CITY OF MARLIN

VOLUME I

WATER TREATMENT PLANT EFFICIENCY EVALUATION

(FALLS COUNTY, TEXAS)

STATE OF TEXAS
KATHERINE M. DIETZ
104894
LICENSED
PROFESSIONAL ENGINEER
4-8-15

Katherine M. Dietz, P.E.

STATE OF TEXAS
BRENT P. BASSETT
108486
LICENSED
PROFESSIONAL ENGINEER
4/8/2015

Brent P. Bassett, P.E.

Prepared by:

KSA Engineers, Inc.

(TBPE Firm Registration No. F-1356)
4833 Spicewood Springs Road
Suite 204
Austin, TX 78759
Telephone: 512.342-6868
www.ksaeng.com

KSA ENGINEERS

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Introduction

This report is Volume I of a three part study completed for the City of Marlin under a grant from the Heart of Texas Council of Government grant. This report focuses on the City of Marlin Water Treatment Plant and reviews the treatment process, operations, and equipment. The goal for this study is to go beyond an evaluation and provide the City of Marlin resources that will promote efficient operations. This study was initiated after discussions with city administrators and operators who indicated that the water and wastewater treatment plants have significant expenses. The body of the report presents an overview of the findings from site visits and discussions with the operators, while the attachments and appendixes provide resources for regular use.

A. Study Authority

This study was completed under a grant from the Heart of Texas Council of Governments (HOTCOG). KSA Engineers was authorized to complete this work under Task Order No. MAR.043 City of Marlin Water and Wastewater Treatment Plant Efficiency Study, executed on February 19, 2015. This study will be incorporated into the larger grant project completed by HOTCOG.

B. Study Overview

KSA Engineers was retained to evaluate the City of Marlin's Water Treatment Plant process and operation. An asset management plan for the Water Treatment Plant is also being developed in conjunction with the evaluation (Volume II). The intent of this study is to evaluate the water treatment plant and identify major condition, operations, and maintenance problems and provide guidance for effective operation.

From these studies, it is recommended that the City of Marlin develop a Capital Improvements Plan (CIP) along with updating the treatment plant operations and maintenance procedures. As outlined in this study, efficient treatment plant operations will incorporate the following elements:

1. Treatment plant units are operating according to their design intent.
2. Maintenance occurs at regularly scheduled intervals to ensure the longest life for the unit.
3. Operations and maintenance activities are well documented so that inefficient trends may be identified and corrected.

To assist with readability, the efficiency recommendations are in bold. These recommendations need to be read in the context of the treatment plant's process and operations. The asset management plan fully outlines each asset and assigns a condition and criticality. The recommendations presented in this report should be used in conjunction with the asset management plan to create a capital improvements plan. It is anticipated that the city will determine that some efficiency recommendations may require greater capital expenditures than are warranted by the efficiencies gained. To present a complete plant overview, all inefficiencies are identified in this report.

SECTION I

PROCESS EVALUATION

The City of Marlin Surface Water Treatment Plant (SWTP) is a conventional drinking water treatment plant with membrane filtration. The SWTP was upgraded to membrane treatment in 2009. This section summarizes and evaluates the current operation of each of the major water treatment plant processes.

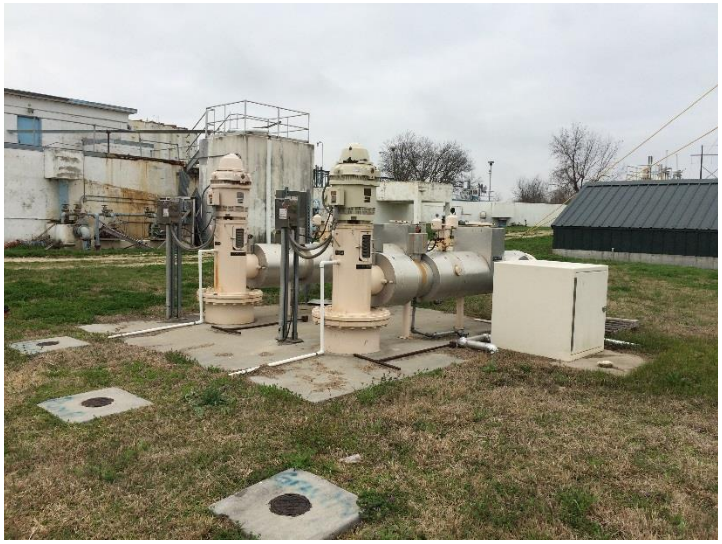
A. Surface Water Treatment Plant Processes

