.

3.2.2 Discharge from Reservoir

Reservoir discharges will consist of losses from evaporation, seepage, environmental deliveries, agricultural deliveries, and excess volume outflows. A more detailed description of each discharge is provided in Sections 6.2.5 and 6.2.6 of the BODR.

Releases from the Reservoir will be made from the STA-3/4 Inflow Canal control structures S-602 and S-603, the control structure S-609 and spillway adjacent to the northeast pump station, and pumped discharges from the irrigation pumps adjacent to the northeast pump station.

3.3 SERVICE LIFE

According to USACE Engineering Manuals EM-1110-2-3104, EM-1110-2-3102, and Major Pumping Station Engineering Guidelines, the design life for the new northeast pump station and any modifications to G-370 and G-372 pump stations will be 50 years. With proper maintenance, this design life can be achieved by following the guidance in those documents.

The mechanical equipment will require rehabilitation or replacement over the design life. The engines and pumps will operate intermittently but will require regular maintenance. The engines may require at least one major overhaul during the design life while the pump materials will be

designed to provide long service life. The architectural and structural design of the pump stations will include elements that will require minimum maintenance and repair over the design life.

The design elements for the geotechnical; structural; architectural; mechanical; civil; plumbing; heating, ventilation, and air conditioning (HVAC); electrical; and instrumentation and control elements are described in more detail in Sections 5.2 through 5.8.

3.4 PROJECT WORK LIMITS

The Reservoir Project limits are bounded by U.S. 27 on the east, STA-3/4 on the south, the Holey Land WMA on the southwest, and farmland in the EAA on the northwest and north. A survey of some of the cross-sections along the boundary of the Reservoir was completed in 2004 (Wantman Group, 2004). Final surveys for the northeast pump station and other Reservoir components will be completed when the approved facility locations have been finalized.

3.5 UNITS

The units and system of measurement will be in English.

3.6 CODES AND STANDARDS

3.6.1 General

- CERP Guidance Memoranda
- District Design Criteria Memoranda
- District Standard Design Guidelines adopted August, 2005
- Acceler8 Design Criteria Memoranda (DCM)

3.6.2 Site Work Design Criteria

Codes and standards: design and specification of all work shall be accordance with the latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein.

- American Association of State Highway and Transportation Officials (AASHTO)
- American National Standards Institute, Inc. (ANSI)
- American Society for Testing and Materials (ASTM)
- Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)
- Asphalt Institute (AI)
- Federal Highway Administration (FHWA)
- Florida Department of Transportation (FDOT)
- Manual on Uniform Traffic Control Devices (MUTCD)

- South Florida Water Management District (District)
- Uniform Federal Accessibility Standards (UFAS)
- United States Army Corps of Engineers (USACE)

3.6.3 Geotechnical Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with the latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein. Recommended and recognized standards from other organizations shall be used where required and approved to serve as guidelines for the design, fabrication, and construction when not in conflict with the standards referenced herein.

- American Society for Testing and Materials (ASTM)
- Design Manual for Roller Compacted Concrete (RCC) Spillways and Overtopping Protection, Portland Cement Association, 2002
- Engineering Manual (EM) 1110-2-2300, General Design and Construction Considerations for Earth and Rock-Fill Dams
    - EM 1110-2-1901, Seepage Analysis and Control For Dams
    - EM 1110-2-1902, Slope Stability
    - EM 1110-2-2006, Engineering Design – Roller Compacted Concrete
- Florida Building Code, 2004 Edition
- Florida Department of Transportation (FDOT)
- South Florida Water Management District (District)
- United States Army Corp of Engineers (USACE)

3.6.4 Architectural Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with the latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein.

- Florida Accessibility Code - Latest Edition
- Florida Building Code - 2004 Edition
- Occupational Safety and Health Administration - 29 CFR

3.6.5 Structural Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with the latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein.

- Aluminum Design Manual "Specifications for Aluminum Structures," 2000
- American Concrete Institute (ACI)
  - ACI 318-02 "Building Code Requirements for Reinforced Concrete"
  - ACI 350-01/350R-01 "Code Requirements for Environmental Engineering Concrete Structures and Commentary"
  - ACI 350.4R-04 “Design Considerations for Environmental Engineering Concrete Structures”
  - ACI 530 “Building Code Requirements for Masonry Structures”
  - ACI 530.1 “Specification for Masonry Structures”
- American Institute of Steel Construction, Inc. (AISC): Manual of Steel Construction, Allowable Stress Design, 9th Edition
- American Society of Civil Engineers (ASCE) 7-02: Minimum Design Loads for Buildings and Structures
- American Welding Society (AWS)
  - American Welding Society, Structural Welding Code – Steel
  - American Welding Society, Structural Welding Code – Stainless Steel
  - American Welding Society, Structural Welding Code – Aluminum
- CERP Standard Design Manual, June 6, 2003
- Concrete Reinforcing Steel Institute Handbook
- Florida Building Code, 2004 Edition
- PCI Design Handbook, Precast and Prestressed Concrete
- South Florida Water Management District, Major Pumping Station Engineering Guidelines, December 1, 2005
- United States Army Corps of Engineers (USACE)
  - EM 1110-1-2009 Architectural Concrete
  - EM 1110-2-2000 Standard Practice for Concrete for Civil Works Structures, dated 1 February 1994
  - EM 1110-2-2102 Waterstops and Other Preformed Joint Materials for Civil Works Structures, dated 30 September 1995
  - EM 1110-2-2104 Strength Design for Reinforced Concrete Hydraulic Structures, dated 30 June 1992
  - EM 1110-2-2105 Design of Hydraulic Steel Structures, dated 31 March 1993
  - EM 1110-2-2502 Retaining and Flood Walls, dated 29 September 1989
  - EM 1110-2-2701 Vertical Lift Gates, dated 30 November 1997

- EM 1110-2-3104 Structural and Architectural Design of Pumping Stations, dated 30 June 1989

3.6.6 Special Mechanical Equipment Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with the latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein.

- American Association of State Highway and Transportation Officials (AASHTO)
- American Bearing Manufacturers Association (ABMA)
- American Gear Manufacturers Association (AGMA)
- American Petroleum Institute (API)
  - API Standard 620 - Design and Construction of Large Low Pressure Storage Tanks
  - API Standard 650 - Welded Steel Tanks for Oil Storage
- American Society of Mechanical Engineers (ASME)/American National Standards Institute (ANSI)
  - ANSI/ASME B1.20.1 - General Purpose Pipe Threads
  - ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
  - ANSI/ASME B16.5 - Steel Pipe Flanges and Flanged Fittings
  - ANSI/ASME B16.11 - Forged Fittings, Socket-Welding and Threaded
  - ANSI/ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges
  - ANSI/ASME B16.25 - Butt-welding Ends
  - ANSI/ASME B31.10 - Pressure Piping
- American Society of Testing and Materials (ASTM)
  - ASTM A36 - Structural Steel
  - ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
  - ASTM A105 - Forgings, Carbon Steel for Piping Components
  - ASTM A139 - Electric Fusion Welded Steel Pipe
  - ASTM A139B - Specification for Electric-Fusion (Arc)-Welded Steel Pipe
  - ASTM A181 - Forgings, Carbon Steel for General Purpose Piping
  - ASTM A283 - Carbon Steel Plate, Shapes, or Bars
  - ASTM A307 - Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile

- ASTM A312 - Specification for Seamless and Welded Austenitic Stainless Steel Pipe
- ASTM A563 - Specifications for Carbon and Alloy Steel Nuts
- ASTM A568 - Steel, Sheet, Carbon, and High Strength, Low Alloy Hot Rolled and Cold Rolled
- ASTM A570 - Hot Rolled Carbon Steel Sheet
- ASTM F593 – Stainless Steel Bolts, Hex Nuts, Screws, and Studs, 2000

- American Water Works Association (AWWA)
  - AWWA C200 - Steel Water Pipe 6 Inches and Larger
  - AWWA C207 - Steel Pipe Flanges for Waterworks Service, Sizes 4 Inch through 144 Inch
  - AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings
  - AWWA M11 - Steel Water Pipe - A Guide for Design and Installation
  - AWWA C600 - Installation of Ductile-Iron Water Mains and their Appurtenances
- ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe
- CERP Standard Design Manual, 2003, USACE Jacksonville District and the District
- EPA Regulation 40 CFR Part 280.41
- Heat Exchange Institute (HEI)
- Hydraulics Institute Standards (HI)
  - ANSI/HI Standard 9.8-1998 - Pump Intake Design
  - ANSI/HI Standard 2.1-2.6-2000 - Standards for Vertical Pumps
  - ANSI/HI Standard 9.6.1-1998 – NPSH Margin
- Manufacturers Standardization Society of Valve and Fitting Industry (MSS)
  - MSS-SP 58 (1993) Pipe Hangers and Supports + Materials, Design, and Manufacture
  - MSS-SP 69 (1996) Pipe Hangers and Supports + Selection and Application
- National Fire Protection Association (NFPA)
  - NFPA 30 - Flammable and Combustible Liquids Code
  - NFPA 30A - Automotive and Marine Station Code
  - NFPA 37 - Stationary Combustion Engines and Gas Turbines
  - NFPA 329 - System Test
- Pipe Fabrication Institute (PFI):
  - PFI-ES5 - Cleaning of Fabricated Pipe
- Steel Structures Painting Council (SSPC)

- SSPC SP1 - Solvent Cleaning
- SSPC SP3 - Power Tool Cleaning
- SSPC SP5 - White Metal Blast Cleaning
- SSPC-SP6 - Commercial Blast Cleaning
- SSPC SP7 - Brush Off Blast Cleaning

- South Florida Water Management District, Major Pumping Station Engineering Guidelines, December 1, 2005
- Underwriters Laboratories Inc. (UL)
  - UL-142 - Steel Aboveground Tanks for Flammable and Combustible Liquids
- United States Army Corps of Engineers (USACE)
  - EM 1110-2-3102, General Principles of Pumping Station Design and Layout, 1995
  - EM 1110-2-3104, Structural and Architectural Design of Pumping Stations, 1989
  - EM 1110-2-3105, Mechanical and Electrical Design of Pumping Stations, 1999

3.6.7 HVAC, Plumbing and Fire Suppression Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with the latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. In addition to the applicable codes and standards previously identified, the system designs will also be based on but not limited to the following publications and standards:

- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbooks and Standards
- American Society of Plumbing Engineers (ASPE) Handbooks
- Florida Building Code 2001 – Mechanical
- Florida Building Code 2001 – Plumbing
- Florida Fire Protection Code
- South Florida Water Management District, Major Pumping Station Engineering Guidelines, 2004
- National Fire Protection Association Recommended Practices (NFPA) and Manuals
- Occupational Safety and Health Act (OSHA) Standards Manual
- Sheet Metal and Air Conditioning Contractor National Association (SMACNA) Handbooks

3.6.8 Fire Protection and Detection Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with the latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein.

- International Building Code (International Code Council) - 2003
- International Fire Code (ICC) - 2003
- National Fire Protection Association (NFPA)
- Occupational Safety and Health Administration (OSHA)
- Underwriters' Laboratories, Inc. (UL)

3.6.9 Electrical Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with the latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein.

- American National Standards Institute (ANSI)
  - ANSI C2, National Electrical Safety Code
  - ANSI C84.1, Electric Power Systems and Equipment - Voltage Ratings
  - ANSI A117.1, Buildings and Facilities - Providing Accessibility and Usability for Physically Handicapped People
  - ANSI/IEEE Std. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (The Buff book)
- Institute of Electrical and Electronics Engineers (IEEE) C62.41 Surge Voltage in Low Voltage AC Power Circuits
- Illuminating Engineering Society (IES) Lighting Handbook, Reference Volume and Application Volume
- National Fire Protection Agency (NFPA)
  - NFPA 70, National Electrical Code
  - NFPA 72, National Fire Alarm Code
  - NFPA 101, Code for Safety to Life from Fire in Buildings and Structures
  - NFPA 78, Lightning Protection Code
- Uniform Federal Accessibility Standards (UFAS)
- UL 268, Smoke Detectors for Fire Protective Signaling Systems
- USACE Technical Standards, TI-800-01

3.6.10 Instrumentation and Controls Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with the latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein.

- American National Standards Institute (ANSI)
  - ANSI C37.90 (1989) Relays and Relay Systems Associated with Electric Power Apparatus
  - ANSI C37.90.1 (1989) Surge Withstand Capability (SWC) Test for Protective Relays and Relay Systems
  - EM ANSI/EIA/TIA -232-F (2002) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
- Institute of Electrical and Electronics Engineers (IEEE)
  - IEEE C62.41 (1991) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
  - IEEE Std 100 (2000) IEEE Standard Dictionary of Electrical and Electronics Terms
  - IEEE Std 802 (1990; R 1995) Information Processing Systems, Local Area Networks: Part 4: Token Passing Bus Access Method and Physical Layer Specifications
- International Electrotechnical Commission (IEC) 61131-3 (2003) Programmable Controllers — Part 3: Programming Languages
- National Electrical Manufacturer's Association (NEMA)
  - NEMA 250 (1997) Enclosures for Electrical Equipment (1,000 Volts Maximum)
  - NEMA ICS 1 (2000) Industrial Control and Systems: General Requirements
  - NEMA ICS 2 (2000) Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 volts
  - NEMA ICS 4 (2000) Industrial Control and Systems: Terminal Blocks
  - NEMA ICS 6 (1993; R 2001) Industrial Control and Systems: Enclosures
- National Fire Protection Agency (NFPA) 70 (2002) National Electrical Code
- Underwriter's Laboratories
  - UL 1059 (2001) Terminal Blocks
  - UL 508 (1999; Rev thru Dec 2002) Control Equipment

3.6.11 Telemetry System Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with the latest laws and regulations of the State of Florida and the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein.

- Electronics Industries Alliance (EIA)
  - EIA ANSI/TIA/EIA-222-F (1996) Structural Standards for Steel Antenna Towers and Antenna Supporting Structures
  - EIA ANSI/EIA/TIA-232-F (2002) Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange
  - EIA ANSI/EIA-310-D (1992) Racks, Panels, and Associated Equipment
- Federal Communications Commission (FCC) 47 CFR 15 Radio Frequency Devices
- District Design Standards and Guidelines

3.6.12 Design Criteria Memoranda

Following is a summary of the Design Criteria Memoranda and their respective issue dates.

• DCM-1	Hazard Potential Classification	August 19, 2005
• DCM-2	Wind and Precipitation Design Criteria for Freeboard	October 11, 2005
• DCM-3	Spillway Capacity and Reservoir Drawdown Criteria	August 19, 2005
• DCM-4	Minimum Dimensions of Dams and Embankments	August 19, 2005
• DCM-5	Major Pump Station Engineering Guidelines	December 1, 2005
• DCM-6	Geotechnical Seismic Evaluation of CERP Dam Foundations	May 16, 2005
• DCM-7	Procedure for Development of Engineering Construction Cost Estimates	August 5, 2005
• DCM-8	Vulnerability Protection Requirements	In Progress
• DCM-9	Embankment Instrumentation	In Progress
• DCM-10	Construction Quality Assurance Procedures	In Progress
• DCM-11	Post Construction/Inspection/Dam Safety Program	In Progress
• DCM-12	Value Engineering	In Progress

3.7 REFERENCES

Copp, R. (A.D.A. Engineering, Inc.), Personal Communication, July 12, 2005.

Office of Modeling, *ECP 2010 and 2015 Model Runs (Version 5.4.2)*. South Florida Water Management District, June, 2005.

Piccone, T. Personal Communication. E-mail dated July 19, 2005.

Wantman Group. *South Florida Water Management District Storage Reservoir Specific Purpose Survey*, May, 2004.

4.0 AMENDMENTS TO BASIS OF DESIGN REPORT

This Section describes changes in the design or documentation that have been made since the BODR was submitted. There are seven amendments to the BODR:

- The S-610 pump station was shifted out of the embankment and the discharge arrangement was changed to over-the-embankment rather than through-the-embankment
- Formed suction intakes were used for the S-610 pump station
- The operations floor in the S-610 pump station was raised
- The seepage pumps located in the S-610 pump station were changed to serve only the North seepage canal. The South seepage canal will be routed to the existing seepage pump located in the G-370 pump station
- Irrigation pumps will be provided at the S-609 control structure to pump from the Reservoir to the NNRC when the Reservoir is too low to flow by gravity into the NNRC
- The capacity of the S-610 pump station and connector canal from the NNRC was increased to 5,000 cfs
- For the S-602 and S-603 control structures, the gates were moved to the interior side of the embankment, a slide gate was added to each culvert, and stop log groves were added to each culvert both on the interior and exterior of the embankment. The structures were shifted to be as close as practical to the existing G-383 control structure.

4.1 S-610 PUMP STATION SHIFTED

For the BODR the S-610 pump station (then designated as the northeast pump station) was generally located along the eastern side of the Reservoir near the Northeast corner. As part of the 30 percent design for the embankments, the Northeast corner of the Reservoir was rounded as a cost savings measure. The S-610 pump station was subsequently moved into the curve and positioned such that an approximate 1,000-foot straight run could be maintained in the connector canal between the pump station and the NNRC. In accordance with the BODR and directions from the TRB, the design proceeded with the pump station located in the embankment and the discharges from the pumps passing through the embankment with valves providing backflow protection. As a result of workshops conducted on May 12, 2006 and May 24, 2006, the pump station was shifted out of the embankment and the pump discharge lines were routed over the embankment at a height sufficient to provide backflow protection without the need for valves.

4.2 FORMED SUCTION INTAKES

The recommendation in the BODR was to conservatively follow Hydraulic Institute Standards for pump suction submergence. Subsequent discussions with pump suppliers revealed that using

this approach would not assure that vortexing would not occur at the pump intake. Use of a formed intake reduces the submergence requirements and justifies the additional concrete work for constructing the formed intake.

4.3 RAISED S-610 OPERATING FLOOR

The S-610 operating floor elevation was established in the BODR on the basis of required clearance for the pumps. Setting the operating floor elevation also established the basement floor elevation for the pipe chase such that the floor elevation would be below the potential high water level in the connector canal. The operating floor level was raised from El. 19.0 to El. 28.0 in order to eliminate this possibility.

4.4 SEEPAGE PUMPING MODIFICATIONS

It was recommended in the BODR and accepted by the Acceler8 Team that seepage pumping for all of the Reservoir seepage canals would be located in the S-610 pump station. The existing seepage pumping system in the G-370 pump station was to be connected to the eastern seepage canal for additional reliability. The basis for this recommendation was that:

- The G-370 seepage pumps discharge to the Inflow Canal for STA-3/4 rather than to the Reservoir
- Seepage pumping modification would be required in the event that the PIR is implemented
- The general comment from Operations has been that they never have sufficient seepage pumping capability
- The District has previously expressed a concern regarding reducing the treatment capacity of the STA by allowing seepage to enter the STA
- At a meeting on May 12, 2006 the Engineer was directed by Acceler8 to utilize the G-370 seepage pumps and to eliminate the redundant pumps serving the eastern seepage canal from the S-610 pump station. This is functionally acceptable to Engineer. The firm capacity of the G-370 seepage pumps (150 cfs) is essentially equal to the required capacity established through modeling, which was conducted using the conservative assumption that it would be necessary to draw down the seepage canal to 3.5 feet below normal. The project cost will be reduced due to elimination of four pumps from the S-610 pump station and significant reduction in the size of the auxiliary generators.

4.5 IRRIGATION PUMPS

While irrigation pumps were recommended in the BODR as a means of transferring water for agricultural deliveries from the Reservoir to the NNRC when the Reservoir water level was low, sizing and configuration was not established at that time. If necessary, the irrigation pumps can also supply water for environmental deliveries. Design criteria can be found in Section 5 of the Preliminary Design Report. The pumping system has been incorporated into the S-609 control structure and is shown in the Preliminary Drawings.

4.6 PUMP STATION AND CONNECTOR CANAL CAPACITY

As directed by the TRB, the design of the S-610 pump station will include provisions to expand the capacity to 5,000 cfs. To accommodate this future expansion, the connector canal between

the pump station and the NNRC will be sized for the future flow. Design criteria and details can be found in the Preliminary Design documents.

4.7 MODIFICATION TO S-602 AND S-603 CONTROL STRUCTURES

The S-602 and S-603 control structures were not specifically located in the BODR other than to place them on either side of the G-383 control structure. The structures were shifted to be near G-383 in order to preserve the capability to develop flow calibration curves for Reservoir outflow without the installation of flow monitoring equipment. The structures have been positioned to minimize hydraulic impacts on STA-3/4 inflow structures. Control gates have been moved to the interior of the Reservoir. A roller gate will be provided for control and shutoff on each culvert and a slide gate will be provided to back up each roller gate and provide capability to dewater the roller gate area for maintenance. Stop logs will be provided on both the interior and exterior structures to dewater individual culverts for maintenance of the gates and inspection of the culvert.

4.8 PROJECT ASSURANCES

The following Project Assurances section was provided by Acceler8 following the submittal of the BODR. It encompasses the entire project area and is applicable for inclusion in this Preliminary Design Report.

PROJECT ASSURANCES
(as provided by Acceler8)

1.0 INTRODUCTION

The EAA Reservoir A-1 Preliminary Design Report for the Everglades Agricultural Area (EAA) Storage Reservoir Project recommends a plan in Palm Beach County that is designed to capture, store and redistribute freshwater previously lost to tide and to regulate the quality, quantity, timing and distribution of water flows. Additional storage in the project area is needed to reverse declines in ecological function and productivity in Lake Okeechobee and the estuaries of the Caloosahatchee River and St. Lucie Canal. The overall objectives of the EAA Storage Reservoir A-1 project are to improve the timing of environmental deliveries to the Water Conservation Areas (WCAs), including reducing damaging flood releases from the Everglades Agricultural Area; reducing Lake Okeechobee regulatory releases to the estuaries; meeting EAA irrigation and Everglades water demands; and providing incidental flood protection in the EAA. Constructing and operating the EAA Reservoir A-1 would reduce water demands from Lake Okeechobee, reduce the need to back-pump EAA storm water to the Lake, and reduce the damaging pulsed regulatory releases from Lake Okeechobee to the Caloosahatchee River and St. Lucie Canal. This should enhance habitat function and quality in Lake Okeechobee's littoral zone, the WCAs and the Caloosahatchee River and St. Lucie estuaries (the northern estuaries), and improve native plant and animal species abundance and diversity by retaining natural waters in the system. Benefits to the downstream estuaries are expected as a result of reduction in abrupt and high-volume fresh water flows and pulsed releases from Lake Okeechobee.

2.0 REASONABLE ASSURANCES FOR ACCELER8 PROJECTS

Although Florida State statutes (F.S) require analyses in the Draft Project Implementation Report for the EAA Storage Reservoir, theses analyses are provided as supplemental information for the Acceler8 preliminary design report. The types of analyses provided herein are described below.

Section 373.1501(5)(d), F.S. states that the SFWMD shall "Consistent with this Chapter, the purpose for the restudy in the Water Resources Development Act of 1996, and other applicable federal law, provide reasonable assurances that the quantity of water available to existing legal users shall not be diminished by implementation of project so as to adversely impact existing legal users, that existing levels of service for flood protection will not be diminished outside the geographic area of the project, and that water management practices will continue to adapt to meet the needs of the restored natural environment."

Section 373.470(3)(c), F.S. states that "Each project implementation report shall also identify the increase in water supplies resulting from the project component. The additional water supply shall be allocated or reserved by the District under Chapter 373."

2.1 Water Supply Assurance

This section is intended to provide sufficient information for providing "reasonable assurances that the quantity of water available to existing legal users shall not be diminished by implementation of project components so as to adversely impact existing legal users, . . ." Section 373.1501(5)(a), F.S. Pursuant to Section 373.219, Florida Statutes, existing legal users are those that have a consumptive use permit or are exempt from permitting requirements, such

as domestic users. Section 373.2223(4), F.S. requires that when establishing a water reservation for protection of fish and wildlife, existing legal users "be protected so long as such use is not contrary to the public interest."

These requirements necessitate a quantification of the amount of water permitted to all existing legal users, used by exempt users or protected through settlement agreements between the Seminole Tribe of Indians of Florida and the SFWMD affected by the EAA Reservoir A-1 project. This quantification is included in the existing condition PIR baseline model run which is compared to the selected alternative plan to examine the potential impact of the Acceler8 project on the quantity and quality of water for the existing legal users.

To identify project effects, the regional water management system including the operations of the EAA Reservoir A-1 project is simulated with the regional model, South Florida Regional Water Management Model, version 5.4. Modeled outputs are compared to those produced for the Existing Condition in 2005. Table 2.1-1 lists the existing legal users potentially affected by the EAA Reservoir A-1 project and their sources.

Table 2.1-1 Existing Legal Users Potentially Affected by the EAA Reservoir A-1 Project

Existing Legal Users	Source
Lake Okeechobee Service Aarea, including Everglades Agricultural Area	Lake Okeechobee; local basin storage and runoff
Urban Water Supplies: Lower East Coast	Lake Okeechobee, local basin storage and runoff; surficial aquifer
Urban Water Supplies: C-44 Canal/St. Lucie Basin	Lake Okeechobee; local basin storage and runoff; surficial aquifer
Urban Water Supplies: C-43 Canal/Caloosahatchee Basin	Lake Okeechobee; local basin storage and runoff; surficial aquifer
Seminole Tribe of Florida (Big Cypress Reservation)	Lake Okeechobee; local basin storage and runoff; surficial aquifer
Miccosukee Tribe of Indians of Florida (WCA 3 and Everglades National Park)	Lake Okeechobee; local basin storage and runoff
Exempt Domestic Users	varies

2.1.1 Hydrologic Model Simulations

Two different operational plans were modeled to evaluate project assurances and Savings Clause requirements (see Table 2.1-2). A volume envelope approach was used in the hydrologic simulation modeling to determine the range of volumes that the EAA Reservoir A-1 project is capable of delivering to meet environmental demands and for the other water-related needs of the south Florida region.

Table 2.1-2 Model Simulations

Simulation Name	Explanation	Description
ExPIR	Existing Condition PIR Baseline	2005 Baseline condition for State of Florida existing legal users evaluation
EAA-NoRDO	Existing Condition –With Project	Conservative with-project simulation (EAA Reservoir A-1 operated to act as a surge tank for Lake Okeechobee releases) performed for comparison to baselines to evaluate project effects; WCAs operated per regulation schedules.
EAA-RDO	Existing Condition – With Project	Potentially optimized with-project simulation performed for comparison to baselines to evaluate project effects; environmental deliveries to WCAs and ENP per rainfall-driver triggers

The EAA-RDO model run represents a potentially optimized operational scenario whereby water can be prospectively delivered out of the EAA Reservoir A-1 based on a series of rainfall-based (aka rain driven operations – RDO) environmental targets in the Water Conservation Areas and Everglades National Park while still maintaining Existing Conditions water supply performance.

The EAA-NoRDO model run represents a more conservative operational scenario, whereby the EAA Reservoir A-1 is operated primarily as a surge tank for the storage of regulatory releases from Lake Okeechobee and EAA runoff, and water is delivered out of the EAA Reservoir A-1 primarily to ensure, at a minimum, that Existing Conditions water supply performance (including agriculture, urban and fish and wildlife and Everglades National Park) is achieved as a result of project implementation. The regulation schedules are in effect in the WCA's and not rain driven operation (No-RDO).

2.1.2 Urban and Agricultural Water Supply

Existing legal users of water supply for urban and agricultural uses of water likely to be affected by implementation of the EAA Storage Reservoir A-1 include users in the Lake Okeechobee Service Area (LOSA), which includes EAA, the C-43 (Caloosahatchee) Basin, the C-44 (St. Lucie) Basin, as well as L-8, S-4, S-236 Lower Istokpoga, North and Northeast Lake Shore Basins and 298 Districts surrounding the Lake. In addition to LOSA, existing legal users include the North Palm Beach Service Area, and Lower East Coast Service Areas 1, 2, and 3. As would be expected through the construction and operation of an impoundment capable of storing approximately 190 k acre-feet of water, implementation of the project will increase the quantity of water available to meet agricultural and urban water supply demands. The following sections summarize project effects on users of water for agricultural and urban water supplies in the project area, which are based on operations closer to existing conditions (EAA-NoRDO). In the other operating scenario (EAA-RDO), water is delivered to WCA's and ENP when available to meet natural system demands. The EAA-RDO model simulation was not optimized for this condition and resulted in one additional water supply restriction event when Lake Okeechobee stages fell into the Supply-Side Management zone. During actual operations, deliveries south to the WCA's and ENP would be moderated to avoid these low Lake levels.

Everglades Agricultural Area - Due to the reduction in demand for supplemental irrigation associated with the conversion of agricultural lands within the Everglades Agricultural Area (including the footprint of the EAA Reservoir A-1 project), the overall demand for supplemental irrigation in the Everglades Agricultural area is reduced from annual average of 348 k ac. ft. in the Existing Conditions to 331 k ac. ft. (EAA-NoRDO) as a result of project implementation.

Compared to Existing Conditions volumes, the EAA Storage Reservoir A-1 project will reduce the volume of unmet demand for supplemental irrigation in the Everglades Agricultural Area by approximately 12.0 k ac. ft., from 25 k ac. ft. to 13 k ac. ft. (36-year annual averages). This represents a percentage reduction of approximately 4.0 percent.

This overall improvement toward meeting demands for supplemental irrigation is accomplished by reducing the volume of water delivered from Lake Okeechobee to meet irrigation demands from an annual average volume of approximately 323 k ac. ft. to 217 k ac. ft., while providing an average of 101 k ac. ft. for irrigation from the EAA Reservoir A-1 itself (period of record).

Other Areas of Lake Okeechobee Service Area - Compared to Existing Conditions quantities, modeling results indicate that the EAA Reservoir A-1 project will reduce the average annual volume of unmet demands for supplemental irrigation from Lake Okeechobee to supply areas of Lake Okeechobee Service Area other than EAA (namely, S-4, S-236, L-8, Lower Istokpoga, North and Northeast Lake Shore Basins plus 298 Basins) from 5.5 percent to 4.3 percent for the EAA-NoRDO model simulation. For these portions of LOSA, the project will reduce the volume of unmet demands (water year) from approximately 5 k ac.-ft. (Existing Conditions) to less than 4 k ac.-ft (EAA-NoRDO).

C-43 (Caloosahatchee) Basin - Modeling results indicate that on average annually, the project will reduce the volume of unmet demand for supplemental irrigation in the C-43 Basin (4.5 percent; approximately 5 k ac.-ft.) compared to the Existing Condition volume (5.8 percent; approximately 6.4 k ac.-ft.).

C-44 (St. Lucie Canal) Basin - For the C-44 Basin, modeling results indicate that the project will result in a decrease from the Existing Conditions level of unmet demand for supplemental irrigation (6.4 percent; approximately >1 k ac.-ft) to 4.8 percent.

North Palm Beach and Lower East Coast Service Areas - Based on modeling results, implementation of the EAA Reservoir A-1 project will improve water supply performance in the North Palm Beach Service Area and Lower East Coast Service Areas 1 (central and southern Palm Beach County), 2 (Broward County) and 3 (Miami-Dade County), although the project effects are least significant in Service Area 2. In particular, although Lake Okeechobee stages are lower on average (thereby improving in-lake habitat conditions), storage of Lake Okeechobee discharges and runoff from the Everglades Agricultural Area by the project creates additional capability for Lake Okeechobee to provide water supply deliveries to these areas. Project implementation is also predicted to result in fewer months experiencing water supply cutbacks and, either no effect, or a reduction in the volume of cutbacks for public water supplies all service areas; results are summarized in Table 2.1-3.

Table 2.1-3 Number of Years with a Restriction Event and Total Number of Months of Restrictions in 36 year Simulation

	2005 Existing Condition (ExPIR)		2005 Existing Condition with EAA Storage Reservoir (EAA-NoRDO)	
Service Area	**Number of Years**	**Total Number of Months**	**Number of Years**	**Total Number of Months**
LOSA	9	25	4	7
LECSA 1	6	39	4	29
LECSA 2	24	128	24	127
LECSA 3	5	36	3	25
North Palm Beach SA	5	34	3	24

The results of this comparative analysis indicate the quantity of water for the existing legal users within the EAA Reservoir A-1 Project boundary will not be diminished. Based upon this information, the SFWMD is providing reasonable assurances that the quantity of water available to existing legal users shall not be diminished by implementation of project components so as to adversely impact existing legal users.

2.2 Flood Protection Assurance

The primary purpose of the Project is to store runoff from the EAA and discharges from Lake Okeechobee to improve ecological functions in Lake Okeechobee, the St. Lucie and Caloosahatchee Estuaries, and the EPA. The storage of up to 190,000 acre-feet of water in an above ground EAA Reservoir A-1 operated at a normal above ground pool depth of 12 feet will incidentally improve flood protection by removing 16,700 acres from the drainage basin. The EAA Reservoir A-1 may be expected to increase average elevations of groundwater in adjacent lands unless appropriate flood mitigation measures are included as part of project implementation. Sub-regional hydrologic modeling has been conducted using the MODFLOW (a three-dimensional groundwater flow model) and SEEP/W (a two-dimensional finite element model) to determine the project's effects on the level of service for flood protection in 2005.

An initial evaluation of potential project effects has been conducted for the Project using the MODFLOW model. The results of the initial evaluation indicate that the Project may increase groundwater elevations in portions of STA 3/4 adjacent to the Project and in a small area of the Holey Land WMA. A slight increase in groundwater elevations beneath STA 3/4 is not expected to adversely affect water quality treatment functions of that project and can be further managed by project surface water operations considering these groundwater deliveries. The effects within the Holey Land WMA are confined to within approximately 500 to 1000 feet of the EAA Reservoir A-1 project footprint, and are not expected to adversely affect fish and wildlife habitat and recreational use functions of that area and can be further managed by project surface water operations considering these groundwater deliveries.

The project includes a 150-200 foot buffer area surrounded by a seepage collection canal including seepage return pumps to manage seepage within the project footprint. Due to the inclusion of this feature, the initial evaluation did not indicate that there was an effect on

groundwater elevations in agricultural lands north of the Project site beyond the Project footprint due to the southeasterly gradient of groundwater in this area. Project engineers have recommended including a cutoff wall beneath the levee to provide additional stability and seepage control. The cutoff wall would provide additional control of seepage resulting from the hydraulic head created by the storage of water in the EAA Reservoir A-1. This feature is included in the cost estimate for the selected alternative plan. Due to the location of the proposed buffer and seepage collection system west of the FDOT right-of-way for U.S. 27 and the results of the preliminary hydrologic and hydraulic modeling analyses to date, which indicate that the proposed EAA Reservoir project is not expected to result in increased water levels in adjacent canal systems, the EAA Reservoir A-1 Project is not expected to adversely impact the integrity of U.S. 27.

A summary of the effect on groundwater levels in the vicinity of the Project due to operation of the EAA Reservoir A-1 is included on Figure 2.2-1.

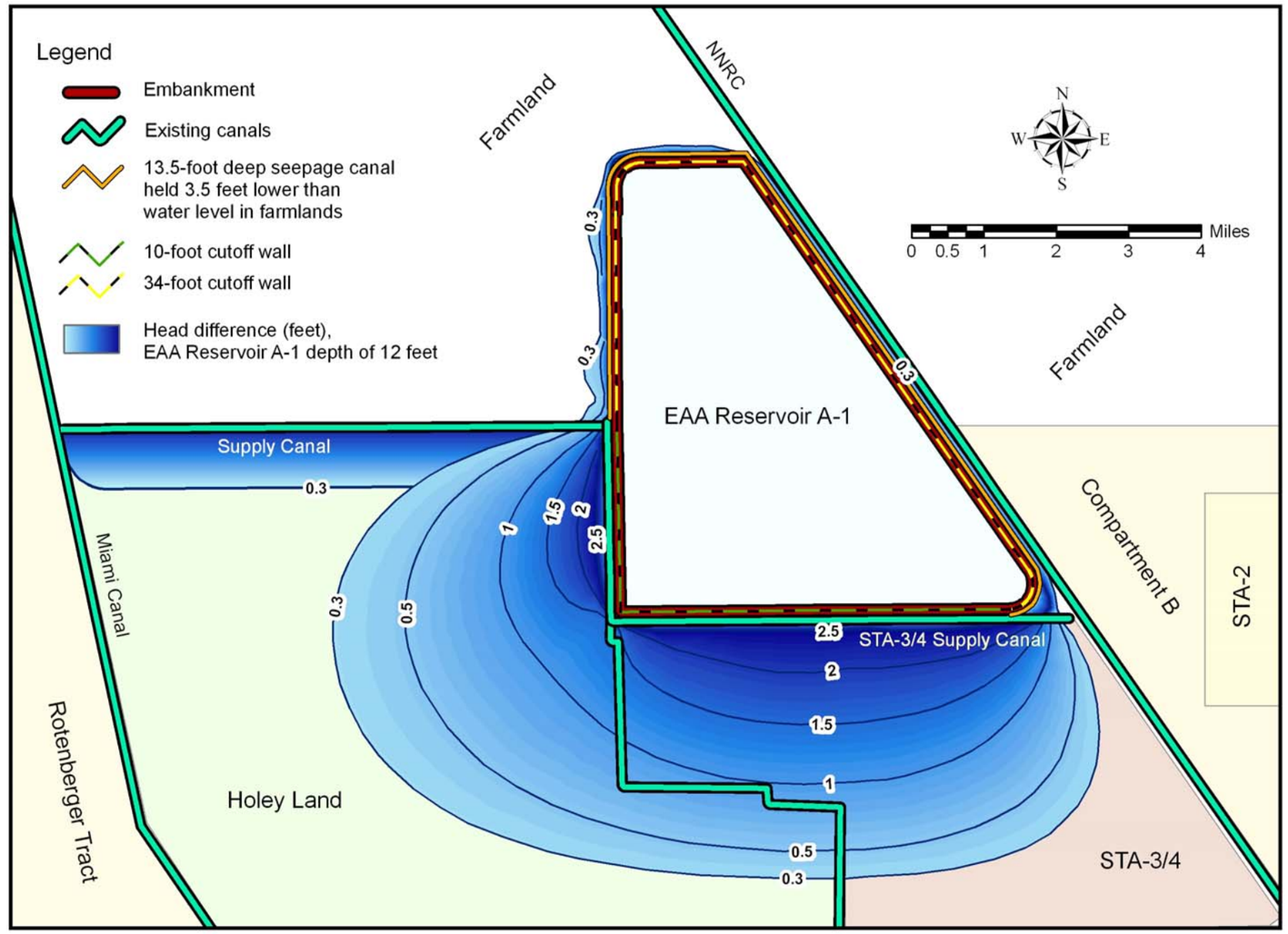
Figure 2.2-1 Final Selected Seepage Mitigation Plan along with Maximum Offsite Water Level Changes with a 12 Foot Pool in EAA Reservoir A-1

Configuration:

- EAA Reservoir A-1 at full depth of 12 feet
- 34-foot cutoff wall and seepage canal around northwest, north, and east sides of EAA Reservoir A-1; 10 foot cutoff and no seepage canal along STA-3/4 and Holey Land
- Seepage canal held 3.5 feet below farm water levels. Assumes STA and Holey Land are not operated to offset the rise in groundwater levels

Results:

- This alternative keeps rise in groundwater levels in farms less than 0.3 feet
- This alternative causes a rise in groundwater levels of up to 2.5 feet in STA-3/4 and Holey Land. Keeps groundwater at acceptable levels beneath U.S. 27. Some seepage will migrate to the Holey Land during periods of the year when the water level in the Supply Canal is elevated to fill the EAA Reservoir A-1. Seepage to the north of the Supply Canal will be controlled by an existing seepage canal
- Total EAA Reservoir A-1 seepage = 346 cfs (only when EAA Reservoir A-1 is full)
- Seepage canal collects 290 cfs
- Total additional volume to STA-3/4 is approximately 10,900 acre-feet per year with a maximum additional flow rate of approximately 29 cfs when Supply Canal is floated to 8 feet
- Net additional volume to the Supply Canal is approximately 30,100 acre-feet per year. Maximum flow into Supply Canal is approximately 84 cfs when EAA Reservoir A-1 is full of water. Maximum flow out of Supply Canal to surrounding areas is approximately 60 cfs when Supply Canal is floated to 8 feet.
- Total additional volume to Holey Land is approximately 9,900 acre-feet per year with a maximum additional flow rate of approximately 39 cfs when Supply Canal is floated to 8 feet
- Seepage control cost for Alternative 3 = $64,590,000



3.0 INCREASED WATER SUPPLY AVAILABLE FROM PROJECT

3.1 State Requirements

Section 373.470, F.S., requires that the PIR identify the increase in water supplies resulting from the project components and that the additional water be allocated or reserved under Chapter 373, F.S. The Acceler8 is providing this same information for the public's use.

The EAA Reservoir A-1 project is intended to affect Lake Okeechobee, the St. Lucie and Caloosahatchee Estuaries, and WCAs 3 and Everglades National Park. In terms of the quantity of water for the protection of fish and wildlife in these areas, the project's effects have been evaluated by comparing volume probability curves based on water budget data produced by a regional scale model (the South Florida Water Management Model vs. 5.4). To identify project effects, the regional water management system including the operations of the selected alternative plan have been simulated with the regional model, and the modeled outputs compared to those produced for the base condition representative of the initiation of project operations (Existing Condition).

Similar to the process for identifying water for the protection of fish and wildlife, to evaluate effects of the project on water for other water-related needs, the selected alternative plan is added to other components of the regional water management system and modeled with the regional hydrologic simulation model, and the modeled outputs compared to those produced for the existing condition representing conditions as of 2005 (Existing Conditions). The project's effects have been evaluated by applying water supply performance measures used during plan formulation for the PIR produced by a regional scale model.

3.2 Model Simulation Period

The model used to determine project effects simulates the period from January 1, 1965 through December 31, 2000. Therefore, there are 36 years of data but only 35 water years (November 1, 1965 through December 31, 2000) considered in the analysis of water to be reserved for the natural system.

3.3 Volume Probability Curves

For purposes of identifying water for the natural system, volume probability curves are produced depicting the range of the quantities of water delivered to selected natural areas under all climatic conditions through the period of record used to perform project evaluations. The volume probability curve indicates the probability (percentage of time equaled or exceeded) that a certain quantity of water is delivered to natural areas for fish and wildlife protection as a function of historical rainfall distribution. To identify incremental project effects, volume probability curves for the with-project condition are compared to volume probability curves for the existing condition in 2005.

Volumes of water to be potentially made available by the EAA Reservoir A-1 project were synthesized from SFWMM simulations, and are based on a 36-year (35-water-year) simulated period of record. The total volume of water made available by the project was synthesized for each water year as the difference between volumes observed in the "without-project" simulation and the "with-project" simulation. For each water year, the observed differences (i.e., with-

project-volume minus without-project-volume) in volumes delivered into and out of a given sub-basin were noted, and charted as: time series of total annual volumes made available; and total annual volume exceedance curves.

In an effort to present the potential utility and benefit of the EAA Reservoir A-1 project, while recognizing that potential near-term constraints on its operations exist, the volumes to be potentially made available by the EAA Reservoir A-1 project are presented as a volume envelope. The upper and lower quantities of the volume envelope illustrate total volumes of water that could be made available as a result of this project's implementation.

3.4 Water Made Available by the Project for Natural System

3.4.1 System-wide Effects

For those projects expected to result in system-wide effects on the natural system and other water related needs in south Florida, a regional-scale hydrologic simulation model is utilized to evaluate those effects. Due to its central location, storage volume, and influence on the regional water budget, the EAA Reservoir A-1 project is expected to have system-wide effects. To identify these effects and quantify the water made available by the project, a model simulation representing Existing Conditions in 2005 (the timeframe for the EAA Storage Reservoir's Project Implementation Report) is compared to a simulation of the same existing conditions plus the EAA Reservoir A-1 project's selected plan features and operations (Table 3.4-1).

To evaluate system-wide effects on the natural system, the SFWMM is used to identify the quantity, timing, and distribution water made available by the project in the Water Conservation Areas (WCAs) and Everglades National Park.

Water made available by the EAA Reservoir A-1 project includes both water for the natural system and water for other water related needs. The water evaluation results indicate that the EAA Reservoir A-1 project makes additional water available for the natural system in WCA-3A, WCA-3B, and Everglades National Park.

Table 3.4-1 Summary of Model Simulations for EAA Storage Reservoir

	Existing Condition (2005) (Ex PIR)	**Existing Condition w/A-1 Reservoir (2005) EAA-No RDO**	**Existing Condition w/A-1 Reservoir EAA-RDO**	**NSM462**
Selected Plan – EAA Storage Reservoir	No	Yes	Yes	n/a
Regional System Operations	2005	2005	2005	n/a
System Demands and Land Use	2005	2005	2005	n/a
Everglades Construction Project	STAs 1W, 2, 5, 6	STAs 1W, 2, 3/4 5, 6	STAs 1W, 2, 3/4, 5, 6	n/a
Everglades Rain Driven Operations	No	No	Yes	n/a
Non-CERP Projects*	2005	2005	2005	n/a
Model simulation used as basis	2005B	2005B	2005B	NSM v 4.6.2.

The goals of this project include increasing the quantity of water and improving the timing and distribution of water delivered to the Water Conservation Areas and Everglades National Park and reducing damaging high water levels in Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries. This is accomplished by storing runoff and Lake Okeechobee discharges, and providing an alternate source of water for agricultural water users in the EAA in lieu of withdrawals from Lake Okeechobee. One of the fundamental principles of the CERP is to capture and store water that is lost to tide or discharged to or stored in natural areas when those areas do not require additional water, and use the stored water to improve regional water availability.
The EAA Reservoir A-1 project is intended to capture water that would be lost to tide via the C-44 and C-43 Canals, and to provide an alternate storage facility in lieu of keeping water in Lake Okeechobee when lake water levels should be falling or when high water levels require regulatory releases. Water stored in the EAA Reservoir A-1 is to be used for environmental deliveries to the Everglades (via delivery to Water Conservation Area 3) and for water supply deliveries in the EAA via the North New River in lieu of the current withdrawal of water from Lake Okeechobee via the North New River. Creation of this supplemental source of water is expected to result in improved hydroperiods and hydropatterns necessary to support fish and wildlife habitat in the Everglades, increase the quantity of water available to be delivered for the natural system within the Water Conservation Areas and Everglades National Park, and increase the quantity of water available to meet agricultural water supply demands in the EAA.

Project effects are quantified by comparing a model simulation representing Existing Conditions in 2005 (the timeframe for the EAA Reservoir A-1 project Implementation Report) to a simulation of the same existing conditions plus the EAA Reservoir A-1 project's selected plan features and operations. Because it is recognized that constraints on operations currently exist, the volumes to be potentially made available by the EAA EAA Reservoir A-1 project are presented as a volume envelope. The ranges of the volume envelope illustrate total volumes of water that could be made available as a result of this project's implementation. The model runs labels are EAA_ExCond for the Existing Conditions and EAA_No RDO and EAA-RDO for the envelope ranges of the Existing Conditions PIR plus the project:

- EAA_No RDO – A conservative with project simulation (EAA Reservoir A-1 operated to act as a surge tank for Lake Okeechobee releases) performed for comparison to Existing Conditions baseline; represents conditions expected upon initial operation of the project based on projects, features, and regional water management policies/practices as they exist today (e.g., WCAs operated using regulation schedules)

- EAA_RDO – Potentially optimized with-project simulation performed for comparison to caselines to evaluate project effect; represents the amount of water that the project can provide to the natural system once existing constraints on operations are reduced/removed and regional water management practices adapted to more "need-based" natural system deliveries (e.g., WCAs operated using rainfall/depth-based targets).

It is intended that this project will be operated to yield no adverse impacts to downstream natural areas, delivering water to downstream natural areas in a manner that is consistent with restoring and/or sustaining hydrologic conditions necessary to protect fish and wildlife. Until such time that those deliveries can be made in the manner described, it is recognized that the total volumes of water made available by the EAA Reservoir A-1 project for introduction to the Everglades Protection Area are likely to remain near the lower-end of the described volume envelope. Once existing constraints on operations are reduced and/or removed such that additional water could be delivered in the manner described (i.e., in a manner consistent with restoration goals), total volumes of water made available by the EAA Reservoir project for introduction to the Everglades Protection Area are anticipated to increase to be near but not limited to the higher-end of the described volume envelope.

Consistent with the project purpose and objectives to improve hydroperiods and hydropatterns in the Everglades, modeling to evaluate effects on the quantity of water made available by the project for the natural system in the EAA_RDO scenario included a partial implementation of rain-driven operations in the Everglades. For the most part, modeling results indicate that the EAA Reservoir A-1 project is affecting flows to WCA 3A, 3B and Everglades National Park.

Loxahatchee National Wildlife Refuge (WCA 1) - The model results indicate that the project does not substantially change inflows or outflows to WCA1.

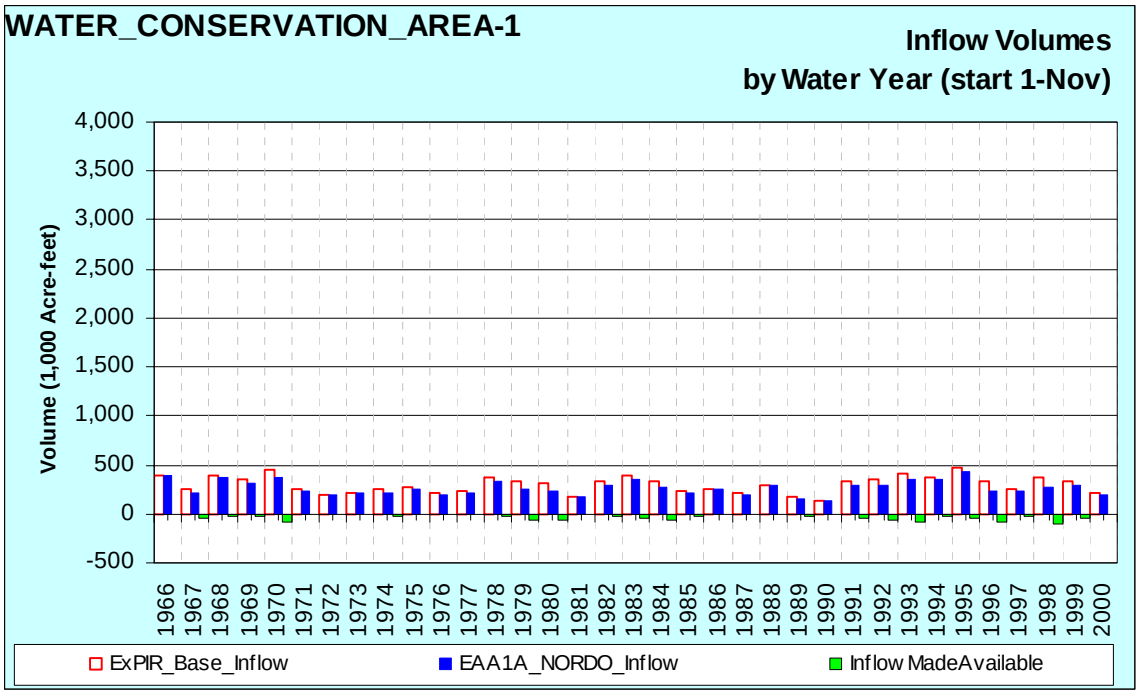
Water Conservation Area 2A - The EAA Reservoir A-1 project appears to slightly decrease inflows and outflows to WCA2A.

Water Conservation Area 2B - The results indicate that the project does not significantly change the inflow or outflow volumes in WCA2B.

Water Conservation Area 3A - In most years, the EAA Reservoir A-1 project appears to create additional inflows in WCA 3A.

Water Conservation Area 3B - Modeling results indicate that in most years the EAA Reservoir A-1 project will create a significant quantity of additional water through inflows in WCA-3B.

Everglades National Park - The model results indicate that the EAA Reservoir A-1 project provides additional water via inflows to ENP in most years.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Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
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-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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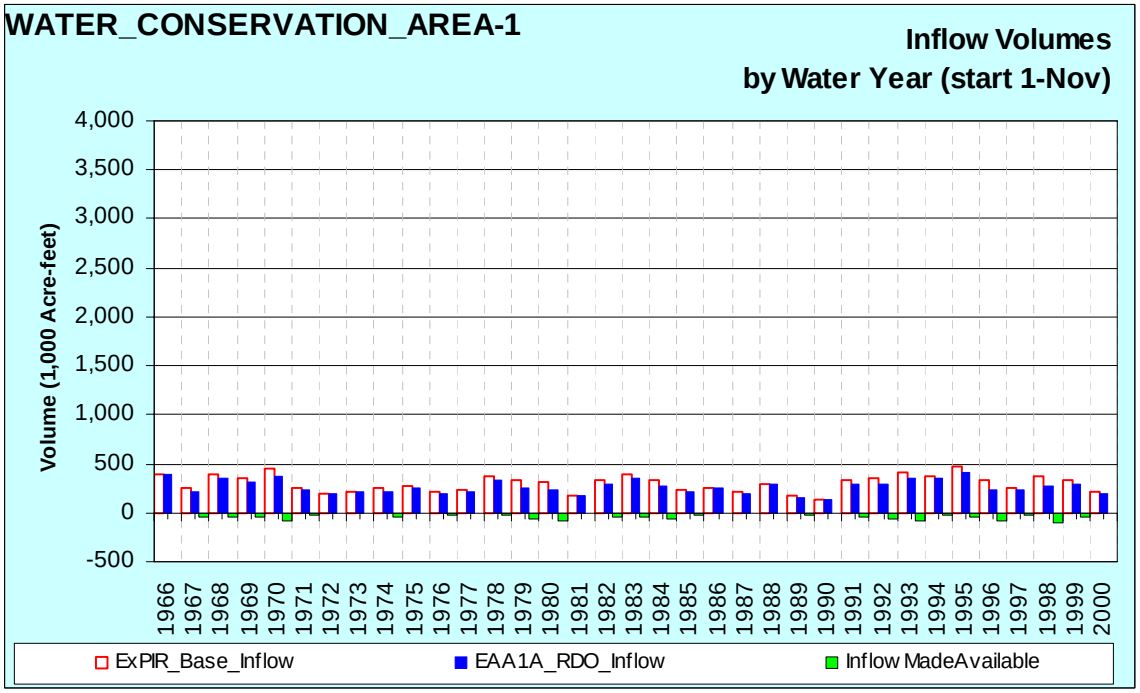
EAA1A_NORDO_Inflow
Inflow MadeAvailable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Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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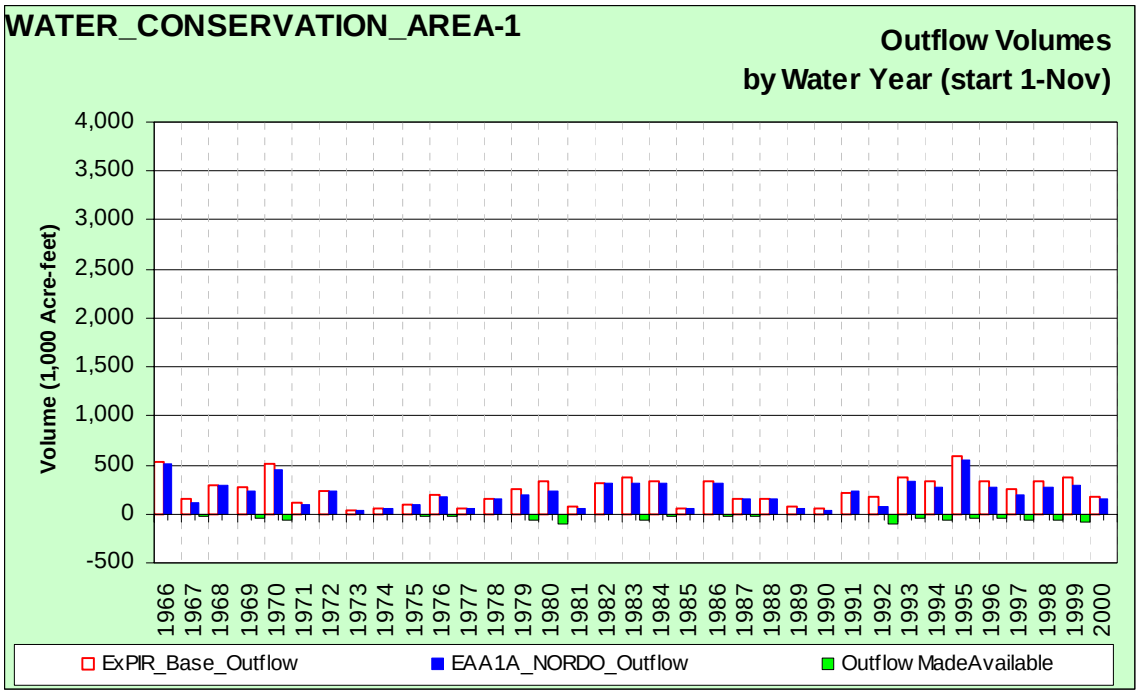
EAA1A_RDO_Inflow
Inflow MadeAvailable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Volume (1,000 Acre-feet)
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3,000
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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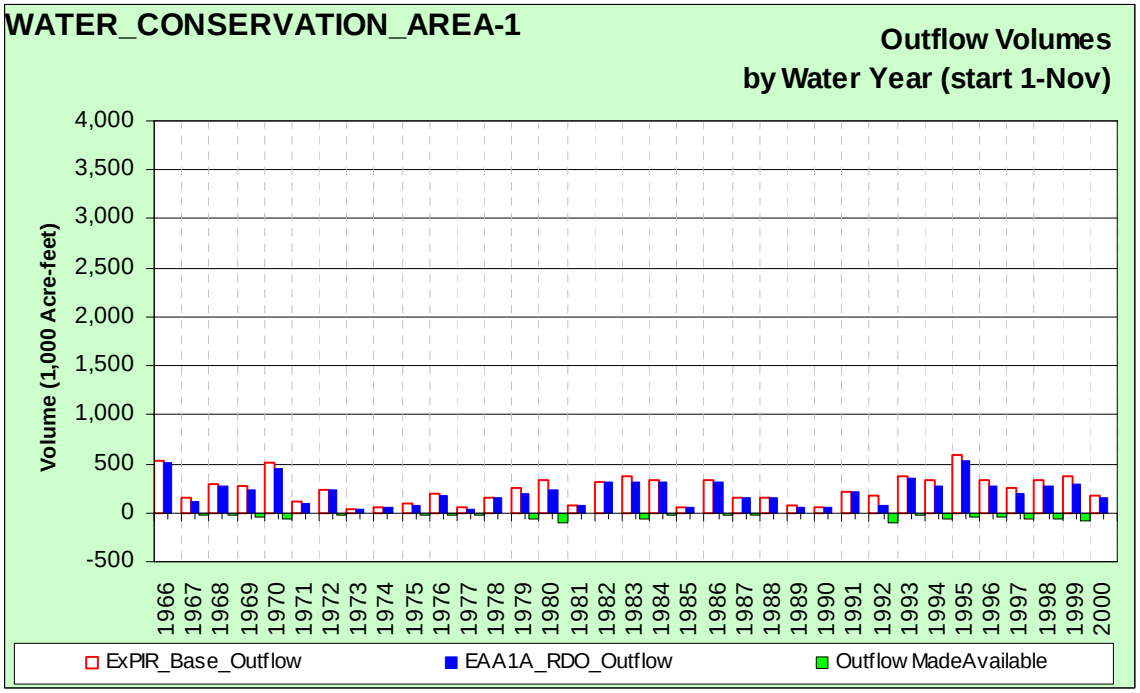
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Outflow Volumes
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Volume (1,000 Acre-feet)
4,000
3,500
3,000
2,500
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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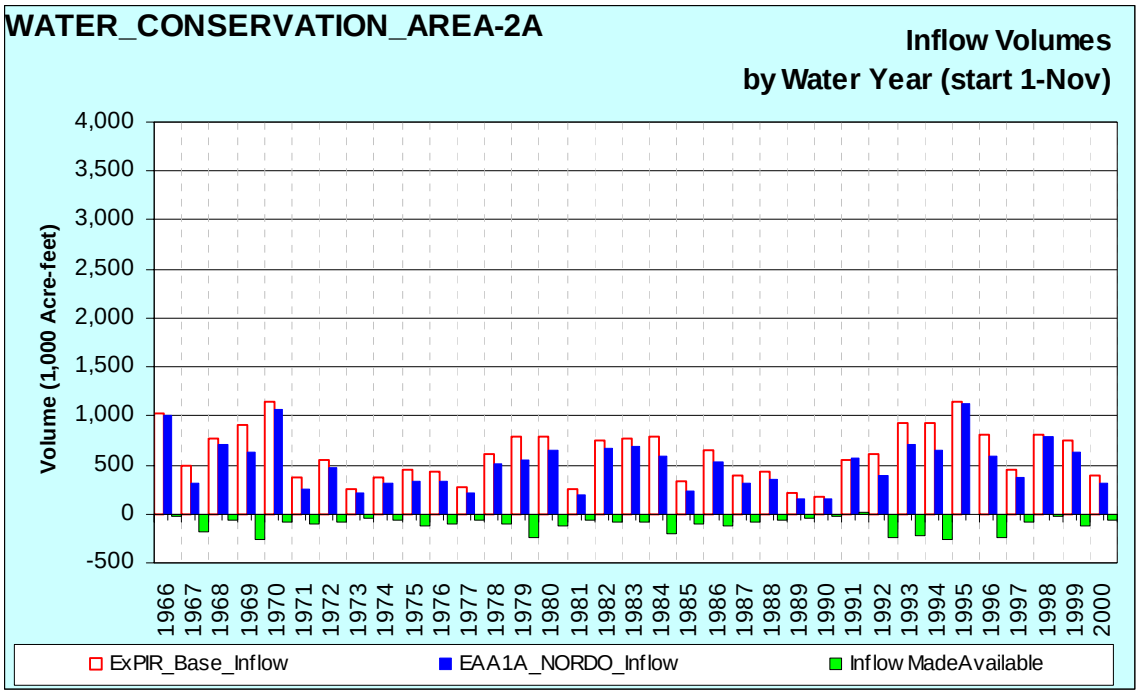
EAA1A_RDO_Outflow
Outflow MadeAvailable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Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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3,000
2,500
2,000
1,500
1,000
500
0
-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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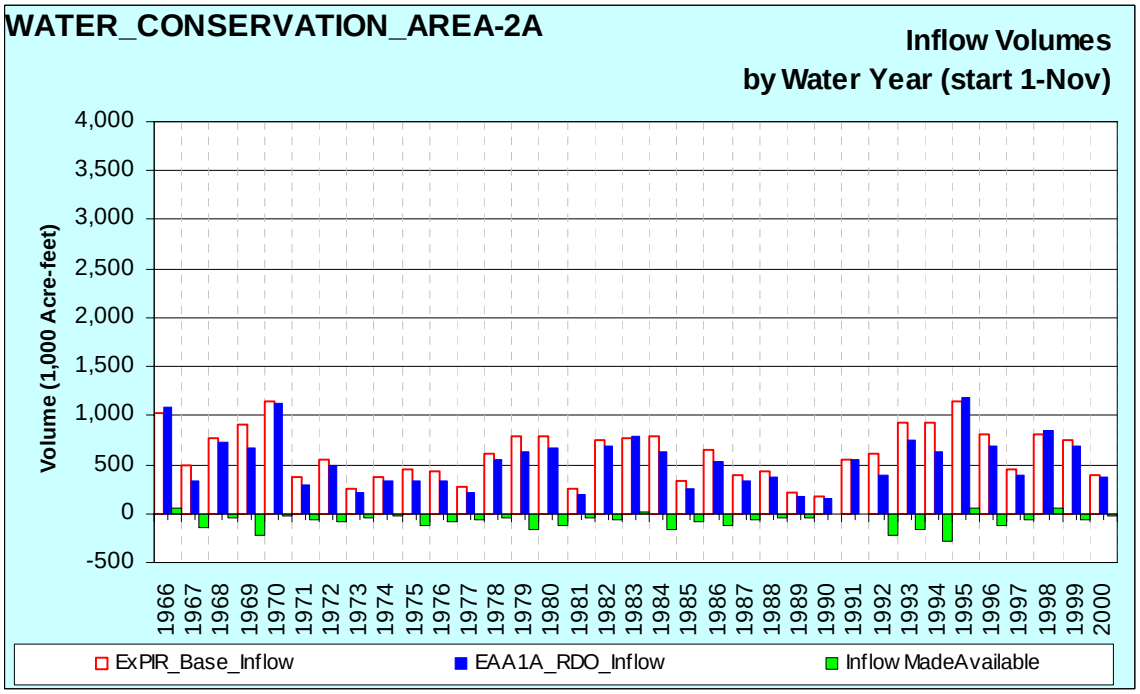
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Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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3,500
3,000
2,500
2,000
1,500
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-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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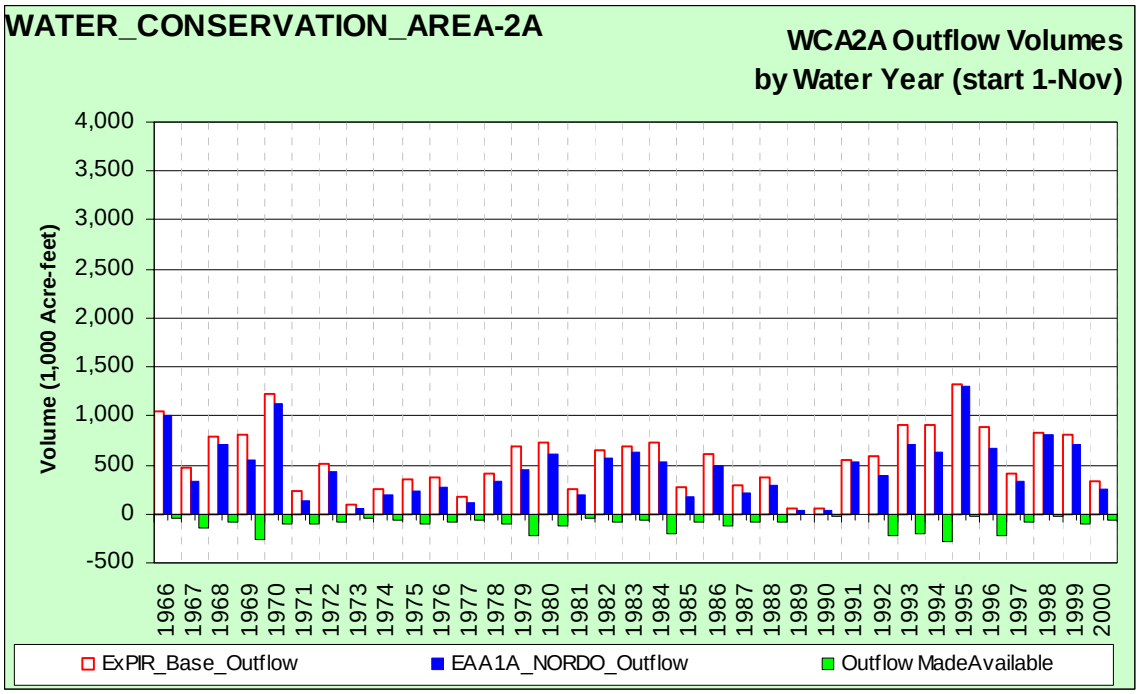
Inflow MadeAvailable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WCA2A Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
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2,500
2,000
1,500
1,000
500
0
-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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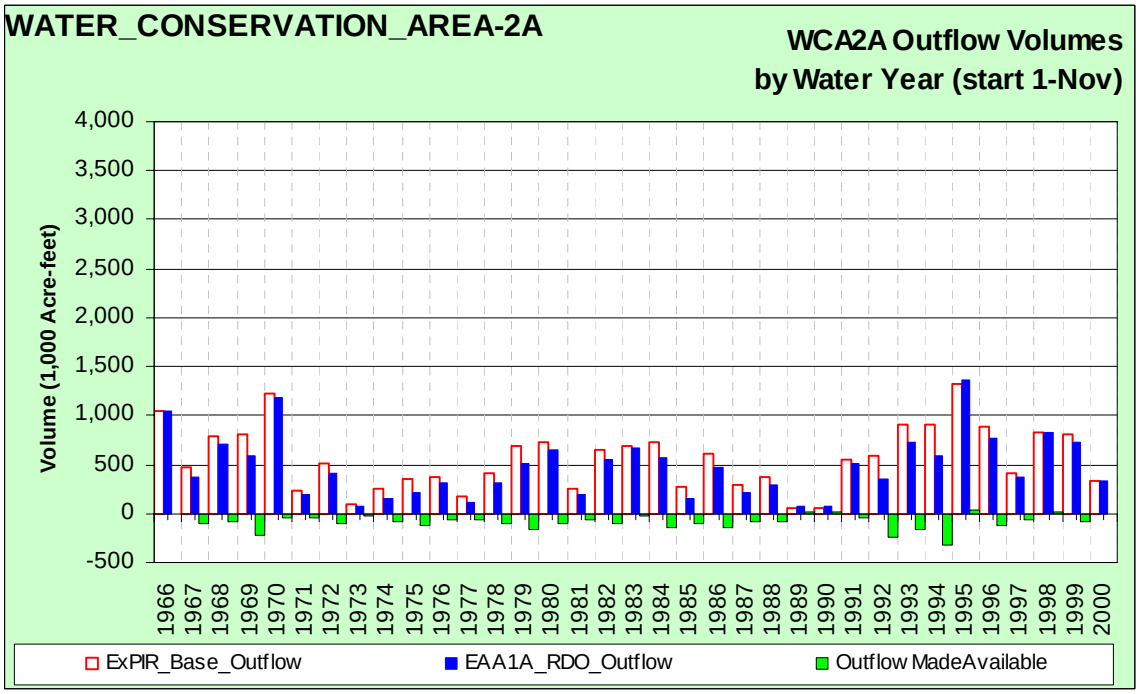
Outflow MadeAvailable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WCA2A Outflow Volumes
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Volume (1,000 Acre-feet)
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1,500
1,000
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-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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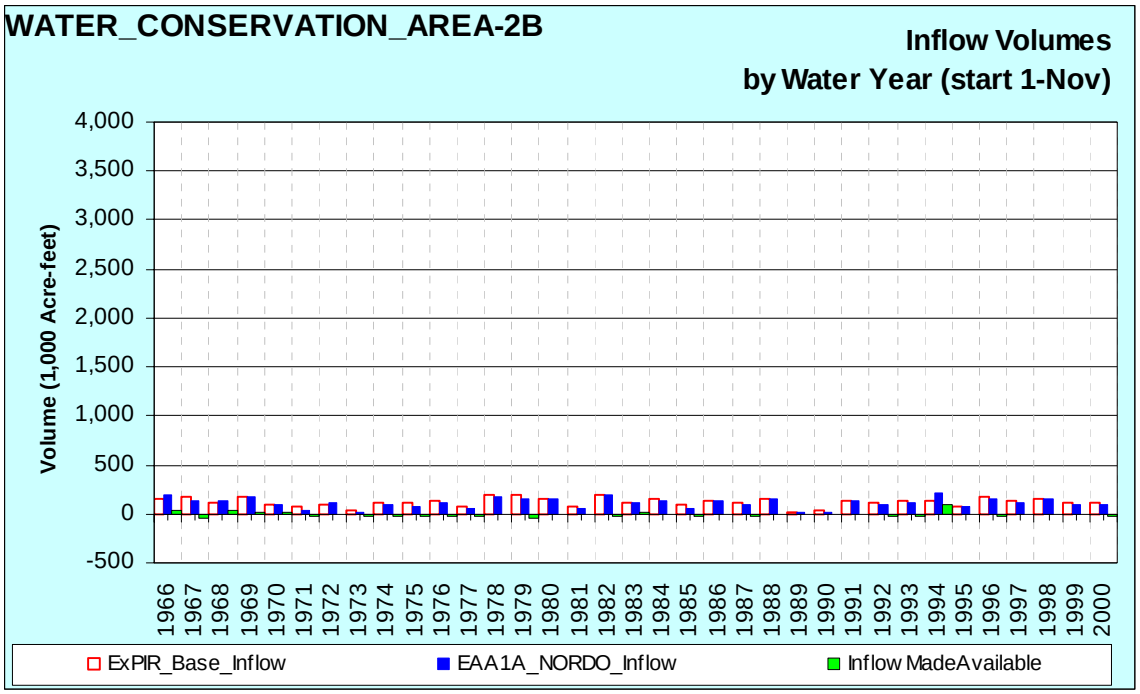
EAA1A_RDO_Outflow
Outflow MadeAvailable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Inflow Volumes
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Volume (1,000 Acre-feet)
4,000
3,500
3,000
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-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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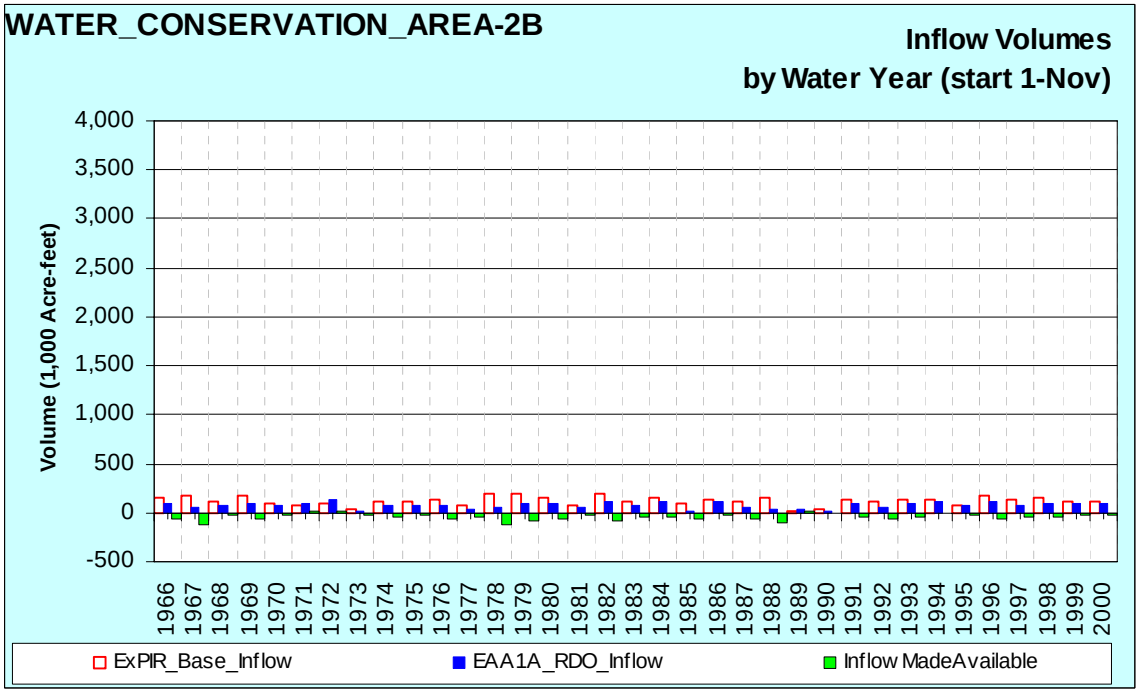
EAA1A_NORDO_Inflow
Inflow MadeAvailable


WATER_CONSERVATION_AREA-2B
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
3,000
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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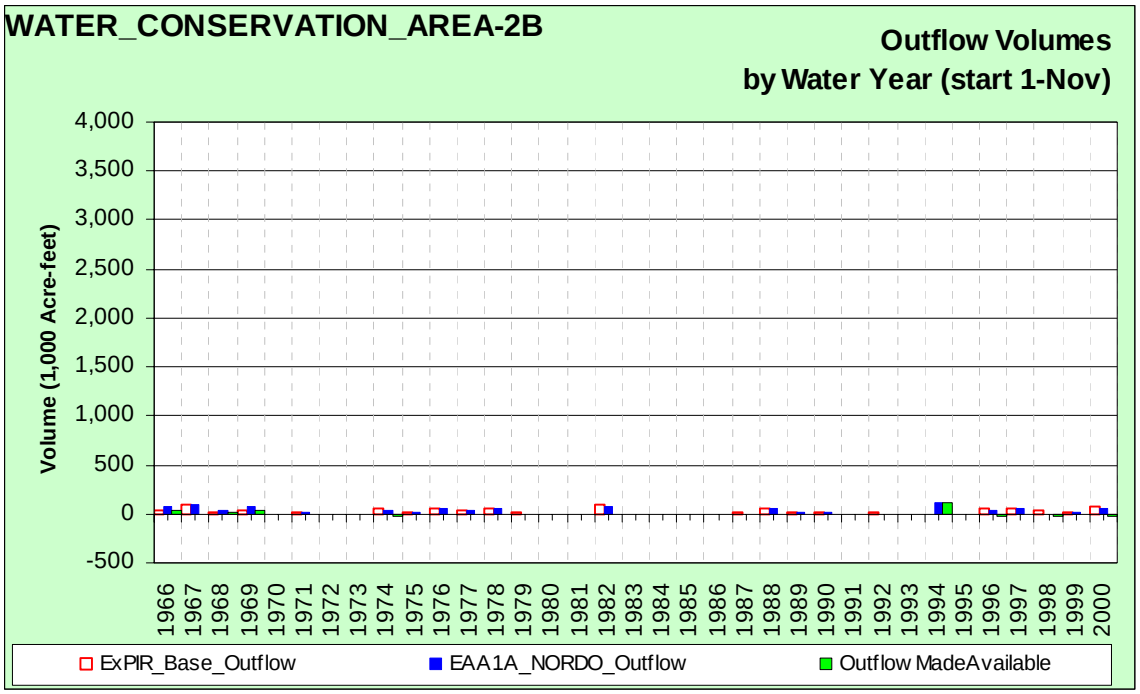
Inflow MadeAvailable


WATER_CONSERVATION_AREA-2B
Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
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2,500
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-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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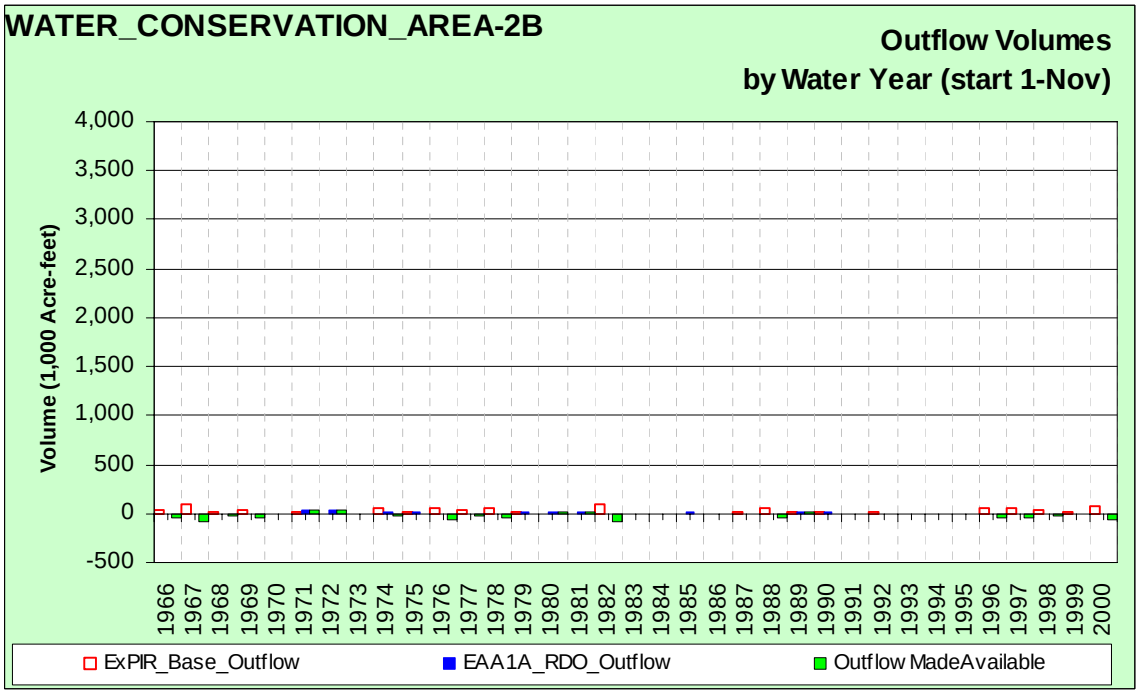
Outflow MadeAvailable


