EXHIBIT 40

PREPARED FOR
MIAMI-DADE COUNTY
WATER AND SEWER
DEPARTMENT

Biscayne Bay Coastal Wetlands Rehydration Pilot Project

PRELIMINARY ENGINEERING REPORT | JUNE 2009

MWH

BUILDING A BETTER WORLD

In Association with Brown & Caldwell

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Executive Summary

The Preliminary Engineering Report (PER) for the Biscayne Bay Coastal Wetlands Rehydration Pilot Project (BBCWRPP) is developed to evaluate the treatment processes associated with the planning and design of an advanced wastewater treatment pilot plant. The objective of this report is to establish preliminary design parameters to enable a pilot plant to be constructed and operational.

1. Introduction

The Miami-Dade Water and Sewer Department (MDWASD), is undertaking a wetlands rehydration project (the BBCWRPP) as part of an attempt to restore estuarine ecosystems and as part of the South Florida Water Management District (SFWMD) Water Use Permit (WUP) No. RE-ISSUE 13-00017-W.

The purpose of the BBCWRPP is to evaluate the potential effects of rehydrating the Biscayne Bay Coastal Wetlands with highly treated reclaimed water. This involves evaluating options for treating secondary effluent from the South District Wastewater Treatment Plant (SDWWTP) to produce reclaimed water.

Timing for the BBCWRPP is a critical factor. The SFWMD WUP states, *"….the Permittee shall develop and complete a pilot testing program in consultation with the SFWMD, FDEP and BNP. Following the pilot testing program, the parties shall agree on the water quality treatment required and the feasibility of this project on or before January 15, 2011"*.

This report consists of the following eight sections:

1. Introduction
2. Design Water Quality and Quantity
3. Process Design Conditions
4. Electrical
5. Civil/Mechanical
6. Procurement
7. Permitting
8. Implementation and Schedule

The BBCWRPP will provide water quality monitoring of the pilot plant processes for multiple years, requiring the installation of a permanent building for the pilot plant. Permitting for this building will take up to 9 months; however, preliminary data from the pilot is required before January 2011 to enable discussion on the establishment of final water quality goals. Therefore, to establish the pilot and gather preliminary data at an accelerated timeframe, a initial pilot site will be established under this PER. This will allow the pilot to be producing treated water for testing, while the permanent building is designed, permitted and constructed.

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2. Design Water Quality and Quantity

In order to design the appropriate pilot treatment trains, MWH conducted a Technical Assessment under *Technical Memorandum 1 (TM1)* that reviewed the influent water quality that will enter the pilot plant, which is the effluent from the existing SDWWTP. TM1 also summarized the water quality goals as defined by Chapter 62-611, Florida Administrative Code (FAC) for discharge of potential effluent into wetlands, and summarized proposed water quality targets developed by the Comprehensive Environmental Restoration Plan (CERP) for Biscayne Bay, as being part of Class III Outstanding Florida Waters (OFW). Using these proposed water quality goals, a process assessment was performed in *Technical Memorandum 2 (TM2)*.

A selection of the most critical effluent water quality standards are summarized in **Table ES-1**. These parameters and the target water quality goals were determined using stakeholder input.

Table ES 1
Previously Proposed BBCWRPP Treated Water Goals

Parameter	Units	Reuse / Wetlands Application[1]	Class III / OFW[1]
TSS	mg/L	5	3.5
$CBOD_5$	mg/L	5	N/A
Total Nitrogen as N	mg/L	3	0.27
Total Phosphorous as P	mg/L	1	0.005
Fecal Coliform	#/100 ml	<1.0	<1.0
Total Ammonia as N	mg/L	N/A	0.02 – 0.05[2]
Nitrate/Nitrite as N	mg/L	N/A	0.01
TKN	mg/L	N/A	0.22
Ortho-Phosphate as P	mg/L	N/A	0.002
Dissolved Oxygen	mg/L	N/A	5.0-7.3
Turbidity	NTU	N/A	0.5
Salinity		N/A	--[3]
pH range		N/A	6.5-7.5
Microconstituents		N/A	--[4]
Microconstituents		N/A	--[4]
Cryptosporidium and Giardia		N/A	--[4]

1. Effluent requirements are based on annual average conditions.
2. Treated water goal depends on the method of sample collection and analysis.
3. Background salinity shall not change by more than 5 parts per trillion.
4. There are no established numerical criteria or anti-degradation data.

Pilot Plant Flow Rates

The pilot plant will be designed to produce an effluent flow of approximately 40 gpm (0.06 million gallons per day [mgd]); design feed flows for the initial pilot plant will be approximately 100 gpm (0.14 mgd). When the pilot plant is relocated to the permanent site, the design feed flow rate will increase to 200 gpm (0.28 mgd). The feed flow rate for the permanent BBCWRPP is based on the smallest commercially available treatment process units, and is further described in **Section 3-Process Design Conditions**.

Technology Selection

Currently the South District Wastewater Treatment Plant (SDWWTP) is being upgraded to include filtration and disinfection process (HLD) post secondary treatment process. If the BBCWRPP goes to full scale it may either take effluent from the secondary treatment process or take effluent post filtration and disinfection process as an influent. This report includes a process that indicates the most adaptable and precise sequential process that will allow the pilot to adapt to the full scale conditions in the future.

In order to simulate different water qualities that may be suitable for release into a wetlands environment, TM 2 recommends three treatment trains for testing. Train A is the main line, projected to meet nitrogen and phosphorus water quality standards that are suitable for wetland application, and will provide for additional reduction of microconstituents. Trains B and C are alternative lines configured to test lower concentrations of nitrogen and phosphorus. Unit processes included in each train are summarized in **Table ES-2** and are further described in **Section 3-Process Design Conditions**.

Table ES 2

BBCWRPP Pilot Plant – Process Train Configuration

Unit Process	Train A	Train B	Train C
Sand Filters (HLD)	✓	✓	✓
Nitrification Filters	✓	✓	✓
Denitrification Filters	✓	✓	✓
Chemical Phosphorus Removal	✓		✓
MF/UF	✓	✓	✓
Reverse Osmosis		✓	✓
Advanced Oxidation Process	✓	✓	✓

Secondary effluent from the SDWWTP will be obtained from the pressurized line that feeds on-site Injection Well No. 7 and will first pass through sand filters (HLD) to remove suspended solids. Ongoing pilot studies at the SDWWTP have already tapped into the secondary effluent line, and it is assumed for the purpose of this study that the same influent line will be used. Filtered effluent will then flow through biological aerated filters (for nitrification) and then through denitrification filters with methanol addition for nitrogen reduction. Effluent from the denitrification filters will then be treated for chemical phosphorus removal or high rate clarification. This effluent will be sent through MF/UF and RO units for additional solids removal and AOP (either ultraviolet or ozone disinfection combined with hydrogen peroxide) for the removal of microconstituents. Samples will be taken throughout the process train to assist in the evaluation of the treatment processes.

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3. Process Design Considerations

The treatment process design conditions for each process are presented in this section are based on the SD-WWTP secondary effluent quality and wetlands water quality objectives summarized in **Section 2-Design Water Quality and Quantity** of this report. A general description of the proposed pilot plant is provided, followed by a description of each process technology, its applicability to the treatment process, and design criteria.

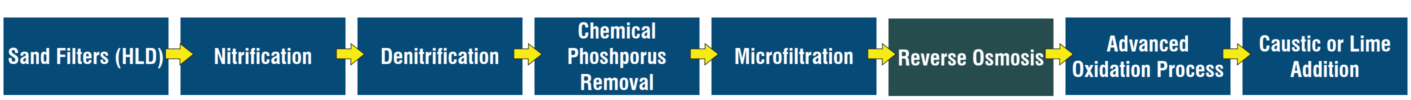
In order to simulate different water qualities that may be suitable for release into a wetlands environment, three treatment trains are recommended for testing in TM2. Train A is the main line, providing nitrogen and phosphorus removal, and further disinfection and treatment using alternative AOPs, including UV and ozone treatment. Product water is projected to meet nitrogen and phosphorus water quality standards that are suitable for wetland application, and will provide for additional reduction of microconstituents. The unit processes included in the treatment train for Train A are illustrated in **Figure ES-1**. Currently the South District Wastewater Treatment Plant (SDWWTP) is being upgraded to include filtration and disinfection process (HLD) post secondary treatment process. If the BBCWRPP goes to full scale it may either take effluent from the secondary treatment process or take effluent post filtration and disinfection process as an influent. This report includes a process flow diagram that indicates the most adaptable and precise sequential process that will allow the pilot to adapt to the full scale conditions in the future. All three treatment trains include sand filters (HLD) as the initial treatment step, however this process is not included on the illustrations. Each of these three treatment trains is further developed in TM2.

Train B, the first bypass line, has a similar process configuration to Train A, but replaces chemical phosphorus removal with RO to attain lower effluent concentrations for both nitrogen and phosphorus. Train C, the second bypass line, retains all the unit processes of Train A, and adds RO to attain lower concentrations of nitrogen and phosphorus. The unit processes included in the treatment trains for Train B and Train C are illustrated in **Figure ES-2** and **Figure ES-3**, respectively.

Figure ES-1
Train A – Proposed Process Configuration

Figure ES-2
Train B – Proposed Process Configuration

Figure ES-3
Train C – Proposed Process Configuration



4. Electrical

The initial pilot plant site is currently fitted with both underground and above ground conduits and cabling to supply the existing recharge pilot. The existing conduit is available for reuse with this pilot however, the cabling will be required to be amended to ensure proper cable distribution.

Two existing distribution panels are available that can be reused from the recharge pilot. These panels are rated at 400 Amps and 225 Amps. Both panels will be required for use to allow for all items of equipment and additional spare capacity for miscellaneous items including emergency lighting, onsite facilities and the standard 25 percent spare capacity

5. Civil/Mechanical

The section establishes the preliminary design of the civil and mechanical portion of the pilot plant.

Site Planning

The pilot plant will initially be located closer to the center of the SDWWTP in a location currently used by the South District Groundwater Recharge pilot plant (**Figure ES-4**). The proposed permanent pilot site is located in the northeast corner of the site, adjacent to one of the deep injection wells for ease of access to SDWWTP effluent.

At the initial location, he pilot plant will use the three existing concrete slabs. Each of these slabs is 10 inches thick with a 12-inch footing around the edges, and is suitable for anchoring of major process equipment. For hurricane protection, several process units associated with the pilot will be installed securely on these concrete slabs. Other process units will be made readily removable for storage in a secured location during hurricane events.

Figure ES-4
Site Planning

Existing Facilities

Where practical the pilot plant will utilize existing facilities and external connections from the SDWWTP and the Groundwater Recharge Pilot. External connections for the initial location include:

» Pilot plant influent pipeline

» Pilot plant effluent water and waste return pipeline

» Potable water connection pipeline

» Electrical and communications supply

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6. Procurement

The schedule for pilot testing requires the pilot plant to be operational by January 2010, following optimization of biological processes. For pilot testing to commence in January 2010, installation of the pilot plant should commence no later than the end of September 2009 to allow a 4 month installation and start-up period followed by a 1 month process optimization period. In order to meet this deadline, it is proposed to lease all major process equipment required initially as purchasing will take too long.

All major process equipment will be sourced from vendors with the exception of the RO system, which is currently owned by the MDWASD and ready for use. These include:

» Sand filters (HLD) and ancillaries

» Nitrifying filters and ancillaries

» Denitrifying filters and ancillaries

» Chemical phosphorus removal equipment and ancillaries

» MF/UF filters and ancillaries

» Hydrogen peroxide/ozone systems and ancillaries

» Ultraviolet disinfection system and ancillaries

Lead times for major process equipment range from 0 to 24 weeks, indicating that procurement for some long lead items should being as soon as possible. Existing equipment already on-site includes the sand filters (HLD), MF/UF systems and the RO system. While lead-times for procurement are not a concern for these items, they require rehabilitation work to ensure suitability for use on at the BBCWRPP.

7. Permitting

It is proposed to return all water produced by the pilot plant, including final water used for testing, and waste, to the sewer system. This will remove the need to amend the wastewater discharge permit of the SDWWTP.

For the pilot plant, permits are required for the electrical supply and utilities supply to allow connection to existing services on site at the SDWWTP. These are currently in place for an existing South District Groundwater Recharge pilot plant. New permits will be required as the recharge pilot project is decommissioned and this BBCWRPP is installed. They will be submitted the Miami-Dade Building Department for temporary installation.