The City of Marlin Surface Water Treatment Plant (SWTP) combines conventional drinking water treatment processes with membrane filtration. Raw water is supplied to the plant through an intake structure located on New Marlin City Lake. The plant can be fed by gravity or raw water pumps depending on the intake level used and the water level in the lake. The raw water is gravity-fed or pumped to the raw water splitter box where the flow is split between the two solids contact clarifiers. Rapid mixing of coagulant occurs in the raw water splitter box prior to the clarifiers. The coagulated water flows to the solids contact clarifiers where flocculation and clarification takes place. The settled water then flows to the filter feed wet well. The filter feed wet well supplies pressurized water to the two (2) ultrafiltration membrane skids. Permeate from the membranes is conveyed to an above ground clearwell. Finished water is supplied to the distribution system by the high service pumps. This section of the report evaluates each of the treatment processes as they are working now and identifies possible ways to increase the efficiency of each process.

Raw Water Intake, Pumps, and Meter Vault

Water is taken from New Marlin City Lake via a concrete intake structure and a raw water line to the raw water pumps. The intake structure is located at the southern end of the lake on the north side of the dam. The intake structure has three canal type gates. Each of these gates is located at varying elevations at the intake structure. Raw water is withdrawn from New Marlin City Lake via these facilities and then pumped or fed by gravity to the treatment plant.

Photo 1. Raw Water Pumps



There are three raw water vertical turbine pumps with variable frequency drives (VFDs) located at the raw water pump station. Once through the pump station, the raw water is fed through the raw water meter vault where flow to the treatment plant is measured. Raw water flow to the plant is controlled by an operator-set flow rate and modulating valves when utilizing gravity feed, or by the raw water pump VFDs. For the last year, the raw water flow to the plant has been controlled by gravity with no use of the raw water pumps.

Sedimentation build-up at the lowest gate was reported to cause problems with its operation. Currently, only the top two intake elevations are open to flow. There are also large amounts of sediment entering the intake structure and moving through the system. The excess sediment in the raw water line most likely caused the raw water sample pump to fail. The amount of sediment in the raw water system most likely clogged the tubing of the peristaltic pumps. Currently, raw water samples are manually taken by the operators at the hose bib located adjacent to the abandoned raw water sample pump.

The raw water meter vault appears to be in good condition. The control valves and the flow meters in the meter vault are operating as intended. There have also been no reported problems with the pumps. However, the raw water pumps have not been in use for over a year, and the pumps and valves should each be exercised once a month to ensure continued reliability of the station.

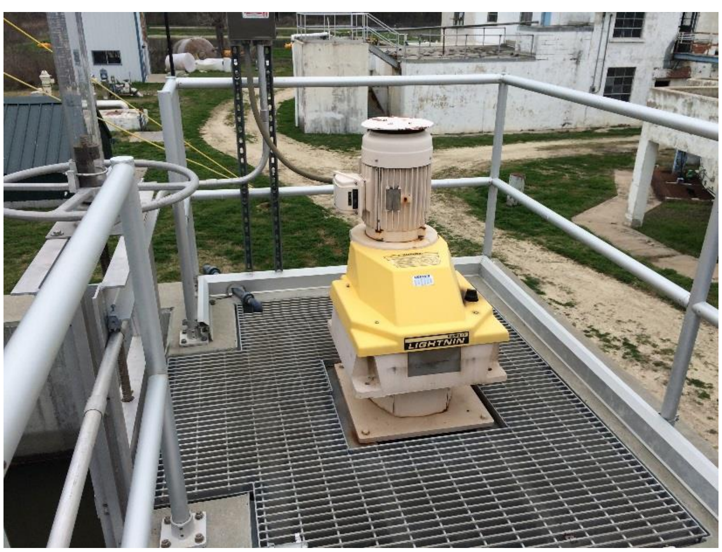
To increase efficiency of flow to the plant, the sedimentation build-up at the intake structure should be dredged. This would increase gravity flow to the plant when necessary and prevent damage to the raw water pumps from sediment moving through the system. Once the excess sediment is cleared, a new raw water sample pump could be installed to send the raw water sample to the lab building on a continuous basis, increasing the amount of time operators have for regular maintenance activities.

While the dredging project will provide significant benefit, completing this project should be weighed with other priorities at the plant. A dredging project along with upgrading other failed assets at the intake structure could be a significant capital expense.