WATER_CONSERVATION_AREA-2B
Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
3,000
2,500
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-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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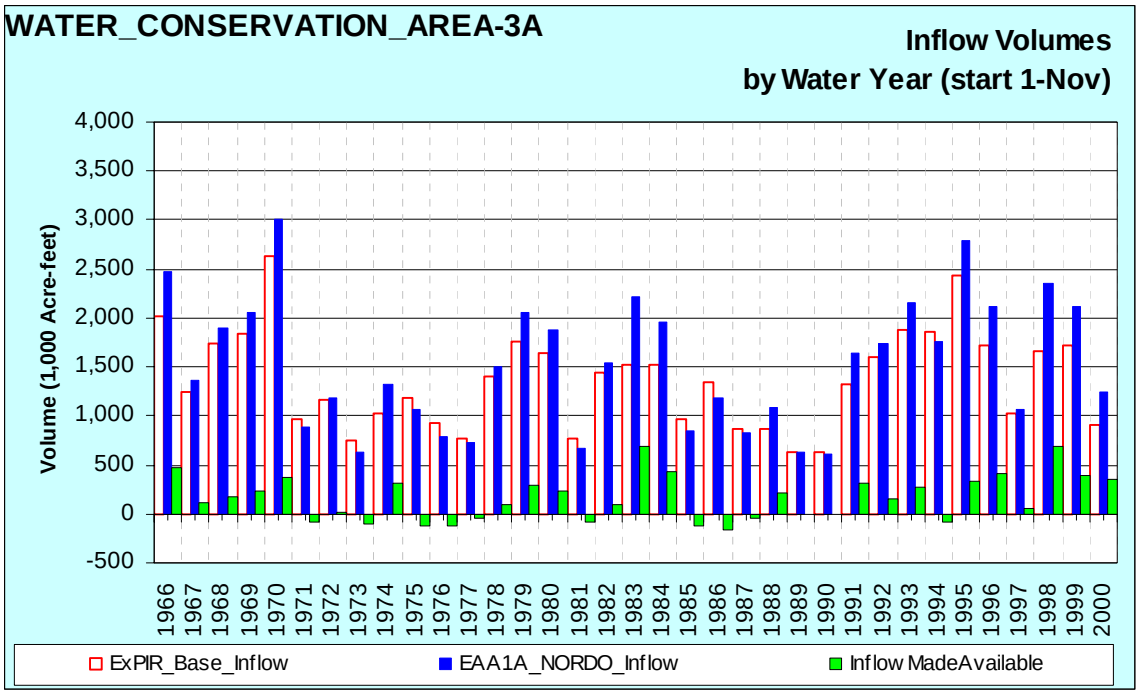
WATER_CONSERVATION_AREA-3A
Inflow Volumes
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Volume (1,000 Acre-feet)
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2,000
1,500
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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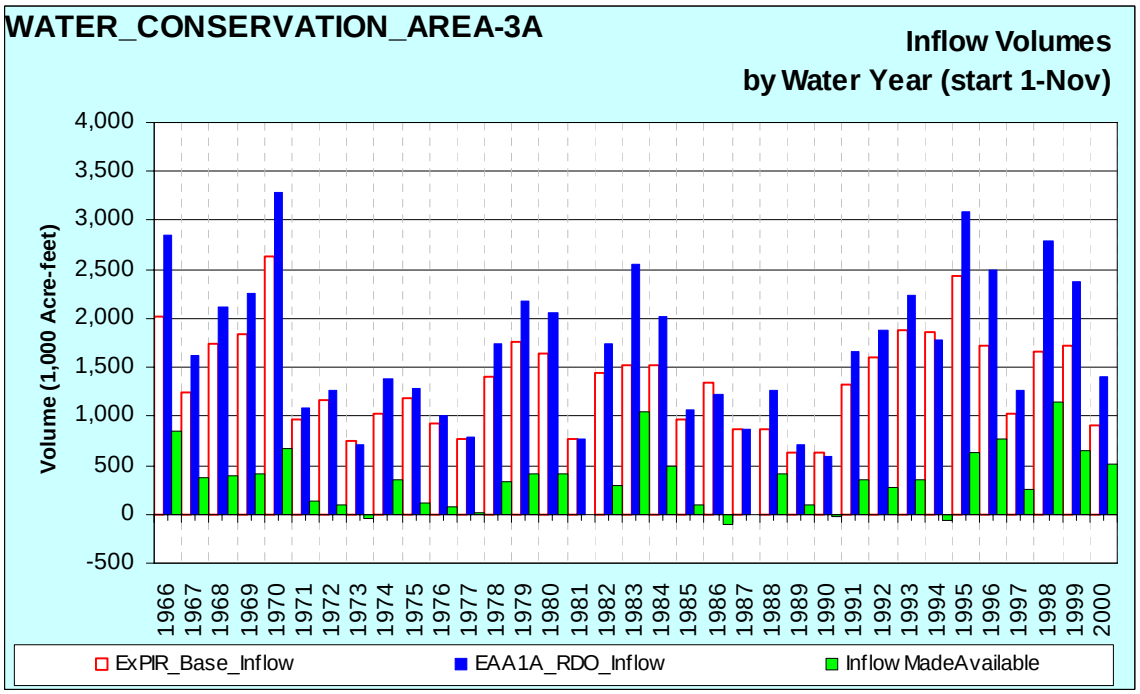
Inflow MadeAvailable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Inflow Volumes
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Volume (1,000 Acre-feet)
4,000
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2,000
1,500
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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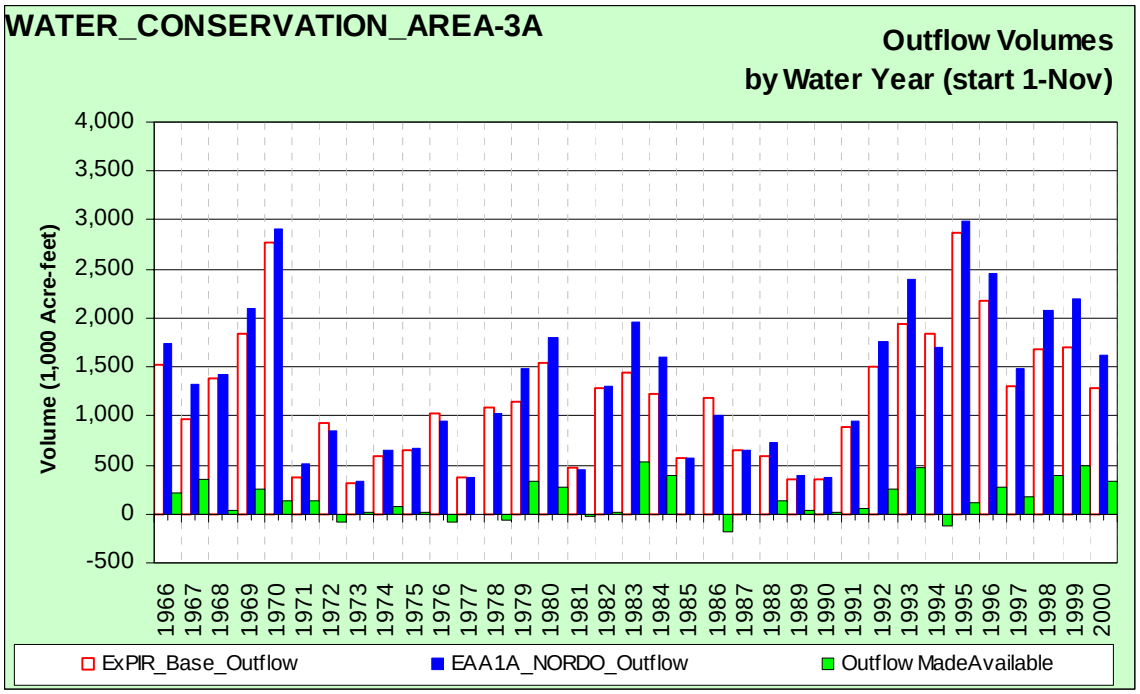
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Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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3,500
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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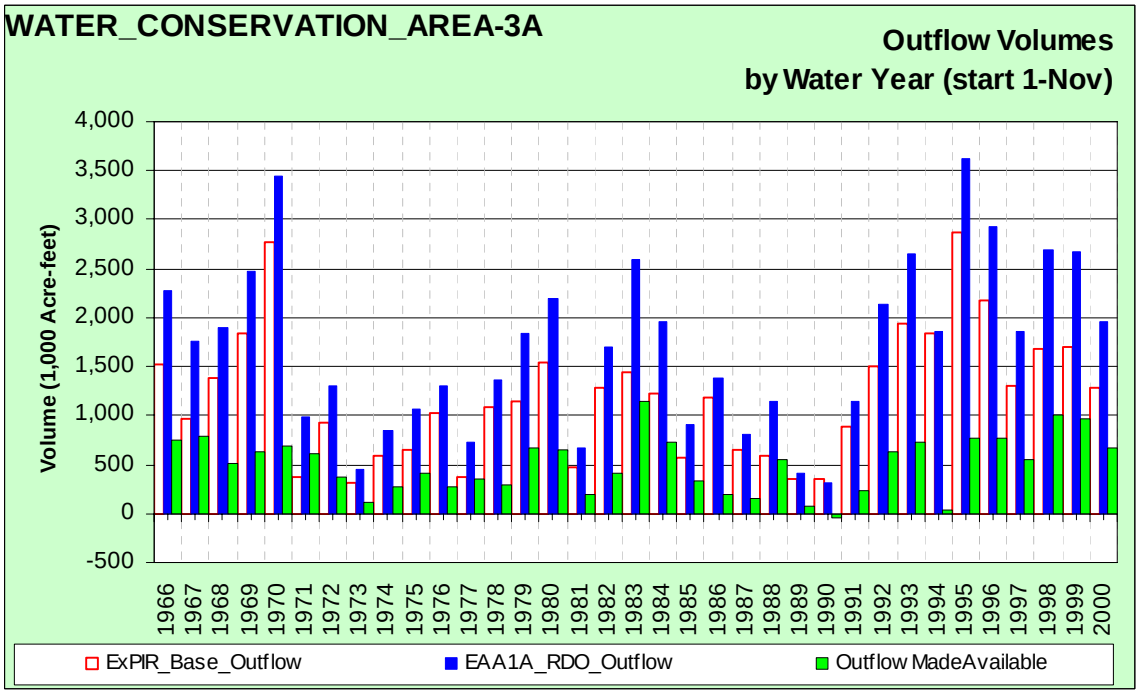
WATER_CONSERVATION_AREA-3A
Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
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2,500
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-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
ExPIR_Base_Outflow
EAA1A_RDO_Outflow
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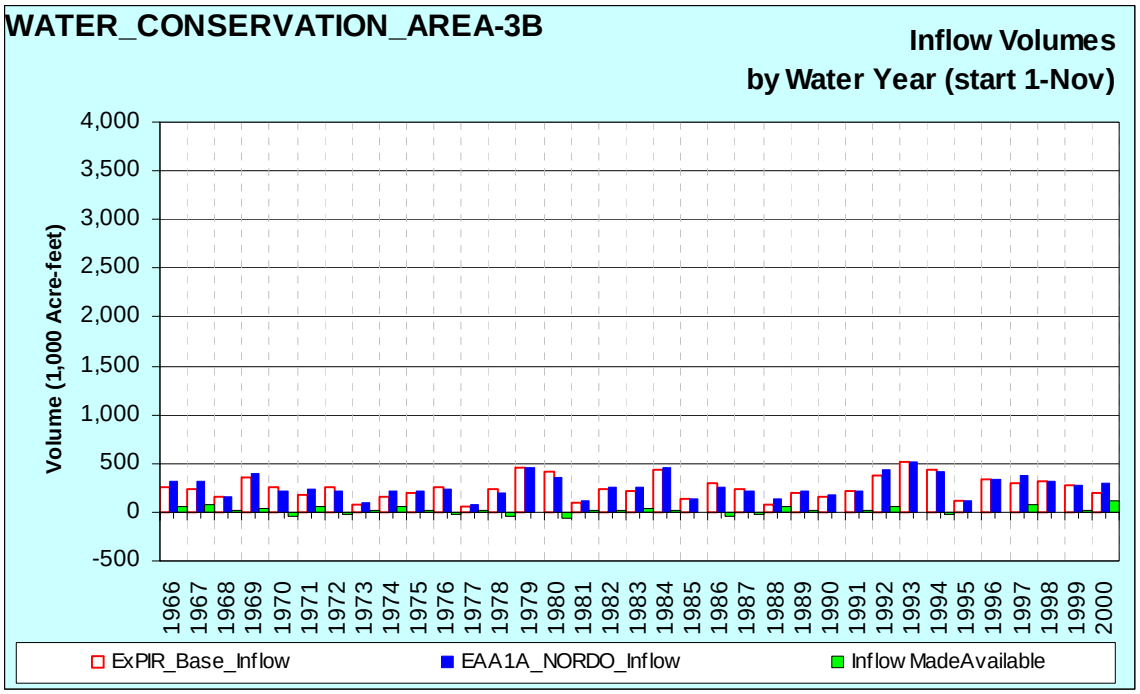
WATER_CONSERVATION_AREA-3B
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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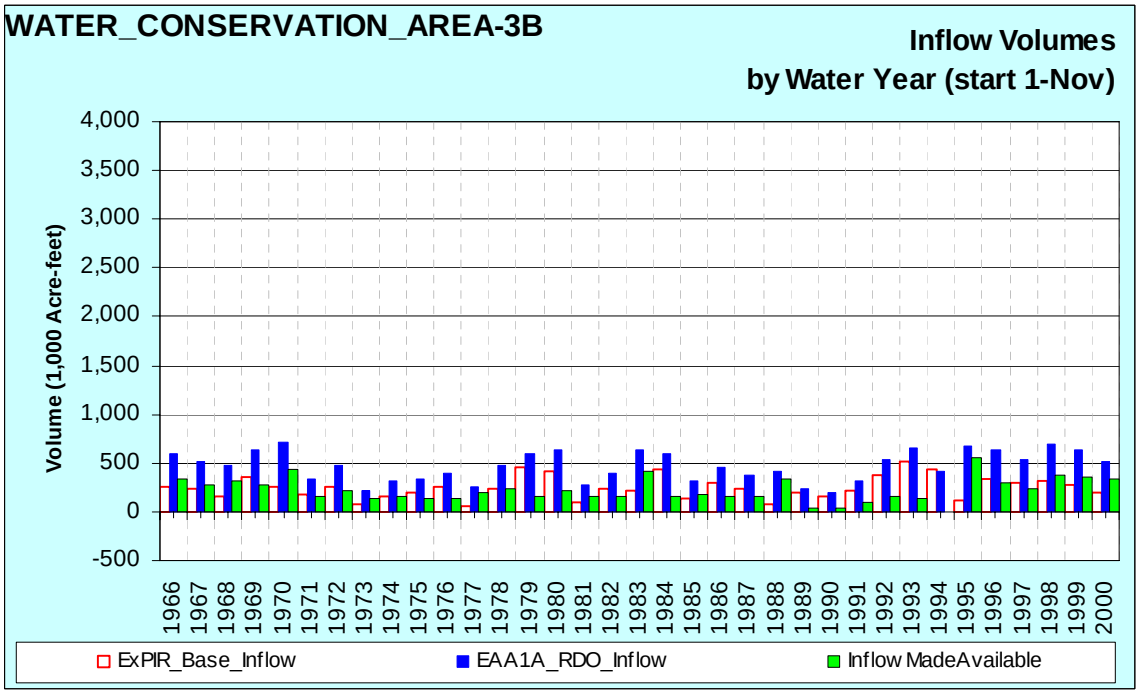
WATER_CONSERVATION_AREA-3B
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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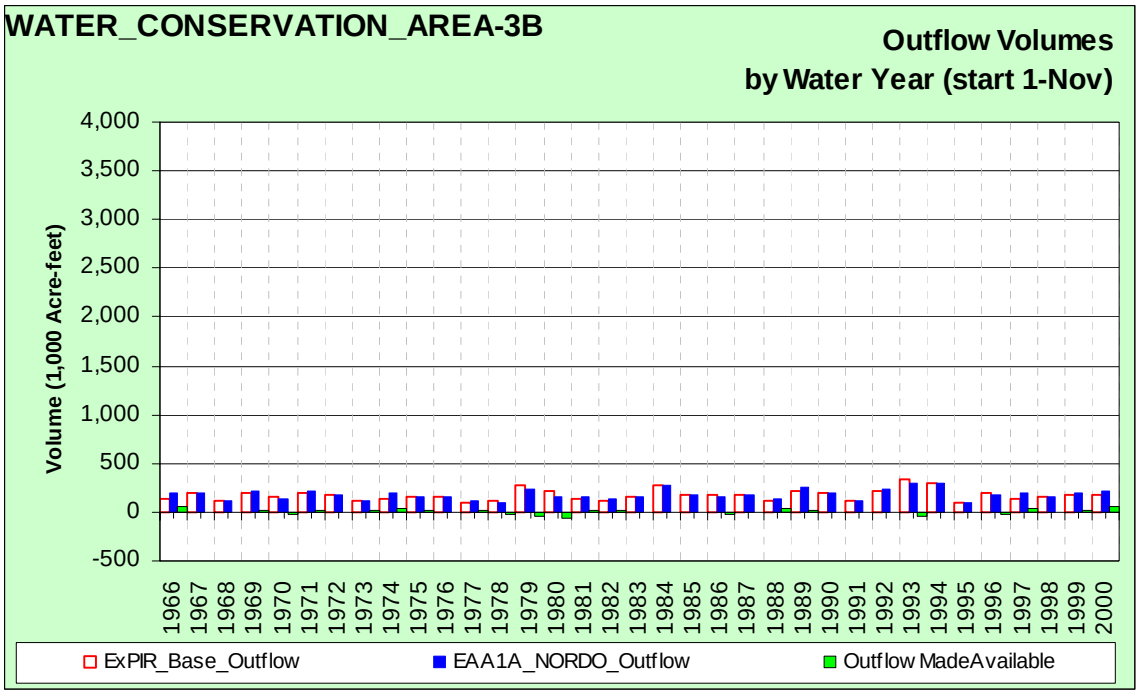
WATER_CONSERVATION_AREA-3B
Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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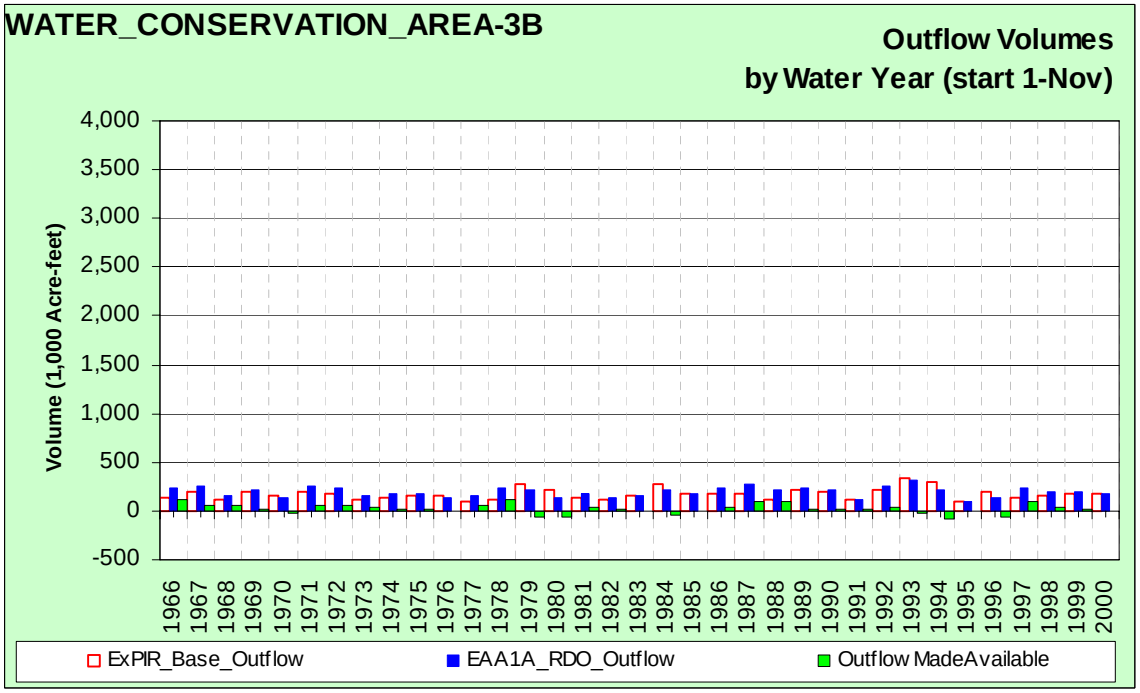
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Outflow Volumes
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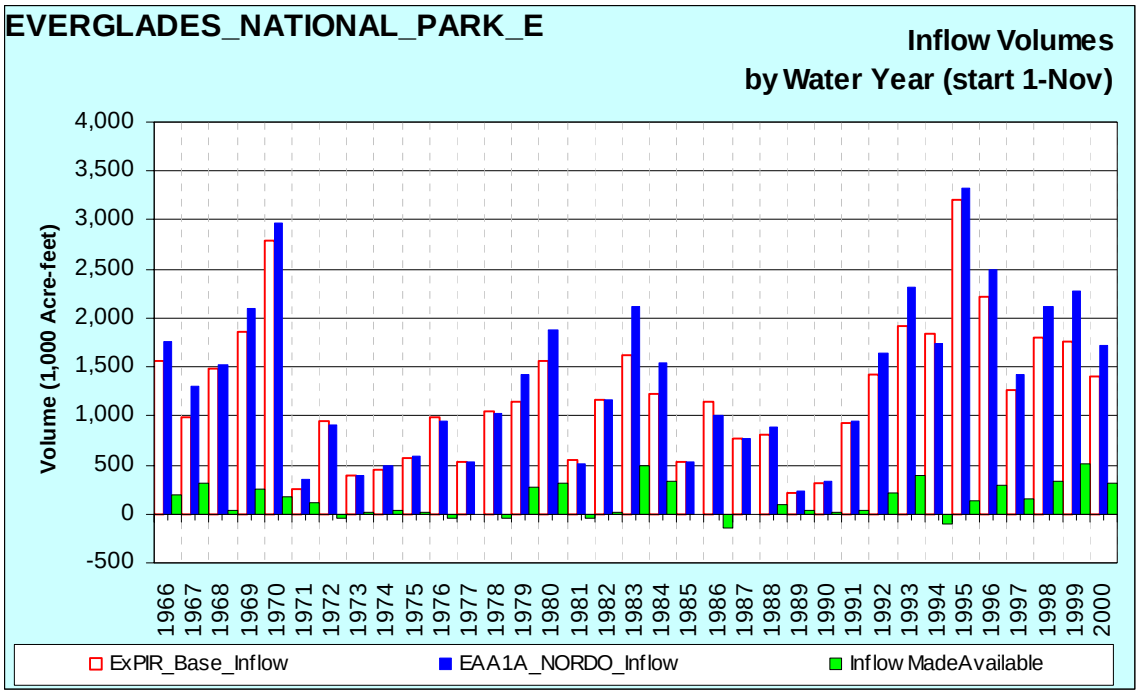
EVERGLADES_NATIONAL_PARK_E
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
3,000
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2,000
1,500
1,000
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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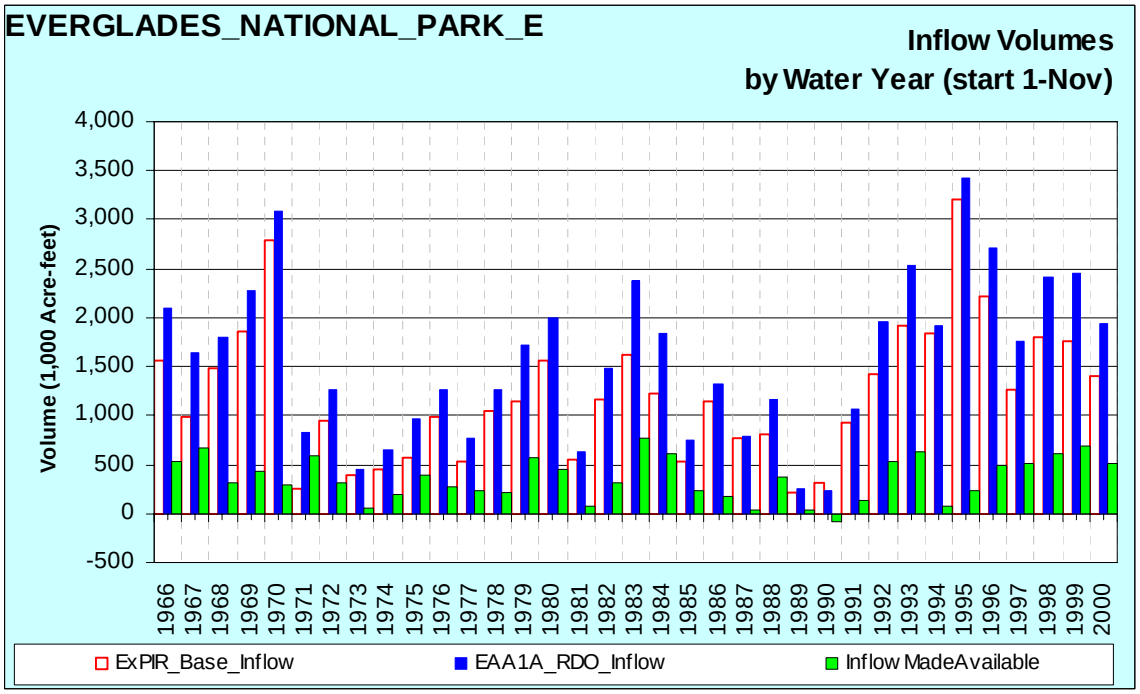
EVERGLADES_NATIONAL_PARK_E
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
3,000
2,500
2,000
1,500
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1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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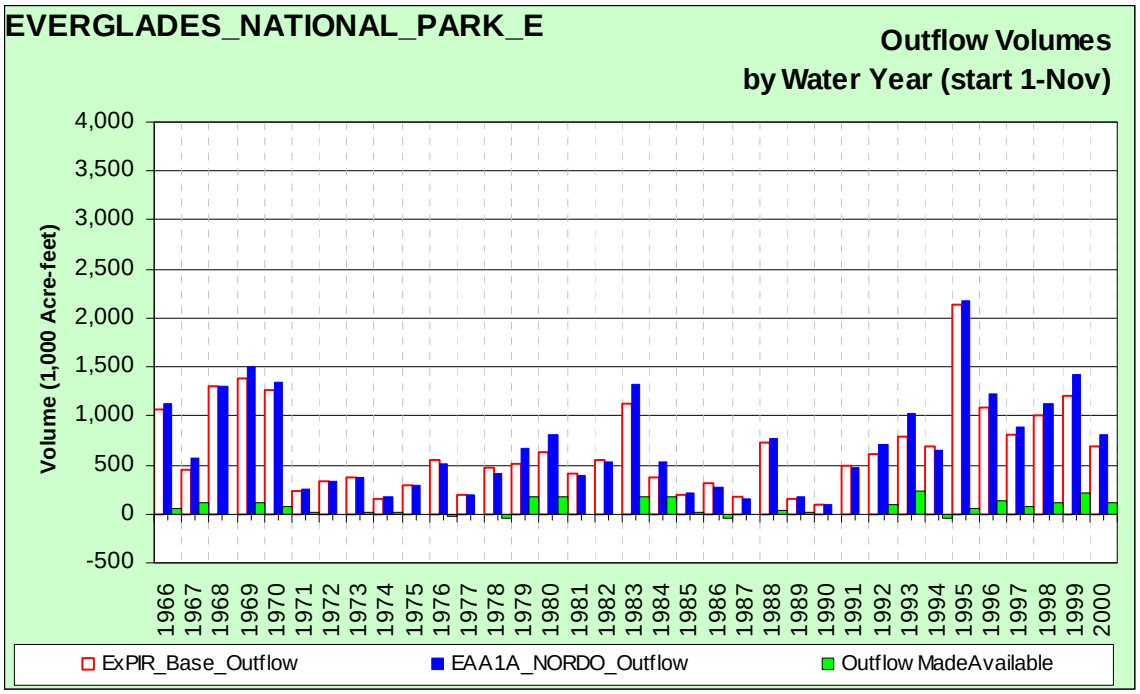
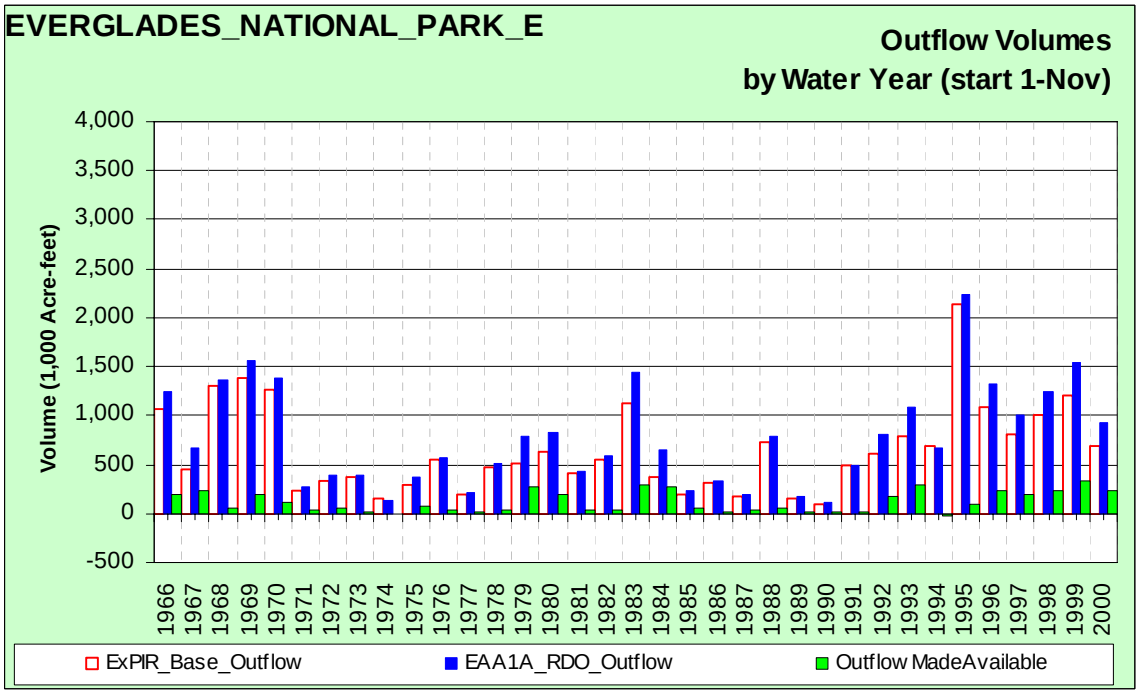




3.4.2 Project Level Effects

Although the EAA Reservoir A-1 project includes project-level features within impoundment cells and seepage canals that may provide fish and wildlife habitat, these are incidental effects that are the result of environmentally responsible design features. The primary purpose of the

seepage management features is to protect adjacent lands from potentially damaging high water levels. The improved fish and wildlife habitat in the seepage management area is expected to be somewhat ephemeral, and is dependent on operations of the impoundment cells to achieve the primary objectives of water storage and delivery of stored water for environmental and agricultural water supply. The deepwater refugia provided by the excavated areas within the impoundment will also provide fish and wildlife habitat, but the project will not be operated and managed to optimize these incidental environmental effects within the impoundment cells. Since these project-level features were not specifically formulated to increase the quantity of water for the natural system, a project-level evaluation to identify project-level water was not performed.

3.5 Water Made Available by the Project for Other Water Related Needs of the Region

The EAA Reservoir A-1 project stores discharges from Lake Okeechobee and runoff from the EAA that would otherwise be discharged to tide or delivered to the Everglades when the Everglades do not need additional water. Water is released from the EAA Reservoir A-1 to meet natural system water supply needs in the Everglades and agricultural supplemental irrigation needs in the Everglades Agricultural Area (EAA). This reduces the demand on Lake Okeechobee to function as a source of supply to meet those needs, and prevents low lake levels that contribute to water supply restrictions in the Lake Okeechobee Service Area (LOSA) and Lower East Coast Service Areas; therefore, implementation of the EAA Reservoir A-1 project increases the net amount of water available in the C&SF Project.

To determine the quantity of water made available for other water-related needs, metrics used include whether public water supply demands and supplemental irrigation demands for agriculture can be met and whether resources can be protected (e.g., salt water intrusion into fresh water aquifers). These metrics are directly linked to the goals and purposes of CERP.

Also worth noting is the reduction in demand for supplemental irrigation associated with the conversion of agricultural lands within the Everglades Agricultural Area due to the footprint of the EAA Reservoir A-1 project. The overall demand for supplemental irrigation in the Everglades Agricultural Area decreases from an annual average of 348,000 ac. ft. in the existing (ExPIR) condition to 318,000 ac. ft. as a result of project implementation (No RDO & RDO).

The volume of water stored in the impoundment creates a net increase in the volume of water capable of being delivered to the EAA to meet agricultural water supply needs. This represents the total amount of water provided directly by the project to meet the other water-related needs of the region. Table 3.5-1 summarizes these amounts as calculated from SFWMM simulations of Existing PIR condition with EAA Reservoir A-1 project under both operating conditions (No RDO and RDO). Annually, on average approximately 98,000 to 102,000 ac-ft of water stored by the EAA Reservoir A-1 is available in addition to the existing sources of water for the EAA (EAA runoff and Lake Okeechobee).

Table 3.5-1Total and Average Annual Discharges from EAA Storage Reservoir for Other Water-Related Needs (Thousand acre-feet)

Basin	2005 Existing Condition with EAA Reservoir A-1 (Thousand acre-feet) (No RDO)		2005 Existing Condition With EAA Reservoir A-1 (Thousand acre-feet) (RDO)	
	Average Annual	Total for 36 yr simulation	Average Annual	Total for 36 yr simulation
North New River Basin	102	3,664	98	3,542
Miami Basin	0	0	0	0
Discharges to NNRC & Miami Basins	102	3,664	98	3.542

For the Lake Okeechobee Service Area, the mean annual supplemental irrigation demands met and not met are similar and in some basins more irrigation demands are met by Lake Okeechobee when comparing the Existing PIR Conditions to the Existing PIR condition with EAA Storage Reservoir (see Table 3.5-2) under either operating condition. When Lake Okeechobee stages fall to the Supply Side Management zone (SSM) on the Lake's regulation schedule, a portion of the water supplies to the Lake Okeechobee Service Area (LOSA) and Lower East Coast Service Areas (LECSA) is restricted from their use.

Table 3.5-2 Mean Annual Volume of Supplemental Irrigation Deliveries Met and Not Met (Thousand Acre Feet) by Lake Okeechobee and EAA Storage Reservoir

Basin	2005 Existing Condition (ExPIR) (Thousand acre-feet)		2005 Existing Condition with EAA Reservoir A-1 (No RDO/RDO) (Thousand acre-fee)	
	Deliveries Met	Deliveries Not Met	Deliveries Met	Deliveries Not Met
EAA	323	25	318/310	13/30
S-4, S-236, L-8, Lower Istokpoga, N & NE Lake Shore basins Plus 298 districts	85	5	86/82	4/8
C-43/Caloosahatchee Basin	111	6	112/107	5/10
C-44/St Lucie Basin	26	2	27/25	1/3
Seminole Tribe – Big Cypress Reservation	24	5	28/28	1/1
Seminole Tribe – Brighton Reservation	27	1	28/26	1/2

The Lower East Coast Service Areas performs similar to LOSA with either the same or improvements to the ability of the C&SF Project to meet water demands. Both the number of

times and duration of water supply restrictions considered significant[1] in LOSA and LECSA decrease when the EAA Reservoir A-1 project operates as simulated in the SFWMM (See Table 3.5-3), thereby ensuring similar or an increase in the amount supplemental irrigation demands and public water supply demands can be met. As the number and duration of restrictions decrease, the total volume of water available for use in the Lower East Coast Service Area to meet urban and agricultural demands also increases.

Table 3.5-3 Number of Years with a Restriction Event and Total Number of Months of Restrictions in 36 year Simulation

	2005 Existing Condition (ExPIR)		**2005 Existing Condition with EAA Reservoir A-1 (No RDO/RDO)**	
Service Area	Number of Years	Total Number of Months	Number of Years	Total Number of Months
LOSA	9	25	6/12	16/33
LECSA 1	6	39	6/7	41/35
LECSA 2	24	128	24/24	129/132
LECSA 3	5	36	5/6	37/42
North Palm Beach SA	5	34	5/6	36/43

Percentage of demands not met provides another way to look at all basins and service area performance using the same metric. The percentage of supplemental irrigation and public water supply demands not met tied to Lake Okeechobee or groundwater stages in the Biscayne aquifer remain essentially the same with project implementation (see Table 3.5-4).

[1] Three criteria are used to determine if the water restrictions are significant in LOSA. First, for a month to be counted there must be supply-side restrictions for seven or more days; second, the reductions in deliveries must be 10% or more; and third, the total reduction in deliveries during the month must exceed 18,000 acre feet. Any water year with one or more months meeting these criteria is counted as a year with significant supply-side restrictions. For LECSA, some of these shortages result from local conditions beyond the reach of the regional water system. Water restrictions less than two months in duration triggered by local groundwater conditions will not be considered a regionally significant water shortage.

Table 3.5-4 Percentage of Supplemental Agricultural and Public Water Supply Deliveries Not Met[2]

	2005 Existing Condition (ExPIR)	2005 Existing Condition with EAA Reservoir A-1 (No RDO/RDO)
Service Area	Percent of Deliveries Not Met (percent)	Percent of Deliveries Not Met (percent)
EAA	7	24/9
Other LOSA[3]	6	5 /9
LECSA 1	1.4	1.4/1.4
LECSA 2	4.6	4.6 //4.8
LECSA 3	1.4	1.2/1.4
North Palm Beach SA	1.2	01.2/1.4

Another use of water supplied by the C&SF Project is to maintain stages in its primary coastal canals to prevent salt-water intrusion of the Biscayne aquifer. Operating criteria and reference stages for control structures located nearest the Atlantic Ocean were established as part of the minimum flow and level necessary to protect the Biscayne aquifer from serious harm. Inability to meet these stages for 180 days exceeds the Minimum Flows and Levels (MFL) criteria. The 2005 Existing Conditions model run fails to meet the criteria once at one location in the 36 year simulation, the C-4 Canal at the S-25B structure. Modeling of the 2005 Existing Conditions with EAA Storage Reservoir results in meeting the criteria at all locations (see Table 3.5-5) except for the C-4 Canal at the S-25B structure. The MFL performance at this structure is similar to the performance of the 2005 Existing Conditions. In general, with implementation of the project, regional water is available and delivered to avoid exceeding the minimum flow and level canal stage criteria and canal stages are maintained, enabling continued protection of the Biscayne aquifer.

[2] For the Lower East Coast Service Area only deliveries not met for public water supply are tabulated; the percentages do not include meeting supplemental irrigation demands for urban landscaping, nurseries, golf or agriculture in the Lower East Coast Service Area.

[3] Other LOSA combines S-236, S-4, L-8, C-43, C-44, north and Northeast Lake Shore and Lower Istokpoga basins.

Table 3.5-5 Number of Times and Percent of Time Minimum Flow and Level Canal Stage Criteria to Protect the Biscayne Aquifer is not Met

Canal and Structure	2005 Existing Condition (ExPIR)		2005 Existing Condition with EAA Reservoir A-1 (NoRDO/RDO)	
	Number of Times	Percent of Time	Number of Times	Percent of Time
C-15 @ S-40	0	1	0/0	1/1
Hillsboro @ G-56	0	0%	0/0	0%/0%
C-14 @ S-37B	0	1%	0/0	1%/1%
C-13 @ S-36	0	0%	0/0	0%/0%
North New River @ G-54	0	0%	0/0	0%/0%
C-9 @ S-29	0	14%	0/0	14%/13%
C-6 @ S-26	0	19%	0/0	18%/16%
C-4 @ 25B	1	13%	1/0	12%/11%

5.0 BASIS OF DESIGN

5.1 INTRODUCTION

The design of the northeast pump station facilities includes design of the connector canal; U.S. 27 highway bridge; pump station structure and equipment including pumps and drivers, trash racks, seepage pumps, and intake and discharge channels; control structures; and spillway. Additional control structures S-602 and S-603 will be designed for construction along the southern Reservoir embankment adjacent to the STA-3/4 Supply Canal.

5.1.1 Connector Canal and Bridge

The Connector Canal will convey water from the NNRC to the northeast pump station intake. The canal will intersect the NNRC northeast of the pump station site and will pass under U.S. 27. The highway bridge required to permit the canal crossing will be a multi-span concrete slab bridge and will be designed to Florida Department of Transportation (FDOT) standards. The Connector Canal will be designed for a capacity up to 5,000 cfs at a velocity less than 3 feet per second (fps). An approach length of approximately 1,000 feet will be provided upstream of the pump station intake to allow the flow into the pump station to be steady and uniformly distributed.

5.1.2 Pump Station

The northeast pump station will be located in the northeast corner of the Reservoir embankment. The pump station will be constructed near the exterior toe of the embankment with pump discharge piping extending through the embankment above the Reservoir normal full pool elevation . The pump station design will include the sizing and layout of the pumps, pump drivers, appurtenant equipment, and associated systems.

The pump station will utilize vertical axial flow pumps with gear reduction transmissions, and diesel engine drivers. The pump station equipment layout will generally be in accordance with USACE EM 1110-2-3105 Mechanical and Electrical Design of Pump Stations and the District's "Major Pump Station Engineering Guidelines." Auxiliaries will include flexible connections, tension bars, vacuum priming systems and air vents, lube oil systems, waste lube oil system, etc., as appropriate. The diesel engine drivers will be water cooled. The pump units will be capable of local/manual, local/auto and remote operation. Stilling wells with water level sensors and low water level shut off switches will be installed in each pump bay.

A diesel fuel system will include aboveground double-walled fuel storage tanks, double walled fuel piping, leak monitoring devices, fuel level measurement, filling pipes, venting pipes, access manholes, etc. The fuel storage system will be designed to hold seven days of fuel for continuous operation of all pumps and accessories.

The pump station will have ventilation as required for the equipment operation. The supply fans for building ventilation will provide filtered air and will be thermostatically controlled. An air conditioned control room, as well as break room with restrooms is provided. A standby rated diesel fueled engine-generator along with a back-up engine generator will be provided for the building service electrical loads.

Trash racks will be provided in each pump bay upstream of the pumps. The trash racks will be designed to minimize head loss and protect the pump in accordance with the pump manufacturer's recommendations. Two motorized rakes will be provided to remove trash from the racks and deposit it in a dump site. The racks and rakes will be designed for easy removal and maintenance. All subaqueous components will be corrosion resistant. The rakes will be designed to operate when a main pump is operating. Each rake will serve as a back-up to the other.

Provisions for insertion of stop logs in front of the trash racks will be made to permit isolation of each pump bay for maintenance.

5.1.3 Control Structures

Control structures will be used to release water from the Reservoir to the NNRC and STA-3/4 Supply Canal for environmental, agricultural, and emergency release purposes. Control structures will also be used to help fill the Reservoir when the water suface elevation in the canals is higher than the water surface elevation in the Reservoir.

Two control structures, S-602 and S-603, will be provided on the southern Reservoir embankment, one on either side of Structure G-383 in the existing Inflow/Supply Canal. An additional control structure, S-609, is provided adjacent to the northeast pump station to release reservoir water to the NNRC via the Connector Canal.

Structure S-609 at the northeast pump station will be designed to allow release of up to 1,960 cfs from the Reservoir to the Connector Canal and NNRC. Five parallel concrete box culverts will be provided. Each culvert will be 14 feet by 8 feet with roller gates on the interior headwall and at the exterior discharge wall adjacent to the Connector Canal.

The control structures on the southern Reservoir embankment will be 10-foot by 10-foot box culverts with vertical roller gates located on the external embankments. Parallel box culverts will be constructed side by side to achieve the appropriate total gate width required for peak discharges.

5.1.4 Spillway

An orifice spillway will be constructed at the northeast pump station and the discharge flow will be limited to 500 cfs at two feet of head by constricting the discharge conduit. Four slotted openings, each 2 feet by 13 feet, will be located in the embankment headwall, with the bottom of the openings set at the reservoir normal pool elevation, and discharging to the spillway conduit. A 5.5 feet by 5.5 feet opening in the spillway conduit will be used as an orifice to limit the flows.

5.1.5 Seepage Pumps

The seepage collection canals constructed along portions of the western boundary and northern boundary of the Reservoir site will route the collected seepage to the northeast pump station. At the pump station, three seepage pumps will be provided to pump the seepage from the seepage canal back into the Reservoir. To provide a firm pumping capacity of 116 cfs, the maximum projected seepage flow, each seepage pump will be sized to pump 58 cfs.

The seepage collection canal constructed along the eastern boundary is routed to the existing G-370 pump station. Existing seepage pumps in the pump station will discharge to the Inflow Canal.

5.1.6 Irrigation Pumps

Irrigation pumps are provided to pump water from the Reservoir to the Connector Canal when the water level in the Reservoir is lower than elevation 10.0 NAVD88, which is the water level required in the canal to supply existing agricultural irrigation pumps. Five pumps, each sized to pump 200 cfs, will be placed in the five discharge culverts adjacent to the northeast pump station and will discharge over the top of the culvert wall to the Connector Canal.

5.2 GEOTECHNICAL DESIGN

This section describes the basis of geotechnical design for the northeast pump station facilities and control/control structures. Geotechnical design for the bridge along U.S. 27 Highway will be provided by others.

5.2.1 Applicable Codes and Standards

Design of structural elements will comply with the design codes and standards included in the Codes and Standards portion of Section 3.

5.2.2 Northeast Pump Station

The recommendations included in this section are based on the subsurface information obtained from borings CB0258 and CB0058 (borings closest to the proposed location of the pump station building), the Geotechnical Data Report (GDR) and the BODR. The design information provided shall be confirmed with a structure specific subsurface investigation to follow.

5.2.2.1 Construction Considerations

The northeast pumping station is a multi-level structure that will bear for the most part below existing grade (below El. -11.4). However, the pump station has a big step-up to +/- El. 14 near the access manholes, where the higher slab will support the pipes coming from the embankment. This slab is also directly below the Control Room and the Break/Maintenance Room that sit on a slab with a finish floor elevation of El. 28.0.

Given the northeast pump station dimensions, the changes of grade across the structure, and the expected groundwater seepage, an open cut excavation could be used. Groundwater could be controlled by using a perimeter slurry cutoff wall combined with a system to collect groundwater seepage into the excavation. The trenching machine to be used to cut through the caprock for the

embankment cutoff wall installation could also be used to install a cutoff wall along the perimeter of the pump station excavation. The groundwater flows into the excavation and the required length of the cutoff wall will require analysis based on the information obtained from the structure specific subsurface investigation program. A similar excavation/dewatering technique is expected to take place for the pipe discharge structures to be constructed under the bottom of the reservoir.

The pump discharge pipe will be installed above the new embankment on a 3:1 slope until the invert elevation of the discharge pipe reaches elevation 25.5 NAVD88. The discharge pipe will then be installed horizontally and penetrate the embankment at elevation 25.5 NAVD88. The sloped portion of the piping will be supported by concrete pipe supports with a mat foundation. The horizontal portion of the pipe will be supported by concrete pipe supports resting on a concrete slab supported by rockfill material. Since the embankment cross-section will be modified to support the pump station pipes, a seepage cutoff across the rockfill will be provided. The system will consist of a vinyl sheet pile wall to be placed to a specified depth into the embankment cutoff wall. The exposed vinyl sheets will be supported through different means during construction. A concrete slab will be poured to hold the sheets in place. The slab will be covered with a random fill berm, allowing the sheets to be supported laterally so that rockfill can be placed against the sheets. The rockfill should be placed simultaneously on both sides of the sheet pile wall to avoid a cantilever effect on the sheet pile wall.

5.2.2.2 Foundation Design

5.2.2.2.1 Bearing capacity

Pump station structures bearing on compacted rockfill or prepared subgrades may be supported on shallow spread and strip footings. Spread and strip footings may be designed using a net allowable bearing pressure of 3,500 psf. According to the 2004 Florida Building Code, all footings shall have a minimum embedment of 1 foot below the adjacent grade.

When using the net allowable bearing pressure, the weight of the footing and soil backfill over the footing including the floor slab weight may be excluded; therefore, only the loads applied at or above the top of the finished slab need to be considered for sizing the footings. Based on the net allowable design values given herein, total settlements are not likely to exceed 1 inch. Mat foundations bearing greater than 10 feet below existing grades and mat foundations bearing on compacted rockfill should be designed for a modulus of subgrade reaction of 250 pounds per cubic inch (pci). These values are for a 1 foot by 1 foot plate and should be adjusted for the mat size.

5.2.2.2.2 Lateral Load (Lateral Earth Pressure)

Lateral earth pressure recommendations for structure backfill materials are given in Table 5.2-1. A friction angle of 33 degrees should be used for the compacted Ft. Thompson Sand, and a friction angle of 40 should be used for the compacted rockfill (Caprock).

Table 5.2-1 Lateral Earth Pressure Recommendations

Condition	Material Type	Lateral Earth Pressure
Active earth pressure	Ft. Thompson Sand	34 pounds per cubic foot (pcf)
	Rockfill (from caprock)	29 pounds per cubic foot (pcf)
At-rest earth pressure	Ft. Thompson Sand	52 pounds per cubic foot (pcf)
	Rockfill (from caprock)	48 pounds per cubic foot (pcf)
Passive earth pressure	Ft. Thompson Sand	390 pounds per cubic foot (pcf)
	Rockfill (from caprock)	621 pounds per cubic foot (pcf)
Lateral surcharge load from compaction (decreases linearly)	N/A	400 psf at the ground surface, 0 psf at the depth equal to 400 psf divided by the earth pressure
Hydrostatic	N/A	63 pounds per cubic foot (pcf)
Vertical surcharge, at locations subject to truck or equipment loads	N/A	Surcharge shall be calculated based on the equipment listed in Section 5.3.3.2, subject to a 500 psf minimum

The active pressure values will only be used for site retaining walls that are free to rotate.

5.2.3 Control Buildings and Control Structures

The recommendations included in this section are based on the subsurface information obtained from borings CB0313 and CB0416 (borings closest to. the proposed location of the control structures) and the information provided in the Geotechnical Data Report (GDR) and the Basis of Design Report (BODR). The design information provided shall be confirmed with a structure specific subsurface investigation to follow.

5.2.3.1 Construction Considerations

The proposed control structures located along the south embankment will discharge water into the STA-3/4 Inflow Canal. The construction of these structures will require a temporary cofferdam type structure with associated dewatering if the operation of the inflow canal is to continue during construction. The foundations for the control structures will bear below the proposed key trench near El. -6.9. Sections of sheet piling used for the cofferdam structure could permanently remain in place to provide a seepage cutoff underneath the control structures. This option will require a detailed seepage analysis to determine the placement and required sheeting depths.

The Control Buildings will be slab-on-grade buildings with a control room, a generator room and a liquid propane gas tank. The liquid propane tank should bear above grade to prevent groundwater seepage contamination of the STA-3/4 Inflow Canal and containment for gas spills should be provided. The proposed location of the control structures is just north of the crest of

the existing canal levee (which will be used as an access road) and would therefore bear on new random fill placed on the existing embankment. Boring CB0416 was drilled on the existing embankment and shows that peat material was used as part of the embankment fill. To alleviate the potential of primary and secondary settlement of peat materials, the areas where the control buildings will be founded should be excavated down to the caprock surface to remove the peat from under the existing fill. Then rockfill should be placed and compacted from caprock level up to the structure bearing elevation.

5.2.3.2 Foundation Design

5.2.3.2.1 Bearing capacity

Control Buildings and control structures bearing on compacted rockfill or prepared subgrades may be supported on shallow spread and strip footings. Spread and strip footings may be designed using a net allowable bearing pressure of 3,500 psf. According to the 2004 Florida Building Code, all footings shall have a minimum embedment of 1 foot below the adjacent grade.

When using the net allowable bearing pressure, the weight of the footing and soil backfill over the footing including the floor slab weight may be excluded; therefore, only the loads applied at or above the top of the finished slab need to be considered for sizing the footings. Based on the net allowable design values given herein, total settlements are not likely to exceed 1 inch. Mat foundations bearing below 15 feet below existing grades and mat foundations bearing on compacted rockfill should be designed for a modulus of subgrade reaction of 250 pci. These values are for a 1 foot by 1 foot plate and should be adjusted for the mat size.

5.2.3.2.2 Lateral Load (Lateral Earth Pressure)

Recommendations for lateral earth pressure shall follow recommendations provided for the northeast pump station.

5.3 STRUCTURAL DESIGN

This section describes the basis of structural design for new or modified facilities.

5.3.1 Applicable Codes and Standards

Design of structural elements will comply with the design codes and standards included in the Codes and Standards portion of Section 3.

5.3.2 Design Stresses

5.3.2.1 Minimum Concrete Compressive Strength (Unconfined)

- Mass concrete, f’c — 3,000 psi at 28 days
- Structural concrete, f'c — 4,000 psi at 28 days

5.3.2.2 Reinforcing Steel

• ASTM A615, steel yield strength (fy)	60,000 psi

5.3.2.3 Structural Steel

• Wide flange shapes, ASTM A572, Grade 50, fy	50,000 psi
• Angles, channels and plates, ASTM A36, fy	36,000 psi
• Pipe sections, ASTM A53, Type E, fy	35,000 psi
• Tube sections, ASTM A500, Type B or C, fy	46,000 psi

5.3.2.4 Masonry

• Concrete masonry units (CMU), Grade N-1, compressive strength	1,900 psi
• Compressive strength of mortar, Type S	1,800 psi
• Compressive strength of grout	2,000 psi
• Masonry unit assembly, compression strength (f'm)	1,500 psi

5.3.3 Loading Criteria

5.3.3.1 Dead Loads

• Equipment	Actual
• Phantom load	1 kip[1] at secondary beams 2 kips at primary beams
• Bridge crane or monorail	Actual crane beam + rail only
• Roof, superimposed	Actual, 15 pounds per square foot (psf) minimum

5.3.3.2 Live Loads, per Major Pumping Station Engineering Guidelines

• Roof (minimum, unreduced)	50 psf
• Operating floors	250 psf, or the heaviest piece of machinery anticipated to be placed therein, whichever is larger

[1] A unit of weight equal to 1,000 pounds or 455 kilograms

• Control rooms	100 psf
• Restrooms	100 psf
• Equipment and storage rooms	200 psf
• Maintenance work areas	300 psf
• Stairways	100 psf
• Elevator lift and handicap ramp	200 psf
• Deck grating	250 psf
• Service bridge	HS-25 or District 40T truck crane loading (P&H 440TC), whichever is larger
• Guardrails (at top rail)	50 pounds per linear foot (plf) + 200 pound concentrated load, acting in any direction
• Bridge crane or monorail, vertical load	Rated capacity (full wheel load) + 25 percent impact
• Bridge crane or monorail, lateral and longitudinal loads	Lateral load = 20 percent of the sum of the weights of the lifted load + the crane trolley. Longitudinal load = 10 percent of the maximum wheel load.

For large equipment areas the combined weight of equipment and base plus an additional live load of 50 psf over the base area will be used as the live load.

5.3.3.3 Lateral Loads

Lateral loads for structures shall be as indicated in Section 5.2 Geotechnical Design (Table 5.2-1).

The active pressure values indicated in the table will only be used for site retaining walls that are free to rotate.

5.3.3.4 Snow Loads - Not Applicable

5.3.3.5 Seismic Loads

Earthquake loads will not be considered, in accordance with the 2004 Florida Building Code.

5.3.3.6 Wind Loads – Pump Station

- Design 3-second gust wind speed — 155 mph
- Height and exposure coefficient — Exposure C
- Structure importance factor — 1.51
- Building type — Partially enclosed

5.3.3.7 Wind Loads – Flood Control Elements

- Design 3-second gust - wind speed — 130 mph
- Height and exposure coefficient — Exposure C
- Structure importance factor — 1.30
- Building type — Partially enclosed

5.3.3.8 Flood Load (Hydrostatic + Wave)

- Dynamic Pressure Coefficient (ASCE 7-02, Table 5-2) — 3.5

5.3.4 Hydraulic Structures and Pumping Station Substructure

5.3.4.1 Materials of Construction

Hydraulic structures and the new northeast pump station substructure will be constructed of reinforced concrete. Because water in the Everglades is aggressive to concrete, Type II Cement will be specified. Any platforming associated with these items will be constructed of aluminum shapes, aluminum grating and aluminum guardrail. Connection bolts will be either stainless steel or aluminum. Reinforced concrete platforming will be used in locations where the use of grating is not appropriate.

5.3.4.2 Design Procedures and Assumptions

Hydraulic structures and the new northeast pump station substructure will be designed based upon the loads, load combinations, and allowable stresses contained in EM 1110-2-2104, subject to meeting the requirements of the District's Design Standards of August, 2005 and ACI 318-02. Temperature and shrinkage reinforcement and cracking limits will be in accordance with ACI 350.

- Rectangular walls may be analyzed as two way rectangular plates when the aspect ratio of length to height is 2H:1V or less. The boundary conditions will be chosen to give reasonably conservative results. If the aspect ratio exceeds 2H:1V, the wall will be designed as a one way rectangular plate and the corners will be investigated assuming a 2H:1V ratio.

- The design of water containment walls will consider both flexure and tension in the walls. The horizontal reinforcement on the water side will be apportioned for 100 percent flexure steel plus 100 percent tension steel.
- Direct tension in the foundation and top slabs due to internal water pressure will be accounted for in the design of the slab's horizontal reinforcing. The foundation's top reinforcement will be assumed to resist 100 percent of the tension at the foundation. The tension in the top slab may be resisted equally between the top and bottom reinforcement for reasonably thin slabs.
- A minimum reinforcement for shrinkage and temperature will be provided in accordance with ACI 350. As indicated in ACI 350, a minimum reinforcement ratio of 0.5 percent will be provided in basin walls and base slab with a basin dimension of 50 feet or more in any direction. Reinforcement ratios in the direction where the structure dimension are less than 50 feet will be in accordance with ACI 350. Minimum size of shrinkage and temperature reinforcement will be #4 and will be divided equally between the two surfaces of the concrete section. Concrete sections greater than 24 inches thick may have minimum reinforcing based on a 24-inch thickness. The shrinkage and temperature reinforcement in the bottom of slabs reinforced top and bottom, in contact with the subgrade, can be reduced to one-half the values calculated.
- Hydrostatic groundwater pressure for structures adjacent to the Reservoir will be based on the water level of the Reservoir. In accordance with USACE EM 1110-2-2104, the uplift pressure distribution along the base of foundations will be assumed to be linear between the upstream and downstream edges of the foundation. The pressure distribution will be modified to take into account any foundation drains or groundwater cutoff devices. Uplift reduction at drains may not exceed 50 percent of the difference between the full uplift head at the pump station intake and the drain.

5.3.4.3 Design Load Cases

Listed below is a summary of the loading assumptions and load factors for design:

Where:

DL = Dead load

LL = Live load

Hw = Lateral hydrostatic pressure

Hweq = Lateral hydrodynamic pressure

Hs = Lateral Static Soil Load (including at-rest soil plus groundwater hydrostatic pressure, surcharge, and compaction pressures)

Fa = Flood load

W = Wind load

U = Required strength to resist factored loads

5.3.4.4 Service Water Condition

For a maximum service water level, ignore the soil backfill loads unless soil loads are additive to the overall loading on a structural element, and consider internal tensile forces in the wall with a hydraulic factor of 1.65, and load combinations as follows:

Flexure: U = 1.3[1.4(DL) + 1.7(LL) + 1.7(Hw)]

Shear: U = [1.4(DL) + 1.7(LL) + 1.7(Hw)]

Flexure and Shear: U = 0.9D + 1.6W + 1.6Hw

5.3.4.5 Flood/Overflow Water Condition

For maximum water level at the flood/overflow elevation (highest water elevation that could occur hydraulically, which is not necessarily at the top of wall), where the cracking limit is not applicable, ignore the soil backfill loads unless the soil loads are additive to the overall loadings on a structural element. Then consider internal tensile forces in the wall, and load combinations are as follows:

Flexure and Shear: U = [1.4(DL) + 1.7(LL) + 1.7(Hw)]

U = 1.2DL + 0.8 W + 1.0Fa + L + 1.7Hw

U = 0.9DL + 0.8 W + 1.0Fa + 1.6Hw

5.3.4.6 Seismic Water Condition

Earthquake loads will not be considered, in accordance with the 2004 Florida Building Code.

5.3.4.7 Service Soil Condition

For maximum soil backfill height with at rest pressure, with and without internal liquid loads, and the groundwater table is at its normal elevation, include soil compaction or soil surcharge whichever controls the load. Load combinations are as follows:

Flexure: U = 1.3[1.4(DL) + 1.7(LL) + 1.7(Hs)]+

Shear: U = [1.4(DL) + 1.7(LL) + 1.7(Hs)]

Flexure and Shear: U = 1.2DL + 0.8W + 1.0Fa + L + 1.7Hw

U = 0.9DL + 0.8W + 1.0Fa + 1.6Hw

5.3.4.8 Flood Soil Condition

For maximum soil backfill height with at-rest pressure plus hydrostatic pressure of groundwater at 100-year flood level and Reservoir at maximum full storage level, with internal liquid loads, including soil compaction or soil surcharge whichever controls the load, load combinations are as follows:

Flexure and Shear: U = 0.75[1.4(DL) + 1.7(LL) + 1.7(Hs)]

U = 1.2DL + 0.8 W + 1.0Fa + L + 1.7Hw

U = 0.9DL + 0.8 W + 1.0Fa + 1.6Hw

Note: that the one-third allowable stress increase is included in the above equations.

5.3.4.9 Steel Hydraulic Structures

Steel hydraulic structures will be designed in accordance with the Allowable Stress Design Method listed in EM-1110-2-2105 and the AISC Manual of Steel Construction. Allowable stresses will be reduced by 0.83 in accordance with Type B modifications listed in Section 4-4 of EM-1110-2-2105. No corrosion allowance will be added to steel cross-sections.

5.3.4.10 Overturning, Sliding and Flotation

Overturning stability, sliding safety factor and the flotation safety factor shall be in accordance with the following values, based on service level loads, and neglecting live loads. (Table 5.3-1)

Table 5.3-1 Overturning, Sliding, and Flotation Factors

Aspect	Usual	Unusual	Extreme
Percent of Base in Compression	100	75	Resultant must be within the base
Sliding Safety Factor	2	2	1.33
Flotation Safety Factor	1.5	1.3	1.1

5.3.5 Building Structures

Building structures, excluding structural concrete, will be designed based upon the loads, load combinations, and allowable stresses contained in the 2004 Florida Building Code. Structural concrete design will be based on strength design in accordance with the District Design Standard of August, 2005 and ACI 318-02. The additional concrete design requirements of ACI 350-01 and EM1110-2-2104 will not be considered applicable for building structures unless exposed to water, wastewater, or aggressive chemicals such as saltwater. Additionally, building structures and their components that are subject to equipment impact and vibration will be designed in accordance with the applicable recommendations of ACI 350.4R subject to engineering judgment.

Lateral wind loads will be transferred to the foundation from their origin in a rational manner. The horizontal distribution of wind loads will be based upon the assumption that the roof/floor diaphragms are both rigid and flexible for steel deck diaphragms, and rigid for cast in place or precast concrete diaphragms. Where the diaphragm is assumed to behave in a flexible manner, the wind lateral load distribution will be based upon the tributary area to the resisting elements. Where the diaphragm is assumed to behave as a rigid panel, the wind lateral load distribution is based on the relative rigidities of the resisting elements.

5.3.6 Inspection Requirements

Inspection will be required per the 2004 Florida Building Code, Chapters 1 and 17.

5.3.7 Bridge over Connector Canal

A new bridge will be constructed to carry traffic on U.S. 27 over the new connector canal between the NNRC and the new northeast pump station. U.S. 27 is a divided highway at the planned location of the new connector canal, so two bridges structures will probably be required.

The bridge configuration under any conditions should maintain a minimum of two feet of freeboard above the design high water level of the connector canal.

The Bridge Analysis Technical Memorandum and the Bridge Design Report for the bridge development process have not been completed and will be submitted at a later time. Completion of these reports will be made upon approval of the connector canal size and design, approval of final location of the new northeast pump station, and completion of additional surveys and geotechnical work. The bridge will be designed in accordance with AASHTO's Standard Specifications for Highway Bridges, 17th Edition – 2000. The bridge will be designed for an HS25 loading.

5.4 ARCHITECTURAL DESIGN

5.4.1 Design Criteria

5.4.1.1 Introduction

The northeast pump station building will be constructed to accommodate the pumps, motors, generators, and ancillary systems. In addition, adequate area will be provided for a control room, offices, break room, toilet, locker/shower and mechanical equipment.

5.4.1.2 Design Requirements

Codes and Standards - Design and specifications of all work will be in accordance with the latest laws and regulations of the federal government, applicable state and local codes and ordinances, and applicable industry standards. Florida Building Code, 2004 Edition, and Florida Fire Prevention Code, 2004 Edition apply. Other recommended standards will be used where required to serve as guidelines for design, fabrication, and construction when not in conflict with the above standards. The building will be designed in accordance with Florida Accessibility Code and Americans with Disabilities Act Accessibility Guidelines (ADAAG). Anti-Terrorism/Force Protection measures for the building will be addressed during the final design phase. There is no requirement to incorporate the principles of Sustainable Design and Development for the building.

5.4.1.3 Life Safety

The building will be designed to meet the minimum construction and life safety requirements as required by the applicable codes and criteria. Appropriate type, size, and quantity of fire extinguishers will be provided in compliance with all applicable fire and life safety codes; including a sprinkler system in designated areas. For details, refer to Section 5.7.

(Note: Florida Building Code 2004 Edition defines diesel fuel as a Class II Combustible Liquid. Quantities stored inside the building in excess of 120 gallons cause the building Occupancy to be defined as H-3 Hazardous. This Occupancy rating requires fire sprinklers throughout the building. The building size of 31,700 sq. ft. places the building under Construction Type I-B which requires minimum of 1 Hour fire rating on all steel columns and roof structure. A Variance from the local Fire Marshal will be required to eliminate the sprinkler requirement and

the fire protection on the steel frame to meet the requirements described in the Engineering Guidelines paragraph 5.3.2.3 -Engine Day tanks)

5.4.1.4 Material and Life Cycle

The building shall be designed to minimize life cycle cost, energy consumption, and maintenance through proper selection of mass, form, materials, and construction standards. Integrally colored materials shall be used as much as possible to eliminate painting. The design life of the building shall be a minimum of 50 years. Refer to Sections 5.3.3.5 and 5.3.3.6 for seismic and wind loading design criteria. The service life span will be the same as the building service life, except for the following: protective elements, wall primary weather-barrier elements, joint sealers, surfaces exposed to view, and roof covering weather barriers. These will have varying service lives, as shown in Table 5.4-1.

Table 5.4-1 Exceptions to the Building Service Life Span

Material	Life Cycle
Protective Elements	Minimum 20 Years
Wall Primary Weather-Barrier Elements	Minimum 50 Years Functional And Aesthetic Service Life, Excluding Joint Sealers
Joint Sealers (fuel resistant)	Minimum 20 Years Before Replacement
Surfaces Exposed to View	Minimum 20 Years Aesthetic Service Life - No Color Fading, Crazing and Delamination of Applied Coatings
Roof Covering Weather-Barriers	Minimum 20 Years, Fully Functional

5.4.2 Exterior Architectural Features

5.4.2.1 Shell

The elements forming usable enclosed space and separating that space from the external environment comprise the shell and consist of:

5.4.2.1.1 Superstructure

The superstructure includes all elements forming floors and roofs above grade, and the elements required for their support, insulation, fireproofing and fire stopping. The structural system for the superstructure shall be a steel frame with reinforced precast concrete walls and poured in place concrete roof and shall be designed in accordance with the applicable building codes as defined in Section 5.3.5.

5.4.2.1.2 Exterior Enclosure

The exterior enclosure includes all essentially vertical elements forming the separation between exterior and interior conditioned space, including exterior skin, components supporting weather barriers, and jointing and interfacing components; not including the interior skin unless an

integral part of the enclosure. The exterior enclosure will be precast concrete. Thermal performance for the exterior enclosure is not applicable to main equipment rooms. Exterior enclosures will be insulated for all air-conditioned spaces.

All exterior doors will be painted, hollow metal doors with painted metal frames. Insulated doors will secure air-conditioned spaces. Overhead doors shall be roll-formed galvanized steel construction, electrically-operated and shall be sized to fit the largest equipment for the building. Louvers will be designed as required for ventilation of the spaces and equipment. The building wall openings for fans and louvers will have missile barrier protection over screens constructed to withstand 155 mph wind loading and windborne debris in accordance with the wind load design criteria specified in Section 5.3.3.6. All doors and louvers will be hurricane impact resistant.

5.4.2.1.3 Roofing

Roofing includes all elements forming weather and thermal barriers at horizontal roofs, decks, and roof fixtures. A single ply roofing membrane will be used over the reinforced poured concrete roof deck. The roof will be sloped to stainless steel drain scuppers formed through the parapet. The roof runoff is directed down the walls via downspouts made from hollow structural tubing to resist missile impact during hurricane events. All flashing, trim, and accessories will be of stainless steel sheet metal. Access to the roof will be provided by a roof hatch and will be controllable by authorized personnel only.

5.4.3 Interior Architectural Features

5.4.3.1 Floor

All floor slabs will be sealed reinforced poured concrete.

5.4.3.2 Partitions

Partitions provided for physical separation between spaces will be constructed to achieve fire ratings required by code; appropriate security between adjacent spaces; and visual, acoustical, olfactory, and atmospheric isolation as necessary to maintain desirable conditions in each space. Partitions will comprise the following elements: Fixed partitions of fully-grouted, reinforced, full-height CMU; and partial height partitions of fixed, solid, opaque visual barriers for toilet compartments. The control room will have glass panels to allow the operator an unobstructed view of the operation floor. The control room/break room will be designed for sound proofing with a minimum Sound Transmission Coefficient (STC) of 49.

5.4.3.3 Interior Doors and Windows

All interior doors shall be painted, hollow metal doors with painted metal frames. Interior windows will be provided between adjacent spaces. Fixed interior windows and operable interior windows, when closed, will function as partition elements and will not degrade performance of partitions below the levels specified. Sound insulated doors and windows will be provided to meet the STC of not less than 49.

5.4.3.4 Interior Finishes

5.4.3.4.1 Offices/Control Room/Break Room

- Wall: Painted
- Floor: Non-skid ceramic tiles
- Ceiling: Suspended acoustical ceiling tiles

5.4.3.4.2 Toilets/Showers

Wall: Ceramic tiles
Floor: Non-skid ceramic tiles
Ceiling: Moisture resistant gypsum board

5.4.3.4.3 Locker Room

Wall: Painted
Floor: Non-skid ceramic tiles
Ceiling: Moisture resistant gypsum board

5.4.3.4.4 Equipment Room/Maintenance Shop/Janitor's Closet

Wall: Painted
Floor: Sealed concrete
Ceiling: None. All exposed concrete will be painted

5.4.3.4.5 Fan/Filter Rooms

Wall: Painted
Floor: Sealed concrete
Ceiling: None. All exposed concrete will be painted

5.4.3.4.6 Vertical Circulation

Stairs will be provided for access to mechanical spaces and equipment mezzanines. Also, a vertical lift that meets accessibility requirements will provide access to the control room.

5.4.4 Interior Fixtures

Interior fixtures permanently attached to interior walls, ceilings, and floors, except for equipment items, will be provided and comprise the following elements:

5.4.4.1 Identifying Devices

Informational accessories, including room numbers, signage, and directories.

5.4.4.2 Storage Fixtures

Items intended primarily for storing or securing objects, materials, and supplies, including cabinets, casework, and shelving.

5.4.4.3 Accessory Fixtures

Specialty items intended to provide service or amenity to building interiors, including toilet and bath accessories, visual display surfaces, and telecommunications fixtures.

5.4.4.4 Interior Fixtures

Other items fixed to the interior construction that enhance comfort or amenity in building spaces.

5.5 MECHANICAL DESIGN

5.5.1 Introduction

This Section describes mechanical equipment requirements for the Reservoir structures. Primary mechanical needs include equipment that will be installed in the new northeast pump station and inlet and outlet structures between the Reservoir and both the NNRC and the STA-3/4 Supply Canal.

5.5.2 Northeast Pump Station

5.5.2.1 Design Criteria

The northeast pump station will be located at the northeast corner of the Reservoir and will connect to the NNRC via a connector canal that will include a highway bridge for U.S 27 which parallels the NNRC to its west. The station's function is to pump basin runoff and Lake Okeechobee releases from the NNRC to the Reservoir. The northeast pump station's pumps will have the capability of lifting the water from the connector canal's design low water stage to the proposed Reservoir's maximum stage of 21.0 NAVD88. Discharge gates will be provided to allow gravity discharge of water from the Reservoir to the NNRC during low canal stages. Additional pumps will be provided to pump water to the NNRC when the Reservoir water level does not permit gravity discharge.

Layouts showing pump and equipment arrangements are shown on the Preliminary Drawings. A plan view of the pump station operating floor and gated discharge structures is shown on Sheet M-1 and a cross-section of the pump station intake and discharge piping is shown on Sheet C-6.

Equipment: Northeast Pump Station

Capacity: 3,600 cfs (expandable to 5,000 cfs)

Number of pumps: total pump bays – 6 present + 2 future

Pump capacity: 6 – 600 cfs pumps initial (625 cfs future) + 2 future 625 cfs pumps

Design static head range, min/max: 0/14.4

Pump arrangement: vertical, axial flow

Pump intake: formed suction inlet

Pump driver: engine-driven with right-angle gear drive

Engine fuel supply: diesel

Discharge arrangement: Over the embankment with siphon assist

Trash racks: bar racks with picker style traveling rake

5.5.2.2 Protection Elevation

The operating floor elevation at the northeast pump station should limit the possibility of damage to the pump equipment caused by flooding. For the over-the-embankment discharge configuration that will be utilized for the pump station, the maximum invert elevation of the discharge pipe is 25.5 NAVD88, equal to the maximum normal pool plus PMP. The operating floor will be set at elevation 28.0 NAVD88 to correspond with the dimensions required for the pumps at minimum submergence. The pipe gallery floor will be set at elevation 15.0 NAVD88 to provide one foot of freeboard between the floor elevation and the maximum water surface elevation in the Connector Canal.

5.5.2.3 Connector Canal Considerations

The connector canal to the northeast pump station will intersect the NNRC at 90 degrees and proceed a short distance west under a bridge crossing for U.S. 27 and then to the northeast corner of the Reservoir. An unobstructed approach length of approximately 1,000 feet will be provided upstream of the pump station intake. The flow approaching the pump intake should ideally be steady and uniformly distributed both laterally and vertically. To accomplish this as much as possible, the approach channel will be designed to be in line with the intake centerline. The channel bottom will be flared outward to the full width of the pump station intake at an angle of no more than 10 degrees from the centerline. The invert elevation of the structure at the trash racks and pump intakes will be set to match the bottom elevation of the canal to minimize vertical turbulence and to provide adequate submergence on the pump impeller. Baffle walls will be provided at the entrance to the trash racks to direct the flow directly into the pump inlets. Stoplog guides will be cast into the baffle walls to allow each suction bay to be isolated and dewatered for maintenance.

5.5.2.4 General Mechanical Arrangement

5.5.2.4.1 Design Life

There are a number of USACE references in regard to pump station service life. According to EM-1110-2-3104, EM-1110-2-3105, and the District's Major Pump Station Engineering Guidelines, the design life of a pump station is 50 years. It is anticipated the mechanical equipment will require rehabilitation or replacement at least once during the 50-year service life. The engines and pumps will operate intermittently and with proper preventative maintenance the engines should have a 25-year service life. Pump equipment will be designed and manufactured to ensure a long service life.

5.5.2.4.2 Reliability and Cost Considerations

Pump stations should be considered emergency facilities. Equipment and power supply are specified and selected primarily on the basis of reliability under emergency conditions. Since the northeast pump station is probably the most vulnerable feature of the Reservoir Project, dependability must be a primary consideration during the design process. Since the station can potentially be in service during extreme weather conditions when commercial power is not

available, the pumps are engine driven and the station auxiliaries have backup power from engine driven generators.

Water supply, seepage return, or other pumping systems not associated with the Reservoir pumps do not require the same level of high reliability. Since their operation is not critical to the health and well being of the public, down time can be tolerated with repairs addressed in non-emergency mode. The drivers for this equipment will be powered by electric motors.

5.5.2.4.3 Recommended Pump Station Layout

The recommended alternative is a pump station having six 600 cfs pumps. Space is provided to allow addition of two pumps and drivers in the future to expand the pumping capacity. The general arrangement shown on Sheet M-1 of the Preliminary Drawings provides the greatest flexibility for operation of the current and future pumping system. This station design has the following:

- Self-priming with no vacuum system required reducing potential complications for remote operation of the station
- The greater number of pumps with smaller capacity provides the most pumping flexibility
- With the greater number of pumps, provides least impact to station operation when a pump unit is off line
- Having identical drivers, reducers, and pumps reduce the spare parts inventory, operator training, and the necessary operator experience, making the pump station significantly simpler to operate
- Recovery of velocity head and exit losses with a discharge siphon
- Steel discharge pipes to reduce friction losses and lessen construction cost
- Lowest operating static heads due to siphon assisted delivery
- Low friction losses due to slower flow velocities as a result of the use of larger impeller and slower rotative speed for this 600 cfs rated capacity
- Over-the-embankment discharge arrangement does not require backflow protection
- Control room and break rooms at opposite side of pump house from engines permitting optimum viewing of operating floor equipment and engine control panels
- Control room and break rooms at opposite side of pump house from engine and exhaust system reducing noise
- Engines located close to exterior wall permitting exhaust ventilators to be located in close proximity to engines for optimum ventilation arrangement
- Compressed air system for engine starting, instrument air, and service air

5.5.2.4.4 Intake

The intake's primary function is to provide the required flow to the pump. This flow should be uniform with a minimum of rotational wakes, free of harmful debris, have enough depth to prevent the formation of free surface vortices, and have an approach speed that avoids flow separation at boundaries. The pump intake also performs a number of other functions including providing the foundation for the service bridge and the pump house. The design standard generally used in North America to design the geometry of the intake is the Hydraulic Institute Standard ANSI/HI 9.8-1998 - Pump Intake Design Standard. In accordance with section 9.8 of the hydraulic institute (HI) standard, each pump will be installed in its own bay. The pump bay will have adequate width and depth to limit the approach velocity to 1.5 fps.

In accordance with District Major Pump Station Engineering Guidelines, a formed suction intake will be utilized to uniformly accelerate the hydraulic flow from the intake channel to the pump impeller. Formed Suction Intake (FSI) designs were developed by the USACE by the Hydraulics Laboratory in Vicksburg. The intake was developed to minimize the submergence needed as well as the width in comparison to the rectangular intake. The geometry for the intake is presented in the USACE ETL 1110-2-327 as well as in Appendix I of EM 1110-2-3105. HI 9.8 also provides the geometry of the type 10 intake. The geometry is presented in terms of the throat diameter which is commonly taken as the impeller diameter. The use of a FSI is typically limited to large capacity pumps, 84-inch diameter and larger.

There is a significant difference in the submergence as determined by the USACE EM 1110-2-3105 and HI 9.8 with the HI intake being considerably deeper. Therefore, the use of the USACE method significantly reduces pump station excavation, dewatering and substructure costs. The length of the formed suction inlet from the inlet entrance to the centerline of the pumps is greater than the dimensions published by the USACE due to the space requirements of the pump engine. The FSI was lengthened to place the FSI entrance at the face of the pump station wall. The width of the FSI is in accordance with the USACE dimensions; however, the height of the FSI entrance was increased to allow for a uniform slope on the ceiling of the FSI. The submergence from the top of the FSI entrance to the minimum water surface elevation in the suction well conforms to the USACE dimensions.

The intake will be provided a means to be dewatered for inspection, maintenance, and/or removal of the pumps.

5.5.2.4.5 Pumps

The low head conditions of the system design for the northeast pump station will require axial flow pumps. Vertical pumps are the most common style pump currently being used in similar pump station applications. Typically the slow rotative speed of the pump requires a reduction gear transmission to reduce the shaft speed of the diesel driver. Therefore, the general arrangement is a vertical axial flow pump driven by a diesel engine through a right angle speed reducer. Vertical axial flow pumps have their impeller submerged and therefore are self-priming.

Hydraulic conditions governing the design of the pumps at the northeast pump station are summarized in.Table 5.5-1.

Table 5.5-1 Pump and Hydraulic Description of Northeast Pump Station

Aspect	Extreme
Number of pumps	6 initial + 2 future
Discharge capacity, each pump, cfs	600 at initial design stage 625 at future design stage
Normal Suction stage, feet	8.6
Low water stage, feet	6.6
Maximum Suction stage, feet	14.0
Low water shutoff, feet	5.6 *
Maximum discharge stage, feet	21.0
Design discharge stage, feet	17.3
Minimum discharge stage, feet	8.6
Design Head, pool to pool, feet	8.7
Maximum Head, pool to pool, feet	14.9*
Maximum priming head, pool to pool, feet	21.2
Nominal pump operation speed, rpm	189
Minimum engine power rating capacity, hp	1500
Brake hp @ design head, pool to pool	1000
Brake hp @ max head, pool to pool	1400
Maximum engine speed, rpm	900
Efficiency at Design Stage, pool to pool, per cent	65**
Efficiency at Maximum Stage, pool to pool, per cent	72**
Impeller diameter, inches	102
Submergence at inlet, feet	4.5
Discharge type	Over the embankment
Discharge size, diameter, inches	102
*Based on a one-foot differential across the trash rack at low water stage. ** Includes all station losses plus 0.6 inch screen loss	

Pump discharge will be "over-the-embankment" type. For this arrangement, the invert of the discharge line will be equal to or above the maximum discharge pool elevation to prevent backflow through the pumps when they are not running. The design also includes the use of a siphon for energy savings due to the lower head when primed. The discharge line requires a vacuum valve at the highest point to allow venting of the air and closure when the siphon is established. The pumps will be selected to operate over the entire range of heads provided by the siphon.

Several factors were taken into consideration to determine the maximum elevation of the pump discharge piping. Positive pressure must be maintained in the pump discharge piping for proper operation of the siphon. To maintain positive pressure, the elevation difference between the top of the discharge pipe and the water surface elevation at the discharge into the reservoir was limited to 25 feet.

To ensure that the pump discharge siphon will function to recover energy at all Reservoir water levels, the bottom of the discharge siphon was placed at the elevation of the Reservoir bottom. The bottom of the Reservoir is at approximate elevation 8.6 NAVD88, therefore the maximum elevation of the top of the discharge pipe is limited to elevation 33.6 NAVD88, which places the invert of the 96-inch discharge pipe at elevation 25.5 NAVD88.

The pump hydraulic operating conditions were examined to ensure that this discharge elevation did not raise the horsepower requirements for pump start-up sufficiently to require an increase in the engine size.

Additionally, the invert elevation of the discharge piping must be sufficiently high to prevent backflow through the pumps. Based on an evaluation of different design criteria in Section 21.2.2 of the BODR, the return frequency for an event that results in a water surface elevation in the Reservoir above elevation 25.5 NAVD88 would be greater than every 500 years. The probable maximum precipitation event raises the water level by 4.5 feet. The 500 year wind raises the water level due to wind setup by 3.8 feet. The 100-year rain and a Category 5 hurricane raise the water level by 5 feet; however it is anticipated that the combination of these two events would occur with a return frequency much greater than every 500 years.

5.5.2.5 Diesel Engine Drivers

5.5.2.5.1 General Description and Design Requirements

The northeast pump station will require a reliable driver that will function through severe storm conditions as well as many days after the event. Typically diesel engines are the most reliable and efficient drivers for this application. Electric service is not considered to be a reliable power source at this location. Therefore, diesel engine drivers will be used at the northeast pump station.

For vertical pumps, the diesel engine drives the shaft of the axial flow single stage propeller pump through a right angle speed reducing gear transmission. The engine is connected to the reducer's horizontal input shaft by two universal joints and an intermediate shaft. The engine can be remotely monitored and operated via telemetry or other communications facilities. Local manual starting and monitoring is provided. The engine's electronic control module will transmit engine parameters and functions via a data-link to a logic controller.

The engine selected is a compression-ignition type, two or four cycle, diesel engine for stationary applications. The engine can be either a vertical in-line or vee piston type, and have a solid cast block with not less than six cylinders. The engine can be naturally aspirated or turbocharged-after-cooled type. Engines should be current models of a type in regular production with all devices specified or normally furnished with the engine. The engines shall meet the requirements of the New Source Performance Standard (NSPS) for Stationary Reciprocating Compression Ignition Engines. The available models of drivers will be matched to the pumping system requirements. The engine model proposed will be a current production model and will be a unit with a satisfactory service record of not less than 36 months of operating 1,200 hours/year under similar or more severe conditions of duty. The engine should be provided and installed complete and totally functional, with all necessary ancillary equipment including, but not limited to: air filtration; starting system; fuel system; cooling system; instrumentation; and engine exhaust system. The engine will use compressed air for starting and will be cooled via a heat exchanger.

5.5.2.5.1.1 Engine Rating

The engine service shall be “Continuous Duty” intended for continuous use for load application requiring uninterrupted service at full power for 24 hours per day and 365 days per year. The standard reference conditions, methods of declaring the power, fuel consumption, lubricating oil consumption, and test methods for diesel engines is in accordance with applicable sections of ISO 3046 for the conditions listed below. The basis for gross engine power rating, methods for correcting observed power to reference conditions and the method for determining gross full load engine power with a dynamometer is SAE J1995.

5.5.2.5.1.2 Project Site Conditions

- Maximum air temperature: 105 degrees F
- Minimum air temperature: 35 degrees F
- Maximum raw water temperature: 90 degrees F
- Minimum raw water temperature: 60 degrees F
- Elevation: sea level
- Relative humidity: 80 percent

5.5.2.5.1.3 Engine Speed at the Rated Condition

The maximum engine speed will be 900 revolutions per minute (rpm) to determine the available engine models for the required horsepower/torque range of operation.

5.5.2.5.1.4 Fuel Requirements

Standard engine models will be selected which operate on 2 or 2-D, (regular) diesel fuel oil, 40 cetane, (minimum), ASTM D396 and ASTM D975.

5.5.2.5.1.5 Fuel Consumption

The standard reference conditions and methods of declaring fuel consumption will be in accordance with applicable sections of ISO 3046. The fuel consumption rate will not exceed 0.45 pounds per bhp-hour between 75 percent and 100 percent of rated full load for the following conditions:

- Fuel heat value: 140,000 BTU/gallon
- Unit elevation: sea level unless otherwise noted.
- Intake air temperature: 90 degrees F
- Barometric pressure: greater than 28.25 inches mercury

5.5.2.5.1.6 Emissions Requirements

The Environmental Protection Agency (EPA) emissions regulations for stationary diesel engine applications are being drafted for the finished installation to comply with EPA Tier 2, Stage II emissions requirements. Engine manufacturers are aware of these requirements and have had to deal with them for their on-road engines. On many models this technology has been adapted to the modern stationary production models. The EPA regulation requirement will be specified to ensure that the Contractor satisfies the most current EPA requirements. The engines used in this preliminary design are Tier I compliant.

5.5.2.5.1.7 Engine Electronics

The engine's electronic control module provides monitoring of vital engine parameters and control of engine operation. The system regulates emissions and optimizes fuel economy and provides condition monitoring to prevent engine damage. The electronic control system has programmable speed control. The electronic package also provides a standard data-link to a logic controller for manual and remote monitoring and operation via telemetry facilities. A standard factory supplied engine control and monitoring panel will be specified for manual operation.

5.5.2.5.1.8 Rotation

The rotation of the engine will be the SAE standard rotation with the speed reducer and pump to match this rotation. This direction, looking towards the front of the engine, is counter-clockwise. It is intended that the engine deliver power in one direction only and an anti-reverse rotation device shall be provided by the reduction gear to prevent reverse rotation by the backflow of water through the pump at shut down.

5.5.2.5.1.9 Engine Mounting

Complete equipment foundation plates, sole plates, mounting straps, brackets or structural bases with suitable anchor bolts, nuts, sleeves, washers and shims or wedge plates, and vibration dampers or isolation blocks will be furnished as required. Resilient mounts will also be provided and will be capable of fully restraining the engine and limiting its motion under acceleration-induced forces and torque reactions. The engine mounts will be capable of alignment and

leveling. These mounts are standard designs provided by the engine manufacturer. It is important that the foundation requirements be coordinated with the various trades for the anchorage and foundation details to be provided.

5.5.2.5.1.10 Exhaust System

A complete and separate exhaust system will be provided for each engine. The engine exhaust system piping will be provided and laid out with the shortest and straightest runs as possible, and consistent with the location of the exhaust silencers in relation to the engines. Sharp bends will be avoided by the use of long sweep fittings wherever practical. Horizontal sections of the piping will be sloped downward and away from the engine to a condensate trap and drain valve.

5.5.2.5.1.11 Piping

All exhaust piping will be ASTM A312 Grade TP 304L stainless steel. All pipe sections will be flanged where practical. Piping smaller than two inches in diameter will be Schedule 80. Piping with a diameter of two inches or larger will be Schedule 40. The vertical exhaust piping will be provided with a hinged, gravity-operated, stainless steel, self closing cap. Thermal expansion and/or vibration will be addressed by a short length or lengths of an approved multi-ply stainless steel bellows-type flexible section at each engine. Suitable stainless steel sleeves with retainer rings will be provided together with suitable packing for wall penetrations to allow free movement of the pipe in accordance with NFPA 37.

5.5.2.5.1.12 Supports

Pipe supports for the exhaust lines and braces for the exhaust silencer and tailpipe will be provided as necessary. Pipe hangers will be in accordance with MSS SP-58 and MSS-69. Details of the supports and hangers will be provided in the construction contract drawings to ensure a quality installation.

5.5.2.5.1.13 Exhaust Silencer

A silencer will be provided on each exhaust to decrease noise levels in the vicinity of the pump station. The noise level taken three feet from the silencer shall not exceed 86 dBA. The exhaust silencer will be, at a minimum, a critical grade chamber type exhaust muffler mounted on the exterior of the pump station building. The exhaust silencer, support, and miscellaneous fasteners will be ASTM A312 Type 304L stainless steel. Silencer support details will be provided on the drawings. The engine manufacturer needs to provide input for the proper selection of the silencer that will provide the most effective system considering; noise levels generated, pressure drop and physical size of the silencer.

5.5.2.5.1.14 Exhaust Line Insulation

All exhaust lines for the engines inside the building need to be insulated with not less than three inch thickness of ASTM C 533 calcium silicate insulation such that the cold face temperature at operating conditions does not exceed 150 degrees F. The insulation shall be secured with stainless steel bands and covered with an aluminum jacket. The aluminum jacket should overlap not less than three inches longitudinal and circumferential joints and should be secured by bands

at not more than 12-inch centers. Longitudinal joints shall be overlapped down. Circumferential joints should be sealed with a coating that is recommended by the insulation manufacturer. Aluminum should be smooth sheet 0.016-inch nominal thickness and have a factory applied polyethylene and kraft paper moisture barrier. At pipe flanges and expansion joints, the insulation at each side of the flanged connection should be tapered for a short section to permit removal of bolts without disturbing the insulation.