For the permanent pilot site, additional permits will be required, including a building permit for the permanent building. Other permit requirements include miscellaneous construction activity permits, including, but not limited to, dewatering and stormwater management.

8. Implementation And Schedule

In order to meet the timeline established in the Miami-Dade Water Use Permit, issued November 2007 by the SFWMD, pilot testing needs to commence by early 2010. An approach of pilot testing at an already established site (initial site) followed by a transition to a permanent site is proposed to meet the aggressive timeline. Major activities proposed in the schedule are further developed in **Section 8-Implemtation and Schedule** of this report and include:

» Permanent pilot plant building permit acquisition

» Pilot plant final design

» Equipment procurement

» Condition assessment and rehabilitation of on-site units

» Demobilization of the Groundwater Recharge Pilot Plant

» Pilot startup

» Pilot testing

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Section 1 – Introduction

The Miami-Dade Water and Sewer Department (MDWASD), is undertaking a wetlands rehydration project (the BBCWRPP) as part of an attempt to restore estuarine ecosystems and as part of the South Florida Water Management District (SFWMD) Water Use Permit (WUP) No. RE-ISSUE 13-00017-W.

The purpose of the BBCWRPP is to evaluate the potential effects of rehydrating the Biscayne Bay Coastal Wetlands with highly treated reclaimed water. This involves evaluating options for treating secondary effluent from the South District Wastewater Treatment Plant (SDWWTP) to produce reclaimed water.

Timing for the BBCWRPP is a critical factor. The SFWMD WUP states, *"….the Permittee shall develop and complete a pilot testing program in consultation with the SFWMD, FDEP and BNP. Following the pilot testing program, the parties shall agree on the water quality treatment required and the feasibility of this project on or before January 15, 2011"*.

The MDWASD requested that MWH Americas, Inc. (MWH) perform engineering services for the planning, design, construction management, operation and evaluation of an advanced wastewater treatment pilot plant project. This Preliminary Engineering Report (PER) evaluates the treatment processes required for the pilot and establishes preliminary design parameters to enable a pilot plant be constructed and operational.

Project Background

In order to design the appropriate pilot treatment trains, MWH conducted a *Technical Assessment Technical Memorandum 1, (TM1)* that reviewed the influent water quality that will enter the pilot plant, which is the effluent from the existing SDWWTP. TM1 also summarized the water quality goals as defined by Chapter 62-611, Florida Administrative Code (FAC) for discharge of potential effluent into wetlands, and summarized proposed water quality targets developed by the Comprehensive Environmental Restoration Plan (CERP) for Biscayne Bay, as being part of Class III Outstanding Florida Waters (OFW). Using these proposed water quality goals, a process assessment was performed in *Technical Memorandum 2, (TM2)*. The process assessment identified three treatment trains, Trains A, B and C, outlined further in **Section 3-Process Design Conditions** of this report. Several variations of these trains may also be identified and tested as physical data is analyzed during the pilot operation. These treatment trains will provide water for laboratory testing to determine suitability for the required application. It is to be noted that this pilot is to be used to test and analyze the treatment processes and not specific vendor equipment.

The BBCWRPP will provide water quality monitoring of the pilot plant processes for multiple years. Thus, a permanent building is required for the pilot plant. The project team is in the process of obtaining the permit for the permanent building, however it is expected that this process will take up to 9 months. Preliminary data from the pilot is required before January 2011 to enable discussion on the establishment of final water quality goals. Therefore, to establish the pilot and gather preliminary data at an accelerated timeframe, pilot testing will commence at an already established site followed by relocation to a permanent site. This will allow the pilot to be producing treated water for testing, while the permanent building is designed, permitted and constructed.

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Preliminary Engineering Report Organization

This PER evaluates the treatment processes required for the pilot and establishes preliminary design parameters to enable the final design Transfer to the permanent site will require some further adaptation.

The following topics represent subsequent Sections of this report.

Executive Summary

1. Introduction
2. Design Water Quality and Quantity
3. Process Design Conditions
4. Electrical
5. Civil/Mechanical
6. Procurement
7. Permitting
8. Implementation and Schedule

A list of expected final drawings for the pilot plant is included in **Appendix E-Preliminary Drawing List For Initial Pilot Detailed Design.**

Glossary Of Terms

Table 1-1 following includes terms and abbreviations that will be used throughout this document.

Table 1-1
Glossary of Terms and Abbreviations

Abbreviation	Definition
#/100 ml	Number per 100 milliliters
A	Amp
ADF	Average Daily Flow
Al(III)	Aluminum
AOP	Advanced Oxidation Process
BBCWRPP	Biscayne Bay Coastal Wetlands Rehydration Pilot Plant
BNP	Biscayne National Park
BOD	Biological Oxygen Demand
CBOD	Carbonaceous Biochemical Oxygen Demand
CERP	Comprehensive Everglades Restoration Plan
cfm	Cubic Feet per Minute
CIP	Clean in Place
DEP	Department of Environmental Protection
DERM	Department of Environmental Resource Management
°F	Degrees Fahrenheit
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
Fe(III)	Ferric
$FeCl_3$	Ferric Chloride
fps	Feet per second
ft	foot
ft^2	Square feet
ft^3/lb	Cubic foot per pound
Gpd/ft^2	Gallons per day per square foot
gpm	Gallons per minute
gpm/ft^2	Gallons per minute per square feet
HFO	Hydrous ferric oxide
HLD	High level disinfection

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Abbreviation	Definition
KW	Kilowatts
in	inches
lb/ft^2	Pound per square foot
LCP	Local control panel
MDWASD	Miami-Dade Water and Sewer Department
MF	Microfiltration
MF/UF	Microfiltration/Ultrafiltration
mg/L	Milligrams per Liter
mgd	Million Gallons Day
micro-ohms/cm	Micro-ohms per centimeter
mph	Miles per Hour
MWH	MWH Americas, Inc.
N/A	Not Available
NH_3-N	Ammonia as Nitrogen
NO_2-N	Nitrite as Nitrogen
NO_3-N	Nitrate as Nitrogen
NO_x-N	Nitrate/Nitrite as Nitrogen
NPSH	Net Positive Suction Head
NTU	Nephelometric Turbidity Units
OCI	Office of Capital Improvements
OFW	Outstanding Florida Waters
OIT	Operator Interface Terminal
Ortho-P	Ortho-Phosphate
P&ID	Process and Instrumentation Diagrams
PER	Preliminary Engineering Report
PFD	Process Flow Diagram
PLC	Programmable Logic Controller
PM	Project Manager
psi	Pounds per square inch

Abbreviation	Definition
psia	Pounds per square inch absolute
PVC	Polyvinyl chloride
PVDF	Polyvinylidene Fluoride
RFI	Request for Information
RO	Reverse Osmosis
SDWWTP	South District Wastewater Treatment Plant
SFWMD	South Florida Water Management District
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Compounds
TM	Technical Memorandum
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UF	Ultrafiltration
μm	Microns
V	Volts
VFD	Variable Frequency Drive
WWTP	Wastewater Treatment Plant
WUP	SFWMD Water Use Permit No. RE-ISSUE 13-00017-W. (November 2007)

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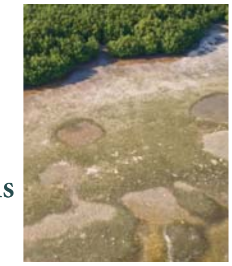
Section 2 – Design Water Quality and Quantity



This section provides a summary of the influent water quality from the SDWWTP and effluent water quality requirements for the BBCWRPP. In addition, it describes quantities of effluent water that determine flowrate sizing of the pilot needed for testing. Previous technical memorandums *(TM1 – Water Quality Assessment [MWH, 2009]*; **and** *TM 2 – Process Technology Assessment [MWH, 2009])* **defined this information in detail; this section provides excerpts of these data in order to provide a background for the process design conditions described in Section 3 of this report.**

2.1 Influent Water Quality

As part of its normal operating procedures for process control and permit requirements, the SDWWTP regularly samples the quality of the wastewater throughout the plant.

The following data sets are available for the SDWWTP effluent:

» **Daily sampling results** required by the SDWWTP operating permit (January 2004 through December 2007).

» **Monthly sampling results** required by the SDWWTP operating permit (January 2004 through December 2007).

» **Annual sampling results** for primary and secondary drinking water standards required by the SDWWTP operating permit (January 2004 through December 2007).

» **Periodic microconstituent testing** that does not include any single body of parameters.

Summaries of daily and monthly testing are presented in **Table 2-1** and **Table 2-2** on page 2. Full data reports are provided in the appendices of TM1 .

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Table 2-1
SDWWTP – Daily Sampling Results (January 2004 – December 2007)

Parameter[1]	Units	SDWWTP Effluent Concentration (Percentile)				
		10th	50th	90th	95th	Maximum
$CBOD_5$	mg/L	2.9	4.4	7.4	8.8	21.0
TSS	mg/L	5.4	8.0	12.8	16.4	53.0

1. Samples are 24-hour flow proportioned composite samples.

Table 2-2
SDWWTP – Monthly Sampling Results (January 2004 – December 2007)

Parameter	Units	SDWWTP Effluent Concentration (Percentile)				
		10th	50th	90th	95th	Maximum
TOC	mg/L	9.0	11.3	13.7	15.0	28.7
TN	mg/L	17.5	23.5	30.4	33.1	37.4
TKN	mg/L	17	23.1	30.3	32.7	37.0
NH^3-N	mg/L	15.2	20.9	27.4	29.4	31.5
NO^2-N	mg/L	0.11	0.37	0.98	1.6	2.27
NO^3-N	mg/L	0.09	0.21	0.54	0.65	0.73
TP	mg/L	1.18	1.81	2.66	3.61	10.10
Temperature	°F	77.9	83.3	86.5	87.4	87.8
TDS	mg/L	328	368	472	480	580
Sulfate	mg/L	22	28	35	37	55
Chloride	mg/L	68	77	120	125	127
pH		6.3	6.6	6.8	6.92	7.3
Conductivity	micro-ohms/cm	696	785	991	1020	2000
Fecal Coliform	#/100 ml	9,819	74,775	600,000	4,700,000	6,000,000

Secondary effluent from the SDWWTP will be used as the influent water for the BBCWRPP. However, the SDWWTP is in the process of being upgraded to meet High Level Disinfection (HLD) regulations, and this upgrade will not be complete until late 2011. In order to accurately replicate the HLD treated effluent from the SDWWTP that would ultimately feed a full-scale wetlands rehydration project, this pilot plant will simulate HLD using sand filters prior to the treatment process units to achieve the required influent water quality.

The Groundwater Reclamation pilot plant is adding chlorine to the filter effluent as will the proposed full-scale plant to meet the HLD requirements. In addition, chlorine may be present in the existing ring main, which many require removal prior to entering the pilot plant treatment process train. Since the biological organisms in the downstream nitrification and denitrification filters will not survive a chlorinated flow stream, the addition of chlorine will require evaluation prior to the design of the full scale plant. If dechlorination of the SDWWTP effluent is required before or after filtration, a dechlorination process will also be incorporated into final design.

2.2 Pilot Plant Flow Rates

Water quantity or flow produced by the pilot plant is driven by the amount of water needed for the forthcoming ecological and microcosm studies as well as the minimum size of equipment. It has been assumed that a flow of approximately 40 gallons per minute (gpm) is required for sampling, testing, and analysis.

The sizing of the individual process units was based on a required effluent flow of 40 gpm from the final treatment process (advanced oxidation). Upstream of the microfiltration units, chemical phosphorus removal technology will drive the sizing of the remaining unit processes. Hydrous ferric oxide (HFO) reactive filtration has been selected as the initial chemical phosphorus removal process. HFO has a design flow of 100 gpm. Performance is intended to be compared to ballasted flocculation, anotherchemical phosphorus removal process. Ballasted flocculation requires 200 gpm, a higherinfluent flow rate than HFO. Therefore, the initial sizing of the unit processes upstream have been sized for HFO. Upon relocation and transfer to the permanent site, the processes will be expanded to evaluate ballasted flocculation Individual process flow rates are further described in Section 3.