Raw Water Splitter Box and Rapid Mix

Raw water is either gravity-fed or pumped to the raw water splitter box. The splitter box includes one inlet chamber and two outlet chambers. Flow is split between the two outlet chambers (rapid mix) via hand wheel operated weir gates. Chlorine injection points are provided in the inlet chamber. LAS, coagulant (Alum) and caustic injection points are provided in each of the two outlet chambers. Caustic is typically not added at this point in the process; however, LAS and coagulant (Alum) are. The coagulant is added in the outlet chambers to take advantage of the high energy rapid mixing which disperses the chemicals. The rapid mixers utilize turbine mixing blades on VFD motors to allow the operators flexibility in mixing energy.

Photo 2. Rapid Mixer



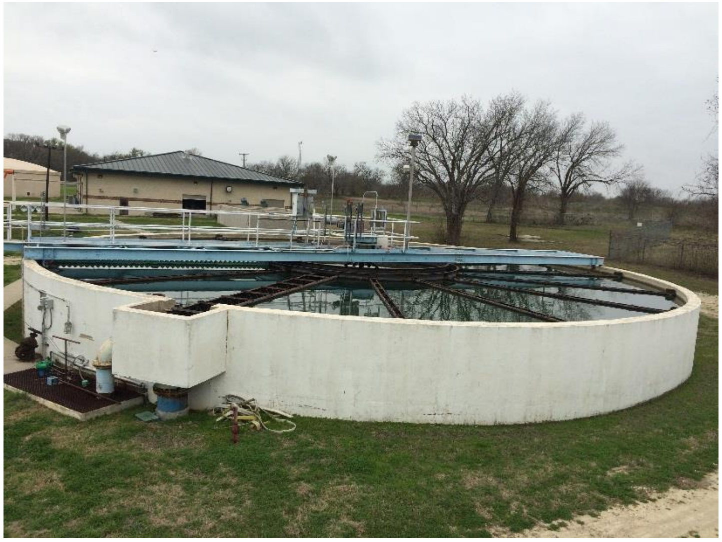
Currently, there are no operational issues with the raw water splitter box and rapid mixers. However, one of the rapid mixers is showing evidence of a bent shaft.

The efficiency of this part of the process is dependent on both the mixing energy imparted to disperse the coagulant in the raw water and the amount of coagulant used. The speed of the mixers is adjustable by VFDs, thereby allowing the operators to only use the amount of energy necessary to obtain desired mixing results. Using this operational scheme is much more efficient than constant speed mixers that may impart too much or too little mixing energy, thereby increasing coagulant quantities necessary to achieve similar settled water turbidity levels.

Solids Contact Clarifiers

The Marlin Surface Water Treatment Plant operates in solids contact treatment mode. The plant uses two upflow clarifiers in its treatment process. The purpose of the solids contact clarifier is to remove settleable and suspended solids in the raw water. These types of units employ sludge blanket - solids contact principles to reduce the required detention time for clarification. Solids contact reactors take advantage of the mass action effect of floc formation in the presence of previously formed floc to enhance sedimentation. Chemical coagulants are added prior to the clarifiers in rapid mix chambers, and flocculation occurs in the reaction-flocculation zone of the clarifier prior to sedimentation.

Photo 3. Solids Contact Clarifier



The mixer in Clarifier No. 2 is not operational. Without mixing energy in the reaction-flocculation zone, more coagulant is necessary. The operators are currently feeding more coagulant yet are still seeing higher turbidities in the settled water as compared to Clarifier No. 1. This is evidence of inadequate flocculation energy or short-circuiting.

In addition, the weir elevations are not level across the clarifiers. This could be contributing to the elevated settled water turbidities. If the weirs are not level across the clarifier, the process is in danger of both short-circuiting during normal flows and allowing significant solids to wash over while operating at peak flow.

Also, according to plant staff, the sludge scraper arms have no sweeps installed. A sludge scraper arm without a sweep will be unable to move all the sludge at the bottom of the clarifier to the hopper.

Currently, sludge blowdown is performed manually once or twice a shift for a period of approximately 2 - 3 minutes. This time is determined by visual inspection of the sludge. The pneumatic actuators installed on these valves in 2009 were taken offline because there were issues with their operation.