5.5.2.5.1.15 Air Intake System

A complete air intake system will be provided for each engine. The contractor shall be responsible for the design and installation of the air intake system in accordance with the engine manufacturer's requirements and the project site conditions specified above.

5.5.2.5.1.16 Air Intake Filter

The air intake filter for each engine will consist of high-efficiency, washable paper elements packaged in a low restriction waterproof housing. The filter will be provided in a location convenient for servicing.

5.5.2.5.1.17 Inline Silencer

An inline silencer will be provided on the air intake for turbo-charged engines, if recommended by the engine manufacturer. The silencer shall be of the high frequency filter type. A combined filter silencer unit meeting the requirements for the separate filter and silencer items may be provided.

5.5.2.5.2 Engine Cooling System

The cooling system will be a closed type system. The contractor shall be responsible for the details of the design and installation of the system in accordance with the engine manufacturer's requirements and the Project site conditions specified.

The closed system for each engine cooling system will include a double wall type heat exchanger, located on the auxiliary skid. The heat exchanger will be of ample capacity to match the engine with maximum water temperature in the intake. The jacket water shall flow from the engine to the heat exchanger and then to the expansion tank before returning to the jacket water pump inlet. The temperature rise of the coolant across the engine shall not exceed the recommendations of the engine manufacturer.

Each engine cooling system will include one thermostatically controlled proportioning valve of appropriate size and temperature rating installed at the after cooler and bypass line. The valve will be complete with automatic control element. A bypass with an automatic temperature regulator will be installed around the heat exchanger so that the temperature of the jacket water may be regulated.

Each engine will be equipped with a coolant temperature sensor and coolant level sensor. The temperature sensors will provide signals for coolant temperature indication and high coolant temperature alarms.

A jacket water expansion tank will be furnished for each engine. The tank will be of welded steel construction and shall be hot dipped galvanized inside and out after fabrication. The tank will have a capacity of not less than 10 gallons and shall be suitable for an operating temperature of 250 degrees F and a working pressure of 125 pounds per square inch gauge (psig). The tank shall be tested and stamped in accordance with ASME BPV VIII Div 1 and registered with the National Board of Boiler and Pressure Vessel Inspectors. The tank will be properly fitted for vent, overflow, expansion, and make-up lines and mounted so the bottom of the tank is above the top of the engine. A brass water gauge with valves will be provided on the tank.

5.5.2.5.3 Oil Lubrication System

The engine lubricating oil system will be of the manufacturer's standard design for the engine model proposed. The lubricating system will be monitored and controlled by the engine's electronic control system to ensure proper lubrication for the application proposed. The system shall be readily accessible for service such as draining and refilling. Each system shall permit the addition of oil and have an oil-level indication. All items of equipment are to be furnished and installed as complete units ready for operation.

5.5.2.5.3.1 Lubricating Oil Sensors

Each engine will be equipped with lubricating oil temperature and pressure sensors. The temperature sensors will provide signals for high lubrication oil temperature indication and alarm. In addition, low lubrication oil pressure indication and alarm sensors will be provided.

5.5.2.5.3.2 Lubricating Oil Filter

Each engine lubricating oil system will include a suitable lubricating oil full-flow, duplex (80) micron filter of the disposable cartridge type. The filter medium will be absorbent type as recommended for use with the type of oil used in the engine. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have the inlet and outlet connections plainly marked.

5.5.2.5.4 Starting System

The engines will be started by a compressed air system via an air motor supplied by the engine manufacturer. The starting air system will include a pressure regulating valve (with the required set point by the engine manufacturer) and an isolation valve with a 24-volt DC solenoid valve. The engine manufacturer needs to provide input for the proper selection of the compressed air system that will provide the most effective system considering: physical size and number of start attempts.

5.5.2.5.5 Drive Shaft and Coupling Assembly

The speed reducer is typically connected to the driver by universal joints. The bearings should have minimum rating of a B10 life of not less than 16,000 hours (including applicable service factor for driver utilized) and shall have a service factor of two based on the maximum rated load. In addition, at maximum overload conditions, the stresses shall not exceed 80 percent of yield strength. Universal joints shall have forged steel yokes and spiders and shall have sealed

needle roller bearings. Universal joints shall be installed in pairs. The angle between each shaft and the intermediate shaft shall be equal and not exceed the manufacturer's recommendations. The driving pins on the yokes attached to the intermediate shaft shall be set parallel to each other. The universal joints shall be dynamically balanced to AGMA balance classification seven or better and shall be grease lubricated unless they are self-lubricated.

To address torsional vibration, rubber torsional coupling between the engine/PTO output shaft and the carden shaft is recommended.

5.5.2.6 Speed Reducers

For vertical pumps to transmit the power from the horizontal shaft of the engine to the vertical shaft of the pump, a right angle gear is required. To reduce the output shaft rotary speed of the engine to the input shaft speed of the pump requires a speed reducer. These functions are combined in one unit as a right angle speed reducer. Right angle speed reducers perform the following functions:

- Transmit the power from the diesel engine driver to the vertical axial flow pump
- Redirect the power from the horizontal shaft of the driver to rotate the vertical shaft of the pump
- Reduce the speed of the shaft rotation of the engine driver to the required rpm of the pump shaft
- Prevent rotation of the pump shaft from backflow of water after shutdown of the driver
- Provide a thrust bearing(s) to address the up-thrust and down-thrust hydraulic loads of the pump

Speed reducers are standard products of manufacturers and conform to American Gear Manufacturer's Association (AGMA) standards. The furnished unit should display the AGMA insignia as evidence of conformance to the requirements of AGMA 6010-F97 or AGMA 6025-D98. Standard practices shall be as defined and set forth by the AGMA. The procedure outlined in AGMA 2005-C96 and AGMA 6010-F97 shall be followed.

The speed reducer used in the vertical pump application is a single reduction right angle spiral-bevel gear. The reducer’s low speed output shaft is of a hollow shaft design. This arrangement permits the pump head shaft to pass concentrically through the reducer shaft for vertical adjustment of the pump propeller. The reducer’s high speed input shaft is connected to the driver by two universal joints and an intermediate shaft.

Bevel gears are used to connect shafts whose axes intersect. Spiral bevel gears have obliquely curved teeth with a spiral angle such that the face advance is greater than the circular pitch. This results in a continuous pitch line contact in the plane of axes of the gears. The contact between teeth begins at one end of the tooth and progresses obliquely across the face of the tooth. This results in a smooth action suitable for high speed operation.

5.5.2.6.1 Performance Requirements

The performance requirements of the speed reducer are determined by coordination with the pump and driver requirements. The unit's primary function is to transmit the necessary torque from the approved driver to the pump shaft for the entire operating range of the system. A service factor of two will be applied to the manufacturer's published rating. The reducer's shaft output speed is designed to equal the pump rotary speed at the rated condition. The overall reduction ratio will properly match the driver speed with the pump rpm at the pump's rated condition. The rotation of the input shaft of the speed reducer should match the typical rotation of the driver.

The reducer will have a continuous mechanical horsepower rating of not less than 150 percent of the horsepower rating of the engine driver. The pump input power (Pp) at the rated condition is defined by the requirements of the vertical pump. The reducer shall be designed with sufficient capacity to stall the driver without injury to the reducer. The reducer includes a thrust bearing(s) to address the up-thrust and down-thrust hydraulic loads of the pump. Speed reducers have efficiencies in the range of 96 percent. Before assembly, each gear and shaft assembly shall be dynamically balanced in accordance with ANSI/AGMA 2005-C96.

5.5.2.6.2 Operating Conditions

Operating conditions for the design of the speed reducer are as follows:

- Maximum input power, hp 1600
- Driver speed at rated condition, rpm 900
- Speed reducer ratio 4.8 to 1

5.5.2.6.3 Couplings

The primary function of couplings is to transmit the rotary motion and torque from the prime mover to the driven equipment. The secondary functions include:

- Accommodation of misalignment of shafts
- Transmission of axial thrust loads
- Maintain alignment between connected shafts
- Permit adjustment of shafts
- Limit torsional vibration transmission from reciprocating prime mover to driven equipment

There are two primary coupling types, rigid and flexible. Rigid couplings are necessary to maintain precise alignments or to support the position of the rotor in the drive train. An example is the line shaft couplings. There are a variety of rigid coupling types including flanged and split types.

The speed reducer to pump shaft coupling is of a rigid design and of the same material as the shaft. The speed reducer half of the coupling is typically keyed and has the proper shrinkage fit

on the hollow output shaft. A service factor of two based on the maximum rated load is generally specified. In addition, the stresses shall not exceed 80 percent of the yield strength at the maximum rated load condition. The coupling shall be dynamically balanced to AGMA balance classification of seven or better.

Flexible couplings are classified into two types, mechanically flexible and materially flexible. Mechanically flexible couplings compensate for the misalignment by clearances incorporated in the design of the coupling. Flexible couplings rely on the flexing of the coupling element to compensate for any shaft misalignment. The flexing material must have adequate resistance to fatigue failure. Typical flexing elements are composed of elastomer materials. There are numerous flexible coupling types as well as elastomer materials employed in the coupling.

5.5.2.7 Fuel System

The fuel system design for the diesel engine drivers must conform to the requirements of National Fire Protection Association (NFPA) 30-Flammable and Combustible Liquids Code and NFPA 37-Stationary Combustion Engines and Gas Turbines. The fuel oil supply system for each engine will consist of a motor driven fuel oil transfer pump, day tank, and aboveground fuel storage tanks. The fuel oil flows through a strainer from the outside fuel oil storage tanks to the day tank. From the day tank, oil flows to the engine. The overflow and drip lines from the engine return the oil to the day tank. A pump will be provided to deliver fuel from the tank to the day tank.

5.5.2.7.1 Primary Storage Tanks

The primary storage tanks will be aboveground double walled tanks. The tanks will be UL 142 and UL 2085 listed and normally store the specified petroleum product at atmospheric pressure but will also be designed to withstand a pneumatic pressure test. The secondary containment structure shall also be UL 142 listed. The tanks nominal capacity will provide for a minimum of seven days of fuel for continuous operation of all units operating at maximum horsepower.

The primary and secondary tank will both be fabricated from steel, will be of welded construction throughout and will be fabricated conforming to ASTM materials, grades and thickness. The secondary containment will be a second steel wall. All tank openings will be located on top of the tank. Catwalks will be provided on top of the tanks to permit access to all tank openings and piping connections.

Four 10.5-foot diameter by 43 foot-long fuel storage tanks, each with capacity of 25,000 gallons, will be provided initially, with space allocated for installation of a fifth tank when the pump station capacity is expanded.

The fuel oil storage tanks, along with the lubrication oil storage tank and waste oil storage tank, will be enclosed in a concrete containment area sized to completely contain the contents of the largest tank.

5.5.2.7.2 Day Tank

The day tank is a unit composed of a small capacity fuel storage tank with secondary containment, with level controls and is located inside the pump house near the engine driver. It

functions as a collection point for transfer of the supply and return fuel to the outside tank. A day tank is furnished for each engine. The tanks are of steel construction, double walled with leak detection monitoring, and built in accordance with the applicable provisions of the NFPA 30 and UL 142. Motor driven redundant fuel supply transfer pumps that are mounted on top of each storage tank will supply fuel to each day tank. Each pump transfers fuel oil from the storage tank to the day tank. The engine's fuel pump transfers the fuel oil from the day tank to the engine. A line is provided for return of unused fuel to the day tank. The fuel transfer pump assembly will be included as part of the day tank package. A pressure relief valve will return fuel to the storage tank in the event of high fuel level in the day tank.

The storage capacity of each of the day tanks located inside the pump station shall not exceed 660 gallons.

5.5.2.7.3 Transfer Pumps

The fuel transfer pump system includes redundant high capacity submersible pumps. Each pump includes a check valve, air eliminator, and expansion relief valve. The fuel oil transfer pump shall be sized to provide 150 percent of the combined fuel consumption rate.

5.5.2.7.4 Fuel Inlet Equipment

The fuel inlet equipment system will be a complete system that includes remote fill box, fill pipe, level gauge, shutoff valves, and control panel.

5.5.2.8 Trash Racks and Rakes

The trash screen, rake and conveyance system is custom engineered equipment that is complete with all structural support, motors, and monitoring and control components for the removal of trash accumulated on the trash rack and its conveyance to a disposal area. A pre-manufactured picker type rake will be provided in conformance with the Major Pumping Station Engineering Guidelines. One manufacturer shall design and furnish the bar screens and two monorail traveling gripper rakes including all structural supports and controls.

5.5.2.8.1 Gripper Rake

The gripper style rake descends in an open position with the rear tooth penetration through the rack bars. The descending rake head captures the debris on the way down and closes grabbing the trash in a similar manner as a clam shell excavator.

The rake shall be a single piece of equipment capable of automatically or manually raking each bar screen, transporting debris to a designated dump site and capable of reloading debris into awaiting dumpsters or dump trucks under manual control.

5.5.2.8.2 Design Considerations

The various models of trash rakes are unique in their design and operation and are difficult to compare. An important selection consideration is the performance of the rake under storm conditions. In hurricane prone regions, operation during high wind events can be the governing criteria. Where wind is not the over riding consideration the rake's ability to remove heavy trash loads or large floating items may be the deciding factor.

5.5.2.8.3 Operating Conditions

The rake and conveyance equipment will be specified to be suitable for outdoor service. For the BODR, the hydraulic system design of the station assumed a three foot maximum head loss across the trash rack. The cycle time and the load lifting capabilities of the rake proposed to be supplied needs to be adequate to prevent the build-up of trash on the rack that will cause a head loss in excess of three feet.

Design criteria for the trash racks and rakes are summarized in Table 5.5-2.

Table 5.5-2 Trash Rack and Rake Design Criteria

Number of Trash Racks and Rakes	10 (8 Reservoir pump intakes + seepage pump intake and cooling water pump intake)
Rack vertical bar thickness, inches, minimum	0.5
Vertical Bar Opening, inches	3-4
Elevation at bottom of rack, feet NAVD88	-11.4
Normal water stage, El NAVD88	8.6
Minimum water stage, El NAVD88	6.6
Maximum water stage, El NAVD88	14.0
Trash Rack width, feet	27 at eight main pump bays 24 at one seepage pump bay 8 at one auxiliary pump bay
Number of screen panels at each pump intake opening	As determined by manufacturer
Maximum velocity through trash rack, fps	2
Design head differential, feet	5
Trash rack material of construction	304L Stainless steel or 316L Stainless steel
Type of rake	Picker rake
Capacity of rake, pounds	2,200

5.5.2.8.3.1 Trash Loading

An estimate of the loading rate will depend on many factors. It can be assumed that during a storm event, large objects can end up in the waterway. Loading criteria for the rake will be specified to ensure the equipment supplied has adequate capabilities for the more severe conditions. It may not be a storm event that causes these heavy loads. Constructed wetlands after start-up of the discharge pumps after a dormant period can up-root the new growth vegetation causing an extreme slug of trash.

Trash loading is also not a steady state event. Typically the maximum loading occurs at start-up of the pump and diminishes with time. However, given that the pump is continuously operating during a storm event, there is the possibility the maximum loading may occur as a result of an upstream situation caused by the storm. One method to specify the estimated loading rate is by a percentage of the pump water volume. This estimate may be more useful for sizing the dump area than the rake. Constructed wetlands produce a considerable amount of vegetative trash. Under normal operation the trash will consist of submerged and floating vegetation consisting of aquatic and wetland vegetation. This vegetation may vary from tall grasses, reeds and other aquatic plants such as hydrilla to floating leafy plants such as water hyacinth. The rate of loading will vary seasonally as well as with discharge conditions. During a flood event there is the possibility of larger debris being part of the trash load. This debris could be upland vegetation including small trees and brush as well as man-made items such as lumber.

The gripper rake capacity and size will be specified to be identical to the gripper rakes provided at the G-370 and G-372 pumping stations. The capacity of the G-372 pumping station (3,700 cfs) is similar to the initial capacity of the northeast pumping station (3,600 cfs). Specifying identical equipment will minimize the spare part inventory required and operating personnel will be familiar with the operating characteristics and limitations of the rakes.

5.5.2.8.3.2 Handling Capacity

Two rakes will be furnished. Both rakes shall operate at the same time but each rake shall be capable of cleaning all of the bar screens in case of a failure of one of the trash rakes. Each rake and its conveyance equipment will be capable of collecting and conveying the debris specified in a cycle time that results in a head loss across the rack less than the maximum allowed. Because the rate of trash loading may be highly variable, the cycle time needs to be capable of adjustment to optimize the rake's performance. The rake manufacturer should visit the project site and make an evaluation of the service condition requirements to determine the necessary handling capacity of the rake/conveyance equipment proposed to be supplied. The weight of this trash can be assumed to be 35 pounds per cubic foot. The minimum handling capacity per rake should not be less than 2,200 pounds.

5.5.2.8.3.3 Standby Service

The rake/conveyance equipment will be designed for standby service which is defined as a normally idle piece of equipment that is capable of immediate automatic or manual start-up and continuous operation. The rake should operate when the pump is operating.

5.5.2.8.3.4 Intake Design

The trash rake and conveyance equipment are mounted on the service bridge. The equipment is positioned on the intake side of the bridge. The layout of the equipment will ensure the vehicular traffic across the bridge is not impacted by the system. The rack inclination shall be 30 degrees in accordance with the Florida Fish and Wildlife Conservation Commission requirements. The flatter slope of the rack, typically the greater the trash load the rake can remove. The flow velocity into the intake also impacts the performance of the rake.

5.5.2.8.3.5 Removal and Reinstallation

The trash rack support monorail shall be capable of being removed from each pump bay to allow for installation of dewatering stop logs in the pump bay with a crane from the service bridge.

5.5.2.8.3.6 Maintenance

Submerged components will not require service, lubrication, etc. i.e. bearings. The layout of the trash conveyance equipment will allow for easy access to the major operating parts of the mechanism for maintenance, cleaning and repair. Stoplog channels will be provided in each of the intake channels ahead of the trash racks to permit each trash rack to be taken out of service, if needed.

5.5.2.8.3.7 Operation Control

The operation of the rake and conveyance equipment will be determined by the position of an "Auto–Off–Manual" selector switch located on the Control Panel. "Auto" mode will interlock the rake and conveyance equipment with the operation of the pump and shall require no operator interface for proper operation of the system. "Manual" mode will allow operation of the system or any of the system components by an operator. Manual mode will be used to allow an operator to use the rake to load accumulated debris from the debris storage area onto trucks or dumpsters for disposal.

5.5.2.8.3.8 Electrical Controls

The electrical control panels for the rake/conveyance equipment are located in the pump station building. Local controls, disconnects, etc. as required, will be located adjacent to rake equipment on the service bridge. The operation of the trash conveyance equipment is controlled by the control panel. If the trash conveyance equipment is a separate mechanism from the trash rake the operation of the two systems shall be interlocked.

5.5.2.8.3.9 Load Limiting Device

The rake will be provided with a load limiting device that will shut down the rake and signal an alarm condition back to the control panel, if the pull force on the rake exceeds the setting of the load limiting device.

5.5.2.8.3.10 Structural Design

The design of the structural support and anchorage of the rake and the conveyance equipment will be in accordance with the AISC Manual of Steel Construction. Welding will be in accordance with ANSI/AWS D1.1 and AWS D1.6 – Structural Welding Code.

5.5.2.8.3.11 Wind Loading

The rake and associated conveyance equipment will be designed to withstand without structural damage sustained wind speeds up to 155 mph. The rake/conveyance equipment will also be designed to operate without loss of effectiveness up to sustained wind speeds of 70 mph. The

rake manufacturer shall provide a written certification the unit proposed for use is capable of satisfying the wind load requirements specified above.

5.5.2.8.3.12 Safety

The equipment will be specified to comply with the applicable provisions of the OSHA.

5.5.2.8.3.13 Materials of Construction

All components subject to submergence shall be fabricated from 304L or 316L stainless steel.

5.5.2.9 Discharge Piping and Appurtenances

Each pump is connected to a steel discharge pipe of an equal diameter to the pump barrel. A harnessed flexible compression coupling will be used to connect the pump elbow to the discharge line. Harnessed flexible couplings should be used whenever the pipe runs into or out of concrete structures or any other location where differential settlement is anticipated.

The pump discharge piping will be designed to withstand all stresses resulting from external loads and internal pressures. The pipe will be fabricated to accommodate thrust rods or other means of constraint as specified. Flanged wall thimbles will be provided for all penetrations through pumping station structure walls.

5.5.2.9.1 Pipe

The pipe design shall conform to AWWA C200, AWWA M11, and as specified except that hydrostatic test of fittings after fabrication will not be required.

Wall thicknesses are tabulated in Table 5.5-3.

Table 5.5-3 Pipe Wall Thickness

Normal Pipe Diameter (inches)	**Thickness** (inches)
<48 inches	3/8 inch
48-inch to 60-inch	1/2 inch
60-inch to 96 inch	5/8 inch

5.5.2.9.1.1 Materials

The pipe shall be fabricated from one of the following materials:

- Sheet or coil conforming to the requirements of ASTM A570, Grades 30, 33, 36, or 40
- Plate in coil form conforming to the requirements of A36, A283, Grades C or D, or A572, Grade 42
- Coil conforming to the requirements of ASTM A-139, Grades A or B

5.5.2.9.1.2 Joints

Provide flanged joints for all interior locations. All joints shall conform to AWWA C200 and AWWA C207 and the flanges shall have a pressure rating AWWA Class B and be drilled ANSI B16.1 Class 25. Lap welded joints conforming to AWWA C206 will be provided for exposed exterior and buried locations.

5.5.2.9.2 Fittings and Special Connections

Elbows shall be fabricated from tested pipe to conform to AWWA C208 and shall be reinforced in accordance with applicable provisions of AWWA M11. Openings for air vent connections shall be provided with flanged outlets and shall be flanged in accordance with ANSI/ASME B16.5 standard 125 pound flange.

5.5.2.9.2.1 Harnessed Couplings

A flexible mechanical coupling, Dresser style or equal, will be provided to connect the pump discharge elbow to the discharge piping. Flexible mechanical couplings will also be provided at the intersection of the horizontal piping and sloped piping on the interior and exterior of the reservoir to account for differential settlement. All components of the coupling will be stainless steel. The connecting ends of the discharge pipe will be fabricated in accordance with the requirements of the coupling provided. Adjustable thrust rods will be provided to transfer thrust loads to the discharge piping or wall thimble. All bolts, rods, nuts, and associated hardware shall conform to ASTM F593 Type 316 stainless steel.

5.5.2.9.2.2 Wall Thimble

A wall thimble will be provided for embedment in the pumping station structure wall. The thimble shall have a seal ring centered in wall when embedded and shall have flanged ends to mate to the discharge piping.

5.5.2.9.3 Gaskets and Bolting Materials

Gaskets for flanged joints shall conform to ANSI B16.21, 1/8-inch thick full-face synthetic rubber. Full-face gaskets for all pump and equipment connections shall be provided. Bolts for flanged joints shall conform to ASTM F593 Type 316 stainless steel. Nut and bolt heads shall be hexagonal.

5.5.2.9.4 Coatings and Linings

The interior of steel pipe shall be provided with a cement mortar lining complying with AWWA C602. The exterior of steel pipe in buried locations shall be provided with cold applied tape coatings complying with AWWA C214.

5.5.2.10 Lubrication Oil System

A lube oil system suitable for unloading, storage, and transfer of supply and waste lube oil will be provided, including all necessary storage tanks, pumps, piping, valves, controls, and accessories. Lube oil and waste lube oil storage systems will have a minimum capacity for one

complete oil change for all engines within the station. Storage tanks will be aboveground double wall type and will be designed and constructed in accordance with applicable industry codes, including API and UL. Tanks will be provided with level detection and overflow prevention devices. The system will be designed for truck unloading of lube oil and loading of lube oil waste, to include all necessary storage tanks, pumps, piping, valves, and accessories for unloading lube oil and loading lube oil waste. System design will facilitate minimal loading and unloading time. Lube oil and waste lube oil pumps will be self-priming, positive displacement type. Pumps will be motor-driven and equipped with an integral internal relief valve.

5.5.2.11 Vacuum Priming System

The vacuum system for each station will consist of two electric-powered pumps, one online and one standby, to remove air from the pump discharge pipe to establish full flow through the pump discharge. To establish vacuum in each inflow pump discharge conduit, air will be drawn out through two 8-inch to 12-inch ports from the discharge tube which will then be manifolded together and directed to a barometric tube and then to a vacuum pump. Each vacuum line will have its respective vacuum release valves, with both auto and manual operation, providing two vent areas for siphon break to minimize time to break siphon on shut down. The vacuum pumps, which will alternate, will be manually started from each engine control panel and will utilize a barometric tube separator between the vacuum pump and the main pumps to protect the vacuum pump from water slugs. The system will signal run status to the control console. A sensor will monitor vacuum pressure and send a high vacuum alarm to the control console. Seal water for the vacuum pumps, if required, will be supplied by the cooling water system and will have solenoid controls. Selection of pump size should be based upon an 8 to 12 minute time to evacuate all air from submerged suction and discharge tubes.

5.5.2.12 Compressed Air System

The compressed air system will consist of two air compressors, (one redundant), with a starting air receiving tank for each engine and one air receiving tank for the instrument and service air. The compressed air system will include all necessary equipment and accessories, including compressors, receivers, dryers, filters, motors, piping, instrumentation, and controls. The air compressor will be air cooled and oil lubricated. The compressor will be motor-driven with the motor and compressor mounted on a fixed base. The compressor will utilize a belt drive with a spring-loaded tensioner. Discharge pressure will be as required for engine starting with a minimum pressure of 150 psig. Accessories will include oil filter, air filter, silencers, and vibration isolators. A receiver will be provided for instrument and service air. Receivers will be ASME code stamped vessels and will include a pressure relief valve and automatic condensate drain. Pressure regulators will be provided for instrument air and service air. A refrigerated dryer for instrument air suitable for continuous operation will be provided. The dryer will be equipped with inlet and outlet filters and an automatic condensate drain.

5.5.2.13 Gates and Operators

For openings in the pumping station structure with bay widths of 10 feet or less a single stem fabricated stainless steel slide gate shall be specified. Gates provided on inlet and outlet control structures shall consist of a drum and cable hoist and roller gates. The gate and operator

specifications shall written to ensure a reliable, durable, and low maintenance water control gate of high industry standards. The gates are to be manually or automatically operated. However, operation can be relatively infrequent so the gate design must consider the reliability of operation after periods of inactivity of a year or more.

5.5.2.13.1 Slide Gates

5.5.2.13.1.1 Gate Frames

The gate frame shall be embedded into the reinforced concrete of the structure. The frame including the guide rails, mounting frame, sill, and yoke shall be a rigid, welded unit extending from the floor of the structure to the operating platform.

The yoke or horizontal operator support member shall satisfy the following criteria:

- The yoke shall be designed to provide the required structural support for the operator and the loads produced from the gate operation under maximum head differential conditions
- The structural members of the yoke shall be sized to limit deflections to 1/360 of its span and prevent harmful rotation
- The yoke shall have a minimum strength of not less than twice the rated thrust output of the operator
- The yoke shall allow removal of the gate without disassembly

Guides shall satisfy the following criteria:

- Guides to run the full length of the disc
- Capable of taking the total thrust produced by water pressure
- Capable of supporting the disc when the gate is open

5.5.2.13.1.2 Seals

The gate seals shall satisfy the following criteria:

- A top gate seal shall be provided to prevent leakage over top of gate when closed
- Seals shall be securely fastened to the slides and sill using dovetail grooves or other methods which securely seat seal in place
- The seals shall be easily removed and replaced for maintenance
- The seal shall be adjustable to ensure full contact with gate disc to limit leakage through the full range of stage

5.5.2.13.1.3 Disc

The slide cover shall be a flat plate, reinforced with structural members welded to the plate as required for the application. The disc shall satisfy the following criteria:

- The structural design of the disc shall limit deflection to not more than 1/360 of the span under the maximum loading condition

- The stem connection shall be of a standard design with a thrust nut supported in a welded nut pocket. The pocket shall have a minimum design strength of not less than twice the rated thrust output of the operator
- The disc shall be designed to drain and not trap debris, soil, etc.
- A drain will be provided for thrust nut assembly

5.5.2.13.1.4 Stem and Thrust Nut

The lift stem shall satisfy the following criteria:

- Thrust nut designed for all loads during opening and closing
- Thrust nut locked to prevent turning in the slide
- Stem design force shall not be less than 1.25 times the output thrust of the electric motor lift unit in the stalled motor condition
- Stem threads shall be machine cut or rolled and of the square or Acme type. The number of threads per inch shall be as required for efficient operation in accordance with the lift mechanism used
- Provide rising stem with adjustable stem guides to ensure alignment and stem support
- Provide a stop collar at the full-open position
- Each rising-stem unit shall be provided with a stem cover
- The cover shall be of sufficient diameter and length to permit full travel of the threaded stem without obstruction
- The top of the stem cover shall be closed
- The bottom end of the stem cover shall be vented, drained, and mounted in a housing or adaptor plate for easy field mounting installation
- Indicator. Each actuator for rising-stem gates with a galvanized pipe cover shall be provided with a position indicator to show the position of the gate at all times. The indicator shall be attached to the mechanism

5.5.2.13.1.5 Electric Operators

The lifts shall have electric motor operators with rising stems and stem covers. The gates shall have manual/auto operation. A factory-mounted on pedestal type operator shall be specified. The driver shall be an ac electric motor operator with stop-open-close operation on 208 Vac, 3 phase service, 60 Hz, with position indicator. The electric operator shall open and close the gate at a nominal speed of six inches per minute. The pedestal height shall be approximately three feet. An auxiliary manual crank shall be specified for hand wheel operation of lift. The crank shall be removable and fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 15 inches.

5.5.2.13.1.6 Lift Mechanism

The lift mechanism shall be supplied with a pedestal, machined and drilled to receive the gear housing, and drilled for bolting to the operating floor. The mechanism shall be geared to limit the slide operation to not more than 40 foot-pounds on the lifting device after the slide is unseated from its wedges. A lift nut threaded to fit the operating stem shall be provided. Ball or roller bearings shall be provided above and below the flange on the lift nut to take the thrust developed in opening and closing the gate with a force of 100 foot-pounds (135 N-m). Gears shall be machined accurately with cut teeth to provide smooth, proper operation for the lifting mechanism. Suitable shafts shall be installed with sleeve, ball, or roller bearings of appropriate size. All gears and bearings shall be enclosed in a housing. Fittings shall be provided so that all gears and bearings can be lubricated periodically. All geared lifts shall be suitable for operation by use of a portable-motor apparatus. The lift shall be self locking at any position of the stem travel.

The lift shall satisfy the following criteria:

- Furnish the following limit switches mounted in the lift assembly for control of the electric motor
- Provide adjustable torque responsive switch
- Provide intermittent adjustable gear type limit switches for stop of gate travel
- Opening direction. The direction of wheel or crank rotation to open the gate shall be indicated on the lift cover
- Lubrication: Provide totally enclosed gearing with lubrication fittings and all necessary mechanical seals

5.5.2.13.1.7 Electric Motor

The motor shall be specifically designed for the electric actuator service, with a high starting torque. The motor horsepower shall be determined by the manufacturer.

5.5.2.13.2 Roller Gates

5.5.2.13.2.1 Gate Frames

The gate frame shall be embedded into the reinforced concrete of the structure.

- Frame shall consist of prefabricated structural steel roller slots
- Standard lightweight steel rails shall be used to guide rollers on gate disc as it moves
- Rails shall extend full height of structure so gate can be raised completely out of structure
- Bottom sill shall consist of structural steel beam with stainless steel seating surface

5.5.2.13.2.2 Seals

The gate seals shall satisfy the following criteria:

- Seals shall be arranged to have a positive initial precompression (compression without water pressure) when the gate is closed. Mounting shall be such that the water pressure shall increase the seal compression. Mounting shall provide adequate freedom of movement for seal deflection
- Seals shall be located on the seal seat and held in place by clamp bars bolted (with lock washers) to the gate
- Seal seat angle shall be continuous within each section
- J-seal corners shall be formed by continuous molded sections

5.5.2.13.2.3 Disc and Rollers

Gate disc shall consist of smooth skin plate with horizontal and vertical structural reinforcing members and shall be continuously welded throughout to form a box-like structure.

- Disc deflection shall not exceed 1/800 of nominal gate width
- Rollers shall be spaced along side of gate disc to support equal portions of hydrostatic load
- Roller assemblies, complete with axles, shall be removable from gate

5.5.2.13.2.4 Lift Mechanism

Roller gate shall be provided with a wire rope drum hoist mounted on a structural steel hoist frame to open gate. Gate shall close under its own weight. The lift mechanism will include drums, drive shafts, couplings, worm gear reducers, sheaves, drive motor, brake, wire rope fittings, welded rigid steel base frame, anchor bolts, electrical equipment, hoist cover, position indicator, slack cable limit switches, and accessories.

5.5.2.13.3 Materials

Stainless steel materials will be specified for the purposes of durability, strength, and resistance to erosion and corrosion. The manufacturer may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose. All material shall conform to the latest ASTM specification or other listed commercial specifications covering the class or kind of material to be used.

5.5.2.14 Station Standby Power

During a power outage the pump station requires electric power backup. Typically, the minimum capacity of the diesel fueled engine-generator is provided for back up station service during the time utility power is lost. In large pumping stations a second redundant system is provided. For the northeast pump station, two 1000 kw engine generators will be provided on the pump operating floor to power the seepage pumps and to provide station lighting and ventilation requirements. Controls are provided in the automatic transfer switch (ATS) to either manually or automatically start the engine-generator. A RTU output command will remotely stop the engine generator should the unit unnecessarily start. Engine-generators will use unit mounted radiators for cooling and will have critical grade exhaust silencers mounted outside the building. A

manually operated 20 kw engine generator will also be provided to power station lighting equipment. This generator may be used to allow for inspection of the facility during a power outage without the need to turn on the large engine generators.

5.5.2.15 Stage Monitors

Upstream and downstream stilling wells with level transmitters provide analog water level data of the approach channel and reservoir level. A stilling well with a level transmitter is also provided in each pump intake to monitor low water levels. The water level transmitters provide a proportional 4 – 20 ma signal. The stilling well level transmitters are normally continuously powered from a 120 VAC to 24 VDC power supply. Upon the loss of 120 VAC service, the RTU's "PULSE ANALOG CIRCUITS" program will intermittently power and scan the analog water level transmitters.

5.5.3 Control/Control Structures

Control structures are required to control the release of water from the Reservoir to the NNRC and the STA-3/4 Inflow Canal, and to control the flow of water from the STA-3/4 Inflow Canal to the Reservoir when the G-370 and G-372 pump stations are discharging into the Reservoir. The specific hydraulic requirements of the control structures at the Reservoir site are discussed in Section 6.6 of the BODR.

In general, these control structures will conform to the gate configuration shown in the District Design Guidelines Sheet G-S1. This standard shows the general criteria for the District standard water control structure with vertical roller lift gates. The structures will each have a control and generator building or will be located directly next to a pump station. The operating platforms will be elevated above the structure walls as necessary for proper gate operation and to allow access to stoplogs for dewatering to enable dry maintenance. The structures will not interrupt the embankment crest road or the STA-3/4 Inflow Canal North Levee road.

5.5.3.1 Control Structure S-609

The control structure S-609 will be located adjacent to the northeast pump station. It is required to meet the agricultural deliveries to the EAA served by the Reservoir. According to the 2x2 model, agricultural deliveries from the Reservoir to the EAA system range from 0 cfs in the wet season, to a maximum of approximately 1,960 cfs during the dry season. The control structure will consist of five gated concrete box culverts. The minimum required water surface elevation in the Reservoir for agricultural discharges depends on the necessary backwater condition in the NNRC. For irrigators to have sufficient suction conditions for their irrigation pumps, the minimum water surface elevation in the NNRC is 10 to 10.5 NAVD88.

The control structure may also be used to fill the Reservoir when the water surface elevation in the NNRC and Connector Canal is greater than the Reservoir level.

In order to accommodate the irrigation pumps which will be installed in the downstream portion of the control structure, the culvert width was increased to 14 feet. Five parallel 14 feet by 8 feet gated culverts will be used. Each culvert will have one 8 ft by 8 ft roller gate at the embankment headwall and two 4 ft by 8 ft sluice gates at the culvert discharge wall, one on each side of the irrigation pump discharge pipe.

5.5.3.2 Southeast and Southwest Control Structures S-602 and S-603

The existing G-383 control structure was installed in the STA-3/4 Inflow Canal to allow isolation of the eastern and western flow ways of STA-3/4. The structure has limited hydraulic capacity and would not allow the full capacity of either pump station to pass. It has been assumed that it will remain in service and will normally be closed, thereby requiring that two separate control structures be constructed in the north embankment of the STA-3/4 Inflow Canal. Therefore, Structure S-602 will be located east of the G-383 control structure and Structure S-603 will be located west of the G-383 control structure, and are referred to as the Southeast and Southwest Control structures, respectively, in the BODR.

As recommended in the Gate Evaluation Technical Memorandum, vertical roller lift gates will be used for the two control structures adjacent to the STA-3/4 Inflow Canal, due to the District staff's familiarity with the operations and maintenance of these types of gates. Additionally, slide gates will be installed upstream of the vertical roller lift gates for redundancy.

These control structures through the Reservoir are series of parallel culverts with 10 foot by 10 foot gates located on the Reservoir side of the embankment. They will be submerged structures, with the invert at -6.0 feet NAVD88 to correspond with the current bottom of the STA-3/4 Inflow Canal. To achieve the appropriate gate width, parallel 12-foot wide by 10-foot tall culverts will be constructed. Five culvert sections are included at Structure S-602 and seven culvert sections are included at Structure S-603. A detailed discussion on the size and hydraulic capacity of the Reservoir control structures is included in Section 6.6 of the BODR.

A backup power supply will be provided for each control structure. The method for providing backup power will be standby generators located in the adjacent control building.

5.5.4 Seepage Pumping

Seepage collection canals will be constructed along portions of the western boundary, the northern boundary, and the eastern boundary of the Reservoir site. The collected seepage from the western and northern canals will be directed to the new northeast pump station. At the northeast pump station, seepage pumps will be selected to provide firm capacity to pump seepage back into the EA Reservoir. Seepage from the eastern seepage collection canal will be routed to G-370 pump station, where existing seepage pumps will discharge to the Inflow Canal.

At the northeast pump station, three electric motor operated seepage pumps will be installed, (two duty and one standby), to provide firm station capacity of 120 cfs. The seepage pumps will normally be operated to maintain a water elevation of -1.0 in the seepage canal and will be capable of pumping to varying reservoir levels, up to the overflow spillway elevation of 21.0 NAVD88.

Other seepage pump design criteria are shown in Table 5.5-4.

Table 5.5-4 Seepage Pumps Design Criteria

Number of pumps	3
Total installed pumping capacity, cfs	180
Firm pumping capacity, cfs	120
Discharge capacity, each pump, cfs	60
Rated head, feet	24.0
Maximum head, feet	27.0
Pump discharge diameter, inches	36
Motor size, horsepower	200
Motor speed, rpm	500
Efficiency at rated head, per cent	80

5.5.5 Irrigation Pumps

Irrigation pumps will be installed at the northeast control structure to allow water for irrigation to be released from the EAA Reservoir A-1 to the NNRC when the EAA Reservoir A-1 level does not allow for gravity discharge. This will occur when the Reservoir water elevation is below 10.0 NAVD88. Five irrigation pumps will be provided with total capacity of 1000 cfs. The pumps will be installed at the discharge end of the five gated culverts comprising the control structure. The pumps will be installed at an elevation of 19.0 NAVD88 so that motors and operators will be above the maximum water surface elevation in the Connector Canal. The pumps will be vertical axial-flow type and will discharge over the top of the culvert wall to the Connector Canal. The discharge pipe will terminate below the minimum canal water surface elevation for energy recovery. An anti-siphon valve will be installed on each of the pump discharge pipes.

The pumps will be housed in a pump station structure using the same materials of construction as the northeast pump station. An overhead crane will be provided for pump removal. Floor space is provided within the irrigation pump station for pump storage3 and servicing. Overhead door access is provided to the pump station to allow pump components to be loaded onto a trailer using the overhead crane.

Other irrigation pump design criteria are shown in Table 5.5-5.

Table 5.5-5 Irrigation Pumps Design Criteria

Number of pumps	5
Discharge capacity, each pump, cfs	200
Total discharge capacity, cfs	1,000
Rated head, feet	6
Maximum priming head, feet	16
Pump discharge diameter, in	60
Motor size, horsepower	400
Motor speed, rpm	354

5.5.6 Spillway

For the EAA, the District criteria allow a discharge of 20 cfs per square mile with a five year design frequency (equal to ¾ inch of runoff per 24 hours). For the Reservoir area, this equates to a discharge of 500 cfs. If this limit is exceeded, it reduces the NNRC's capacity available to other discharges.

Because uncontrolled spillway discharges from the Reservoir would result in substantially higher flows during more extreme storm events, which could cause damage to farmland, U.S. 27, bridges and other structures, the BODR recommended limiting the discharge. This will be accomplished by constructing an orifice spillway and constricting the discharge conduit.

The spillway will be located adjacent to the northeast pump station and will be contiguous with the control control structure. An orifice spillway will be constructed by placing four slotted openings in the embankment headwall. Each opening will be 2 feet by 13 feet, with the bottom of the opening set at 21.0 NAVD88, the normal pool reservoir elevation. The slotted openings are designed to limit discharge to 500 cfs at two feet of head. Higher heads will produce slightly greater discharges, but flow increases will be limited by use of a 5.5 foot by 5.5 foot box culvert used as an orifice. It is estimated that peak spillway discharges at the design maximum reservoir water level plus wind setup (El 27.6 NAVD88) will be approximately 600 cfs.

5.6 CIVIL SITEWORK

5.6.1 General

The northeast pump station facilities will be located at the northeast corner of the Reservoir. The northeast pump station will be a structure approximately 318 feet long by 92 feet wide, housing the Reservoir pumps and drivers, seepage pumps, emergency generating equipment, and ancillary facilities.

The pump station will be placed outside the Reservoir embankment with the face of the structure at approximately the toe of the embankment. Discharge will be over the top of the embankment at an elevation above the maximum normal pool elevation. The pump station will be constructed on three levels. The operating floor will be at elevation 28.0 NAVD88 and will house six 600-cfs

pumps and diesel engine drivers. Space will be allocated for the addition of two identical pumps and drivers in the future. Also located on this level will be the seepage pump motors, engine generators, electrical switchgear, cooling and fresh water pumps, air compressor skid, vacuum pumps, supply fans, a maintenance room, employee break room, and restroom/locker room facilities. A control room will be located on a second floor level, above the break room and locker room area. A bridge crane traversing the entire operating floor will be provided for removal of pumps, drivers, and other equipment. Rolling overhead doors on each end of the building will allow truck access to the operating floor.

The lower level will include the pump intakes and the trash racks.

The trash racks and rake mechanisms will be located outside the building on an extension of the pump intake channels. The Reservoir spillway, discharge gates, and irrigation pumps will be located adjacent to the pump station with a discharge channel connecting to the connector canal. A service bridge will be constructed along the north side of the pump station to allow vehicle access to both sides of the pump station.

A pipe gallery will be located at elevation 15.0 NAVD88 to provide a utility chase to serve the equipment on the operating floor level and as storage. Additionally the seepage pumps, main pump discharge piping, waste fuel oil storage, and potable water pumps will be located on the pipe gallery level. Access to the pipe gallery will be via stairs from the operating floor, a ladder from the operating floor, and through a rolling steel door and man door to the exterior of the pump station.

A site plan of the pump station facilities is shown on the Preliminary Drawings.

5.6.2 Northeast Pump Station Connector Canal

The connector canal will be constructed from the NNRC to the northeast pump station. The following design criteria were used in order to determine an appropriate cross-section:

- Potential maximum northeast pump station and connector canal capacity of 5,000 cfs
- Potential maximum outflow from the Reservoir at the northeast pump station is approximately 1,960 cfs, based on the agriculture deliveries taken from the SFWMM.
- A minimum straight approach to the pump station of 1,000 feet
- Side slopes of 2.5H:1V
- Maximum velocity of 3 fps
- Unlined earthen side slopes with an average Manning's "n" value of 0.030 for the entire perimeter
- Bottom of connector canal set at -11.4 NAVD88 (approximately two feet above the bottom of the NNRC at the northeast pump station)

A hydraulic analysis of the connector canal indicated that a canal with a bottom width of 55 feet would produce a maximum velocity of less than 3 fps and would result in a hydraulic drawdown of less than 0.23 feet from the NNRC to the northeast pump station. A typical cross-section

through the connector canal is shown on the Preliminary Drawings. Near the pump station, the connector canal will be widened to the full width of the pump station intake channels. In accordance with District guidelines, changes in channel cross-section and bottom slope will be gradual, limited to no more than a 10 degree angle from the canal centerline or invert elevation, to minimize horizontal and vertical currents and produce a steady and uniformly distributed flow pattern at the entrance to the intake channels.

It will be necessary to construct berms above the existing grade on either side of the canal near the pump station, since the surrounding grade of approximately 8.0 NAVD88 is below the maximum canal water level of 14.0 NAVD88. The berms can also serve as a road for maintenance and access. The top of the berms will be at elevation 14.6 NAVD88. The design criteria require that all raised slopes are at 3H:1V for maintenance purposes, and that is sufficient to ensure stability of these low banks.

5.6.3 Site Access and Roadways

5.6.3.1 General

General access to the Reservoir and associated structures will be limited to District staff and guests. Public access to the Reservoir site will only be allowed through designated public access points near the northeast and southeast corners of the Reservoir.

The Project is located in an agricultural area and access to the Project site is limited to U.S. 27. Existing gravel and dirt service roads created either by the agricultural interests or by the District operations and maintenance staff currently provide access through the Project Site. U.S. 27 is a north-south trending four-lane divided highway that borders the entire east side of the Reservoir and the site for the new northeast pump station. This is a major traffic route for transportation from the Fort Lauderdale area to the central Florida area, and is also a hurricane evacuation route. U.S. 27 will be the primary access route to be used by the contractor during construction. After the Project is complete, U.S. 27 will provide the main access to the Reservoir and the northeast pump station.

The Reservoir Project is bordered on the north side by an existing gravel service road used by the agricultural interests. This service road has access to U.S. 27 by way of an existing intersection. The Reservoir is bordered on the west side by an agricultural area and by the Supply Canal adjacent to the Holey Land WMA. A District service road is located on top of the existing Supply Canal levee that extends along the southern half of the Reservoir Project area's west side, and continues east along the southern boundary on the Inflow Canal levee. This service road provides District vehicle access between the G-372 pump station and the G-370 pump station.

Permanent access on the Reservoir site will include perimeter roads constructed completely around the top of the Reservoir embankment, completely around the exterior toe of the embankment between the embankment and the seepage canal, and an internal perimeter road at the interior toe of the embankment. The road along the top of the embankment will be used for access to control structures and for inspection of the inside of the Reservoir. The exterior perimeter road around the embankment will be used for inspection of the exterior embankment slope and toe area. An entrance road from U.S. 27 to the new northeast pump station will serve

as one public access road to the site. The existing entrance road to the G-370 pump station will serve as a second public access point.

All vehicular access roads are designed, as a minimum, to meet District standards, as set forth in the DCMs.

5.6.3.2 Pump Station Access

Access roads for the northeast pump station and discharge control structures will be designed to connect to the site and Reservoir access roads and will be subject to the same design criteria.

The primary access point for the northeast pump station will be from the perimeter road northwest of the station. This road will lead onto a paved parking and maneuvering area adjacent to the pump station. This paved area will also provide truck access to the aboveground diesel storage tanks, to the pump station operating floor via the overhead door at the end of the building, and to the western berm road along the connector canal.

A service bridge on the north side of the pump station will extend across the connector canal and will connect with the perimeter road on the east side of the pump station. It will provide access to the trash racks, irrigation pumps, and gates on the north and west sides of the pump station. A paved area on the east side of the pump station, constructed above the discharge structure at approximately elevation 19.0 NAVD88, will provide a second access point to the pump station operating floor, storage for collected trash rack debris, and access to the connector canal berm road on the east side of the canal.

Access to the gates and operators along the embankment headwall will be provided by an extension of the embankment crest road. A 16-foot paved roadway will be constructed between the headwall and the pump station structure and will be connected to the crest road on the west side of the pump station and the east side of the discharge structure. A ramp will be provided to the crest road from the exterior perimeter road on the northwest side of the pump station. An interior ramp leading to the internal perimeter road will also be provided. This ramp will also serve as a boat ramp to the reservoir at the pump station site.

5.6.3.3 Access to Discharge Structures

Access to the new gated discharge structures in the south embankment along the Inflow Canal will be provided by the perimeter road located along the top of the embankment and by the existing perimeter levee road located along the toe of the embankment's exterior slope. Turnaround areas adjacent to the discharge structures will be provided and additional ramps leading to the interior perimeter road will be constructed.

5.6.3.4 Other Access Roads

Existing U.S. 27 intersections near the G-370 pump station and near the north site boundary will be utilized for access roads connecting to the Reservoir perimeter roads.

Roads will be constructed on top of the berms on each side of the connector canal for maintenance of the canal. The roads will be gravel surfaced and will be 14-feet wide. A turnaround will be provided at the end of each road, near the U.S. 27 right of way line.

There are currently other east-west service roads within the boundary of the Reservoir that have intersections with U.S. 27. These service roads will be removed during the course of the Reservoir construction, but they may be used for construction contractors' access to the Reservoir site. The construction contractor will be limited to entering the Reservoir Project site from U.S. 27. It will be the responsibility of the construction contractors to coordinate with FDOT regarding the maintenance of traffic during construction.

5.6.4 Bridges and Culverts

The new northeast pump station moves water from the NNRC into the Reservoir and vice versa. The NNRC runs parallel to and on the east side of U.S. 27. The Reservoir and northeast pump station are located on the west side of U.S. 27. Therefore, a new connector canal will be required to connect the NNRC to the northeast pump station and a new highway bridge will be required to carry U.S. 27 traffic across the connector canal. The proposed location of the bridge and the required bridge opening at the connector canal is shown on the Preliminary Drawings.

Preliminary bridge design will be conducted in two stages as part of this Work Order. A Bridge Analysis Technical Memorandum presenting preliminary data and design criteria will be submitted separately from this document and will include an evaluation of the type and size of bridges required and a summary of the design approach.

A Bridge Design Report will be prepared after the site surveys and additional geotechnical work have been completed and will define the scope of work and form the basis of design for the bridges. The report will be prepared in accordance with the FDOT Plans Preparation Manual, Chapter 26 and will preliminarily define the geometry of the bridges, including typical sections, span configurations, under clearances, and vertical and horizontal alignments. The report will document the analyses performed and conclusions reached in the Bridge Analysis Technical Memorandum. The analyses will evaluate several superstructure and substructure types and select one type of each to form the most appropriate combination for the bridges, based on comparative costs and other considerations.

The northeast pump station entrance road and vehicular access roads to the southeastern Reservoir public access point will need to cross the seepage canals. Precast concrete culverts with invert elevations matching the canal bottom and headwalls and/or wing walls, as appropriate, will be provided at these locations.

5.6.5 Stormwater Control/Site Drainage

5.6.5.1 During Construction

A conceptual Stormwater Pollution Prevention Plan (SWPPP) will be required as a part of the contract documents. The objective of the SWPPP will be to prevent erosion where construction activities are occurring, prevent pollutants from mixing with stormwater, and prevent pollutants from being discharged by containing them onsite, before they can affect the receiving waters. The contractors will be required to prepare and submit a comprehensive SWPPP that will be tailored to their sequence of construction. The contractor will be provided conceptual plans, guidelines, and criteria so that detailed drainage plans for all phases and sequences of construction can be prepared.

5.6.5.2 Permanent Construction

The site grading around the new northeast pump station, connector canal and discharge structures will include provisions for capturing the stormwater runoff, where necessary. Long term site drainage along the north and east borders will be directed to the Reservoir seepage canal. Long term site drainage along the STA-3/4 Supply Canal will be directed to the Supply Canal. Long term site drainage along the west border will either be directed to the Reservoir seepage canal or to the Miami Canal via existing agricultural canals. Stormwater calculations and facilities will be prepared to comply with local and State guidelines and regulations.

5.6.6 Utilities

5.6.6.1 Electric Power

5.6.6.1.1 Florida Power & Light (FPL) Overhead Distribution Lines

Electric distribution lines are located along the U.S. 27 highway easement. Electric power for the northeast pump station can be obtained from those lines. There are no overhead distribution lines that will need to be removed or relocated for the Reservoir Project.

5.6.6.1.2 FPL Overhead Primary Lines

The new northeast pump station will require a primary power line connected to the distribution line in the U.S. 27 easement. Location and routing of this line will be shown on the Preliminary Drawings.

The new outlet control structures to be located along the south embankment of the Reservoir will require a primary power line. A connection will be made to the existing primary line supplying power to the STA-3/4 inlet gates Location and routing of the primary power line will be shown on the Preliminary Drawings.

5.6.7 Site Security

Pedestrian, horseback, and bicycle access will be allowed throughout the Reservoir site, except at the pump stations.

The District requires that no public access be allowed within 200 yards of the pump stations. This will be accomplished by fencing the embankment toe-to-toe on each side of the northeast pump station and providing gates at the top embankment road and exterior perimeter road. Additional fencing will be provided along the seepage canals and the connector canal to restrict access to the pump station.

Security lighting will be provided by exterior lights mounted on the pump station structure and by pole lighting as needed around the pump station facilities..

5.7 HVAC, PLUMBING, AND FIRE SUPPRESSION SYSTEMS DESIGN

5.7.1 Design Criteria

The following describes the basis of mechanical design and criteria associated with the heating, ventilating, and air conditioning (HVAC); plumbing; and fire suppression systems for the new northeast pump station. Table 5.7-1 details the Reservoir Project site design criteria.

Table 5.7-2 details the indoor design criteria for the Reservoir Project.

Table 5.7-1 Reservoir Project Site Design Criteria

Location	Measurement
Site Elevation Above sea level, feet NAVD88	 16 to 27
Site Location North latitude, degrees West longitude, degrees	 26 81
Ambient Design Temperatures (1) Winter, design dry bulb, degrees F Summer, design dry bulb/mean coincident wet bulb, degrees F Dehumidification, design dew point, degrees F	 42 93/77 78
Degree Days Heating (Base 65 degrees F), days Cooling (Base 50 degrees F), days	 418 8,924
Rainfall Intensity (2) Actual, inches/hour Design, inches/hour	 4.7 5

(1) The winter and summer design temperatures are based on the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) frequency levels 99.6 percent and 1 percent, respectively.

(2) The actual rainfall intensity rate is based on a 60 minute duration and 100 year return period.

Table 5.7-2 Indoor Design Criteria for Reservoir Project

Area	Design Temperatures (F) [1]			Ventilation Requirements	Ventilation Notes
	Summer	Winter			
	Design	Design	Setpoint		
Engine Pump Room	100	--	--	1.5 cfm/sf (C)	Note 2
Pump Station Pipe Gallery	100	--	--	6 AC/HR (I)	Note 1
Irrigation Pump Room	100	--	--	6 AC/HR (I)	Note 1
Shop	78	72	72	--	Note 4
Janitor's Closet	100	--	--	--	Note 3
Control Room	70	70	70	--	Note 4
Break Room	78	72	72	--	Note 4
Locker Room	78	72	72	--	Note 3
Restroom(s)	78	72	72	--	Note 3

AC/HR = designates air changes per hour
(C) = designates the ventilation system operates continuously
(I) = designates the ventilation system operates intermittently

[1] Indoor conditions reflect operating temperatures for personnel comfort, code/standard recommendations, or equipment protection.

Notes:

1. The ventilation system will be sized on the more restrictive of the AC/HR (or cubic feet per minute per square foot – cfm/sf) listed, or the airflow required to maintain the indoor design temperature based on the summer outside design temperature
2. Additional intermittent ventilation will be provided as required to maintain the indoor design temperature based on the summer outside design temperature, or to meet the engine combustion air requirements
3. The exhaust rate will be based on the most stringent requirement of: 0.5 cfm/sf of floor area; 50 cfm per toilet or urinal; or 100 cfm minimum
4. The ventilation rate will be based on the exhaust requirements or as required by ASHRAE 62-1989, whichever is more stringent

5.7.2 HVAC

The following is a description of the HVAC systems:

5.7.2.1 Heating Systems

Electric wall heaters will be provided in the Men's and Women's Toilet/Locker rooms for supplemental heat.

5.7.2.2 Ventilation Systems

A forced air ventilation system will be provided for the Engine Pump Room, Pump Station Pipe Gallery, and Irrigation Pump Room. The system will utilize propeller fans for supply and propeller fans (except duct fan for Pump Station Pipe Gallery) for exhaust. Automatic roll filters will be used to filter the air supplied. All ventilation wall openings will be protected by a fabricated metal hood of the District's standard design.

The ventilation system fans will be controlled by their individual ON-OFF-AUTO selectors switches. When the exhaust fan selector switches are in the "AUTO" position, the exhaust fans will be interlocked with the controls for the supply fans. When the supply fan selector switches are in the "AUTO" position, the quantity of supply fans operated will be automatically controlled based upon the quantity of engines operating and/or controlled by the room thermostats.

5.7.2.3 Air Conditioning Systems

The air conditioning systems will be split system type heat pumps. A heat pump will be provided for the shop, control room, break room, locker room, and restroom. The heat pump serving the break room, locker room, and restroom will also be ducted to provide a backup to the control room's air conditioning system. Each heat pump will be provided with a backup emergency electric heating coil. Each unit will be controlled by a remote wall mounted thermostat to maintain the desired space temperature.

The air handling units and heat pumps will be located inside the pump station.

The locker room, restroom, and janitor's closet will be exhausted by duct fans ducted to exhaust louvers or wall caps.

5.7.3 Potable Water

Investigation of potable water usage at the existing major pumping stations (G-310 and G-370) indicates low demand and infrequent use of potable water. Potable water is supplied to a kitchen sink, restrooms, and showers. Bottled water is used for drinking. It was reported that the current potable water systems are sized for more demand than the system experiences, and as a result, the treatment systems are experiencing problems due to a lack of flow.

As an alternative to the potable water supply system installed at the existing pumping stations, which is canal water processed through sand filters and reverse osmosis (RO) membranes, the use of a shallow water well will be reviewed. Treatment of this water could be with aeration, canister filtration, chlorination, and softening. The design will incorporate storage that will serve the typical low demand but also accommodate the infrequent periods of larger demands when the

pump station houses personnel during extreme weather events. Changing the potable water source to a well would require water quality sampling and analyzing, and based on the results of the analysis, an appropriate water purification system would be compared to the current RO treatment system. The potable water system design will be finalized during final design after direction from the District regarding their preferred potable water system

The potable water system selected shall supply potable water to restrooms, sinks, and showers. An electric-powered domestic water heater will be provided to supply water at 120 degrees F to the sinks and showers.

5.7.4 Fresh Water Supply System

A fresh water system will be provided to supply water for lubricating water, seal water, and hose bibs for area washdown. The fresh water system will be supplied by water from the adjacent canal, and treated using in-line strainers.

5.7.5 Cooling Water System

Cooling water for use in the pump engines and gear reducers will be provided by strained water from the adjacent canal. This will be a once-through cooling system, and the used water will be collected and discharged back into the canal.

5.7.6 Sanitary System

All plumbing fixtures that require drainage will discharge to the sanitary system. In addition, floor drains located in the locker room and restrooms will discharge to the sanitary system. Floor drains will not be provided in the pump room so that potential oily waste will not be discharged to the sanitary system. Sanitary drainage from the building will be collected in a septic tank. A leach field will be provided at the edge of the built up area adjacent to the pump station. Soil material for the leach field will consist of sanitary backfill as defined in Florida Regulation 64E-6.

5.7.7 Stormwater System

Storm drainage will be collected from the roof drains and leaders. All storm drainage at the pump station will be routed to the forebays.

5.7.8 Fire Suppression System

Code investigations indicate that an automatic fire sprinkler and detection system will be required for the entire pump station facility. However, this is in conflict with the District Guidelines (Paragraph 5.3.14). It appears that the Owner will need to obtain a variance from local fire officials to install the system recommended in the Guidelines. The Preliminary Drawings are based on the District Guidelines, including installation of portable fire extinguishers. If a fire sprinkler and detection system is required, it will be included in the detailed design.

The District shall review all design assumptions, criteria, and calculations. Verification with the District and the District's insurance underwriter shall be done for the fire protection systems.

5.8 ELECTRICAL DESIGN

5.8.1 Design Criteria

5.8.1.1 Utility Power

5.8.1.1.1 Pump Station

Florida Power & Light has an overhead 13.2 Kilovolt (kV) power line running along the canal to the east of the pump station and it is anticipated this line will be used to serve the new pump station. We have indicated on the Electrical site plan an underground service from a FP&L pole to two pad mounted transformers. We have to verify, but are anticipating that FP&L will furnish their metering requirements at the transformer secondary. Preliminary contact with FPL was made a year ago to inform them of the proposed pump station and the anticipated power demands. No additional information was received from FPL at that time concerning what their requirements would be to serve the new pump station.

To stay consistent with existing pump stations, we will request that FPL furnish and install step-down station transformers at the northeast pump station. The secondary will be requested to be wye connected with the neutral solidly grounded at the transformer installation.

5.8.1.1.2 Control Structures

Florida Power & Light has an overhead 13.2 Kilovolt (kV) power line running along the canal to the south of the two control structures and it is anticipated this line will be used to serve the new control structures. We have indicated on the Electrical site plan an underground service from a FP&L pole to a pad mounted transformer at each structure. We have to verify, but are anticipating that FP&L will furnish their metering requirements at the transformer secondary.

To stay consistent with existing pump stations, we will request that FPL furnish and install a step-down transformer at each control structure. Since the load at each control structure will be small, the transformers will be single phase with a 120/240 volt secondary.

5.8.1.2 Station Equipment Voltage

Pump station voltage received from FPL will be 480 volts, three phase, 60 hertz. In general, station equipment voltages will be specified to operate at the following voltages.

Motors rated one Horsepower (Hp) and larger	460 volts, 3 phase
Motors less than one Hp	115 volts, 1 phase
Lighting	115 volts, 1 phase
Convenience receptacles	115 volts, 1 phase

The remote control structures will receive service from FPL at 120/240 volt single phase.

5.8.1.3 Pump Station Power Distribution

A pump station one-line diagram is included with the Preliminary Drawings. The distribution system will be serviced by the FPL transformer serving a split bus. Normally the tie breaker is open and the two main breakers are closed, thus dividing the loads between the two main breakers. To prevent voltage back-feed from the two generators, only two of the three breakers can be closed at the same time. This is mechanically accomplished via key interlocks.

5.8.1.4 Station Switchgear

A switchboard consisting of circuit breakers will be provided to distribute 480 volts of power to various loads, including but not limited to the following equipment:

- Two vacuum system pumps
- Two air compressors
- Six motor control centers for diesel engine pump support equipment. (Provisions for two future engine MCCs to be added).
- Three seepage pumps
- Two motor control centers for miscellaneous loads
- Crane and hoist
- Five irrigation pumps

The two motor control centers for miscellaneous loads will supply power to individual pumps that are not part of a vendor supplied package and other loads as indicated below. The list of equipment is tentative and subject to change during final design.

- Building supply fans
- Building exhaust fans
- Two waste fuel oil pumps
- Fuel oil receiving pump
- Two lube oil supply pumps
- Lube oil receiving pump
- Seven cooling water pumps
- Two fresh water pumps
- Two water lubrication pumps
- Two potable water pumps
- Two waste lube oil pumps
- Generator block heater
- Two traveling trash rakes

- Three rotating strainers
- Two lighting panels (120/208 volt, three phase)
- Motor operated valves
- Water heater
- Instrument air compressor
- Two engine cooling water valves
- HVAC power panel (120/240 volt, single phase)
- Fire alarm and security system power panel (120/240 volt, single phase)
- Other loads as required

5.8.1.5 Standby Generator Power

In addition to normal utility power, the pump station will have two diesel engine powered generators. Each will be sized to operate the station systems should the normal utility power fail. One generator will operate at a time automatically, with the second serving as a stand-by. Fuel storage requirements will be based on a single generator operation for a minimum of seven days.

Each generator will be sized to meet the stand-by requirements of the pump station. This will include operation of all plant loads and firm capacity for the seepage pumps. Specifically the entire pump station can operate from one generator except for the following equipment.

- No irrigation pumps can operate
- The crane cannot operate
- Only 1 of the 2 air compressors can operate
- Only 2 of the 3 seepage pumps can operate (in accordance with the District Major Pumping Station Engineering Guidelines Section 5.4.7a and 5.2.6)

Upon failure of the utility power, a transfer switch will automatically transfer power supply from a generator to feed the main switchgear. A manual generator start will be provided to exercise the unit.

A manually operated 20 kw engine generator will also be provided to power station lighting equipment. This generator may be used to allow for inspection of the facility during a power outage without the need to turn on the large engine generators.

5.8.1.5.1 Motor

Motors will be totally enclosed, fan cooled, and of premium efficiency. All outdoor motors will have integral space heaters. Indoor motors five Hp and larger will have integral space heaters.

5.8.1.5.2 Monitors

The 480 volt switchboard and the motor control centers will each have a power monitor that will provide line and phase voltages, phase currents, kilowatt (kW), kilovolt-ampere reactive (kVAR), power factor, and kilovolt-ampere (KVA).

5.8.1.5.3 Lighting and Receptacles

Lighting panel boards will be rated for 120/208 volts, three phase. Bus bars will be copper. Circuit breakers will be thermal magnetic bolt-on type.

High bay areas of the pump station will be provided with metal halide light fixtures. The pipe gallery area will have fluorescent light fixtures. Control room, break room, and offices will have T-8 fluorescent light fixtures. Outdoor light fixtures will be wall mounted and controlled by a photoelectric switch. The diesel tank storage area lighting will be pole mounted metal halide fixtures. Lighting for the trash rack area will be installed on the pump station wall. Lighting levels will be in accordance with the USACE EM 1110-2-3105, Chapter 21 Standard.

Major paths of exit will have LED type exit signs on a dedicated circuit. Emergency lighting will also be provided on this dedicated circuit.

Switches used for lighting will be rated 20 amperes, 120 volts. Duplex receptacles will be rated 20 amperes, 120 volts. Ground fault circuit interrupter (GFCI) type receptacles will be used outdoors and in the restrooms. Office receptacles will have stainless steel plates. Outdoor receptacles will have “in-use” weatherproof covers.

5.8.1.5.4 Conduits and Wiring

Conduits above grade will be rigid steel. Conduits below grade will be Polyvinyl Chloride (PVC) Schedule 40 pipe. Underground conduits, in general, will be encased in concrete.

Liquid-tight flexible metal conduit will be used at all motors, transformers, and any other equipment that can vibrate or move. Rigid steel conduits will be terminated at equipment and boxes with insulated plastic bushings. The cable tray will be reviewed for use in the pump station during final design.

Wire for 480 volt power applications will be thermoplastic high heat resistant nylon coated (THHN)/thermoplastic heat and water resistant nylon coated (THWN) insulation with stranded copper conductors. The minimum size wire will be 12 gauge.

Wire for control and alarm circuits will be multi-conductor type THHN/THWN insulation, with stranded copper conductors, and a nylon jacket suitable for installation in either a tray or conduit. The minimum size wire will be 14 gauge.

Wire for milliamp (mA) /millivolt (mV) circuits will be single pair shielded instrument cable, type Thermoplastic Fixture Wire Nylon Jacketed (TFN) insulation, with stranded copper conductors, and a nylon jacket suitable for installation in either a tray or conduit. The minimum size wire will be 16 gauge.

5.8.1.6 Building Systems

5.8.1.6.1 Lightning Protection

The building will have air terminals on the roof interconnected with copper conductors.

5.8.1.6.2 Grounding

A ground ring will be installed around the pump station consisting of 4/0 copper cable and ground rods to establish a resistance of five ohms or less. The building's steel columns, steel rebar in the footing, water piping, lightning protection system, motors, panels, transformers, etc. will be connected to the ground ring in accordance with the National Electric Code.

5.8.1.6.3 Fire Alarm System

A zoned, supervised fire detection and alarm system will be installed. Ionization type smoke detectors will be used in the pump room and the generator room. To protect against false alarms, the detectors in these rooms will be cross-zoned so that two detectors must be initiated before an alarm is sounded.

5.8.1.6.4 Closed Circuit Television System

A closed circuit television (CCTV) system, similar to the system at G-370 pump station, will be installed in the northeast pump station.

5.8.1.6.5 Materials of Construction

FPL will provide the service transformers.

The switchboard manufacturer should have a distributor and authorized service representative within the State of Florida. The equipment should be manufactured in the United States. Acceptable manufacturers will be Square D, Siemens, Cutler Hammer, Allen-Bradley, General Electric, or approved equal.

Lighting and 480 volt distribution panel boards and lighting fixtures should be made in the U.S. Light fixtures will be industrial grade.

Generators will be Cummins, Onan, Caterpiller, Detroit Allison, or approved equal. Automatic transfer switches will be Asco, Zenith, or approved equal.

Rigid steel conduit will be Allied, Robroy, Triangle, or approved equal. PVC conduit will be Carlon, Certain-Teed, or approved equal. Liquid-tight conduit will be Electri-Flex, Carol Cable, Anamet, or approved equal.

Wire and cable will be Okonite, Alpha, or approved equal.

5.8.2 Gate/Valve Operators and Controls

The gate and valve operators will be similar to Limitorque operators which have an integral reversing starter, limit switches, control power transformer, open, stop, and close pushbuttons, and local-remote selector switch. The operators will require 480 volt, three phase power from the MCCs. A local mounted safety disconnect switch will be provided near each operator.

5.8.3 Pump Station Engineering Guidelines

The District has in place a standard titled "Major Pumping Station Engineering Guidelines" dated December 1, 2005. That document was used in preparing this basis of design Section.

5.9 INSTRUMENTATION AND CONTROLS DESIGN

5.9.1 Design Criteria

This Section defines the instrumentation and controls design criteria for the water control facilities, pump stations and telemetry systems. All systems will be designed in accordance with District standards. All systems and facilities, as general practice, will be monitored and controlled from a local control system in the pump station. The local control system will be Programmable Logic Controller (PLC) based. Monitoring and control will be available from the Remote Terminal Unit (RTU) of the District Supervisory Control and Data Acquisition (SCADA) facilities. The existing telemetry system centralized at the District headquarters will be extended to include the new facilities. Instrumentation and control features will include the following features:

- The master control PLC will be an Allen-Bradley ControlLogix 1756 PLC system. Packaged systems in the pump station will be provided with stand-alone Allen-Bradley SLC-5/04 (or possibly SLC-5/05 with Ethernet) controllers
- Monitoring and control of remote sites, including gated spillways, gated culverts, and monitoring stations will be over Data-linc spread spectrum radios. Equipment will be controlled by the Master PLC, and passed through to the RTU
- Pumps will have control from the District Control Center, through the RTU. Gated structures will also have control through the Control Center
- Analog control signals will be 24 VDC, 4-20 mA. Discrete signals will be 24 volt, direct current (VDC). Interposing relays shall be used where necessary to provide isolation and conversion to 24 VDC. Discrete output signals will interface field devices through interposing relays. Surge suppression shall be provided for all instrumentation. The District design details will be followed

5.9.2 Reservoirs and Canals

The level of the Reservoir and all canals associated with the pumping stations will be monitored through a Campbell Scientific RTU. The signal will be transmitted to the SCADA system for display.

The District standard for level monitoring is the Balluff linear potentiometer, located in a stilling well. For variable applications exceeding 20 feet, the Rittmeyer pressure transmitter provides increased range. Stilling wells shall be installed in accordance with the District design details. Water levels in the embankment will be monitored with piezometers. Water quality monitoring will be provided as outlined in the District design details.

5.9.3 Water Control Facilities

Monitoring and control of gated spillways will be through the RTU. Control of the gates will be manual from the control system, and will be based on the water level in the Reservoir.

Monitoring and control of gated culverts will be through Campbell Scientific RTUs.

5.9.4 Pump Stations

Pump station control and monitoring can vary from the simple manual operation of an agricultural style station to the more complicated automatic or remote operation of a typical District station. There are also varying degrees of complications for the remote operation of a station. Electric motor drivers have far less auxiliary systems than a diesel engine driven pump station and therefore, a much simpler control and monitoring system. Electric driven pump stations are also typically not used for flood control applications due to the possibility of power outages during a storm event. Therefore, pump system reliability of a flood control station does not apply to an electric motor driven station. District pump station auxiliary systems and the start/stop of the driver are controlled by a PLC. The receiving and sending of the control and monitoring data are via an RTU.

5.9.4.1 Operation

In the more recently constructed District flood control stations, there are typically three modes of operation: local/auto, local/manual and remote. Local/auto operation consists of operating the engine with the auxiliary systems automatically controlled from a remote facility. Local/manual operation consists of operating each component of the pumping system by using manual controls. Remote operation consists of operating the engine via the District's telemetry system with the auxiliaries automatically controlled. Remote or manual start-up and shutdown, as well as alarm shutdown sequences for the engine are automatically controlled by the engine's electronics.

Emergency shutdown of the engine requires an immediate deceleration of the engine speed to zero. The control panel includes a hard-wired emergency shutdown system to shutdown the engine in the event that a failure occurs and the engine controller fails to initiate its own shutdown sequence. The emergency shutdown also functions when the "manual-auto-off" switch is in the manual mode. The circuit generates a shutdown on the actuation of the emergency stop pushbutton. The trash rake and fuel auxiliary systems are also shutdown during an emergency stop condition.

5.9.4.2 Diesel Engine Driver Control and Monitoring System

The diesel engine's electronic control module (ECM) provides monitoring of vital engine parameters and control of engine operation. The ECM output is data-linked to the engine PLC through a converter that translates automotive protocol standard SAE-J1939 serial data to the required digital input of the input/output (I/O) modules of the PLC. The ECM J1939 output data includes all monitoring data, diagnostic information, and operating history and can be displayed by the PLC's monitor. The engine PLC through a converter shall be networked to the RTU (MOSCAD) for communication to the District's operational center. The RTU (MOSCAD) typically has a monitor to display all station data. The various auxiliary functions, such as low

water level shut-down, trash rake operation and alarm, and high reduction gear oil temperature or vibration, are monitored and controlled by the engine's PLC. The PLC shall have the capability to automatically shut the engine down given an alarm condition. Instrumentation signals for station monitors such as stage data, electrical service power phase monitoring, and fuel storage tank levels shall be connected directly to the RTU (MOSCAD) unit.

5.9.4.2.1 Logic Controller (PLC)

The microprocessor based controller shall be an Allen-Bradley model or equal for machine level control applications requiring limited I/O quantities and limited communications capabilities. The PLC shall be mounted in the engine control panel and shall provide control and monitoring of the engine, transmission, and the auxiliary systems. The engine ECM I/O serial data via a converter (J1939/DF1-RS232) shall be linked to the I/O module of the controller. The PLC is linked to a DH485 network and with the RTU (MOSCAD) via a converter (DH485/DF1). A station PLC shall be located in the control room with control and monitoring capabilities for all station systems.

5.9.4.2.2 Display Panel

An Allen-Bradley display panel model or equal will be provided for each PLC. The display will be mounted in the engine control panel door.

5.9.4.2.3 Converter (J1939/DF1-RS232)

A communication device will be provided to convert the J1939 serial communication data to the DF1-RS232 digital input that is required by the PLC.

5.9.4.2.4 Interface Module (DH485/DF1)

An Allen-Bradley 1770-KF3 module will be provided for conversion of the network DH485 digital output to the serial DF1 communication signal that is required by the RTU (MOSCAD).

5.9.4.2.5 Surge Suppressor

A surge suppressor will be provided that will protect the I/O modules of the PLC from lightning induced surges, electrical fast transients and EMI/RFI noise. The surge suppressor shall meet or exceed highest class severity level of IEC 1000-4-4 and 1000-4-5. The suppressor shall be UL-497B listed. The surge protector will be Circuit Components, Inc.'s "Surge Control SAB Series" or District approved equal.

5.9.4.2.6 Vibration Switch

Each reduction gear shall be provided with a vibration control switch to protect the equipment from damaging shock or vibration. Each switch shall be a 24 VDC powered electro-mechanical device, with two Single Pole, Double Throw (SPDT) snap acting switches rated at 2A up to 30 VDC, and mounted in a National Electrical Manufacturers Association (NEMA) four enclosure. Each switch shall have a remote reset to allow reset of the tripped unit from a remote location, an adjustable time delay to override trip operation for a preset length of time (to prevent trips during transient pump cavitation events, for instance), and a fine adjustment to precisely select the degree of sensitivity.

5.9.4.2.7 Temperature Monitors

The temperature probes provided shall be resistance temperature detectors (RTDs) and shall comply with ANSI 34. RTDs shall be 100 ohm 3-wire platinum in a Type 304 stainless steel sheath with watertight connection head.

5.9.4.2.8 Liquid Level Gage

A combination liquid level gage with adjustable low limit switch will be used to provide visual indication of oil level and signal low level conditions.

5.9.4.3 Indicating Level Switches

Indicating level switches shall be provided to signal a low level condition. Water level sensors shall be installed to signal a low level condition. Sensors shall be floatless, pressure sensitive, diaphragm actuated switches.

5.9.4.4 Monitoring Instrumentation

Compliance monitoring locations shall be provided with auto samplers. The auto sampler will be activated by the level at the monitoring location. Auto samplers will include all necessary facilities for access, including platforms and stairs.

5.9.4.5 Station Emergency Power

Given a power outage, the flood control station requires emergency electric power backup. Typically an adequately sized engine generator is provided for backup station service during the time that utility power is lost. In a large flood control station, a redundant system is provided. Controls are provided in the 125 ampere Automatic Transfer Switch (ATS) to either manually or automatically start the engine-generator. A RTU output command will remotely STOP the engine generator should the unit unnecessarily start.

Electric motor driven seepage pump stations intended for flood control shall utilize a backup generator to operate the pump station during a loss of utility power.

5.9.4.6 Stage Monitors

Upstream and downstream stilling wells with water level transmitters provide analog water level data of the approach and discharge channels. A stilling well with a water level transmitter is also provided in each pump intake to monitor low water levels. The water level transmitters provide a proportional 4-20 mA signal. The stilling well water level transmitters are normally continuously powered from 120 volts, alternating current (VAC) to 24 VDC power supply. Upon the loss of 120 VAC service, the RTU's "PULSE ANALOG CIRCUITS" program will intermittently power and scan the analog water level transmitters.

5.9.5 Telemetry

The SCADA system RTU will be located in the building close to the antenna. The RTU will be a Motorola MOSCAD or equal unit to be compatible with the existing units already installed at other District locations. The pump stations will be remotely monitored through the District's

SCADA system. This is the District's proprietary system consisting of an RTU and an antenna. The RTU will be capable of transmitting data to a main station via radio. Data to be transmitted is to be determined. The District may require the remote control of the station and the SCADA system, of the station should provide for this type.

6.0 PERMITTING REQUIREMENTS

Regulatory and permitting requirements within the State of Florida that may be required for the Reservoir Project were presented in Section 4 of the BODR.

A summary of the permits applicable to the construction of the pumping station, discharge structures, and sitework is shown in Table 6-1.

Table 6-1 Reservoir Project Federal and State Permitting Requirements

Permit/Approval	Regulated Activity	Agency and Contact	Authority	Approval Timeline*
FEDERAL PERMITTING REQUIREMENTS				
NEPA	Major Federal Action Affecting the Environment	U.S. Army Corps of Engineers Ms. Tori White South Permits Section Office, SESAJ-RD-SS 4400 PGA Boulevard, Ste. 500 Palm Beach Gardens, FL 33410-2933 561-472-3517	40 CFR Parts 1508	12-18 months
Section 404	Fill of wetlands	U.S. Army Corps of Engineers Ms. Tori White South Permits Section Office, SESAJ-RD-SS 4400 PGA Boulevard, Ste. 500 Palm Beach Gardens, FL 33410-2933 561-472-3517	Clean Water Act	Minimum 6 months
Section 401-Water Quality Certification Refer to State/ Approvals	Fill of Wetlands	U.S. Army Corps of Engineers Ms. Tori White South Permits Section Office, SESAJ-RD-SS 4400 PGA Boulevard, Ste. 500 Palm Beach Gardens, FL 33410-2933 561-472-3517	Clean Water Act	Minimum 6 months
SPCC Plan	Petroleum Storage	EPA-Region 4	Clean Water Act	Minimum 6 months
NPDES Refer to State Permits Approvals	Wastewater Discharge	Florida Department of Environmental Protection 2600 Blair Stone Rd, MS 3560 Tallahassee, FL 33399	Clean Water Act	6-12 months

* From the date of permit application submittal.

Permit/Approval	Regulated Activity	Agency and Contact	Authority	Approval Timeline*
Coastal Zone Management Consistency Refer to State Permits, Approvals	Development in Coastal County	Florida Coastal Management Program Department of Environmental Protection Mail Station #47 3900 Commonwealth Boulevard Tallahassee, FL 32399-0250 850- 245-2163	Coastal Zone Management Act	Minimum 45-60 days
Endangered Species Act Consultation	Wildlife Impacts	Florida Ecological Services Office 1339 20th Street Vero Beach, FL 32960 772-562-3909 FWC South Regional Wildlife Diversity Ricardo Zambrano Conservation Biologist 850-625-5122 FWC Imperiled Species Management/FWS West Indian Manatee (Trichechus Manatus) Mary Duncan, 850-922-4330	Endangered Species Act	3-6 months
Cultural Resources Refer to State Permits Approvals	Excavation	State Historic Preservation Office R.A. Gray Building 500 Boronough Street Tallahassee, FL 32399-0250	National Historic Preservation Act	60 days

STATE PERMITTING REQUIREMENTS				
Comprehensive Everglades Restoration Plan Act Regulation Act	Project Construction	Florida Department of Environmental Ms. Temperance M. Morgan 2600 Blair Stone Rd., MS 3560 Tallahassee, FL 32399 850-245-8424	Title XXVII Section 373, 373.1502 F.S.	12-18 months
Well Construction	Well Construction	South Florida Water Management District 3301 Gun Club Road West Palm Beach, FL 33406 (561) 686-8800	Rule 40 E-2, F.A.C.	60-90 days
Consumptive Water Use	Water Use	South Florida Water Management District 3301 Gun Club Road West Palm Beach, FL 33406 (561) 686-8800	Rule 40 E-2, F.A.C.	60-90 days
Florida Department of Transportation Access	Bridge and Road Construction	Michael Rippe, Director Southwest Area Office Florida Department of Transportation, District 1 2295 Victoria Ave, Ste# 292 Ft. Myers, FL 33901 (863) 519-2628	Section 40E-6.091, F.A.C.	60-90 days
Clean Air Construction (PSD) Clean Air Title V-Operating Permit	Pump Station Emissions	Florida Department of Environmental Protection, Division of Air Response Management 2600 Blair Stone Rd, MS 3560 Tallahassee, FL 32399-0250	Section 62-210.300, F.A.C.	60-90 days

Petroleum Storage Tanks	Storage Tank Installation	Florida Department of Environmental Protection 2600 Blair Stone Rd, MS 3560 Tallahassee, FL 32399-0250	Rules 62-761, 62-762- F.A.C.	3-6 months
Dewatering	Dewatering	South Florida Water Management 3301 Gun Club Road West Palm Beach, FL 33406 561-686-8800	Rule 40 E-20, F.A.C.	60-90 days
NPDES	Stormwater	DEP NPDES Stormwater Program 2600 Blair Stone Rd, MS 2500 Tallahassee, FL 33399 850-245-7522	Rule 62-621 F.A.C	6-9 months
NPDES	Produced Groundwater	Florida Department of Environmental Ms. Temperance M. Morgan 2600 Blair Stone Rd., MS 3560 Tallahassee, FL 32399 850-245-8424	Rule 62-621 F.A.C.	6-9 months
Dam Safety	Embankment Construction	Florida Department of Environmental Protection 2600 Blair Stone Rd, MS 3560 Tallahassee, FL 33399	Chapter 373 F.S.	3-6 months
LOCAL PERMITTING REQUIREMENTS				
Development Review Building Permits Zoning Approval	Reservoir Ancillary Facilities	Planning, Zoning, & Building Dept. Midwestern Office 200 Civic Center Way Suite 300 Royal Palm Beach, FL 33411 561-784-1300	County Ordinance	3-6 months

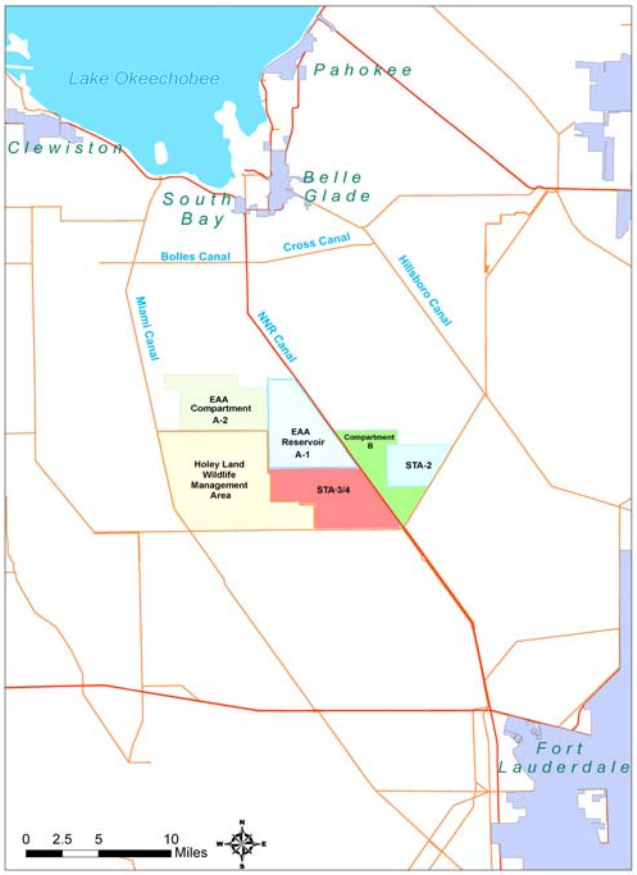
Vegetation Preservation and Protection Stormwater Pollution Prevention Permit Wellfield Protection Petroleum Storage Tank	Reservoir Ancillary Facilities Construction	Environmental Resource Management Florida Department of Environmental Protection 2600 Blair Stone Rd, MS 3560 Tallahassee, FL 33399	County Ordinance	3-6 months

7.0 DRAFT PROJECT OPERATING MANUAL

7.1 INTRODUCTION

The Project Operating Manual (POM) is for day-to-day water management under essentially all foreseeable conditions affecting the Reservoir Project. The POM for STA-3/4 is a separate document and is not updated in this document. The draft POM is developed as part of the Preliminary Design of the Reservoir Embankments Project. Modifications and revisions to the document will occur in further construction phases. See Figure 7.1-1 for the Reservoir location.