2.3 Effluent Water Quality Objectives

There are four primary regulatory guides for effluent water quality standards for this project:

1. **Reuse Water Quality** – dictated by Chapter 62-610, FAC for the irrigation of landscaped areas, edible crops, golf courses and parks.
2. **Wetlands Application Standards** – dictated by Chapter 62-611, FAC which vary depending on the type of wetlands that are being used as receiving waters; these variations dictate the loading and application rates.
3. **Miami-Dade County Code** – dictated by Miami-Dade County Code Article III 24-42 which regulates environmental issues within Miami-Dade County, including groundwater and surface water quality.
4. **Class III/OFW** – requires that discharges must not degrade the ambient water quality at the discharge site.

Water quality goals are expected to be further developed as a result of forthcoming ecological studies. Effluent water from this pilot plant will be tested in a controlled environment to evaluate its effect on a wetlands environment. The approach for this project is to produce an effluent with water quality that can sustain a wetlands ecosystem. Upper and lower water quality targets are proposed to, coincide with the Wetlands Application Standards (Chapter 62-611, FAC), and previously proposed Class III/OFW (Chapter 62-302, FAC), respectively. Results from the ecological tests will define the final water quality targets.

A selection of the most critical effluent water quality standards are summarized in **Table 2-3**. These parameters and the target water quality goals were determined using stakeholder input.

Table 2-3
Previously Proposed BBCWRPP Treated Water Goals

Parameter	Units	Reuse / Wetlands Application[1]	Class III / OFW[2]
TSS	mg/L	5	3.5
CBOD5	mg/L	5	N/A
Total Nitrogen as N	mg/L	3	0.27
Total Phosphorous as P	mg/L	1	0.005
Fecal Coliform	#/100 ml	<1.0	<1.0
Total Ammonia as N	mg/L	N/A	0.02 – 0.05[2]
Nitrate/Nitrite as N	mg/L	N/A	0.01
TKN	mg/L	N/A	0.22
Ortho-Phosphate as P	mg/L	N/A	0.002
Dissolved Oxygen	mg/L	N/A	5.0-7.3
Turbidity	NTU	N/A	0.5
Salinity		N/A	--[3]
pH range		N/A	6.5-7.5
Microconstituents		N/A	--[4]
Cryptosporidium and Giardia		N/A	--[4]

1. Effluent requirements are based on annual average conditions.
2. Treated water goal depends on the method of sample collection and analysis.
3. Background salinity shall not change by more than 5 parts per trillion.
4. There are no established numerical criteria or anti-degradation data.

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Based on a comparison between the influent water quality and the recommended water quality goals for nitrogen and phosphorus, it can be determined that advanced treatment is required in order to discharge the effluent into a wetlands environment. Influent, effluent and percent removal requirements for nitrogen and phosphorus are presented in **Table 2-4**.

The percent removal of nitrogen, phosphorus, and other constituents regulated by the wetlands and Class III/ OFW standards drove the selection of the treatment train unit processes in TM2. These unit processes are further described in Section 3 of this report.

Table 2-4
Nitrogen and Phosphorus – Potential Removal Targets

Parameter	Influent (mg/L)	Effluent (mg/L)		Percent Removal Required (%)	
		Reuse / Wetlands Application[1]	Class III / OFW[2]	Reuse / Wetlands Application[1]	Class III / OFW[2]
Total Nitrogen – Average	23.5	3	0.27	87.0	98.8
Total Nitrogen – Maximum	37.4	3	0.27	92.0	99.3
Phosphorus – Average	1.81	1	0.005	44.8	99.7
Phosphorus – Maximum	10.10	1	0.005	90.1	99.95

1. FAC 62-611, Wetlands Application Standard

2. Based on previously proposed water quality targets. Ecological testing results will help define final target levels.

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Section 3 – Process Design Conditions

The treatment process design conditions for each process are presented in this section are based on the SDWWTP secondary effluent quality and wetlands water quality objectives summarized in Section 2-Design Water Quality and Quantity of this report. A general description of the proposed pilot plant is provided, followed by a description of each process technology, its applicability to the treatment process, and design criteria.

3.1 Alternative Streams Analysis

In order to simulate different water qualities that may be suitable for release into a wetlands environment, three treatment trains are recommended for testing in *Technical Memorandum #2 (MWH 2009)* (TM2). Train A is the main line, providing nitrogen and phosphorus removal, and further disinfection and treatment using alternative AOPs, including UV and ozone treatment. Product water is projected to meet nitrogen and phosphorus water quality standards that are suitable for wetland application, and will provide for additional reduction of microconstituents. The unit processes included in the treatment train for Train A are illustrated in **Figure 3-1**. Currently the South District Wastewater Treatment Plant (SDWWTP) is being upgraded to include filtration and disinfection process (HLD) post secondary treatment process. If the BBCWRPP goes to full scale it may either take effluent from the secondary treatment process or take effluent post filtration and disinfection process as an influent. This report includes a process flow diagram that indicates the most adaptable and precise sequential process that will allow the pilot to adapt to the full scale conditions in the future. All three treatment trains include sand filters (HLD) as the initial treatment step, however this process is not included on the illustrations. Each of these three treatment trains is further developed in TM2.

Train B, the first bypass line, has a similar process configuration to Train A, but replaces chemical phosphorus removal with RO to attain lower effluent concentrations for both nitrogen and phosphorus. Train C, the second bypass line, retains all the unit processes of Train A, and adds RO to attain lower concentrations of nitrogen and phosphorus. The unit processes included in the treatment trains for Train B and Train C are illustrated in **Figure 3-2** and **Figure 3-3**, respectively.

Figure 3-1
Train A – Proposed Process Configuration

Sand Filters (HLD) → Nitrification → Denitrification → Chemical Phosphorus Removal → Microfiltration → Advanced Oxidation Process → Caustic or Lime Addition

Figure 3-2
Train B – Proposed Process Configuration

Sand Filters (HLD) → Nitrification → Denitrification → Microfiltration → Reverse Osmosis → Advanced Oxidation Process → Caustic or Lime Addition

Figure 3-3
Train C – Proposed Process Configuration

Sand Filters (HLD) → Nitrification → Denitrification → Chemical Phosphorus Removal → Microfiltration → Reverse Osmosis → Advanced Oxidation Process → Caustic or Lime Addition

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3.2 Preliminary Process Configuration

As a result of a thorough technology evaluation, along with a comprehensive literature and process review, a number of treatment processes were identified as viable for pilot testing. The additional treatment of the SDWWTP secondary effluent will further reduce concentrations of CBOD5, TSS, nitrogen, phosphorus, and microconstituents.

A process flow diagram (PFD) and process and instrumentation diagrams (P&IDs) have been prepared to illustrate the process configuration of the pilot plant. The PFD is included in **Appendix A** and illustrates the main line process train and the two bypass trains as described above. The PFD illustrates the process units for both the initial and permanent sites, and therefore indicates the facility feed flow rates for the pilot testing at permanent site. The P&IDs are included in **Appendix B**.

3.3 Flow Balance

The pilot plant is designed to produce an effluent flow of approximately 40 gpm (0.06 million gallons per day [mgd]); design feed flows for the pilot plant at the initial site will be approximately 100 gpm (0.14 mgd). When the pilot plant is relocated to the permanent site, the design feed flow rate will increase to 200 gpm (0.28 mgd). The feed flow rate for the permanent site is based on the smallest commercially available treatment process units.

The pilot plant at the initial site will be sized for an influent average daily flow (ADF) of 100 gpm upstream of the chemical phosphorus removal system, and a design ADF of 63 gpm to feed the MF/UF processes. Design flows for each of the pilot plant processes are summarized in **Table 3-1**. Design criteria for each process are included at the end of this section in **Table 3-3**.

Since some of the unit processes are being sized using the smallest commercially available process units, some processes will have an effluent flow that is much higher than is required by the downstream process. For example, the chemical phosphorus removal process will have an effluent flow that is much higher than the downstream MF process requires, or can accept. In addition, upstream processes are oversized by a small contingency so that fine tuning of operating parameters (i.e. flux for MF/UF) will not be restricted. Therefore, hydraulic balance tanks or break tanks will be installed between processes to allow this overflow of excess flow to be continuously bypassed to the waste collection system and not flood the downstream processes. The break tank requirements (location and size) will be further developed during final design.

Table 3-1
BBCWRPP Pilot Plant – Influent Process Design Flows

Unit Process	Average Feed Flow (gpm)	Weather Protection Requirements	Maximum Feed Flow (gpm)
	Initial Site	Permanent Site	
Sand Filters (HLD)	100	200	252
Nitrification Filters	100	200	TBD
Denitrification Filters	100	200	TBD
Chemical Phosphorus Removal			
Reactive Filtration	85	85	85
High Rate Clarification	N/A	200	200
MF/UF	63	63	70
Filtrate Flow	59	59	59
Recovery	95%	95%	85%
Reverse Osmosis	48	48	54
Permeate Flow	36	36	46
Recovery	75%	75%	85%
Advanced Oxidation Process			
UV/Peroxide	30	30	30
Ozone/Peroxide	10	10	25

3.3.1 Concentration Balance

A preliminary concentration balance of the proposed treatment process was developed based on the secondary effluent characteristics of the SDWWTP and common removal rates obtained during the literature review task of this project. Results are presented in **Table 3-2.** The actual performance of the treatment processes during the pilot study will depend on site specific factors, water quality of the influent flow stream, and performance of the process units during pilot operation.

Table 3-2
BBCWRPP Pilot Plant – Concentration Balance at Feed Flow

Treatment Process	Ammonia (NH_3-N) (mg/L)	Nitrate/Nitrite (NO_x-N) (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
SDWWTP Secondary Effluent	25	0.75	27	2.7
Sand Filters (HLD)	25	0.75	27	2.8
Nitrification Filters	0.5	25.25	27	2.3
Denitrification Filters	0.5	0.5	2.2	1.95
Chemical Phosphorus Removal	0.5	0.5	1.85	0.1
MF / UF Membranes	0.5	0.5	1.85	0.1 – 0.05
Reverse Osmosis	0.05	0.02	0.2	0.003 – 0.0015
Advanced Oxidation Process (w/o RO)	0.5	0.5	1.85	0.1 – 0.05

3.4 Process Flow Description

Secondary effluent from the SDWWTP will be obtained from the pressurized line that feeds on-site Injection Well No. 7 and will first pass through sand filters (HLD) to remove suspended solids. Ongoing pilot studies at the SDWWTP have already tapped into the secondary effluent line, and it is assumed for the purpose of this study that the same influent line will be used. This effluent carries disinfected water. Filtered effluent will then flow through biological aerated filters (for nitrification) and then through denitrification filters with methanol addition for nitrogen reduction. Effluent from the denitrification filters will then be treated for chemical phosphorus removal (either by reactive filtration at the initial or permanent site or high rate clarification at the permanent site). This effluent will be sent through MF/UF and RO units for additional solids removal and disinfection (either ultraviolet/peroxide or ozone disinfection or ozone combined with hydrogen peroxide) for the removal of microconstituents. Samples will be taken throughout the process train to assist in the evaluation of the treatment processes.

3.4.1 Sand Filters (High Level Disinfection)

It is assumed for the purpose of the design of the pilot plant at the initial site that a flow rate of 100 gpm for the sand filters will be used. Based on conversations with Severn-Trent, it may be possible to decrease the number of filters currently in use to achieve the same removal rates at a flow rate 100 gpm. When the plant equipment is moved to the permanent site, the filters that were taken out of service will be reinstated. Since this system already includes valves and instruments on the skid, removing these filters from, or putting these filters into service should not be difficult.

DESIGN CRITERIA

The filter for this pilot plant consists of 6 vessels. Each filter is a deep bed sand media filter that is 3-feet in diameter. Piping and wiring are assembled with the filters on one skid. All necessary manual and automatic valves and instruments are also assembled on the skid. This filter system includes two centrifugal type backwash blowers, two horizontal end suction, centrifugal backwash water pumps, and one air compressor system. A clearwell for use during backwash cycles is also included with the system which also serves as an intermediate hydraulic balance tank. All backwash waste is sent to the SDWWTP via gravity by way of an on-site manhole connection.

The existing on-site filter assembly will be used for the sand filters. The filters and clearwell are currently being operated at a flow rate of 100 gpm, but based on filter area and surface loading rate provided by Severn-Trent, it is expected that these filters will be able to handle a flow of 200 gpm. Additional evaluation of this system will be completed during final design. Modifications to the clearwell or an additional tank to augment the clearwell may be required depending on the required detention time for an increased flow rate to feed the nitrification filters.