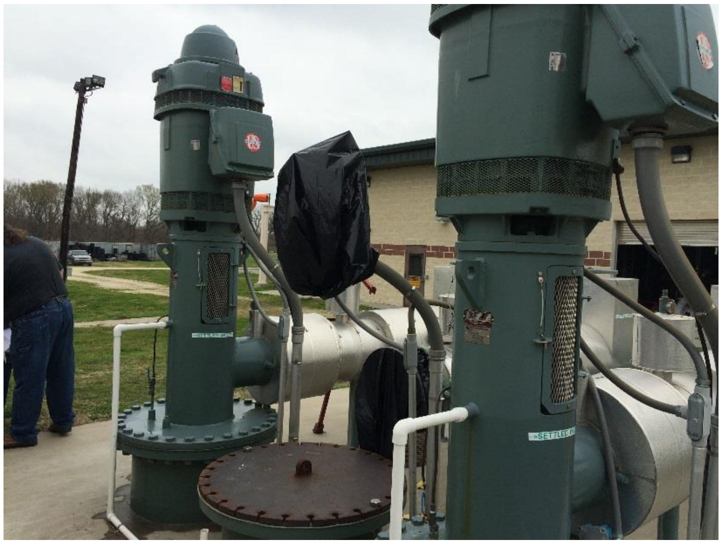
To increase efficiency of the solids contact clarifiers, the following items should be considered:

- **The mixer on Clarifier No. 2 should be replaced to decrease the amount of coagulant required to lower the settled water turbidities.**
- **The weirs should be leveled to prevent short-circuiting and solids carryover, which in turn will increase the efficiency of the process.**
- **The sludge scrapers should be fitted with sweeps/squeegees. Without proper sludge removal, the sludge can become septic and prevent the process from being effective.**
- **Electric actuators should be installed on the sludge blowdown valves so the process can be automated to operator-selected frequency and duration. Typically, electric actuators are less maintenance-intensive than pneumatic actuators. This should increase the amount of time the operators have for regular plant maintenance activities.**

Filter Feed Wet Well and Filter Feed Pumps

Water leaving the clarifiers flows to the filter feed wet well. The filter feed wet well acts as a storage buffer for clarified water so that the filter feed pumps can pump water to the membrane filters. The filter feed wet well is a rectangular structure with inner baffle walls. A secondary disinfection point is located at the north end of the filter feed wet well, and samples of settled water were originally pumped to the lab via a sample pump located on the south end next to the filter feed pumps. The sample pump is no longer operational and samples are currently collected manually from the filter feed wet well by the operators.

Photo 4. Filter Feed Wet Well Pumps



The filter feed pumps provide feed water to the membrane filters in the Filter Building. The water treatment plant utilizes pressure-driven ultrafiltration membrane filters. Thus, the filter feed pumps provide pressure for the membrane filtration system. Three (3) vertical turbine pumps are used to provide pressurized water for the membrane filters. The pumps are installed with VFDs which are controlled by the membrane filtration control system and connected to the SCADA system.

The filter feed wet well has three chemical diffusers: one for caustic, one for LAS, and one for chlorine. The chlorine and LAS can be injected at the filter feed wet well to form chloramines.

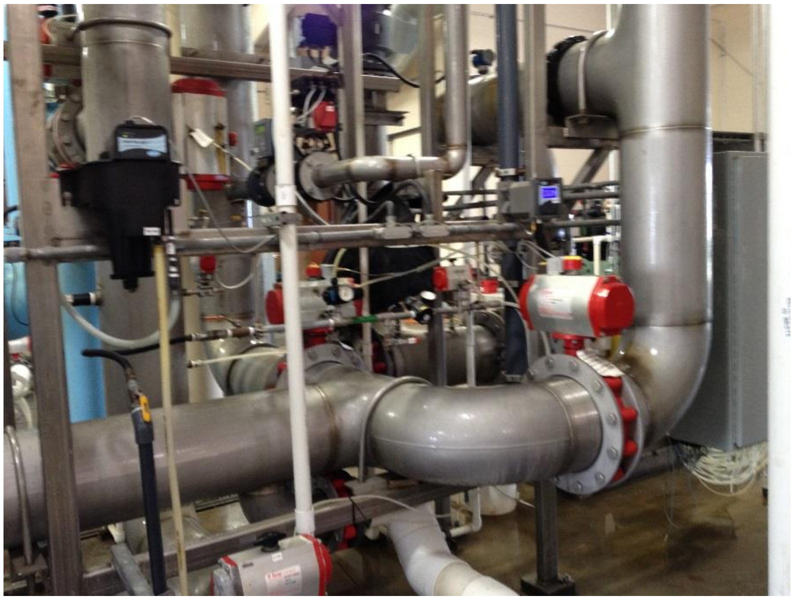
According to plant staff, the filter feed wet well occasionally accumulates branches and leaves, and there is no immediate way for an operator to clean out this debris.