Figure 7.1-1 Reservoir Location Map



7.2 GENERAL PURPOSES

The Reservoir concept was designed to reduce the LOK regulatory releases to the estuaries and the backpumping from the EAA into LOK by sending the water to the Reservoir. Additional

goals include the following: Improve environmental releases through the storage of water and release to the Everglades during the dry season; flow equalization and optimization of treatment performance of STAs by capturing peak storm event discharges within the Reservoir for slow release to the STAs; and improve regional water supply to the agricultural community currently served by the EAA canals and other areas served by LOK.

7.3 PROJECT FEATURES

7.3.1 Reservoir

Layout of the Reservoir includes set backs to the exterior toe of the embankment as follows:

- East – 285 feet from the property line
- North – 2,925 feet from the property line
- West (North of Supply Canal) – the western top of bank of the seepage canal will coincide with the western top of bank of the existing secondary agricultural canal
- West along Supply Canal – the centerline of the embankment will be located 106 feet west of the eastern top of slope of the Supply Canal, such that the Reservoir embankment top will be directly over the existing seepage canal.
- South – the southern toe of the embankment will be located 14 feet north of the top of bank of the Supply Canal such that the centerline of the Reservoir embankment is directly over the existing seepage canal.

The Reservoir is designed for a normal maximum operating depth of 12.5 feet and total storage of approximately 190,000 acre-feet. The perimeter embankment is approximately 108,965 feet long and is 12 feet wide at the crest, with 3H:1V side slope on each side. Total embankment height is 26.5 feet above original grade (OG) to provide for the PMP, wind setup, and wave run-up. Design data for the Reservoir Project is included in Table 7.3-1.

Table 7.3-1 Reservoir Project Design Data

Description	Size
Total Surface Area, Acres	15,150
Length of Embankment, Feet	108,965
Total Height of Embankment, Above OG, Feet	26.5
Width of Embankment at Crest, Feet	12
Embankment Side Slopes	3H:1V
Elevation Bottom of Reservoir, Feet	8.6 NAVD88
Normal Maximum Operating Depth, Feet	12.5
Total Storage Capacity, Acre-Feet	190,000 (approximately)

7.3.2 Northeast Pump Station

A new northeast pump station will be constructed near the northeast corner of the Reservoir to pump water from the NNRC to the Reservoir. The pump station is expected to have six pumps sized for total pumping capacity of 3,600 cfs at full design water level.

Seepage control pumps will be included in the design of the northeast pump station. Seepage canals along the north and west sides of the Reservoir will drain to the northeast pump station where the seepage pumps will discharge into the Reservoir. The seepage pumps will be variable speed to allow them to maintain the desired seepage canal water level. The seepage canal along the east side of the Reservoir will drain to the existing G-370 pump station. Seepage pumps in that facility will discharge to the Inflow Canal.

7.3.3 Modifications to G-370 and G-372 Pump Stations

For purposes of this draft POM, it has been assumed that G-370 and G-372 pump stations will not be modified to deliver flow to the normal maximum operating pool of the Reservoir. (See Table 7.3-2 and Table 7.3-3) Several pumping alternatives are being considered that would require modifications to one or both of the pump stations, which would result in modifications to the operation scenarios presented in this document.

Table 7.3-2 Pump and Hydraulic Description of G-370 Pump Station

Pump Station Description		Other Notes
Number of Pumps	3	Inflow pumps
Discharge Capacity (each pump)	925 cfs	Pool-to-pool head 7.0 feet. Brake horsepower (Hp) 1182
Design Headwater Elevation	8.6 NAVD88	Headwater varies from 6.6 feet to 12.6 NAVD88
Headwater (HW) Start Up Condition	6.6 NAVD88	50 percent flow @ 23 feet head without vacuum system
Design Low Water (HW) Elevation	6.6 NAVD88	In front of trash screen
Maximum High water (HW) Elevation	12.6 NAVD88	
Maximum Screen Loss to Tailwater At Elevation 16.6 NAVD88	3.6 NAVD88	50 percent flow @ 13 feet head, brake Hp @ 1,315
Design tailwater elevation	13.6 NAVD88	
Maximum Tailwater Elevation	16.6 NAVD88	
Minimum Tailwater Elevation	13.1 NAVD88	
Nominal Pump Operation Speed	113 rpm	
Nominal “On Elevation”	As needed to maintain headwater at or below 8.6 NAVD88	
Nominal “off elevation”	As needed to maintain headwater at or below 8.6 NAVD88	
Motor/Engine Size	935 Hp	Brake horsepower @ rated condition
Motor/Engine Size	1467 Hp	Brake horsepower @ start-up condition
Motor/Engine Speed	720 rpm	Naturally aspirated 2-cycle diesel engine
Centerline Discharge Connection	22.6 NAVD88	Discharge sill elevation @ 18.6 NAVD88
Pump Station Floor Elevation	29.6 NAVD88	
Intake Floor Elevation	-9.9 NAVD88	At entrance to Formed Suction Intake tunnel
Discharge Floor Elevation	-5.4 NAVD88	At exit of discharge, tunnel height 12 feet

Table 7.3-3 Pump and Hydraulic Description of G-372 Pump Station

Pump Station Description		Other Notes
Number Of Pumps	4	Inflow pumps
Discharge Capacity (Each Pump)	925 cfs	Pool-to-pool head 9.0 feet. Brake Horsepower (Hp) 1182
Design Headwater Elevation	8.6 NAVD88	Headwater varies +6.6 to + 12.6 NAVD88
Design Low Water (Headwater) Elevation	6.6 NAVD88	Headwater level in front of screen
Start-Up Headwater Elevation	6.6 NAVD88	50 percent flow at 16.0 feet pool-to-pool Hd.
Maximum High Water Headwater Elevation	12.6 NAVD88	
Maximum Screen Loss Headwater Elevation	3.6 NAVD88	50 percent flow with tailwater elevation 17.6 NAVD88
Design Tailwater Elevation	15.6 NAVD88	
Maximum Tailwater Elevation	17.6 NAVD88	
Minimum Tailwater Elevation	13.1 NAVD88	
Nominal Pump Operation Speed	119 rpm	
Nominal "On Elevation"	As needed to maintain headwater at or below 8.6 NAVD88	
Nominal "Off Elevation"	As needed to maintain headwater at or below 8.6 NAVD88	
Motor/Engine Size	1663 Hp	Start-up condition
Motor/Engine Speed	720 rpm	2 cycle diesel naturally aspirated
Centerline Discharge Connection	22.6 NAVD88	Discharge sill elevation at 18.6 NAVD88
Pump Station Floor Elevation	29.6 NAVD88	
Intake Floor Elevation	-9.9 NAVD88	At FSI tunnel entrance
Discharge Floor Elevation	-5.4 NAVD88	At exit of discharge, tunnel height 12 feet

7.3.4 Reservoir Gate Structures

7.3.4.1 Supply Canal Gate Structures

Two Reservoir gate structures will be provided for discharge from the Reservoir to the Supply Canals feeding the STA-3/4. (see Table 7.3-4 below for Inflow/Supply Canal, Levee, Hydraulic Parameters, and Figure 7.3-1 for the Reservoir Control Structures Location Map). One structure (southeast gate) will be located in the south Reservoir embankment between G-370 pump station and control structure G-383. The second structure (southwest gate) will be located in the South Reservoir embankment just to the west of control structure G-383.

Figure 7.3-1 EAA Reservoir A-1 Control Structures Location Map

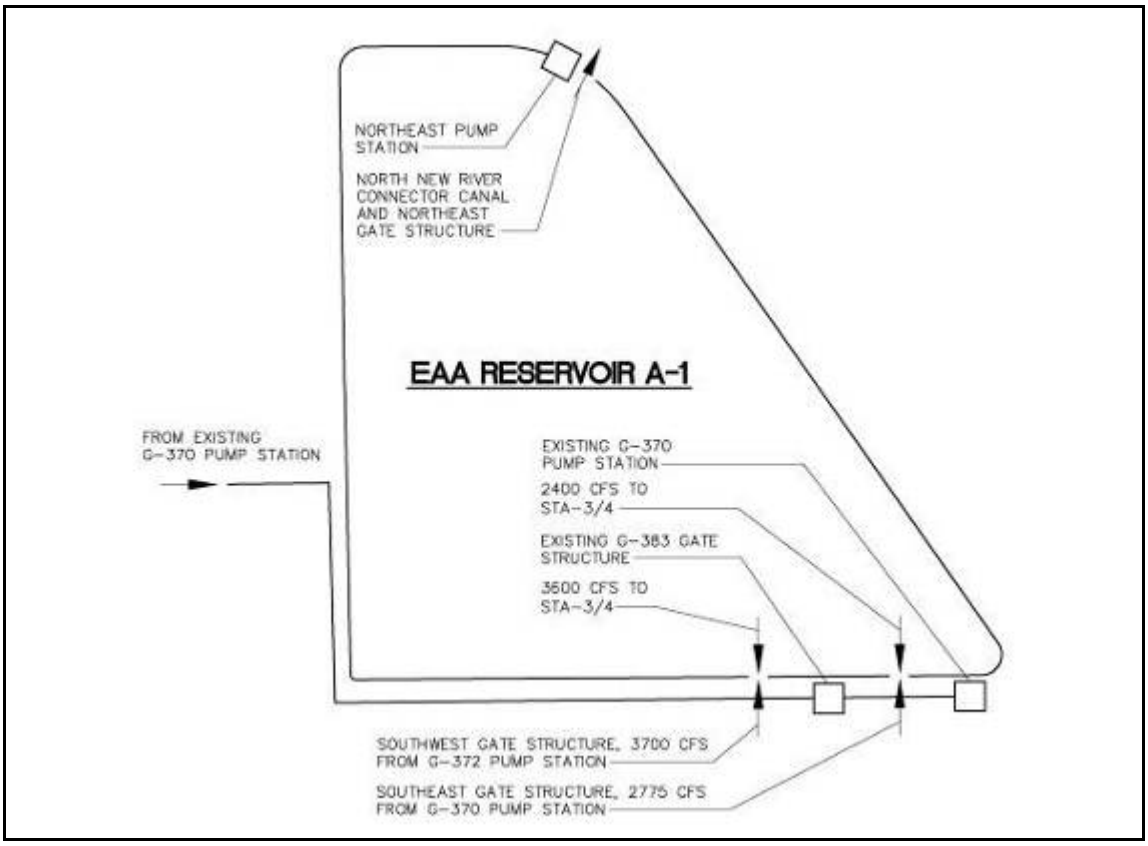


Table 7.3-4 Inflow/Supply Canal Levee Hydraulic Parameters

Canal Description	Inflow Canal[1]	Supply Canal
Canal Length	6.2 miles	10.4 miles
Canal Invert	-6.9 NAVD88	-6.9 NAVD88
Canal Bottom Width	30 to 45 feet	45 feet
Canal Side Slopes	2.5H:1V	2.5H:1V
Exterior Embankment Height	17.6 NAVD88	21.6 NAVD88
Holey Land Embankment Height	-	20.6 NAVD88
Inflow Control Embankment Height	18.1 NAVD88	-
Berm Heights	12.6 NAVD88	12.6 NAVD88
Design Maximum Flow	2,775 cfs[2]	3,670 cfs
Design Water Surface Elevation	13.6 NAVD88	15.6 (13.6) NAVD88
Design Maximum Canal Velocities	0.29 to 1.71 fps[3]	0.32 to 1.88 fps
Standard Project Storm Flow	2,775 cfs	3,670 cfs
Standard Project Storm Water Surface Elevation	16.6 NAVD88	18.6 (16.6) NAVD88
Standard Project Storm Canal Velocities	<Design Velocity	<Design Velocity

[1]The original designer distinguished between two canal sections. The portion adjacent to STA-3/4 was called Inflow Canal while the portion abutting the Holey Land on the north and west sides was called the Supply Canal. Currently both canal reaches are commonly known as the Supply Canal.
*Inflow Canal Section from G-380F to G-383 Gate Structures
[2] cfs = cubic feet per second
[3]fps = feet per second

The two gate structures will be multiple-barreled, gated concrete box culverts to allow flow into the Reservoir from the inflow canal and out of the Reservoir to the canals, depending on the water level and operation of the STA-3/4. Data for these structures will be developed during the design phase (see Figure 7.3-2 for a schematic of STA-3/4 structures).

7.3.4.2 Northeast Gate Structure

A new gate structure will be constructed near the northeast pump station. Its primary use will be for releasing water to the NNRC for agricultural deliveries. The gates will be available for opening in an emergency. The structure will connect to the new connector canal between the northeast pump station and the NNRC.

7.3.5 Spillway

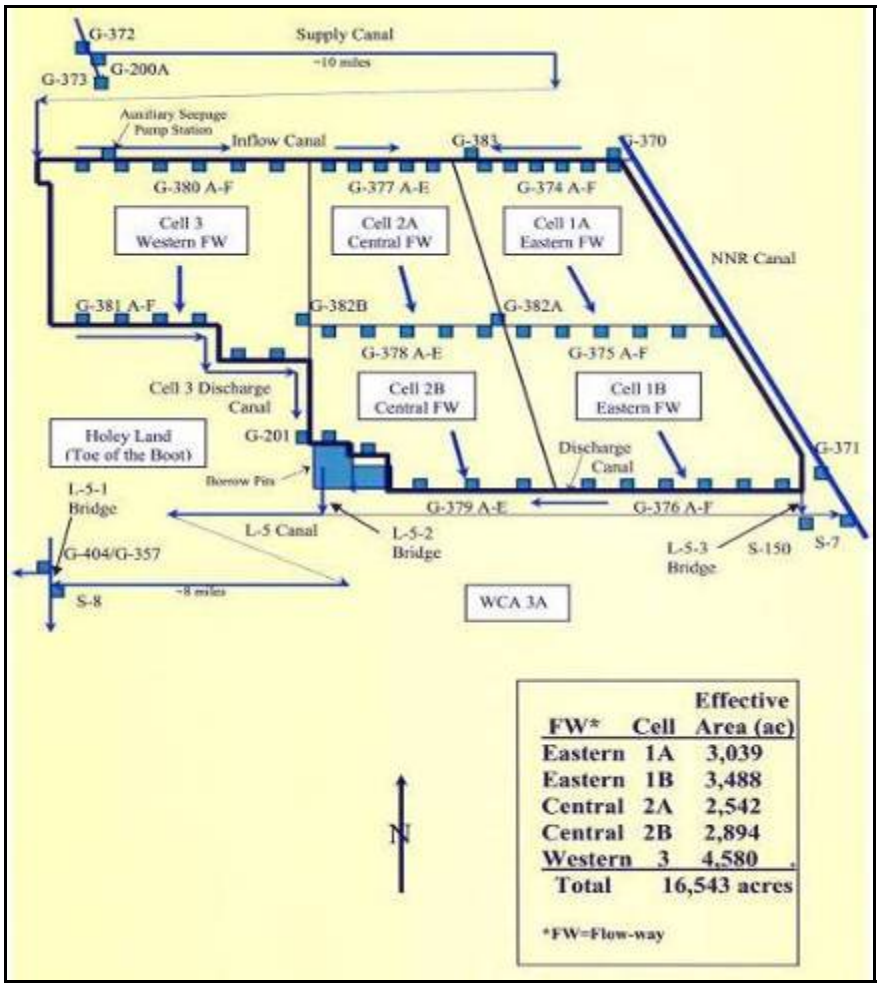
An uncontrolled orifice type spillway will be integral with the northeast gate structure near the northeast pump station. The crest will be set at an elevation of 21 NAVD88 and the orifice will be sized to limit discharges to 20 cfs per square mile (CSM) with a depth of flow over the crest of two feet. The spillway will discharge to the headwater canal for the northeast pump station and discharges will flow to the NNRC.

7.3.6 STA-3/4 Gate Structures

STA 3/4 will receive water directly from the NNRC and Miami Canal via G-370 and G-372 pump stations, respectively. A schematic of STA-3/4 structures is provided for informational purposes on Figure 7.3-2. Tables 7.3-5 and 7.3-6 provide details of the STA-3/4 gate structures.

The Project Operating Manual for STA-3/4 is not included in this POM.

Figure 7.3-2 Schematic of STA-3/4 Structures



(Not to scale)

Table 7.3-5 Supply Control Structures G-374, G-377, and G-380

Control Structure Description	G-374 A-F[1]	G-377 A-E	G-380 A-F
Number of Culverts	6	5	6
Culvert / Gate Size (H x W)	8 feet x 10 feet	9 feet x 10 feet	7 feet x 7 feet
Culvert Length (including wingwalls)	115 feet	115 feet	111 feet
Culvert Invert	0.6 feet NAVD88	-0.4 NAVD88	1.6 NAVD88
Design Inflow (each culvert)	362 cfs	396 cfs	282 cfs
Design Maximum Headwater Elevation	13.5 NAVD88	13.5 NAVD88	13.7 NAVD88
Design Low Water (Headwater) Elevation	9.6 NAVD88	9.6 NAVD88	9.6 NAVD88
Standard Project Storm (Headwater) Elevation	16.6 NAVD88	16.6 NAVD88	16.6 NAVD88
Design Maximum Tailwater Elevation	13.0 NAVD88	13.0 NAVD88	12.6 NAVD88
Design Low Water (Tailwater) Elevation	9.2 NAVD88	9.5 NAVD88	9.6 NAVD88
Standard Project Storm (Tailwater) Elevation	16.0 NAVD88	16.0 NAVD88	15.6 NAVD88
Headwater/Tailwater Data Via Telemetry	G-374 B & E	G-377 B & D	G-380 B & E

[1]Control Structure Descriptions are illustrated in Figure 7.3-1
cfs = cubic feet per second

Table 7.3-6 Control Structure G-383

Control Structure Description	G-383
Number of Culverts	2
Culvert / Gate Size (H x W)	10 feet x 10 feet
Culvert Length (Including Wingwalls)	114 feet
Culvert Invert	-1.4 NAVD88
Design Inflow (Each Culvert)	735 cfs[1]
Design Maximum Water Elevation	13.6 NAVD88
Design Low Water Elevation	9.6 NAVD88
Standard Project Storm Elevation	16.6 NAVD88
Maximum Differential Head	1.4 feet
Headwater/Tailwater Data Via Telemetry	G-374 E and G-377 B

[1]cfs = cubic feet per second

7.3.7 Removed Features

7.3.7.1 Auxiliary Seepage Pump Station

Existing facilities for an auxiliary pump station located in the western section of the Supply Canal near control structure G-380E include two-42 inch diameter steel discharge pipes and an equipment pad for installation of District furnished portable hydraulic pumps. It was expected that this pump station could be activated if seepage rates from the Supply Canal exceeded the capability of the G-370 and G-372 pump stations to maintain desired seepage canal levels. The existing seepage canal in this area will be eliminated with the construction of Reservoir, and therefore, these facilities will no longer be needed.

7.3.8 Operational Interaction of Project Features

The Reservoir will primarily store regulatory releases from LOK. When the Reservoir is full, storm runoff will be delivered to the STA- 3/4 as it was prior to construction of the Reservoir. During periods when the LOK water level is low and there is storage available in Reservoir, and depending upon hydrologic conditions and seasonal outlook, storm water runoff may also be captured in Reservoir. The storage of excess stormwater that can be sent to STA-3/4 at a later time will improve the quantity, timing, and distribution of water dedicated and managed for the natural system. In addition, storage of storm runoff will reduce flooding and provide water, which would otherwise have passed to tide, that can be released for agricultural purposes.

Factors which will impact operating decisions include:

- Water level in the Reservoir
- LOK water level
- Availability of water in the NNRC and Miami Canal
- Desired operating level in STA-3/4
- Impending or existing hydrologic conditions
- Environmental deliveries needed
- Agricultural deliveries needed
- Water availability from other watersheds

For normal operating conditions, the northeast pump station will be utilized to pump LOK regulatory releases into the reservoir and G-370 and G372 pump stations will be utilized to pump storm runoff into the STA-3/4. When the Reservoir is full, LOK regulatory releases will be pumped into STA-3/4 from G-370 and G372 pump stations when there is little or no storm runoff. When environmental deliveries are required when there is little or no runoff and water is available in Reservoir, water will be released from Reservoir through the southeast and southwest gate structures into the Supply Canal for distribution to STA-3/4.

The Reservoir will provide water for agricultural deliveries by storing LOK regulatory releases and by capturing runoff that would otherwise have gone to tide. Agricultural deliveries that cannot be met by the Reservoir will continue to be supplied from LOK. When water is available in the Reservoir for agriculture deliveries, it will normally be released through the northeast gate structure located near the northeast pump station from where it will flow to the NNRC via the

connector canal for the pump station. When the Reservoir water level is below that needed for gravity flow to the NNRC, pumps located adjacent to the northeast pump station will be activated.

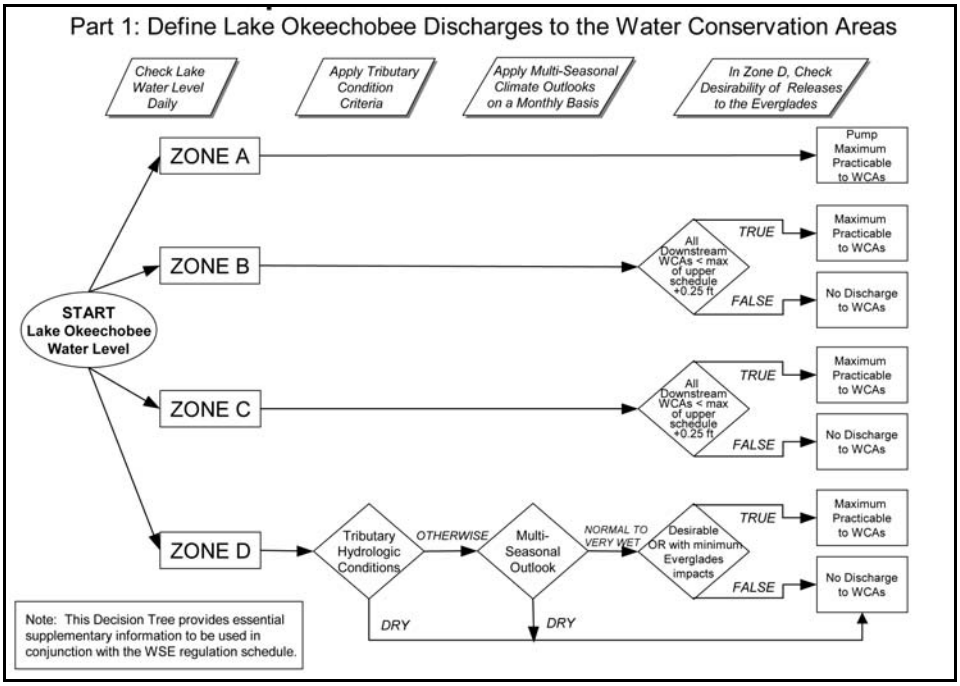
7.4 OPERATIONAL STRATEGY TO MEET PROJECT OBJECTIVES

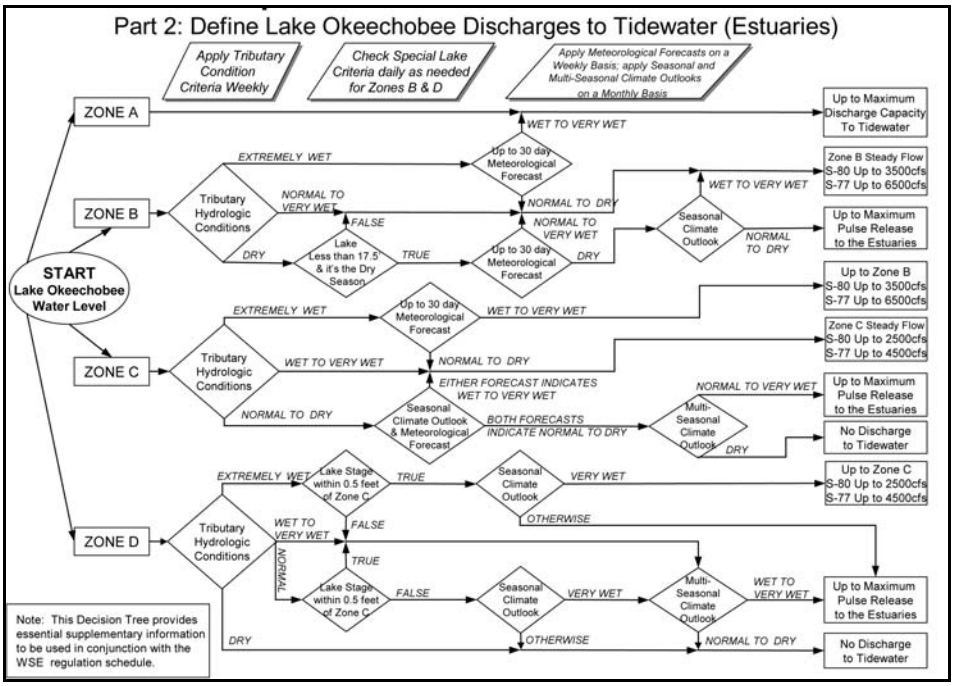
The Draft POM for the Reservoir will be modified and revised, as necessary, through several Project phases. During the detailed design phase, the POM will be modified to define any temporary operations to be used during construction including startup and filling. The POM for STA-3/4 will also be modified as required to reflect operations during periods when construction along and within the embankments for the Supply Canals could disrupt operations.

Knowledge gained from the Operational Testing and Monitoring Phase will then be incorporated into the POM, which will be coordinated with District and the USACE South Atlantic Division (SAD), and will supersede all other iterations of the Draft Operating Plan. The final version of the Draft Operating Plan will be used by District when they accept responsibility for long-term operations of the Reservoir.

The current LOK regulation schedule indicates that when the LOK elevation is in zones A, B, or C, releases are made per the USACE's WSE Decision Trees (Figure 7.4-1). The construction of Reservoir will allow LOK regulation discharges to be released to Reservoir when storage is available, rather than to the estuaries of the Caloosahatchee and St. Lucie Rivers. During wet conditions, runoff captured by the NNRC and Miami Canal will be stored in the Reservoir when capacity is available. This stored water will be used to supplement agricultural water use in the NNRC basin, and to deliver water to the environment. The need to back pump water to LOK will also be reduced and overall flood protection will be enhanced.

Figure 7.4-1 WSE Operational Guidelines Decision Trees





source: http://www.saj.usace.army.mil/h2o/lib/documents/WSE/wsedectree.pdf

7.5 PROJECT RELATIONSHIPS AND INTERACTIONS

Operation of the Reservoir and associated structures is linked to the operation of STA-3/4. Before the new facilities are in place, some modifications to the Operating Plan for STA-3/4 will be required to incorporate the Reservoir's storage capability for dry weather releases and for potential decreased stormwater flows to STA-3/4 during Reservoir filling operations.

Other systems downstream from the STA-3/4, including the WCA-3A Everglades Protection Area may also impact operation of the Reservoir system.

7.6 MAJOR CONSTRAINTS

Constraints to the operation of the Reservoir system include the availability of water in the NNRC and Miami Canal, water availability from LOK, the requirement of maintaining a minimum water elevation in the Supply Canal to maintain minimum stages in STA-3/4 cells, and the varying agricultural deliveries.

During drought conditions, sufficient water may not be available to completely fill the Reservoir on an annual basis, resulting in potential decreased capacity to maintain environmental deliveries and agricultural deliveries during the dry season.

Since pumping to the Reservoir will occur mostly during the wet season, (LOK regulatory releases may also be sent to the Reservoir during the wet season), operation of STA-3/4 during those periods will dictate how much of the total canal flow will be available for storage. Likewise, environmental and agricultural deliveries may conflict, and therefore, constrain the distribution of the stored water for those purposes.

Minimum operating levels for both the Supply Canal and NNRC will prevent gravity releases from the Reservoir when the Reservoir operating water level is low.

7.7 STANDING INSTRUCTIONS TO PROJECT OPERATORS

Once the operational testing and monitoring phase of components of Reservoir has been completed, District will be responsible for the day-to-day water management operations. During normal conditions, the Reservoir water control structures shall be operated in accordance with the approved Operating Manual for the Reservoir. Standing instructions will be drafted during the detailed design phase and finalized during the construction phase.

7.8 OPERATIONS TO MEET PROJECT PURPOSES

7.8.1 Achieving Natural System Goals, Objectives, and Benefits

Currently, when the LOK elevation is in zone A, B, C, or D (as illustrated in Figure 7.4-1 above), regulatory releases are made through the St. Lucie Canal and the Caloosahatchee River which flow to estuaries downstream. These releases from LOK have resulted in declines in aquatic vegetation and oyster populations. Upon completion of Reservoir, a portion of the flow that would otherwise have gone to the St. Lucie Canal and the Caloosahatchee River will be sent to Reservoir. When water levels in the primary canals reach predetermined levels, the G-370, G-372, and the new northeast pump stations will be operated to pump the released waters to the Reservoir. Stored water can later be released to the Supply Canal for environmental deliveries when the Reservoir water level exceeds the minimum Supply Canal water level. When the Reservoir water level is below the minimum water level for the Supply Canal, water may be released through the northeast gate structure into the NNRC from where it can be lifted into the Supply Canal by the G-370 pump station. When appropriate, G-370 and G-372 pump stations can also pump LOK releases directly to the Supply Canals for environmental deliveries.

7.9 FLOOD DAMAGE REDUCTION

7.9.1 Normal and Emergency Operations

For normal operating conditions, the northeast pump station will be utilized to pump LOK regulatory releases into the Reservoir and G-370 and G372 pump stations will be utilized to pump storm runoff into the STA-3/4. When the Reservoir is full, LOK regulatory releases will be pumped into STA-3/4 from G-370 and G372 pump stations when there is little or no storm runoff. When environmental deliveries are required or when there is little or no runoff and water is available in Reservoir, water will be released from Reservoir through the southeast and southwest gate structures into the Supply Canal for distribution to STA-3/4.

7.9.2 Hurricane or Tropical Storm Operations

The hurricane season occurs each year from June 1 through November 30. When there are tropical depressions, tropical storms, and/or hurricanes in the Atlantic/Caribbean Basin or the Gulf Coast of Florida, the National Hurricane Center issues public advisories, forecast advisories, forecast discussions, and strike probability forecasts.

Water management operations within the Reservoir during hurricanes or tropical storms should follow District Emergency Preparedness Manual Suggested Hurricane Operation Procedures, April 2004. The USACE, Jacksonville District, Emergency Operations Standard Operating Procedures document (CESAJ SOP 500-1-1) should be consulted for emergency preparation and actions.

7.9.3 Reservoir Emergency Overflow/Uncontrolled Discharge

An uncontrolled orifice type spillway will be constructed as described in this Operating Manual under Proposed Features, including any required provisions for operating the Reservoir to avoid re-suspension of phosphorus.

7.10 WATER QUALITY

Additional operational procedures to improve water quality will be developed during the detailed design phase of the Reservoir Project and will be included in the final Operating Manual. This includes any required operating provisions to avoid re-suspension of phosphorus.

7.11 WATER SUPPLY OPERATIONS

During dry conditions when water is needed for agricultural deliveries, and the Reservoir level is above 11.5 NAVD88, the northeast gate structure can be opened as necessary to allow gravity discharge to supply agricultural deliveries to the NNRC. When the Reservoir water level is below that elevation, provisions will be available at the northeast pump station to pump water from Reservoir back to the NNRC.

If environmental deliveries are needed and the water level in the Reservoir is above the water level in the Supply Canal, water can be released through the southeast and southwest gates. If the Reservoir water level is less than the required water level in the Supply Canal, water can be released through the northeast gate structure near the northeast pump station, or pumped from the northeast pump station to the NNRC and then pumped by G-370 pump station from the NNRC into the Supply Canal. G-383 gate structure would be opened to allow flow to the western flow ways.

7.12 RECREATION

Activities such as fishing and boating will be permitted at the discretion of the District. No special operations will be required.

7.13 FISH AND WILDLIFE

Existing canals within the Reservoir site, along with borrow canals and quarry areas, will provide deep-water refugia. In addition, littoral shelves will be incorporated along the seepage canal. No special operations will be required.

7.14 PRESTORM/STORM OPERATION

If there is unused storage capacity in the Reservoir, the preferred operating mode will be to maximize pumping into the Reservoir during storm events. This operation would decrease the impact of high flow stormwater events on STA-3/4. If the northeast pump station is operating to full capacity and the NNRC has excess flow, G-370 pump station will be activated to pump into the Reservoir or directly into STA-3/4.

If a heavy rainfall is forecasted by the National Weather Service Advisories and the District, a pre-storm drawdown of Reservoir may be initiated to increase available storage capacity. Storage may be created by discharging to the NNRC through the northeast gate structure or to the Supply

Canal through the southeast and southwest gate structures. The ability to discharge to either the environment or to the NNRC will be a function of the water depths and flows at the time.

If the Reservoir exceeds the normal maximum operating pool as the result of a storm, operations would include drawdown of the Reservoir by releasing water to STA-3/4 and/or NNRC in order to bring the water level back to the normal maximum operating pool.

7.15 CONSISTENCY WITH THE IDENTIFICATION OF WATER RESERVATIONS OR ALLOCATIONS FOR THE NATURAL SYSTEM

Certain Reservoir Project assurances analyses are not yet complete. This section will be updated during the detailed design phase. The appropriate quantity, timing, and distribution of water for the natural system and other water related needs will be identified in the PIR.

The Reservoir will store some runoff that would otherwise have gone to tide and will improve the timing and distribution of water deliveries to the environment. It has been demonstrated using an area specific computer model and POS data from the SFWMM (which is the same as the EPC 2010 and 2015 version 5.4.2), that more than 600,000 acre-feet per year can be delivered to the environment by the Reservoir. Operating criteria for Reservoir will be developed in subsequent versions of this manual to be consistent with the water reservations or allocations for the natural system made by the State in accordance with Section 373.1501(5) F.S.

7.16 CONSISTENCY WITH SAVING CLAUSE AND STATE ASSURANCES PROVISIONS

During periods when Reservoir contains water and it is necessary to prevent seepage from impacting adjacent properties, the seepage canal water level can be pumped down as required to prevent the groundwater level from rising. A groundwater model has been utilized to verify that depressing the seepage canal will be effective in preventing flooding of adjacent properties.

The Reservoir will provide capacity for storage of LOK regulatory releases and some storm runoff and will increase the pumping capacity from the NNRC. In addition, the area occupied by the Reservoir previously used for agriculture will no longer deliver runoff to the NNRC, thereby making available 500 cfs of NNRC capacity that was previously unavailable. Therefore, the Project will not diminish flood protection and should reduce flooding in the NNRC.

The Project will store some runoff that would otherwise have gone to tide and will, therefore, provide water for agricultural uses during the dry season. It has been demonstrated using an area specific computer model that a high percentage of the agricultural deliveries along the NNRC can be provided by Reservoir.

A berm will be constructed outside of the seepage canal and any runoff between the berm and the Reservoir embankment will be collected in the seepage canal and delivered to the Reservoir.

7.17 DROUGHT CONTINGENCY PLAN

During a drought in the Reservoir Project area, operations will be in accordance with District Rules, Chapter 40E-21, F.A.C., Water Shortage Plan.

7.18 FLOOD EMERGENCY ACTION PLAN

The Flood Emergency Action Plan will be completed for the Reservoir prior to completion of construction. The Flood Emergency Action Plan to be developed should be consulted for related

emergency preparation and action. Local emergency management offices will be provided copies of the Flood Emergency Action Plan as necessary. This plan may be used to supplement Hurricane or Tropical Storm Regulations. As outlined in USACE Engineering Regulation 1130-2-530, the Flood Emergency Action Plan shall include:

- A written Emergency Notification Procedure for serious abnormal conditions to provide for safety of people in the vicinity of the Reservoir area and also to trigger immediate response for remedial assistance to the embankment and water control structures
- A description or list of conditions leading to emergency situations and ways of dealing with them should they occur
- Storage area dewatering procedures
- Embankment and water control structure failure inundation maps
- Listing of location, types, and quantity of emergency repair materials and equipment
- Details outlining responsibilities for inspection and execution of emergency repairs
- List of contractors available within a reasonable distance of the Reservoir

7.19 DEVIATIONS FROM NORMAL OPERATING CRITERIA

The USACE District Commander is occasionally requested by the non-Federal sponsor to approve deviations from normal operation criteria. Prior approval for a deviation is required from USACE-SAD except as noted in paragraphs below. Deviation requests usually fall into the following categories:

7.19.1 Emergencies

Emergencies that can be expected include water recreation related accidents such as drowning or boating accidents, failure of Reservoir facilities, and flushing of pollutants. Water control actions necessary to abate the problems should be implemented immediately unless such action would create worse conditions. The USACE-SAD office must be informed of the problem and the emergency operating changes as soon as practical. In addition, the non-Federal sponsor, the State of Florida (Florida Department of Environmental Protection and District), and the U.S. Department of the Interior should be informed.

7.19.2 Unplanned Minor Deviations

There are unplanned instances that create a temporary need for minor deviations from the normal operating criteria, although they are not considered emergencies. Construction accounts for the major portion of incidents requiring minor deviations. Deviations are also sometimes necessary to carry out the maintenance and inspection of facilities. Request for changes in release rates generally involve time periods ranging from a few days to a few weeks. Each request should be analyzed on its own merits. In evaluating the proposed deviation, consideration must be given to low flow requirements, fish and wildlife, water rights, roles of the USACE and the District, short-term release scheduling, long-range release planning, and storage utilization (seasonal commingled, joint use).

7.20 SEEPAGE CONTROL

The Reservoir will be constructed immediately north of the existing Supply Canal. The embankment for the Reservoir will be constructed over the existing seepage canal along the north side of the Supply Canal. Therefore, the existing seepage pumps in G-370 pump station will not serve their original purpose but will be connected to the seepage canal along the east side of the Reservoir.

New seepage canals will be constructed along the northern and western sides of the Reservoir and will convey seepage to the new northeast pump station. Seepage pumps in that facility will be designed to pump the seepage flow back into the Reservoir

7.21 INITIAL RESERVOIR/TREATMENT AREA FILLING PLAN

The Initial Storage Filling Plan (ISFP) is defined as a deliberate impoundment of water to meet Project purposes and is a continuing process as successively higher water levels are attained. The initial Reservoir filling is the first opportunity to test whether the containing embankments and water control structures will perform as designed. To monitor this performance, the rate of filling will be controlled to the extent feasible to allow as much time as needed for implementation of a predetermined monitoring program, including the observation and analysis of instrumentation data. Information furnished in the ISFP will generally be concerned with action that can be taken without a significant impact to Project purposes, provided no unsafe conditions are observed. An ISFP will be developed during design and construction. The ISFP will include but is not limited to the following:

- Preferred filling rate and the available options to control the rate of filling, as well as the consequences of operation with the prime objective of controlling the rate of Reservoir water level rise
- The most likely type of problem(s) that may develop during initial filling and the monitoring necessary to detect those problems
- A description of the proposed hydrologic data collection and transmission system, and a plan for reading the instruments and evaluating the data with regard to the filling plan
- A plan for inspecting the embankment and downstream areas prior to and during filling, including the relationship between frequency of inspection and rate of pool rise
- Instructions for observers on conditions that require immediate attention of personnel authorized to make emergency decisions. Clearly identify who is responsible for decisions and how they can be contacted. Alternative decision makers should be identified
- An emergency plan listing responsibilities, name and/or positions, telephone numbers, pager numbers, and radio frequencies to be used
- Water quality requirements, if any, for the initial filling

7.22 WATER CONTROL DATA ACQUISITION SYSTEM PLAN

The remote automation components installed at the pump stations and other structures are remote terminal units (RTU) and a communication channel to the District control center. The access for the RTU to the control center is via field interface units (FIU). The automation components of all pump stations and structures that will eventually be operated and maintained by the District will conform to District standards.

7.23 CONSISTENCY WITH THE ADAPTIVE MANAGEMENT PROGRAM AND PERIODIC CERP UPDATES

After initiation of long-term operations and maintenance of the Reservoir, the Operating Manual may be further modified based on operating criteria approved by the USACE and the District that results from CERP updates and/or recommendations from the adaptive assessment process as outlined in Guidance Memorandum Number 6 of the Programmatic Regulations.

8.0 LIST OF DRAWINGS

The following proposed drawing list is a compilation of the drawings expected to be included for the Final Detailed Design of the Reservoir pump station, control structures, and U.S. 27 Bridges.

General

Sheet Number	Drawing Number	Sheet Title
1.	G-1	Cover Sheet
2.	G-2	Sheet List
3.	G-2	Legend & Abbreviations
4.	G-4	Project Location Plan
5.	G-5	Horizontal and Vertical Control

Civil

Sheet Number	Drawing Number	Sheet Title
6.	C-01	Structure S-602 Site Plan
7.	C-02	Structure S-603 Site Plan
8.	C-03	Pump Station/Connector Channel Site Plan
9.	C-04	U.S. 27 Bridge Site Plan
10.	C-05	Pump Station Site Plan
11.	C-06	Pump Station Access Road and Drainage
12.	C-07	Pump Station Access Road and Drainage
13.	C-08	Structure S-602, S-603 Access Road
14.	C-09	Pump Station and S-609 Excavation Plan
15.	C-10	Pump Station and S-609 Excavation Sections
16.	C-11	Structures S-602 and S-603 Excavation Plan
17.	C-12	Structure S-602 Excavation Sections
18.	C-13	Structure S-603 Excavation Sections
19.	C-14	Pump Station Retaining Wall Plan
20.	C-15	Structure S-609 Retaining Wall Plan
21.	C-16	Structure S-602 Retaining Wall Plan
22.	C-17	Structure S-603 Retaining Wall Plan
23.	C-18	Retaining Wall Sections
24.	C-19	Retaining Wall Sections
25.	C-20	Retaining Wall Sections
26.	C-21	Retaining Wall Sections

Sheet Number	Drawing Number	Sheet Title
27.	C-22	Retaining Wall Details
28.	C-23	Retaining Wall Details
29.	C-24	Retaining Wall Details
30.	C-25	Cross Section at Main Pumps
31.	C-26	Pump Station Longitudinal Sections
32.	C-27	Structure S-602 Sections
33.	C-28	Structure S-603 Sections
34.	C-29	Typical Canals Cross Sections
35.	C-30	Access Ramp Cross Sections
36.	C-31	Access Road Details
37.	C-32	Boat Ramp Details
38.	C-33	Stilling Well Details
39.	C-34	Drop Inlet Details
40.	C-35	Septic System Details
41.	C-36	Sampler System Details
42.	C-37	Civil Details
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01200	Project Meetings and Reports
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The South Florida Water Management District's Engineering Design Standards for Water Resource Facilities Technical Specifications will be supplemented by Black & Veatch standard specifications where indicated with bold font.

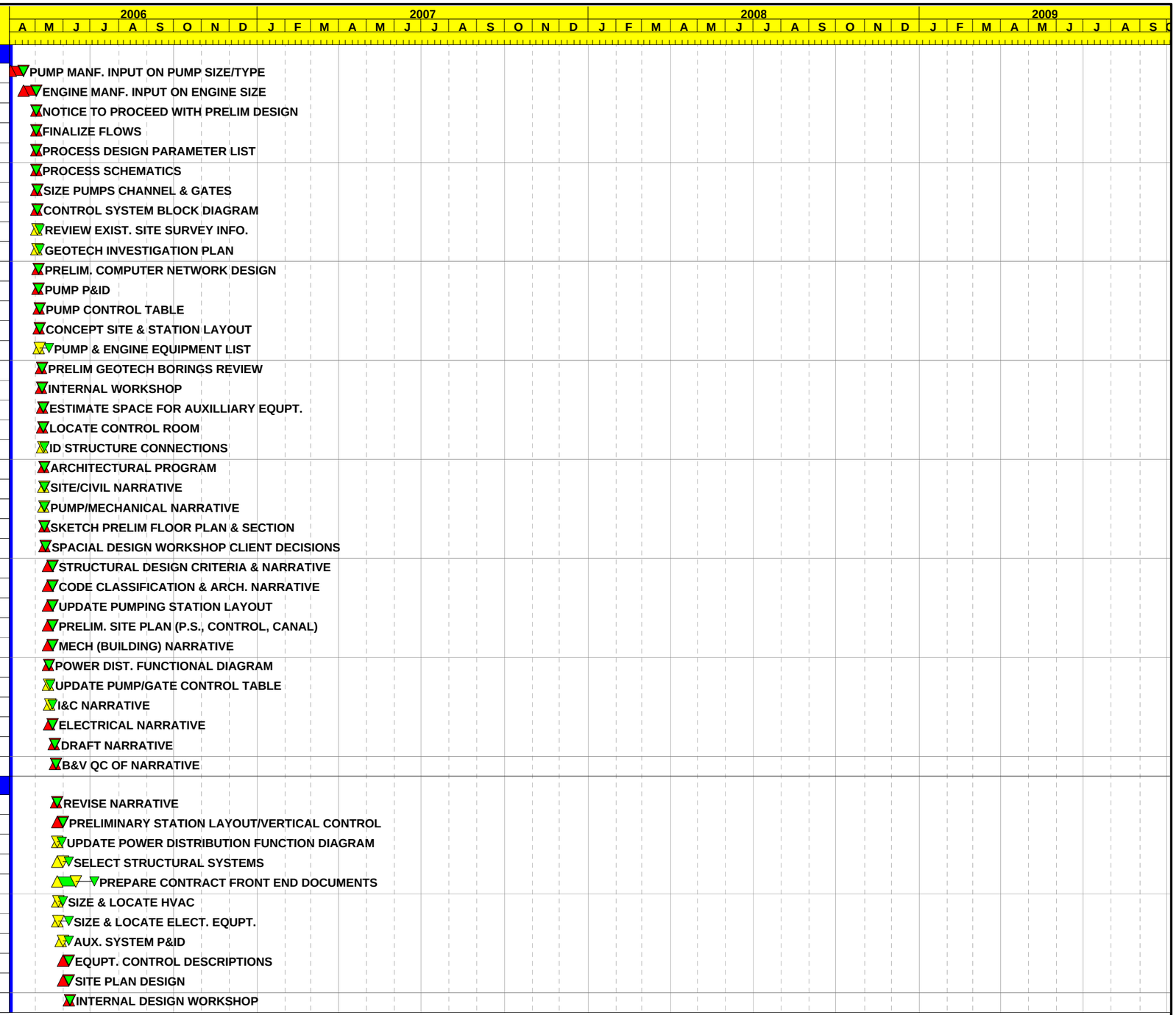
10.0 OPINION OF PROBABLE COST

The Opinion of Probable Cost is a completely separate document that is not included as part of this Preliminary Design Report.

11.0 CONSTRUCTION SCHEDULE

The updated Construction Schedule for the Pump Station, control structure and U.S. 27 Bridges is found on the following five pages.

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Pump Sta.& Control Struct. Preliminary Design						
CD01	PUMP MANF. INPUT ON PUMP	10	10	0	04APR06	17APR06
CD04	ENGINE MANF. INPUT ON ENGINE	10	10	0	18APR06	01MAY06
PD00	NOTICE TO PROCEED WITH PRELIM	1	1	0	02MAY06	02MAY06
PD01	FINALIZE FLOWS	1	1	0	02MAY06	02MAY06
PD02	PROCESS DESIGN PARAMETER LIST	1	1	0	02MAY06	02MAY06
PD06	PROCESS SCHEMATICS	1	1	0	02MAY06	02MAY06
PD07	SIZE PUMPS CHANNEL & GATES	1	1	0	03MAY06	03MAY06
PD08	CONTROL SYSTEM BLOCK DIAGRAM	1	1	0	03MAY06	03MAY06
PD04	REVIEW EXIST. SITE SURVEY INFO.	1	1	0	03MAY06	03MAY06
PD05	GEOTECH INVESTIGATION PLAN	1	1	0	03MAY06	03MAY06
PD09	PRELIM. COMPUTER NETWORK	1	1	0	04MAY06	04MAY06
PD12	PUMP P&ID	1	1	0	04MAY06	04MAY06
PD03	PUMP CONTROL TABLE	1	1	0	05MAY06	05MAY06
PD19	CONCEPT SITE & STATION LAYOUT	1	1	0	05MAY06	05MAY06
PD16	PUMP & ENGINE EQUIPMENT LIST	1	1	0	05MAY06	05MAY06
PD15	PRELIM GEOTECH BORINGS	1	1	0	08MAY06	08MAY06
PD20	INTERNAL WORKSHOP	1	1	0	08MAY06	08MAY06
PD22	ESTIMATE SPACE FOR AUXILLIARY	1	1	0	09MAY06	09MAY06
PD23	LOCATE CONTROL ROOM	1	1	0	09MAY06	09MAY06
PD21	ID STRUCTURE CONNECTIONS	1	1	0	09MAY06	09MAY06
PD24	ARCHITECTURAL PROGRAM	1	1	0	10MAY06	10MAY06
PD26	SITE/CIVIL NARRATIVE	1	1	0	10MAY06	10MAY06
PD27	PUMP/MECHANICAL NARRATIVE	1	1	0	10MAY06	10MAY06
PD28	SKETCH PRELIM FLOOR PLAN &	1	1	0	11MAY06	11MAY06
PD29	SPACIAL DESIGN WORKSHOP	1	1	0	12MAY06	12MAY06
PD30	STRUCTURAL DESIGN CRITERIA &	5	5	0	15MAY06	19MAY06
PD32	CODE CLASSIFICATION & ARCH.	5	5	0	15MAY06	19MAY06
PD34	UPDATE PUMPING STATION LAYOUT	5	5	0	15MAY06	19MAY06
PD37	PRELIM. SITE PLAN (P.S., CONTROL,	5	5	0	15MAY06	19MAY06
PD41	MECH (BUILDING) NARRATIVE	5	5	0	15MAY06	19MAY06
PD49	POWER DIST. FUNCTIONAL	2	2	0	15MAY06	16MAY06
PD38	UPDATE PUMP/GATE CONTROL	1	1	0	15MAY06	15MAY06
PD42	I&C NARRATIVE	2	2	0	16MAY06	17MAY06
PD40	ELECTRICAL NARRATIVE	3	3	0	17MAY06	19MAY06
PD39	DRAFT NARRATIVE	1	1	0	22MAY06	22MAY06
PD43	B&V QC OF NARRATIVE	1	1	0	23MAY06	23MAY06
Pump Station and Control Structures 30% Design						
DDC101	REVISE NARRATIVE	1	1	0	24MAY06	24MAY06
DDC108	PRELIMINARY STATION	5	5	0	25MAY06	31MAY06
DDC103	UPDATE POWER DISTRIBUTION	1	1	0	25MAY06	25MAY06
DDC105	SELECT STRUCTURAL SYSTEMS	5	5	0	25MAY06	31MAY06
DDC104	PREPARE CONTRACT FRONT END	15	15	0	25MAY06	14JUN06
DDC106	SIZE & LOCATE HVAC	1	1	0	26MAY06	26MAY06
DDC107	SIZE & LOCATE ELECT. EQUPT.	1	1	0	26MAY06	26MAY06
DDC110	AUX. SYSTEM P&ID	3	3	0	29MAY06	31MAY06
DDC109	EQUPT. CONTROL DESCRIPTIONS	5	5	0	01JUN06	07JUN06
DDC112	SITE PLAN DESIGN	5	5	0	01JUN06	07JUN06
DDC113	INTERNAL DESIGN WORKSHOP	1	1	0	08JUN06	08JUN06



Start Date	04APR06
Finish Date	16JUN09
Data Date	04APR06
Run Date	17JUL06 08:41

Early Bar
Float Bar
Progress Bar
Critical Activity

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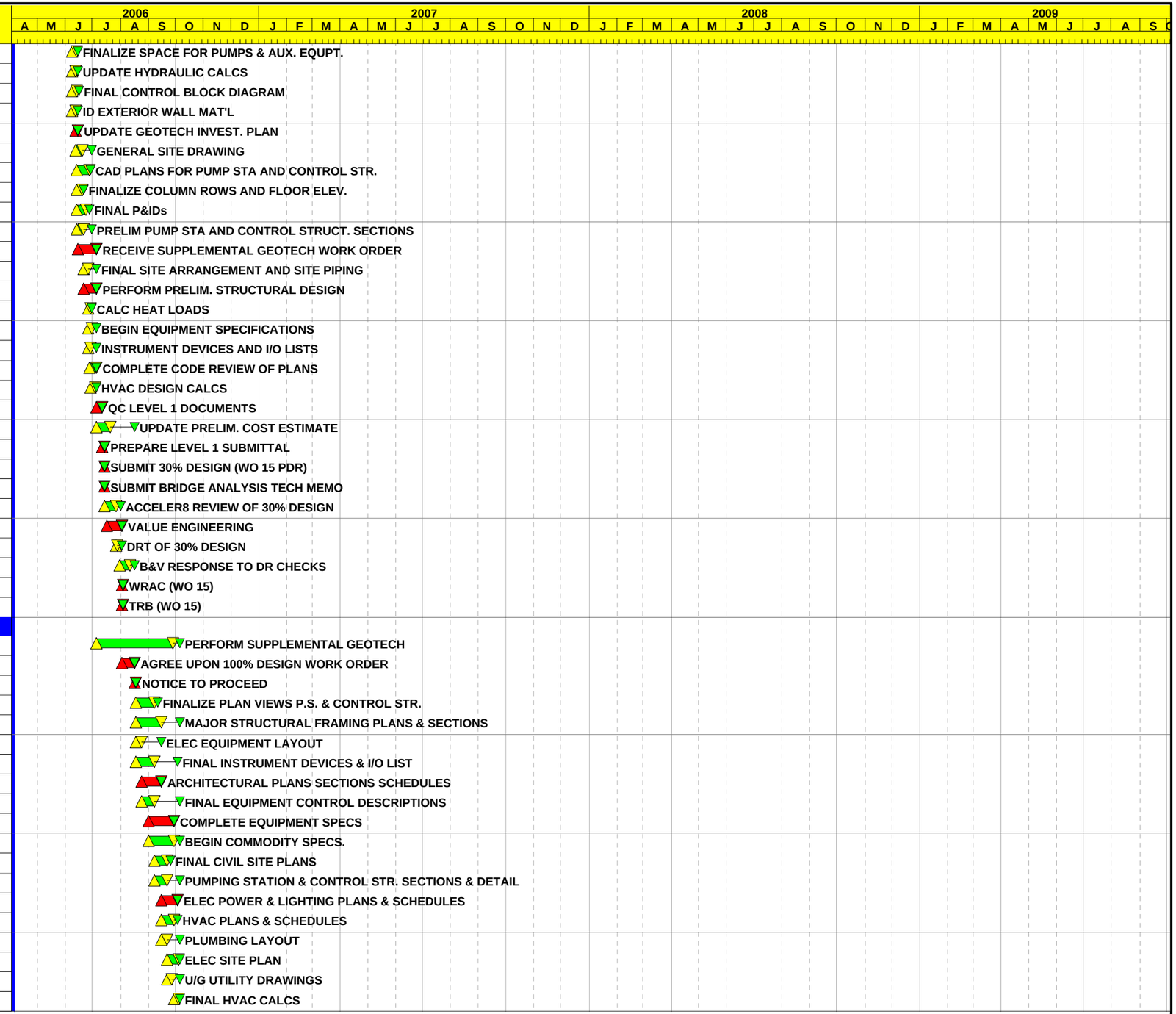
EAA RESERVOIR A-1

Pump Station, Control Structures, and U.S. 27 Bridges

30% Submittal Schedule Update

Date	Revision	Checked	Approved
15JUL06	30% Submittal Schedule Update	KMN	JET

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
DDC115	FINALIZE SPACE FOR PUMPS & AUX.	3	3	0	09JUN06	13JUN06
DDC114	UPDATE HYDRAULIC CALCS	2	2	0	09JUN06	12JUN06
DDC116	FINAL CONTROL BLOCK DIAGRAM	3	3	0	09JUN06	13JUN06
DDC118	ID EXTERIOR WALL MAT'L	2	2	0	09JUN06	12JUN06
DDC119	UPDATE GEOTECH INVEST. PLAN	2	2	0	13JUN06	14JUN06
DDC117	GENERAL SITE DRAWING	5	5	0	13JUN06	19JUN06
DDC126	CAD PLANS FOR PUMP STA AND	10	10	0	14JUN06	27JUN06
DDC120	FINALIZE COLUMN ROWS AND	4	4	0	14JUN06	19JUN06
DDC125	FINAL P&IDs	8	8	0	14JUN06	23JUN06
DDC123	PRELIM PUMP STA AND CONTROL	5	5	0	14JUN06	20JUN06
DDC122	RECEIVE SUPPLEMENTAL GEOTECH	15	15	0	15JUN06	05JUL06
DDC128	FINAL SITE ARRANGEMENT AND	4	4	0	21JUN06	26JUN06
DDC124	PERFORM PRELIM. STRUCTURAL	10	10	0	22JUN06	05JUL06
DDC138	CALC HEAT LOADS	3	3	0	26JUN06	28JUN06
DDC130	BEGIN EQUIPMENT SPECIFICATIONS	5	5	0	26JUN06	30JUN06
DDC121	INSTRUMENT DEVICES AND I/O	3	3	0	26JUN06	28JUN06
DDC127	COMPLETE CODE REVIEW OF	5	5	0	28JUN06	04JUL06
DDC137	HVAC DESIGN CALCS	3	3	0	29JUN06	03JUL06
DDC129	QC LEVEL 1 DOCUMENTS	4	4	0	06JUL06	11JUL06
DDC132	UPDATE PRELIM. COST ESTIMATE	11	11	0	06JUL06	20JUL06
DDC136	PREPARE LEVEL 1 SUBMITTAL	2	2	0	12JUL06	13JUL06
DDC150	SUBMIT 30% DESIGN (WO 15 PDR)	1	1	0	14JUL06	14JUL06
DDC152	SUBMIT BRIDGE ANALYSIS TECH	1	1	0	14JUL06	14JUL06
DDC141	ACCELER8 REVIEW OF 30% DESIGN	10	10	0	14JUL06	27JUL06
DDC154	VALUE ENGINEERING	13	13	0	17JUL06	02AUG06
DDC156	DRT OF 30% DESIGN	1	1	0	28JUL06	28JUL06
DDC158	B&V RESPONSE TO DR CHECKS	10	10	0	31JUL06	11AUG06
DDC160	WRAC (WO 15)	1	1	0	03AUG06	03AUG06
DDC162	TRB (WO 15)	1	1	0	03AUG06	03AUG06
Pump Station and Control Structure 60% Design						
DDC211	PERFORM SUPPLEMENTAL	60	60	0	06JUL06	27SEP06
DDC200	AGREE UPON 100% DESIGN WORK	10	10	0	03AUG06	16AUG06
DDC202	NOTICE TO PROCEED	1	1	0	17AUG06	17AUG06
DDC203	FINALIZE PLAN VIEWS P.S. &	15	15	0	18AUG06	07SEP06
DDC207	MAJOR STRUCTURAL FRAMING	20	20	0	18AUG06	14SEP06
DDC222	ELEC EQUIPMENT LAYOUT	4	4	0	18AUG06	23AUG06
DDC205	FINAL INSTRUMENT DEVICES & I/O	15	15	0	18AUG06	07SEP06
DDC204	ARCHITECTURAL PLANS SECTIONS	15	15	0	25AUG06	14SEP06
DDC201	FINAL EQUIPMENT CONTROL	10	10	0	25AUG06	07SEP06
DDC213	COMPLETE EQUIPMENT SPECS	20	20	0	01SEP06	28SEP06
DDC214	BEGIN COMMODITY SPECS.	20	20	0	01SEP06	28SEP06
DDC208	FINAL CIVIL SITE PLANS	10	10	0	08SEP06	21SEP06
DDC215	PUMPING STATION & CONTROL STR.	10	10	0	08SEP06	21SEP06
DDC212	ELEC POWER & LIGHTING PLANS &	12	12	0	15SEP06	02OCT06
DDC219	HVAC PLANS & SCHEDULES	10	10	0	15SEP06	28SEP06
DDC209	PLUMBING LAYOUT	5	5	0	15SEP06	21SEP06
DDC221	ELEC SITE PLAN	8	8	0	22SEP06	03OCT06
DDC228	U/G UTILITY DRAWINGS	3	3	0	22SEP06	26SEP06
DDC225	FINAL HVAC CALCS	3	3	0	29SEP06	03OCT06



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Early Bar
Float Bar
Progress Bar
Critical Activity

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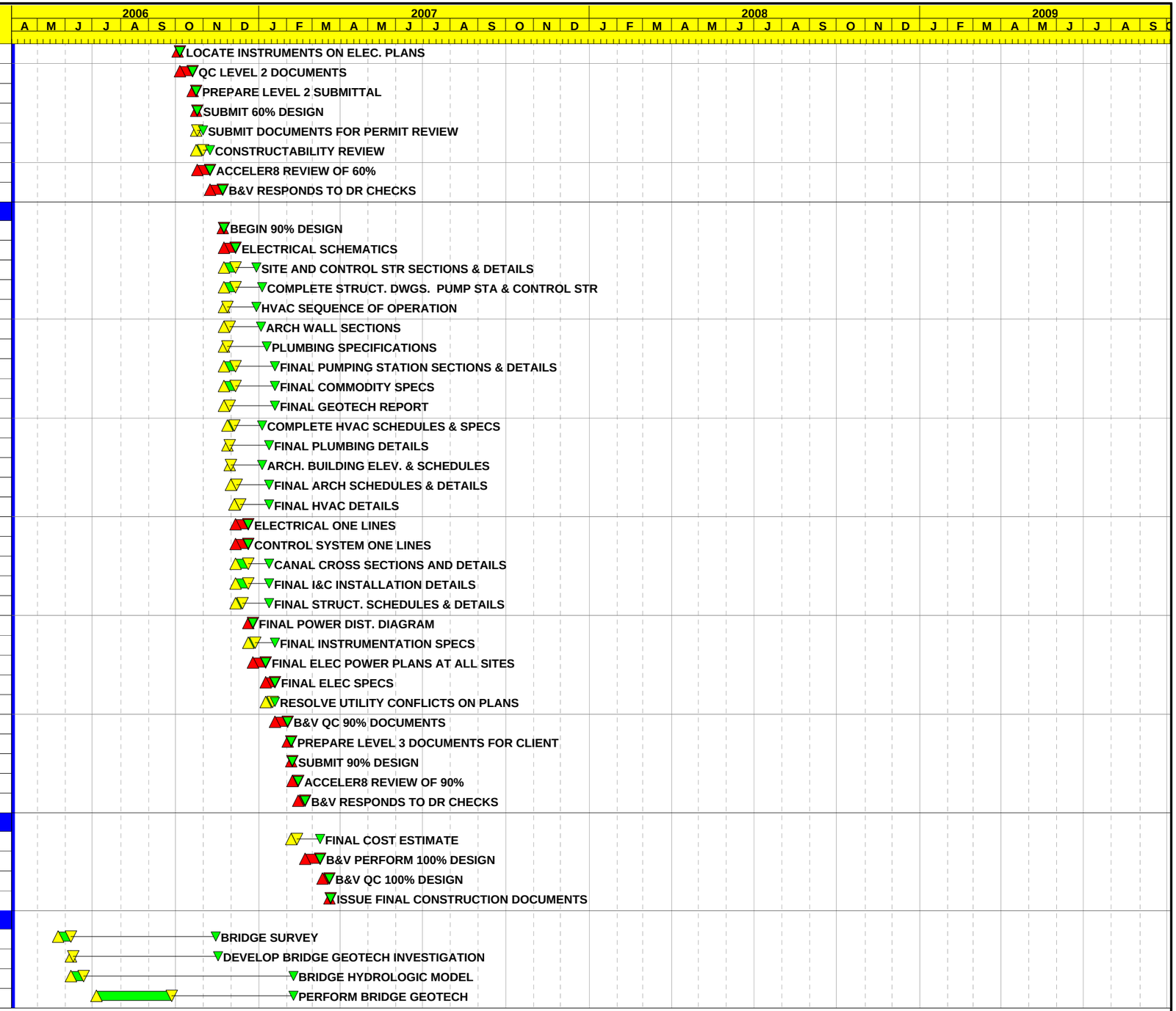
DDC227	LOCATE INSTRUMENTS ON ELEC.	3	3	0	03OCT06	05OCT06
DDC229	QC LEVEL 2 DOCUMENTS	10	10	0	06OCT06	19OCT06
DDC230	PREPARE LEVEL 2 SUBMITTAL	2	2	0	20OCT06	23OCT06
DDC232	SUBMIT 60% DESIGN	1	1	0	24OCT06	24OCT06
DDC234	SUBMIT DOCUMENTS FOR PERMIT	1	1	0	24OCT06	24OCT06
DDC236	CONSTRUCTABILITY REVIEW	6	6	0	24OCT06	31OCT06
DDC231	ACCELER8 REVIEW OF 60%	10	10	0	25OCT06	07NOV06
DDC238	B&V RESPONDS TO DR CHECKS	10	10	0	08NOV06	21NOV06
Pump Station and Control Structure 90% Design						
DDC301	BEGIN 90% DESIGN	1	1	0	22NOV06	22NOV06
DDC307	ELECTRICAL SCHEMATICS	10	10	0	23NOV06	06DEC06
DDC313	SITE AND CONTROL STR SECTIONS	10	10	0	23NOV06	06DEC06
DDC316	COMPLETE STRUCT. DWGS. PUMP	10	10	0	23NOV06	06DEC06
DDC317	HVAC SEQUENCE OF OPERATION	3	3	0	23NOV06	27NOV06
DDC306	ARCH WALL SECTIONS	5	5	0	23NOV06	29NOV06
DDC302	PLUMBING SPECIFICATIONS	3	3	0	23NOV06	27NOV06
DDC304	FINAL PUMPING STATION SECTIONS	10	10	0	23NOV06	06DEC06
DDC330	FINAL COMMODITY SPECS	10	10	0	23NOV06	06DEC06
DDC325	FINAL GEOTECH REPORT	5	5	0	23NOV06	29NOV06
DDC308	COMPLETE HVAC SCHEDULES &	5	5	0	28NOV06	04DEC06
DDC324	FINAL PLUMBING DETAILS	2	2	0	28NOV06	29NOV06
DDC305	ARCH. BUILDING ELEV. &	1	1	0	30NOV06	30NOV06
DDC321	FINAL ARCH SCHEDULES & DETAILS	5	5	0	01DEC06	07DEC06
DDC323	FINAL HVAC DETAILS	5	5	0	05DEC06	11DEC06
DDC309	ELECTRICAL ONE LINES	10	10	0	07DEC06	20DEC06
DDC311	CONTROL SYSTEM ONE LINES	10	10	0	07DEC06	20DEC06
DDC314	CANAL CROSS SECTIONS AND	10	10	0	07DEC06	20DEC06
DDC322	FINAL I&C INSTALLATION DETAILS	10	10	0	07DEC06	20DEC06
DDC320	FINAL STRUCT. SCHEDULES &	5	5	0	07DEC06	13DEC06
DDC303	FINAL POWER DIST. DIAGRAM	3	3	0	21DEC06	25DEC06
DDC329	FINAL INSTRUMENTATION SPECS	5	5	0	21DEC06	27DEC06
DDC326	FINAL ELEC POWER PLANS AT ALL	10	10	0	26DEC06	08JAN07
DDC327	FINAL ELEC SPECS	8	8	0	09JAN07	18JAN07
DDC328	RESOLVE UTILITY CONFLICTS ON	5	5	0	09JAN07	15JAN07
DDC333	B&V QC 90% DOCUMENTS	10	10	0	19JAN07	01FEB07
DDC336	PREPARE LEVEL 3 DOCUMENTS	2	2	0	02FEB07	05FEB07
DDC338	SUBMIT 90% DESIGN	1	1	0	06FEB07	06FEB07
DDC340	ACCELER8 REVIEW OF 90%	5	5	0	07FEB07	13FEB07
DDC342	B&V RESPONDS TO DR CHECKS	5	5	0	14FEB07	20FEB07
Pump Station and Control Structure 100% Design						
DDQ1	FINAL COST ESTIMATE	5	5	0	06FEB07	12FEB07
DDQ2	B&V PERFORM 100% DESIGN	13	13	0	21FEB07	09MAR07
DDQ3	B&V QC 100% DESIGN	6	6	0	12MAR07	19MAR07
DDQ4	ISSUE FINAL CONSTRUCTION	1	1	0	20MAR07	20MAR07
Bridge Preliminary Design						
BPD01	BRIDGE SURVEY	10	10	0	24MAY06*	06JUN06
BPD04	DEVELOP BRIDGE GEOTECH	3	3	0	07JUN06	09JUN06
BPD08	BRIDGE HYDROLOGIC MODEL	10	10	0	07JUN06	20JUN06
BPD05	PERFORM BRIDGE GEOTECH	60	60	0	05JUL06*	26SEP06



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Early Bar
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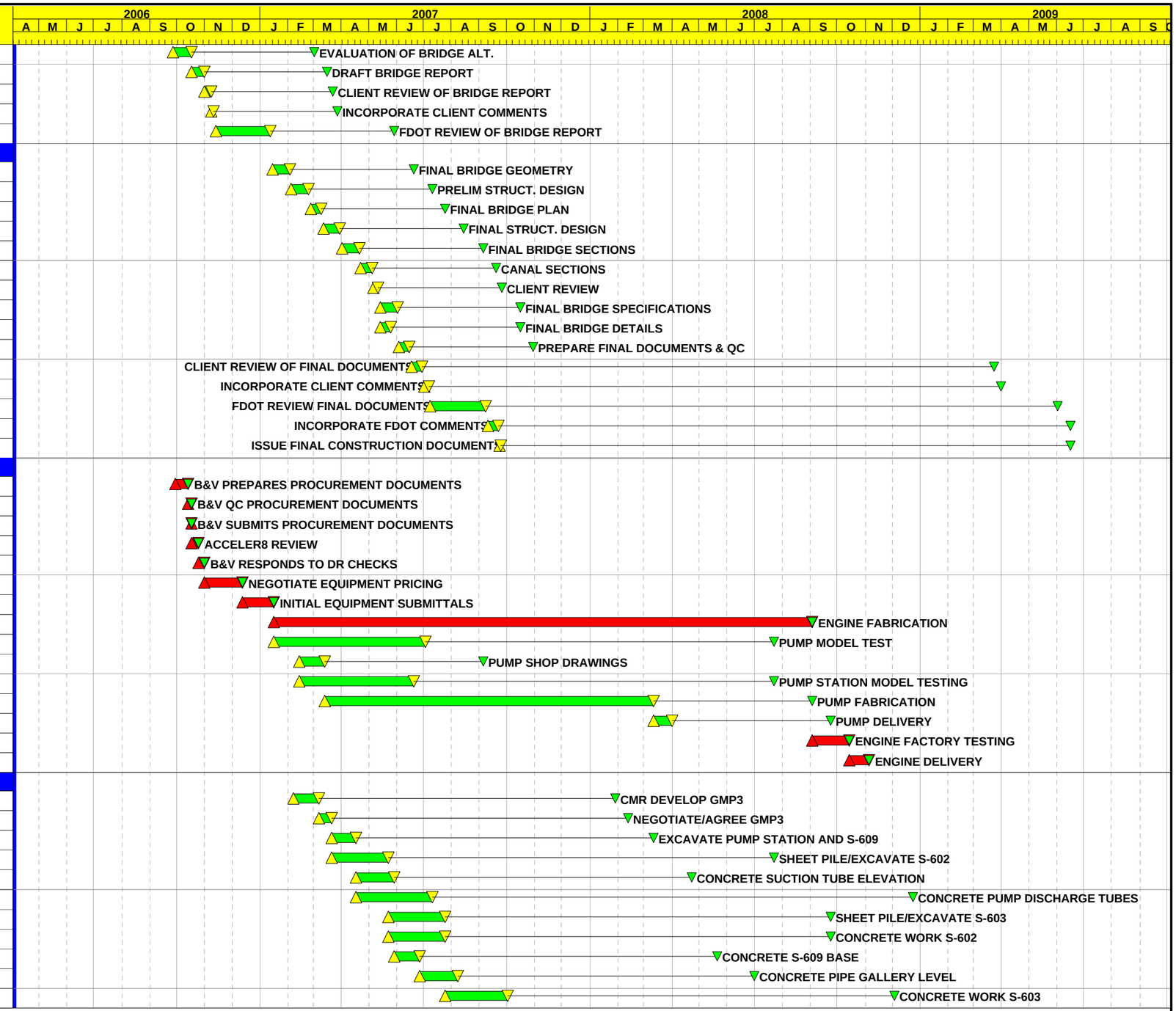
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
BPD09	EVALUATION OF BRIDGE ALT.	15	15	0	27SEP06	17OCT06
BPD12	DRAFT BRIDGE REPORT	10	10	0	18OCT06	31OCT06
BPD14	CLIENT REVIEW OF BRIDGE REPORT	5	5	0	01NOV06	07NOV06
BPD16	INCORPORATE CLIENT COMMENTS	3	3	0	08NOV06	10NOV06
BPD18	FDOT REVIEW OF BRIDGE REPORT	45	45	0	13NOV06	12JAN07
Bridge Final Design						
BFD01	FINAL BRIDGE GEOMETRY	15	15	0	15JAN07	02FEB07
BFD04	PRELIM STRUCT. DESIGN	15	15	0	05FEB07	23FEB07
BFD06	FINAL BRIDGE PLAN	10	10	0	26FEB07	09MAR07
BFD07	FINAL STRUCT. DESIGN	15	15	0	12MAR07	30MAR07
BFD08	FINAL BRIDGE SECTIONS	15	15	0	02APR07	20APR07
BFD10	CANAL SECTIONS	10	10	0	23APR07	04MAY07
BFD12	CLIENT REVIEW	5	5	0	07MAY07	11MAY07
BFD16	FINAL BRIDGE SPECIFICATIONS	15	15	0	14MAY07	01JUN07
BFD14	FINAL BRIDGE DETAILS	10	10	0	14MAY07	25MAY07
BFD18	PREPARE FINAL DOCUMENTS & QC	10	10	0	04JUN07	15JUN07
BFD20	CLIENT REVIEW OF FINAL	10	10	0	18JUN07	29JUN07
BFD22	INCORPORATE CLIENT COMMENTS	5	5	0	02JUL07	06JUL07
BFD24	FDOT REVIEW FINAL DOCUMENTS	45	45	0	09JUL07	07SEP07
BFD26	INCORPORATE FDOT COMMENTS	10	10	0	10SEP07	21SEP07
BFD28	ISSUE FINAL CONSTRUCTION	1	1	0	24SEP07	24SEP07
Major Equipment Procurement						
PRO01	B&V PREPARES PROCUREMENT	10	10	0	29SEP06	12OCT06
PRO02	B&V QC PROCUREMENT	2	2	0	13OCT06	16OCT06
PRO04	B&V SUBMITS PROCUREMENT	1	1	0	17OCT06	17OCT06
PRO06	ACCELER8 REVIEW	5	5	0	18OCT06	24OCT06
PRO08	B&V RESPONDS TO DR CHECKS	5	5	0	25OCT06	31OCT06
PRO10	NEGOTIATE EQUIPMENT PRICING	30	30	0	01NOV06	12DEC06
PRO12	INITIAL EQUIPMENT SUBMITTALS	25	25	0	13DEC06	16JAN07
PRO18	ENGINE FABRICATION	425	425	0	17JAN07	02SEP08
PRO14	PUMP MODEL TEST	120	120	0	17JAN07	03JUL07
PRO21	PUMP SHOP DRAWINGS	20	20	0	14FEB07	13MAR07
PRO16	PUMP STATION MODEL TESTING	90	90	0	14FEB07	19JUN07
PRO22	PUMP FABRICATION	260	260	0	14MAR07	11MAR08
PRO24	PUMP DELIVERY	15	15	0	12MAR08	01APR08
PRO20	ENGINE FACTORY TESTING	30	30	0	03SEP08	14OCT08
PRO26	ENGINE DELIVERY	15	15	0	15OCT08	04NOV08
Pump Station and Control Structure Construction						
PSC02	CMR DEVELOP GMP3	20	20	0	07FEB07	06MAR07
PSC04	NEGOTIATE/AGREE GMP3	10	10	0	07MAR07	20MAR07
PSC100	EXCAVATE PUMP STATION AND	20	20	0	21MAR07	17APR07
PSC06	SHEET PILE/EXCAVATE S-602	45	45	0	21MAR07	22MAY07
PSC102	CONCRETE SUCTION TUBE	30	30	0	18APR07	29MAY07
PSC104	CONCRETE PUMP DISCHARGE	60	60	0	18APR07	10JUL07
PSC08	SHEET PILE/EXCAVATE S-603	45	45	0	23MAY07	24JUL07
PSC10	CONCRETE WORK S-602	45	45	0	23MAY07	24JUL07
PSC106	CONCRETE S-609 BASE	20	20	0	30MAY07	26JUN07
PSC108	CONCRETE PIPE GALLERY LEVEL	30	30	0	27JUN07	07AUG07
PSC12	CONCRETE WORK S-603	50	50	0	25JUL07	02OCT07



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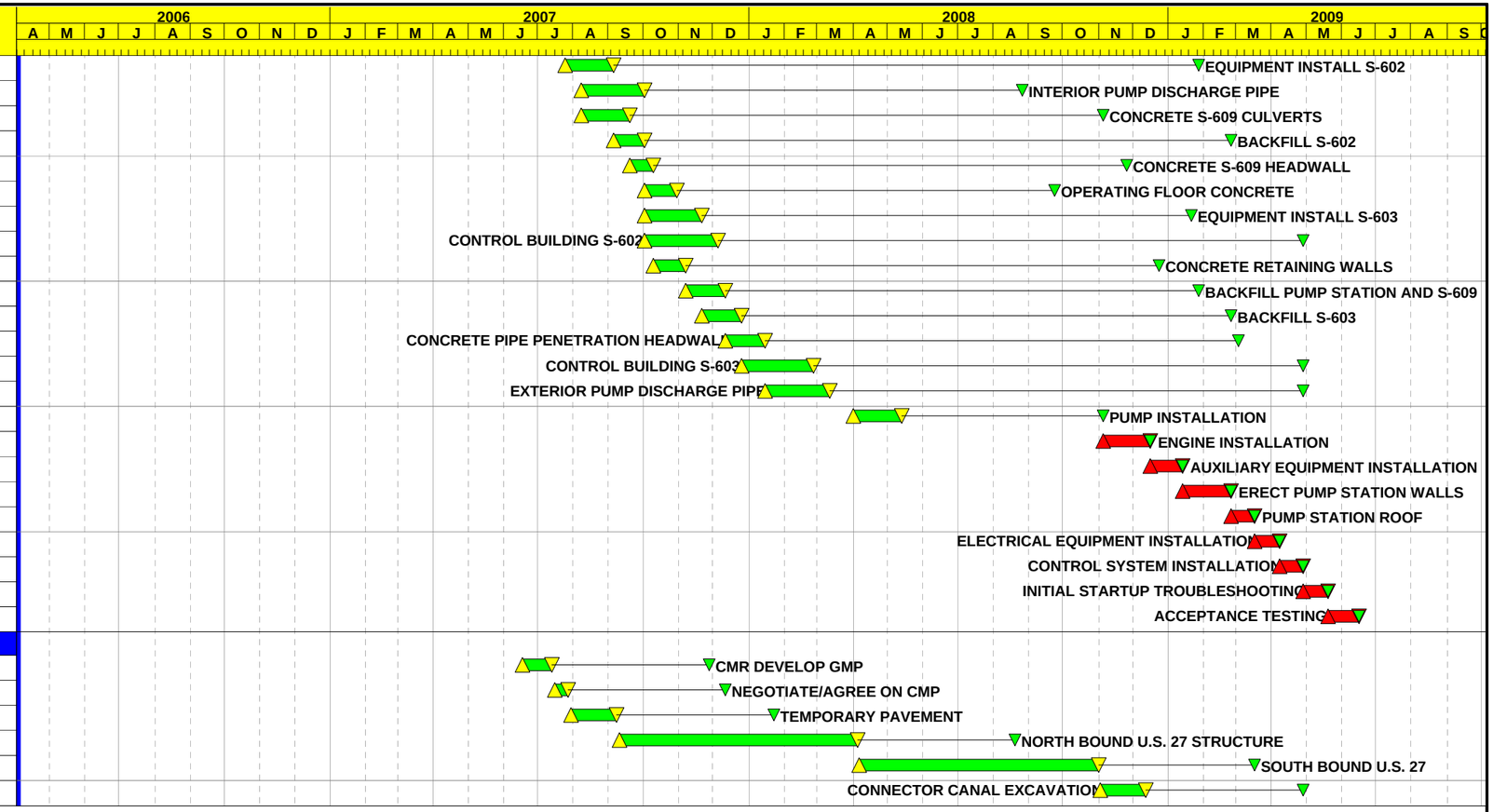
PSC14	EQUIPMENT INSTALL S-602	30	30	0	25JUL07	04SEP07
PSC120	INTERIOR PUMP DISCHARGE PIPE	40	40	0	08AUG07	02OCT07
PSC110	CONCRETE S-609 CULVERTS	30	30	0	08AUG07	18SEP07
PSC18	BACKFILL S-602	20	20	0	05SEP07	02OCT07
PSC112	CONCRETE S-609 HEADWALL	15	15	0	19SEP07	09OCT07
PSC122	OPERATING FLOOR CONCRETE	20	20	0	03OCT07	30OCT07
PSC16	EQUIPMENT INSTALL S-603	35	35	0	03OCT07	20NOV07
PSC22	CONTROL BUILDING S-602	45	45	0	03OCT07	04DEC07
PSC114	CONCRETE RETAINING WALLS	20	20	0	10OCT07	06NOV07
PSC116	BACKFILL PUMP STATION AND S-609	25	25	0	07NOV07	11DEC07
PSC20	BACKFILL S-603	25	25	0	21NOV07	25DEC07
PSC118	CONCRETE PIPE PENETRATION	25	25	0	12DEC07	15JAN08
PSC24	CONTROL BUILDING S-603	45	45	0	26DEC07	26FEB08
PSC124	EXTERIOR PUMP DISCHARGE PIPE	40	40	0	16JAN08	11MAR08
PSC126	PUMP INSTALLATION	30	30	0	02APR08	13MAY08
PSC128	ENGINE INSTALLATION	30	30	0	05NOV08	16DEC08
PSC130	AUXILIARY EQUIPMENT	20	20	0	17DEC08	13JAN09
PSC132	ERECT PUMP STATION WALLS	30	30	0	14JAN09	24FEB09
PSC134	PUMP STATION ROOF	15	15	0	25FEB09	17MAR09
PSC136	ELECTRICAL EQUIPMENT	15	15	0	18MAR09	07APR09
PSC138	CONTROL SYSTEM INSTALLATION	15	15	0	08APR09	28APR09
PSC140	INITIAL STARTUP	15	15	0	29APR09	19MAY09
PSC142	ACCEPTANCE TESTING	20	20	0	20MAY09	16JUN09
Bridge and Connector Channel Construction						
BC02	CMR DEVELOP GMP	20	20	0	18JUN07	13JUL07
BC04	NEGOTIATE/AGREE ON CMP	10	10	0	16JUL07	27JUL07
BC06	TEMPORARY PAVEMENT	30	30	0	30JUL07	07SEP07
BC08	NORTH BOUND U.S. 27 STRUCTURE	150	150	0	10SEP07	04APR08
BC10	SOUTH BOUND U.S. 27	150	150	0	07APR08	31OCT08
BC12	CONNECTOR CANAL EXCAVATION	30	30	0	03NOV08	12DEC08



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12.0 CALCULATIONS

Calculations on the following topics are included in this Section.