The current pilot plant is adding chlorine to the filter effluent as will the proposed full-scale plant to meet the HLD requirements. In addition, chlorine may be present in the existing ring main, which many require removal prior to entering the pilot plant treatment process train. Since the biological organisms in the downstream nitrification and denitrification filters

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will not survive a chlorinated flow stream, the addition of chlorine will require evaluation prior to the design of the full scale plant. If dechlorination of the SDWWTP effluent is required before or after filtration, a dechlorination process will also be incorporated into final design.

Additional information regarding the sand filters is summarized in the Equipment List **(Table 3-3)** *and on the P&IDs* **(Appendix B).**

3.4.2 Biologically Aerated Filters (BAFs) – Nitrification

Biologically aerated filters are biological reactors with a submerged media bed that supports an attached biological growth. These high rate, fixed film filters combine biological treatment, clarification, and filtration for the removal of soluble and suspended organic material. Microorganisms attached to the reactor media reduce the nitrogenous content of the feed water, and have been proposed in this pilot plant for the nitrification process, sequentially converting ammonia to nitrite and then to nitrate. Insoluble solids (TSS) and residual dissolved carbon are also retained on the filter media. Process air is added to the filter to meet oxygen demands of the biomass and provide flow distribution throughout the filter bed. Accumulated solids and excess biomass are flushed out during backwash cycles.

Although BAFs can be configured in the downflow or upflow direction, the upflow configuration has been recommended for this pilot plant. In an upflow configuration, the feed flow is introduced at the bottom of the filter, proceeding upwards in the same direction as the air. This upward flow allows a more even distribution of water and air. As the water flows upwards, the carbonaceous material is consumed by the microorganisms; ammonia and TSS are also reduced during this process.

DESIGN CRITERIA

The BAFs for this pilot plant will be designed as submerged aerated filters (SAFs) and will consist of six reactor vessels. Each filter will consist of a carbon steel vessel that is 6 feet in diameter. Sizing of vessels to fit on the existing concrete slab will be confirmed in the next phase of design. The vessels include an air header, sump, and effluent trough; piping and wiring will be assembled with the filters. All necessary manual and automatic valves and instruments will also be included. Solids will be removed from the surface of the media and sent to the SDWWTP via gravity by way of an on-site manhole connection.

Due to space constraints at the pilot location, modifications to this proposed filter system will be evaluated during the final design. When the equipment is moved to the permanent site, a duplicate nitrification filter assembly will be added to handle the increased flow.

Additional information regarding the nitrification filters is summarized in the Equipment List **(Table 3-3)** *and on the P&IDs* **(Appendix B).**

3.4.3 Denitrification Filters

The reduction of nitrate to gaseous nitrogen in denitrification filters is accomplished by using facultative heterotrophic bacteria. Denitrification filters typically consist of deep bed gravity sand filters that are seeded with bacteria. Flow can be either downwards or upwards, and requires a carbon source for the denitrifiers. Typically methanol is selected as the carbon source, due to the fact that it is readily degradable under anaerobic and aerobic conditions. The addition of oxygen is typically limited so that the denitrifying bacteria use the nitrate for metabolism instead of the oxygen.

When the denitrifying bacteria consume the nitrate, nitrogen gas is produced. Air is "pulsed" at regular intervals to remove the nitrogen gas bubbles that accumulate on the filter media. Backwashing is also required to remove accumulated solids and excess biomass.

DESIGN CRITERIA

The denitrification filters for this pilot plant will consist of ten reactor vessels. Each filter will consist of a carbon steel vessel that is 3 feet-4 inches in diameter. Sizing of vessels to fit on the existing concrete slab will be confirmed in the next phase of design. The vessels include an air header, sump, and backwash trough; piping and wiring will be assembled with the filters. One clearwell will be included for backwash purposes. A clearwell and two backwash pumps for use during backwash cycles are also included with the system and also serves as the feed tank for the phos-

phorus removal step. All necessary manual and automatic valves and instruments will also be included. All backwash waste will be sent to the SDWWTP via gravity by way of an on-site manhole connection.

Due to space constraints at the pilot location, modifications to this proposed filter system will be evaluated during detailed design. When the equipment is moved to the permanent site, a duplicate denitrification filter assembly will be added to handle the increased flow.

Additional information regarding the denitrification filters is summarized in the Equipment List **(Table 3-3)** *and on the P&IDs* **(Appendix B).**.

3.4.4 Chemical Phosphorus Removal

Effective removal of phosphorus from a water stream can be accomplished by many processes, including biological, chemical, or a combination of both. For the purpose of this pilot plant, chemical removal was selected as the process to test; biological removal would require substantial upgrades of the eventual full-scale SDWWTP and would also require a larger footprint for the pilot test and full-scale system.

Chemical phosphorus removal is based upon reactions that take place between phosphorus and multivalent ions (coagulants), such as aluminum (Al[III]) and ferric (Fe[III]). The addition of a coagulant results in the precipitation of phosphorus, which is then settled out and removed through a solids separation process, such as sedimentation and/or reactive filtration.

DESIGN CRITERIA

Two chemical phosphorus removal processes may be evaluated during the operation of this pilot project; hydrous ferric oxide (HFO) reactive filtration, and high rate clarification. Current plans are to use reactive filtration (e.g. BluePro®) as the primary chemical phosphorus removal process for the pilot plant at the initial site.

Reactive Filtration

Reactive filtration involves unique processes, including reactive filter media and continuous regeneration of that media. Adsorption in combination with co-precipitation maximizes the efficiency of the filter. Continuous regeneration of the media is accomplished by using a moving bed filter, which constantly generates fresh filter surface area for adsorption. Conventional backwashing of the media or change-out of the media is not required, reducing operations and maintenance costs.

During the BluePro® treatment process, ferric chloride ($FeCl_3$) will be added to the wastewater stream prior to entering the rapid conditioning zone. The mixture of wastewater and chemical additive enters the filter at the bottom of the sand bed, which then flows upwards, with clean water discharging from the top of the vessel. The moving bed filters moves the sand downward and is returned to the top of the filter using an airlift. Sand is separated from waste particles, and waste will be routed for appropriate disposal. All reject will be sent to the SDWWTP via gravity by way of an on-site manhole connection. An illustration of the BluePro® process is presented in **Figure 3-4**; *a photograph of an actual BluePro® installation is presented in* **Figure 3-5.**

The BluePro® system for this pilot plant will consist of one Model "CF-28 UF" filter in a single pass configuration. The dimensions of the filter are approximately 6 feet in diameter and 21 feet high with a footprint of approximately 70 square feet (ft^2). Average loading rate of the filter is 2.1 gallons per minute per square foot (gpm/ft^2) and the approximate filter bed depth is 60 inches. Ancillary equipment including an air control panel, influent feed pump and flow meters, chemical feed system, air compressor and an electrical control panel which will be housed in a cargo container. The container will have an approximate footprint of 160 ft^2.

Additional information regarding reactive filtration is summarized in the Equipment List **(Table 3-3)** *and on the P&IDs* **(Appendix B).**

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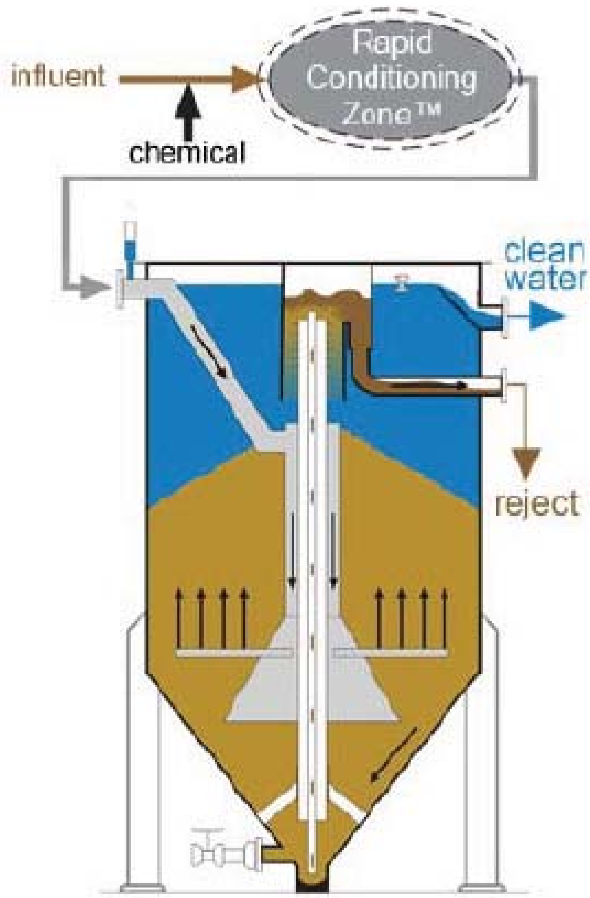
Figure 3-4
BluePro® – Operational Concept



Source: Blue Water Technologies, Inc., 2009

Figure 3-5
BluePro® – Actual Installation

Source: Blue Water Technologies, Inc., 2009

High Rate Clarification

High rate clarification as a phosphorus removal process for this study combines ballasted flocculation and plate settling. Microsand in the system promotes flocculation and acts as a weighted structure to produce a dense floc with a high settling velocity.

During the Actiflo® process, a coagulant such as alum or FeCl3 is introduced into the flow stream to destabilize the colloids. After the addition of a polymer, the particles attach to the microsand promoting sedimentation and the clarified water is collected above the settling plates. The settled microsand and sludge settles to the bottom of the clarifier and is re-circulated to a hydrocyclone. The hydrocyclone uses centrifugal force to separate the microsand from the sludge. The sludge is discarded and the microsand is recycled back into the system. All sludge will be sent to the SDWWTP via gravity by way of an on-site manhole connection. A schematic of the Actiflo® process is presented in **Figure 3-6**.

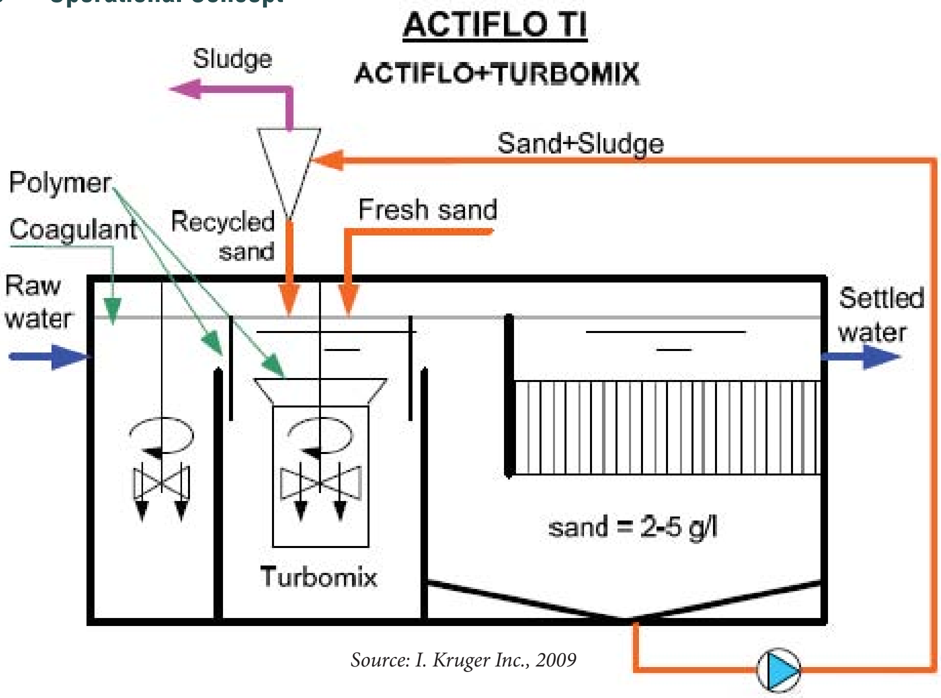
The Actiflo® system for this pilot plant will consist of one equipment trailer (53 feet by 8 feet with an approximate footprint of 424 ft2). The trailer will contain all processes needed to run the system, including two coagulation tanks/mixers, one maturation tank/mixer, circulation pump, hydrocyclone, chemical storage tanks and dosing pumps, MCC and PLC panel. Average loading rate of the filter is 32 gpm/ft2.