Discipline	**Computed by**	**Verified by**
Geotechnical	Jacques Moraille	Dick Vaeth
Civil	Kevin Nelson	Jim Touslee
Hydraulics	Jim Schlaman Gail Montgomery	Gerry Miller Jim Touslee
Structural	Andre Lubaga	Balbir Sandhu
Process Mechanical	Ted Stolinski Larry Pittman	 David Long
HVAC	Jim Painter	David Nelson
Electrical	John Wright	Gary Partin
Cost Data	Ted Stolinski, Kevin Nelson, Kevin Lee, Bill Brant	-----

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Bearing Capacity Determination for EAA Project Structures

Page 1 of 3

Owner: SFWMD

Computed by: J. Morrillo (JM) Date: 6/26/2006

Project No.: 144777

Verified by: R.M. Voelk Date: 7/11/06

Northeast Pump Station

The closest boring information was found in borings CB Ø258. A generalized profile @ this location is as follows:

Layer	1	2	3	4	5	6
Soil Type	Peat	Caprock	Gravelly SAND	SAND	GRAVEL	SAND
Depth below ground surface (bgs)	0'-4.5'	4.5'-8.5'	8.5'-13.5'	13.5'-23.5'	23.5'-28.5'	28.5'-38.5'
Elevation NAVD 88	10.4 to 5.9	5.9 to 1.9	1.9 to -3.1	-3.1 to -13.1	-13.1 to -18.1	-18.1 to -28.1
Average (1) N_{60} Value	— (Remove)	22% (2) RQD	$N \geq 50$ bpf	$N_{60} = 23 \times 1.25 \times 1 = 29$	$N_{60} = 52 \times 1 \times 1.1 = 57$	$N \geq 50$ bpf
Saturated (3) Unit Weight	—	140 pcf	125 pcf	125 pcf	125 pcf	125 pcf
Effective Unit Weight (pcf)	—	77.6 pcf	63 pcf	63 pcf	63 pcf	63 pcf
Relative Density	—	N.A.	90%	75%	90%	90%
Angle of Internal Friction ϕ	—	40	35	33	35	35

Notes:

(1) $N_{60} = N_{SPT} \times C_{ER} \times C_N$

C_{ER} ← Energy Rod Correction (use 1)

C_N ← overburden correction

(2) Core drilled (no SPT values apply)

(3) Taken from BODR table 8.5-1

For $\phi = 35°$ $N_c = 57.8$, $N_q = 41.4$, $N_\gamma = 47.3$ (Terzaghi, Table 6.2, Reference 2)

To assign a net allowable bearing pressure, use procedure in Reference 2, p. 249:

1. Perform bearing capacity analysis on smallest proposed footing and determine q_a'

2. Perform a settlement analysis on the largest of proposed footings and determine the largest q' that keeps settlement within tolerable limits

3. Use the lowest of the two values as the net allowable bearing pressure

According to the 2004 Florida Building Code, the smallest footing width should be 12 in. (1 ft.) as stated in Article 1805.4.1

$$q_u' = \cancel{1.3 c N_c} + \sigma_D'(N_q - 1) + 0.4\,\gamma B N_\gamma$$
$$= 0 + (63\,pcf \times 4.5\,ft)(41.4 - 1) + 0.4(63\,pcf)(1)(47.3)$$
$$= 12{,}645\ psf \text{ (used 4.5 due to overexcavated peat)}$$

$q_a' = \frac{q_u'}{3} = 4{,}216\,psf$; say $\underline{3{,}500\,psf}$ to be conservative

$$q_u' = c N_c + \sigma_D'(N_q - 1) + 0.5(\gamma B N_\gamma)$$
(continuous)

$$q_u' = 12{,}943\,psf \ ; \ q_a' = 4314.4\,psf$$

<u>Use mat foundation below pump station for settlement estimate</u>

$$\frac{\delta}{B_r} = \frac{0.68 q'/\sigma_r}{\bar{N}_{60}\ K_d}\left(\frac{B}{B + B_r}\right)^2 \rightarrow \text{from Reference 2, eqn. 7.14, p. 220}$$

where δ = settlement
B_r = reference width = 1 ft.
q' = net bearing pressure
σ_r = reference stress = 2,000 lb/ft^2
$\bar{N}_{60}$ = avg. SPT_{60} between bottom of footing to 2B depth
B = footing width ; K_d = depth factor = $1 + 0.33\,D/B$

assume 1" max. allowable settlement →

$$\frac{0.083\,ft.}{1\,ft.} = \frac{0.68\,q'}{\bar{N}_{60}} \frac{2000\,lb/ft^2}{K_D} \left(\frac{103\,ft.}{103\,ft. + 1\,ft.}\right)^2$$

$$K_D = 1 + 0.33\frac{D}{B} = 1.33\left(\frac{23\,ft}{103\,ft}\right) = 1.07$$

$$(0.083\,ft.)(33)(1.07) = \frac{0.68\,q'}{2{,}000\,lb/ft^2}(.980862)$$

$\bar{N}_{60}$ = 33 blows/ft. from CB Ø258

$$\frac{0.083\,ft.(33)(1.07)(2000\,lb/ft^2)}{.980862} = 0.68\,q'$$

$$5{,}975.83 = 0.68\,q'$$

$$q' = 8{,}788\,\frac{lb}{ft^2}$$

$$\boxed{\therefore \text{Use } q_a'' = 3{,}500\,lb/ft^2}$$

References:

1. EAA Storage Reservoir A-1, Basis of Design Report (BODR), January 2006, B&V
2. Foundation Design, Principles and Practices (1st Edition), Donald P. Coduto, Prentice Hall, 1994
3. Bearing Capacity of Soils, EM 1110-1-1905, October 30, 1992.
4. Geotechnical Data Report, EAA Storage Reservoir A-1
5. NAVFAC Design Manual 7.1, Soil Mechanics, Department of the Navy, September 1986.
6. NAVFAC Design Manual 7.2, Foundations and Earth Structures, Department of the Navy, September 1986.

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South Florida Water Management District

EAA Reservoir A-1 Preliminary Design Report for Pump Station, Control Structures and U.S. 27 Bridges

July, 2006

DIVIDER PAGE

Min Wall Thickness -

- For vacuum D/t less than 158

96" pipe t = 5/8" D/t = 153.6 ∴ ok
36" pipe t = 3/8" D/t = 96 ∴ ok

- Internal Pressure

$$t = \frac{pd}{2s}$$

For
t = 5/8"
d = 96"
s = 15,000 psi (50% of yield strength)

$$\text{allowable pressure} = \frac{(5/8)(2)(15{,}000)}{96}$$

= 195 psi ∴ well above

For t = 3/8"
d = 36"
s = 15,000 psi

$$\text{allowable pressure} = \frac{3/8\,(2)(15{,}000)}{36}$$

= 312 psi ∴ ok

Span length of 15' is in accordance with B&V standards for steel pipe.

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Determine Angular offset at Pump Sta.
EM- Reservoir A-1 : Structures — Page 1 of 1
Owner: SFWMD — Computed by: K. Nelson — Date: 6-13-2006
Project No. 144777.300 — Verified by: [illegible] — Date: [illegible]-06

The NE Pump Station is located in embankment curve CV 4

Curve Data

$\Delta = 55.19$

$R = 7,500$

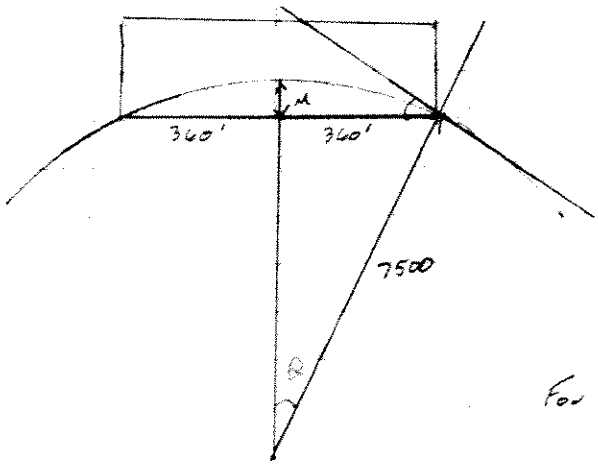
$L = 7224.75$

$T = 3920$

Overall P.S. length + Spillway Length = 400'

Auxiliary facilities require 200' on west of P.S and 120' on east of P.S.

Total Chord length = 720'



$\sin\theta = \frac{360}{7500}$

$\theta = 2.75°$

M = middle ordinate

$7500 - 7500\cos\theta = 8.64'$

For 50'

If straight is reduced to 50' each side of PS & spillway

$\sin\theta = \frac{250}{7500}$

$\theta = 1.91°$

$M = 7500 - 7500\cos\theta = 4.16'$

DO NOT WRITE IN THIS SPACE

PGN-172B

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: TABLE OF VELOCITIES VS. PUMP "D"
EAA RESERVOIR A-1: STRUCTURES
Page 1 of 1
Owner: SFWMD
Computed by: K. NELSON
Date: 4-25-2006
Project No.:
Verified by:
Date: 7-12-06

Flow 625

Diameter	Diameter(f	Impeller Area	Impeller Velocity	FSI Entrance Area	FSI Entrance Velocity	FSI Throat Area	FSI Throat Velocity
80	6.67	34.91	17.90	84.09	7.43	50.31	12.42
81	6.75	35.78	17.47	86.20	7.25	51.57	12.12
82	6.83	36.67	17.04	88.35	7.07	52.85	11.83
83	6.92	37.57	16.63	90.51	6.91	54.15	11.54
84	7.00	38.48	16.24	92.71	6.74	55.46	11.27
85	7.08	39.41	15.86	94.93	6.58	56.79	11.01
86	7.17	40.34	15.49	97.18	6.43	58.14	10.75
87	7.25	41.28	15.14	99.45	6.28	59.50	10.50
88	7.33	42.24	14.80	101.75	6.14	60.87	10.27
89	7.42	43.20	14.47	104.07	6.01	62.26	10.04
90	7.50	44.18	14.15	106.43	5.87	63.67	9.82
91	7.58	45.17	13.84	108.80	5.74	65.09	9.60
92	7.67	46.16	13.54	111.21	5.62	66.53	9.39
93	7.75	47.17	13.25	113.64	5.50	67.98	9.19
94	7.83	48.19	12.97	116.10	5.38	69.45	9.00
95	7.92	49.22	12.70	118.58	5.27	70.94	8.81
96	8.00	50.27	12.43	121.09	5.16	72.44	8.63
97	8.08	51.32	12.18	123.62	5.06	73.96	8.45
98	8.17	52.38	11.93	126.19	4.95	75.49	8.28
99	8.25	53.46	11.69	128.77	4.85	77.04	8.11
100	8.33	54.54	11.46	131.39	4.76	78.60	7.95
101	8.42	55.64	11.23	134.03	4.66	80.18	7.79
102	8.50	56.75	11.01	136.70	4.57	81.78	7.64
103	8.58	57.86	10.80	139.39	4.48	83.39	7.49
104	8.67	58.99	10.59	142.11	4.40	85.02	7.35
105	8.75	60.13	10.39	144.86	4.31	86.66	7.21
106	8.83	61.28	10.20	147.63	4.23	88.32	7.08
107	8.92	62.44	10.01	150.43	4.15	89.99	6.94
108	9.00	63.62	9.82	153.25	4.08	91.68	6.82
109	9.08	64.80	9.64	156.10	4.00	93.39	6.69
110	9.17	66.00	9.47	158.98	3.93	95.11	6.57
111	9.25	67.20	9.30	161.88	3.86	96.85	6.45
112	9.33	68.42	9.14	164.81	3.79	98.60	6.34
113	9.42	69.64	8.97	167.77	3.73	100.37	6.23

EAA Reservoir A-1
Preliminary Design for Pump Station, Control Structures, and U.S. 27 Bridges
MAIN PUMPS

3.2.4.2 Determine Elevation of Invert

Enter Minimum connector canal elevation [redacted] 3.6 NAVD

Enter Pump Impeller Diameter d [redacted] 30 inches

Enter design flow rate in cfs [redacted] 625 cfs — 280,500 gpm

Hydraulic Institute Submergence — S=D+0.574Q/D^1.5
D= 124.17 inches (equivalent diameter of FSI entrance)
S= 240.54 inches — 20.04 feet

invert based on HI submergence = minimum elevation in canal-submergence-0.44d
= -19.38 NAVD

SFWMD Plate 9 Submergence

invert based on SFWMD Plate 9 = minimum elevation in canal - 0.55d-0.88d
= -5.93 NAVD

3.2.4.4 Pump Station Velocity (clear width of screen)

$W = \frac{Q}{(d-hc)(V)}$ — hc= 0.15
d= depth of flow (feet)
Hydraulic Institute Submergence — d= 22.98

For V= [redacted] 2 fps

W(clear)= 13.69 feet
For 3-inch bar spacing and 1/2 inch bars
W(total)= 14.83 feet

SFMD FSI Plate 9 Submergence — d= 9.53
For V= [redacted] 2 fps
W(clear)= 33.30 feet
For 3-inch bar spacing and 1/2 inch bars
W(total)= 36.08 feet

SFMD FSI if invert is higher than canal — d= 15 — 14.85
For V= [redacted] 2 fps
W(clear)= 21.04 feet
For 3-inch bar spacing and 1/2 inch bars
W(total)= 22.80 feet

3.2.4.5 Width of Formed Suction Tunnel Entrance

d= impeller diameter
Tunnel Width = 2.31*d
Tunnel Height= 0.88*d
Tunnel Area = (2.31-0.16)*d*0.88*d

Tunnel Width=	184.80 inches	15.40 feet
Tunnel Height=	70.40 inches	5.87 feet
Tunnel Area=	12108.80 sq inches	84.09 sq. ft.

Equivalent inlet opening for use in HI Submergence Calculations: 10.35 feet

Length of FSI from center of pump to FSI tunnel entrance = 3.3*d
Tunnel Length= 264 inches — 22 feet

Dimension Rectangular Inlet

Submergence as calculated in 3.2.4.3 using HI standards for suction bell with 5.5 fps.

S= 19.77 feet
Inlet Bell D= Q/5.5 fps (in accordance with HI 9.8.6
Bell Area = 113.6364 sq. ft.
Bell Diam= 144.3426 inches or 12.02855 feet

Elevation of Invert = minimum elevation in canal - submergence - 0.5 * bell diameter
= -22.1798 NAVD

Length of Pump Bay= 5* bell diameter
Width of Pump Bay = 2* bell diameter
Bottom of Bell to floor= 0.5 * bell diameter
Bell Centerline to back wall = 0.75 * bell diameter

Length of Pump Bay=	60.14274 feet
Width of Pump Bay =	24.0571 feet
Bottom of Bell to floor=	6.014274 feet
Bell Centerline to back wall =	9.021411 feet

Area of entrance $= \frac{Q}{V} = \frac{625 \text{ cfs}}{5 \text{ fps}}$

$= 125 \text{ ft}^2$

Dimensions of entrance

Maintain the same width of $2.31d - 0.16d$
for $d = 80''$
width of FSI entrance = 16.46 ft.

Height of FSI entrance to limit V to 5fps

$H = \frac{125 \text{ ft}^2}{16.46 \text{ ft}}$

$= 7.59$ feet

Calculate Submergence $S = D + 0.574\, Q / D^{1.5}$

D = equivalent diameter of FSI entrance

$D = \sqrt{\frac{125 \times 4}{\pi}}$

$= 12.61$ feet

$= 151.39$ inches

$Q = 280{,}500$ gpm

$S = 151.39 + \frac{0.574(280{,}500)}{151.39^{1.5}}$

$S = 237.83$ inches

$S = 19.82$ feet

Calculate invert elevation

Inv = Min Level − Submergence − Opening Height/2

$= 3.6 - 19.82 - 7.59/2$

$= -20.02$

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length of FSI

Original FSI

rise of (.88d - .49d) in run of 3.30d - 1.45d

or rise of 31.2 inches in 148 inches

new rise is (7.49 feet x 12 in/ft - .49(80))

= 50.68 inches

$$\frac{run}{50.68} = \frac{148}{31.2}$$

run = 240"

length from pump ℄ = 240" + 1.45(80")

= 356 inches

= 29.7 feet

Using Pump Station width based on equipment layout

℄ pump to edge of P.S wall = 44 feet

(44x12) - 1.45(80) = new run

412" = new run

$$\frac{rise}{412} = \frac{31.2}{148}$$

86.85" = new rise

Height of FSI = 86.85 + .49(80)

= 126"

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PGN-172B

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

EAA Reservoir A-1
Preliminary Design for Pump Station, Control Structures, and U.S. 27 Bridges
IRRIGATION PUMPS

3.2.4.2 Determine Elevation of Invert

Enter Minimum reservoir elevation [redacted] 8.6 NAVD

Enter Pump Impeller Diameter d [redacted] 60 inches

Enter design flow rate in cfs [redacted] 200 cfs — 89,760 gpm

Hydraulic Institute Submergence — S=D+0.574Q/D^1.5
D= inlet bell diameter
D= 81.65249 inches — based on HI 9.8.6
S= 151.48 inches — 12.62 feet

Enter Inlet Bell Diameter if other than above [redacted] 80 inches
S= 152.0045 inches — 12.66704 feet

3.2.4.4 Pump Station Velocity (clear width of screen)

$W = \frac{Q}{(d-hc)(V)}$ — hc= 0.15
d= depth of flow = water elevation - invert
Hydraulic Institute Submergence — d= 16.03

For V= [redacted] 2 fps

W(clear)= 6.30 feet
For 3-inch bar spacing and 1/2 inch bars
W(total)= 6.82 feet

Dimension Rectangular Inlet

Submergence remains the same as calculated in 3.2.4.3 using HI standards.

S= 12.62
Inlet Bell D= Q/5.5 fps (In accordance with HI 9.8.6
Bell Area = 36.36364 sq. ft.
Bell Diam= 81.65249 inches or 6.804374 feet

Elevation of Invert = minimum elevation in canal - submergence - 0.5 * bell diameter
= -7.42571 NAVD

Length of Pump Bay= 5* bell diameter
Width of Pump Bay = 2* bell diameter
Bottom of Bell to floor= 0.5 * bell diameter
Bell Centerline to back wall = 0.75 * bell diameter

Length of Pump Bay= 34.02187 feet
Width of Pump Bay = 13.60875 feet
Bottom of Bell to floor= 3.402187 feet
Bell Centerline to back wall = 5.103281 feet

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Dimension Seepage Pump Inlet
EAA Reservoir A-1: Structures
Page 1 of 1

Owner: SFWMD
Computed by: K. Nelson
Date: 6-20-2006

Project No.: 144777
Verified by: [illegible]
Date: 7-12-06

EAA Reservoir A-1
Preliminary Design for Pump Station, Control Structures, and U.S. 27 Bridges
SEEPAGE PUMPS

3.2.4.2 Determine Elevation of Invert

Enter Minimum seepage canal elevation [redacted] NAVD

Enter Pump Impeller Diameter d [redacted] inches

Enter design flow rate in cfs [redacted] cfs 26,928 gpm

Hydraulic Institute Submergence S=D+0.574Q/D^1.5
D= inlet bell diameter
D= 44.72291 inches
S= 96.40 inches 8.03 feet

Enter Inlet Bell Diameter if other than above [redacted] inches
S= 96.95866 inches 8.079888 feet

3.2.4.4 Pump Station Velocity (clear width of screen)

$W = \frac{Q}{(d-hc)(V)}$ hc= 0.15
d= depth of flow = water elevation - invert
Hydraulic Institute Submergence d= 9.90

For V= [redacted] fps

W(clear)= 3.08 feet
For 3-inch bar spacing and 1/2 inch bars
W(total)= 3.33 feet

Dimension Rectangular Inlet

Submergence remains the same as calculated in 3.2.4.3 using HI standards.

S= 8.03
Inlet Bell D= Q/5.5 fps (in accordance with HI 9.8.6
Bell Area = 10.90909 sq. ft.
Bell Diam= 44.72291 inches or 3.726909 feet

Elevation of Invert = minimum elevation in canal - submergence - 0.5 * bell diameter
= -8.89701 NAVD

Length of Pump Bay= 5* bell diameter
Width of Pump Bay = 2* bell diameter
Bottom of Bell to floor= 0.5 * bell diameter
Bell Centerline to back wall = 0.75 * bell diameter

Length of Pump Bay= 18.63455 feet
Width of Pump Bay = 7.453819 feet
Bottom of Bell to floor= 1.863455 feet
Bell Centerline to back wall = 2.795182 feet

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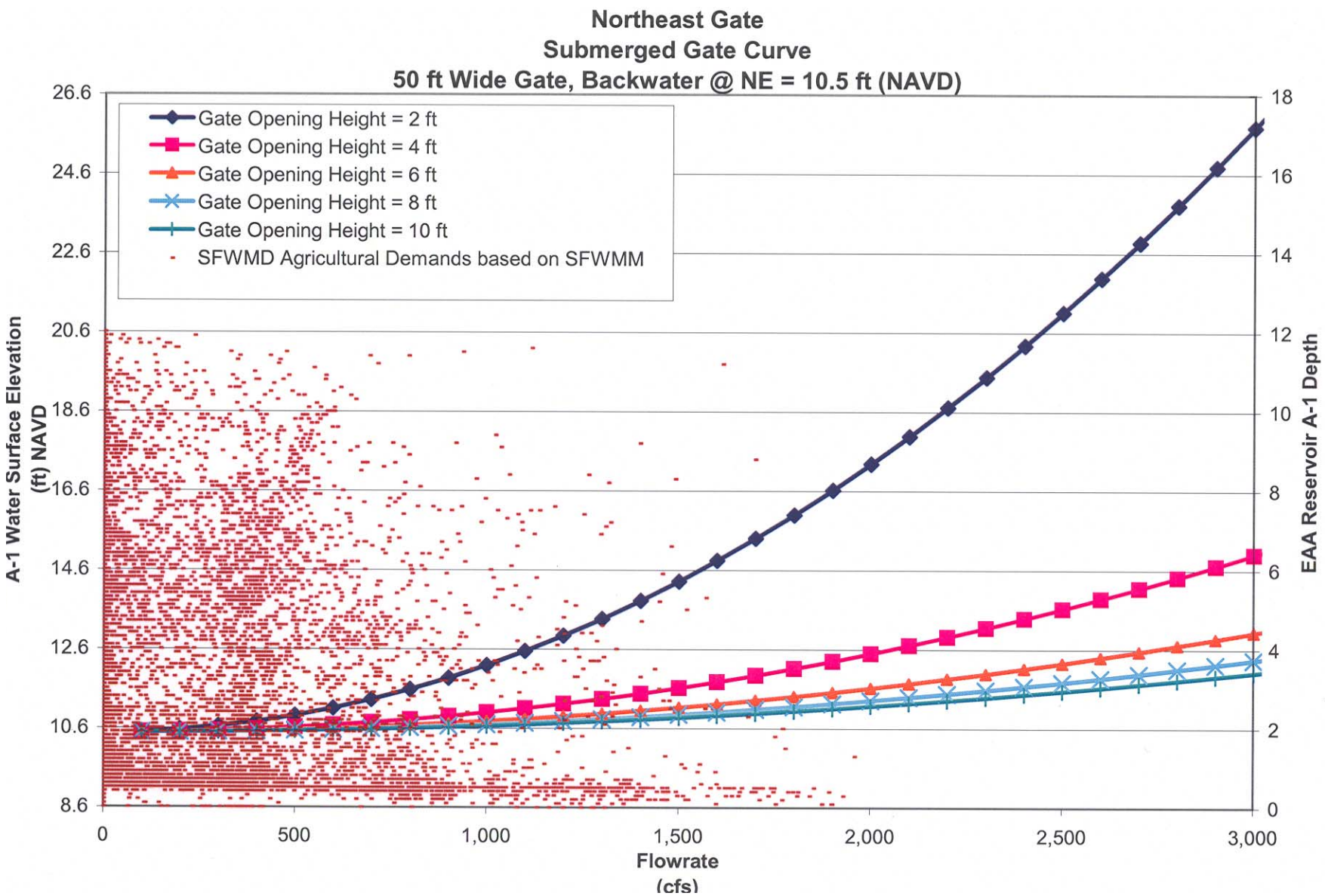
South Florida Water Management District

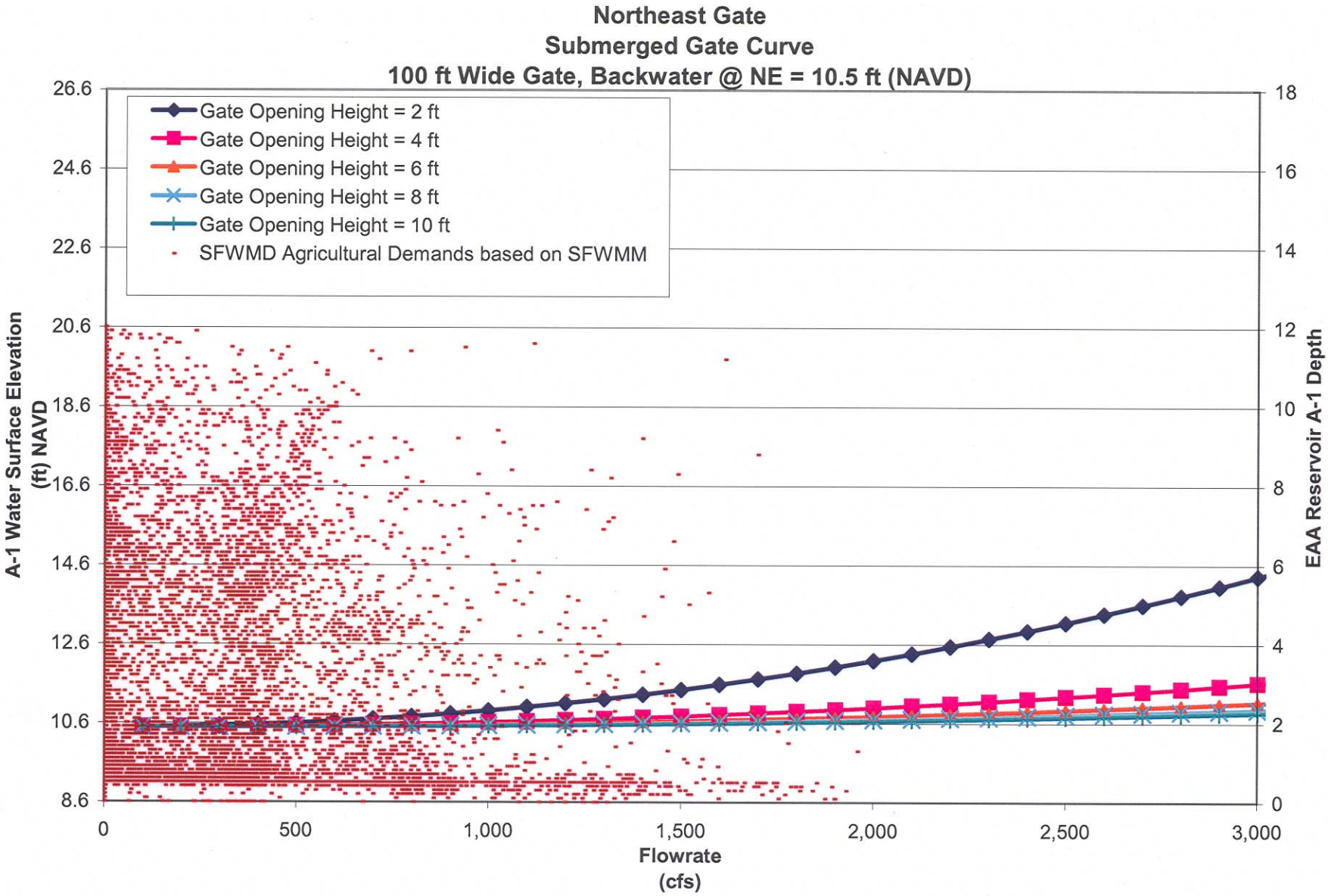
EAA Reservoir A-1 Preliminary Design Report for Pump Station, Control Structures and U.S. 27 Bridges

July, 2006

DIVIDER PAGE


Northeast Gate
Submerged Gate Curve
50 ft Wide Gate, Backwater @ NE = 10.5 ft (NAVD)
Gate Opening Height = 2 ft
Gate Opening Height = 4 ft
Gate Opening Height = 6 ft
Gate Opening Height = 8 ft
Gate Opening Height = 10 ft
SFWMD Agricultural Demands based on SFWMM
A-1 Water Surface Elevation (ft) NAVD
EAA Reservoir A-1 Depth
Flowrate (cfs)
26.6
24.6
22.6
20.6
18.6
16.6
14.6
12.6
10.6
8.6
18
16
14
12
10
8
6
4
2
0
0
500
1,000
1,500
2,000
2,500
3,000

Flow Data	50ft wide 10.6 backwater in I Water surface el 10 ft opening	50ft wide 10.6 backwater in I Water surface el 8 ft opening	50ft wide 10.6 backwater in Water surface el 6 ft opening	50ft wide 10.6 backwater in Water surface el 4 ft opening	50ft wide 10.6 backwater in NNR Water surface el 2 ft opening
100	10.50169	10.50204	10.50281	10.505	10.51699
200	10.50677	10.50818	10.51123	10.51999	10.56795
300	10.51523	10.51841	10.52527	10.54498	10.65288
400	10.52708	10.53272	10.54493	10.57996	10.77178
500	10.54232	10.55113	10.5702	10.62494	10.92466
600	10.56094	10.57362	10.60109	10.67991	11.11151
700	10.58295	10.60021	10.6376	10.74488	11.33233
800	10.60834	10.63089	10.67972	10.81985	11.58713
900	10.63711	10.66566	10.72745	10.90481	11.8759
1000	10.66928	10.70451	10.78081	10.99976	12.19864
1100	10.70483	10.74746	10.83978	11.10471	12.55536
1200	10.74376	10.7945	10.90437	11.21966	12.94605
1300	10.78608	10.84563	10.97457	11.3446	13.37072
1400	10.83179	10.90085	11.05039	11.47954	13.82936
1500	10.88088	10.96017	11.13183	11.62447	14.32197
1600	10.93336	11.02357	11.21888	11.7794	14.84856
1700	10.98923	11.09107	11.31156	11.94433	15.40913
1800	11.04848	11.16265	11.40985	12.11926	16.00367
1900	11.11112	11.23833	11.51375	12.30418	16.63219
2000	11.17715	11.3181	11.62328	12.4991	17.29468
2100	11.24657	11.40196	11.73842	12.70401	17.99115
2200	11.31937	11.48992	11.85919	12.91893	18.7216
2300	11.39556	11.58196	11.98557	13.14384	19.48602
2400	11.47514	11.6781	12.11757	13.37875	20.28443
2500	11.55811	11.77834	12.25519	13.62366	21.11681
2600	11.64446	11.88266	12.39842	13.87857	21.98317
2700	11.7342	11.99108	12.54728	14.14347	22.88351
2800	11.82733	12.10359	12.70176	14.41838	23.81782
2900	11.92385	12.2202	12.86185	14.70329	24.78612
3000	12.02376	12.3409	13.02757	14.99819	25.78839
3100	12.12706	12.4657	13.19891	15.3031	26.82464
3200	12.23375	12.59459	13.37587	15.61801	27.89488
3300	12.34383	12.72757	13.55844	15.94291	28.99909
3400	12.4573	12.86465	13.74664	16.27782	30.13728
3500	12.57416	13.00582	13.94047	16.62273	31.30945
3600	12.69441	13.15109	14.13991	16.97764	32.51561
3700	12.81805	13.30046	14.34497	17.34256	33.75574
3800	12.94508	13.45392	14.55566	17.71747	35.34949
3900	13.0755	13.61148	14.77197	18.1024	37.20251
4000	13.20931	13.77313	14.99391	18.49732	39.10366
4100	13.34652	13.93889	15.22147	18.90224	41.05294
4200	13.48712	14.10873	15.45465	19.31717	43.05035
4300	13.63111	14.28268	15.69345	19.74211	45.09589
4400	13.77849	14.46072	15.93788	20.17704	47.18956
4500	13.92927	14.64286	16.18793	20.62198	49.33137
4600	14.08344	14.8291	16.44361	21.07693	51.5213
4700	14.241	15.01944	16.70491	21.54187	53.75936
4800	14.40196	15.21388	16.97183	22.01683	56.04555
4900	14.56631	15.41241	17.24439	22.50179	58.37987
5000	14.73405	15.61504	17.52256	22.99675	60.76233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SFWMD Agricultural Demands based on SFWMM
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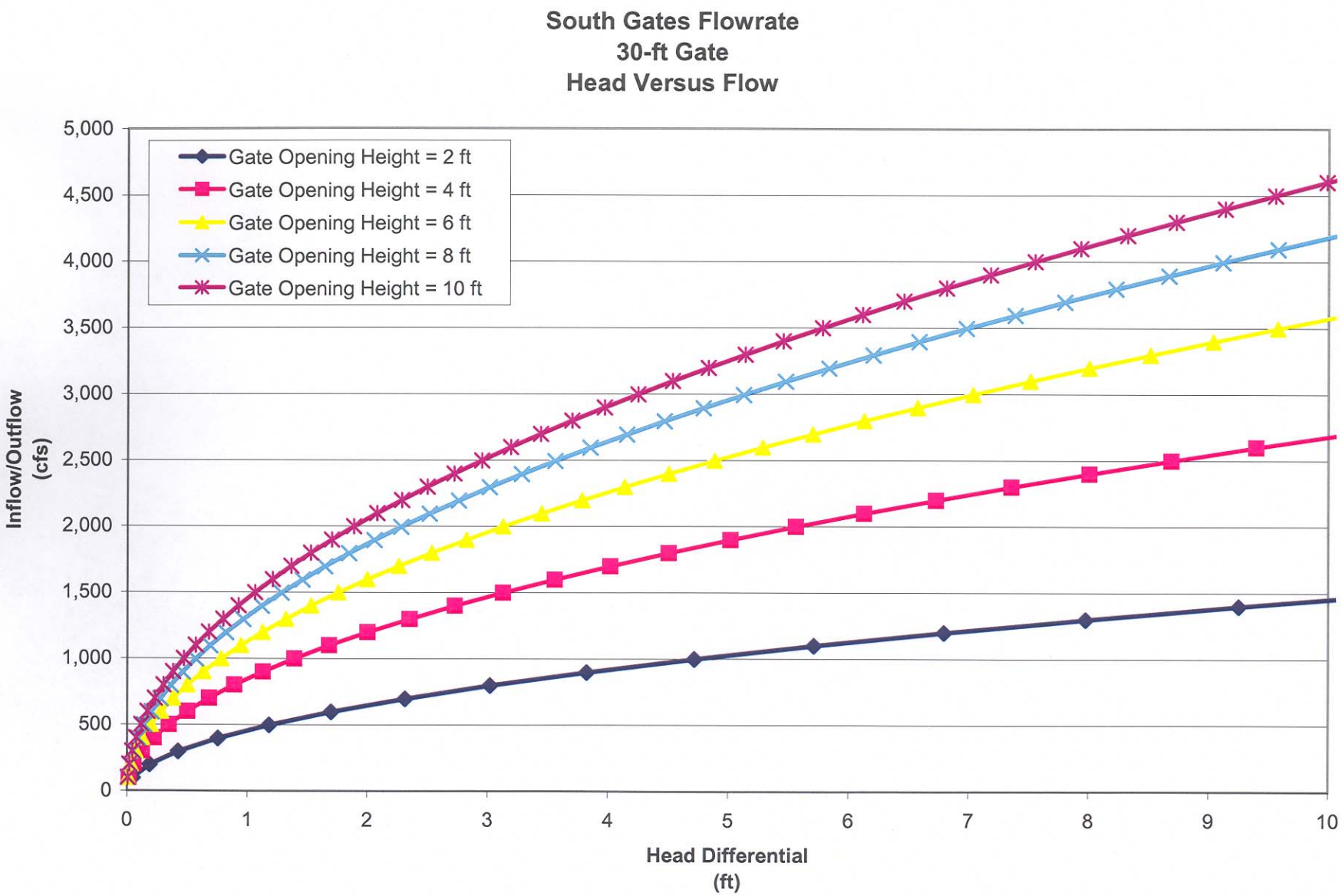
26.6
24.6
22.6
20.6
18.6
16.6
14.6
12.6
10.6
8.6
EAA Reservoir A-1 Depth
18
16
14
12
10
8
6
4
2
0
0
500
1,000
1,500
2,000
2,500
3,000
Flowrate (cfs)

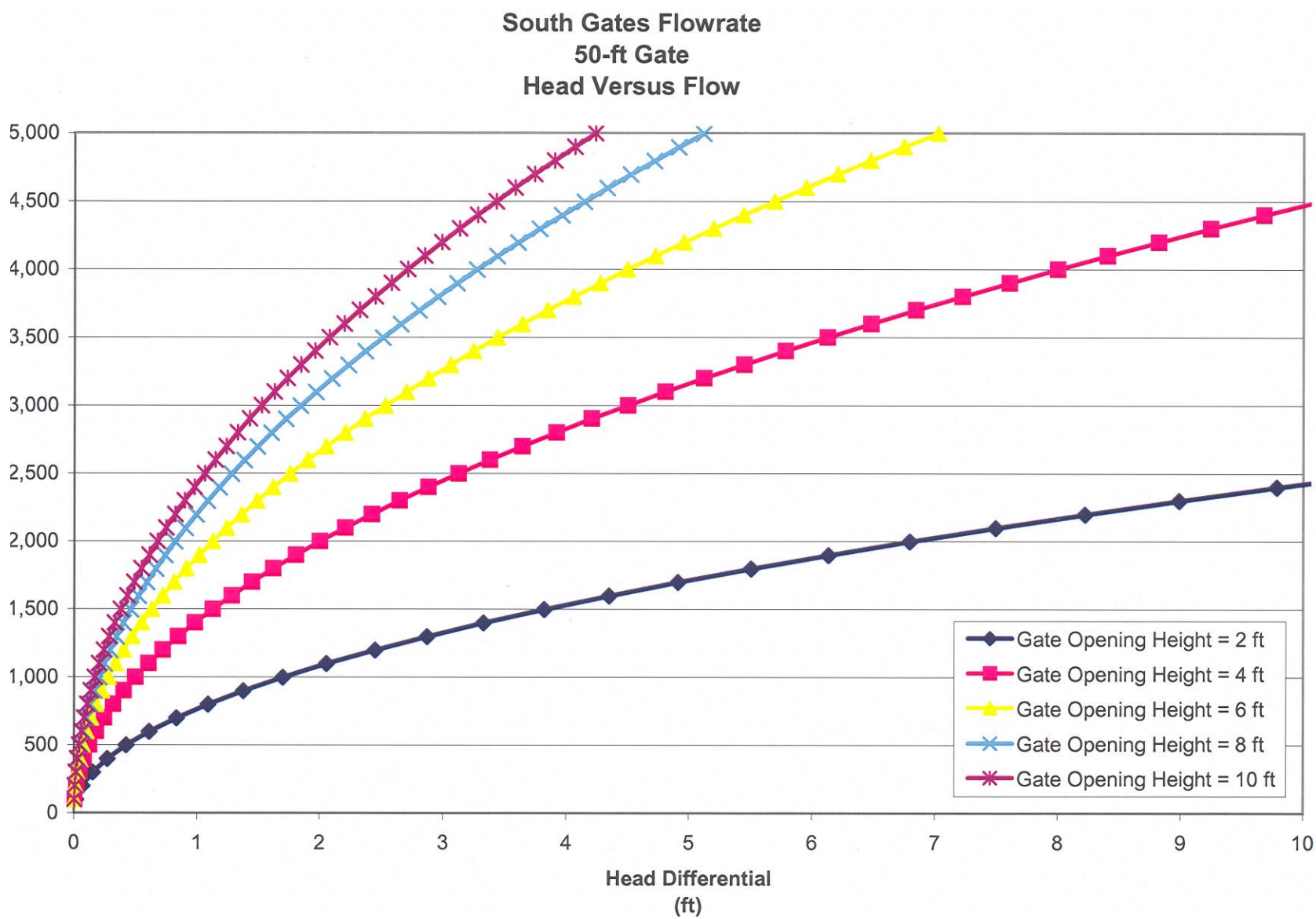
100-ft wide 10.6 backwater in NNF Water surface el 10 ft opening	100-ft wide 10.6 backwater in NNR Water surface el 8 ft opening	100-ft wide 10.6 backwater in NNR Water surface el 6 ft opening	100-ft wide 10.6 backwater in NNR Water surface el 4 ft opening	100-ft wide 10.6 backv 10.6 backwater in NI Water surface el 2 ft opening
10.50042	10.50051	10.5007	10.50124	10.50424
10.50167	10.50202	10.50278	10.50497	10.51696
10.50375	10.50455	10.50626	10.51119	10.53817
10.50667	10.50808	10.51114	10.51989	10.56785
10.51043	10.51263	10.5174	10.53108	10.60601
10.51502	10.51819	10.52505	10.54476	10.65266
10.52044	10.52476	10.5341	10.56092	10.70779
10.5267	10.53233	10.54454	10.57957	10.77139
10.53379	10.54092	10.55637	10.60071	10.84349
10.54172	10.55052	10.5696	10.62434	10.92406
10.55048	10.56114	10.58422	10.65045	11.01311
10.56007	10.57276	10.60022	10.67904	11.11064
10.5705	10.58539	10.61762	10.71013	11.21666
10.58176	10.59903	10.63641	10.7437	11.33115
10.59386	10.61368	10.6566	10.77976	11.45413
10.60679	10.62934	10.67817	10.8183	11.58559
10.62056	10.64602	10.70114	10.85934	11.72553
10.63516	10.6637	10.7255	10.90285	11.87395
10.6506	10.6824	10.75126	10.94886	12.03086
10.66687	10.70211	10.7784	10.99735	12.19624
10.68398	10.72283	10.80694	11.04834	12.37012
10.70192	10.74455	10.83687	11.1018	12.55246
10.72069	10.76729	10.86819	11.15776	12.7433
10.7403	10.79104	10.90091	11.2162	12.94261
10.76075	10.81581	10.93502	11.27713	13.15041
10.78203	10.84158	10.97052	11.34055	13.36669
10.80414	10.86836	11.00741	11.40646	13.59146
10.82709	10.89616	11.0457	11.47485	13.8247
10.85088	10.92496	11.08538	11.54573	14.06643
10.8755	10.95478	11.12645	11.6191	14.31665
10.90096	10.98561	11.16891	11.69495	14.57535
10.92725	11.01745	11.21277	11.7733	14.84252
10.95437	11.0503	11.25802	11.85413	15.11819
10.98233	11.08417	11.30467	11.93745	15.40234
11.01113	11.11905	11.3527	12.02326	15.69497
11.04076	11.15493	11.40213	12.11156	15.99609
11.07123	11.19183	11.45296	12.20234	16.30569
11.10254	11.22975	11.50518	12.29562	16.62377
11.13468	11.26867	11.55879	12.39138	16.95034
11.16765	11.30861	11.61379	12.48963	17.2854
11.20147	11.34955	11.67019	12.59037	17.62894
11.23612	11.39151	11.72799	12.6936	17.98097
11.2716	11.43449	11.78717	12.79932	18.34147
11.30792	11.47847	11.84775	12.90753	18.71047
11.34508	11.52347	11.90973	13.01823	19.08796
11.38307	11.56948	11.9731	13.13142	19.47392
11.4219	11.6165	12.03786	13.2471	19.86838
11.46157	11.66454	12.10402	13.36526	20.27132
11.50207	11.71359	12.17158	13.48592	20.68275
11.54341	11.76365	12.24052	13.60907	21.10266


South Gates Flowrate
30-ft Gate
Head Versus Flow
Gate Opening Height = 2 ft
Gate Opening Height = 4 ft
Gate Opening Height = 6 ft
Gate Opening Height = 8 ft
Gate Opening Height = 10 ft
Inflow/Outflow (cfs)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
1
2
3
4
5
6
7
8
9
10
Head Differential (ft)

Backwater = Constant 8.6 ft

flow (cfs)	30 ft Gate Open 2ft	30 ft Gate Open 4ft	30 ft Gate Open 6ft	30 ft Gate Open 8ft	30 ft Gate Open 10ft
100	10.5472	10.5139	10.50781	10.50569	10.50472
200	10.68879	10.55559	10.53126	10.52278	10.51886
300	10.92479	10.62507	10.57033	10.55126	10.54245
400	11.25518	10.72234	10.62503	10.59112	10.57546
500	11.67997	10.84741	10.69536	10.64238	10.61791
600	12.19915	11.00027	10.78132	10.70503	10.66979
700	12.81274	11.18093	10.88291	10.77907	10.7311
800	13.52072	11.38938	11.00013	10.86449	10.80185
900	14.32311	11.62562	11.13298	10.96131	10.88203
1000	15.21989	11.88966	11.28146	11.06952	10.97164
1100	16.21107	12.18149	11.44556	11.18913	11.07069
1200	17.29666	12.50111	11.6253	11.32012	11.17917
1300	18.47664	12.84853	11.82067	11.46251	11.29709
1400	19.75103	13.22375	12.03167	11.61629	11.42444
1500	21.11982	13.62676	12.2583	11.78146	11.56123
1600	22.58301	14.05757	12.50057	11.95803	11.70745
1700	24.14061	14.51618	12.75847	12.14598	11.86311
1800	25.79261	15.00258	13.032	12.34534	12.02821
1900	27.53901	15.51679	13.32116	12.55609	12.20274
2000	29.37982	16.05879	13.62596	12.77823	12.38671
2100	31.31503	16.62859	13.94639	13.01177	12.58011
2200	33.34465	17.22618	14.28245	13.2567	12.78295
2300	35.96214	17.85159	14.63416	13.51303	12.99524
2400	39.10397	18.50479	15.00149	13.78075	13.21696
2500	42.37949	19.18578	15.38446	14.05988	13.44811
2600	45.78873	19.89459	15.78307	14.3504	13.68871
2700	49.33165	20.63119	16.19732	14.65232	13.93875
2800	53.00826	21.3956	16.6272	14.96563	14.19823
2900	56.81858	22.18781	17.07272	15.29035	14.46716
3000	60.76258	23.00782	17.53388	15.62646	14.74551
3100	64.84029	23.85563	18.01068	15.97397	15.03332
3200	69.05168	24.73125	18.50311	16.33289	15.33056
3300	73.39677	25.63467	19.01119	16.7032	15.63725
3400	77.87556	26.5659	19.5349	17.08492	15.95338
3500	82.48803	27.52492	20.07426	17.47803	16.27895
3600	87.23421	28.51176	20.62925	17.88254	16.61397
3700	92.11408	29.52639	21.19989	18.29846	16.95843
3800	97.12765	30.56883	21.78616	18.72578	17.31233
3900	100.9718	31.63908	22.38808	19.1645	17.67567
4000	101.0794	32.73714	23.00564	19.61462	18.04846
4100	101.1709	33.86298	23.63884	20.07614	18.4307
4200	101.2444	35.01665	24.28768	20.54907	18.82238
4300	101.3172	36.19812	24.95215	21.0334	19.2235
4400	101.386	37.40738	25.63227	21.52913	19.63407
4500	101.4541	38.64445	26.32804	22.03626	20.05408
4600	101.5177	39.90934	27.03944	22.5548	20.48354
4700	101.5749	41.20201	27.76648	23.08474	20.92244
4800	101.6383	42.6205	28.50917	23.62608	21.37079
4900	101.7076	44.30543	29.2675	24.17883	21.82859
5000	101.7442	46.02509	30.04147	24.74298	22.29583

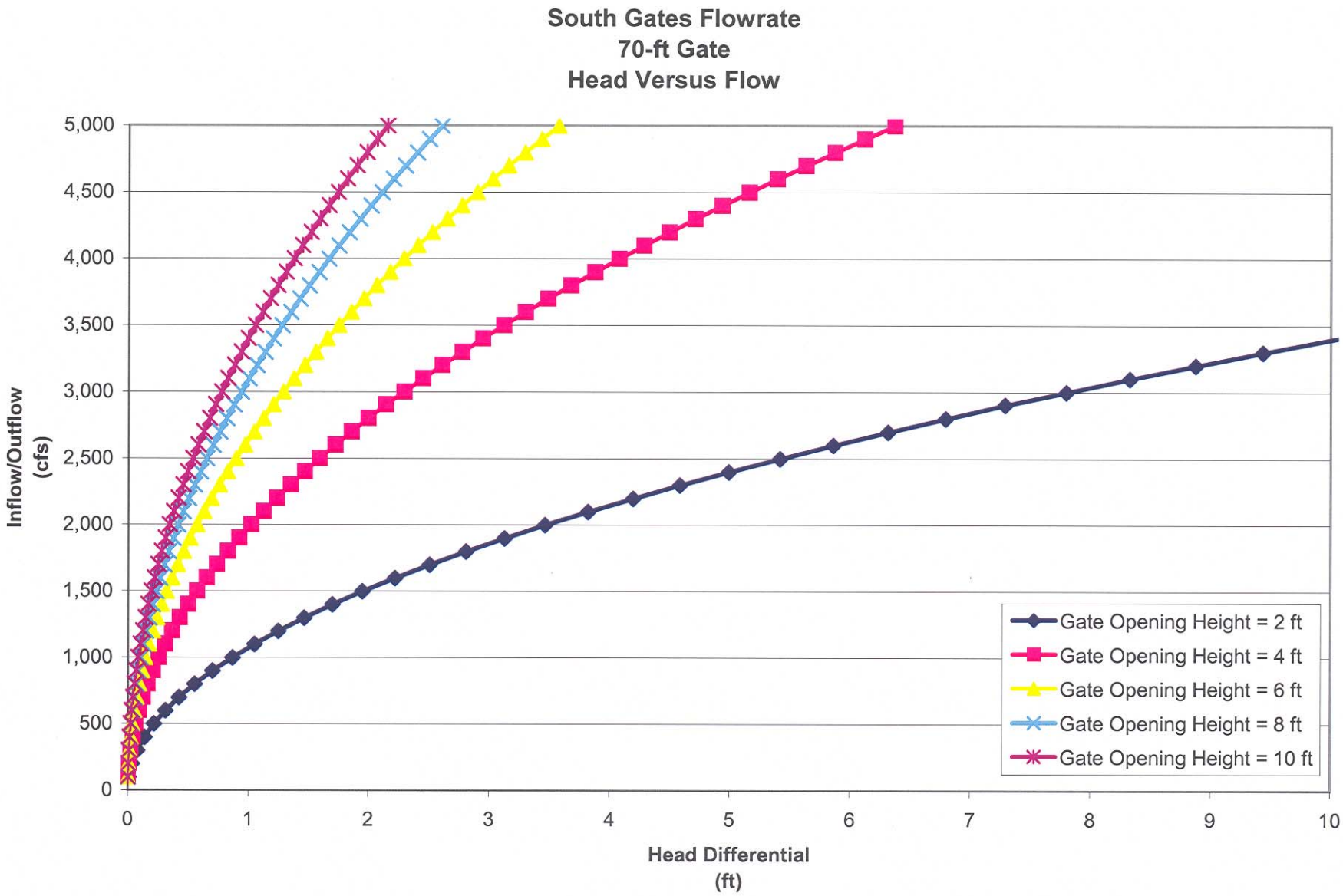
Head Differential Open 2ft	Backwater = Constant 8.6 ft 30 ft Gate Open 4ft	31 ft Gate Open 6ft	32 ft Gate Open 8ft	33 ft Gate Open 10ft	34 ft Gate Flow
0.05	0.01	0.01	0.01	0.00	100
0.19	0.06	0.03	0.02	0.02	200
0.42	0.13	0.07	0.05	0.04	300
0.76	0.22	0.13	0.09	0.08	400
1.18	0.35	0.20	0.14	0.12	500
1.70	0.50	0.28	0.21	0.17	600
2.31	0.68	0.38	0.28	0.23	700
3.02	0.89	0.50	0.36	0.30	800
3.82	1.13	0.63	0.46	0.38	900
4.72	1.39	0.78	0.57	0.47	1000
5.71	1.68	0.95	0.69	0.57	1100
6.80	2.00	1.13	0.82	0.68	1200
7.98	2.35	1.32	0.96	0.80	1300
9.25	2.72	1.53	1.12	0.92	1400
10.62	3.13	1.76	1.28	1.06	1500
12.08	3.56	2.00	1.46	1.21	1600
13.64	4.02	2.26	1.65	1.36	1700
15.29	4.50	2.53	1.85	1.53	1800
17.04	5.02	2.82	2.06	1.70	1900
18.88	5.56	3.13	2.28	1.89	2000
20.82	6.13	3.45	2.51	2.08	2100
22.84	6.73	3.78	2.76	2.28	2200
25.46	7.35	4.13	3.01	2.50	2300
28.60	8.00	4.50	3.28	2.72	2400
31.88	8.69	4.88	3.56	2.95	2500
35.29	9.39	5.28	3.85	3.19	2600
38.83	10.13	5.70	4.15	3.44	2700
42.51	10.90	6.13	4.47	3.70	2800
46.32	11.69	6.57	4.79	3.97	2900
50.26	12.51	7.03	5.13	4.25	3000
54.34	13.36	7.51	5.47	4.53	3100
58.55	14.23	8.00	5.83	4.83	3200
62.90	15.13	8.51	6.20	5.14	3300
67.38	16.07	9.03	6.58	5.45	3400
71.99	17.02	9.57	6.98	5.78	3500
76.73	18.01	10.13	7.38	6.11	3600
81.61	19.03	10.70	7.80	6.46	3700
86.63	20.07	11.29	8.23	6.81	3800
90.47	21.14	11.89	8.66	7.18	3900
90.58	22.24	12.51	9.11	7.55	4000
90.67	23.36	13.14	9.58	7.93	4100
90.74	24.52	13.79	10.05	8.32	4200
90.82	25.70	14.45	10.53	8.72	4300
90.89	26.91	15.13	11.03	9.13	4400
90.95	28.14	15.83	11.54	9.55	4500
91.02	29.41	16.54	12.05	9.98	4600
91.07	30.70	17.27	12.58	10.42	4700
91.14	32.12	18.01	13.13	10.87	4800
91.21	33.81	18.77	13.68	11.33	4900
91.24	35.53	19.54	14.24	11.80	5000


South Gates Flowrate
50-ft Gate
Head Versus Flow
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
1
2
3
4
5
6
7
8
9
10
Head Differential
(ft)
Gate Opening Height = 2 ft
Gate Opening Height = 4 ft
Gate Opening Height = 6 ft
Gate Opening Height = 8 ft
Gate Opening Height = 10 ft

flow (cfs)	Backwater = Constant 8.6 ft 50 ft Gate Open 2ft	50 ft Gate Open 4ft	50 ft Gate Open 6ft	50 ft Gate Open 8ft	50 ft Gate Open 10-ft
100	10.51699	10.505	10.50281	10.50204	10.50169
200	10.56795	10.51999	10.51123	10.50818	10.50677
300	10.65288	10.54498	10.52527	10.51841	10.51523
400	10.77178	10.57996	10.54493	10.53272	10.52708
500	10.92466	10.62494	10.5702	10.55113	10.54232
600	11.11151	10.67991	10.60109	10.57362	10.56094
700	11.33233	10.74488	10.6376	10.60021	10.58295
800	11.58713	10.81985	10.67972	10.63089	10.60834
900	11.8759	10.90481	10.72745	10.66566	10.63711
1000	12.19864	10.99976	10.78081	10.70451	10.66928
1100	12.55536	11.10471	10.83978	10.74746	10.70483
1200	12.94605	11.21966	10.90437	10.7945	10.74376
1300	13.37072	11.3446	10.97457	10.84563	10.78608
1400	13.82936	11.47954	11.05039	10.90085	10.83179
1500	14.32197	11.62447	11.13183	10.96017	10.88088
1600	14.84856	11.7794	11.21888	11.02357	10.93336
1700	15.40913	11.94433	11.31156	11.09107	10.98923
1800	16.00367	12.11926	11.40985	11.16265	11.04848
1900	16.63219	12.30418	11.51375	11.23833	11.11112
2000	17.29468	12.4991	11.62328	11.3181	11.17715
2100	17.99115	12.70401	11.73842	11.40196	11.24657
2200	18.7216	12.91893	11.85919	11.48992	11.31937
2300	19.48602	13.14384	11.98557	11.58196	11.39556
2400	20.28443	13.37875	12.11757	11.6781	11.47514
2500	21.11681	13.62366	12.25519	11.77834	11.55811
2600	21.98317	13.87857	12.39842	11.88266	11.64446
2700	22.88351	14.14347	12.54728	11.99108	11.7342
2800	23.81782	14.41838	12.70176	12.10359	11.82733
2900	24.78612	14.70329	12.86185	12.2202	11.92385
3000	25.78839	14.99819	13.02757	12.3409	12.02376
3100	26.82464	15.3031	13.19891	12.4657	12.12706
3200	27.89488	15.61801	13.37587	12.59459	12.23375
3300	28.99909	15.94291	13.55844	12.72757	12.34383
3400	30.13728	16.27782	13.74664	12.86465	12.4573
3500	31.30945	16.62273	13.94047	13.00582	12.57416
3600	32.51561	16.97764	14.13991	13.15109	12.69441
3700	33.75574	17.34256	14.34497	13.30046	12.81805
3800	35.34949	17.71747	14.55566	13.45392	12.94508
3900	37.20251	18.1024	14.77197	13.61148	13.0755
4000	39.10366	18.49732	14.99391	13.77313	13.20931
4100	41.05294	18.90224	15.22147	13.93889	13.34652
4200	43.05035	19.31717	15.45465	14.10873	13.48712
4300	45.09589	19.74211	15.69345	14.28268	13.63111
4400	47.18956	20.17704	15.93788	14.46072	13.77849
4500	49.33137	20.62198	16.18793	14.64286	13.92927
4600	51.5213	21.07693	16.44361	14.8291	14.08344
4700	53.75936	21.54187	16.70491	15.01944	14.241
4800	56.04555	22.01683	16.97183	15.21388	14.40196
4900	58.37987	22.50179	17.24439	15.41241	14.56631
5000	60.76233	22.99675	17.52256	15.61504	14.73405

Backwater = Constant 8.6 ft

Head Differentia Open 2ft	50 ft Gate Open 4ft	50 ft Gate Open 6ft	50 ft Gate Open 8ft	50 ft Gate Open 10ft	50 ft Gate Flow
0.01699	0.005	0.00281	0.00204	0.00169	100
0.06795	0.01999	0.01123	0.00818	0.00677	200
0.15288	0.04498	0.02527	0.01841	0.01523	300
0.27178	0.07996	0.04493	0.03272	0.02708	400
0.42466	0.12494	0.0702	0.05113	0.04232	500
0.61151	0.17991	0.10109	0.07362	0.06094	600
0.83233	0.24488	0.1376	0.10021	0.08295	700
1.08713	0.31985	0.17972	0.13089	0.10834	800
1.3759	0.40481	0.22745	0.16566	0.13711	900
1.69864	0.49976	0.28081	0.20451	0.16928	1000
2.05536	0.60471	0.33978	0.24746	0.20483	1100
2.44605	0.71966	0.40437	0.2945	0.24376	1200
2.87072	0.8446	0.47457	0.34563	0.28608	1300
3.32936	0.97954	0.55039	0.40085	0.33179	1400
3.82197	1.12447	0.63183	0.46017	0.38088	1500
4.34856	1.2794	0.71888	0.52357	0.43336	1600
4.90913	1.44433	0.81156	0.59107	0.48923	1700
5.50367	1.61926	0.90985	0.66265	0.54848	1800
6.13219	1.80418	1.01375	0.73833	0.61112	1900
6.79468	1.9991	1.12328	0.8181	0.67715	2000
7.49115	2.20401	1.23842	0.90196	0.74657	2100
8.2216	2.41893	1.35919	0.98992	0.81937	2200
8.98602	2.64384	1.48557	1.08196	0.89556	2300
9.78443	2.87875	1.61757	1.1781	0.97514	2400
10.61681	3.12366	1.75519	1.27834	1.05811	2500
11.48317	3.37857	1.89842	1.38266	1.14446	2600
12.38351	3.64347	2.04728	1.49108	1.2342	2700
13.31782	3.91838	2.20176	1.60359	1.32733	2800
14.28612	4.20329	2.36185	1.7202	1.42385	2904
15.28839	4.49819	2.52757	1.8409	1.52376	3000
16.32464	4.8031	2.69891	1.9657	1.62706	3100
17.39488	5.11801	2.87587	2.09459	1.73375	3200
18.49909	5.44291	3.05844	2.22757	1.84383	3300
19.63728	5.77782	3.24664	2.36465	1.9573	3400
20.80945	6.12273	3.44047	2.50582	2.07416	3500
22.01561	6.47764	3.63991	2.65109	2.19441	3600
23.25574	6.84256	3.84497	2.80046	2.31805	3700
24.84949	7.21747	4.05566	2.95392	2.44508	3800
26.70251	7.6024	4.27197	3.11148	2.5755	3900
28.60366	7.99732	4.49391	3.27313	2.70931	4000
30.55294	8.40224	4.72147	3.43889	2.84652	4100
32.55035	8.81717	4.95465	3.60873	2.98712	4200
34.59589	9.24211	5.19345	3.78268	3.13111	4300
36.68956	9.67704	5.43788	3.96072	3.27849	4400
38.83137	10.12198	5.68793	4.14286	3.42927	4500
41.0213	10.57693	5.94361	4.3291	3.58344	4600
43.25936	11.04187	6.20491	4.51944	3.741	4700
45.54555	11.51683	6.47183	4.71388	3.90196	4800
47.87987	12.00179	6.74439	4.91241	4.06631	4900
50.26233	12.49675	7.02256	5.11504	4.23405	5000

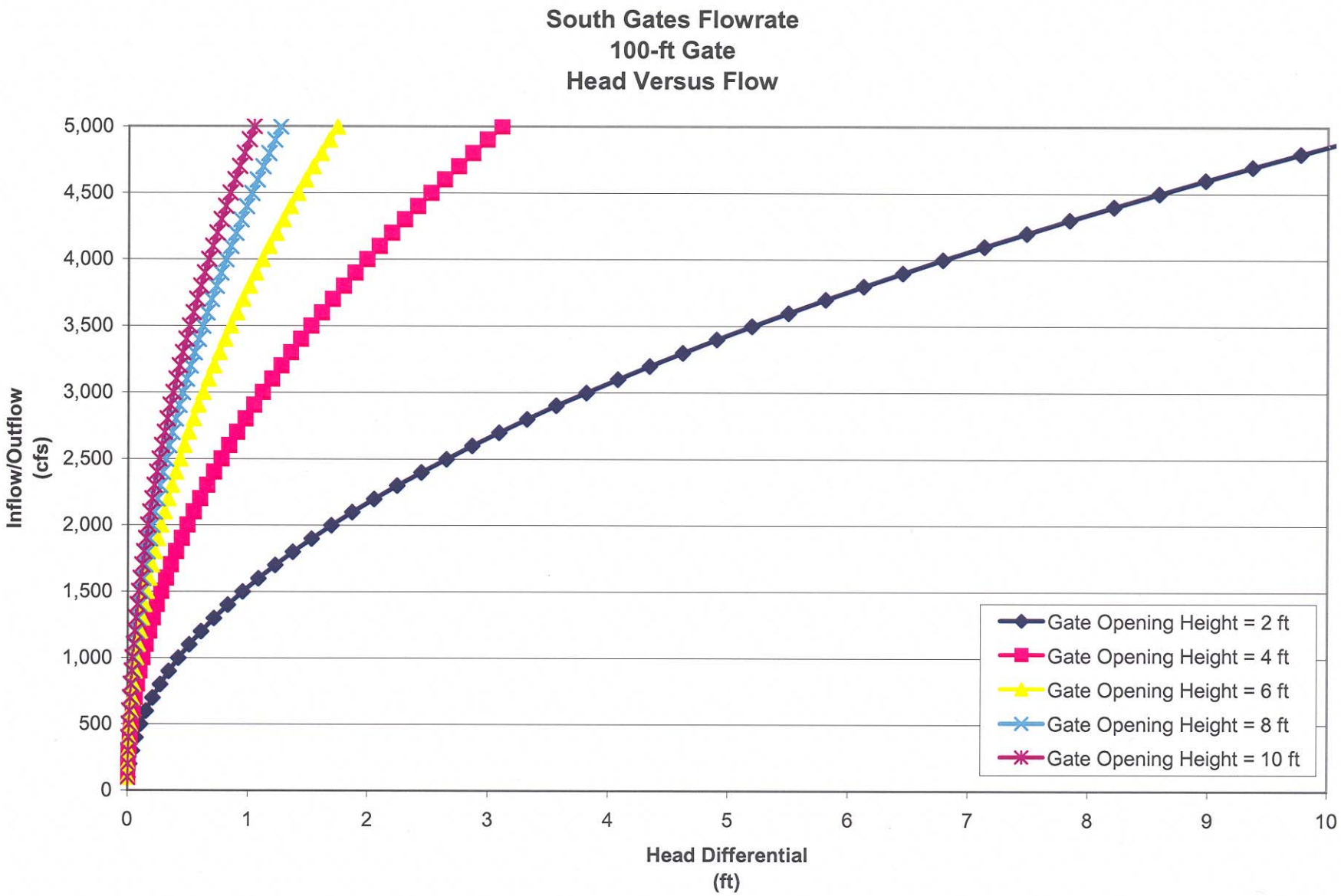

South Gates Flowrate
70-ft Gate
Head Versus Flow
Inflow/Outflow (cfs)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
1
2
3
4
5
6
7
8
9
10
Head Differential (ft)
Gate Opening Height = 2 ft
Gate Opening Height = 4 ft
Gate Opening Height = 6 ft
Gate Opening Height = 8 ft
Gate Opening Height = 10 ft

Backwater = Constant 8.6 ft

flow (cfs)	70 ft Gate Open 2ft	70 ft Gate Open 4ft	70 ft Gate Open 6ft	70 ft Gate Open 8ft	70 ft Gate Open 10ft
100	10.50866	10.50255	10.50143	10.50104	10.50086
200	10.53465	10.51018	10.50571	10.50416	10.50344
300	10.57796	10.52291	10.51286	10.50936	10.50774
400	10.6386	10.54073	10.52286	10.51663	10.51375
500	10.71656	10.56364	10.53572	10.52599	10.52149
600	10.81185	10.59165	10.55143	10.53742	10.53095
700	10.92447	10.62475	10.57001	10.55093	10.54212
800	11.0544	10.66293	10.59144	10.56653	10.55502
900	11.20167	10.70621	10.61573	10.5842	10.56964
1000	11.36626	10.75458	10.64287	10.60395	10.58597
1100	11.54818	10.80805	10.67288	10.62578	10.60403
1200	11.74742	10.8666	10.70574	10.64969	10.6238
1300	11.96398	10.93025	10.74146	10.67568	10.64529
1400	12.19788	10.99899	10.78004	10.70374	10.66851
1500	12.44909	11.07282	10.82147	10.73389	10.69344
1600	12.71764	11.15175	10.86577	10.76612	10.72009
1700	13.00351	11.23576	10.91292	10.80042	10.74847
1800	13.30671	11.32487	10.96293	10.83681	10.77856
1900	13.62724	11.41907	11.0158	10.87527	10.81037
2000	13.96509	11.51837	11.07152	10.91582	10.84391
2100	14.32027	11.62275	11.13011	10.95844	10.87916
2200	14.69277	11.73223	11.19155	11.00315	10.91614
2300	15.08261	11.84681	11.25585	11.04993	10.95483
2400	15.48977	11.96647	11.32301	11.0988	10.99524
2500	15.91427	12.09123	11.39303	11.14975	11.03738
2600	16.35609	12.22108	11.46591	11.20277	11.08124
2700	16.81524	12.35603	11.54165	11.25788	11.12682
2800	17.29171	12.49607	11.62025	11.31507	11.17412
2900	17.78552	12.64121	11.70171	11.37433	11.22314
3000	18.29666	12.79144	11.78602	11.43568	11.27388
3100	18.82512	12.94676	11.8732	11.49911	11.32634
3200	19.37092	13.10718	11.96323	11.56462	11.38053
3300	19.93405	13.27269	12.05613	11.63222	11.43643
3400	20.5145	13.44329	12.15189	11.70189	11.49406
3500	21.11229	13.619	12.2505	11.77365	11.55341
3600	21.7274	13.79979	12.35198	11.84748	11.61448
3700	22.35985	13.98569	12.45632	11.9234	11.67728
3800	23.00963	14.17668	12.56351	12.0014	11.74179
3900	23.67674	14.37276	12.67357	12.08149	11.80803
4000	24.36118	14.57394	12.78649	12.16365	11.876
4100	25.06295	14.78022	12.90228	12.2479	11.94568
4200	25.78205	14.9916	13.02092	12.33424	12.01709
4300	26.51849	15.20807	13.14242	12.42265	12.09022
4400	27.27226	15.42963	13.26679	12.51315	12.16508
4500	28.04336	15.6563	13.39402	12.60573	12.24166
4600	28.83179	15.88806	13.52411	12.70039	12.31996
4700	29.63755	16.12492	13.65707	12.79714	12.39998
4800	30.46064	16.36688	13.79288	12.89597	12.48173
4900	31.30107	16.61394	13.93156	12.99689	12.56521
5000	32.15883	16.86609	14.07311	13.09989	12.65041

Backwater = Constant 8.6 ft

Head Differentia Open 2ft	70 ft Gate Open 4ft	70 ft Gate Open 6ft	70 ft Gate Open 8ft	70 ft Gate Open 10ft	70 ft Gate Flow
0.00866	0.00255	0.00143	0.00104	0.00086	100
0.03465	0.01018	0.00571	0.00416	0.00344	200
0.07796	0.02291	0.01286	0.00936	0.00774	300
0.1386	0.04073	0.02286	0.01663	0.01375	400
0.21656	0.06364	0.03572	0.02599	0.02149	500
0.31185	0.09165	0.05143	0.03742	0.03095	600
0.42447	0.12475	0.07001	0.05093	0.04212	700
0.5544	0.16293	0.09144	0.06653	0.05502	800
0.70167	0.20621	0.11573	0.0842	0.06964	900
0.86626	0.25458	0.14287	0.10395	0.08597	1000
1.04818	0.30805	0.17288	0.12578	0.10403	1100
1.24742	0.3666	0.20574	0.14969	0.1238	1200
1.46398	0.43025	0.24146	0.17568	0.14529	1300
1.69788	0.49899	0.28004	0.20374	0.16851	1400
1.94909	0.57282	0.32147	0.23389	0.19344	1500
2.21764	0.65175	0.36577	0.26612	0.22009	1600
2.50351	0.73576	0.41292	0.30042	0.24847	1700
2.80671	0.82487	0.46293	0.33681	0.27856	1800
3.12724	0.91907	0.5158	0.37527	0.31037	1900
3.46509	1.01837	0.57152	0.41582	0.34391	2000
3.82027	1.12275	0.63011	0.45844	0.37916	2100
4.19277	1.23223	0.69155	0.50315	0.41614	2200
4.58261	1.34681	0.75585	0.54993	0.45483	2300
4.98977	1.46647	0.82301	0.5988	0.49524	2400
5.41427	1.59123	0.89303	0.64975	0.53738	2500
5.85609	1.72108	0.96591	0.70277	0.58124	2600
6.31524	1.85603	1.04165	0.75788	0.62682	2700
6.79171	1.99607	1.12025	0.81507	0.67412	2800
7.28552	2.14121	1.20171	0.87433	0.72314	2904
7.79666	2.29144	1.28602	0.93568	0.77388	3000
8.32512	2.44676	1.3732	0.99911	0.82634	3100
8.87092	2.60718	1.46323	1.06462	0.88053	3200
9.43405	2.77269	1.55613	1.13222	0.93643	3300
10.0145	2.94329	1.65189	1.20189	0.99406	3400
10.61229	3.119	1.7505	1.27365	1.05341	3500
11.2274	3.29979	1.85198	1.34748	1.11448	3600
11.85985	3.48569	1.95632	1.4234	1.17728	3700
12.50963	3.67668	2.06351	1.5014	1.24179	3800
13.17674	3.87276	2.17357	1.58149	1.30803	3900
13.86118	4.07394	2.28649	1.66365	1.376	4000
14.56295	4.28022	2.40228	1.7479	1.44568	4100
15.28205	4.4916	2.52092	1.83424	1.51709	4200
16.01849	4.70807	2.64242	1.92265	1.59022	4300
16.77226	4.92963	2.76679	2.01315	1.66508	4400
17.54336	5.1563	2.89402	2.10573	1.74166	4500
18.33179	5.38806	3.02411	2.20039	1.81996	4600
19.13755	5.62492	3.15707	2.29714	1.89998	4700
19.96064	5.86688	3.29288	2.39597	1.98173	4800
20.80107	6.11394	3.43156	2.49689	2.06521	4900
21.65883	6.36609	3.57311	2.59989	2.15041	5000


South Gates Flowrate
100-ft Gate
Head Versus Flow
Inflow/Outflow (cfs)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
1
2
3
4
5
6
7
8
9
10
Head Differential (ft)
Gate Opening Height = 2 ft
Gate Opening Height = 4 ft
Gate Opening Height = 6 ft
Gate Opening Height = 8 ft
Gate Opening Height = 10 ft

Backwater = Constant 8.6 ft

flow (cfs)	100 ft Gate Open 2ft	100 ft Gate Open 4ft	100 ft Gate Open 6ft	100 ft Gate Open 8ft	100 ft Gate Open 10ft
100	10.50424	10.50124	10.5007	10.50051	10.50042
200	10.51696	10.50497	10.50278	10.50202	10.50167
300	10.53817	10.51119	10.50626	10.50455	10.50375
400	10.56785	10.51989	10.51114	10.50808	10.50667
500	10.60601	10.53108	10.5174	10.51263	10.51043
600	10.65266	10.54476	10.52505	10.51819	10.51502
700	10.70779	10.56092	10.5341	10.52476	10.52044
800	10.77139	10.57957	10.54454	10.53233	10.5267
900	10.84349	10.60071	10.55637	10.54092	10.53379
1000	10.92406	10.62434	10.5696	10.55052	10.54172
1100	11.01311	10.65045	10.58422	10.56114	10.55048
1200	11.11064	10.67904	10.60022	10.57276	10.56007
1300	11.21666	10.71013	10.61762	10.58539	10.5705
1400	11.33115	10.7437	10.63641	10.59903	10.58176
1500	11.45413	10.77976	10.6566	10.61368	10.59386
1600	11.58559	10.8183	10.67817	10.62934	10.60679
1700	11.72553	10.85934	10.70114	10.64602	10.62056
1800	11.87395	10.90285	10.7255	10.6637	10.63516
1900	12.03086	10.94886	10.75126	10.6824	10.6506
2000	12.19624	10.99735	10.7784	10.70211	10.66687
2100	12.37012	11.04834	10.80694	10.72283	10.68398
2200	12.55246	11.1018	10.83687	10.74455	10.70192
2300	12.7433	11.15776	10.86819	10.76729	10.72069
2400	12.94261	11.2162	10.90091	10.79104	10.7403
2500	13.15041	11.27713	10.93502	10.81581	10.76075
2600	13.36669	11.34055	10.97052	10.84158	10.78203
2700	13.59146	11.40646	11.00741	10.86836	10.80414
2800	13.8247	11.47485	11.0457	10.89616	10.82709
2900	14.06643	11.54573	11.08538	10.92496	10.85088
3000	14.31665	11.6191	11.12645	10.95478	10.8755
3100	14.57535	11.69495	11.16891	10.98561	10.90096
3200	14.84252	11.7733	11.21277	11.01745	10.92725
3300	15.11819	11.85413	11.25802	11.0503	10.95437
3400	15.40234	11.93745	11.30467	11.08417	10.98233
3500	15.69497	12.02326	11.3527	11.11905	11.01113
3600	15.99609	12.11156	11.40213	11.15493	11.04076
3700	16.30569	12.20234	11.45296	11.19183	11.07123
3800	16.62377	12.29562	11.50518	11.22975	11.10254
3900	16.95034	12.39138	11.55879	11.26867	11.13468
4000	17.2854	12.48963	11.61379	11.30861	11.16765
4100	17.62894	12.59037	11.67019	11.34955	11.20147
4200	17.98097	12.6936	11.72799	11.39151	11.23612
4300	18.34147	12.79932	11.78717	11.43449	11.2716
4400	18.71047	12.90753	11.84775	11.47847	11.30792
4500	19.08796	13.01823	11.90973	11.52347	11.34508
4600	19.47392	13.13142	11.9731	11.56948	11.38307
4700	19.86838	13.2471	12.03786	11.6165	11.4219
4800	20.27132	13.36526	12.10402	11.66454	11.46157
4900	20.68275	13.48592	12.17158	11.71359	11.50207
5000	21.10266	13.60907	12.24052	11.76365	11.54341

Backwater = Constant 8.6 ft

Head Differentia Open 2ft	100 ft Gate Open 4ft	100 ft Gate Open 6ft	100 ft Gate Open 8ft	100 ft Gate Open 10ft	100 ft Gate Flow
0.00424	0.00124	0.0007	0.00051	0.00042	100
0.01696	0.00497	0.00278	0.00202	0.00167	200
0.03817	0.01119	0.00626	0.00455	0.00375	300
0.06785	0.01989	0.01114	0.00808	0.00667	400
0.10601	0.03108	0.0174	0.01263	0.01043	500
0.15266	0.04476	0.02505	0.01819	0.01502	600
0.20779	0.06092	0.0341	0.02476	0.02044	700
0.27139	0.07957	0.04454	0.03233	0.0267	800
0.34349	0.10071	0.05637	0.04092	0.03379	900
0.42406	0.12434	0.0696	0.05052	0.04172	1000
0.51311	0.15045	0.08422	0.06114	0.05048	1100
0.61064	0.17904	0.10022	0.07276	0.06007	1200
0.71666	0.21013	0.11762	0.08539	0.0705	1300
0.83115	0.2437	0.13641	0.09903	0.08176	1400
0.95413	0.27976	0.1566	0.11368	0.09386	1500
1.08559	0.3183	0.17817	0.12934	0.10679	1600
1.22553	0.35934	0.20114	0.14602	0.12056	1700
1.37395	0.40285	0.2255	0.1637	0.13516	1800
1.53086	0.44886	0.25126	0.1824	0.1506	1900
1.69624	0.49735	0.2784	0.20211	0.16687	2000
1.87012	0.54834	0.30694	0.22283	0.18398	2100
2.05246	0.6018	0.33687	0.24455	0.20192	2200
2.2433	0.65776	0.36819	0.26729	0.22069	2300
2.44261	0.7162	0.40091	0.29104	0.2403	2400
2.65041	0.77713	0.43502	0.31581	0.26075	2500
2.86669	0.84055	0.47052	0.34158	0.28203	2600
3.09146	0.90646	0.50741	0.36836	0.30414	2700
3.3247	0.97485	0.5457	0.39616	0.32709	2800
3.56643	1.04573	0.58538	0.42496	0.35088	2904
3.81665	1.1191	0.62645	0.45478	0.3755	3000
4.07535	1.19495	0.66891	0.48561	0.40096	3100
4.34252	1.2733	0.71277	0.51745	0.42725	3200
4.61819	1.35413	0.75802	0.5503	0.45437	3300
4.90234	1.43745	0.80467	0.58417	0.48233	3400
5.19497	1.52326	0.8527	0.61905	0.51113	3500
5.49609	1.61156	0.90213	0.65493	0.54076	3600
5.80569	1.70234	0.95296	0.69183	0.57123	3700
6.12377	1.79562	1.00518	0.72975	0.60254	3800
6.45034	1.89138	1.05879	0.76867	0.63468	3900
6.7854	1.98963	1.11379	0.80861	0.66765	4000
7.12894	2.09037	1.17019	0.84955	0.70147	4100
7.48097	2.1936	1.22799	0.89151	0.73612	4200
7.84147	2.29932	1.28717	0.93449	0.7716	4300
8.21047	2.40753	1.34775	0.97847	0.80792	4400
8.58796	2.51823	1.40973	1.02347	0.84508	4500
8.97392	2.63142	1.4731	1.06948	0.88307	4600
9.36838	2.7471	1.53786	1.1165	0.9219	4700
9.77132	2.86526	1.60402	1.16454	0.96157	4800
10.18275	2.98592	1.67158	1.21359	1.00207	4900
10.60266	3.10907	1.74052	1.26365	1.04341	5000

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Owner _____ Computed By JCS

Plant _____ Unit _____ Date _____ 20 ____

Project No. _____ File No. _____ Verified By _____

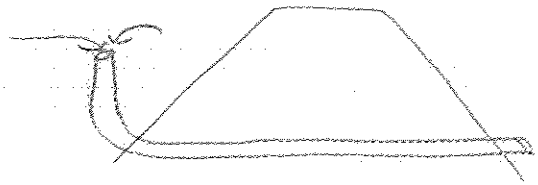
Title Everglades Date _____ 20 ____

Spillway Weir / Orifice Page ____ of ____

Initial Calcs

Uncontrolled Spillway

- Requirements: Allow no more than 3/4 of an inch per day release from Reservoir A-2 during the 100-yr event
- Refer to Rich's e-mail to see development of spillway length.
- Spillway should be no greater than 170' @ an elevation of 12'. This keeps from exceeding the 100-yr, OCM-3 criteria.
- To protect against wind set-up conditions, the spillway cannot by a free event. Should be a drop-inlet w/ some inherent orifice controls to restrict maximum out flows



Not to scale

Opening can be square or circular and an effective length of 170 ft in length.

Roughly $2\pi r = C$ $r = 27'$ (or smaller)

Box: 170/4 or 42.5' square opening

- max outflow during surge conditions: there is no criteria. Let's pick 630 cfs for 12 ft head and see what max out flow is

DO NOT WRITE IN THIS SPACE

PGN-175B

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL.

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Page _____ of _____

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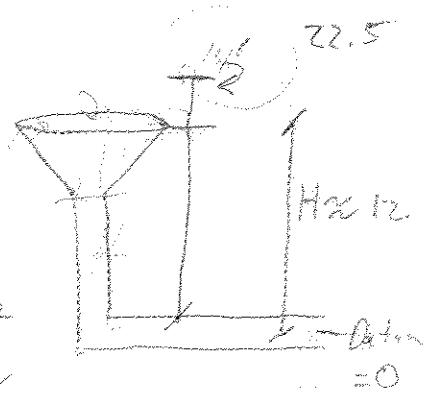

Head = Head Loss + Velocity Head

$$Head = K_L \frac{V^2}{2g} + \frac{V^2}{2g}$$

$$Head = [\overset{ent}{0.5} + \overset{conv}{0.5} + 0.5 + \overset{exit}{1}]\frac{V^2}{2g} + \frac{V^2}{2g}$$

$$\left[+ f \frac{l}{D} \frac{V^2}{2g}\right] \left[0.03 \frac{164}{5.5}\right]\left[\frac{V^2}{2g}\right]$$

Orifice Control Design: Head = 500 cfs @ 14 ft Head

14 ft of Head, Flowrate = 500

$$14 = [2.5]\frac{V^2}{2g} + \frac{V^2}{2g} \qquad V = 16$$

V = 14.32

$Q = VA$

$500 = (16)(A) \qquad A = 31.25$ pipe losses

square = 5.6 × 5.6'

5.9 × 5.9 (pipe losses)

Minimum Weir Length: 500 cfs w/ 2 ft Head

$Q = CLH^{3/2}$

$500 = (3.2)(L)(2)^{3/2}$

$L = 55'$ $\qquad 2\pi r = 55$ $\qquad r = 9'$

Check

At Storm Surge: H = 22 / no wave runup (just wind set-up / half wave height) $H_o = 2$, $R_s = 9$ $= 0.22 = H_o/R_s$

weir flow

$$22 = [2.5]\frac{V^2}{2g} + \frac{V^2}{2g}$$

$V = 20$

$Q = (20)(31.25)$ $\qquad Q = 625$ cfs

55 × 55

Orifice flow:

$Q = CA\sqrt{2gh}$

$Q = (31.25)\sqrt{2g(14)}$

* Flow is limited under surge conditions

PGN-175B

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL

Northeast Pump Station
Spillway Calcs.

1. Limit discharge to 500 cfs @ 2' head
2. Use series of slotted orifices in headwall
3. Set bottom of orifice at EL. 21.0 to maintain 12.5 ft of water in reservoir.

Orifice Equation: $Q = C A \sqrt{2gH}$
where Q = discharge in cfs
C = constant => use 0.6
A = Area of opening, ft^2
g = acceleration of gravity = 32.2 ft/sec^2
H = Head at orifice
(from centerline of opening to water surface)

Slotted openings will act as weirs until the opening is submerged. Then act as orifices.

1. Size opening area to pass 500 cfs at 2 ft head.
a) Set bottom of opening at El. 21.0
For 2' head, water level is El. 23.0
Try 2' high slotted openings
mid point is at EL 22.0
$H = 23 - 22 = 1'$

At water level of 23.0, openings will operate as orifices. Use orifice equation to solve for Area required to pass 500 cfs

$Q = C A \sqrt{2gH}$
$A = Q / C\sqrt{2gH}$
$= 500 / 0.6\sqrt{64.4(1)}$
$= 500 / 4.81 = 103.84\ ft^2$
L = length of weir = A/H
$L = 103.84\ ft^2 / 2\ ft = 51.92$ Use 52 ft.

b) Try 1' high openings
for 1' high slotted openings, mid point is
at El 21.0 + 0.5 = 21.5
$H = 23.0 - 21.5 = 1.5$

$A = Q / C\sqrt{2gH}$
$= 500 / 0.6\sqrt{64.4(1.5)}$
$= 500 / 5.897$
$= 84.79\ ft^2$

$L = 84.79\ ft$ Say 85 (Too long for headwall

∴ Use 2' slotted openings $L = 52\ ft$
Use 4 openings, each 2' x 13'
Center above 4 of discharge culverts

Compute discharge through slotted openings at different Reservoir design conditions

From BOOR: for wind speed of 103 mph

• ground elev	8.5		
• full pool water depth	12.0	EL	21.0
• PMP rainfall depth	4.5 ft		25.5
• wind setup	2.1		27.6
• wave runup	6.0		33.6
• Freeboard	1.0		34.6
• Settlement Allowance	0.4		35.0 = Crest Elevation

Case 1 Full Pool with 2' wind setup EL = 23.0
Case 2 Full Pool with 4.5 rainfall event EL = 25.5
Case 3 Full Pool with 4.5 rainfall event plus wind setup EL = 27.6

For 2' slotted openings w/ total length = 52 ft A = 104 ft²

Case 1:

$Q = CA\sqrt{2gH}$ C = 0.6 2g = 64.4
A = 104 H = 23.0 - 22 = 1

$Q = 0.6(104)\sqrt{64.4(1)}$

Q = 500.75 cfs ok

Case 2: H = 25.5 - 22 = 3.5

$Q = 0.6(104)\sqrt{64.4(3.5)}$

Q = 936.8 cfs

Case 3: H = 27.6 - 22 = 5.6

$Q = 0.6(104)\sqrt{64.4(5.6)}$

Q = 1185 cfs

Conclusion: Discharge too high for case 2 & 3
Need to provide downstream restriction.