Additional information regarding high rate clarification is summarized in the Equipment List **(Table 3-3)** *and on the P&IDs* **(Appendix B).**

3.4.5 Microfiltration/ Ultrafiltration

Microfiltration (MF) is a filtration process which removes undissolved contaminants from a fluid by passage through a micro porous membrane. A typical MF membrane pore size range is 0.1 to 1.0 micrometers (μm). In addition, MF effectively removes major pathogens and contaminants such as

Figure 3-6
Actiflo® – Operational Concept



Source: I. Kruger Inc., 2009

The MF and UF systems generally utilize hollow fiber membranes capable of being backwashed with air or water or a combination of both. Hollow fiber membrane systems are then subcategorized yet one more time into submerged and pressurized systems. Both submerged and pressurized systems are assembled in a similar manner. Groups of hollow fibers are bundled into modules. Then modules are bundled into skids (pressurized), or cassettes (or racks to be submerged), and finally units are grouped into trains.

giardia lamblia cysts, cryptosporidium cysts, protozoa and large bacteria. For this application the MF system membrane pore size has a nominal rating of 0.2 µm or less.

Ultrafiltration (UF) is a variety of membrane filtration in which hydrostatic pressure forces a liquid against a semi permeable membrane. Suspended solids and large colloidal organics are retained, while water and low molecular weight solutes pass through the membrane. The pore size for a UF membrane ranges 0.01 to 0.001 µm. Small colloids and viruses can be removed by UF.

DESIGN OPTIONS

Microfiltration and ultrafiltration are defined as pressure or vacuum driven separation process on which particulate matter is rejected by an engineered polymeric membrane barrier primarily through a size exclusion mechanism and which has a measurable removal efficiency of a target organism or target contaminants that can be verified through the application of a direct integrity test (USEPA 815-R-06-009, Membrane Filtration Guidance Manual – November 2005). A MF or UF system provides a mechanism for controlling the product water quality independent of the feed water quality. It is therefore used frequently when the product water quality needs to be very stringent, which is the case for pretreatment to RO membranes.

Pressure vs. Submerged

With pressurized systems the membrane modules are housed in cylindrical pressure vessels which are then manifolded together to form a unit. Pressurized systems utilize a feed pump located upstream of the membrane unit to develop the required driving pressure. The driving pressure is used to push water through the membranes and has enough pressure to reach a downstream treatment tank.

Submerged systems submerge the cassettes of membrane modules into open top basins/cells. A filtrate pump located downstream from the basin/cells draws water through the membrane using a vacuum. Water must be pumped into the basins/cells, unless it flows in by gravity. Because the basins/cells are open to atmosphere, the pressure on the feed side of the membrane is limited to the static pressure developed by the column of water. Therefore in a submerged membrane system the transmembrane pressure is limited to the Net Positive Suction Head (NPSH) that the permeate pump can develop. Submerged membrane systems are sometimes referred to as immersed systems.

Operational concepts for both pressurized and submerged membranes are illustrated in **Figure 3-7***.*

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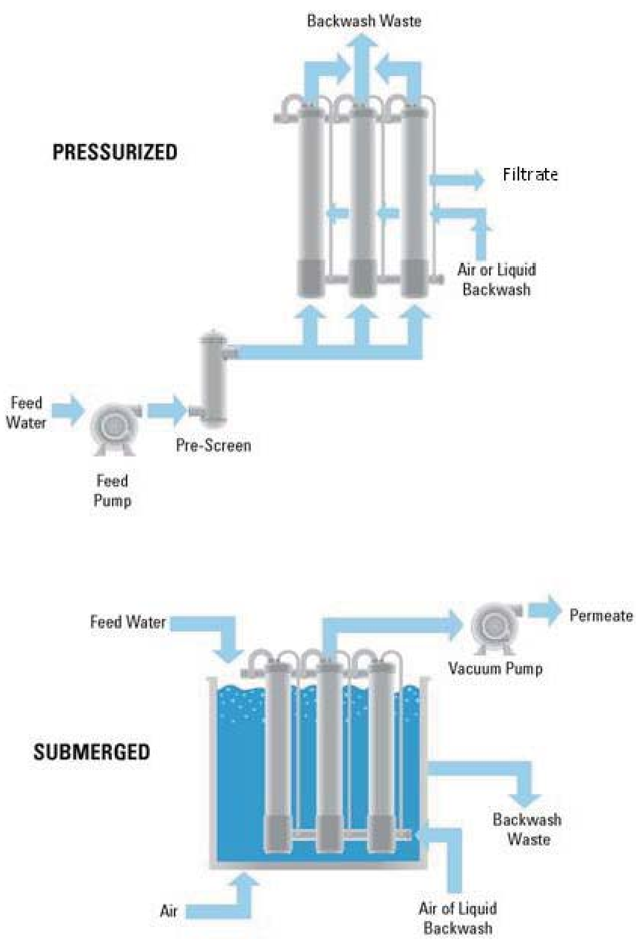
Figure 3-7
Pressurized and Submerged Membranes – Operational Concept



DESIGN CRITERIA

In order to appropriately size the MF/UF system, the downstream processes must be evaluated to determine their required flow rates. Based on the maximum product flow requirement of approximately 40 gpm for the RO system, the influent flow for the MF/UF system was back calculated (see **Table 3-1** *for more details). With an estimated maximum RO recovery of 85 percent and MF/UF recovery of 85 percent, a required maximum MF/UF influent flow rate of 70 gpm was calculated (see* **Table 3-2)** *for additional information on process water and concentrate flow rates). The available flow rate per MF/UF pilot unit was calculated by multiplying the flux of each unit by the available surface area. Flux rates were estimated between 30 and 60 gpm/ft² for pressure systems, and between 20 and 40 gpm/ft² for vacuum systems. Total surface area per module was provided by the manufacturer. Based on this evaluation, each individual pilot unit required between 19 and 26 gpm; therefore, in order to obtain a total flow of 70 gpm, three pilot units would be required.*

A MF/UF feed tank will be included upstream of the process in order to provide a constant flow rate to each of the three MF/UF process units.

The three selected MF/UF systems will be operated in parallel during this study, each treating a portion of the influent flow. The MF/UF system will reduce the TSS concentrations and remove colloids from the wastewater.

Based on an initial site evaluation, it is proposed to use three existing on-site pilot units for testing. The selection of the three units was based on discussions with one of the Groundwater Recharge pilot plant operators to select the units with the best physical condition, ease of operation and maintenance, reliability of the systems, and consistency of effluent flow quality.

Each MF/UF unit will include a fully operable clean-in-place (CIP) system on the skid. Parameters specific to each membrane unit include backwash flow rates, pressures, and durations. All backwash and clean-in-place waste will be sent to the SDWWTP via gravity by way of an on-site manhole connection.

MF Pilot Unit No. 1

The first pressure MF system used will be the Pall Aria® Single Module Pilot. Filter modules are provided by Microzoa® and use hollow-fiber polyvinyldene fluoride (PVDF) membranes (model UNA-620A), with a pore size of 0.1 microns. Maximum transmembrane pressure is 35 to 40 pounds per square inch (psi) with an operating pH range of 1 to 10. There are 6,500 fibers per module for a total active surface area of 538 ft². This system operates in an outside-in flow pattern. This system includes all necessary equipment to perform air scrubbing, reverse filtration, forward flush, enhanced flux maintenance, and membrane CIP operations.

MF Pilot Unit No. 2

The second pressure system used will be the Siemens/Memcor® 1XP20V trial UF unit. Filter modules use patented ultrafiltration hollow-fiber PVDF membranes (model L20V), with a pore size of 0.04 microns. These membranes are low pressure membranes with a maximum transmembrane pressure of 22 psi. Each module has a total active surface area of 410 ft². This system operates in an outside-in flow pattern. This system includes all necessary equipment to perform air scrubbing, reverse filtration, forward flush, enhanced flux maintenance, and membrane CIP operations.

MF Pilot Unit No. 3

The vacuum MF system used will be the GE/Zenon ZeeWeed® 1000 pilot UF unit. Submerged filter modules use hollow-fiber PVDF membranes, with a pore size of 0.02 microns. These membranes are low pressure membranes with a maximum transmembrane pressure of 13 psi. Each module has a total active surface area of 600 ft². This system operates in an outside-in pattern. This system includes all necessary equipment to perform air scrubbing, reverse filtration, forward flush, enhanced flux maintenance, and membrane CIP operations.

A hydraulic balance tank for the MF/UF filtrate will be included to provide a volume of operational storage to ensure continuous flow to the downstream AOP or RO processes.

Additional information regarding the MF/UF units is summarized in the Equipment List **(Table 3-3)** and on the P&IDs **(Appendix B)**. Alternate manufacturers may be used depending on the outcomes of the contract/lease negotiations.

3.4.6 Reverse Osmosis

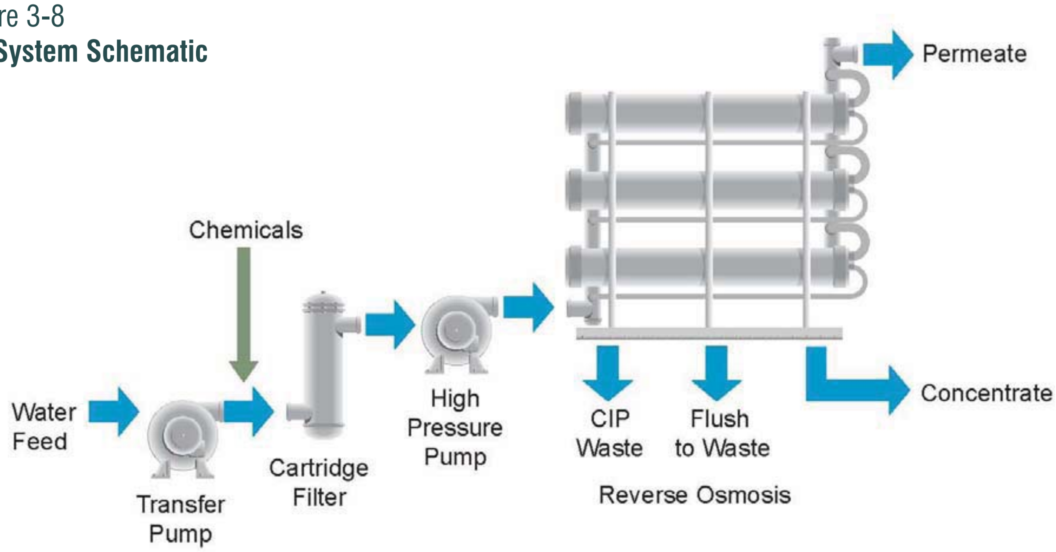
Reverse osmosis relies on flow and net driving pressure to overcome the osmotic pressure of the feed water, allowing it to permeate through a semi-permeable membrane while carrying away rejected constituents in the concentrate/brine stream. The permeate is forced across the membrane based on net driving pressure (applied energy), which is determined as a function of the temperature, osmotic pressure, and backpressure on the membrane.

An important RO process parameter is operating flux (permeate flow per unit area of membrane). RO systems utilized for groundwater treatment typically operate at flux rates of 14 to 16 gpd/ft², which is 20 to 30 percent higher than RO systems operating on secondary wastewater effluent at flux rates around 10 to 15 gpd/ft². The reason for this difference is the higher degree of organic constituents and colloidal materials typically found in secondary effluent, which increase the fouling potential on the membranes.

Another important operating parameter is recovery, which is defined as the ratio of the permeate flow to the feed water flow, therefore indicating the percentage of the feed water that is "recovered" as clean effluent by the process. Maximizing recovery is a common objective of typical RO operations, but there are limitations due to the concentration of specific constituents such as dissolved salts on the feed side of the membrane. At a very high recovery, the concentrations of these salts in the concentrate stream may reach a point where they exceed their saturation limits and form precipitates that scale or foul the membrane. Typical water recoveries for RO of secondary effluent range from 75 to 85 percent. A schematic of RO system flow is illustrated in **Figure 3-8.**

Based on an initial site evaluation, it is proposed that the existing on-site Sanitaire Water Equipment Technologies (Sanitaire) 35 gpm pilot RO unit be rehabilitated and reused for this pilot plant. This RO unit contains seven vessels arranged in a 4:2:1 array, with each vessel containing seven elements, with all equipment housed in an on-site trailer. Also contained in the trailer as part of the RO unit is a fully operable membrane CIP sys-

Figure 3-8
RO System Schematic



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tem, acid and antiscalent chemical addition, and cartridge filters. Parameters including flow rate, pH, and conductivity will be monitored throughout the operation of the unit. All clean-in-place and flush waste, and RO concentrate will be sent to the SDWWTP via gravity by way of an on-site manhole connection.

3.4.7 Advanced Oxidation Processes

Advanced Oxidation Processes (AOPs) are used for the destruction and removal of microconstituents from wastewater. The aim of the AOP will be to reduce the concentrations of certain identified microconstituents to acceptable concentrations. Two processes will be evaluated for their performance in reducing microconstituents – UV with hydrogen peroxide and ozone with hydrogen peroxide. For each process, hydrogen peroxide will be added to the process stream prior to proceeding through the additional treatment step (UV or ozone).

UV/Peroxide Disinfection

UV radiation is an effective disinfectant for bacteria and viruses in wastewater. As shown in the following equation, the addition of the peroxide allows the production of the hydroxyl radical, which is the most powerful oxidant available for water treatment.

$$H_2O_2 + UVLight \rightarrow 2 \bullet OH$$

The production of the hydroxyl radical initiates additional oxidation reactions, resulting in the production of carbon dioxide and water if the reactions go to completion. The combination of UV light and hydrogen peroxide produces an environment that is conducive to the treatment of organic compounds. Generally, the target compounds for this treatment process are NDMA and 1,4-dioxane.

DESIGN CRITERIA

A Trojan or Calgon system will be used consisting of one train with one reactor. No standby reactors will be provided. For the Trojan UV system, eight parallel low pressure high intensity mercury lamps are provided per reactor. The average UV output from the lamp after 12,000 hours is approximately 98 percent. The low pressure amalgam lamp emits 100 percent of its output at 254 nanometers. For the Calgon UV system, three parallel medium pressure high intensity lamps are provided per reactor.

The hydrogen peroxide dosing system will be comprised of one double contained storage tank, with one duty metering pump. The target dose for the peroxide is 5 mg/L. A static mixer will be provided upstream of the UV reactor for mixing of the hydrogen peroxide.

Additional information regarding the UV/peroxide system is summarized in the Equipment List **(Table 3-3)** *and on the P&IDs* **(Appendix B)**

Ozone/Peroxide Disinfection

Ozone is a very effective chemical for pathogen disinfection, oxidation of organic compounds, and improving the aesthetic quality of the water through color removal, taste and odor removal, and increased water clarity (UV transmittance). The AOP provides further oxidative power compared to just ozone, and in some cases, are more effective than ozone alone at treating specific trace organics. Furthermore, AOPs tend to increase reaction rates relative to ozone only applications. As shown in the following equation, the combination of ozone and hydrogen peroxide allows the production of the hydroxyl radical.

$$2O_3 + H_2O_2 \rightarrow 2OH \bullet + 3O_2$$

HiPOx is an ozone-based technology that can be used as an AOP reactor packaged by Air Products Water System. In the AOP mode, HiPOx efficiently injects and mixes ozone and hydrogen peroxide to maximize the production of hydroxyl free radicals to treat various compounds. Air Products has demonstrated that the HiPOx AOP is significantly more efficient at reducing microconstituents than ozone alone with respect to both ozone dose and reaction time. This increase in efficiency results in lower operating costs, smaller footprint, and improved performance. Additionally, HiPOx AOP provides many of the typical benefits from ozonation including enhanced clarification (e.g., color removal, improved clarity, and reduction in coagulant dosage), elimination of taste and odor compounds, treatment of organic carbon to assist with removal of disinfection by-product precursors, reduction of emerging contaminants, and disinfection. An elevation view of a HiPOx pilot unit is presented in **Figure 3-9**.

Figure 3-9
HiPOx Pilot Unit

DESIGN CRITERIA

The HiPOx Pilot System is fully-automated and skid-mounted (approximate footprint of 36 ft²), with a flow rate ranging from 10 to 25 gpm. An ozone generator/chiller and hydrogen peroxide storage tank and feed system are supplied as part of the skid unit. The unit is fully automated with a programmable logic controller (PLC) and operator interface terminal (OIT) to allow the user extended and remote operation, if required; however, manual adjustments will be needed with respect to adjusting flow rates and dosing levels.

Additional information regarding the ozone/peroxide disinfection system is summarized in the Equipment List **(Table 3-3)** *and on the P&IDs* **(Appendix B)**

3.5 Ancillary Systems

Chemical feed systems for the unit processes will consist of secondary contained drums with peristaltic pumps used for chemical dosing. Some processes, including the reactive filtration and ozone/peroxide units, include chemical storage and dosing units on their skids. Additional information regarding chemical feed systems is summarized on the P&IDs. Analyzers may be reused from the existing Groundwater Recharge pilot system; this will be determined during final design.

3.6 Waste Disposal

The existing Groundwater Recharge waste disposal system will be used for the initial pilot site. This is composed of a gravity pipeline discharge into a wet well containing pumps to pump the waste back to the head of the plant. Waste disposal for the permanent site will be determined during final design.

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Section 4 – Electrical

4.1 Electrical Design Criteria

4.1.1 Area Classifications, Codes and Standards

The electrical design for the pilot plant at the initial site involves an evaluation of the existing panels, conduit, and cables to determine suitability for reuse and modifications required for service.

4.1.2 Load Analysis

A preliminary load analysis has been performed by identifying all the loads connected to all power panels, distribution panels, and pieces of equipment. Standby loads are excluded from the analysis. The result of the load analysis has determined the bus capacity of the main power supply and will be used as the basis for coordination with MDWASD. Spare capacity will be provided for all equipment if reasonable. Future loads, where known, were included. The amperage rating of the largest motors will dictate the service voltage of the facility. A preliminary load list is presented in Table 4-1.

Total operating load for the pilot plant is estimated to be 273 kilowatts (kW). It is common practice to allow 25 percent contingency on operating load. Therefore total power output required is 367kW.

Table 4-1
Initial Loading List

Load Description	Quantity and Amps	Starting/ Controller	Proposed Supply Voltage	Operating Load[1] (kW)
Sand Filter System	1 x 30 A[2]	N/A	480V[3]	21
Nitrification System Feed Pump	1 x 30 A	VFD[4]	480V	21
Nitrification System Blowers[1]	3 x 5 A	VFD	480 V	11
Denitrification System Feed Pump	1 x 30 A	VFD	480 V	21
Denitrification System Blowers[1]	3 x 5 A	VFD	480 V	11
Chemical Phosphorus Removal System	1 x 30 A	VFD	480 V	21
MF Feed Pumps	3 x 10 A	VFD	480 V	21
MF/UF System 1	1 x 10 A	Constant	480 V	7
MF/UF System 2	1 x 30 A	Constant	480 V	21
MF/UF System 3	1 x 20 A	Constant	480 V	14
Filtrate Transfer Pump	1 x 7.5 A	Constant	480 V	5
RO Booster Pump and System	1 x 60 A	VFD	480 V	42
UV System 2	1 x 32 A	Constant	480 V	13
Ozone System	1 x 80 A	Constant	240 V	57
Service Water Pump	1 x 10 A	VFD	480 V	2
Chemical Feed Pumps	8 x 1 A + 4 x 1.5 A	VFD	240 V	3
Total	453.5 A			294kW

1. Estimated load based on preliminary vendor design.
2. A = amps
3. V = volts
4. VFD = variable frequency drive

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Based on the information provided, the estimated total amperage required is 453.5 Amps. Allowing the 25 percent contingency takes this to 567 Amps. Two existing distribution panels are available that can be reused from the Groundwater Recharge pilot. These panels are rated at 400 Amps and 225 Amps. Both panels will be required to allow for all items of equipment and additional spare capacity for miscellaneous items including emergency lighting, onsite facilities and the standard 25 percent spare capacity.

A preliminary single line diagram for the loads required on the existing distribution panels is included in Appendix C.

4.2 Power Distribution Design

Power will be distributed in the facility by a dual supply with one rated at 480 V and the other 240 Vs. These will be sourced from existing distribution panels and associated transformers at the site. The existing onsite distribution switchboards have been confirmed to be National Electrical Manufacturers Association (NEMA) 4X enclosure rated, suitable for outdoor use.

The pilot site is currently fitted with both underground and above ground conduits and cabling to supply the existing recharge pilot. The existing conduit is available for reuse with this pilot. However, the cabling will be required to be amended according to the single line diagram, site plan, and vendor requirements to ensure proper cable distribution.

4.3 Lightning Protection System

Lightning protection systems will be provided site on vendor equipment as required if equipment is placed outside.

4.4 Lighting System

The initial site is located in an area with surrounding external lighting already in place.

Temporary battery-back-up operated lights will be used in the RO trailer and in the weather protected area.

4.5 Miscellaneous Electrical System

4.5.1 Receptacles and Switches

Receptacles rated for 20 Amps and 240 V will be provided at several locations as required for plug and play equipment by plant operators. Receptacles in all outdoor areas will have weatherproof covers.

4.5.2 Safety Disconnect Switches

Safety disconnect switches installed outdoor and for all corrosive areas will have NEMA 4X stainless steel enclosures.

4.5.3 Local Control Panels (LCP)

Local control panels will be provided with vendor package equipment, where required by the vendor.

4.6 Standby Power And Auxiliary System

There are frequent power outages, and due to the sensitive nature of the biological processes and the requirement to flush the RO system to protect the membranes from fouling an emergency stand-by generator will be supplied for the pilot plant to perform the following:

» Provide an uninterrupted power supply to safeguard the biological systems where possible.

» A minimum of one hour of emergency power is required to feed the RO Trailer to allow for a full flush of the RO membranes and prevent fouling.

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Section 5 – Civil/Mechanical

This section establishes the preliminary design of the civil and mechanical portion of the pilot plant.

5.1 Introduction

This aspect of the work defines the equipment and other facilities or connections for the pilot plant. The basis of the site plan development at the initial site is predominantly the existing Groundwater Recharge Pilot Plant and other information available for the SDWWTP. This section of the preliminary design addresses requirements for weather protection of certain equipment, including covering equipment to protect from corrosion and wet weather and anchoring equipment for protection in a hurricane area.

A site plan for the pilot plant at the initial site is included in Appendix D. This site plan best utilizes the existing concrete slabs for the Groundwater Recharge pilot and surrounding area for access and anchoring and support of equipment.

The section includes:

- Site planning and layouts
- Plan for hurricane provision
- Hydraulic design of pipe work
- Vehicle and pedestrian access
- Existing utilities and storm water

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5.2 Location Of Existing And Planned Facilities

The SDWWTP was first built in the 1960s, and has since been expanded and upgraded to cope with increased population in the service area, resulting in higher flow demands and more stringent treatment regulations. An overview of the existing plant and the proposed initial and permanent sites are shown in **Figure 5-1.** All new facilities under this project are located on the northern side of the SDWWTP. The proposed permanent site is located in the northeast corner of the site, adjacent to one of the deep injection wells for ease of access to SDWWTP effluent. The initial site is closer to the center of the SDWWTP in a location currently used by the South District Recharge pilot plant. A survey of the Groundwater Recharge pilot plant includes the area that will be utilized for the development of initial site.

5.3 Placement Of Facilities

The layout of the area provided for the initial site currently consists of three concrete slabs with the remaining area covered in gravel. The sizes of the three concrete slabs are:

» 60 feet by 30 feet

» 19 feet by 11 feet

» 19 feet by 11 feet

Each of these slabs is 10 inches thick with a 12-inch footing around the edges, and are suitable for anchoring of major process equipment. For hurricane protection, several process units associated with the pilot at the initial site will be installed securely on these concrete slabs. Other process units will be made readily removable for storage in a secured location during hurricane events. Preferred placement options for the locations of all equipment and weather protection requirements are summarized in **Table 5-1**.