Compute tailwater on slotted openings resulting from a 5.5 ft × 5.5 ft constriction in culvert downstream of spillway openings for a range of flows. If tailwater is above mid point of openings, orifice flow would be reduced.

$Q = C A \sqrt{2gH}$

$Q^2 = C^2 A^2 \, 2g \, H$

$H = Q^2 / C^2 A^2 \, 2g$

$H = Q^2 / 21{,}214.8$

$C^2 = 0.6^2 = 0.36$

$A^2 = (5.5 \times 5.5)^2 = 915.06 \text{ ft}^2$

$2g = 32.2 \times 2 = 64.4$

Water El @ discharge canal = 8.6

Let Q =	Q^2	H	El @ slotted openings
450	202,500	9.55 + 8.6	18.15
475	225,625	10.64 "	19.24
500	250,000	11.78 "	20.38
525	275,625	12.99 "	21.59
550	302,500	14.26 "	22.86
575	330,625	15.58 "	24.18
600	360,000	16.97 "	25.57
625	390,625	18.41 "	27.01
650	422,500	19.92 "	28.52

Compute H through slotted openings with tailwater elevations computed by 5.5 x 5.5' downstream constriction.

$H = Q^2 / c^2 A^2 (2g)$ $c^2 = (0.6)^2 = 0.36$

$H = Q^2 / (0.36)(10816)(64.4)$ $A^2 = (52 \times 2)^2 = 10,816$

$H = Q^2 / 250,758$ $2g = 64.4$

Q	Q^2	H	Tailwater @ slotted openings	Reservoir Elev.
450	202,500	0.81	< 22 - NO orifice restriction	
475	225,625	0.90	< 22 "	"
500	250,000	1.00	< 22 "	"
525	275,625	1.10	21.59	22.69
550	302,500	1.21	22.86	24.07
575	330,625	1.32	24.18	25.50
600	360,000	1.44	25.57	27.01
625	390,625	1.56	27.01	28.57
650	422,500	1.68	28.52	30.20

Spillway Discharge

Reservoir Water El.	Description	Discharge
21.0	Normal Full Pool	0 cfs
23.0	Full Pool + 2 ft head on openings	500 cfs
25.5	Full Pool + 4.5' design rainfall	575 cfs
27.6	Full Pool + 4.5' design rainfall + 2.1 ft wind setup	Approx 600 cfs

Summary:

Use 2 ft high slotted openings in headwall L = 52 ft.

Use 4 - 13 ft x 2' openings connecting to discharge channel.

Provide 5.5 ft x 5.5 ft restriction in disch channel. Max discharge

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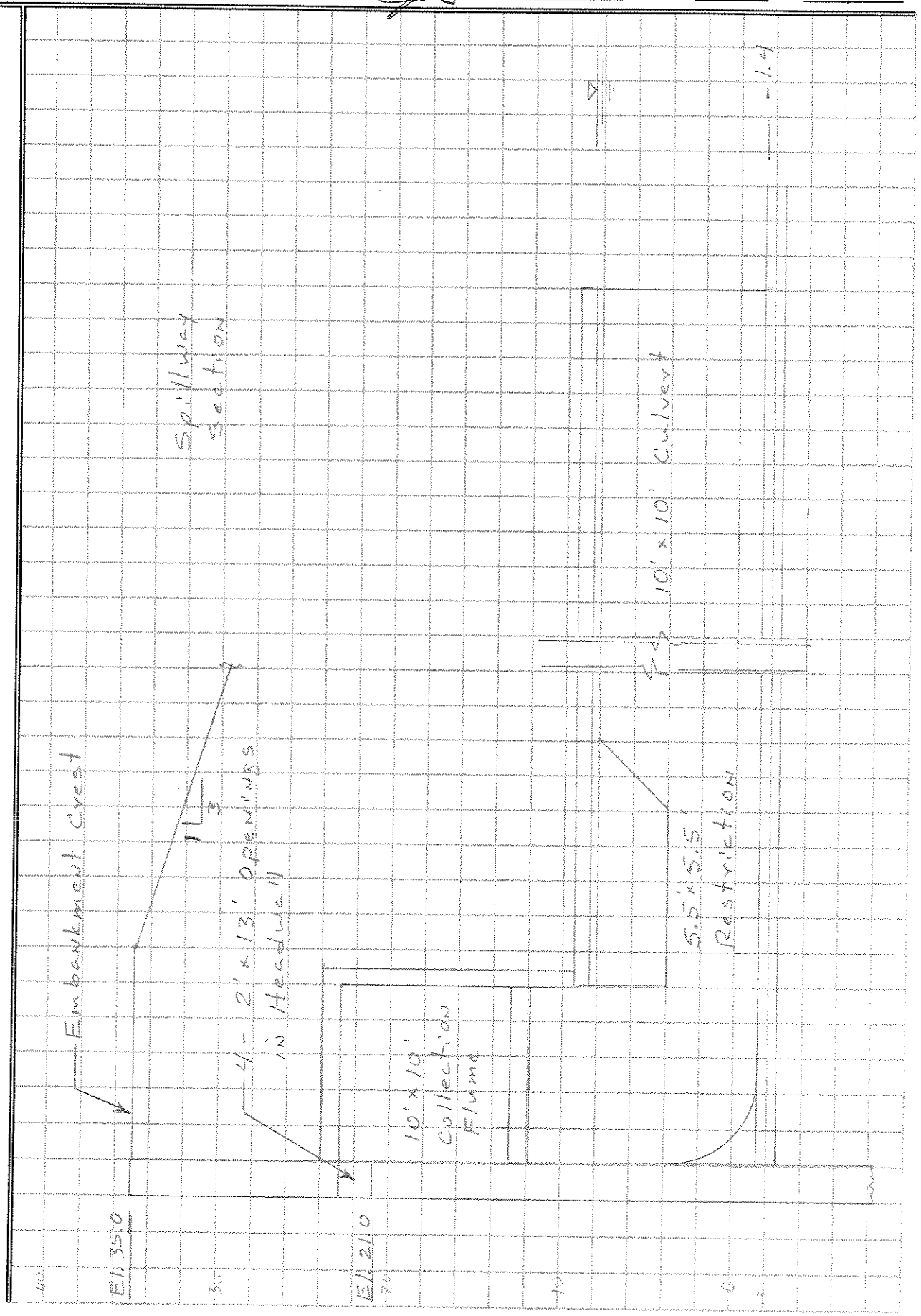
building a world of difference.
ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name _____
First Name _____ Author _____
Date 5/18 20 06 Computed by G. Montgomery
Verified by _____ Page 6 of 7



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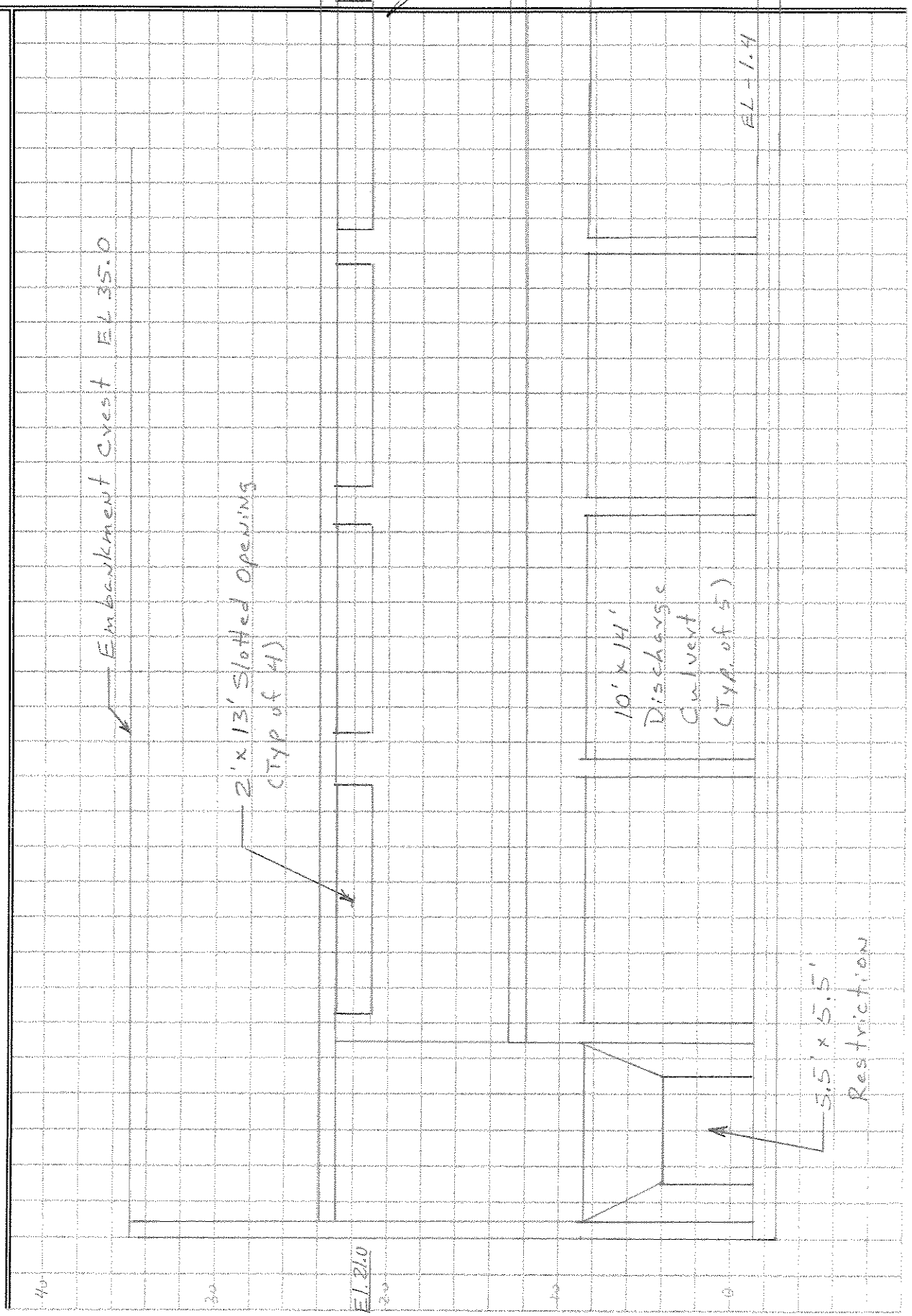
Hand Calculation Sheet

Work Product Name _____
First Name _____ Author _____
Date 5/18 20 06 Computed by G. Montgomery
Verified by _____ Page 7 of 7



DIVIDER PAGE

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OBJECTIVE

THE OBJECTIVE OF THIS SET OF CALCULATION IS TO ESTIMATE AN ADEQUATE SIZE FOR THE RESERVOIR' S COLUMN CAPABLE OF SUSTAINING HIGH WIND LOAD USING THE FLORIDA BUILDING CODE 2004; SECTION 1605.3

WE WILL CONSIDER 3 LOAD COMBINATIONS:

1) D + W

2) D + 0.75 (W+ Lr)

3) D + 0.5 W + 0.75 CRANE

1. ESTIMATE ROOF SIZE

REF: VULCRAFT CATALOG

3" CONFORM DECK ; SLAB = 7" ; t = 4"

3 C 18 3 SPAN CONSTRUCTION SPAN = 11'-4" MAX
USE 10'-0" SPACING

DEAD LOAD = 69 PSF FROM CATALOG

SUPERIMPOSED DL ⇒ USE 20 PSF

LIVE LOAD = 50 PSF — DESIGN CRITERIA

TOTAL = 69 + 20 + 50 = 139 PSF

ROOF JOIST @ 10' SPACING, W = 1.39 KLF

TOTAL LOAD = 90' SPAN × 1.39 KLF = 125 K

REF: VULCRAFT JOIST CATALOG 88 SLH 21, P_{allow} = 132K

→ REDUCE SPAN TO 8', REDUCE SLAB TO 2" DECK, 6" SLAB,

D = 63 PSF ⇒ LOAD = 63 + 20 + 50 = 133 PSF
W = 8' × 133 PSF = 1.064 KLF
W = 90' × 1.064 KLF = 96 K

80 SLH 20, P_{allow} = 107 K

→ REDUCE SPAN TO 7' ⇒ W = 7 × 133 = 0.931 KLF

W = 90' × 0.931 KLF = 84 K
80 SLH 19 ; P_{allow} = 95.2 K

→ REDUCE SPAN TO 6'

→ W = 6' x 133 PSF = 798 PLF

W = 90' x 0.798 KLF = 72 K

72 DLH 19, P_{allow} = 80.2 K

Owner	South Florida Water Management District	Computed By	A. Lubaga
Plant	RESERVOIR A - 1	Date	7/3/2006
Project No.	144777	Verified By	B. Smolkin
Title	Pumping Station	Date	7/12/06
		Page	4 of 12

Wind loads based on IBC 2003 / ASCE 7-02
for Components and Cladding

WALLS

Input:

			Reference:
Wind Velocity, V	=	155 mph	IBC Figure 1609, pg 284/285
Exposure	=	C	IBC Section 1609.4, pg 290
Category	=	III	IBC Table 1604.5, pg 272
mean roof height, h	=	49 feet	
Kh	=	1.085	Velocity Pressure Exp. Coef., ASCE Table 6-3, pg 75
Kd	=	0.85	Directionality Factor (Table 6-4, p.76)
Kzt	=	1	Topographic Factor (ASCE Fig 6-4, p. 47, 48)
Effective Wind Area	=	800.33 feet^2	=49' eave wall height^2/3
GCp	=	-0.8	External Pressure Coef., ASCE Figure 6-11A, pg 57
Gcpi	= +/-	0.55	Internal Pressure Coef, ASCE Fig 6.5, pg 49

Output

I	=	1.51 ✓	Importance Factor, Design Criteria Memo
qh = 0.00256*Kh*Kzt*Kd*V^2*I=		85.65 psf	velocity pressure at height = h, ASCE Eq 6-15

wind pressure = qh*(GCp +/- Gcpi)= -115.63 psf ✓

2. ESTIMATE COLUMN SIZE

USING THE BxV WALLS DESIGN SPREADSHEET, WE HAVE

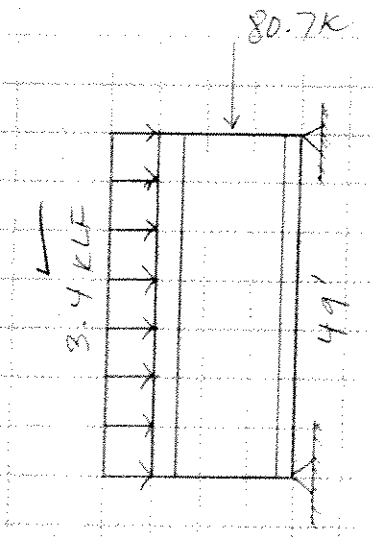
WIND LOAD = -115.63 PSF

* LOAD CASE 1

DEAD LOAD = 63 PSF CAUSING AXIAL STRESS
WIND LOAD = 115.63 PSF CAUSING BENDING STRESS

WIND TRIB = 29' => WIND LOADING = 115.63 PSF x 29' = 3.4 KLF

AXIAL LOAD = 63 PSF x 44.167' x 29' = 80.7 K



V_{max} = 3.4 KLF x 49'/2 = 83.3 K

M_{max} = 3.4 KLF x $49^2/8$ = 1020.43 K-ft

REF: AISC 9th Edition ASD Manual (pg 2-192)

TRY W 21 x 201 => M_{allow} = 1152 K-ft > M_{max} OK

→ W 21 x 201 ⇒ $r_x = 9.47''$ & $r_y = 3.02''$

$l_x = 47'$ & $l_y = 15'$ & $A_g = 59.2\ in^2$

$$\frac{Kl_x}{r_x} = \frac{47 \times 12}{9.47} = 59.6 \checkmark$$

$$\frac{Kl_y}{r_y} = \frac{15 \times 12}{3.02} = 59.6$$

REF: AISC 9th Ed. ASD Manual (pg. 3-17)

$F_a = 22.79$ KSi

$P_{allow} = F_a \times A_g = 22.79 \times 59.2 = 1349.17\ K$

$P_{allow} = 1349.17\ K > P = 80.7\ K$

→ CHECK $\frac{P}{P_{allow}} + \frac{M}{M_{allow}} \leq 1.0 \Rightarrow 0.95 \leq 1$ OK

USE W21x201

* LOAD CASE 2

DEAD LOAD = 63 PSF
WIND LOAD = 115.63 PSF
ROOF LIVE LOAD = 50 PSF

WIND LOADING = $0.75 \times 115.63 \times 29' = 2.52$ KLF

AXIAL LOADING = $(63\ PSF + 0.75 \times 50\ PSF) \times 44.167' \times 29' = 129\ K$

FROM WIND LOADING, DETERMINE:

$V_{max} = 61.74\ K$ & $M_{max} = 757\ K\text{-}ft$

REF: AISC 9th Ed. ASD Manual (pg. 2-194)

TRY W21×182 ⇒ $M_{allow} = 1042$ K-ft > M_{max} OK

→ W21×182 ⇒ $r_x = 9.4''$ & $r_y = 3.0''$

$l_x = 47'$ & $l_y = 15'$ & $A_g = 53.6\ in^2$

$$\frac{Kl_x}{r_x} = \frac{47 \times 12}{9.4} = 60$$

$$\frac{Kl_y}{r_y} = \frac{15 \times 12}{3} = 60$$

REF: AISC 9th Ed. ASD Manual (pg. 3-17)

$F_a = 22.72$ ksi ⇒ $P_{allow} = 22.72 \times 53.6 = 1217.79K > P = 129K$ OK

→ CHECK $\frac{P}{P_{allow}} + \frac{M}{M_{allow}} \leq 1.0 \Rightarrow 0.83 \leq 1.0$ OK

W21×182 OK

* LOAD CASE 3

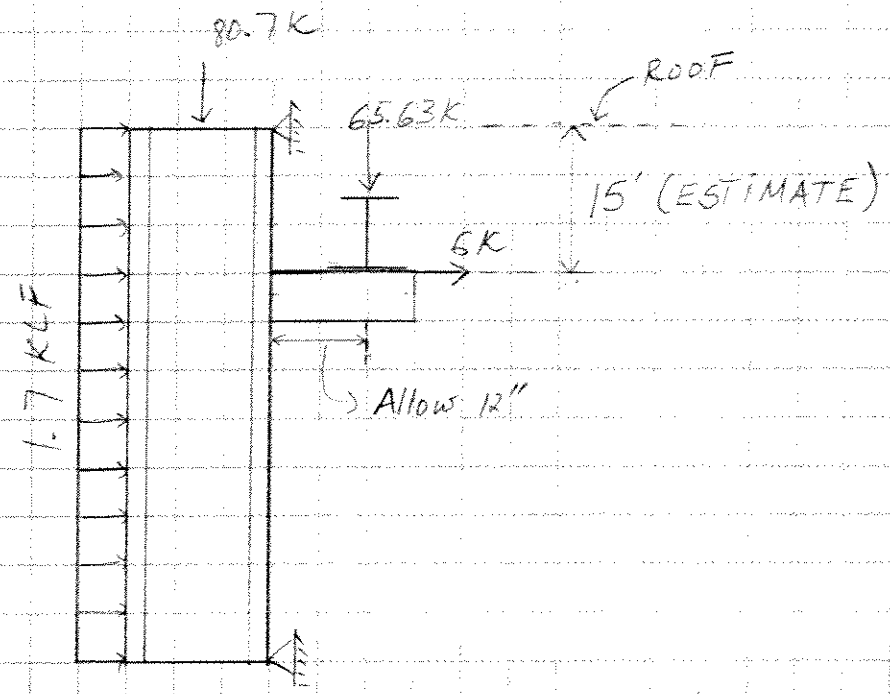
CRANE RATED CAPACITY = 35 TONS (70 KIPS)

VERTICAL LOAD = 1.25% OF RATED CAPACITY TO INCLUDE IMPACT + CRANE TROLLEY & BRIDGE WT.

VERTICAL LOAD = 70 × 1.25 = 87.5 K
ALLOW 5 K FOR TROLLEY FOR LATERAL LOAD

→ LATERAL LOAD = 20% LIFTED LOAD + TROLLEY (DESIGN REPORT)
$= (70K + 5K)(0.2)/2$ RAILS $= 8$ KIPS

DEAD LOAD = 63 PSF
0.5 W = 57.815 PSF
0.75 CRANE = 65.63 K

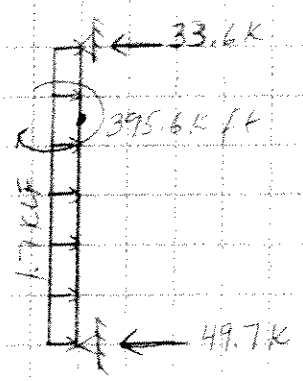


TRY W21x201

THE 8 KIPS LOAD IS CAUSING A MOMENT (M_p)

$M_p = 65.63(12'' + 23.03'') + 6K \times 34' = 395.6$ K-ft

* BENDING STRESS IS CAUSED BY WIND LOADING & M_p, WE ANALYSE:



$V = 0$ @ $\frac{49.7}{1.7} = 29.24'$

$M_{max} = \frac{1}{2} \times 49.7 \times 29.24 = 727$ K-ft

REF: AISC 9th Ed. ASD Manual (pg 2-192)

$M_{allow} = 1152$ K-ft $> M_{max} = 727$ K-ft

* AXIAL STRESS IS CAUSED BY 80.7K + 65.63K = 146.33K

WITH W21X201 WE HAD $P_{allow} = 1349.17$ K (IN CASE 1)

→ CHECK $\frac{P}{P_{allow}} + \frac{M}{M_{allow}} \leq 1.0 \Rightarrow 0.74 \leq 1.0$ OK

USE W21X201

NOTE

THE SIZE ESTIMATE ABOVE IS DONE WITH A 29 FEET SPACING BETWEEN COLUMNS; NOW LET CUT THE SPACING INTO HALF (14.5 FEET) AND GO THROUGH THE SAME CALCULATIONS

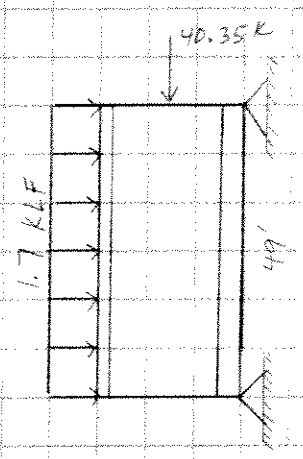
* LOAD CASE 1

DEAD LOAD = 63 PSF

WIND LOAD = 115.63 PSF

WIND TRIB = 14.5' ⇒ WIND LOADING = 115.63 PSF × 14.5 = 1.7 KLF

AXIAL LOAD = 63 PSF × 44.167' × 14.5 = 40.35 K



$V_{max} = 1.7\ KLF \times 49'/2 = 41.65\ K$

$M_{max} = 1.7\ KLF \times \frac{49'^2}{8} = 510.2\ K\text{-}ft$

REF: AISC 9th Ed. ASD MANUAL (pg 2-198)

TRY W18x119

$M_{allow} = 578\ K\text{-}ft > M_{max}$ OK

→ W18x119 ⇒ $r_x = 7.90''$; $r_y = 2.69''$; $A_g = 35.1\ in^2$

$$\left(\frac{KL}{r}\right)_x = \frac{47 \times 12}{7.90} = 71.5$$

$$\left(\frac{KL}{r}\right)_y = \frac{15 \times 12}{2.69} = 67$$

REF: AISC 9th Ed. ASD MANUAL TABLE C-50 (pg 3-17)

$F_a = 20.655$ ksi ⇒ $P_{allow} = 20.655 \times 35.1 = 725\ K$

$P_{allow} = 725\ K > P = 40.35\ K$ OK

→ CHECK $\frac{P}{P_{allow}} + \frac{M}{M_{allow}} \leq 1.0 \Rightarrow 0.94 \leq 1.0$ OK

* LOAD CASE 2

DEAD LOAD = 63 PSF
WIND LOAD = 115.63 PSF
ROOF LIVE LOAD = 50 PSF

WIND LOADING = 0.75 x 115.63 x 14.5 = 1.26 KLF

AXIAL LOADING = (63 + 0.75 x 50) x 44.167' x 14.5 = 64.5 K

FROM WIND LOADING, DETERMINE:

V_{max} = 30.87 K & M_{max} = 378.2 K-ft

REF: AISC 9th Ed. ASD MANUAL (pg. 2-198): TRY W18x97

M_{allow} = 470 K-ft > M_{max} OK

→ W18x97 ⇒ r_x = 7.82" ; r_y = 2.65" ; A_g = 28.5 in²

$\left(\frac{KL}{r}\right)_x$ = 72.1 & $\left(\frac{KL}{r}\right)_y$ = 68 ⇒ F_a = 20.54 KSI

P_{allow} = 585.4 K > P = 64.5 K OK

→ CHECK $\frac{P}{P_{allow}} + \frac{M}{M_{allow}} \leq 1.0$ ⇒ 0.91 ≤ 1.0 OK

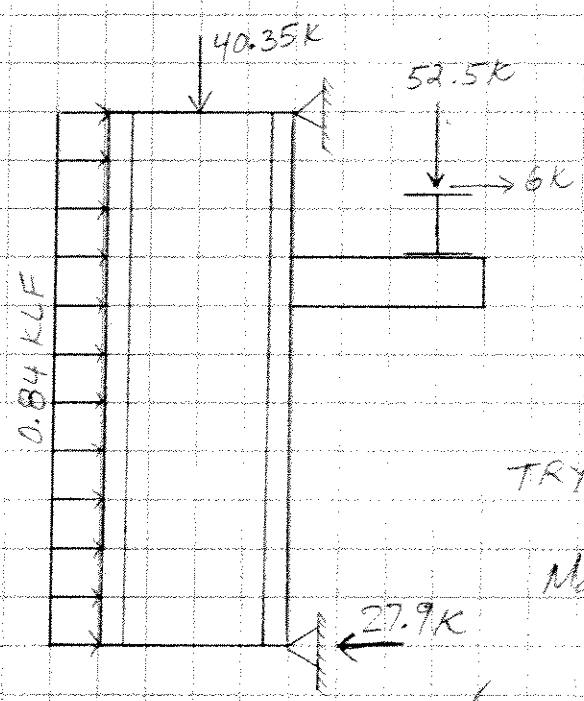
USE W18x97

* LOAD CASE 3

FOR 14.5' COLUMN SPACING, USE 100% FOR THE VERTICAL LOAD

→ VERTICAL LOAD = 70 K

→ LATERAL LOAD = 8 K



$V = 0 \ @ \ \frac{27.9}{0.84} = 33.21'$

$M_{max} = \frac{1}{2} \times 27.9K \times 33.21'$

$= 463.3 \ K\text{-}ft$

REF: ASD MANUAL (pg. 2-198)

TRY W 18x119

$M_{allow} = 578 \ K\text{-}ft > M_{max}$ OK

→ W18x119 : $A_g = 35.1 \ in^2$; $r_x = 7.90''$; $r_y = 2.69''$

$\left(\frac{KL}{r}\right)_x = 71.5$ & $\left(\frac{KL}{r}\right)_y = 67$

⇒ $F_a = 20.655 \ ksi$ ⇒ $P_{allow} = 725 \ K > P$ OK

→ CHECK $\frac{P}{P_{allow}} + \frac{M}{M_{allow}} \leq 1.0$ ⇒ $0.93 \leq 1.0$ OK

DIVIDER PAGE

Stolinski, Theodore J. (Ted)

From: Stolinski, Theodore J. (Ted)
Sent: Thursday, March 16, 2006 4:09 PM
To: Touslee, James E.; Molyneux, James D. (Dominic); Moore, Roy A.
Cc: Pittman, Larry D.
Subject: Everglades Northeast Pumping Station

Revised as follows:

Summarizing what we discussed Wednesday March 15, 2006, the Northeast Pumping Station Design will be based on the following criteria:

1. The pumping station will not operate above the design depth of the reservoir, 12.5 feet (21.0 feet NAVD88). The pumping units will be provided with a permissive that will shut the pumping units down when the reservoir level exceeds 12.5 feet regardless of whether the reservoir is actually full or whether the high level at the pumping station is a result of wind or tide.

2. The connector canal to the pumping station will be designed for 8.6 feet NAVD88 which is the start elevation for G-370 and G-372. Canal variation can be from elevation 6.6 feet to 14.0 feet NAVD88.

3. The design level of the reservoir selected is 8.8 feet deep (17.3 feet NAVD88). This is the elevation for establishing the 3,600 cfs and for maximum efficiency. Reservoir depth of 8.8 was the average water depth back when our first priority was capturing runoff. We are using for lack of a better number to establish our rated condition.

4. The station will be designed for the larger of 3,600 cfs at design pool to pool elevations (17.3 feet and 8.6 feet NAVD88). But no less than 80 percent (2900 cfs) at maximum pool to pool elevations (21.0 feet and 6.6 feet). This is based on Section 3.2.1 of the SFWMD Design Guide. Pool to pool elevation represents the difference in static level from the connector canal in front of the screens and the reservoir at the outlet of the pumping station. The design pool to pool elevations will define the capacity and maximum efficiency of the pumps while the maximum pool to pool will establish the horsepower requirements of the engines.

5. The station will be designed for a installed capacity equal to the design capacity. No standby pump based on Section 5.2.2 which only requires standby capacity for flood control and equivalent pumping stations.

6. The pumping station will be designed for six 600 cfs pumps. However the pumps will have a secondary future rating of 625 cfs to permit the addition of two identical 625 cfs pumps to achieve the future design flow of 5,000 cfs. The hydraulic design of structures and the engine horsepower and maximum speeds will be selected to permit the pump to operate at the 625 cfs. For the initial operation, the pump speed will be limited to the speed necessary for the 600 cfs. Designing the initial pumps for 625 should have minor impact to the equipment. The horsepower will go up slightly but not enough to change engine selection. But selecting 625 cfs for the pump design will permit installation of the future pumps without having to go oversize the future pumps and having to do a second design and a second model test.

7. The pumping station will be designed for the 5,000 cfs. The station however will only be equipped with equipment as required for the initial 3,600 cfs flow. Appropriate space will be provided where required for the future equipment.

8. The low level return flow pumps will be installed in the return flow gate structure. The design connector canal elevation for the return flow will be 10.0 feet NAVD88 so they can supply the ag pumps with a canal level below 10 NAVD. Maximum level could 15.0 feet NAVD88 which is approximately the canal bank elevation.

It is recognized that these values have not been reviewed by SFWMD and could change. However these values will at least allow us to start sizing equipment.

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Pump Hydraulics

Page 1 of

Owner: SFWMD | Computed by: Ted Stolinski | Date: June 28, 2006

Project No. | Verified by | Date

With revised layout for a through the levee top - Check Pump Hydraulics

Select Pump for 3 Conditions

a) Design Point - ΔH for the design flow

b) Rated Point = ΔH for 80% of the design Flow

c) Siphon Head = ΔH for 50% of the design Flow to start siphon

d) Max head = Max ΔH

Water Surface Levels

Suction Side

Design Elev = 8.6' before screen

Rated Head = 6.6' before screen

Extreme Head = 3.6' downstream of screen

Max Head = 14.6' before screen

Discharge Side

Design Elev = 17.3'

Rated Head = 21.0'

Min Head = 8.6' Bottom of Reservoir

Min Head (alt) = head over canal weir if req'd to limit siphon

Design Head Q = 625 cfs per pump Total - 8 pumps = 5,000 cfs

STATIC HEAD = 17.3' - 8.6' = 8.7'

Screen loss = 0.5'

Station loss = 2.0' (102"ϕ) See attached Drawing w/ Calc

Static head = 8.7'

Σ = 11.2' @ 625 cfs

Rated Head Q = 500 cfs (80% approx) Total - 8 pumps = 4,000 cfs

STATIC HEAD = 21.0' - 6.6' = 14.4'

Screen loss = 0.5'

Station loss = 1.3' (80% Flow ~ 64% HLoss)

Static head = 14.4'

Σ = 16.2' @ 500 cfs

Siphon Head Q = 313 cfs (50% Q) (Intermittent Flow)

Static Head = 25.5' − 8.6' = 16.9'

Screen loss = 0.5'
Station loss = 2.2'
Static head = 16.9'
Depth @ Crest = 4.3' 102"/12/2

16.9'
4.3'
21.2'

Σ = 23.9' @ Q ~ 313 cfs

Max ~~Normal~~ Non-Siphon head Q = undefined max screen loss

Static Head = 21.5' (Overflow elev.)
− 6.6' (Min
14.9'

Screen loss = 3.0
Station loss = 1.2
Static = 14.9'
19.1 (max continuous flow for engine size)

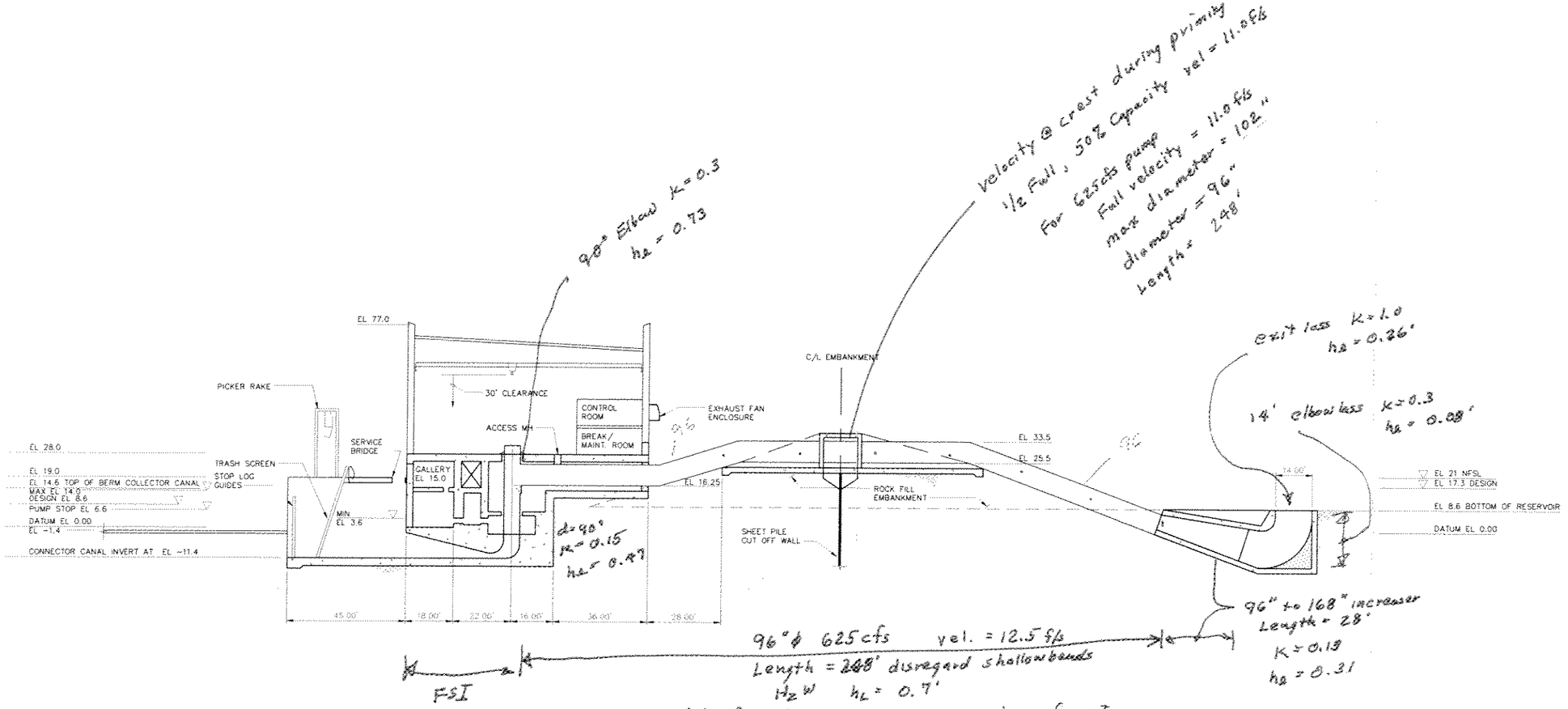
Min Head Q = undefined

Static Head min based on 25' as max siphon head

Crest of siphon = 34.0' Max siphon = 25'
Loss in Downstream pipe + 1.0' Max Δ = 9.0'
velocity head 102" − 2.0' → +1.0
Net = 33.0' → $v^2/2g$ −2.0
8.0 OK @ 8.6' W.L.

STATIC HEAD = 8.6' − 8.6' = 0

screen loss = 0.0'
station loss = 2.0'
static head = 0.0'
Σ = 2.0' @ Q = 625 cfs



While Priming	50% Q	
FSI	0.11'	0.11
Pump El	0.18'	0.18
Pipe	0.10'	0.06
V²/2g @ Crest	1.88'	1.88
Σ =	2.27'	2.23
	96"ϕ	102"ϕ

While Pumping — Downstream of crest

Total hL =		
FSI	0.47'	
Pump Elb	0.73'	
Pipe	0.70'	0.35
Increaser	0.31'	0.31
Elbow	0.08'	0.06
Exit	0.26'	0.26
		1.00
Σ =	2.55 (96"ϕ)	

Add 6" Screen loss 3.05' Pump Station Loss.

Total loss		
96"	102"	109"
2.55'	2.00'	1.60'

Use

STATIC HEAD	SUCTION	DISCHARGE	NET	% Q	hL
Design	8.6	17.3	8.7'	100%	3.00
Max	6.6	21.0	13.4'	80%	3.00
Extreme	3.6	21.0	16.4'	—	3.00
Priming	6.6	29.5	22.9'	50%	3.2

Rated Head	
99.	11.7'
89.4	16.4'
2.4.0	19.4'
3.4.0	25.1'

BLACK & VEATCH

Black & Veatch Corporation

ENGINEER OF RECORD

FL ENGINEERING CERTIFICATE NO.

DATE

CONFIDENTIAL INFORMATION ENCLOSED

The consultant, contractor or other parties associated with this project shall comply with Florida Statutes 119. These plans are the property of the District and must be secured and maintained in a confidential manner. Review by any unauthorized individual or outside/third party not performing work necessary for this project is prohibited.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ACCELERS PROGRAM
PHONE: 561-686-8800
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33406

EAA RESERVOIR A-1
NORTHEAST PUMP STATION
SFWMD SUBMERGENCE
SECTION 1 THROUGH MAIN PUMP

CONTRACT NO. CN060044
DRAWING NO. 011

SHEET 2 OF

REVISION DESCRIPTION	DATE	DRAWN	REV. #

DESIGNER
DRAWN
CHECKED
DATE
SCALE AS SHOWN

Montgomery, Gail E.

From: arnie.sdano@PentairWater.com
Sent: Saturday, July 01, 2006 12:14 PM
To: jeff.selby@PentairWater.com; Stolinski, Theodore J. (Ted)
Cc: don.skinner@pentairpump.com; sam.wood@pentairpump.com; jim.miller@pentairpump.com
Subject: Southern Florida Everglade Pumps KP
Attachments: 95-6310-AH SFWMD C60072.pdf

Jeff/Ted,
Attached is a selection for a 95" propeller pump at 189 RPM. The selection looks reasonable to me, but we will not be compliant with SFWMD's design guidelines of 14 feet per second at the propeller. Please advise if this will be mandated for this application.
Arnie

Jeff Selby/Fairbanks-01/MYERSHQ2/PENTAIR/US

06/28/2006 07:39 PM

To arnie.sdano@pentairpump.com
cc don.skinner@pentairpump.com, sam.wood@pentairpump.com, jim.miller@pentairpump.com
Subject Fw: Southern Florida Everglade Pumps

Arnie,

More hydraulics from Ted.

Jeff Selby
Regional Sales Manager
Fairbanks Morse Pump Corporation
Office: 913-748-4100
Cell: 816-797-4292
Fax: 913-383-9365

----- Forwarded by Jeff Selby/Fairbanks-01/MYERSHQ2/PENTAIR/US on 06/28/2006 07:27 PM -----

"Stolinski, Theodore J. \(Ted\)" <StolinskiTJ@bv.com>

06/28/2006 05:11 PM

To <jeff.selby@PentairWater.com>
cc
Subject Southern Florida Everglade Pumps

Jeff : The SFWMD hydraulics are better defined now. Though by no means final, the hydraulics are pretty well set through 30 percent.

The most significant change is that the pumping station has been pulled out of the levee and we are no longer going through the levee. We are going to go through the top of the levee above maximum operating level relying on a siphon through the top of the levee.

The new hydraulics are as follows:
Rated Point is 625 cfs at 11.2' (bowl performance).

Maximum normal operating head 16.2' (bowl performance).

Extreme maximum continuous operating head 19.1' (bowl performance).

Minimum normal operating head 2.0 feet (bowl performance).

Siphon head 23.9' at a minimum flow of 313 cfs (bowl performance).

All head are for bowl performance. I have included FSI losses, column and discharge elbow losses, and piping (102" diameter), and discharge diffuser losses in the indicated heads for now.

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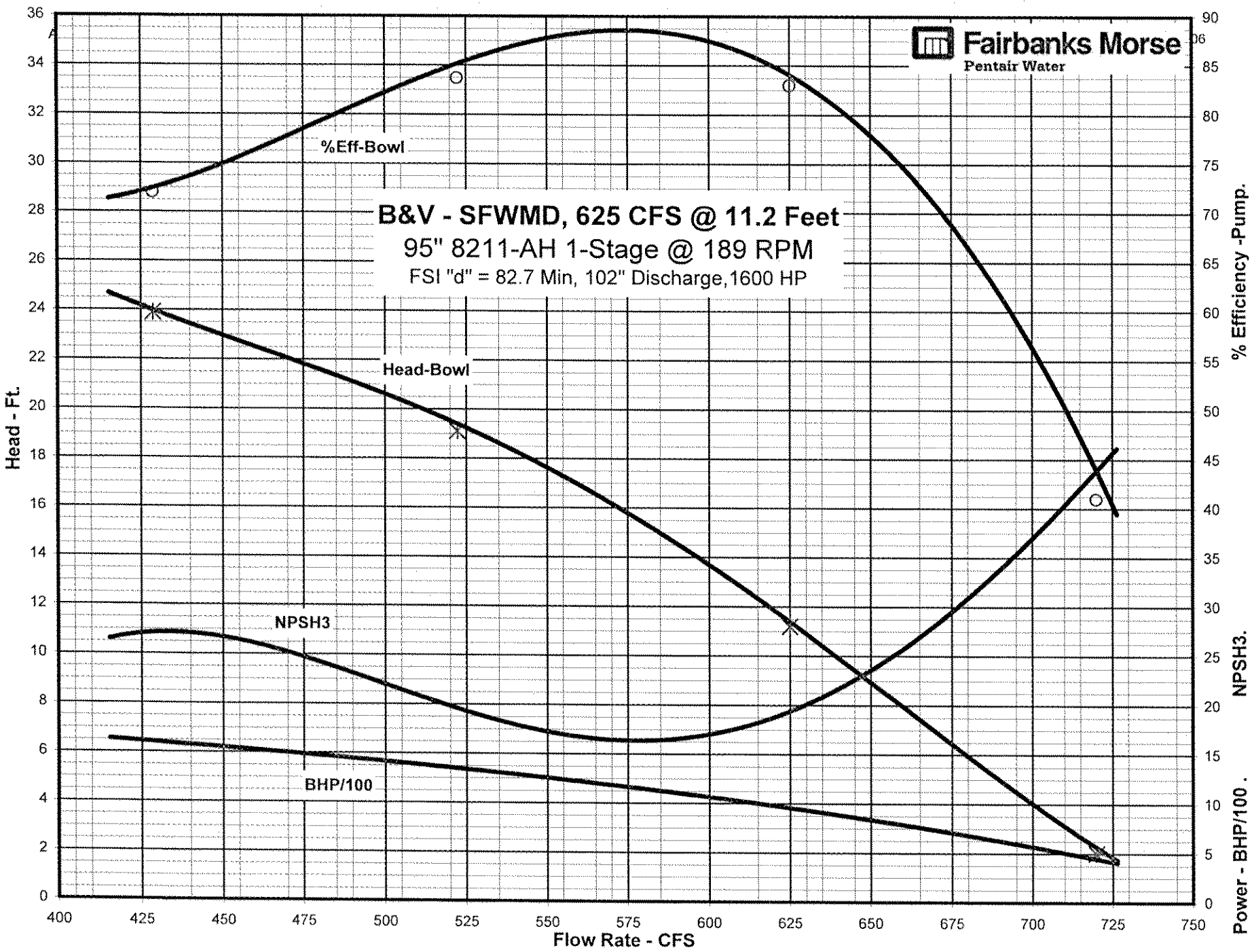
Fairbanks Morse
Pentair Water
B&V - SFWMD, 625 CFS @ 11.2 Feet
95" 8211-AH 1-Stage @ 189 RPM
FSI "d" = 82.7 Min, 102" Discharge,1600 HP
%Eff-Bowl
Head-Bowl
NPSH3
BHP/100
Head - Ft.
% Efficiency -Pump.
NPSH3.
Power - BHP/100 .
Flow Rate - CFS
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
0
5
10
15
20
25
30
35
40
45
50
55
60
65
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85
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675
700
725
750

Montgomery, Gail E.

From: Nelson, Kevin M.
Sent: Friday, July 21, 2006 10:47 AM
To: Touslee, James E.; Montgomery, Gail E.
Subject: FW: WFLT-19381 / SFWMD / B&V
Attachments: 96APS86X1 SHT 1 REV E FPD Eng.tif; 96APS86X1 SHT 2 REV E FPD Eng.tif; 96APS86X1 SHT 3 REV E FPD Eng.tif; 96APS500X3 SHT 1 REV C FPD Eng.tif

By the way, these are the drawings that I used to lay-out the formed suction inlet, so we should be OK.

From: Bob Cornman [mailto:BCornman@flowserve.com]
Sent: Friday, July 21, 2006 10:40 AM
To: Nelson, Kevin M.
Subject: WFLT-19381 / SFWMD / B&V

Here are some drawings for a 96APS. The 101 APS is only slightly larger. Hopefully, these can be used as typical drawings for this type of pumps.

Regards,

Bob Cornman
Director, Technical Services NA & LA
Flowserve Pump Division
942 Memorial Parkway
Phillipsburg, NJ USA

Tel: 908-859-7256
Fax: 908-859-7482

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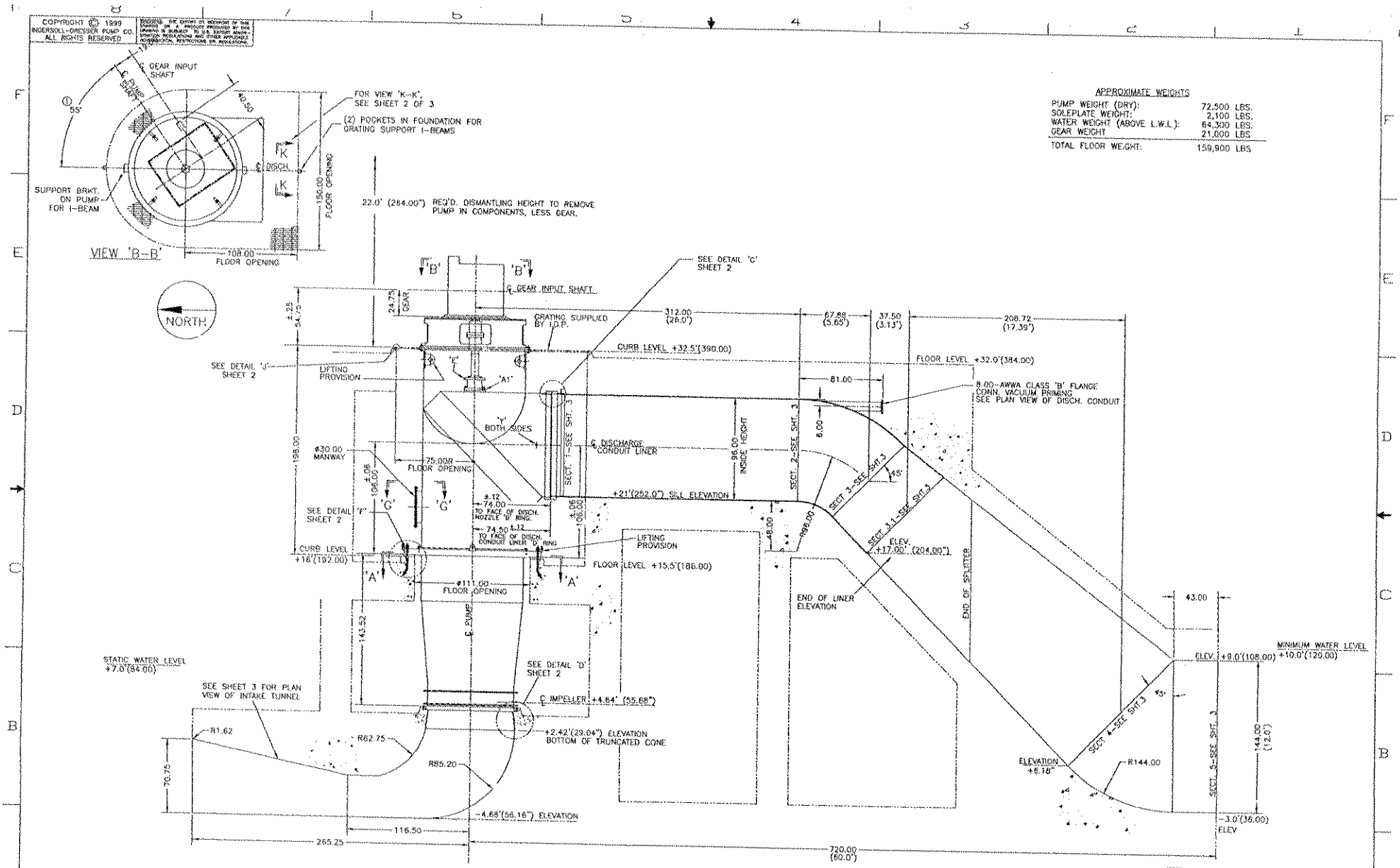

APPROXIMATE WEIGHTS

PUMP WEIGHT (DRY):	72,500 LBS.
SOLEPLATE WEIGHT:	2,100 LBS.
WATER WEIGHT (ABOVE L.W.L.):	64,300 LBS.
GEAR WEIGHT	21,000 LBS
TOTAL FLOOR WEIGHT:	159,900 LBS

REV	DRN	CKD	APP	REV	DRN	CKD	APP	REV	DRN	CKD	APP	REV	DRN	CKD	APP	REV	DRN	CKD	APP
E	D.JS			D	EGA	C.T.	P.F.	C	D.C.	P.F.	JKR	B	D.C.	P.F.	J.R.	A	D.C.	J.R.	M.P.
DATE 1NOV99				DATE 4FEB99				DATE 28DC98				DATE 25JL98				DATE 5FEB98			
(1) REVD. GEAR SUPP. NO. DRILL PATTERN WAS 35°				REVISED TO SHOW POCKETS IN FOUNDATION IN VIEW B-B SHT. 1. ADDED VIEW K-K ON SHT. 2 PER E.C.R. #3337.				MODIFIED PER CUST. TRANSM. NO. 20027				GENERAL REV. AND MODIFIED PER CUSTOMER M/C PRINT.				INITIAL ISSUE			
ECR# 3028																			

GEAR MFG. PRIL. GEAR CORP.	DRIVER DRAINAGE PUMP	CUSTOMER SOUTH FLORIDA WATER MANAGEMENT DISTRICT	SALES NO. 047-82043
TYPE 8406VBX-2PO	LIQUID FRESH WATER	SALES NO. REF NO. C-E203	ITEM NO. 02
SERIAL	LOCATION COW (H.L.)	ITEM NO.	DATE 5EC98
SPL. 720 INPUT 177 OUTPUT	SERVICE	EOP PUMPING STATION EQUIPMENT FOR STORMWATER TREATMENT AREA 1W AND STORMWATER TREATMENT AREA 2	SCALE 0.0
SPL. NO. 03152*0540			DRAWN J.ROLLY
			REVIEWED M.PATEL

REFERENCE NOTES

SEE SHEET 3 FOR GENERAL NOTES.

Ingersoll-Dresser Pump Company

GENERAL ARRANGEMENT

470 CFS--STATION 310 (96 APS)

DWG. NO.	CONC. DWG. NO.	TYPE NO.	REV.
F 88032	96APS86X1		E

NOLE 890722 REV 1 OF 1 A.CAD

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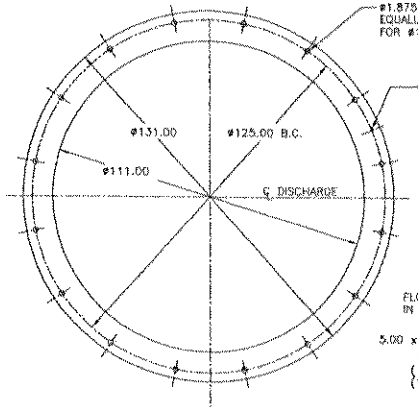
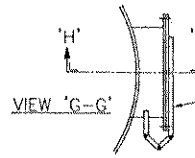
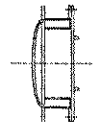


VIEW 'A-A'
SHOWING SOLEPLATE

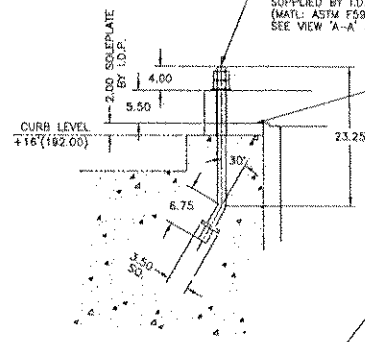


VIEW 'G-G'

ø30.00 MANHOLE WITH TRIPLEX HINGED COVER AND CONTOURED LINER.

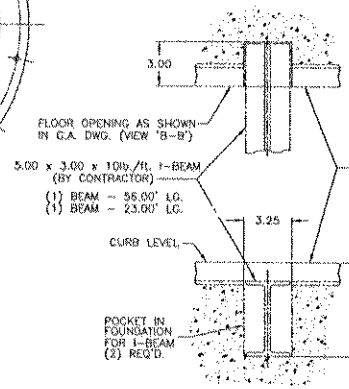


SECTION 'H-H'



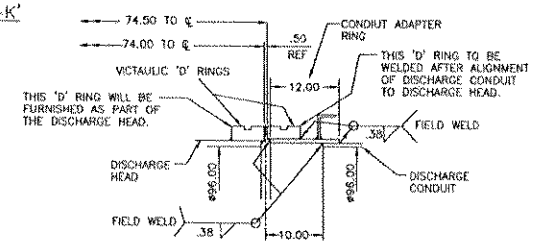
SOLEPLATE IS TO BE INSTALLED IN THE UNRESTRICTED CONDITION WITH A FLATNESS OF 0.001" PER FOOT. THE BOLT CIRCLE DIAMETER OF THE SOLEPLATE IS TO BE INSTALLED CONCENTRIC WITH THE BORE OF THE LOWER EMBEDDED RING WITHIN .125".

DETAIL 'F'



VIEW 'K-K'

DETAIL 'J'

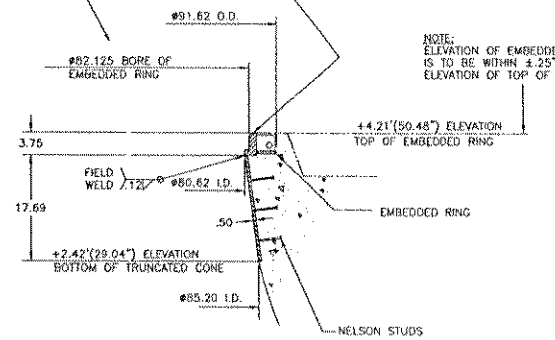


DETAIL 'C'

"D RING" FOR VICTAULIC COUPLING
SEE NOTE 7 ON SHEET 3

LOWER EMBEDDED RING IS TO BE INSTALLED FLAT WITHIN .001" PER FOOT OF DIAMETER AND THE INSIDE DIAMETER IS TO BE ROUND WITHIN 0.020" AROUND CIRCUMFERENCE.

NOTE:
ELEVATION OF EMBEDDED RING IS TO BE WITHIN ±.25" OF ELEVATION OF TOP OF SOLEPLATE.



DETAIL 'D'

MATERIALS & DETAILS OF CONSTRUCTION

COMPONENT	MATERIAL	DETAIL OF CONSTRUCTION
Diffusor/	ASTM A-36	Fabricated carbon steel with thermal stress relieving
Impeller housing	ASTM A-240, Ty 316L	Fabricated austentic stainless steel
Impeller	ASTM A-351, Gr CF3M	Single piece sand casting supplied in the solution annealed condition
Shaft-pump end	ASTM A-276, Type 410	Solid, fully machined barstock
Shaft-upper	ASTM A-276, Type 410	Solid, fully machined barstock
Key-impeller	AISI Type 410	Machined keystock
Key-shaft coupling	AISI Type 410	Machined keystock
Key-journal sleeves	AISI Type 410	Machined keystock
Key-drive coupling	Carbon steel	Machined keystock
Gland	ASTM A-36	Fabricated carbon steel
Packing	Braided cotton yarn impregnated with mineral oil	----
Journal sleeve	ASTM A-276, Type 420	Fully machined, thermally hardened
Bearing	Thordon SXL	Metal backed, Thordon
Shaft coupling	ASTM A-276, Type 420	Fully machined
Fasteners-submerged	ASTM A-593, Gr 304	----
Fasteners-nonsubmerged	ASTM A-307, Gr B	----
Anchor bolting	ASTM A-593, Gr 304	----
Drive Coupling	AISI 1045	Precision machined component
Gear support	ASTM A-36	Fabricated carbon steel with thermal stress relieving
Stuffing box extension	ASTM A-36	Fabricated carbon steel with thermal stress relieving
Discharge head	ASTM A-516	Fabricated carbon steel with thermal stress relieving
Inner column	ASTM A-36	Fabricated carbon steel with thermal stress relieving
Embedded ring	ASTM A-240, Ty 316L	Fabricated austenitic stainless steel
Soleplate	ASTM A-36	Fabricated carbon steel
"D" Rings	Buna "N"	----
Discharge conduit	ASTM A-516	Fabricated carbon steel
Intake cone	ASTM A-516	Fabricated carbon steel

REV	DRN	CKD	APP	REV	DRN	CKD	APP	REV	DRN	CKD	APP	REV	DRN	CKD	APP	REV	DRN	CKD	APP
E	DJS	MP	TF	D	EEA	C.T.	P.F.	C	D.C.	P.F.	JAR	B	D.C.	P.F.	J.R.	A	D.C.	J.R.	M.P.
DATE	7/10/98			DATE	4/7/98			DATE	2/20/98			DATE	2/24/98			DATE	5/7/98		
① REVD. GEAR SUPP. NO. DRILL PATTERN WAS 30°				REVISED TO SHOW POCKETS IN FOUNDATION IN VIEW B-B SHT. 1 ADDED VIEW K-K ON SHT. 2 PER E.C.R. #3337.				MODIFIED PER CUST. TRANSM. NO. 20027				GENERAL REV. AND MODIFIED PER CUSTOMER M/U PRINT.				INITIAL ISSUE			

ECR# 5028

CUSTOMER	PHIL. GEAR CORP.	SERVICE	DRAINAGE PUMP
MODEL	84KVGX-2PD	LIQUID	FRESH WATER
STOP		OPERATING	CCW (H.J.)
SIZE	7.50 INPUT 17.7 OUTPUT	MATERIAL	
SERIAL NO.	03152*0540		

CUSTOMER: SOUTH FLORIDA WATER MANAGEMENT DISTRICT
SALES NO.: RFP NO. Q-2203
ITEM NO.: ECP PUMPING STATION EQUIPMENT FOR STORMWATER TREATMENT AREA 1W AND STORMWATER TREATMENT AREA 2

DWG. NO.: 047-82043
REV. NO.: 02
DATE: 5FEB
DRAWN: D.C
CHECKED: J.PDULY
APPROVED: M.PATEL

Ingersoll-Dresser Pump Company

GENERAL ARRANGEMENT

470 CFS-STATION 310 (96 APS)

SIZE F | DWG. CODE NO. 88032 | SHAPE NO. 96APS86X1 | REV. E

SCALE NONE | 8/07/03 | SHEET 2 OF 3

REFERENCE NOTES

SEE SHEET 3 FOR GENERAL NOTES.

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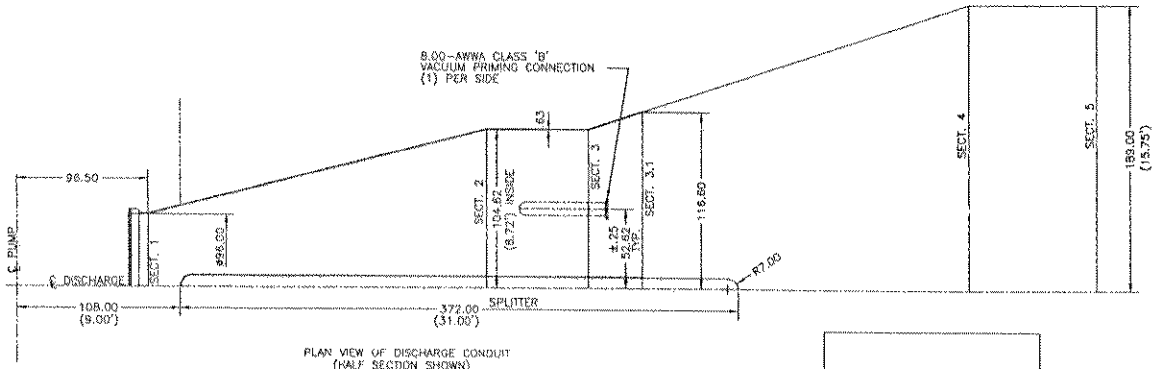
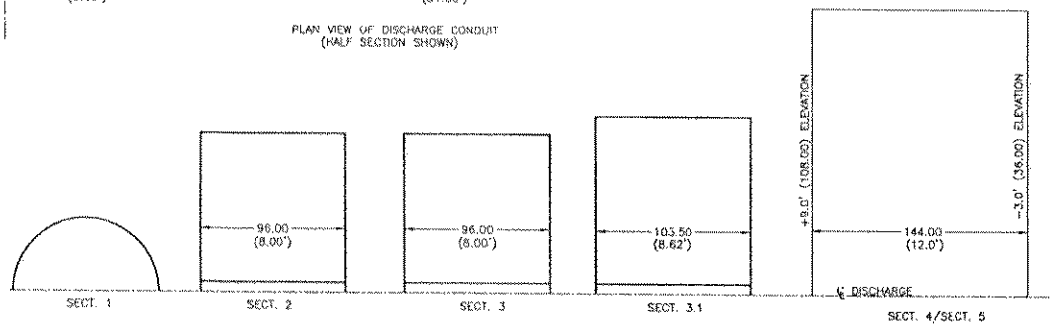
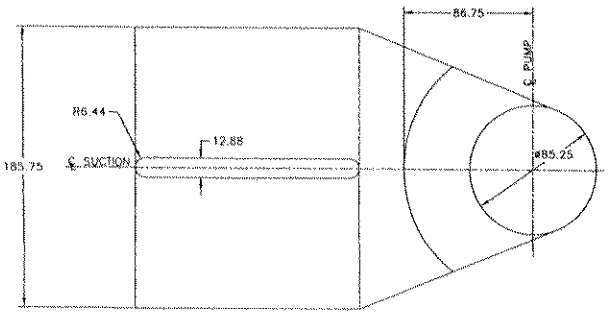


PLAN VIEW OF DISCHARGE CONDUIT (HALF SECTION SHOWN)





PLAN VIEW OF INTAKE TUNNEL

INSTALLATION REQUIREMENTS AND DETAILS.
PLEASE REFER TO THE IDP OPERATING AND MAINTENANCE MANUAL FOR THE COMPLETE INSTALLATION PROCEDURE.

REFER TO IDP CROSS SECTIONAL DRAWING 96APS500X1 FOR COMPONENT PART NUMBERS.

1. The pump design incorporates four components that must be permanently embedded in concrete. Those components are:

   a. Part #498 (Support Ring)
   b. Part #15 (Suction Cone)
   c. Part #471 (Sole Plate)
   d. Discharge conduits

   The above embedments will be shipped to the site prior to the shipment of the main pump components.

2. The discharge conduits will be shipped in two segments which require field assembly and welding by the General Contractor.

3. It will be necessary to install, align, and grout Part # 498 (Support Ring) at the elevation as shown on IDP General Arrangement drawing 96APS86X1.

   Part #498 must be installed flat within 0.001" per foot of diameter. Since the 82.125" diameter bore forms the seal with the pump, this surface must be protected during the installation process. The 82.125" diameter must be held round within 0.020" during the complete installation process.

   The concentricity, roundness, and flatness of this component must be checked prior to and after grouting to assure that the above requirements are achieved.

4. At the curb elevation there are (16) 1.5" diameter anchor bolts supplied by IDP that are equally spaced on a 125" diameter bolt circle. The soleplate is to be used as a template to set the anchor bolts.

   The bolt circle of the Soleplate (Part #471) must be installed concentric with the 82.125" bore of Support Ring (Part #498) within 0.125".

5. It is necessary to field weld the upper end of the Suction Cone (Part #15) to the bottom of the Support Ring (Part #498) once the Support Ring has been positioned in place.

   Part #498 is 316 stainless steel and Part #15 is carbon steel. The contractor is responsible for selecting a suitable weld procedure for these different materials and submitting the procedure to IDP prior to conducting the required field weld. The welding process is to utilize a process to prevent any distortion of the finish machined Support Ring during the welding process. The weld is to be a small fillet weld to seal between the two components.

   After completion of the welding operation, the concentricity, roundness, and flatness of the embedded ring are to be checked to confirm that they are within the limits of this procedure.

6. The pump is then installed as an assembled unit.

7. The discharge coundit is then installed and aligned to the pump discharge head.

   The orientation of the discharge conduit, the discharge conduit adaptor, the Victaulic coupling "D" rings, and the pump discharge head are shown in detail 'C' of this drawing.
   The horizontal and vertical centerlines of the "D" ring on the pump discharge head and "D" ring on the conduit adaptor ring must be coincident within 0.125" in order for the Victaulic coupling to seal properly.

   The contractor is required to install and field weld the discharge conduit, the conduit adaptor ring and the "D" ring in such a manner to obtain the above required alignment.

8. The Victaulic coupling is then installed.

9. The anchor bolts are then tightened and the gear is placed on the Gear Support.

10. The gear must be moved around on the pump gear pedestal until the low speed gear shaft is concentric with the pump shaft within 0.001" as shown by sweeping the pump shaft with a dial indicator attached to the gear shaft. Once this is completed, the gear is then bolted solid to the pump and the feet are then field drilled and doweled.

11. The Pump Half Coupling Hub (Part #33) and the gear low speed shaft coupling hub (Part #34) are connected.

12. The high speed gear shaft is then aligned to the drive shaft and engine.

GENERAL NOTES

THIS DRAWING IS NOT TO SCALE. WORK FROM DIMENSIONS SHOWN. READ INSTRUCTION BOOK BEFORE STARTING EQUIPMENT.

FOR GEAR INSTRUCTIONS, REFER TO LATEST GEAR OUTLINE DRAWINGS AND GEAR PROCEDURES.

"TOLERANCES":
(1) ALLOW PLUS OR MINUS .25" FOR VARIATION OF FOUNDATION BOLT HOLES.
SOLEPLATE IS TO BE USED AS A TEMPLATE TO LOCATE ANCHOR BOLTS.
(2) ALLOW PLUS OR MINUS .38" FOR ALL NOZZLE AND PIPING CONNECTION LOCATIONS.
(3) PLUS OR MINUS 1% FOR ALL NOMINAL LINEAR DIMENSIONS.
(4) PLUS OR MINUS 2 DEGREES FOR ALL NOMINAL ANGLES.

ALL HOLES IN FLANGES STRADDLE CENTERLINE UNLESS OTHERWISE INDICATED.

PIPING AND FITTINGS NOT SHOWN ARE TO BE FURNISHED BY CUSTOMER. DO NOT CONNECT TO PIPE TAPS UNLESS SPECIFIED ON DRAWING.

CONNECTIONS

(A1) 1.00 NPT– LUBRICATION WATER INJECTION–CUSTOMER TO INJECT 15–17 USGPM OF CLEAN WATER AT 10–15 PSI BEFORE STARTING, DURING NORMAL OPERATION, AND DURING SHUTDOWN OF PUMP. I–DP TO PROVIDE A 1.00" SOLENOID VALVE (NORMALLY CLOSED) AND A SIGHT–FLOW INDICATOR. PIPING TO BE DONE BY CUSTOMER.

(E) .75 NPT– GLAND LEAKAGE DRAIN–S.B.E. CATCH BASIN CUSTOMER TO PROVIDE PIPING TO REMOVE LEAKAGE FROM STUFFING BOX PACKING TO INTAKE OF DRAINAGE PUMP.

(Y) .50 NPT – GAGE CONNECTION – PLUGGED FOR SHIPMENT. THESE CONNECTIONS PROVIDED FOR CUSTOMERS USE, IF REQUIRED.

NOTE:
ALL PIPE CONNECTIONS ARE NATIONAL PIPE TAPERED PIPE THREADS.

REV	DRN	CKD	APP	REV	DRN	CKD	APP	REV	DRN	CKD	APP	REV	DRN	CKD	APP	REV	DRN	CKD	APP
E	DJS	MJ	FT	D	CEA	C.T.	P.F.	C	D.C.	P.F.	JAR	B	D.C.	P.F.	J.R.	A	D.C.	J.R.	M.P.
DATE 7/9/99				DATE 4/7/99				DATE 2/20/98				DATE 2/20/98				DATE 5/7/96			
(2) REV'S. GEAR SUMP, HD. DRILL PATTERN WAS 30				REVISED TO SHOW POCKETS IN FOUNDATION IN VIEW B–B SHT. 1 ADDED VIEW K–K ON SHT. 2 PER E.C.R. #3337.				MODIFIED PER CUST. TRANSM. NO. 20027				GENERAL REV. AND MODIFIED PER CUSTOMER M/U PRINT.				INITIAL ISSUE			

ECN# 5026

PRIME MFR.	PHIL. GEAR CORP.
TYPE	640KVBX-2PD
S.N.	
RPM	720 INPUT 177 OUTPUT
DWG. NO.	03152*0540
MODEL	DRAINAGE PUMP
LIQUID	FRESH WATER
MATERIAL	CON (H.I.)
NUMBER	
	ECP PUMPING STATION EQUIPMENT FOR STORMWATER TREATMENT AREA 1W AND STORMWATER TREATMENT AREA 2
CUSTOMER	SOUTH FLORIDA WATER MANAGEMENT DISTRICT
SHOP NO.	RFP NO. C–E203
ITEM NO.	
DWG. NO.	047–B2043
REV. NO.	02
DATE	5FEB8
DRAWN	D.C
CHECKED	J.MILLY
APPROVED	M.PATEL

REFERENCE NOTES

SEE SHEET 3 FOR GENERAL NOTES.

Ingersoll-Dresser Pump Company

GENERAL ARRANGEMENT

470 CFS–STATION 310 (96APS)

SIZE	DWG. NO.	REV.
F	88032 96APS86X1	E

SCALE NONE | 980722 | SHEET 3 OF 3

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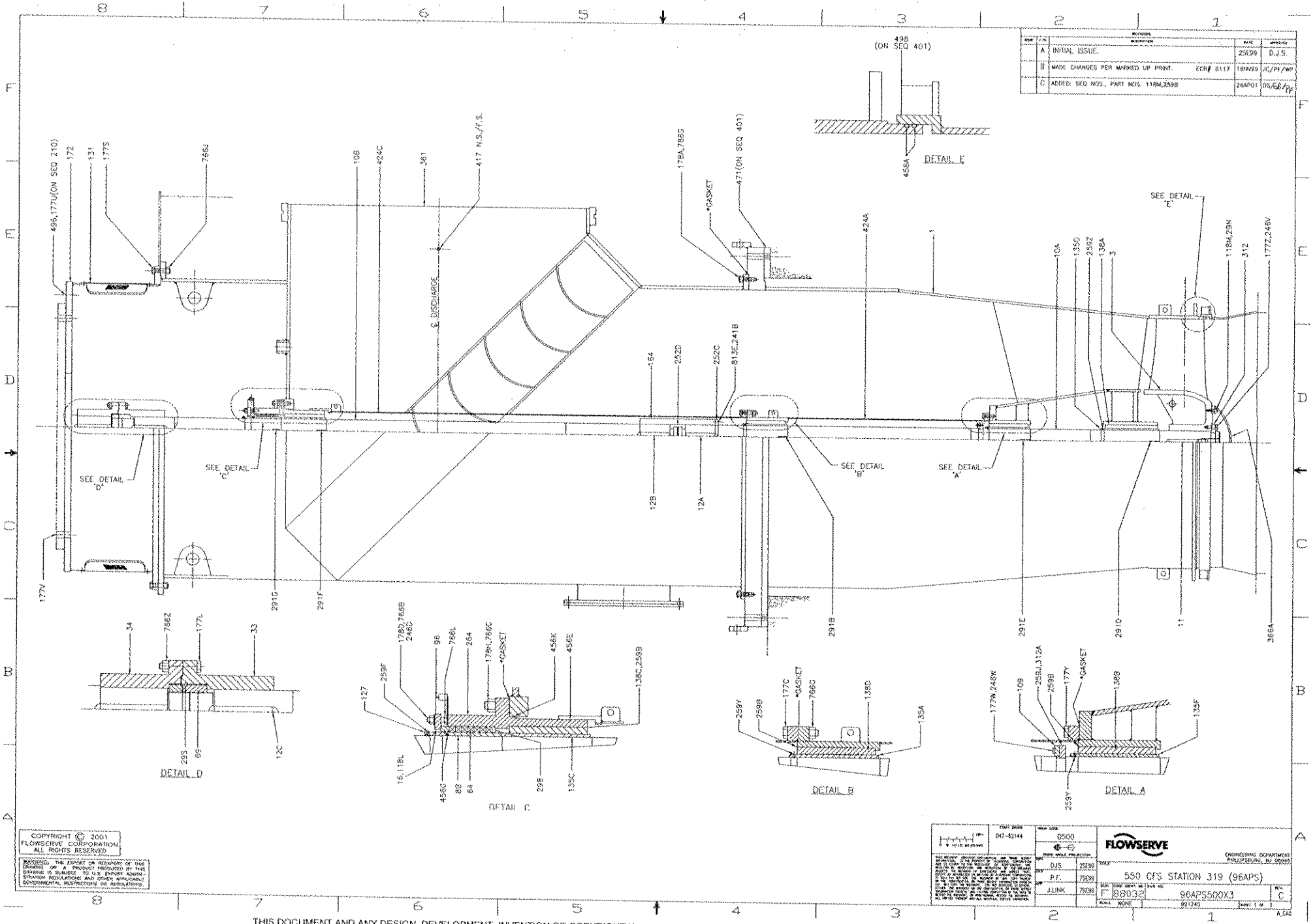
96APS500X3 SHT 1 REV C FPD ENG BCORNMAN JUL-21-2006 11:38:07



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Montgomery, Gail E.

From: Nelson, Kevin M.
Sent: Friday, July 21, 2006 10:41 AM
To: Montgomery, Gail E.; Touslee, James E.
Subject: FW: WFLT 19381 / SFWMD Northeast Pumping Station
Attachments: 101APS_Curve.pdf

From: Bob Cornman [mailto:BCornman@flowserve.com]
Sent: Friday, July 21, 2006 10:31 AM
To: Nelson, Kevin M.
Subject: WFLT 19381 / SFWMD Northeast Pumping Station

Bob Cornman
Director, Technical Services NA & LA
Flowserve Pump Division
942 Memorial Parkway
Phillipsburg, NJ USA

Tel: 908-859-7256
Fax: 908-859-7482

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----- Forwarded by Bob Cornman/North America/Flowserve on 07/21/2006 11:30 AM -----

Bob Cornman/North America/Flowserve

06/29/2006 11:42 AM

To "Stolinski, Theodore J. \(Ted\)" <StolinskiTJ@bv.com>
cc Greg Poska/North America/Flowserve@Flowserve, John Ondrejack/North America/Flowserve@Flowserve
Subject WFLT 19381 / SFWMD Northeast Pumping Station Link

Ted,

Our selection would be a 101APS pump per the attached curve.

Regards,

Bob Cornman
Director, Technical Services NA & LA
Flowserve Pump Division
942 Memorial Parkway
Phillipsburg, NJ USA

Tel: 908-859-7256
Fax: 908-859-7482

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"Stolinski, Theodore J. \(Ted\)" <StolinskiTJ@bv.com>

06/28/2006 06:11 PM

To "Bob Cornman" <BCornman@flowserve.com>

cc

Subject WFLT 19381 / SFWMD Northeast Pumping Station

Bob: The SFWMD hydraulics are better defined now. Though by no means final, the hydraulics are pretty well set through the 30 percent design level.

The most significant change is that the pumping station has been pulled out of the levee and we are no longer going through the levee. We are going to go through the top of the levee above maximum operating level relying on a siphon through the top of the levee.

The new hydraulics are as follows:
Rated Point is 625 cfs at 11.2' (bowl performance).

Maximum normal operating head 16.2' (bowl performance).

Extreme maximum continuous operating head 19.1' (bowl performance).

Minimum normal operating head 2.0 feet (bowl performance).

Siphon head 23.9' at a minimum flow of 313 cfs (bowl performance).

All head are for bowl performance. I have included FSI losses, column and discharge elbow losses, and piping (102" diameter), and discharge diffuser losses in the indicated heads for now.

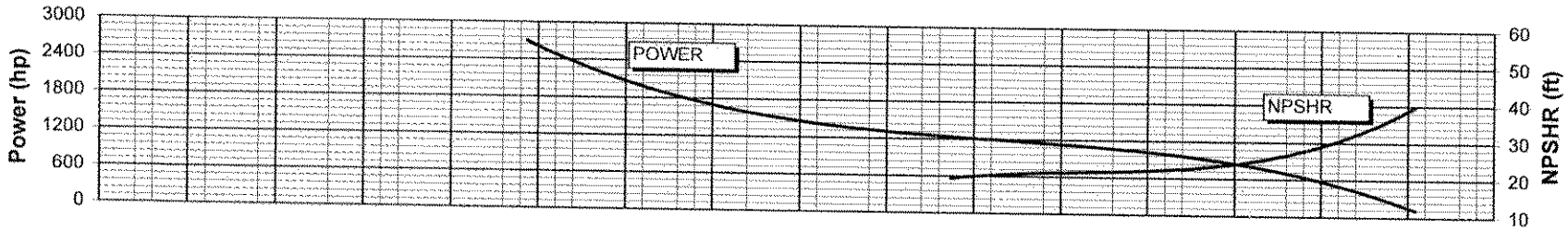
FLOWSERVE

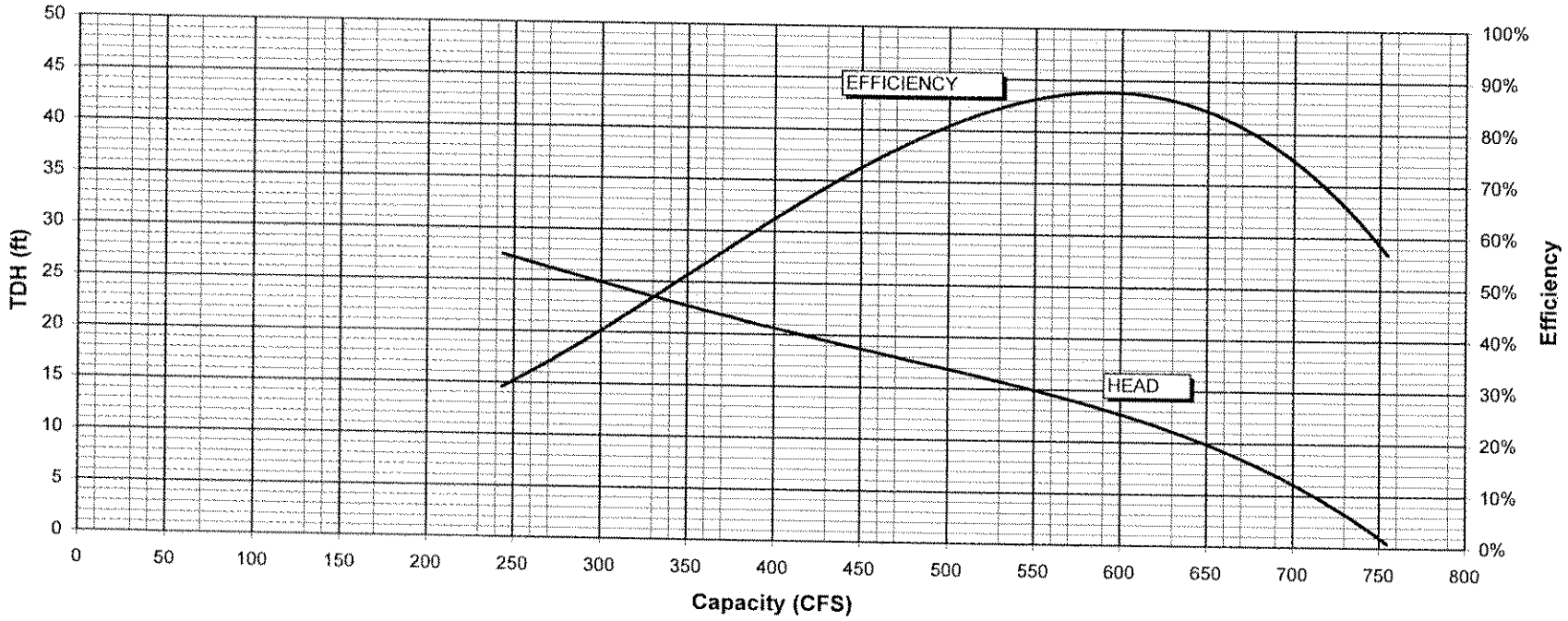
Proposed Performance

Order Number	WFLT-19381	**Liquid**	Water	**Speed (RPM)**	186	**Capacity (CFS)**	625
Customer	B&V / SFWMD	**Temperature (°F)**		**Pump type**	101APS	**TDH (ft)**	11.2
Service		**Viscosity (Cp)**		**Pump Serial No.**		**Efficiency**	
Date	6/29/2006	**Specific Gravity**	1			**NPSHR (ft)**	
	Northeast Pump Station						

Rev. A

Curves are approximate. Pump is guaranteed for one set of conditions. Capacity, head, and efficiency guarantees are based on shop test and when handling clear, cold, fresh water at a temperature of not over 85 degrees.





BLACK & VEATCH

Owner SFWMD
Plant NORTHWEST P. Sta Unit
Project No. File No.
Title Seepage pumps

Computed By T Stolinski
Date April 5 2006
Verified By
Date 20
Page of

80.62"

DO NOT WRITE IN THIS SPACE

PGN-173B

First design had 29 cfs equally split on both sides of pump station w/ 3 pumps on each side.

The calculated split based on length and geo hydrology is 150 cfs from the East Levee and 1000 cfs from North levee

This is great enough difference to design separately

	North	~~East~~	
Firm Capacity	100 cfs	~~150 cfs~~	Sent to G-370
Installed Capacity	150 cfs	~~225 cfs~~	(150% Minimum)

If 3 pumps each side, Then ~~SIZE~~ of pumps

50 cfs 75 cfs (Two different size pumps)

If 3 pumps and North and 4 on East

~~100/2 = 50 cfs 150÷3 = 50 cfs~~
~~150/3 = 50 cfs 225÷4 = 56.25 cfs~~

~~56.25~~ 7
× 7
393.75
-112.50
281.25 5

~~Use 56.25 cfs everywhere~~

~~Pumps rated 56.25 cfs @ 23.5 per 3/24/06 Calcs~~

~~56.25 cfs = 25,481 gpm~~

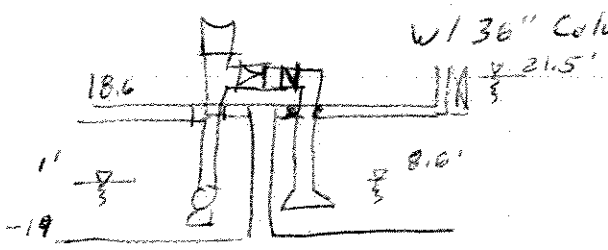
pump has "discharge and column

Suggest a ~~Patterson~~ M&W Model MF30-5700B @ 600 rpm w/ 250 hp motor

or

Cascade Model MF30 @ 500 rpm w/ 200 hp motor

w/ 36" Column and discharge



REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL

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Owner SFWMD | Computed By T Stolinski
Plant | Unit | Date April 6 20 06
Project No. | File No. | Verified By
Title Seepage Pumps | Date 20
Page of

STATIC HEAD

RESERVOIR 21.5'
SEEPAGE CANAL − 1.0'
STATIC 20.5'

11' MIN W.L.

DYNAMIC LOSS - Length of Pump Column
Operating Floor @ 18.6'
Wetwell Floor @ −19.0'
37' long

			HL
Pump Column	36"φ x 37'		0.16
Pump Disch Ell	36"	K = 0.4	0.40
Check Valve	36"	K = 2.0	2.00
~~Bfly~~ Gate	36"	K = 0.2	0.20
Dropleg	36" x 30'		0.12
Diffuser	36" x 42" x 42" Lon	K = 0.13	.13
Exit Vel Hd	42	K = 1.0	.52
			= 3.53'

vel Hd @ 25,500 gpm
36" = 1.00'
42" = 0.54'
hL 36"φ = 0.42'/100'
hL 42"φ = 0.20'/100'

@ 56.25
@ 50.00
$\left(\frac{50}{56.25}\right)^2 \times 3.53 = 2.79'$

Rated Head = 20.5' + ~~3.53'~~ 2.8 = 23.3 = 24.0'

Bowl eff 85%

Bowl Power = $\frac{(56.25\text{ cfs} \times 8.33) \times 24.0'}{3960 \times .85}$
= 181.7'

Pump ~~Bowl~~ eff = ~~(56.25 x 8.33) x (24 + 0.16 + 0.40)~~ / ~~(3960)~~ (
see attached spreadsheet

DO NOT WRITE IN THIS SPACE

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REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED AND DATED BY THE RESPONSIBLE INDIVIDUAL

PUMP EFFICIENCY CALCULATIONS

Project Name = **SFWMD Northeast Pump Station**

Pump Number = **Irrigalion pumps**

Calculated by = **Ted Stolinski**

07-Jul-06

Discharge Elbow Coefficients	
small cast iron elbows, use	**0.8**
fab. steel elbows, dia. < 12", use	**1.4**
fab. steel elbows dia. >= 12", use	**0.4**

disch. elbow coefficient =	0.8	
Total elbow loss -->	0.87	feet

	from curves	
Capacity =	25481.25	gpm
Head @ capacity =	24	feet
Discharge elbow I.D. =	35.25	inches
Column I.D. =	35.25	inches
Enclosing tube O.D. =	4	inches
Line-shaft Diameter =	2.435	inches
Column Length =	37	feet
Thrust Factor =	245	lbs/ft
Impeller Weight =	420	lbs
No. of stages =	1	
bowl efficiency =	85.0%	
pump speed =	505	rpm
motor efficiency =	95.0%	

Calc. column loss per 100 feet	0.76	@ capacity
Total column loss -->	0.28	feet

Note: For diameters > 12" subtract 3/4" from nominal diamter, column wall =3/8"

Note: if there is no enclosing tube, set enclosing tube dia. the same as shaft dia.

Calc. bhp loss per 100 feet =	0.81	bhp
Total line-shaft loss -->	0.30	hp

Hydraulic thrust =	5880	lbs
Shaft weight =	598	lbs
Total impeller weight =	420	lbs
total thrust =	6898	lbs
Total thrust loss -->	0.26	hp

pump hp =	190.97
pump eff =	80.87%
w/w eff =	76.82%

pump hp = [Q * (Head + elbow loss + column loss)] / [3960 * bowl eff] + thrust loss + shaft loss

pump eff = [q * Head] / [3960 * bhp]

For constant speed pumps, wire to water (w/w) efficiency = pump eff. x motor eff.

For pumps with adjustable frequency drives (AFD), w/w efficiency
= pump eff. x motor eff. x AFD eff. x Transformer eff. x AFD effect
where AFD effect varies, but can be taken as 99 percent.

Prepared by Ted Stolinski, revised Aug. 10, 2000

A copy of this template can be found on cygnet/knowledgebase/PS&PE/pumping systems/tools

CASCADE PUMP COMPANY
10107 South Norwalk Boulevard • PO Box 2767
Santa Fe Springs, California 90670-0767

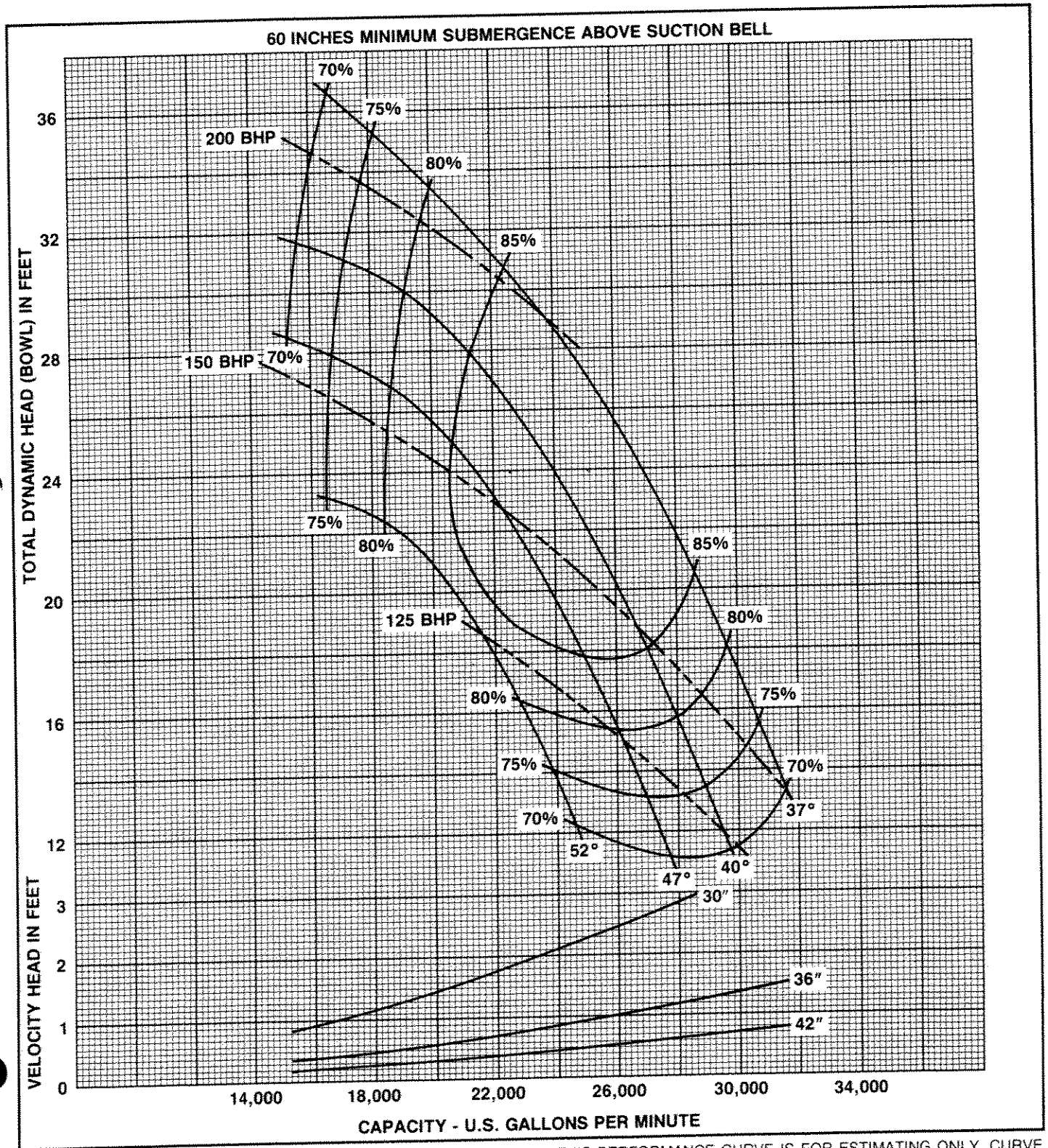
CURVE NUMBER	MF3014A5
DATE	07-92
SUPERCEDES	NEW ISSUE

3U

MF

500 RPM

CASCADE MIXED FLOW PUMP



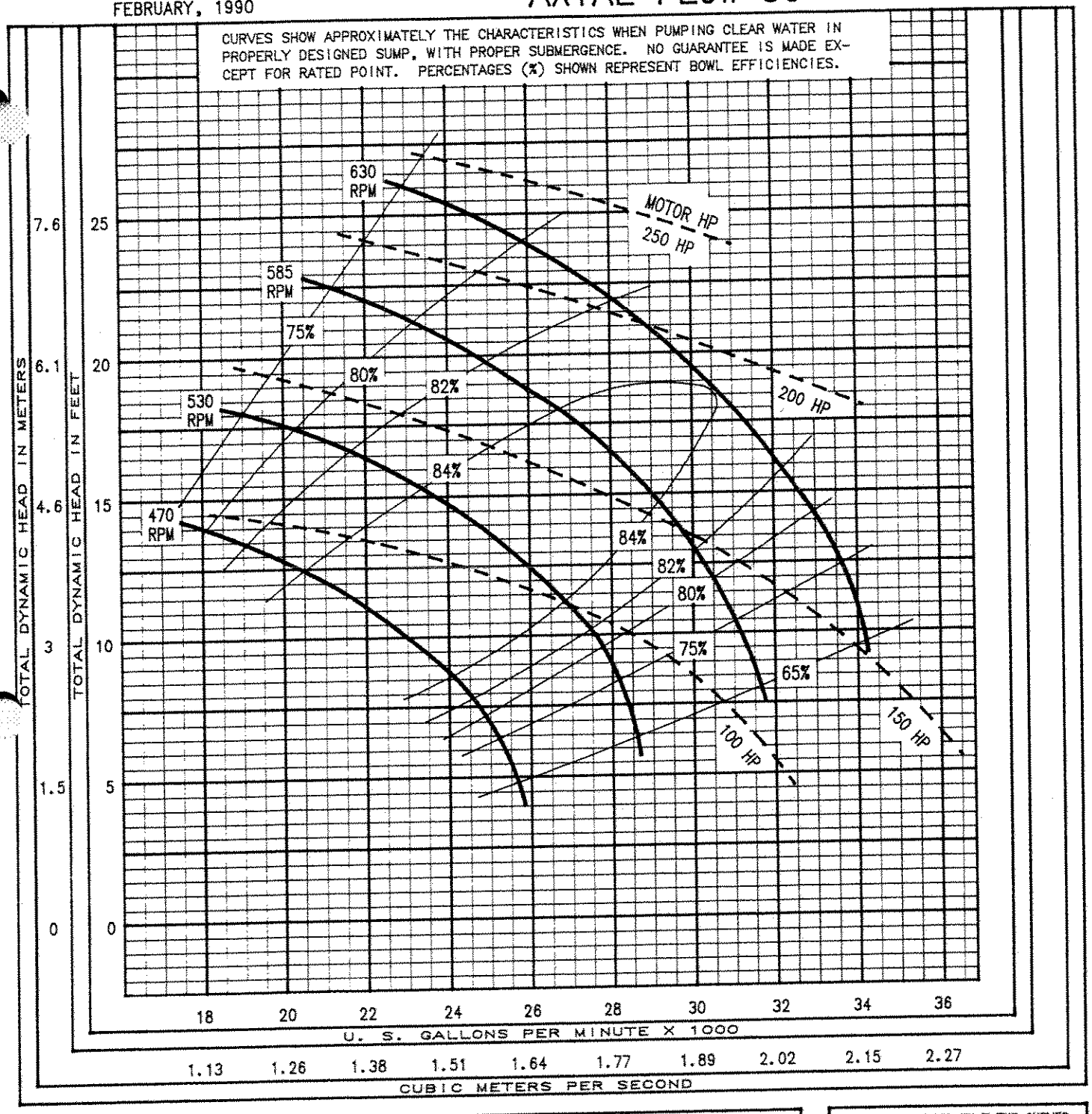
CURVE CHARACTERISTICS BASED ON PUMP PERFORMANCE WITH SPECIFIED AMOUNT OF CLEAR, NON-AERATED, FRESH COLD WATER.

THIS PERFORMANCE CURVE IS FOR ESTIMATING ONLY. CURVE SHOWS SINGLE STAGE PERFORMANCE. FOR MULTIPLE, VARIABLE AND OTHER SPEED APPLICATIONS, CONSULT FACTORY.

AXIAL FLOW 30"

FEBRUARY, 1990

C152



M & W PUMP CORPORATION
33 N. W. 2nd STREET
DEERFIELD BEACH
FLORIDA 33441
U. S. A.
ESTABLISHED 1926

PUMP BOWL PERFORMANCE CURVE

VARIABLE SPEED

TYPE: AXIAL FLOW	PROPELLER DIA: 30"
MODEL NO: NC330P25	SPEED (RPM): AS NOTED
INTAKE DIA: 45"	DISCHARGE COLUMN DIA: 30"
CURVE NO: VS330P25	Ns: 12,300 CODE: .50

SINGLE STAGE
FOR TWO STAGES MULTIPLY HEAD AND HORSEPOWER BY 2.0 AND EFFICIENCY BY 1.0

PERFORMANCE BASED ON PUMPING CLEAR COLD NON-AERATED WATER, SPECIFIC GRAVITY 1.0, TEMPERATURE 85 DEGREES (FAHRENHEIT) OR LESS, AT SEA LEVEL. PERFORMANCE MAY BE AFFECTED BY HIGHER TEMPERATURES, SPECIFIC GRAVITIES, ALTITUDES AND SUMP CONDITIONS.

IT IS CERTIFIED THAT THE CURVES REPRESENT TRUE PERFORMANCE CHARACTERISTICS OF THE M&W PUMP MODEL AND WERE OBTAINED BY SCALE MODEL TESTS AND CALCULATIONS IN ACCORDANCE WITH HYDRAULIC INSTITUTE STANDARDS.

M & W PUMP CORPORATION
CERTIFICATION

AVAILABLE UPON REQUEST

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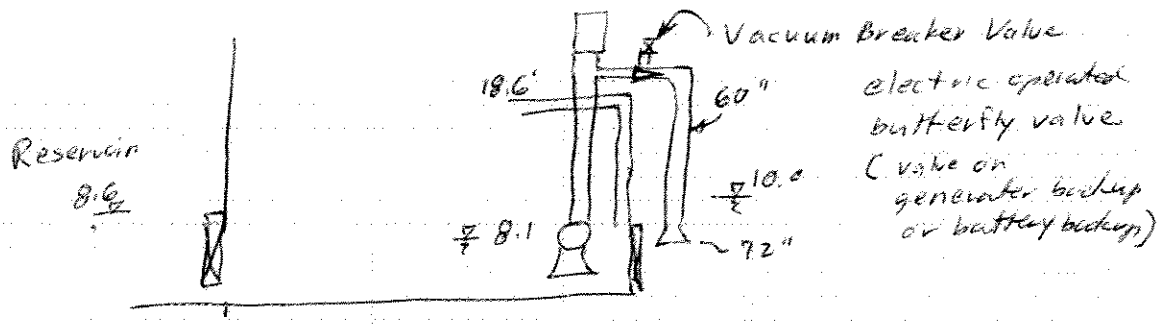
Owner SFWMD | Computed By T STOLINSKI
Plant Northeast P. Sta | Unit | Date April 6 20 06
Project No. | File No. | Verified By
Title IRRIGATION PUMPS | Date 20
Page of

IRRIGATION CAPACITY @ GRAVITY FLOW = 1,900 cfs
@ PUMP FLOW = 1,000 cfs

STATIC HEAD

CONNECTOR CANAL	10.0'
RESERVOIR C.	8.6'
	1.4'
HEAD LOSS TROUGH STRUCTUR	0.5'
TOTAL STATIC	1.9'

THE IRRIGATION RETURN FLOW CHANNEL HAS 5-BARRELS
PLACE ONE PUMP IN EACH.



1,000 cfs / 5 Barrells = 200 cfs each = 90,600 gpm each
Size discharge Column & outlet for 8-10 fps use 60" ϕ

			he
Pump Colume	60" x 10'		0.02
Disch Head	60"	K=0.4	0.65
BFV		K=0.7	1.14
Elbow	60"	K=0.4	0.65
Downpipe	60" x 10'		0.02
Diffusser	60" x 72" x 72"	K=0.02	0.03
Exit	72"		0.80
			Σ = 2.17' - 3.31

@90,600 gpm
$V^2/2g$ 60" 1.63'
72" 0.80'

he/100' 60" = 0.15'

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Owner SFWMD
Plant NORTHEAST P. STA Unit
Project No. File No.
Title IRRIGATION PUMPS

Computed By T STOLINSKI
Date APRIL 6 2006
Verified By
Date 20
Page of

	STATIC	DYNAMIC		
PUMP RATING =	1.9' +	~~2.17'~~ 3.31	= 4.1' 5.2'	DESIGN PT

MAX STATIC CANAL 14.0'
RESERVOIR 8.6'
5.4'
LOSS THROUGH STRUCTURE + .5'
5.9' → 6'

PLUS HL 6' + 2.17' = 8.2'

MAX PRIMING HEAD

24 Disch El
8.6 Reservoir
15.4

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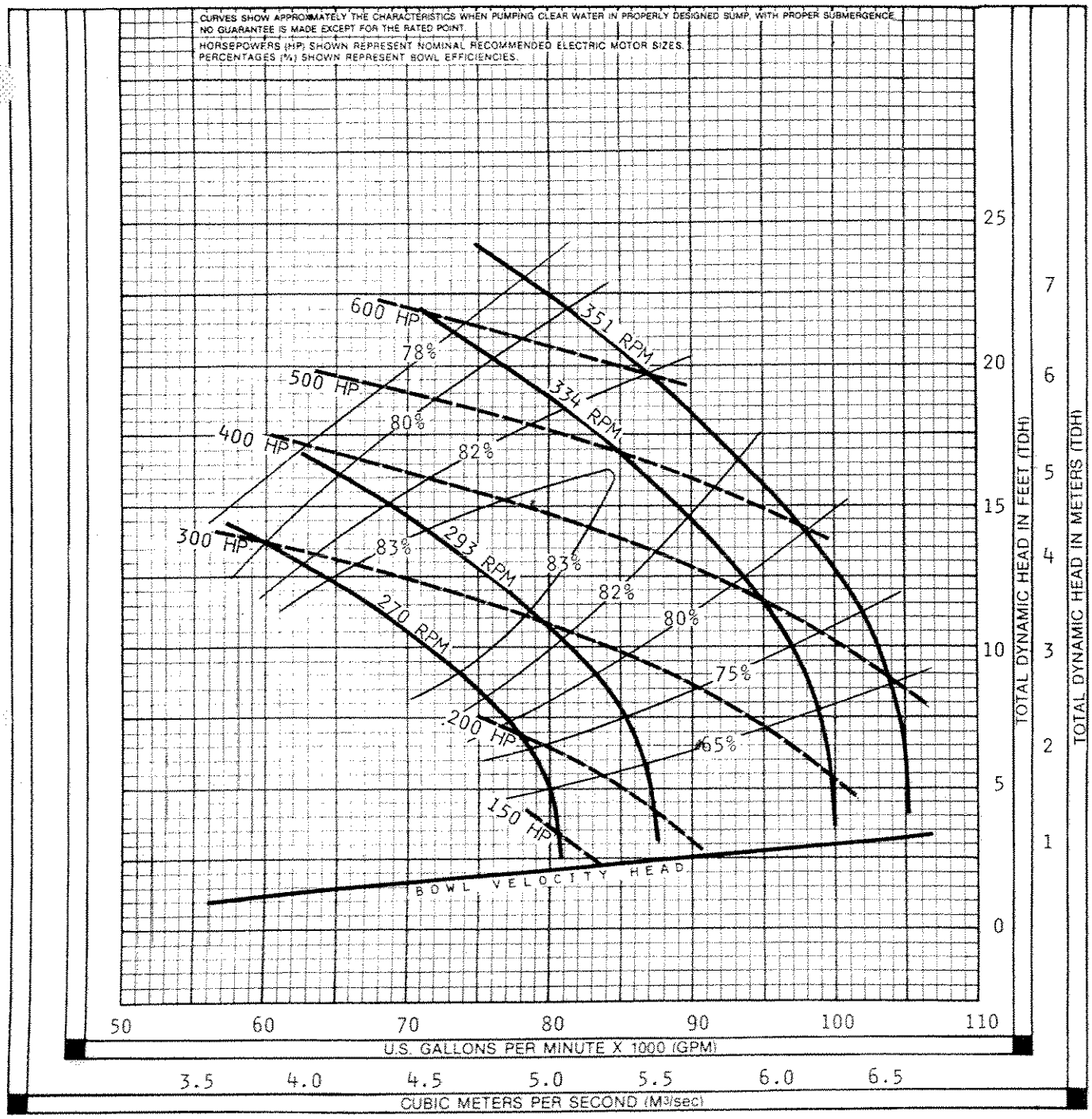
AXIAL FLOW 54"

C182



M&W PUMP CORP.
DEERFIELD BEACH, FLORIDA 33441
U.S.A.
ESTABLISHED 1926

PUMP BOWL PERFORMANCE CURVE
VARIABLE SPEED

TYPE: AXIAL FLOW	PROPELLER DIA.: 54"
MODEL NO.: NC354P12	SPEED (RPM): AS NOTED
INTAKE DIA.: 81"	DISCHARGE COLUMN DIA.: 54"
CURVE NO.: VS54P12	Ns: 11,700 CODE: 50

SINGLE STAGE
FOR TWO STAGES MULTIPLY HEAD AND HORSEPOWER BY 2.0 AND EFFICIENCY BY 1.0

PERFORMANCE BASED ON PUMPING CLEAR COLD NON-AERATED WATER, SPECIFIC GRAVITY 1.0, TEMPERATURE 85 DEGREES (FAHRENHEIT) OR LESS, AT SEA LEVEL. PERFORMANCE MAY BE AFFECTED BY HIGHER TEMPERATURES, SPECIFIC GRAVITIES, ALTITUDES, AND SUMP CONDITIONS.

IT IS HEREBY CERTIFIED THAT THIS CURVE REPRESENTS THE TRUE PERFORMANCE CHARACTERISTICS OF THE M&W PUMP MODEL SHOWN AND WAS OBTAINED BY SCALE MODEL TEST AND CALCULATIONS IN ACCORDANCE WITH STANDARDS OF THE HYDRAULIC INSTITUTE.

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Deerfield Beach, Florida

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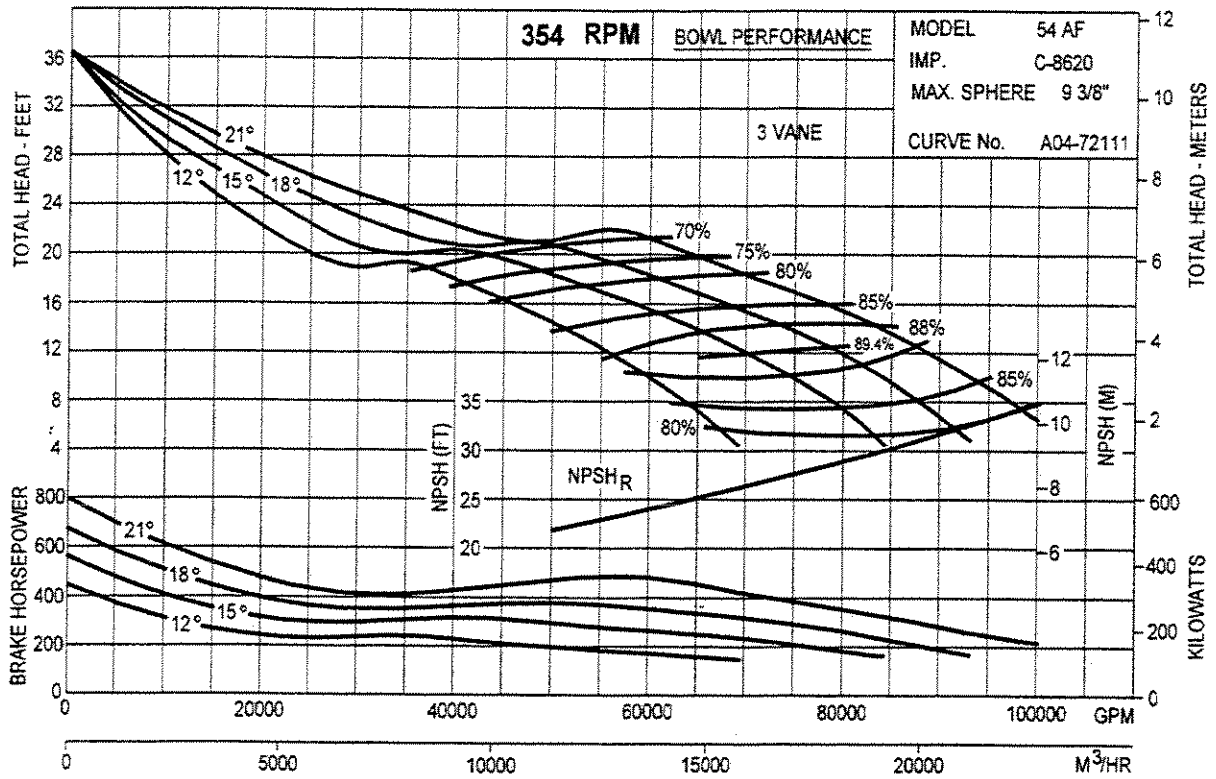
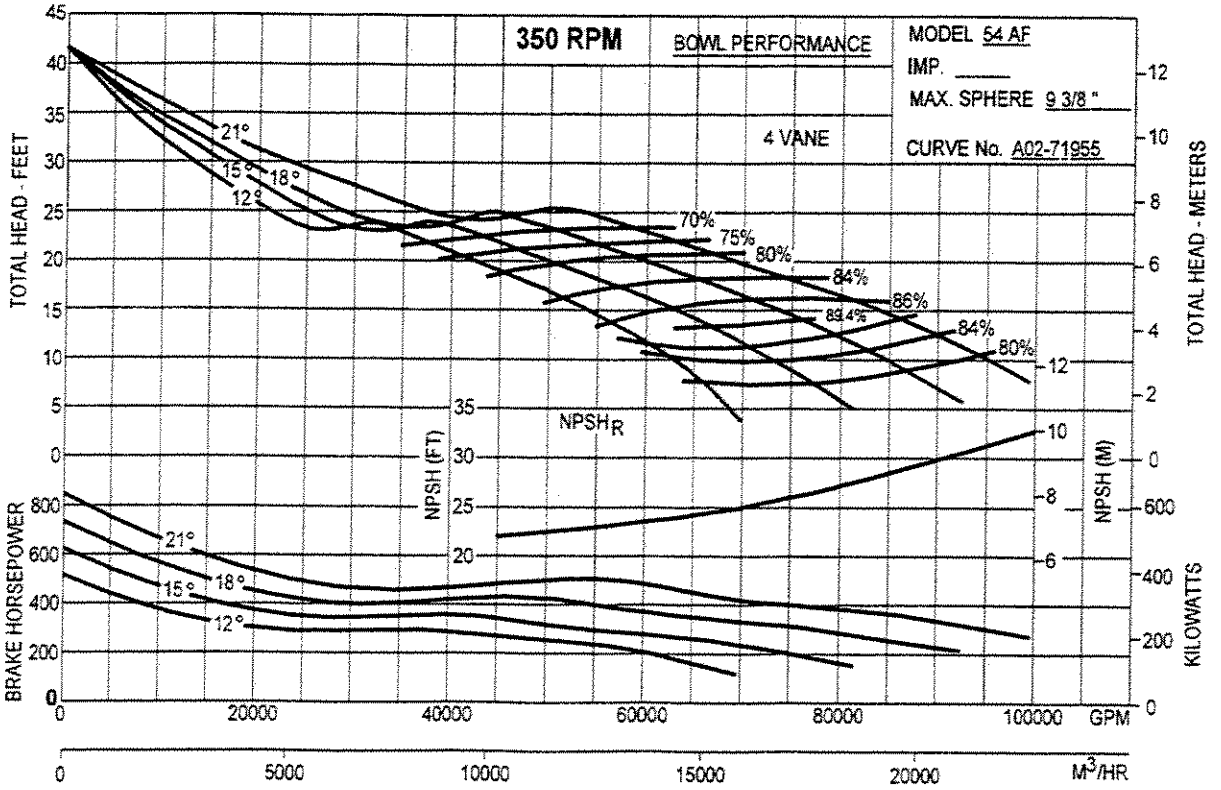
Toccoa, Georgia
U.S.A.

54 AF
AXIAL FLOW PUMP

SECTION P54
PAGE 3
DATE: JAN. 2,2000





A04-76866

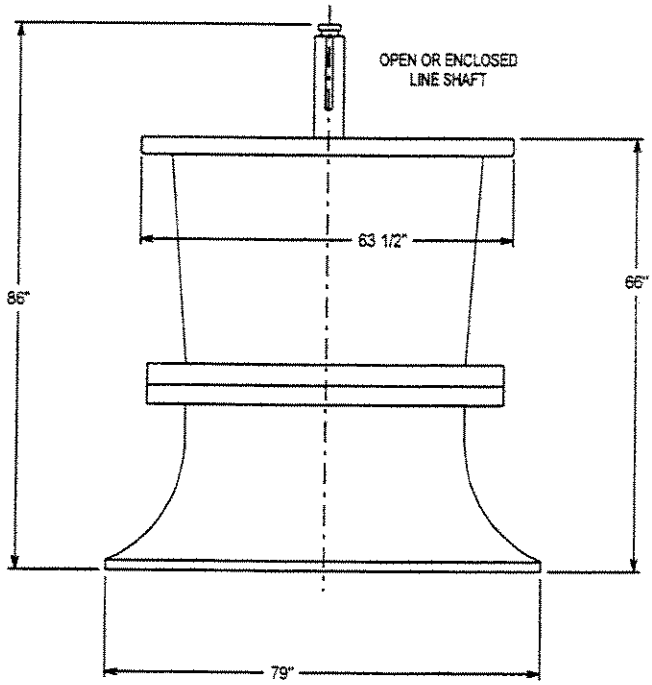
Toccoa, Georgia
U.S.A.

54" AF AXIAL FLOW
BOWL DATA

SECTION P54

PAGE 1

DATE: JAN. 2, 2000



BOWL	54AF	54AF
IMPELLER NO.	C-8620	C04-64799
THRUST FACTOR (LBS./FT.)	697	697
NO. OF IMPELLER VANES	3	4
IMPELLER WR^2 (LB.-IN.^{2}) PER STAGE	235889	297220
SPHERE (IN.)	9 3/8	9 3/8
MAXIMUM WORKING PRESSURE (PSI)	125	125
BOWL SHAFT DIAMETER (IN.)	4 1/2	4 1/2
MINIMUM SUBMERGENCE (IN.)	SEE SUBMERGENCE GRAPH	
STANDARD COLUMN SIZE (IN.)	60	60
IMPELLER WEIGHT (LBS.)	865	965
ONE STAGE WEIGHT (LBS.)	11750	11850
ADDITIONAL STAGE WEIGHT (LBS.)	CONSULT FACTORY	
ADD PER ADDITIONAL STAGE (IN.)	CONSULT FACTORY	

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building a world of difference

ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Fuel Consumption of the Engine Drives

Page ____ of ____

Owner: SFWMD

Project No.: 144777

Computed by: Larry D. Pittman — Date: 4-5-06

Verified by: David W. Long — Date: 7-12-06

Objective: Determine fuel consumption of the engine drives

References:

A) Memo to file dated 4-4-06 from Larry Pittman (Copy Attached)

B) Engineering Report, File No. R-5.15-0515, Dated December 13, 2001, FME Sales Order 206773, (Copy Attached)

C) E-mail from Kevin Lolbury dated 4-5-06 (Copy Attached)

D) SFWMD, Major Pumping Station Engineering Guidelines, Final Dec. 1, 2005

Calculation:

Engine operating hp requirement = 1250 hp (Ref A)

Fairbanks Morse 9 cylinder 38D8⅛ rated 1530 hp @ 720 rpm (Ref B)

$\frac{1250\,hp}{1530\,hp} = 0.817$ or would be 81.7% loaded

Fuel consumption @ 100% capacity (1530 hp) 0.375 lb/bhp hr (Ref B)

Fuel consumption @ 75% capacity (1.148 hp) 0.379 lb/bhp hr (Ref B)

Fuel Consumption @ 81.7% by interpolation

$$.375 - .379\left[\frac{100-75}{81.7-75}\right] + 0.379$$

$$-0.0040\,[3.73] + 0.379$$

$$= 0.364\ lb/bhp\ hr$$

$(0.364\ lb/bhp\,hr)(1250\ hp) = 455\ lb/hr$

$(455\ lb/hr)(1\ gal/7.08\ lb)$

$= 64.27\ gal/hr$ use 65 gal/hr

To: File

From: Larry Pittman Date: 4-4-06

Subject: South Florida

Proj. No.:

Per Ted

Preliminary Pump HP Requirements

Typical running hp for pump ≈ 1250 hp

HP with screens blocked + overflow ≈ 1500 hp

Shutoff of pump 183% of running torque

∴ for sizing (layout) base on ≈ 1500 hp

Pittman, Larry D.

From: Lidbury, Kevin [Kevin.Lidbury@FairbanksMorse.com]
Sent: Wednesday, April 05, 2006 11:34 AM
To: Pittman, Larry D.
Subject: RE: South Florida Water Management

Larry:

Based on the information you have given me, this appears to be the correct engine selection.

Kevin C. Lidbury
Sales Manager-Commercial Engine Sales

FAIRBANKS MORSE ENGINE
701 White Avenue
Beloit, WI 53511

Phone (608) 364-8005
Phone 800-356-6955 Ext. 8005
Cell Phone (608) 312-6008
Fax (608) 364-8380
www.fairbanksmorse.com

From: Pittman, Larry D. [mailto:PittmanLD@bv.com]
Sent: Wednesday, April 05, 2006 10:55 AM
To: Lidbury, Kevin
Subject: South Florida Water Management

Kevin: We are looking are 2 different pumping capacities and therefore 2 different horsepower requirements for the pumping station for the South Florida Water Management Project. First scenario requires approximately 1500 hp, we are looking at the 9 cylinder 38D 8 1/8 unit operating at 720 rpm to meet this requirement. The second scenario requires approximately 1700 hp, for this we are looking at the 10 cylinder 38D 8 1/8 unit. Do you agree with these selections for the Fairbanks Morse units? Please respond as soon as possible as we are laying out the building and need this verification as soon as possible. Thanks

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GOODRICH
Fairbanks Morse Engine

ENGINEERING REPORT

BF3010B

PAGE NO. 1

FILE NO. R-5.15-0515

DATE December 13, 2001

SUBJECT: Contract Performance Test Report

PREPARED BY Joe Eves

REPORT TITLE: Shop Contract Test of Flowserve Engine #1. FME Sales Order 206773

APPROVED BY

Test Equipment Details

Test Date:	December 11, 2001	
Test Procedure:	16 114 155, Rev 2	
Engine Full Rated Load @ Speed:	1530 bhp @ 720 RPM	
Engine Rated Condition Load (RCL) @ Speed:	1182 bhp @ 720 RPM	
Engine Type & Serial Number:	9-cylinder 38D8-1/8	38D801009DS9
Blower Type & Serial Number:	FME 27" Double Wall	R4555
Governor Type & Serial Number:	Woodward EGB13-P	13154302

Contract Requirements*

% Rated Load	BSFC (lb/bhp-hr)	$BSNO_x$ (g/bhp-hr)	BSCO (g/bhp-hr)	$BSHC_T$ (g/bhp-hr)
100	**.380**	**9.0**	**3.0**	**1.5**

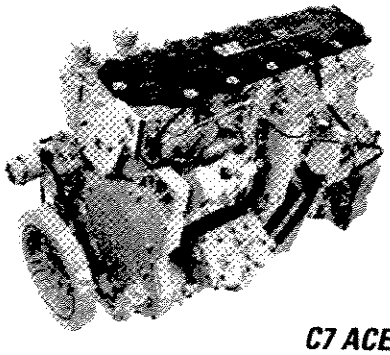
*** Note: Contract requirements / guarantees based on % engine full rated load**

Test Results Summary

% RCL	BSFC	PPM Emissions			Volumetric Emissions		Brake Specific Emissions (g/bhp-hr)		
	(lb/bhp-hr)	NO_x	CO	HC	O_2	CO_2	NO_x	CO	HC
25	.504	150	58	60	18.6	1.5	7.46	1.74	.91
50	.411	260	53	53	17.6	2.4	6.78	.84	.42
75	.379	420	50	44	16.3	3.3	7.16	.52	.24
100	.375	598	58	53	15.1	4.2	7.95	.47	.22
110	.374	648	80	57	14.6	4.7	7.75	.58	.21
100 **	**.375**	775	155	68	13.4	5.6	**7.84**	**.96**	**.22**

**** Note: Load percent based on engine full rated load.**

Attachments:
FME Test Procedure 16 114 155, Rev 1 (4 sheets)
FME Production Test Log (1 sheet)
Diesel Fuel Analysis Report (3 sheets)



C7 ACERT

ACERT® Technology

The latest in a line of successful Cat diesel engine design innovations, ACERT Technology delivers superior emissions reduction, while maintaining engine performance, efficiency, and durability. ACERT Technology is so progressive, in fact, that it is the only diesel emissions reduction program poised to comply with coming Tier 4/StageIIIb standards.

At the core of the ACERT approach is precise control of combustion. By better managing four key engine parameters, combustion temperatures, and thus exhaust emissions, are reduced. These four parameters: air management, fuel delivery, electronic control, and aftertreatment, may be individually tailored to optimize ACERT performance by application and/or engine class.

Variable Valve Actuation and Series Turbocharging are two breakthrough air management strategies that play critical roles in on-highway engines equipped with ACERT Technology for Tier 4, Stage IIIb. Variable Valve Actuation controls the timing and duration of air flow into and exhaust flow out of the combustion chamber. Series Turbocharging, which uses two smaller, slower turbos, results in less lag.

A Cat fuel delivery advance, multiple injection, uses "microbursts" of fuel to more precisely shape the combustion cycle. Providing the "intelligence" for ACERT Technology is the Cat ADEM™ 4. This programmable electronic controller governs many engine functions with incredible precision.

CATERPILLAR

DIESEL AND HEAVY FUEL APPLICATIONS

	Distillate A Rating (Continuous)			Heavy Fuel A Rating (Continuous)		
Model/Type	**bkW**	**bhp**	**rpm**	**bkW**	**bhp**	**rpm**
3606 TA	1490	1998	750	1350	1810	750
3606 TA	1560	2092	800	1355	1817	825
3606 TA	1730	2319	900	1570	2105	900
3606 TA	1850	2481	1000	1680	2253	1000
3608 TA	1980	2655	750	1800	2414	750
3608 TA	2080	2787	800	1800	2414	825
3608 TA	2300	3080	900	2090	2803	900
3608 TA	2460	3300	1000	2240	3004	1000
3612 TA	2980	3996	750	2700	3621	750
3612 TA	3120	4184	800	2710	3634	825
3612 TA	3460	4640	900	3140	4211	900
3612 TA	3700	4962	1000	3360	4506	1000
3616 TA	3960	5310	750	3600	4828	750
3616 TA	4160	5579	800	3600	4828	825
3616 TA	4600	6169	900	4180	5605	900
3616 TA	4920	6598	1000	4480	6008	1000

Abbreviations used:
TA.....Turbocharged/Aftercooled

Rating Definition
Continuous: For powering pipeline pumps, etc. A rating.

SECTION B - DATA AND SPECIFICATIONS

(All data based on full load and engine at 720 rpm)

1-1. ENGINE SPECIFICATIONS AND RATINGS - 8 &9 CYLINDER

Pumping Station	S-370	S-372
Size	8 Cylinder	9 Cylinder
Model	38D8-1/8	38D8-1/8
Type	Opposed Piston	Opposed Piston
Cycle	Two	Two
Bore and Stroke - inches	8-1/8 x 10	8-1/8 x 10
Number of Cylinders	8	9
Brake Horsepower - Rated Load (continuous rating)	1360	1530
Bmep - psi	90	90
Compression Ratio (total trapped volume)	14.6:1	14.6:1
Total Piston Displacement - cu. in.	8,296	9,333
Piston Speed - fpm	1200 fpm	1200 fpm
Engine Idling Speed - rpm (minimum)	300	300
Injection Nozzle (Pintle type, gasketless) - psi (nominal)	2400 - 2500	2400 - 2500
Pumps - Cooling Water		
Type	Centrifugal	Centrifugal
Pump - Fuel Oil		
Type	Gear	Gear
Pump - Lubricating Oil		
Type	Gear	Gear
Pump Relief Valve Setting	80 psi	80 psi
Injection Pump Timing (High Cam)	41° A.I.D.C.	41° A.I.D.C.
Crank Lead	12° L.L.	12° L.L.
Crankcase Vacuum - inches of water	0.5 to 2.5	0.5 to 2.5
Overspeed Governor Trip - rpm	790 to 828	790 to 828

1-2. FUEL OIL SPECIFICATIONS - 8 &9 CYLINDER

Viscosity at 100 °F, Saybolt Seconds Universal (SSU)	32 to 50	32 to 50
Carbon Residue on 10% bottoms - percent by weight	0.35 Max.	0.35 Max.
Sulfur - percent by weight	0.50 Max.	0.50 Max.
Maximum Flash Point	Legal	Legal
Bottom Sediment and Water - percent by volume	0.10 Max.	0.10 Max.
Ash - percent by weight	0.12 Max.	0.12 Max.
Pour Point - °F	*	*
Distillation - 90% point, °F.	675°F Max.	675°F Max.
Cetane Number	40 **	40 **

* A fuel oil must be liquid in order to be used by the fuel injection system. The cloud point (normally slightly higher than the pour point) should be below the lowest temperature at which the fuel is handled. Under various conditions of prevailing temperatures, the allowable value of the pour point will change. If the fuel is preheated before use, it may be used where the temperature is below the pour point.

** A higher cetane rating will add fast start capabilities, therefore engines for emergency standby applications, such as nuclear or government installations, normally require the use of fuels with a minimum of 45 cetane. Low atmospheric temperatures as well as operation at higher altitudes may also require use of fuels with higher cetane.

GOODRICH
Fairbanks Morse Engine

ENGINEERING REPORT

BF3010B

PAGE NO. 1

FILE NO. R-5.15-0515

DATE December 13, 2001

SUBJECT: Contract Performance Test Report

PREPARED BY Joe Eves

REPORT TITLE: Shop Contract Test of Flowserve Engine #1. FME Sales Order 206773

APPROVED BY

Test Equipment Details

Test Date:	December 11, 2001	
Test Procedure:	16 114 155, Rev 2	
Engine Full Rated Load @ Speed:	1530 bhp @ 720 RPM	
Engine Rated Condition Load (RCL) @ Speed:	1182 bhp @ 720 RPM	
Engine Type & Serial Number:	9-cylinder 38D8-1/8	38D801009DS9
Blower Type & Serial Number:	FME 27" Double Wall	R4555
Governor Type & Serial Number:	Woodward EGB13-P	13154302

Contract Requirements*

% Rated Load	BSFC (lb/bhp-hr)	$BSNO_x$ (g/bhp-hr)	BSCO (g/bhp-hr)	$BSHC_T$ (g/bhp-hr)
100	**.380**	**9.0**	**3.0**	**1.5**

*** Note: Contract requirements / guarantees based on % engine full rated load**

Test Results Summary

% RCL	BSFC	PPM Emissions			Volumetric Emissions		Brake Specific Emissions (g/bhp-hr)		
	(lb/bhp-hr)	NO_x	CO	HC	O_2	CO_2	NO_x	CO	HC
25	.504	150	58	60	18.6	1.5	7.46	1.74	.91
50	.411	260	53	53	17.6	2.4	6.78	.84	.42
75	.379	420	50	44	16.3	3.3	7.16	.52	.24
100	.375	598	58	53	15.1	4.2	7.95	.47	.22
110	.374	648	80	57	14.6	4.7	7.75	.58	.21
100 **	**.375**	775	155	68	13.4	5.6	**7.84**	**.96**	**.22**

**** Note: Load percent based on engine full rated load.**

Attachments:
FME Test Procedure 16 114 155, Rev 1 (4 sheets)
FME Production Test Log (1 sheet)
Diesel Fuel Analysis Report (3 sheets)

FAIRBANKS MORSE

	G-370 8-Cylinder		G-372 9-Cylinder
Horsepower	1360		1530
Shop HP tests			
25% site load	234		296
50% site load	468		591
75% site load	701		887
100% site load	935		1182
110% site load	1029		1300
Engine rate load	1360		1530
Exhaust Air			
Inlet Air Flow	4550	SCFM	5130
Air Temperature	70	degrees F	70
Delta P			
Outlet Air Flow	9470	ACFM	10675
Outlet Air Temp.	620	degrees F	620
Heat Exchanger Jacket			
Cold Flow	407	GPM	407
Inlet Temp	95	degrees F	95
Outlet Temp	105	degrees F	105
Delta P	8	PSI	8
Heat Rejection			
Hot Flow	430	GPM	480
Hot Inlet	160	degrees F	160
Hot Outlet	156	degrees F	156
Heat Exchanger Oil			
Cold Flow	407	GPM	407
Inlet Temp	105	degrees F	105
Outlet Temp	112	degrees F	112
Delta P			
Heat Rejection			
Hot Flow	250	GPM	250
Hot Inlet	185	degrees F	185
Hot Outlet	160	degrees F	160
Heat Exchanger Fuel Oil			
Cold Flow	10	GPM	10
Inlet Temp	95	degrees F	95
Outlet Temp	100	degrees F	100
Delta P			
Heat Rejection			
Hot Flow	5	GPM	5
Hot Inlet	130	degrees F	130
Hot Outlet	105	degrees F	105

Maxim Silencers, Inc.

Phone: (832) 554-0980

Fax: (832) 554-0990

Industrial Silencer, Heat
and Catalytic S

Products News Employment Support About Us

Chamber Type Silencers

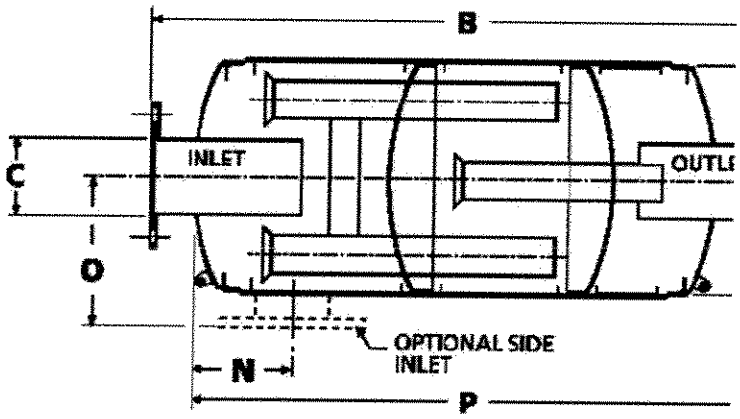
Family Members: M21 M31 M41 **M51** MUL

OVERVIEW

Best Chamber Type Silencer: Expected Attenuation is 28 to 32 dBA

Use a model M51 for the highest degree of "critical" grade silencing for areas requiring "hospital quiet" noise reductions. The M51 is presently the top-of the-line silencer without resorting to multiple silencers in series or custom designed silencers.

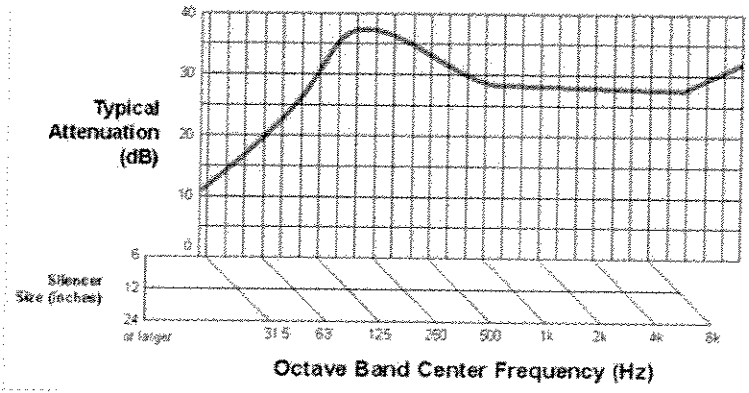
DRAWING



TYPICAL APPLICATIONS

- Internal combustion engine intakes and exhausts
- Blower intakes and discharges
- Vacuum pump discharges

ATTENUATION



FEATURES

- Advanced acoustical design
- Heavy duty, all welded construction and long service life
- Easily installed in any position
- Prime coated exterior finish

ES

- Backfire relief covers
- Flexible connectors

Size	A	B	C	N Min.	N Max.	O	P	Es
1 ½"	7	26	1 ½	3	11	6 ½	24	
2"	10 ¼	25	2	3 ½	10 ½	8	23	
2 ½"	12	36	2 ½	4 ½	15 ½	9	33 ¼	
3	14	45	3	5 ¼	21 ¼	10	42 ½	
3 ½"	16	53	3 ½	6	25	11	50 ¼	
4"	18	64	4	6 ½	31	12	61 ¼	
5"	22	72	5	8	35	14	69 ¼	
6"	26	85	6	9	41 ½	16	82 ½	

- Companion flanges
- Cleanout openings
- Side inlets
- Horizontal or vertical support arrangements
- Special painting

8"	30	103	8	10 ½	50	18 ½	100	[illegible]
10"	36	118	10	12 ½	59	21 ½	115	[illegible]
12"	36	146	12	13	58	21 ½	143	1
14"	40	145	14	16 ½	56	23 ½	142	1
16"	45	164	16	18	63	26	161 ¼	2
18"	50	188	18	20	74	29	185	3
20"	54	217	20	21	84	31	214	4
22"	60	230	22	23	92	34	227	5
24"	64	258	24	25	105	36	255 ¼	6
26"	68	283	26	26	115	38	280 ¼	7
28"	72	315	28	28	128	40	312 ¼	8
30"	78	326	30	30	133	43	323 ½	9

Note: Dimensions are in inches, weights are in pounds.

Phone: 832-554-0980
Fax: 832-554-0990
E-mail: sales@maximsilencers.com

Maxim Sil
10635 Brig
Stafford, T

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Engine cooling water requirements

Owner: SFWMD
Project No.: 144777

Computed by: Larry D. Pittman
Verified by: David W. Long

Page ____ of ____
Date: 5-4-06
Date: 7-12-06

Objective: Preliminary engine and right angle gear cooling water requirements

References:
A) BF Goodrich Fairbanks Morse Engine Division DWG No. 12999063
B) Fairbanks Morse DWG No. 10561384
C) Philadelphia Gear Corporation, Data Sheet, R.H. Pump Drive, DWG No. 03152*055 C Rev C

Calculation:

Based on horsepower requirement of 1500 hp use data from G-372 station

Cooling Water (Includes lube oil)	407 gpm	5.74 psi pressure loss
Fuel	10 gpm	7.78 psi pressure loss
	417 gpm	13.52 psi total

USE 450 gpm @ 20 psi water required

12 999 063

HEAT EXCHANGER, DUAL SECTION-JACKET WATER AND LUBE OIL

- PLATE AND FRAME DESIGN
- PLATES: 316SS, .6MM THICK
- NUMBER OF PLATES: JW-61; LO-74
- CONNECTIONS: 4 INCH 150# ANSI STUDDED
- EXCESS SURFACE AREA: MINIMUM 20%
- WEIGHT: 1,290 POUNDS

JACKET WATER: 2,019,600 BTU/HR

PARAMETER	HOT SIDE	COLD SIDE
FLOW [GPM]	480	407
TEMPERATURE IN [F]	165	95
TEMPERATURE OUT [F]	156	105
PRESSURE DROP [PSID]	7.87	5.74

LUBE OIL: 1,346,400 BTU/HR

PARAMETER	HOT SIDE	COLD SIDE
FLOW [GPM]	250	407
TEMPERATURE IN [F]	185	105
TEMPERATURE OUT [F]	160	112
PRESSURE DROP [PSID]	4.68	7.78

VENDOR: ITT STANDARD BUFFALO, NY	PART NUMBER: P21-1300

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BFGoodrich Fairbanks Morse Engine Division

REV. NO.	CHANGE ORDER NO.	DATE	DESCRIPTION	CHK'D BY
0	E101474	03/27/01	INITIAL RELEASE	CAS

REL. NO. E101474	03/27/01	ASSY OR. LO	
DR. BY C.A. SARGENT	1/25/01	SCALE	
CHK'D. BY		HEAT TR.	
MAT'L. SEE NOTES			
APPV.	CAST.	MAT'L.	
	MACH.	ENGR. C.A. SARGENT	
	WELD		
Sheet Size A	DWG. NO. 12 999 063	SHEET 1 OF 1	

12 999 063

	G-370 8-Cylinder		G-372 9-Cylinder
Horsepower	1360		1530
Shop HP tests			
25% site load	234		296
50% site load	468		591
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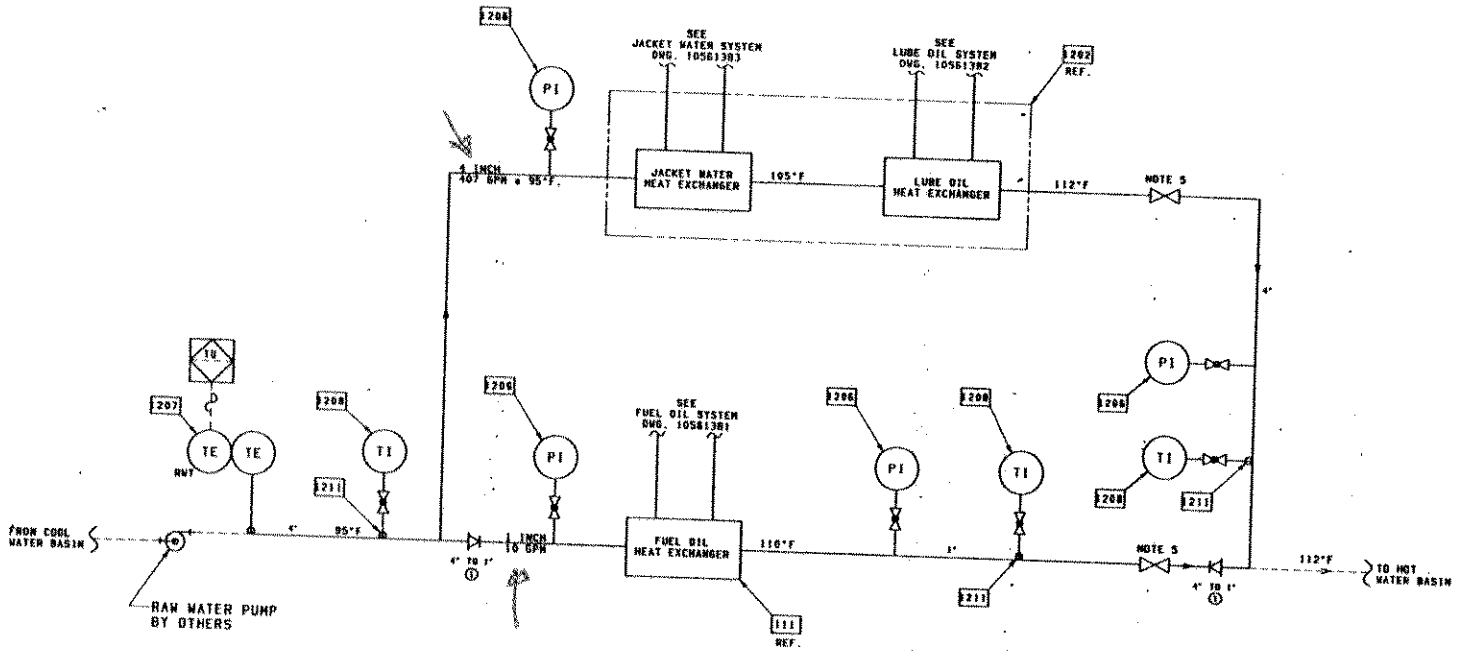
Heat Exchanger Oil			
Cold Flow	407	GPM	407
Inlet Temp	105	degrees F	105
Outlet Temp	112	degrees F	112
Delta P			
Heat Rejection			
Hot Flow	250	GPM	250
Hot Inlet	185	degrees F	185
Hot Outlet	160	degrees F	160
Heat Exchanger Fuel Oil			
Cold Flow	10	GPM	10
Inlet Temp	95	degrees F	95
Outlet Temp	100	degrees F	100
Delta P			
Heat Rejection			
Hot Flow	5	GPM	5
Hot Inlet	130	degrees F	130
Hot Outlet	105	degrees F	105

10561384

SEE NOTES ON SHT. 2



FLOWSERVE/SFWMD
STA G-370 & G-372
S.O. #206773

SEE ITEM DESCRIPTION ON SHEET 2

REV NO	DRAWING NUMBER	DATE	DESCRIPTION	BY
3	E105379	10/10	"AS BUILT"	BRE
2	E104883	10/10	REVISION "AS BUILT"	BRE
1	E102259	11/20	REVISION "FOR CONSTRUCTION"	BRE
1	"	"	ADDED 4" TO 1" REDUCERS	BRE
0	E101434	11/21	INITIAL RELEASE	BRE
REV NO	DRAWING NUMBER	DATE	DESCRIPTION	BY

TITLE
SCHEMATIC DIAGRAM
RAW WATER
COOLING SYSTEM

TOLERANCES
UNLESS DIMENSION SPECIFIED
FRACTIONAL DIMENSIONS ± 1/64
TOOL MARKS ± .005
FINISH MACHINE SURFACE, 125 RMS
FINISH ON SURFACE, 250
DECIMAL DIMENSION TOLERANCES
.0 = .005 .00 = .010 .000 = .005

FAIRBANKS MORSE

REL. NR. E101434 REVISION
DR. BY BRENDAN BRE DATE
CHK'D BY
DATE
DRAWN BY
DATE
CHECK
DATE
TITLE
SIZE D
DWG NO 10561384
REV 3
SHEET 1 OF 2
REVISION
SEAT NR LO
SCALE NONE
SEAT TO
DATE
ART SUBSERT

CORNERS)

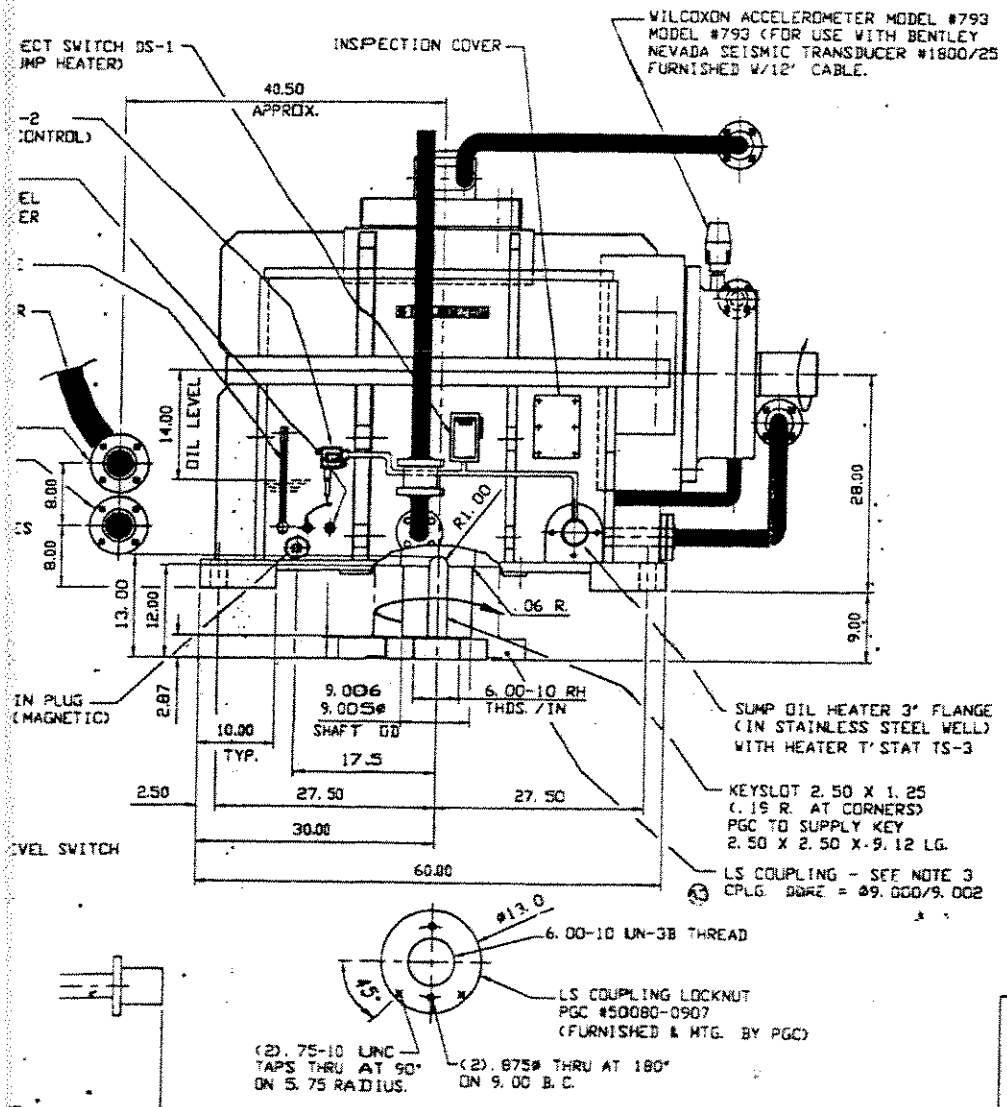
REFERENCE DRAWING:
LUBE SCHEMATIC DRAWING: # 07152*0199
LUBE CONSOLE DRAWING: # 07152*0200
WIRING DIAGRAM DRAWING: # 15152*0015
NAME PLATE DRAWING: # 15152*0014

PHILADELPHIA

PHILADELPHIA GEAR CORPORATION

720 IN
117.597 OUT

* SERIAL NUMBERS: 153548 THRU 153549
(2) UNITS R. H. ASSEMBLY



NOTES:

1. PHILADELPHIA GEAR DRIVE EQUIPPED WITH SURFACE HARDENED PINIONS AND SURFACE HARDENED GEARS.
2. ALL SHAFTS ARE MOUNTED ON ANTI-FRICTION BEARINGS FOR B10 LIFE = 100,000 HOURS
3. COUPLINGS:
   H.S. SHAFT
   (C2) ■ SUPPLIED BY OTHERS
   ■ MOUNTED BY OTHERS.
   L.S. SHAFT
   ■ SUPPLIED BY OTHERS
   ■ MOUNTED BY PGC.
4. PAINT: ■ P.G.C. STANDARD PRIME & FINISH
5. LUBRICATION
   ■ FORCE FEED & SPLASH
   OIL SUMP:
   ■ IN GEAR HOUSING
   SEE LUBE SCHEMATIC DRAWING FOR DETAILS OF LUBRICATION SYSTEM

   TYPE OF LUBE:
   STRAIGHT MINERAL OIL (100 GALS.)
   AGMA#3 EP FOR 15 DEGF. TO 60 DEGF.
   AMBIENT TEMP. 450SUV AT 100 DEGF.
   AGMA#5 EP FOR 50 DEGF. TO 125 DEGF.
   AMBIENT TEMP. 1000SUV AT 100 DEGF.

   COOLER
   SHELL & TUBE
   145 GPM WATER IN AT 95 °F.
   WATER OUTLET TEMP = 96.5 °F
   PRESSURE DROP = 3.5 PSI
   HEAT REJECTION = 99000 BTU/HR
   MAX DESIGN PRESSURE = 150 PSI

6. UNIT FURNISHED WITH A MARLAND-RINGSPANN BACKSTOP, PART #RBI 150-156S. BACKSTOP IS MOUNTED INTERNALLY ON INPUT SHAFT. RATED FOR 36,029 LB/FT.
7. UNIT DESIGNED FOR DOWN THRUST LOAD ON LOW SPEED SHAFT AS FOLLOWS:
   63000 Lbs CONTINUOUS
   91000 Lbs MOMENTARY
8. GEAR NOISE:
   85 dB(A) MAX @ 3 FEET PER AGMA 6025
9. UNIT FURNISHED WITH DUAL LIP SEALS WITH WEAR SLEEVE ON H.S. SHAFT AND DRY WELL TYPE ON LOW SPEED SHAFT.
10. VR**2 REL. TO L.S. SHAFT.....1872942.0 LB*IN2
    VR**2 REL. TO H.S. SHAFT.....49963.8 LB*IN2
    (A2) TOTAL STIFFNESS REL. TO L.S. SHAFT
    = 233.249 MILLION IN.LBS/RAD
    TOTAL STIFFNESS REL. TO H.S. SHAFT
    = 6.222 MILLION IN.LBS/RAD
    OVERALL RATIO = 6.1226

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

STATION: G-372 (960 CFS PUMPS)
PROJECT: S-1613
FLOWSERVE P.O.: P070789

PHILADELPHIA GEAR CORPORATION

DATA SHEET - R. H. PUMP DRIVE

CERTIFIED	DATE 10/08/01	DWG NO. 03152-0545/0539 REF	
KISHORE D. DESAI		505126-2	
P070789			
		DRN KBD	CHK RGS
		APPR ERF	DATE 2/27/01
		1.9MVBX-2PD	
D	17454	03152*0552	C
SCALE 3/32	WEIGHT 27,500 #	SHEET 1 OF 1	

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building a world of difference
ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Required capacity of the Fuel Storage Tanks
Page ____ of ____
Owner: SFWMD
Computed by: Larry D Pittman — Date: 7-10-06
Project No.: 144777
Verified by: David W. Long — Date: 7-12-06

Objective: Determine the required capacity of the fuel storage tanks

References:

A) South Florida Water Management District, Major Pumping Station Engineering Guidelines (Second Edition) Final December 1, 2005, Section 5.3.2.1. and 5.3.2.2.

B) Hand Calculation Sheet Titled Fuel Consumption of the Engine Drives by Larry D Pittman dated 4-5-06

Calculation:

Tank capacity based on fuel consumption of the engine/generator at rated horsepower/KW for seven (7) days operation (Ref A)

Fuel consumption of one engine drive - 65 gph (Ref B)

Fuel consumption for 7 days or 168 hr

(65 gph) x (168 hr) = 10,920 gallons

∴ for 6 engine drives the required capacity is

(6 units) x (10,920 gallons) = 65,520 Gallons

Fuel consumption of one engine-generator assume 200 KW unit or 140 gph

Fuel consumption for 7 days or 168 hr

(140 gph) x (168 hr) = 23,520 gallons

Total Required Storage Capacity: 65,520 gal + 23,520 gal

= 89,040 gallons

USE 4 - 25,000 gallon tanks

vertical Fuel Oil Transfer Pumps mounted on top of each storage tank. A double walled Fuel Oil Day Tank, one per each main pump engine is required. Consider installation of the redundant transfer pump in each of the tanks. This will eliminate the need for transferring contents of the tank with inoperable pump into another tank. Utilizing tanks with top connections only does not allow content transfer if pump is inoperable. Additionally, each diesel generator will have its own diesel fuel day tank supplied with the generator. All interconnecting piping, filters, valves, instruments and controls shall be furnished and installed under the construction contract. Storage tanks shall be sized to provide 7-day operation for each engine/generator. External mounted tanks shall be double wall, fire and ballistic resistant. Any float type level devices shall be stainless steel where practical. The Fuel Oil Supply System shall reflect requirements of ASME B31.3. All day tanks and double walled piping shall have leak detection systems.

5.3.2.2 Storage Tank Sizing and Operation.

The basis for sizing the storage tanks is the fuel consumption of the selected pump engine at its rated horsepower and seven (7) days operation.

Bulk fuel will be transported to the main storage tanks, and delivered through a four inch quick coupler with a check valve from a pumper truck through an automatic fuel port. A fuel oil receiving pump should be installed to receive fuel from a delivery truck not having pumping capabilities. The fuel is pumped through a strainer into a common manifold and then to each storage tank. Flow into each tank is controlled by a motor operated ball valve, which receives a "close" signal from the automatic fuel port level controller when level in the tank rises to 90 percent of volume. The operator will then have an option to override the close signal and open motor operated ball valve to top the tank off to 95 percent, at which point level controller will close the valve and stop the pump. The process will be repeated for each of the tanks. The fuel from each of the main storage tanks will be pumped by a vertical, top of tank mounted fuel transfer pump, through a set of spin on duplex filters, one of which is a particulate filter and second one is a water filter. The anti-siphon valves shall be included at the tanks. These pumps provide fuel to each of the pump engine day tanks and emergency diesel generators in the station. The entire fuel piping system will be jacketed, double wall piping with built-in leak detection system until it reaches the main machinery deck.

A fuel containment system as described in Paragraph 5.1.12, shall be designed around the fuel storage tanks with positive closure at all openings and shall include a valved sump collection area with leak detection sensors. The design shall comply with the Florida Department of Environmental Protection code for spill containment over waterways.

5.3.2.3 Engine Day Tanks.

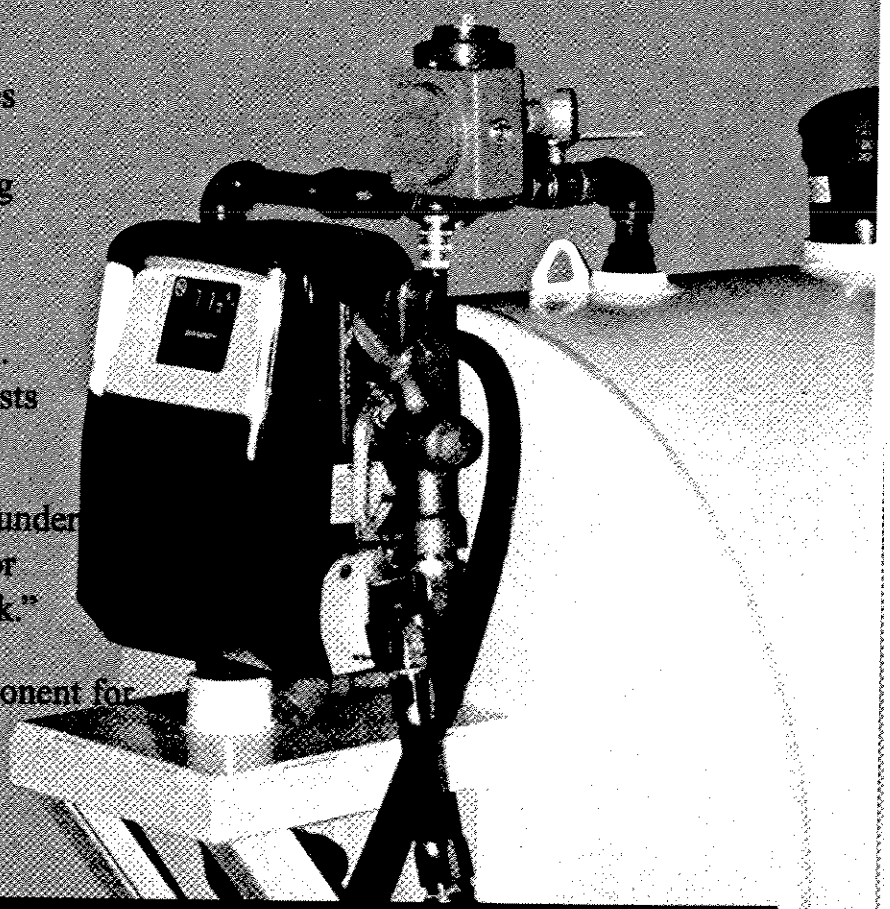
Each pump engine will be equipped with a day tank that will be mounted a minimum eight feet above the operating floor to allow floor access under the tank. The day tank fuel capacity should be sized for a minimum four hour run period, providing that applicable fire codes are not violated. All day tanks will be furnished under the procurement contractor, and furnished by SFWMD to the construction contract.

FIREGUARD® is the New Generation of fire-rated ASTs, going far beyond those "first generation" tanks which were merely enclosed in concrete.

- Fireguard® was the first AST of its design to obtain a UL Listing for secondary containment.
- Fireguard®'s secondary containment can be tightness tested on-site with standard testing procedures!
- Fireguard®'s exterior steel wall provides superior weatherability and low-cost maintenance. Unlike concrete, cracking or spalling will never be a problem!
- Fireguard®'s unique thermal insulating material is 75% lighter than concrete... shipping, installation and relocation costs are reduced!
- The Fireguard® technology is patented under U.S. Patent #5695089 and #5809650 for "Lightweight Double Wall Storage Tank."
- Fireguard® is a UL approved core component for the 2244 system listing

UL 2244 system

core components (Fire
optional equipment fo
motor oil storage and
base tanks (Call for in
airport fueling system



Is Your Aboveground Tank Everything It's Cracked Up to Be?

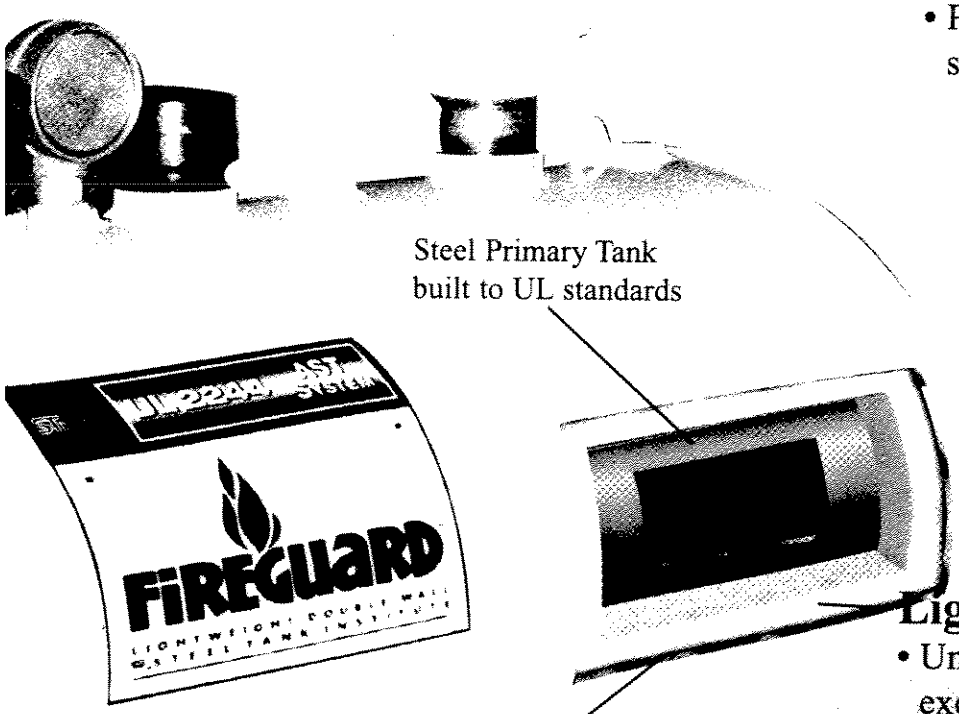
- Secondary containment is testable on-site using standard, economical testing procedures.
- Fireguard®'s steel outer wall provides low-cost maintenance and protects the insulation material from weathering.
- An average 12,000 gallon Fireguard® weighs under 30,000 pounds - well within the legal load limit for trucking.
- 30-year warranty is standard with every Fireguard®.

- The secondary containment on certain designs may require elaborate and expensive procedures to be tested on-site.
- Exposed concrete outer wall is susceptible to cracking, spalling and weathering - problems that are expensive to correct and are usually not covered by warranty.
- An average 12,000 gallon concrete-encased tank weighs upwards of 100,000 pounds - imagine the hassles involved in handling that tank.
- Some manufacturers may charge extra for a 30-year warranty.

listing includes
uard®) and
vehicle fueling,
enerator
ormation on
)

FIREGUARD® TANKS ACCOMMODATE EVERY SITE REQUIREMENT:

- Significantly more size options than most competitive brands.
- Capacities range from 186 to 50,000 gallons.
- Cylindrical or rectangular design
- Compartmentalized configurations
- Ballistics resistant
- Pad/Foundation designs available for seismic zones 0 through 4

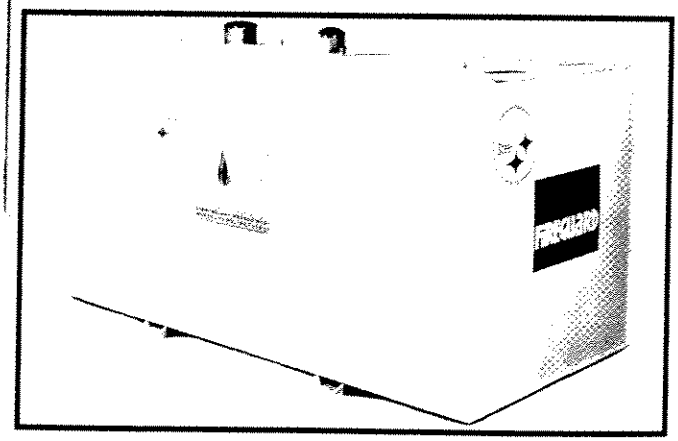


Steel Primary Tank
built to UL standards

Steel Secondary Tank
built to UL standards

Lightweight thermal insulation

- Unique feature that helped Fireguard® exceed the UL 2-hour fire test
- Sufficiently porous to facilitate quick emergency venting and/or leak detection



Modern Fireguard™ listed with:
General Services Administration
Federal Supply Service
FSC Group 54, Part III
SIN:361-20, 21, 22
Contract No: GS-07F-0134K

FIREGUARD® SPECIFICATIONS

CYLINDRICAL DESIGN

SAMPLE OUTER TANK DIMENSIONS (inches)				SAMPLE OUTER TANK DIMENSIONS (inches)			
GALLONS	DIAMETER	LENGTH	APPROX. WEIGHT (lbs.)	GALLONS	DIAMETER	LENGTH	APPROX. WEIGHT (lbs.)
186	48	54	1,750	4,000	90	174	12,300
250	48	68	2,100	5,000	102	168	13,750
300	50	72	2,350	6,000	102	198	15,500
500	60	76	3,100	8,000	102	258	20,000
560	60	84	3,350	10,000	102	330	24,500
1,000	70	78	3,800	12,000	102	390	28,000
1,500	70	114	5,500	15,000	126	312	34,500
2,000	70	150	6,500	20,000	126	414	39,500
2,500	70	186	7,900	25,000	126	516	49,000
3,000	70	222	9,000	30,000	126	618	74,000

RECTANGULAR DESIGN

GALLONS	SAMPLE OUTER TANK DIMENSIONS (inches) LENGTH	WIDTH	HEIGHT	APPROX. WEIGHT (lbs.)
186	44	44	55	2,100
250	117	36	36	3,100
250	78	50	36	2,800
500	140	51	36	4,800
750	140	72	35	6,100
1,000	127	72	36	4,300
1,000	88	72	50	3,800
1,500	124	88	43	5,400
2,000	140	86	50	6,300
2,000	140	72	60	6,100
2,500	140	88	60	7,000
3,000	250	72	50	10,900
3,000	117	102	72	8,800
4,000	331	72	50	14,100
4,000	154	102	72	10,900
5,000	336	72	60	15,600
5,000	191	102	72	13,100
6,000	402	72	60	18,400
6,000	228	102	72	15,200
8,000	370	102	60	21,500
8,000	302	102	72	19,400
10,000	460	102	60	26,300
10,000	376	102	72	23,700
12,000	451	102	72	27,900
15,000	386	102	102	36,500
18,000	462	102	102	42,900
24,700	465	137	102	51,650

Note: Consult manufacturer for exact dimensions. Weights shown may vary.

FIREGUARD®: THE ONLY TANK THAT MEETS ALL OF THESE STANDARDS

- UL 2085 Listed as both a "Protected" and a "Fire-Resistant" AST
- UL Listed Secondary Containment comes standard with every tank
- Both the Inner and Outer steel tanks are built to UL standards
- Uniform Fire Code UFC - Article 79 as a "Protected Tank"
- UL 2244 Aboveground Flammable Liquid Tank System
- National Fire Protection Association (NFPA) 30 & 30A
- Ballistics protection per UFC Article 79, and per UL2085
- Impact protection per UFC Article 79, and per UL 2085
- California Air Resources Board (CARB) testing requirements for air emissions
- Steel Tank Institute (STI) Standard F941 for Thermally Insulated Aboveground Storage Tanks

Fireguard® comes with a 30-year warranty, and is backed by a third-party insurance company

Fireguard® warranty remains in force if tank is relocated by the same owner

STI's Independent quality control inspectors further ensure consistently high fabrication standards

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MODERN WELDING COMPANY OF TEXAS, INC.
715 Sakowitz Street, Houston, TX 77020
Phone: (713) 675-4211 Fax: (713) 673-4062
200 North Main, Rhome, TX 76078
Phone: (817) 636-2215 Fax: (817) 636-2680

MODERN WELDING COMPANY OF FLORIDA, INC.
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Phone: (407) 843-1270 Fax: (407) 423-8187

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Phone: (559) 275-9353 Fax: (559) 275-4381

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Phone: (740) 344-9425 Fax: (740) 344-6018

MODERN WELDING COMPANY OF OWENSBORO, INC.
1450 East Parrish Avenue, Owensboro, KY 42303
Phone: (270) 683-5323 Fax: (270) 684-5245

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130-50-0001 5/00-7M

The PL-Series compressor has been designed to operate in extreme duty applications and is also an alternative to an R-Series unit. Because the PL-Series can operate up to 250 PSI in remote locations or in off-level operations, it is a true industrial use compressor. Gardner Denver is so confident in the way it has engineered and built its products, it offers a 5-year warranty on the compressor pump. The PL-Series features domed pistons, integral cylinder head, disc valves and an oil pump that provides lubricant to all crucial parts of the compressor. From its extra heavy-duty design to its ease of maintenance, the Gardner Denver PL-Series exemplifies reliability, durability and quality.

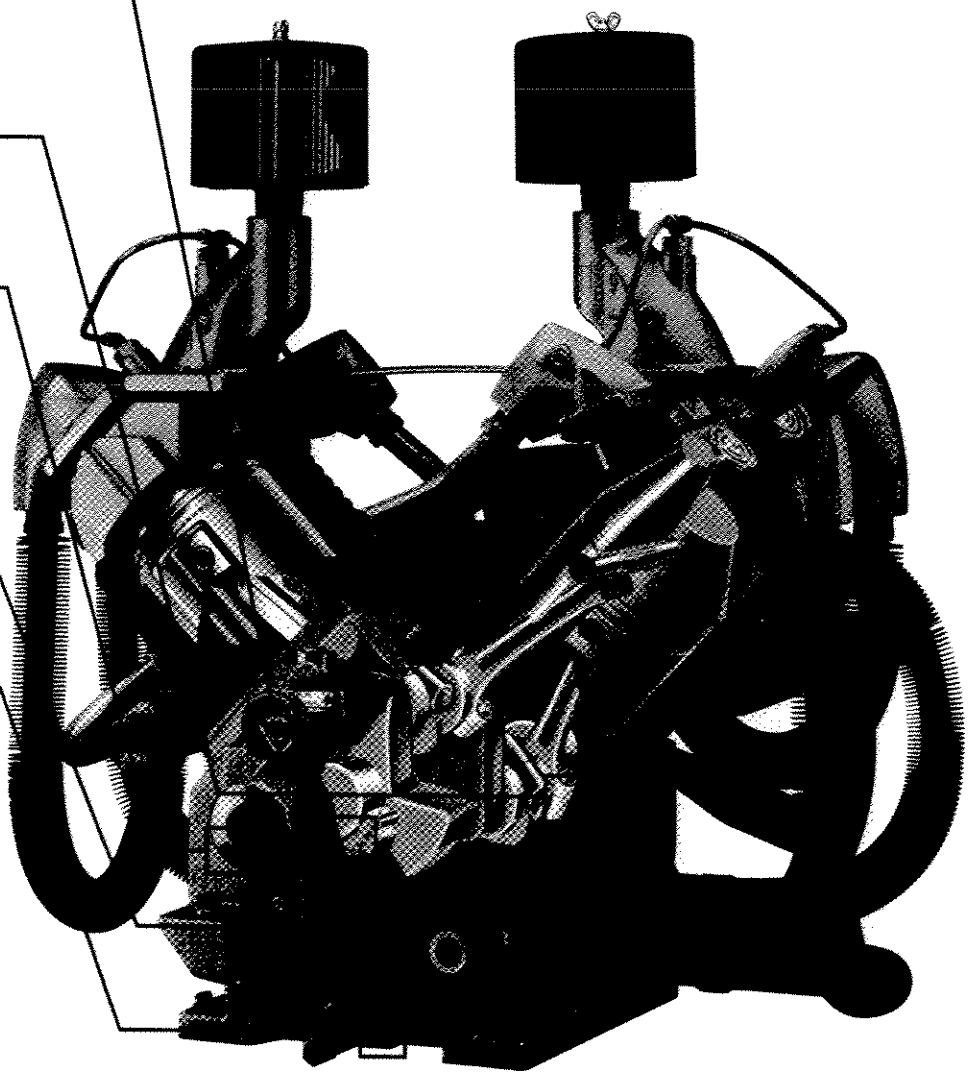
OIL PRESSURE GAUGE
Mounted on the front of the compressor for an excellent view and easy pressure monitoring.

TAPERED ROLLER BEARING
Insures long operating life of the crankshaft

POSITIVE DISPLACEMENT OIL PUMP
Provides lubricant to all critical areas of the compressor pump that require lubrication.

PRESSURE LUBRICATION
Crankshaft and connecting rod bearings are pressure lubricated for extended life.

INTERNAL FILTRATION
An oil inlet screen is located in the center of the crankcase to protect bearings from larger debris.