Figure 5-1
Site Plan

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Table 5-1
Major Pilot Plant Equipment Placement Options

ProcessEquipment	Preferred Location	Weather Protection Requirements	Comment
Sand Filters (HLD)	Anchored to concrete slab	Not Required (Stainless Steel)	Not readily moveable, anchored for hurricane protection
Nitrifying Filters	Anchored to concrete slab	Not Required (Stainless Steel)	Not readily moveable, anchored for hurricane protection
Denitrifying Filters	Anchored to concrete slab	Not Required (Stainless Steel)	Not readily moveable, anchored for hurricane protection
Chemical Phosphorus Removal System	Skid and trailer mounted on gravel	Weather protection provided with equipment where required	Comes in two pieces, main process skid mounted, ancillaries trailer mounted, all removable in event of a hurricane
MF/UF Systems	Preferred anchored to concrete slab	Minimum of cover over control panels	Anchored and covered for wet weather protection but removable in event of a hurricane
Ozone Peroxide Oxidation System	Preferred trailer mounted	Preferred	Trailer mounted for ease of removal during hurricane and weather protection
RO System	N/A	N/A	Currently trailer mounted for ease of removal during hurricane
UV System	Preferred trailer mounted with Ozone system	Not required	Readily removable from pipework but preferred trailer mounted with Ozone system to minimize effort of removal in event of hurricane
Intermediate Storage Tanks	No preference	Not required	Where possible anchor on concrete slab but can sit on skids on gravel. Skid mounted need to be removable in event of a hurricane
Miscellaneous Pumps and Chemical Systems	Pumps preferred on concrete slab	Not required	To minimize vibrations preference is for pumps on slabs
Electrical Items	Mounted on concrete slab or footing	Built-in weather protection	Anchored and built-in cover for wet weather, removable for hurricane protection
Chemical Systems	Mounted on footing	Preferred covered	Readily removable for hurricane storage
UV System 2	1 x 32 A	Constant	480 V
Ozone System	1 x 80 A	Constant	240 V
Service Water Pump	1 x 10 A	VFD	480 V
Chemical Feed Pumps	8 x 1 A + 4 x 1.5 A	VFD	240 V

The sand filters, denitrifying and nitrifying filters are all tall structures where high winds, particularly from hurricane area, are of concern. Therefore these need to be anchored properly to a concrete slab. The slab thickness and reinforcement have been confirmed suitable to anchor these structures and withstand a hurricane wind load of 120 miles per hour (mph).

Dimension restrictions remove the possibility of placing the MF/UF inside a movable trailer for operation, although skids can be removed and placed in secure location in the event of a hurricane. Some ancillaries for the MF/UF system can be placed on temporary support skids located adjacent to the concrete slabs. All other major and other process items can be mounted in trailers or simply mounted on spare area of concrete slabs or temporary supports. All equipment not securely mounted as indicated in **Table 5-1** will be removed from the site and placed in a secure location during hurricane events.

For intermediate storage tanks, preference is to place these on a concrete slab but due to limited availability of space on the three concrete slabs these will be placed on temporary supports.

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5.4 Hydraulic Conduits And Components

The piping for the BBCWRPP pilot has been designed in accordance with applicable standards for fluid velocity, in accordance with the characteristics of the fluid being handled and the piping materials to be used at the initial site.

5.4.1 Pipeline Material

Several options for the pipe material were considered. The majority of piping for the pilot plant will be polyvinyl chloride (PVC). Since the site is temporary, PVC is the least expensive option and will be suitable for both above ground and below ground pipework for the duration until the pilot plant is relocated to the permanent site. Stainless steel piping is also a suitable material for use by vendors, and will be used where required.

5.4.2 Physical Properties of Water

The influent water to the BBCWRPP has been assumed to have the following properties when compared to clean water at 68°F.

	Min. Temp.	Max. Temp.	Units
Temperature	70	90	°F
Specific Volume	0.01610	0.01606	ft^3/lb
Weight	62.27	62.11	lb/ft^3
Vapor Press	0.3631	0.6982	psia
Specific Gravity	1.000	0.997	

5.4.3 Acceptable Velocities

The maximum design velocity will be limited to 6.0 feet per second (fps) to minimize adverse effects on the PVC piping. Higher velocities can be tolerated on the stainless steel sections of the piping, but these have been also limited to a maximum of 6.0 fps to prevent excessive noise and vibration. This maximum velocity will also prevent excessive pressure drops within the systems, and ensure adequate NPSH for the various system pumps, as well as, limit energy costs associated with pumping.

The values for velocity through the pipes have been calculated for both the maximum flow and minimum flow conditions for each section and are summarized in Table 5-2.

As summarized in Table 5-1 the majority of interconnecting piping required is only 2 or 4 inches in diameter. All intra-connecting pipework within each skid for major process equipment will be supplied by the relevant vendors.

Table 5-2
Pipe Sizing and Velocity

	Flow (gpm)	Flow (gpm)	Flow (cfs)	Flow (cfs)			Velocity (fps)	
Pipe ID	Min	Max	Min	Max	Pipe diameter (in)	Area (ft^2)	Min	Max
Sandfilter Inlet[1]	85.0	100.0	0.2	0.2	6	0.09	2.2	5.1
Nitrifying Filters Inlet	85.0	100.0	0.2	0.2	4	0.09	2.2	5.1
Denitrifying Filters Inlet	85.0	100.0	0.2	0.2	4	0.09	2.2	5.1
Overflow	0.0	20.0	0.0	0.05	4	0.09	0.0	3.1
Chemical P Removal Inlet	85.0	100.0	0.2	0.2	4	0.09	2.2	5.1
Combined MF Inlet	25.0	80.0	0.1	0.2	4	0.09	0.6	2.0
Single MF Inlet	25.0	40.0	0.1	0.1	2	0.02	0.6	1.0
AO/UV Combined Inlet	55.0	55.0	0.1	0.1	2	0.02	1.4	1.4
AO/UV Single Inlet	25.0	30.0	0.1	0.1	2	0.02	0.6	0.8
RO Inlet	48.0	48.0	0.1	0.1	2	0.02	1.2	1.2
RO Outlet[2]	36.0	36.0	0.1	0.1	2	0.02	0.9	0.9

1. This is an existing 6 inch pipeline for the recharge pilot that is to be used as the inlet to the pilot.
2. RO outlet to discharge to stabilization tank, once stabilized and required quantity is removed for testing all waste is sent to the existing waste return pump station.
3. Pump duty points are outlined in Section 3 and will be confirmed during detailed design and procurement.

5.5 Existing Facilities

Where practical the pilot plant will utilize existing facilities from the SDWWTP and the Groundwater Recharge Pilot.

5.5.1 Access to Facilities by Operators and Delivery Vehicles

The location of the initial site is surrounded on the North, South and Western edges by existing access roads. These existing roads will be used for vehicle access. To the East is an area of vacant land. This area will be utilized by the pilot for process equipment that cannot fit into the existing Recharge pilot plant area.

The layout of the pilot plant at the initial site is designed to ensure that vehicle access for maintenance or chemical and equipment delivery is available. Where vehicle access is not required, spacing between equipment will be provided to allow personnel access any equipment.

5.5.2 Existing Connections, Utilities and Stormwater

The following are the external connections for the pilot plant at the initial site with the SDWWTP:

» Pilot plant inlet pipeline: The existing Groundwater Recharge pilot inlet pipe will be used for the initial BBCWRPP. This is an existing 6-inch pipeline taking effluent from the existing injection well delivery pipeline and delivering to the head of the pilot plant.

» Final water and waste return pipeline: The existing Groundwater Recharge waste disposal system will be reused for the pilot. This is composed of a 6-inch gravity discharge to a wet well with two submersible pumps to pump waste back to the head of the plant.

» Potable water connection pipeline: The existing potable water connections for both the Groundwater Recharge pilot and SDWWTP will be reused for connection to the chemical systems area for eye wash and showers and to provide emergency potable water supply for fire suppression.

» Electrical and communications supply are to be taken from existing supply to the Groundwater Recharge Pilot. Details on these utility supplies are provided in Section 4.

» Service water will be sourced internally from the pilot plant process using storage tanks of RO permeate and MF filtrate.

The initial site is situated in a developed area and surrounded by access roads and buildings. Generally, the topography of the site is flat, with localized grading to route runoff to existing stormwater inlets or surface run-off.

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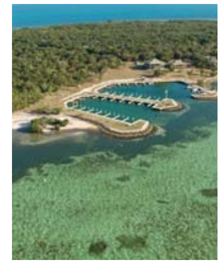
Section 6 – Procurement

This task establishes a procurement plan to provide procurement support to the Department (MDWASD) for the equipment needed for the pilot plant at the initial site.



6.1 Introduction

The schedule for requires that the pilot plant to be operational by January 2010, following optimization of biological processes. For pilot testing to commence in January 2010, installation of the pilot plant should commence no later than the end of September 2009 to allow a 4 month installation and start-up period followed by a 1 month process optimization period. In order to meet this deadline, it is proposed to lease all major process equipment required for the initial site as purchasing will take too long. Purchase of the leased equipment will be evaluated and initiated during the detailed design of the pilot plant.

The MWH will take on the responsibility of negotiating lease requirements and take ownership of the leases negotiated under future work orders to expedite the process. Where possible, any existing equipment in use for the current recharge pilot plant will be reused for the BBCWRPP. Negotiations for transfer of ownership and extension of current leases for these items of equipment or new leases will be required and new leases will be required for the remaining major process equipment. The lease agreement terms will highlight that selection of the vendor for testing at the initial site will not guarantee selection of the vendor for testing at the permanent site, nor for the future full scale facilities.

For all other ancillary equipment, not being provided by vendors under the negotiated leases, purchasing will be performed either directly by MWH or through the Department's (MDWASD's) purchasing department the Office of Capital Improvements (OCI).

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6.2 Major Process Equipment

All major process equipment will be sourced from vendors. These include:

- **Sand filters (HLD) and ancillaries** including piping, valves, control equipment, and a clearwell.
- **Nitrifying filters and ancillaries** including piping, valves, blowers, and control equipment.
- **Denitrifying filters and ancillaries** including piping, valves, blowers, control equipment, and a clearwell.
- **Chemical phosphorus removal equipment and ancillaries** including valves, blowers, piping, pumps and control equipment.
- **MF/UF filters and ancillaries** including feed pumps, backwash pumps, compressors, piping, valves, chemical CIP equipment, and control equipment.
- **Hydrogen Peroxide/Ozone systems and ancillaries** including piping, valves, and control equipment.
- **Ultraviolet disinfection system and ancillaries** including piping, valves, and control equipment.

The RO system is currently owned by the Department (MDWASD) and ready for use. For the initial site it is proposed that all other major process equipment as listed above will be leased directly from the vendors for the duration of the pilot testing at the initial site. For the permanent site the option of purchasing some items of major equipment will be addressed during the detailed design phase.

Suggested procurement options for the major equipment as listed above is outlined in Table 6-1. The options presented are included to raise discussion at a later date on potential options and are not binding. Discussion points to be evaluated include future use of equipment for other pilots by the Department (MDWASD), net present value of lease vs. purchase option and expected lifetime of equipment.

Table 6-1
Major Pilot Plant Equipment Procurement Options

Process Equipment	Pilot Plant Procurement Option for Initial Site	Pilot Plant Procurement Option for Permanent Site
Sand Filters (HLD)	Lease	Purchase
Nitrifying Filters	New Lease	Purchase
Denitrifying Filters	New Lease	Purchase
Chemical Phosphorus Removal System	New Lease	TBD
MF/UF Systems	Extend Lease or New Lease	Purchase
Ozone Peroxide Oxidation System	New Lease	Purchase
UV System	Extend Lease	Purchase
RO System	N/A	N/A

6.3 Minor Process Equipment

The preliminary list of minor ancillary pieces of equipment that are not covered by the terms of the lease agreements for major process equipment includes:

» **Intermediate pumps and associated pipe work** and valves including:
   a. Nitrifying filter feed pump
   b. Denitrifying filter feed pump
   c. Chemical phosphorus removal system feed pump
   d. MF feed pump
   e. RO/AOP system feed pump

» **Intermediate storage tanks** including the following:
   a. Chemical phosphorus removal system feed balance tank
   b. MF/UF system feed balance tank
   c. RO/AOP system feed balance tank
   d. Stabilization tank

» **Chemical systems** not directly supplied with vendor equipment but available as small skid items including:
   a. Methanol
   b. Coagulant
   c. Polymer
   d. Antiscalant
   e. Aqueous Ammonia
   f. Hydrogen Peroxide
   g. Sodium Hypochlorite
   h. Caustic Soda / Lime

» **All interconnecting pipework and associated valves, flow meters, and other fittings.**

» **All associated onsite testing and sampling equipment.**

» **All onsite electrical equipmen**t.

6.4 Timeframe For Procurement

Table 6-2 outlines expected lead-times for manufacture and delivery of vendor supplied equipment. From these lead times a latest target date for procurement of the equipment is set to ensure delivery to site by October 2009 for installation.

Table 6-2
Major Pilot Plant Equipment Lead Times

Process Equipment	Lead Time for manufacture and Delivery	Latest Target Date for Procurement
Sand filters (HLD)	N/A (reuse existing)	N/A
Nitrifying Filters	12 weeks	July 1, 2009
Denitrifying Filters	12 weeks	July 1, 2009
Chemical Phosphorus Removal System	12-24 weeks (subject to demand)	As soon as possible
MF/UF Systems	N/A (reuse existing)	N/A
Ozone Peroxide Oxidation System	8-12 weeks	July 1, 2009
UV System	N/A (reuse existing)	N/A
RO System	N/A (reuse existing)	N/A
Chemical Systems	0-4 weeks	September 1, 2009
Miscellaneous Pumps and Pipework and associated fittings	0-6 weeks	August 15, 2009

As indicated in **Table 6.2**, existing equipment already available onsite includes the sand filters (HLD), MF/UF systems and the RO system. While lead-times for procurement are not a concern for these items of equipment, they require rehabilitation work to ensure suitability for use on the initial site. It is expected this equipment rehabilitation work will be undertaken, prior to installation at the initial site. Allowing 2-3 months for this rehabilitation work requires this work to commence as soon as the Groundwater Recharge pilot is complete in July 2009.

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Section 7 – Permitting

This section addresses the MWH's approach to the permitting process, as well as the main permit requirements, for the pilot plant of the BBCWRPP.

7.2 Permit Requirements For The Pilot Plant At Initial Site

It is proposed to return all water produced by the pilot plant, including final water used for testing, and waste, to the sewer system. This will remove the need to amend the wastewater discharge permit of the SDWWTP.

For the pilot plant, permits are required for the electrical supply and utilities supply to allow connection to existing services on site at the SDWWTP. These are currently in place for an existing South District Groundwater Recharge pilot plant in operation at present. New permits will be required as the recharge pilot project is decommissioned and this BBCWRPP is installed. They will be submitted the Miami-Dade Building Department for temporary installation.

7.3 Permitting Approach

For the permanent site further permits will be required. This will include a building permit for the permanent building. This will be addressed in **Task 1.6 of this Work Order No. 1**. Other permit requirements for the permanent site include miscellaneous construction activity permits, for example dewatering and stormwater management.

7.3.1 Agency Notification/Involvement

As time will be a critical factor during this project, early agency notification and coordination of all permit application submittals with the project schedule is essential. While early submittal will be made to the extent practicable, it will be important to ensure accurate and complete permit applications are made. This need for completeness and accuracy will be balanced against schedule and anticipated agency review time frames.

7.3.2 Response to Request for Information

When Requests for Information (RFIs) are received from an agency, the request will be forwarded to the MWH with the expectation that the request will be given priority attention. The review and resolution of any outstanding issues and submittal of required information will ensure timely approval of applications and receipt of the necessary permits. The appropriate discipline leads or their designee will review the RFI and provide responses. This will ensure any drawing or specification changes made are captured and documented.

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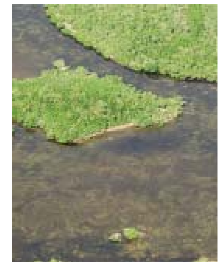
Section 8 – Implementation and Schedule



Timing for the Biscayne Bay Coastal Wetlands Rehydration Pilot Project (BBCWRPP) is a critical factor. The Miami-Dade Water Use Permit, issued November 2007 by the South Florida Water Management District (SFWMD) states, *"….the Permittee shall develop and complete a pilot testing program in consultation with the SFWMD, FDEP and BNP. Following the pilot testing program, the parties shall agree on the water quality treatment required and the feasibility of this project on or before January 15, 2011".*

8.1 Implementation And Schedule

In order to meet this timeline, the pilot testing needs to commence by early 2010. There is a likelihood for the pilot testing to extend for a multi-year period. This is considered a long duration pilot program and, therefore, requires a permanent pilot facility and a permanent building structure. It is estimated that obtaining a building permit requires 8 months to 1 year. An approach of pilot testing at an already established initial site followed by a relocation to a permanent site is proposed to meet the aggressive timeline. Figure 8-1 presents the schedule for implementing the pilot testing. Transition to the permanent site will be scheduled to meet the permitting time frame.

Following are the major activities as proposed in the schedule:

» **Permanent Pilot Building Permit Acquisition** – The Permanent Pilot Building Permit Acquisition is expected to be a long lead activity (currently assumed at a minimum of eight months), thus the permit application effort will commence as part of this task order immediately following the Preliminary Engineering Report.

» **Final Design** – The Final Design for the initial site is expected to be completed within three months. Equipment lease negotiation is planned to commence mid-way through final design, since it is on the critical path.

» **Equipment Procurement** – All equipment is planned to be leased except for the Department (MDWASD) owned Reverse Osmosis trailer. Lease negotiation will consist of either an extension of existing contracts or new contract set-up as part of this process. Nitrification and Denitrification units will need custom fabrication and can take up to three months from the time a contract is implemented. Shipping can take an additional week.

» **Condition Assessment and Rehabilitation of Onsite Units** – This activity may take over a month and a half where an initial site visit will be performed to perform a condition assessment of the existing units to be re-used (MF and RO) will be performed. A need to order replacement parts and pieces for the equipment is envisioned. This will be followed by onsite rehabilitation of the units.

» **Demobilization of Groundwater Recharge Pilot (GWRP) Plant** – The Department (MDWASD) has a South District Groundwater Recharge Pilot onsite, which is scheduled to be complete by July 2009. The GWRP site is planned to be used for the initial BBCWRPP site. Thus, demolition and demobilization is a key activity that is dependent upon the completion of the GWRP testing plans. As mentioned previously, three of the existing MF units and one RO unit which is currently being used by the Recharge pilot is planned to be used for the BBCWRPP. A condition assessment will be needed on existing pilot units planned to be re-used. Parts may be needed to be ordered followed by rehabilitation of the units.

» **Pilot Startup** – Pilot startup activity may take up to four months; this includes installation, commissioning and optimization of the system. Since this is a biological system, optimization may take up to a month before the actual pilot testing can begin.

» **Pilot Testing** – Pilot testing at initial site is scheduled to commence in February 2010.

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Figure 8-1
BBCWPP - Pilot Testing Schedule

ID		Task Name	Duration	Start
1		**BBCWRPP - Temporary Site**	**285 days**	**Mon 6/1/09**
2		**Detailed Design**	**45 days**	**Mon 6/1/09**
3		50% Dsg	20 days	Mon 6/1/09
4		Final Design	20 days	Mon 7/6/09
5		**Procurement**	**90 days**	**Mon 6/29/09**
6		Contract Negotiation and Procurement	1 mon	Mon 6/29/09
7		Equipment Procurement	4 mons	Mon 7/13/09
8		**Demobilization**	**52 days**	**Wed 7/15/09**
9		Demolition/Demobilization of existing SD Recharge pilot plant	20 days	Wed 7/15/09
10		Condition Evaluation of existing equipment	2 days	Wed 8/12/09
11		Rehabilitation of existing onsite units (MF, RO)	15 days	Fri 9/4/09
12		**Pilot Startup**	**91 days**	**Fri 9/25/09**
13		Site Piping setup	7 days	Fri 9/25/09
14		Equipment Installation	1 mon	Mon 11/2/09
15		Commissioning/Startup	20 days	Mon 11/30/09
16		Optimization	25 days	Mon 12/28/09
17		Temporary Pilot Testing	5.5 mons	Mon 2/1/10
18		**BBCWRPP-Permanent Site**	**211 days**	**Fri 8/28/09**
19		Permanent Pilot Building Permit Acquisition	8 mons	Fri 8/28/09
20		Permanent Site Layout, Permitting and Equip Purchase Evaluation	3 mons	Mon 2/1/10
21		Commence Construction and Transition to Permanent Pilot Site	2 mons	Mon 4/26/10

EXHIBIT 40

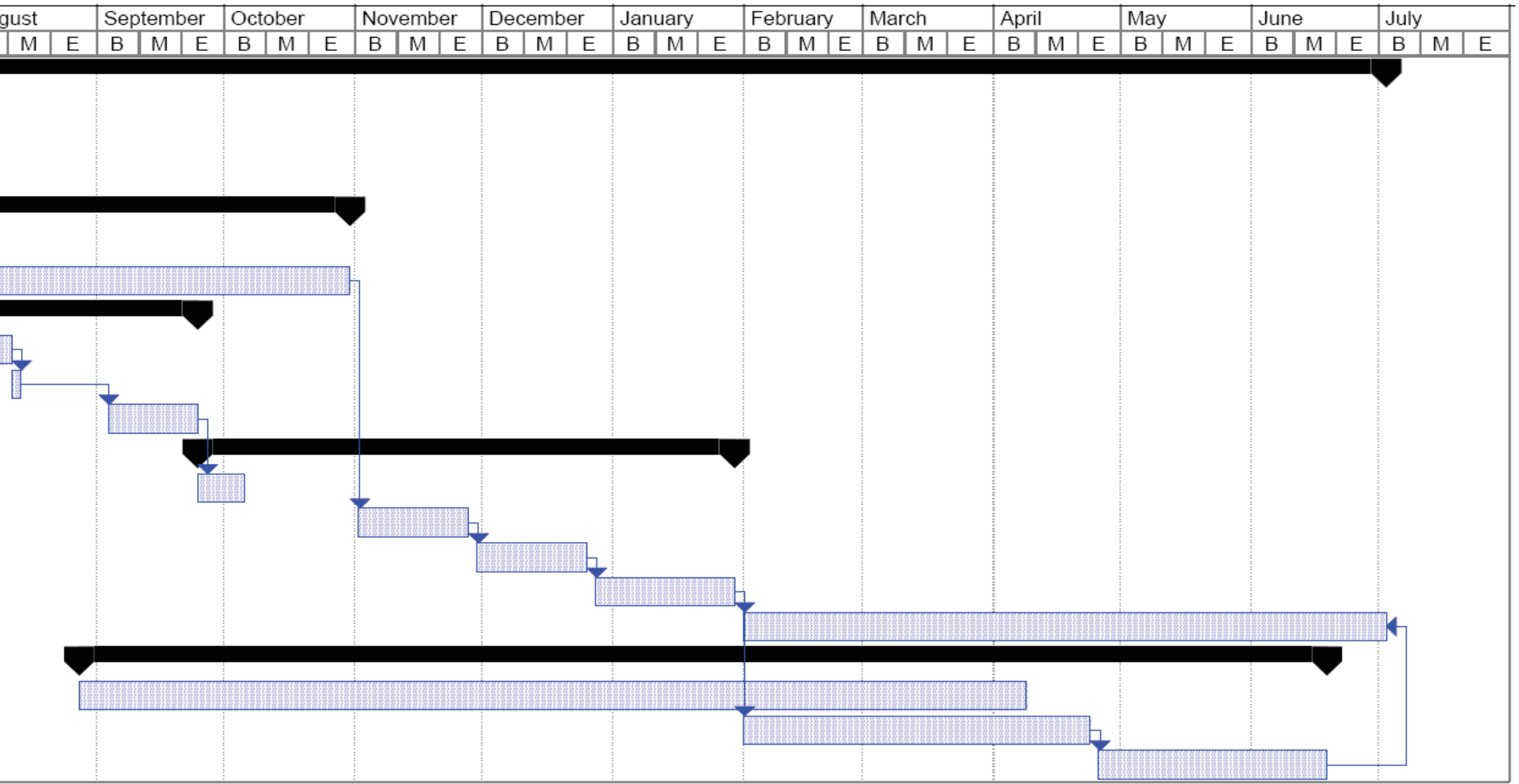
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EXHIBIT 40

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Nova Consulting, Inc.

TetraTech

ConsulTech Development Services , Inc.

ADA Engineering

C H Perez & Associates

Magbe Consulting Services

MWH

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