SPLASH & PRESSURE LUBRICATED — BASE MOUNT (ELECTRIC)

Motor HP	Splash R-Series Model	Pump Comp. Model	Pressure PL-Series Model	Pump Comp. Model	L x W x H Dimensions inches	Aprox. Ship Wt. lbs.	125 PSI Rating* RPM	CFM Displ.	CFM Del'y	175 PSI Rating* RPM	CFM Displ.	CFM Del'y	250 PSI Rating* RPM	CFM Displ.	CFM Del'y
1½	BR-1	R-10D	—	—	29½ x 21 x 29¼	205	575	11.2	6.0	542	10.5	5.3	—	—	—
2	BR-2		—			205	765	14.9	8.3	725	14.1	7.5	—	—	—
3	BR-3	R-15B	BPL-3	PL-15	30½ x 21 x 29¼	230	485	14.1	10.9	440	12.8	9.7	380	11.0	8.0
5	BR-5		BPL-5			280	805	23.5	19.1	710	20.7	16.5	640	18.6	13.6
7½	BRF-7		BPL-7F			310	1035	29.9	24.6	1035	29.9	23.5	940	27.4	19.4
	BR-7	R-30D	BPL-7	PL-30	42¾ x 22⅛ x 28 9/16	430	670	39.6	30.0	575	33.5	25.8	520	30.2	21.3
10	BR-10		BPL-10			540	810	48.5	37.3	740	43.1	34.8	640	37.1	27.5
15	BRF-15		BPL-15F		49½ x 26¼ x 38	550	1045	63.5	50.2	1045	63.5	49.0	900	52.5	42.6
	BRA-15	R-40A	BPL-15	PL-40		730	890	71.1	59.0	770	61.5	53.7	700	55.9	45.8
20	BRA-20	R-70A	BPL-20	PL-70	53 x 27½ x 39½	1000	770	109.0	91.9	655	93.0	76.7	545	77.4	64.1
25	BRA-25		BPL-25			1020	890	127.8	102.1	770	109.4	90.1	660	93.7	76.8
30	BRA-30		BPL-30			1059	890	127.0	102.1	890	127.0	101.1	770	109.4	90.0

SPLASH & PRESSURE LUBRICATED — TWO-STAGE (ENGINE DRIVEN)

Moto HP	Tank Cap Gal.	Splash R-Series Model	Pump Comp. Model	Pressure PL-Series Model	Pump Comp. Model	L x W x H Dimensions inches	Splash Aprox. Ship Wt. lbs.	Pressure Aprox. Ship Wt. lbs.	175 PSI Rating** RPM	CFM Displ.	CFM Del'y	250 PSI Rating** RPM	CFM Displ.	CFM Del'y
8	30	HGR3-3	R-15B	HGPL3-3	PL-15	38 x 22¾ x 45	345	345	600	17.9	14.3	—	—	—
11	30	HGR5-3		HGPL5-3		38 x 22¾ x 45½	409	450	895	26.1	20.1	650	18.9	13.6
	8	HGR5-LP		HGPL5-LP		39⅞ x 21 9/16 x 34¾	404	445						
	—	BGR5		BGPL5		36½ x 21 x 28¾	279	320				—	—	—
	60	HGR5-6H		HGPL5-6H		32½ x 21 x 48	475	514						
	80	HGR5-8		HGPL5-8		66½ x 21 x 51	514	555						
12½	30	HGR6-3		HGPL6-3		38 x 22¾ x 45½	399	440	1025	29.9	23.2	—	—	15.5
	60	HGR6-6K		HPL6-6H		32½ x 21 x 48	475	514						
	80	HGR6-8		HGPL6-8		66½ x 21 x 51	514	555						
	—	BGR6		BGPL-6		37⅞ x 21 x 29¼	279	279						
20	80	HGR10-8	R-30D	HGPL10-8	PL-30	66½ x 21 x 49¾	715	715	765	44.6	34.4	—	—	—
23	5	BGR-12		BGPL-12		46 x 28 x 35⅝	645	645	940	55.0	39.5	—	—	—
30	5	BGRA-15	R-40A	BGPLA-15	PL-40	63 x 41 x 49	1075	1075	910	72.8	59.0	—	—	—
**10	30	HDR5-3	R-15B	HDPL-15	PL-15	38 x 32 x 46	500	500	710	20.7	16.5	650	18.9	13.6
	—	BDR5		BDPL-5		38¾ x 21 x 29¾	493	493				—	—	—
*27	8	BDR-15	R-40A	BDPL-15	PL-40A	52 x 29 x 42	813	813	910	72.8	59.0	800	64.0	51.5

**Diesel Driven *Units tested in accordance with CAGI/PNEUROP Acceptance Test Code PN2CPTC3.

Note: Only Pressure Lubricated units are capable of 250 PSIG operation

SPLASH & PRESSURE LUBRICATED — TANK-MOUNTED DUPLEX UNITS (ELECTR

Motor HP	Tank Cap Gal.	Splash R-Series Model	Pump Comp. Model	Pressure PL-Series Model	Pump Comp. Model	L x W x H Dimension inches	Aprox. Ship Wt. lbs.	125 PSI Rating* RPM	CFM Displ	CFM Del'y	175 PSI Rating* RPM	CFM Displ	CFM Del'y	250 PSI Rating* RPM	CFM Displ	CFM Del'y
3 (2)	80	HR3D-8	R-15B	—	PL-15	67½ x 28½ x 50¼	725	485	28.2	21.8	440	25.6	19.4	—	—	—
	120	HR3D-12		—		91¾ x 26½ x 48¾	950	485	28.2	21.8	440	25.6	19.4	—	—	—
5 (2)	80	HR5D-8		HPL5D8		67½ x 28½ x 50¼	755	805	47.0	38.2	710	41.4	33.0	640	37.2	27.2
	120	HR5D-12		HPL5D12		91¾ x 26½ x 48¾	980	805	47.0	38.2	710	41.4	33.0	640	37.2	27.2
		HR7DF-12		HPL7D12		91¾ x 26½ x 50¼	1485	670	79.2	60.0	575	67.0	51.6	520	60.4	42.6
7½ (2)	250	HR7DF-25		HPL7DF25		87½ x 32 x 64	1485	1035	59.8	49.2	1035	59.8	47.0	940	54.8	38.8
		HR7D-25	R-30D	HPL7D25	PL-30		1675	670	79.2	60.0	575	67.0	51.6	520	60.4	42.6
10 (2)		HR10D-25		HPL10D25			1725	810	97.0	74.6	740	86.2	69.6	640	74.2	55.0
15 (2)		HR15DF-25		HPL15DF25			1860	1045	127.0	100.4	1045	127.0	98.0	900	105.0	85.2
		HRA15D-25	R-40A	HPL15D25	PL-40	88½ x 55 x 73½	2460	890	142.2	118.0	770	123.0	107.4	700	111.8	91.6
20 (2)		HRA20D-25	R-70A	HPL20D25	PL-70	88½ x 62 x 74¾	2845	770	218.0	183.8	655	186.0	153.4	545	154.8	128.2
25 (2)		HRA25D-25		HPL25D25			2940	890	255.6	204.2	770	218.8	180.2	660	187.4	153.6
30 (2)		HR30D-25		HPL30D25			3018	890	255.6	204.2	890	255.6	202.0	770	218.8	180.0

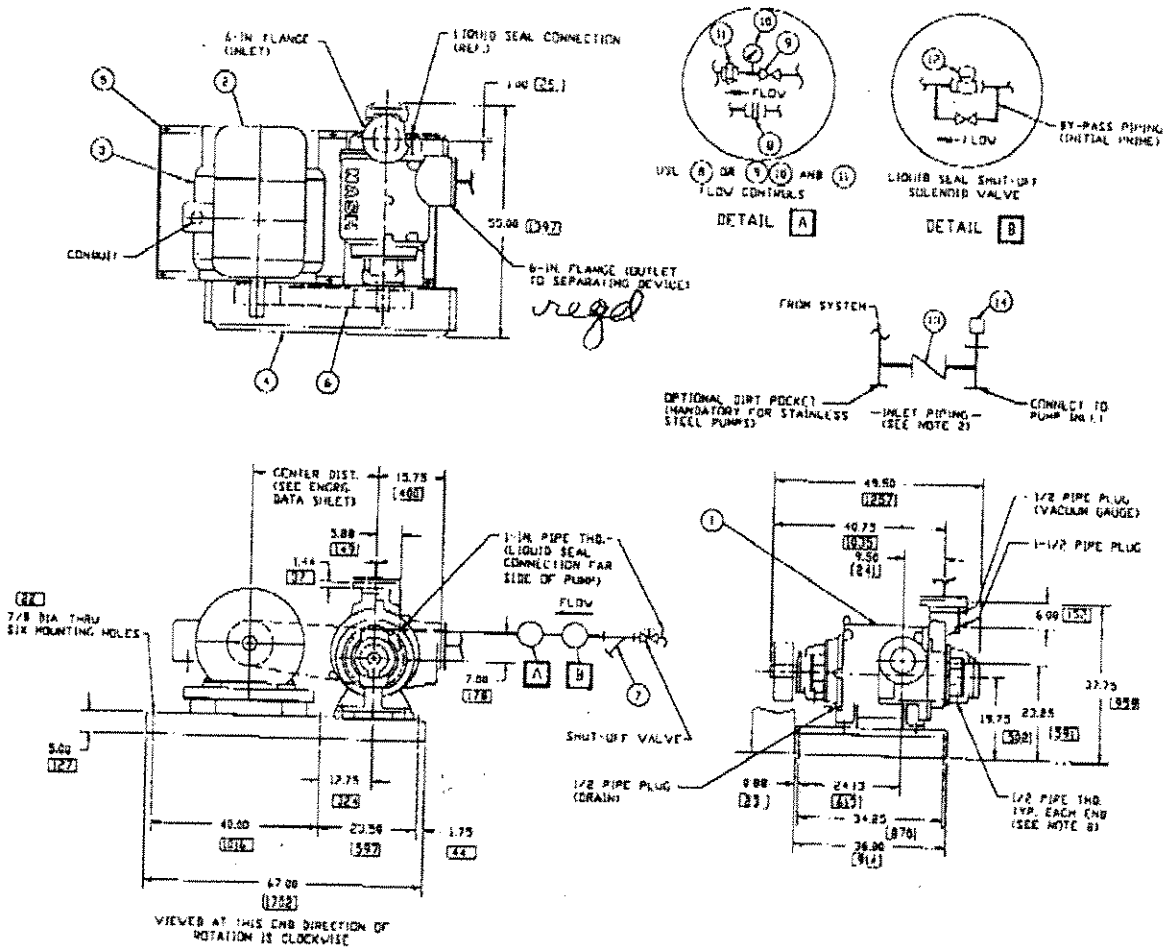
dimensions installation data	VACUUM PUMPS
pumps	type SC

May 1, 1989

subject to change without notice; supersedes all previous data.

Printed in U.S.A.

PUMPS — SIZE SC-7 (motor and V-belt drive)



Drawing 14-9654

NOTES:

1. Bill of Materials. Refer to Engineering Data Sheet for certification and items specifically furnished for this order.

Key No.	Item
1	Vacuum Pump
2	Motor
3	Sliding Base
4	V-Belt Guard
5	Base
6	V-Belt Drive
7	Strainer
8	Flow Control Valve
9	Adjusting Cock
10	Pressure Gauge
11	Orifice Union
12	Solenoid Valve
13	Inlet Check Valve
14	Relief Valve

2. 1/4 inch mesh stainless steel temporary screen for pump inlet supplied by Nash Engineering Company for protection from foreign material during start-up period.
3. Foundation bolts are not furnished.
4. All pump flanges are flat face and conform to ANSI Class 125 bolt patterns. Bolt holes straddle centerlines.
5. Dimensions are in inches; dimensions shown in ▭ are in millimeters.
6. Pump pipe thread connections are ANSI B2. 1.
7. For installation and operation see Instruction Bulletins.
8. Stuffing box drip tray drain connection. For pumps with packing, pipe away to drain.
9. Solidly ground unit. Do not use piping system for ground.
10. Base shown will accommodate motor frame sizes 213T thru 256T.

NASH® ENGINEERING COMPANY
NORWALK, CT. 06850, U.S.A.

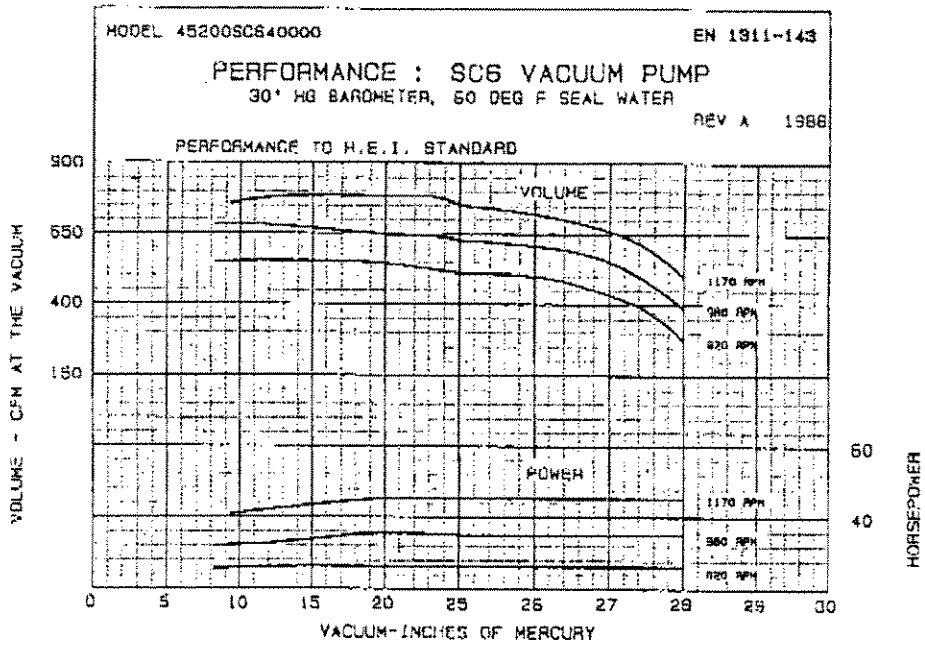
May 1, 1991

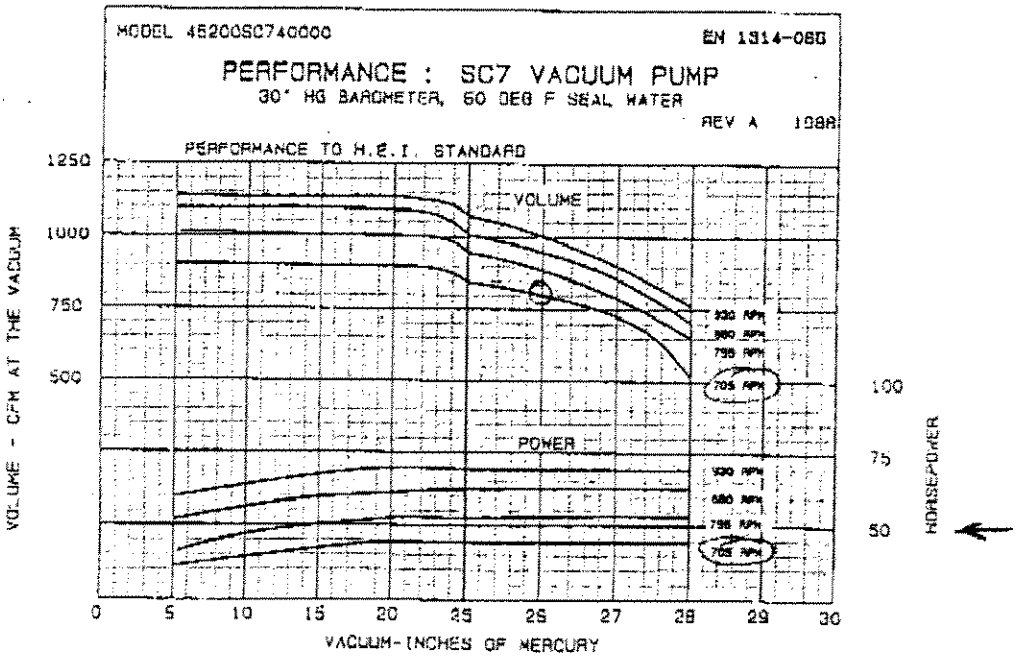
subject to change without notice;
supersedes all previous data.

Printed in U.S.A.

performance	VACUUM PUMPS
pumps	type SC

PUMPS - SIZES SC-6, SC-7





NASH® ENGINEERING COMPANY
NORWALK, CT. 06856, U.S.A.

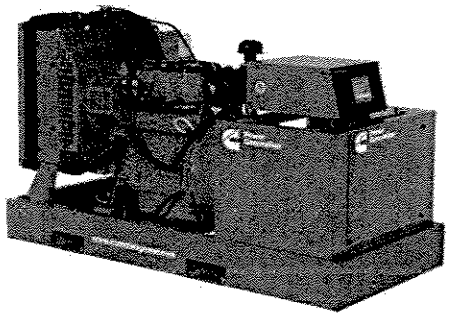
Small Generator for Pump Station Lighting

Power Generation

Diesel Generator Set

Model DKAE 60 Hz

EPA Emissions



20 kW, 25 kVA Standby
18 kW, 22.5 kVA Prime

Description

The Cummins Power Generation DK-series commercial generator set is a fully integrated power generation system providing optimum performance, reliability, and versatility for stationary standby or prime power applications.

A primary feature of the DK GenSet is strong motor-starting capability and fast recovery from transient load changes. The torque-matched system includes a heavy-duty Kubota 4-cycle liquid-cooled diesel engine, an AC alternator with high motor-starting kVA capacity, and an electronic voltage regulator for precise regulation under steady-state or transient loads. The DK GenSet accepts 100% of the nameplate standby rating in one step, in compliance with NFPA110 requirements.

The standard PowerCommand® digital electronic control is an integrated system that combines engine and alternator controls for high reliability and optimum genset performance.

Optional weather-protective enclosures and coolant heaters shield the generator set from extreme operating conditions. Environmental concerns are addressed by low exhaust emission engines, sound-attenuated enclosures, exhaust silencers, and dual-wall fuel tanks.

A wide range of options, accessories, and services are available, allowing configuration to your specific power generation needs.

Every production unit is factory tested at rated load and power factor. This testing includes demonstration of rated power and single-step rated load pickup. Cummins Power Generation manufacturing facilities are registered to ISO9001 quality standards, emphasizing our commitment to high quality in the design, manufacture, and support of our products. The generator set is CSA certified and is available as UL 2200 Listed.

All Cummins Power Generation systems are backed by a comprehensive warranty program and supported by a worldwide network of 170 distributors and service branches to assist you with warranty, service, parts, and planned maintenance support.

Features

UL Listed Generator Set - The complete generator set assembly is available Listed to UL 2200.

Low Exhaust Emissions - Engine certified to U.S. EPA Nonroad Source Emission Standards, 40 CFR 89, Tier 2.

Kubota Heavy-Duty Engine - Rugged 4-cycle, liquid-cooled, industrial diesel engine delivers reliable power, low emissions, and fast response to load changes.

Alternator - Several alternator sizes offer selectable motor starting capability with low reactance 2/3 pitch windings, low waveform distortion with non-linear loads, fault clearing short-circuit capability, and class H insulation. The alternator electrical insulation system is UL 1446 Recognized.

Control Systems - The PowerCommand electronic control is standard equipment and provides total genset system integration including automatic remote starting/stopping and precise frequency and voltage regulation. Optional features include alarm and status message display, output metering, auto-shutdown at fault detection, and NFPA110 Level 1 compliance.

Cooling Systems - Standard cooling package provides reliable running at the rated power level, at up to 50°C ambient temperature.

Integral Vibration Isolation - Robust skid base supports the engine, alternator, and radiator on isolators, minimizing transmitted vibration.

E-coat Finish - Dual electro-deposition paint system provides high resistance to scratches, corrosion, or fading.

Enclosures - Optional weather-protective enclosures are available.

Fuel Tanks - Dual wall sub-base fuel tanks and in-skid day tanks are also offered.

Certifications - Generator sets are designed, manufactured, tested, and certified to relevant UL, NFPA, ISO, IEC, and CSA standards.

Warranty and Service - Backed by a comprehensive warranty and world wide distributor network.

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Generator Set

The general specifications provide representative configuration details. Consult the outline drawing for installation design.

Specifications – General

See outline drawing 500-4222 for installation design specifications.

Unit Width, in (mm)	31.0 (787)
Unit Height, in (mm)	38.6 (980)
Unit Length, in (mm)	66.9 (1699)
Unit Dry Weight, lb (kg)	1210 (549)
Unit Wet Weight, lb (kg)	1252 (568)
Rated Speed, rpm	1800
Voltage Regulation, No Load to Full Load	±2.0%
Random Voltage Variation	±1.0%
Frequency Regulation	5%
Random Frequency Variation	±0.5% (Isochronous optional ± 0.25%)
Radio Frequency Interference	Meets requirements of most industrial and commercial applications

Cooling	**Standby**	**Prime**
Fan Load, HP (kW)	4.0 (3.0)	4.0 (3.0)
Coolant Capacity with radiator, US Gal (L)	2.7 (10.2)	2.7 (10.2)
Coolant Flow Rate, Gal/min (L/min)	14.0 (53.0)	14.0 (53.0)
Heat Rejection To Coolant, Btu/min (MJ/min)	1637.0 (1.7)	1411.0 (1.5)
Heat Radiated To Room, Btu/min (MJ/min)	360.0 (0.4)	320.0 (0.3)
Maximum Coolant Friction Head, psi (kPa)	3.1 (21.4)	3.1 (21.4)
Maximum Coolant Static Head, ft (m)	29.5 (9.0)	29.5 (9.0)

Air		
Combustion Air, scfm (m^3/min)	59.4 (1.7)	59.4 (1.7)
Alternator Cooling Air, scfm (m^3/min)	250.0 (7.1)	250.0 (7.1)
Radiator Cooling Air, scfm (m^3/min)	3900.0 (110.4)	3900.0 (110.4)
Max. Static Restriction, in H_2O (Pa)	0.50 (124.50)	0.50 (124.50)

Rating Definitions

Standby Rating based on: Applicable for supplying emergency power for the duration of normal power interruption. No sustained overload capability is available for this rating. (Equivalent to Fuel Stop Power in accordance with ISO3046, AS2789, DIN6271 and BS5514). Nominally rated.

Prime (Unlimited Running Time) Rating based on: Applicable for supplying power in lieu of commercially purchased power. Prime power is the maximum power available at a variable load for an unlimited number of hours. A 10% overload capability is available for limited time. (Equivalent to Prime Power in accordance with ISO8528 and Overload Power in accordance with ISO3046, AS2789, DIN6271, and BS5514). This rating is not applicable to all generator set models.

Base Load (Continuous) Rating based on: Applicable for supplying power continuously to a constant load up to the full output rating for unlimited hours. No sustained overload capability is available for this rating. Consult authorized distributor for rating. (Equivalent to Continuous Power in accordance with ISO8528, ISO3046, AS2789, DIN6271, and BS5514). This rating is not applicable to all generator set models.

Site Derating Factors

Rated power available up to 800 ft (244 m) at ambient temperatures up to 77°F (25°C). Above 800 ft (244 m), derate at 4% per 1000 ft (305 m) and 1% per 10°F (2% per 11°C) above 77°F (25°C).

Engine

Kubota heavy-duty diesel engines provide stable power, low fuel consumption, quiet operation, and fast response to sudden load changes.

Mechanical governing is standard. Electronic governing is available for applications requiring constant (isochronous) frequency regulation such as Uninterruptible Power Supply (UPS) systems, non-linear loads, or sensitive electronic loads. Optional coolant heaters are recommended for all emergency standby installations or for any application requiring fast load acceptance after start-up.

Specifications – Engine

Base Engine	Kubota V2203, naturally aspirated, diesel-fueled
Displacement in^3 (L)	134.0 (2.2)
Overspeed Limit, rpm	2100 ±50
Regenerative Power, kW	7.00
Cylinder Block Configuration	Cast iron, In-Line 4 cylinder
Battery Capacity	350 amps minimum at ambient temperature of 32°F(0°C)
Battery Charging Alternator	40-amps
Starting Voltage	12-volt, negativeg ground
Lube Oil Filter Types	Single spin-on, full flow
Standard Cooling System	122°F (50°C) ambient radiator cooling system

Power Output	**Standby**	**Prime**
Gross Engine Power Output, bhp (kWm)	37.1 (27.7)	33.8 (25.2)
BMEP at Rated Load, psi (kPa)	107.0 (737.7)	97.0 (668.8)
Bore, in. (mm)	3.43 (87.1)	3.43 (87.1)
Stroke, in. (mm)	3.62 (91.9)	3.62 (91.9)
Piston Speed, ft/min (m/s)	1091.0 (5.5)	1091.0 (5.5)
Compression Ratio	23.0:1	23.0:1
Lube Oil Capacity, qt. (L)	10.4 (9.8)	10.4 (9.8)
Fuel Flow		
Fuel Flow at Rated Load, US Gal/hr (L/hr)	3.5 (13.4)	3.5 (13.4)
Maximum Inlet Restriction, in. Hg (mm Hg)	2.0 (50.8)	2.0 (50.8)
Maximum Return Restriction, in. Hg (mm Hg)	5.8 (147.3)	5.8 (147.3)
Air Cleaner		
Maximum Air Cleaner Restriction, in. H_2O (kPa)	25.0 (6.2)	25.0 (6.2)
Exhaust		
Exhaust Flow at Rated Load, cfm (m^3/min)	170.0 (4.8)	160.0 (4.5)
Exhaust Temperature, °F (°C)	840.0 (448.9)	760.0 (404.4)
Max Back Pressure, in. H_2O (kPa)	41.0 (10.2)	41.0 (10.2)

Fuel System	Indirect injection, number 2 diesel fuel; fuel filter; fuel/water separator; automatic electric fuel shutoff; distributor injection pump with integral mechanical governor.

Fuel Consumption		**Standby**				**Prime**			
60 Hz Ratings, kW (kVA)		**20 (25)**				**18 (22.5)**			
	Load	1/4	1/2	3/4	Full	1/4	1/2	3/4	Full
	US Gal/hr	0.78	1.10	1.45	1.96	0.74	1.04	1.35	1.69
	L/hr	3.0	4.2	5.5	7.4	2.8	3.9	5.1	6.4

Alternator

Several alternators are available for application flexibility based on the required motor starting kVA and other requirements. Larger alternator sizes have lower temperature rise, for longer life of the alternator insulation system. In addition, larger alternator sizes can provide a cost-effective use of engine power in across-the-line motor starting applications and can be used to minimize voltage waveform distortion caused by non-linear loads.

These single-bearing alternators couple directly to the engine flywheel with flexible discs, for drivetrain reliability and durability. No gear reducers or speed changers are used. Two-thirds pitch windings eliminate third-order harmonic content of the AC voltage waveform and provide the standardization desired for paralleling of generator sets. The excitation system is a self (shunt) excited system with the voltage regulator powered directly from the generator set output.

Alternator Application Notes

Alternator Sizes - On any given model, various alternators sizes are available to meet individual application needs. Alternators sizes are differentiated by maximum winding temperature rise, at the generator set standby or prime rating, when operated in a 40°C ambient environment. Available temperature rises range from 80°C to 125°C. Not all temperature rise selections are available on all models. Lower temperature rise is accomplished using larger alternators at lower current density. Lower temperature rise alternators have higher motor starting kVA, lower voltage dip upon load application, and they are generally recommended to limit voltage distortion and heating due to harmonics induced by non-linear loads.

Alternator Space Heater - is recommended to inhibit condensation.

Available Output Voltages

Three Phase Reconnectable

[ ] 120/208

[ ] 139/240

[ ] 120/240 Delta

[ ] 240/416

[ ] 277/480

Single Phase Non-Reconnectable

[ ] 120/240

Three Phase Non-Reconnectable

[ ] 220/380

[ ] 347/600

Specifications – Alternator

Design	Revolving field, single bearing, 4-pole, brushless, drip-proof construction.
Stator	Skewed stator and 2/3 pitch windings minimize field heating and voltage harmonics.
Rotor	Dynamically balanced assembly. Direct coupled to engine by a flexible drive disc. Complete amortisseur (damper) windings help minimize voltage deviations and heating effects under unbalanced loads. The rotor is supported by a pre-lubricated, maintenance-free ball-bearing.
Insulation System	Class H per NEMA MG1-1.65 and BS2757
Standard Temperature Rise	At rated load is less than 125°C at standby rating, per NEMA MG1.22.40, IEEE115 and IEC 34-1.
Exciter Type	The excitation system derives its power from the main output of the generator, eliminating the need for a separate excitation power source.
Phase Rotation	A (U), B (V), C (W)
Alternator Cooling	Direct drive centrifugal blower
AC Waveform Total Harmonic Distortion	Less than 7% total no load to full linear load, and less than 3% for any single harmonic
Telephone Influence Factor (TIF)	Less than 40 per NEMA MG1-22.43
Telephone Harmonic Factor (THF)	Less than 3

Three Phase Table[1]		**80° C**	**80° C**	**80° C**	**80° C**	**105° C**	**105° C**	**105° C**	**105° C**	**125° C**	**125° C**	**125° C**	**125° C**
Feature Code		B257	B269	B386	B305	B256	B268	B385	B304	B255	B267	B384	B303
Voltage Ranges		120/208 Thru 139/240 240/416 Thru 277/480	120/208 Thru 139/240 240/416 Thru 277/480	220/380	347/600	120/208 Thru 139/240 240/416 Thru 277/480	120/208 Thru 139/240 240/416 Thru 277/480	220/380	347/600	120/208 Thru 139/240 240/416 Thru 277/480	120/208 Thru 139/240 240/416 Thru 277/480	220/380	347/600
Surge kW		20	20	20	20	20	20	20	20	20	20	20	20
Motor Starting kVA (at 90% sustained voltage)	Shunt	70	70	90	70	58	70	72	58	58	70	72	58
Full Load Current - Amps at Standby Rating		120/208: 69	139/240: 60	220/380: 38	240/416: 35	277/480: 30	347/600: 24						

Notes:

1. Single phase power can be taken from a three phase generator set at up to 2/3 set rated 3-phase kW at 1.0 power factor. Also see Note 2 below.

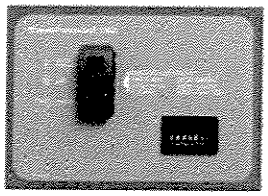
Single Phase Table		**80° C**	**80° C**	**80° C**	**105° C**	**105° C**	**105° C**	**125° C**	**125° C**	**125° C**			
Feature Code		B275	B257	B269	B274	B256	B268	B273	B255	B267			
Voltage Ranges		120/240[2]	120/240[1]	120/240[2]	120/240[2]	120/240[1]	120/240[2]	120/240[2]	120/240[1]	120/240[2]			
Surge kW		20	20	20	20	20	20	20	20	20			
Motor Starting kVA (at 90% sustained voltage)	Shunt	44	44	44	36	36	44	36	36	44			
Full Load Current - Amps at Standby Rating		120/240[1]: 56	120/240[2]: 83										

Notes:

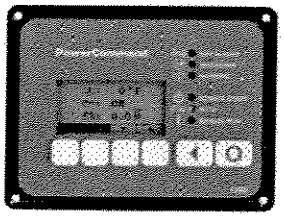
1. The broad range alternators can supply single phase output up to 2/3 set rated 3-phase kW at 1.0 power factor.
2. The extended stack (full single phase output) and 4 lead alternators can supply single phase output up to full set rated 3-phase kW at 1.0 power factor.

Control System

PowerCommand (1301) Control



Standard Operator Panel



Optional Operator/Display Panel

PowerCommand Control

- The PowerCommand Control is an integrated generator set control system providing isochronous governing (optional), voltage regulation, engine protection, generator protection, and operator interface.
- Control provides battery monitoring and testing features, and Smart-Starting control system.
- InPower PC-based service tool available for detailed diagnostics
- Standard PCCNet RS485 network interface to devices such as remote annunciator for NFPA110 applications.
- Control boards are potted for environmental protection.
- Suitable for operation in ambient temperatures from –40C to +70C, and altitudes to 13,000 feet (5000 meters)
- Prototype tested; UL, CSA, and CE compliant

AC Protection

- Over current warning and shutdown*
- Over and under voltage shutdown
- Over and under frequency shutdown
- Over Excitation (loss of sensing) fault
- Field Overload

Engine Protection

- Overspeed shutdown
- Low oil pressure warning and shutdown*
- High coolant temperature warning and shutdown*
- Low coolant level warning or shutdown*
- Low coolant temperature warning*
- High, low, & weak battery voltage warning*
- Fail to start (overcrank) shutdown
- Fail to crank shutdown
- Redundant start disconnect
- Cranking lockout
- Sensor failure indication
- Low fuel level warning or shutdown
- Fuel-in-rupture-basin warning or shutdown

Operator/Display Panel (Optional)

- Manual Off switch
- Alpha-numeric display with pushbutton access, for viewing engine and alternator data and providing setup, controls, and adjustments (English or International symbols)
- LED lamps indicating genset running, not in auto, common warning, common shutdown, manual run mode, remote start
- Suitable for operation in ambient temperatures from -20C to +70C

Alternator Data

- Line to Neutral AC Volts*
- Line to Line AC Volts*
- 3-phase AC current*
- Frequency*
- Total kVA*

Engine Data

- DC voltage*
- Lube oil pressure*
- Coolant temperature*

Other Data

- Genset model data
- Start attempts, Starts, running hours
- Fault history
- RS485 Modbus Interface
- Data Logging and Fault Simulation (Requires InPower Service Tool)

Digital Governing (Optional)

- Integrated digital electronic isochronous governor
- Temperature dynamic governing

Digital Voltage Regulation

- Integrated digital electronic voltage regulator
- 2-phase line to line sensing
- Configurable Torque Matching

Control Functions

- Time delay start and cooldown
- Glow plug control (some models)
- Cycle cranking
- (2) Configurable inputs
- (2) Configurable outputs
- Remote Emergency Stop

*Optional Operator/Display Panel required to display warnings and sensor data, and for NFPA 110 and CSA 282 applications.

Options

- ☐ Local Operator/Display Panel
- ☐ Digital Electronic Governing
- ☐ Auxiliary output relays (2)
- ☐ 120/240 V, 100 W anti-condensation heater
- ☐ Emergency Stop Switch
- ☐ Remote Annunciator with (3) configurable inputs & (4) configurable outputs
- ☐ PowerCommand for Windows remote monitoring software. (Direct connect)
- ☐ Auxiliary, configurable signal inputs (8) and configurable relay outputs (8)

Generator Set Options

Engine

[ ] 120 V, 1000 W coolant heater (thermostatically controlled)
[ ] 240 V, 1000 W coolant heater (thermostatically controlled)
[ ] Electronic governor

Fuel System

[ ] 24 hour dual wall sub-base fuel tank
[ ] 48 hour dual wall sub-base fuel tank

Alternator

[ ] 80°C rise alternator
[ ] 105°C rise alternator
[ ] 120/240 V, 100 W anti-condensation heater
[ ] Extended stack (full single phase output)
[ ] Full single phase output (Non-Reconnectable)
[ ] Single phase - 4 lead

Exhaust System

[ ] Critical grade exhaust silencer
[ ] Industrial grade exhaust silencer
[ ] Residential grade exhaust silencer
[ ] Set mounted critical grade exhaust silencer

Generator Set

[ ] Batteries
[ ] Battery charger
[ ] Export box packaging
[ ] UL 2200 Listed
[ ] In-skid fuel tank
[ ] Main line circuit breaker
[ ] Sound attenuated enclosures with mounted silencer
[ ] Spring isolators
[ ] Weather protective enclosure with mounted silencer
[ ] 2 year prime power warranty
[ ] 2 year standby warranty
[ ] 5 year standby power warranty

Available Products and Services

A wide range of products and services is available to match your power generation system requirements. Cummins Power Generation products and services include:

Diesel and Spark-Ignited Generator Sets

Transfer Switches

Bypass Switches

Parallel Load Transfer Equipment

Digital Paralleling Switchgear

PowerCommand Network and Software

Distributor Application Support

Planned Maintenance Agreements

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Warranty

All components and subsystems are covered by an express limited one-year warranty. Other optional and extended factory warranties and local distributor maintenance agreements are available. Contact your distributor/dealer for more information.

Certifications

UL - The generator set is available Listed to UL 2200 Stationary Engine Generator Assemblies.

CSA - This generator set is CSA certified to product class 4215-01.

PTS - The Prototype Test Support (PTS) program verifies the performance integrity of the generator set design. Products bearing the PTS symbol have been subjected to demanding tests in accordance to NFPA 110 to verify the design integrity and performance under both normal and abnormal operating conditions including short circuit, endurance, temperature rise, torsional vibration, and transient response, including full load pickup.

ISO9001 - This generator set was designed and manufactured in facilities certified to ISO9001.

See your distributor for more information

Power Generation

Cummins Power Generation
1400 73rd Avenue N.E.
Minneapolis, MN 55432
763.574.5000
Fax: 763.574.5298
www.cumminspower.com

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Detector and AmpSentry are trademarks of Cummins Inc.

Important: Backfeed to a utility system can cause electrocution and/or property damage. Do not connect generator sets to any building electrical system except through an approved device or after building main switch is open.

BLACK & VEATCH

South Florida Water Management District

EAA Reservoir A-1 Preliminary Design Report for Pump Station, Control Structures and U.S. 27 Bridges

July, 2006

DIVIDER PAGE

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Equipment combustion air & heat rejection

Owner: SFWMD

Project No.: 144777

Computed by: JEP — Page 1 of

Date: 5-3-06

Verified by: DWN — Date: 7/12/06

Pump Room equipment per Ted Stolinski and Larry Pittman:

(8) diesel engine pumps:

operating hp 1200

starting hp 1400

engine hp 1500

combustion air for engine = 5140 cfm/each

Total combustion air = 8 × 5140 = 41,120 cfm

Heat rejection = 242,323 Btu/hr-each = 71,000 w/ea

Total rejection = 8 × 71,000 = 568,000 w

(2) 2000 kW diesel generators; (2) operating

combustion air = 6367 cfm/each

Total combustion air = 6367 × 2 = 12,750 cfm

Radiator air = 92,383 cfm/each

Total radiator air = 2 × 92,383 = 184,766 cfm

Heat rejection = 722,352 Btu/hr-each = 211,710 w/ea

Total heat rejection = 2 × 211,710 = 423,420 w

(3) seepage pumps; 200 hp each

Heat rejection = 7850 w/ea

Total heat rejection = 3 × 7850 = 23,550 w

Total combustion air = 41,120 + 12,750 = 53,870 cfm

Total radiator air = 184,766 cfm

Total heat rejection = 568,000 + 423,420 + 23,550

= 1,014,970 w

Air flow for cooling from Elite = 400,000

Total airflow for supply = 400,000 (cooling) + 53,870 (combustion) + 184,766 (radiator)

= 638,636

Exhaust = 638,636 − 53,870 − 184,766 = 400,000 cfm

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Equipment combustion air & heat rejection

Owner: SFWMD

Project No. 144777

Computed by: JEP

Verified by: DWN

Page 1 of

Date 5-3-06

Date 7/12/06

Pump Room equipment per Ted Stolinski and Larry Pittman:

(8) diesel engine pumps:

operating hp 1200

starting hp 1400

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combustion air for engine = 5140 cfm/each

Total combustion air = 8 × 5140 = 41,120 cfm

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Total heat rejection = 3 × 7850 = 23,550 W

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Total radiator air = 184,766 cfm

Total heat rejection = 568,000 + 423,420 + 23,550

= 1,014,970 W

Air flow for cooling from Elite ≈ 400,000

Total airflow for supply = 400,000 (cooling) + 53,870 (combustion) + 184,766 (radiator)

= 638,636

Exhaust = 638,636 − 53,870 − 184,766 = 400,000 cfm

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Ventilation Requirements based upon 30% design
Owner: SFWMD
Project No.: 144777
Computed by: J.E. Painter
Verified by: DWN
Page 1 of 3
Date: 6-12-06
Date: 7/12/06

Problem: Determine the preliminary ventilation requirements with the various pump station operating senarios:

Assumptions:

Supply Fan @ low speed = 24,560 cfm
Supply Fan @ high speed = 49120 cfm
Exhaust Fan = 49120 cfm

1. Makeup air requirements with 1 to 4 pump engines operating:

Item Number	Description	Combustion Air	Radiator Makeup	Totals
		CFM	CFM	CFM
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
Totals				20560

Assume: (1) SF operating @ low speed
Relief louver = 4000 to 19420 cfm

2. Makeup air requirements with 5 to 8 engines operating:

Item Number	Description	Combustion Air	Radiator Makeup	Totals
		CFM	CFM	CFM
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
Totals				41120

Assume: (1) SF operating @ high speed
Relief louver = 8000 to 23420 cfm

3. Makeup air requirements with 1 to 4 pump engines and 1 engine generator operating:

Item Number	Description	Combustion Air	Radiator Makeup	Totals
		CFM	CFM	CFM
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Engine Generator	6367	92383	98750
Totals				119310

Assume: (1) SF operating @ low speed
(2) SF operating @ high speed
Relief louver = 3490 to 18910 cfm

4. Makeup air requirements with 5 to 8 pump engines and 1 engine generator operating:

Item Number	Description	Combustion Air	Radiator Makeup	Totals
		CFM	CFM	CFM
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Engine Generator	6367	92383	98750
Totals				139870

Assume: (3) SF operating @ high speed
Relief louver = 7490 to 22910 cfm

5. Makeup air requirements with 1 to 4 pump engines and 2 engine generator operating:

Item Number	Description	Combustion Air CFM	Radiator Makeup CFM	Totals CFM
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Engine Generator	6367	92383	98750
	Engine Generator	6367	92383	98750
Totals				218060

(1) SF operating @ low speed
(4) SF operating @ high speed
Relief louver = 3000 to 18400 cfm

6. Makeup air requirements with 5 to 8 pump engines and 2 engine generator operating:

Item Number	Description	Combustion Air CFM	Radiator Makeup CFM	Totals CFM
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Pump Engine	5140	0	5140
	Engine Generator	6367	92383	98750
	Engine Generator	6367	92383	98750
Totals				238620

(5) SF operating @ high speed
Relief louver = 6980 to 22400 cfm

7. For heat removal, provide 8 pairs of SF & EF each controlled by a thermostat to obtain the approximately 400,000 cfm of cooling requirement indicated in the preliminary load calculations.

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ENERGY WATER INFORMATION GOVERNMENT

Hand Calculation Sheet

Work Product Name: Elite Calculation based on 30% Design
Owner: SFWMD
Project No.: 144777
Computed by: JEP
Verified by: DWW
Page 1 of 7
Date: 6-12-06
Date: 7/12/06

HVAC Load Analysis

for

Prepared By: JEP

Wednesday, July 12, 2006

General Project Data Input

General Project Information

Project file name:	C:\Elite\Projects\Painter's projects\South Florida\South Floriday.CHV
Project title:	South Florida
Designed by:	jep
Project date:	
Project location:	FORT MYERS, FLORIDA, USA
Client name:	
Client address:	
Client city:	
Client phone:	
Client fax:	
Company name:	
Company representative:	
Company address:	
Company city:	
Company phone:	
Company fax:	

page 2 of 7

Barometric pressure:	29.905	in.wg.
Altitude:	15	feet
Latitude:	27	Degrees
Mean daily temperature range:	18	Degrees
Starting & ending time for HVAC load calculations:	1am - 12am	
Floor heat loss coefficient:	0.48	Btuh per foot of slab
Number of unique zones in this project:	2	

Building Default Values

Calculations performed:	Both heating and cooling loads	
Lighting requirements:	1.50	Watts per square foot
Equipment requirements:	0.00	Watts per square foot
People sensible load multiplier:	0	Btuh per person
People latent load multiplier:	0	Btuh per person
Zone sensible safety factor:	10	%
Zone latent safety factor:	10	%
Zone heating safety factor:	10	%
People diversity factor:	100	%
Lighting profile number:	0	
Equipment profile number:	0	
People profile number:	0	
Building default ceiling height:	30.0	feet
Building default wall height:	30.0	feet

Internal Operating Load Profiles (C = 100)

	hr 1	hr 2	hr 3	hr 4	hr 5	hr 6	hr 7	hr 8	hr 9	hr 10	hr 11	hr 12	hr 13	hr 14	hr 15	hr 16	hr 17	hr 18	hr 19	hr 20	hr 21	hr 22	hr 23	hr 24
1	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
2	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
3	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
4	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
5	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
6	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
7	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
8	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
9	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
10	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

General Project Data Input (cont'd)

Page 3 of 7

Building-Level Design Conditions

Design Month	Outdoor Dry Bulb	Outdoor Wet Bulb	Indoor Rel.Hum	Indoor Dry Bulb	Grains Diff	In/Outdoor Correction
August	94	78	50%	75	54.51	3
May	94	74	50%	75	29.52	3
June	94	76	50%	75	41.71	3
July	94	78	50%	75	54.51	3
January	84	68	50%	75	12.29	-7
December	84	71	50%	75	28.45	-7
Winter	41			75		

Master Roofs

Roof No.	ASHRAE Roof#	Roof U-Fac	Dark Color	Susp. Ceil
1	1	0.050	No	No

Master Walls

Wall No.	ASHRAE Group	Wall U-Fac	Wall Color
1	A	0.154	D

Wall #1 Description: 4 inches face brick, with 2 inches of insulation and 8 inches of common brick

Zone Input

Page 4 of 7

Zone 1: Pump Station (40000 sq.ft) (Group 0)

Air Handler number:	1	Zone occurrences:	1
Zone length: (feet)	400.00	Zone width (feet):	100.00
Lighting Watts:	60,000	Equipment Watts:	1,014,970
Number of people in zone:	0	People profile number:	0
Lighting profile number:	0	Equipment profile number:	0
Ceiling height (feet):	30	Heating safety factor (%):	10
Sensible safety factor (%):	10	Latent safety factor (%):	10
Sensible heat per person (Btuh):	0	Latent heat per person (Btuh):	0
Cooling ventilation method:	CFM/Pr	Cooling ventilation value:	0.000
Cooling infiltration method:	AC/Hr	Cooling infiltration value:	0.000
Heating ventilation method:	CFM/Pr	Heating ventilation value:	0.000
Heating infiltration method:	AC/Hr	Heating infiltration value:	0.000
Winter exhaust air CFM:	0	Summer exhaust air CFM:	0
Minimum supply CFM:	0	Latent Btuh equipment load:	0
Ceil. exposed to plenum (sq.ft):	40,000	Exposed floor slab perimeter (sq.ft):	0

Both heating and cooling loads are calculated for this zone.

Roof	Type	ASHRAE#	U-Factor	Dark	Length	Width	Area	Susp.Ceil
1	1	1	0.050	No	400.00	150.00	60,000.0	No

Wall	Type	ASHRAE#	U-Factor	Color	Height	Width	Area	Direction
1	1	A	0.154	D	30.00	400.00	12,000.0	W
2	1	A	0.154	D	30.00	400.00	12,000.0	E
3	1	A	0.154	D	30.00	150.00	4,500.0	N
4	1	A	0.154	D	30.00	150.00	4,500.0	S

Zone 2: Irrigation Pump Rm (3000 sq.ft) (Group 0)

Air Handler number:	2	Zone occurrences:	1
Zone length: (feet)	75.00	Zone width (feet):	40.00
Lighting Watts:	4,500	Equipment Watts:	39,250
Number of people in zone:	0	People profile number:	0
Lighting profile number:	0	Equipment profile number:	0
Ceiling height (feet):	30	Heating safety factor (%):	10
Sensible safety factor (%):	10	Latent safety factor (%):	10
Sensible heat per person (Btuh):	0	Latent heat per person (Btuh):	0
Cooling ventilation method:	CFM/Pr	Cooling ventilation value:	0.000
Cooling infiltration method:	AC/Hr	Cooling infiltration value:	0.000
Heating ventilation method:	CFM/Pr	Heating ventilation value:	0.000
Heating infiltration method:	AC/Hr	Heating infiltration value:	0.000
Winter exhaust air CFM:	0	Summer exhaust air CFM:	0
Minimum supply CFM:	0	Latent Btuh equipment load:	0
Ceil. exposed to plenum (sq.ft):	3,000	Exposed floor slab perimeter (sq.ft):	0

Both heating and cooling loads are calculated for this zone.

Roof	Type	ASHRAE#	U-Factor	Dark	Length	Width	Area	Susp.Ceil
1	1	1	0.050	No	75.00	40.00	3,000.0	No

Wall	Type	ASHRAE#	U-Factor	Color	Height	Width	Area	Direction
1	1	A	0.154	D	30.00	75.00	2,250.0	E
2	1	A	0.154	D	30.00	75.00	2,250.0	W
3	1	A	0.154	D	30.00	40.00	1,200.0	N
4	1	A	0.154	D	30.00	40.00	1,200.0	S

Zone Detailed Loads (At Zone Peak Times)

Page 5 of 7

Load Description	Unit Quan	-SC- CFAC	CLTD SHGF	U.Fac -CLF-	Sen. Gain	Lat. Gain	Htg. Mult.	Htg. Loss
Zone 1-Pump Station peaks (sensible) in June at 2pm, Air Handler 1, Group 0								
Roof-1-1-No.Clg-L	60,000	0.50	18.2	0.050	54,563		1.700	102,000
Wall-1-W-A-D	12,000	1	-4.0	0.154	-7,392		5.236	62,832
Wall-2-E-A-D	12,000	1	-1.0	0.154	-1,848		5.236	62,832
Wall-3-N-A-D	4,500	1	-9.8	0.154	-6,757		5.236	23,562
Wall-4-S-A-D	4,500	1	-13.3	0.154	-9,182		5.236	23,562
Lights-Prof=0	60,000	1.000			204,729			
Equipment-Prof=0	1,014,970	1.000			3,463,221	0		
Sub-total					3,697,333	0		274,788
Safety factors:					+10%	+10%		+10%
Total w/ safety factors:					4,067,066	0		302,267
Zone 2-Irrigation Pump Rm peaks (sensible) in June at 11pm, Air Handler 2, Group 0								
Roof-1-1-No.Clg-L	3,000	0.50	-18.8	0.050	-2,822		1.700	5,100
Wall-1-E-A-D	2,250	1	3.0	0.154	1,040		5.236	11,781
Wall-2-W-A-D	2,250	1	4.0	0.154	1,386		5.236	11,781
Wall-3-N-A-D	1,200	1	-5.8	0.154	-1,063		5.236	6,283
Wall-4-S-A-D	1,200	1	-7.3	0.154	-1,340		5.236	6,283
Lights-Prof=0	4,500	1.000			15,355			
Equipment-Prof=0	39,250	1.000			133,927	0		
Sub-total					146,482	0		41,228
Safety factors:					+10%	+10%		+10%
Total w/ safety factors:					161,131	0		45,351

Air System #1 (Pump Rm) Psychrometric Analysis

Page 6 of 7

System Load Analysis	Latent	Grains	Sensible	Temp	CFM
Leaving Coil Condition		145.506		90.000	
Draw-Thru Fan			85,811	0.207	7,805
Misc Load on Supply Side			0	0.000	0
Supply Air Duct			0	0.000	0
Zone Loads	0	0.000	4,067,066	9.793	369,934
Sensible Reserve			0	0.000	0
Zone Condition	0	145.506	4,152,877	100.000	377,739
Return Air Duct			0	0.000	
Return Air Plenum			0	0.000	
Misc Load on Return Side			0	0.000	
Vent Air 0 CFM	0	0.000	0	0.000	
Blow-Thru Fan			0	0.000	
Entering Coil Condition	0	145.506	4,152,877	100.000	377,739

General Psychrometric Equations Used In Analysis:

PR = (Barometric pressure of site / Standard ASHRAE pressure of 29.921)
TSH = PR x 1.10 x CFM x (DB entering - DB leaving)
TLH = PR x 0.68 x CFM x (Grains entering - Grains leaving)
GTH = PR x 4.50 x CFM x (Enthalpy entering - Enthalpy leaving)

TSH	=	0.999	x	1.10	x	377,739	x (	100.000	-	90.000	) =	4,152,877	Btuh
TLH	=	0.999	x	0.68	x	377,739	x (	145.506	-	145.506	) =	0	Btuh
SUM	=											4,152,877	Btuh
GTH	=	0.999	x	4.50	x	377,739	x (	46.982	-	44.489	) =	4,234,163	Btuh
Total System Load		For 30% design, use: 400,000 cfm									=	4,152,877	Btuh

Chilled And Hot Water Flow Rates

Cooling GPM	=	4,234,163	/ (	0.00	x	500	)	=	0.0	GPM
Heating GPM	=	302,267	/ (	0.00	x	500	)	=	0.0	GPM

Entering Cooling Coil Conditions

Dry bulb temperature:	100.00	
Wet bulb temperature:	83.19	
Relative humidity:	50.00	
Enthalpy:	46.98	Btu/lbm

Entering Heating Coil Conditions

Dry bulb temperature:	75.00

Leaving Cooling Coil Conditions

Dry bulb temperature:	90.00	
Wet bulb temperature:	80.91	
Relative humidity:	67.98	
Enthalpy:	44.49	Btu/lbm

Leaving Heating Coil Conditions

Dry bulb temperature:	75.74

Air System #2 (Irrigation Pump Rm) Psychrometric Analysis

Page 7 of 7

System Load Analysis	Latent	Grains	Sensible	Temp	CFM
Leaving Coil Condition		145.506		90.000	
Draw-Thru Fan			3,400	0.207	309
Misc Load on Supply Side			0	0.000	0
Supply Air Duct			0	0.000	0
Zone Loads	0	0.000	161,131	9.793	14,656
Sensible Reserve			0	0.000	0
Zone Condition	0	145.506	164,530	100.000	14,965
Return Air Duct			0	0.000	
Return Air Plenum			0	0.000	
Misc Load on Return Side			0	0.000	
Vent Air 0 CFM	0	0.000	0	0.000	
Blow-Thru Fan			0	0.000	
Entering Coil Condition	0	145.506	164,530	100.000	14,965

General Psychrometric Equations Used In Analysis:

PR = (Barometric pressure of site / Standard ASHRAE pressure of 29.921)
TSH = PR x 1.10 x CFM x (DB entering - DB leaving)
TLH = PR x 0.68 x CFM x (Grains entering - Grains leaving)
GTH = PR x 4.50 x CFM x (Enthalpy entering - Enthalpy leaving)

TSH	=	0.999	x	1.10	x	14,965	x (	100.000	-	90.000	) =	164,530	Btuh
TLH	=	0.999	x	0.68	x	14,965	x (	145.506	-	145.506	) =	0	Btuh
SUM	=											164,530	Btuh
GTH	=	0.999	x	4.50	x	14,965	x (	46.982	-	44.489	) =	167,751	Btuh
Total System Load											=	164,530	Btuh

use 15,000 cfm

Chilled And Hot Water Flow Rates

Cooling GPM	=	167,751	/ (	0.00	x	500	)	=	0.0	GPM
Heating GPM	=	45,351	/ (	0.00	x	500	)	=	0.0	GPM

Entering Cooling Coil Conditions

Dry bulb temperature:	100.00	
Wet bulb temperature:	83.19	
Relative humidity:	50.00	
Enthalpy:	46.98	Btu/lbm

Entering Heating Coil Conditions

Dry bulb temperature:	75.00

Leaving Cooling Coil Conditions

Dry bulb temperature:	90.00	
Wet bulb temperature:	80.91	
Relative humidity:	67.98	
Enthalpy:	44.49	Btu/lbm

Leaving Heating Coil Conditions

Dry bulb temperature:	77.81

Painter, James E. (Jim)

From: Nelson, Kevin M.
Sent: Monday, June 12, 2006 10:42 AM
To: Painter, James E. (Jim)
Subject: RE: EAA - Northeast Pumping Station - Pipe Gallery Volume

We have two small potable water pumps (each approx. 1 hp) two small lubrication water pumps (each approx. 5 hp), a waste lube oil pump (approx.1 hp), and waste fuel oil pump (approx. 1 hp).

The cooling water returned from each main pump will also be routed through this space before being discharged into the supply canal.

From: Painter, James E. (Jim)
Sent: Monday, June 12, 2006 10:01 AM
To: Nelson, Kevin M.
Subject: RE: EAA - Northeast Pumping Station - Pipe Gallery Volume

Do we have any equipment in the basement giving off heat?

Thanks for the volume.

From: Nelson, Kevin M.
Sent: Monday, June 12, 2006 9:54 AM
To: Painter, James E. (Jim)
Subject: EAA - Northeast Pumping Station - Pipe Gallery Volume

The volume of the pipe gallery is 81,000 cubic feet.

For 30% design, assume 6 AC/hr 8100 cfm; use 10,000 CFM

Irrigation pumps: (5) 200 hp operating

per Kevin Nelson 6/12/06

BLACK & VEATCH

South Florida Water Management District

EAA Reservoir A-1 Preliminary Design Report for Pump Station, Control Structures and U.S. 27 Bridges

July, 2006

DIVIDER PAGE

South Florida
PUMP STATION LOADS FOR BACKUP GENERATORS

July 11, 2006
John Wright
Checked by Gary Partin

BUS A Loads	*Rating*	*KVA*	*Remarks*
Air Comp	40hp	NA	Note 3
Diesel Pp Support		50	Estimated
Diesel Pp Support		50	Estimated
HVAC & Lights		100	Estimated
Seepage Pp	200hp	200	AFD
Seepage Pp	200hp	200	AFD
Total Bus A Load		**600**	

BUS B Loads	*Rating*	*KVA*	
Air Comp	40hp	40	
Diesel Pp Support		50	Estimated
Diesel Pp Support		50	Estimated
HVAC & Lights		100	Estimated
Seepage Pp	200hp	NA	Note 4
Diesel Pp Support		50	Estimated
Diesel Pp Support		50	Estimated
Diesel Pp Support	future	50	Estimated
Diesel Pp Support	future	50	Estimated
Crane	40hp	NA	Note 2
Total Bus B Loads		**440**	

Notes

1. No Irrigation Pumps are included for operation on the standby generator.
2. The Building Crane is not included for operation on the standby generator.
3. Only 1 of the 2 Air Compr. is included for operation on the standby generator.
4. Only 2 of the 3 seepage pumps are included for operation on the standby generator. This will provide for 50% pumping capacity in accordance with SFWMD Major Pumping Station Engineering Guidelines section 5.4.7 (a) and 5.2.6.

Total Load = 600 + 440 = 1040 kva ,

Generator size = 1040 X 0.8pf = 832 kW

Provide 20% extra capacity 832 X 1.2 = 998 kW

Therefore, each generator shall be rated 1000 kW, 0.8 pf

Electrical Load Summary
Maximum Normal Station Loads

Pump Station S-610/ Control Structure S-609

Equipment	Number	Horse-power	Max Normal Load, KVA
1. Air Compressor	2	40	40
2. Vacuum Pump	2	2	2
3. Diesel Engine Pump MCC	8	10	80
4. Seepage Pump	3	200	400
5. Irrigation Pump	5	200	1000
6. Crane/Hoist - S-610	1	40	0
7. Building Supply Fans	15	15	225
8. Building Exhaust Fans	10	10	100
9. Waste Fuel Oil Pump	2	1	1
10. Fuel Oil Receiving Pump	1	5	5
11. Cooling Water Pump	9	10	80
12. Fresh Water Pump	2	5	5
13. Fresh Water Lube Pump	2	5	5
14. Potable Water Pump	2	1	1
15. Waste Lube Oil Pump	2	1	1
16. Generator Block Heater	2	10	20
17. Traveling Trash Rack Rake	2	7.5	15
18. Rotating Strainer	3	1	3
19. Motor Operated Valve	20	1	5
20. Lube Oil Receiving Pump	1	5	5
21. Drainage Pump Bay Drawdown Pump	8	5	10
22. Seepage Pump Bay Drawdown Pump	3	5	5
23. Instrument Air Compressor	2	20	20
24. Water Heater	1	10	10
25. HVAC Power Panel	1 Lot	20	20
26. Lighting Transformer	2	30	30
27. Crane /Hoist - S-609	1	15	0
28. Water Treatment System	1 Lot	10	10
29. Septic System Pump and Aerator	1	1	1
30. Roller Gates - S-609	5	5	25
31. Sluice Gate Actuator - S-609	10	3	30
32. Sluice Gate Actuator - S-610	1	3	3
Total			2157 KVA
			480 volt, 3 phase

Structure S-602

1. Roller Gate Motors	5	5	25
2. Slide Gate Actuators	5	3	15
3. Control Building Lighting	1 Lot		2
4. Control Building I & C	1 Lot		1
5. Control Building HVAC	1 Lot		5
Total			48 KVA
			120/240, 1 phase

Structure S-603

1. Roller Gate Motors		7	5	35
2. Slide Gate Actuators		7	3	21
3. Control Building Lighting	1 Lot			2
4. Control Building I & C	1 Lot			1
5. Control Building HVAC	1 Lot			5
Total				64
			120/240, 1 phase	

DIVIDER PAGE

Montgomery, Gail E.

Pumps

From: Nelson, Kevin M.
Sent: Friday, July 21, 2006 10:21 AM
To: Montgomery, Gail E.; Touslee, James E.
Subject: FW: WFLT 19381 / SFWMD Northeast Pumping Station

From: Stolinski, Theodore J. (Ted)
Sent: Thursday, July 13, 2006 9:36 AM
To: Nelson, Kevin M.
Subject: FW: WFLT 19381 / SFWMD Northeast Pumping Station

Pricing for the pumps. These are delivered costs without the drivers. Add engines, gear reducers, motors plus 40 percent for installation.

From: Bob Cornman [mailto:BCornman@flowserve.com]
Sent: Thursday, July 13, 2006 7:43 AM
To: Stolinski, Theodore J. (Ted)
Cc: Greg Poska; John Ondrejack
Subject: WFLT 19381 / SFWMD Northeast Pumping Station

Ted,

See my comments below.

Regards,

Bob Cornman
Director, Technical Services NA & LA
Flowserve Pump Division
942 Memorial Parkway
Phillipsburg, NJ USA

Tel: 908-859-7256
Fax: 908-859-7482

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"Stolinski, Theodore J. \(Ted\)" <StolinskiTJ@bv.com>

07/12/2006 05:21 PM

To "Bob Cornman" <BCornman@flowserve.com>
cc
Subject RE: WFLT 19381 / SFWMD Northeast Pumping Station

Do you have a budget idea of the price of the main pumps? I would estimate them to be in the $525 - 650,000 each range. We already have requests out for engine and gear reducer pricing, so I only need the pump.

I also have on the same project motor driven seepage pumps and irrigation pumps that I also need pricing on.

Seepage pumps: 50 cfs, 23.3 feet, operating range 11 to 23.3 feet with a 27 feet priming head. There will be three pumps, motor driven. These pumps will be about $95 - 100,000 each w/o motors.

Irrigation pumps. 200 cfs, 5.5 feet, operating range 1 to 9 feet with a 15 feet priming head. There will be five pumps, motor driven. These pumps will be $275 - 375,000 each.

From: Bob Cornman [mailto:BCornman@flowserve.com]
Sent: Thursday, June 29, 2006 10:43 AM
To: Stolinski, Theodore J. (Ted)
Cc: Greg Poska; John Ondrejack
Subject: WFLT 19381 / SFWMD Northeast Pumping Station

Ted,

Our selection would be a 101APS pump per the attached curve.

Regards,

Bob Cornman
Director, Technical Services NA & LA
Flowserve Pump Division
942 Memorial Parkway
Phillipsburg, NJ USA

Tel: 908-859-7256
Fax: 908-859-7482

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"Stolinski, Theodore J. \(Ted\)" <StolinskiTJ@bv.com>

06/28/2006 06:11 PM

To "Bob Cornman" <BCornman@flowserve.com>
cc
Subject WFLT 19381 / SFWMD Northeast Pumping Station

Bob: The SFWMD hydraulics are better defined now. Though by no means final, the hydraulics are pretty well set through the 30 percent design level.

The most significant change is that the pumping station has been pulled out of the levee and we are no longer going through the levee. We are going to go through the top of the levee above maximum operating level relying on a siphon through the top of the levee.

The new hydraulics are as follows:
Rated Point is 625 cfs at 11.2' (bowl performance).

Maximum normal operating head 16.2' (bowl performance).

Extreme maximum continuous operating head 19.1' (bowl performance).

Minimum normal operating head 2.0 feet (bowl performance).

Siphon head 23.9' at a minimum flow of 313 cfs (bowl performance).

All head are for bowl performance. I have included FSI losses, column and discharge elbow losses, and piping (102" diameter), and discharge diffuser losses in the indicated heads for now.

EIMCO WATERTECHNOLOGIES

1335 Regents Park Dr., Ste 260, Houston, Tx 77058
PH: (281) 480-7955 -- FAX: (281) 480-8225

Trash Racks

BUDGET PROPOSAL

TO:	Black & Veatch	DATE:	10th July 2006
Attn:	Mr. Kevin Nelson	Email:	NelsonKM@bv.com
CC:	Litkenhaus & Associates		
Attn:	Mr. Tom Baber	Email:	LITKENHAUS@aol.com
FROM:	Trent T. Gathright	NO. OF PAGES:	Three (3)

SUBJECT: BUDGET PROPOSAL REQUEST

CUSTOMER REFERENCE INFORMATION: **E-mail request of 26th June 2006**
CUSTOMER/SITE REFERENCE: **SFWMD – EEA Reservoir A-1 Pump Station**
EQUIPMENT RECOMMENDED: **Bosker Trash Rake & Stationary Bar Racks**
BG-USA FILE REFERENCE NUMBER: **B06-155**

Dear Mr. Nelson,

We are pleased to provide the following Budget Proposal based on the above customer reference information and the following conditions/considerations: (normally Ex-Works, Prepaid & Added)

I. EQUIPMENT INCLUDED IN BUDGET PRICE BY (X)

X	Brackett Bosker® Raking Machine and Bar Screens	X	Factory Coating
X	Controls	X	Factory Testing
X	Anchor Bolts	X	Shipment Loading
X	O & M Manuals	X	Freight (FOB Houston)
X	Warranty	X	Field Service

II. ITEMS NORMALLY SUPPLIED BY OTHERS

Unloading at Site / Field Touch-up
Installation / Erection / Mounting
Civil Works / Grouting / Anchor Installation
Motor Control Center
Conduit / Wiring / Cables & Glands
Access Ladders / Handrails / Flooring
Site Protection / Storage
State, Federal, Local Taxes or Use Taxes

III. TYPICAL DELIVERY AND SHIPMENT

A. DELIVERY

The Equipment can be typical delivered in 30-32 weeks based on:

		WEEKS
A.	General Drawings for Review	8-10
B.	Review by Client/User	4
C.	Details, Fabrication Shipment	18-20
	TOTAL	30-32

B. OVERALL SIZE / WEIGHT

A.	Approximate Size	Later
B.	Approximate Weight	Later

IV. VALIDITY AND PAYMENT

A. VALIDITY

This Budget Proposal should be considered as valid for approximately three (3) months based on normal industry circumstances. After such time, please check with us for changes such as material/labor rates continued validity.

B. NORMAL PAYMENT TERMS

The budget prices are based on our normal payment terms, which are as follows:

10% - Of the contract value on submission of equipment/foundation drawings.

30% - Of the contract value at a point 3/5ths of the contract period when major raw materials will have been received from our Suppliers.

60% - Of the contract value on deliver to agreed point or as made ready for delivery if delayed by Purchaser.

V. NORMAL TERMS AND CONDITIONS

The following budget prices are based on our standard general conditions of tender available on request.

VI. BUDGET PRICES

A. One (1) Brackett Bosker complete with two (2) Super Duty (2,200 Lb) Trolley/Gripper assemblies (with Stainless Steel Grippers), +/- 418 ft. monorail, seventeen (17) vertical columns, two (2) maintenance platforms and automatic / manual controls

Total Budget Price: $809,000.00 USD Total

(Eight hundred nine thousand dollars)

B. Nine (9) Stationary Bar Racks, 28'-0" wide for an intake +/- 30'-5" deep with 1/2" x 3" bars with 3" clear openings of 304 stainless steel and one (1) Stationary Bar Rack, 8'-0" wide for an intake +/- 30'-5" deep with 1/2" x 3" bars with 3" clear openings of 304 stainless steel

Total Budget Price: $ 2,090,000.00 Total

(Two million ninety thousand dollars)

C. Freight to site – we suggest including the below figure for freight of the equipment to the project site.

Total Budget Price: $ 16,000.00 USD Total

(Sixteen thousand dollars)

D. Field Service

We suggest including approximately $10,000.00 for Field Service to include two (2) round trips, travel time airfare and seven (7) days of field service. If additional days are required, our Field Service Technicians are available for $1,150.00 USD/Day plus all travel, living and per diem at cost.

If you have any further questions, please contact the undersigned directly at 281-480-7955.

Best Regards,
EIMCO Water Technologies, LLC

Trent T. Gathright
Group Product Manager
Screen Products

Montgomery, Gail E.

Roller Gates

From: Nelson, Kevin M.
Sent: Friday, July 21, 2006 10:18 AM
To: Montgomery, Gail E.; Touslee, James E.
Subject: FW: Gate Pricing

Attachments: RE: Everglades Reservoir A-1 ~ Request for Preliminary Costs of Various Water Control Gates

---

From: Lee, Kevin W.
Sent: Wednesday, July 19, 2006 4:37 PM
To: Nelson, Kevin M.
Cc: Tappy, William D. (Bill)
Subject: RE: Gate Pricing

Kevin,

Here is my email correspondence with our local Rodney Hunt rep. He gave me a price of $225,000 for a 12' x 12' gate. However, this price was not for a stainless steel gate, which I believe they are requiring, and we are using 10' x 10' gates at the 2 south structures, and 8' x 8' gates at the northeast structure. So, the price will need some adjusting.

RE: Everglades Reservoir A-1 ~..

From: Nelson, Kevin M.
Sent: Wednesday, July 19, 2006 4:33 PM
To: Lee, Kevin W.
Subject: Gate Pricing

I cannot find any gate pricing information. I thought that you had sent this previously, but I seem to get distracted by other issues whenever I try to find the information. Can you forward any information that you have to me and Bill Tappy for inclusion in the estimate.

Montgomery, Gail E.

From: John Rosson [jrosson@fluidequip.com]
Sent: Wednesday, July 20, 2005 9:29 AM
To: Lee, Kevin W.
Cc: Darryl Beech (E-mail)
Subject: RE: Everglades Reservoir A-1 ~ Request for Preliminary Costs of Various Water Control Gates

Kevin,
Some components are stainless, but not the entire gate, that would get pretty pricey.

I'm not sure these are intended to act a valves by opening partially, seems like open or close makes more sense.

I've copied an expert at Rodney Hunt who may wish to chime in on my thougts as well.
Regards,
John

-----Original Message-----
From: Lee, Kevin W. [mailto:LeeKW@bv.com]
Sent: Tuesday, July 19, 2005 5:49 PM
To: John Rosson
Subject: RE: Everglades Reservoir A-1 ~ Request for Preliminary Costs of Various Water Control Gates

John,

One additional question:

How do vertical roller lift gates respond in throttling conditions - passing flow through a partially open gate. Is vibration a concern?

From: Lee, Kevin W.
Sent: Tuesday, July 19, 2005 5:19 PM
To: 'John Rosson'
Subject: RE: Everglades Reservoir A-1 ~ Request for Preliminary Costs of Various Water Control Gates

John,

Are the gate prices below for stainless steel?

Thanks,
Kevin

From: John Rosson [mailto:jrosson@fluidequip.com]
Sent: Thursday, July 14, 2005 4:01 PM
To: Lee, Kevin W.
Subject: RE: Everglades Reservoir A-1 ~ Request for Preliminary Costs of Various Water Control Gates

Kevin,
Budget prices per your request, in order. Let me know if you have any questions as the project proceeds.
Regards,

John

→ $225,000

$150,000

$175,000

$240,000

-----Original Message-----
From: Lee, Kevin W. [mailto:LeeKW@bv.com]
Sent: Wednesday, July 13, 2005 3:08 PM
To: John Rosson
Subject: Everglades Reservoir A-1 ~ Request for Preliminary Costs of Various Water Control Gates

John,

I am trying to put together a comparison memo for various types of gates to use in discharge structures at several locations around our reservoir for the Everglades project Norm spoke with you about. For this memo, I would like to have some rough costs numbers for the gates below. I need to be completed by the end of the week, so rough cost numbers are fine for this. Give me a call if you (or any of the guys at Rodney Hunt) have questions, and I appreciate your help on this!

12' wide by 12' tall vertical roller lift gate with an electric actuator
12' wide by 12' tall tainter (radial) gate with an electric actuator on a cable drum
12' wide by 18' tall tainter (radial) gate with an electric actuator on a cable drum
12' wide by 28' tall tainter (radial) gate with an electric actuator on a cable drum

THANKS!!

Kevin W. Lee, E.I.T. | **Black & Veatch - building a world of difference™**
ENERGY ♦ WATER ♦ INFORMATION ♦ GOVERNMENT
8400 Ward Parkway
Kansas City, MO 64114
Phone: **(913) 458-3123**
Fax: **(913) 458-2934**
Email: leekw@bv.com
Please visit: http://www.bv.com

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Montgomery, Gail E. Compressed Air

From: Nelson, Kevin M.
Sent: Friday, July 21, 2006 10:17 AM
To: Touslee, James E.; Montgomery, Gail E.
Subject: FW: Everglades South Florida

From: Gilroy, John P.
Sent: Friday, July 14, 2006 4:11 PM
To: Nelson, Kevin M.
Cc: Gass, Julia V. (Julie); Pittman, Larry D.
Subject: Everglades South Florida

Kevin,

I have received budgetary pricing for the compressed air system for the everglades project. Estimate the cost for this system to be $70,000. This cost includes two reciprocating air compressors, one large air receiver and five small air receivers, a refrigerated air dryer with a coalescing filter, an oil/water condensate separation system and includes local controls/gauges. If you need any more information for this let me know.

Thanks,

John P. Gilroy E.I.T.
B&V Water

Black & Veatch Corporation
8400 Ward Parkway
Kansas City, MO 64114
Tel. (913) 458-3018
Fax (913) 458-3163
gilroyjp@bv.com

Montgomery, Gail E.

Structural Steel

From: Nelson, Kevin M.
Sent: Friday, July 21, 2006 12:40 PM
To: Touslee, James E.; Montgomery, Gail E.; Tappy, William D. (Bill)
Subject: FW: STEEL MATERIAL SUMMARY

Attachments: southFlorida-stlmto (2).xls

Jim and Gail,

Additional information to add to backup data

Bill,

Structural steel summary for the estimate is provided in the e-mail below. Sorry for the late delivery of this information, we are scrambling to get as much as we can together.

From: Brant, William D. (Bill)
Sent: Friday, July 21, 2006 12:33 PM
To: Nelson, Kevin M.
Subject: FW: STEEL MATERIAL SUMMARY

Attached is the steel material takeoff for the South Florida Pumping Station.

I will be out of the office this afternoon and Monday.

Bill Brant
Black & Veatch
913.458.6826
913.458.3401 (fax)
brantwd@bv.com

From: Lubaga, Andre L.
Sent: Tuesday, July 18, 2006 11:08 AM
To: Brant, William D. (Bill)
Subject: STEEL MATERIAL SUMMARY

southFlorida-stl
mto (2).xls (2...

Andre Lubaga
Structural Engineer
BLACK & VEATCH
8400 Ward Parkway W-3
Kansas City, Missouri 64114
Tel (913) 458-3168
E-mail lubagaal@bv.com

Project: 143650.300

MTO BY : WDB
SHEET # :
DATE: 07/21/06

STEEL MATERIAL SUMMARY

REFERENCE	SIZE	Paint or FP Type	Base Plate ?	NO. REQ'D	UNIT		UNIT WT	>100# (LBS)	51-100# (LBS)	26-50# (LBS)	16-25# (LBS)	<16# (LBS)	Lad w/o Cage (LBS)	Lad w/ Cage (LBS)	H.R. (LBS)	GRATING (LBS)	CKR PL (LBS)	PAINT (SF)	FIRE PROOFING
						LF	0.0												
						LF	0.0												
Roof						LF	0.0												
	roof joist			15	90.0	LF	70.0		94,500										
	roof joist			15	90.0	LF	70.0		94,500										
	roof joist			15	90.0	LF	70.0		94,500										
perimeter	L5X5X0.5			1	805.0	LF	16.2				13,041								
						LF	0.0												
Walls						LF	0.0												
columns	W18X119		Y	17	49.0	LF	119.0	99,127											
columns	W18X119		Y	17	49.0	LF	119.0	99,127											
columns	W18X119		Y	13	49.0	LF	119.0	75,803											
columns	W18X175		Y	3	49.0	LF	175.0	25,725											
						LF	0.0												
girt (3 per wall)	W16X40			3	805.0	LF	40.0			96,600									
bracing	W12X87			32	30.0	LF	87.0		83,520										
bracing	W12X87			32	16.0	LF	87.0		44,544										
						LF	0.0												
Breakroom/workshop						LF	0.0												
beam	W12X30			31	24.0	LF	30.0			22,320									
						LF	0.0												
Crane Beam						LF	0.0												
	W18X106			2	313.0	LF	106.0	66,356											
						LF	0.0												
Aeration pump station						LF	0.0												
	roof joist			8	31.5	LF	70.0		17,640										
column	W18X97			14	41.0	LF	97.0		55,678										
bracing	W12X87			12	30.0	LF	87.0		31,320										
bracing	W12X87			12	16.0	LF	87.0		16,704										
girts	W16X36			3	180.0	LF	36.0			19,440									
						LF	0.0												
	HANDRAIL			1	224.0	LF	15.6								3,494				
	Type I Ladder w/o Cage			1		LF	12.2												
	Type I Ladder w/Cage			1		LF	34.0												
	GRATING (1")			1	306.0	SF	7.4									2,264			
	Chkrd PL (1/4")			1	122.0	SF	11.4										1,391		
	STAIR TREADS			1		EA	0.0												
	SUBTOTALS							366,138	532,906	138,360	13,041	0	0	0	3,494	2,264	1,391	0	0.0
	CONNECTION ALLOWANCE (*Unit Wt. Includes Conn.)							2%	2%	3%	5%	6%	*	*	*	*	*		
	CONNECTIONS							7,323	10,658	4,151	652	0							
	TOTALS (LBS)							373,461	543,564	142,511	13,693	0	0	0	3,494	2,264	1,391		
	TOTALS (KGS)							169399	246556	64642	6211	0	0	0	1585	1027	631		
	TOTAL THIS SHEET = 540.2 TONS																		

DRAWINGS LIST

			Designer	Due to CADD
		GENERAL		
5 L	5	Overall Site/Staking/Boring Plan (1"= 30')	Mike	
6 L	6	Hydraulic Profile	Betsy	
7 L	7	Liquid Schematic/Process Summary	Peter	
8 L	8	Solids Schematic/Process Summary	Peter	
		CIVIL/SITEWORK		
9 C	1	Site and Grading Plan 1 of 2 (1"=20')	Mike	
10 C	2	Site and Grading Plan 2 of 2 (1"=20')	Mike	
		Yard Piping		
17 Y	1	Yard Piping Plan (1"=20')	Betsy	
18 Y	2	Yard Piping Plan (1"=20')	Betsy	
19 Y	3	Piping Profiles	Betsy	
20 Y	4	Piping Profiles	Betsy	
21 Y	5	Yard Piping Details	Betsy	
		MECHANICAL		
89 M	1	Grit Channel Plan, Sections and Details	Betsy	
90 M	2	Pumping Station - Plans (1/4" = 1'-0")	Betsy	
91 M	3	Pumping Station Sections	Betsy	
92 M	4	Pumping Station Sections	Betsy	
93 M	5	Pretreatment Complex - Plans (1/4" = 1'-0")	Mike	
94 M	6	Pretreatment Complex - Sections	Mike	
95 M	7	Pretreatment Complex - Sections	Mike	
96 M	8	Pretreatment Complex - Sections and Details	Mike	
97 M	9	BNR Basin Plan (3/16" = 1'-0")	Peter	
98 M	10	BNR Basin Plan (3/16" = 1'-0")	Peter	
99 M	11	BNR Basin Plan (3/16" = 1'-0")	Peter	
100 M	12	BNR Basin Plan (3/16" = 1'-0")	Peter	
101 M	13	BNR Basin Sections (1/4" = 1'-0")	Peter	
102 M	14	BNR Basin Sections (1/4" = 1'-0")	Peter	
103 M	15	BNR Basin Sections (1/4" = 1'-0")	Peter	
104 M	16	BNR Basin Sections (1/4" = 1'-0")	Peter	
105 M	17	BNR Basin Details	Peter	
106 M	18	Secondary Clarifier Plan and Section	David	
107 M	19	Secondary Clarifier Section and Detail	David	
108 M	20	UV Channel Plans (3/16" = 1'-0")	Betsy	
109 M	21	UV Channel Sections (1/4" = 1'-0")	Betsy	
110 M	22	UV Channel Details	Betsy	
111 M	23	Filter Complex Top and Base Plan (3/16" = 1'-0")	Peter	
112 M	24	Filter Complex Sections (1/4" = 1'-0")	Peter	
113 M	25	Filter Complex Sections (1/4" = 1'-0")	Peter	
114 M	26	Filter Complex Sections/Details	Peter	
115 M	27	Chemical Storage Plan and Sections (3/16" = 1'-0")		
116 M	28	Aerobic Digester Plan (Typical of 2)	Betsy	
117 M	29	Aerobic Digester Sections (1/4" = 1'-0")	Betsy	

118 M	30	Solids Press Building Plan (3/16" = 1'-0")		
119 M	31	Solids Press Sections (1/4" = 1'-0")		
120 M	32	Solids Press Sections (1/4" = 1'-0")		
121 M	33	Solids Press Details		
122 M	34	Aeration Blowers Plan and Section	David/KC	
123 M	35	Aerobic Digester Blowers Plan and Sections	David/KC	
124 M	36	Mechanical Details	Peter	
125 M	37	Mechanical Details	Peter	
126 M	38	Mechanical Details	Peter	
		INSTRUMENTATION		
171 I	1	Instrumentation Control System Block Diagram		
172 I	2	Instrumentation Installation Details		
		PROCESS AND INSTRUMENTATION DIAGRAMS		
175 PID	3	P&ID Aerated Grit Removal and Bar Rack		
176 PID	4	P&ID Influent Pump Addition & Fine Screens		
177 PID	5	P&ID BNR 1 Anaerobic and 1st Anoxic stages		
178 PID	6	P&ID BNR 1 Oxic Cell, 2nd Anoxic, Re-Aeration stages		
185 PID	13	P&ID Recirculation Pumps		
186 PID	14	P&ID Oxic Blowers		
187 PID	15	P&ID Alum Storage System		
188 PID	16	P&ID Alum Metering Pumps		
189 PID	17	P&ID Methanol Storage System		
190 PID	18	P&ID Methanol Metering Pumps		
191 PID	19	P&ID Final Clarifiers & Scum Pumping		
192 PID	20	P&ID RAS Pumps		
193 PID	21	P&ID Scum Pumps		
194 PID	22	P&ID Filter Feed Pump Station		
195 PID	23	P&ID Deep Bed Filter (Typical of four)		
196 PID	24	P&ID Filter Backwash System		
197 PID	25	P&ID UV Treatment system		
198 PID	26	P&ID Aerobic Digesters		
199 PID	27	P&ID Digester Blower System		
200 PID	28	P&ID Belt Filter Press Systems and Supply Pumps		
201 PID	29	P&ID - BFP Polymer Feed System, Sheet 1 of 2		
202 PID	30	P&ID - BFP Polymer Feed System, Sheet 1 of 2		
203 PID	31	P&ID - Coagulant Aid Feed System		
204 PID	32	P&ID Belt Filter Press Conveyor & Truck Loading Station		
205 PID	33	Instrument Installation Details		

Montgomery, Gail E.

Engine Drives

From: Nelson, Kevin M.
Sent: Friday, July 21, 2006 10:30 AM
To: Touslee, James E.; Montgomery, Gail E.; Pittman, Larry D.
Subject: FW: Everglades Engine Delivery

Larry,

Once again we are scrambling to put together information for the submittal. The client has indicated that they would like catalog cut data, performance curves, or other somewhat relevant information from the equipment manufacturers to be included in with the 30% submittal. Please get any such information to Gail as soon as possible.

From: Pittman, Larry D.
Sent: Monday, June 19, 2006 8:40 AM
To: Touslee, James E.; Stolinski, Theodore J. (Ted); Nelson, Kevin M.
Cc: Montgomery, Gail E.
Subject: FW: Everglades Engine Delivery

See below concerning delivery time for Fairbanks Morse engine drives. Still looking at almost 20 months.

From: Lidbury, Kevin [mailto:Kevin.Lidbury@FairbanksMorse.com]
Sent: Monday, June 19, 2006 8:27 AM
To: Pittman, Larry D.
Subject: RE: Everglades Engine Delivery

Larry:

The 9 cylinder engine at 720 rpm would be the correct engine selection for 1500 continuous horsepower. We currently have two (2) sets of crankshafts in stock for 9 cylinder units. This should allow a quicker delivery of 9 - 12 months after receipt of order (subject to prior sale). Once these cranks are gone and we have to order replacement cranks for stock or order, the lead time on cranks is 15 - 17 months. The unit should be available for shipment 4 - 6 weeks after receiving a crank. I hope that this addresses your question. I you need additional information, please do not hesitate to contact me. What is your timing for bid, award and delivery on this station?

Best regards,

Kevin C. Lidbury
Sales Manager-Commercial Engine Sales

FAIRBANKS MORSE ENGINE
701 White Avenue
Beloit, WI 53511

Phone (608) 364-8005
Phone 800-356-6955 Ext. 8005
Cell Phone (608) 312-6008
Fax (608) 364-8380
www.fairbanksmorse.com

From: Pittman, Larry D. [mailto:PittmanLD@bv.com]
Sent: Tuesday, June 13, 2006 9:26 AM
To: Lidbury, Kevin
Cc: Stolinski, Theodore J. (Ted); Touslee, James E.; Montgomery, Gail E.
Subject: Everglades Engine Delivery

Kevin: For the new engine drives for the Everglades Project we are currently looking at units that can provide approximately 1500 continuous horsepower or the 38D8-1/8 units with 9 cylinders operating at 720 rpm. A while back you indicated delivery time for units was almost 24 months. Would Fairbanks Morse recommend these units for this application and is the delivery time once shop drawings have been approved till around 24 months? Thanks

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