Overall, the filter feed wet well and filter feed pumps appear in good condition with minimal operation issues. **The addition of stairs and a handrail would allow the operators to monitor accumulation of items in the wet well and make manual sampling easier. Otherwise, a new sample pump could be installed to convey a continuous sample stream to the lab.**

Membrane Filtration

The City of Marlin SWTP utilizes the KOCH PMPWTM-10 Membrane, an ultrafiltration type membrane filter. The membrane filter system consists of all units controlled by the membrane filter computer/control system as well as the associated piping, valves, and electronic monitoring equipment. This includes all equipment between the filter feed wet well and the ground storage tank as well as the backwash pumps at the high service pump station.

Photo 5. Membrane Filtration Skid



The membrane filter system operates under various cycles and is controlled automatically via the membrane filter computer supplied by KOCH. The only exceptions are the valves that control whether filter waste flows to the neutralization tank or the filter feed pond. These valves are controlled by the SCADA computer. The membrane system consists of two (2) KMS Model HF-56 Potable Water UF Units with fifty-four (54) KMS, model V1072, UF membrane cartridges each. The net filter production capacity as granted by the TCEQ is 4.22 MGD at 20 °C.

When the filter system operates in production or filtrate mode, water is pumped from the filter feed wet well through the prefilters. Pressure indicators are located on both the inlet and outlet sides of the prefilters and throughout the membrane filtration system. Turbidity and flow meters are also provided on the filter feed lines running from the prefilters to the membranes. Water flows from the prefilters through the membrane filters to the ground storage tank; however, not all the water flows through the membrane filters. Water that passes through the membrane filters is referred to as production permeate. Remaining water that does not pass through the filters is referred to as production retentate. Production retentate is drained to the neutralization tank or reclaim pond.

The membrane filters at the Marlin SWTP operate in recirculation mode as required by the TCEQ. Recirculation mode utilizes a recirculation pump that provides extra cross flow which helps to remove foulants from the surface of the membrane and keep them in suspension in the retentate.

Cleaning and backflush cycles are performed automatically by the membrane filtration system. Chemical pumps have been provided by KOCH for citric acid, caustic, and sodium hypochlorite. These chemicals are pumped to the backflush line and/or the clean in place (CIP) tank. When the system begins a cleaning cycle, a cleaning solution in the cleaning tank is pumped via a cleaning pump to the membrane filters. Both cleaning permeate and cleaning retentate return to the CIP tank afterward the cleaning cycle. The CIP tank drains to the neutralization tank to await pH adjustment prior to discharge to the plant sewer.

Backflushing is performed at regular intervals to remove the layer of fouling that may have accumulated on the surface of the membrane and flush it to the drain. Filtered water from the clearwell is used to backflush the filters. It is pumped via the backwash pumps located at the high service pump station and flows through the membrane filters in the reverse direction (outside-in) for a preset amount of time. The clean permeate water used for backflush may have chemicals added. Currently, a backflush cycle occurs every 45 minutes for a duration of 15 minutes, alternating between 2 water-only backflush cycles, a citric acid backflush cycle, and a chlorine/caustic backflush cycle.

Cleaning cycles are performed periodically on the membranes. The cleaning solution is stored in the CIP tank on-site. The cleaning pump conveys the cleaning solution to the membrane filters or prefilters. Caustic, sodium hypochlorite, and citric acid chemical lines run from the chemical pumps to the CIP tank located on-site. Currently, CIPs are completed on each membrane skid every 2 months.

One requirement of the membrane filters is that integrity testing must be performed to ensure there are no defects in the membrane filters. The membrane system in the City of Marlin SWTP uses a pressure decay test in which the permeate side of the skid is drained and then filled with compressed air to a low pressure. The rate of decay of the pressure is monitored and then correlated to a normalized number of broken fibers. A direct integrity test is being performed by the operators once a week.

Although the rated capacity of the membrane filters at 20 degrees C is 4.22 mgd, discussions with plant staff revealed that a single membrane skid can only produce approximately 1.3 mgd. Once this flow is reached, it is necessary to start the second skid. Based on the age of the membrane filters, production capacity could be increased to the original design capacity if the membrane cartridges were replaced. Membrane filters have an estimated life of 7-10 years. Once they reach this point, no amount of chemical cleaning or backflush will increase their production capacity because the membrane surface has begun to degrade due to normal wear and tear. The frequency of cleaning cycles, while effective at removing foulants, can potentially prematurely degrade the membrane fibers. This degradation reduces the permeate flux rate of the membranes. The membrane filters should be a priority in O&M budget to ensure the production capacity does not continue to decrease.

The City should start a discussion with the TCEQ regarding replacement of their current membrane cartridges. Operations staff stated that Koch has informed them that the membrane cartridges currently installed at the plant are no longer produced, however, there are membranes currently manufactured that can directly replace the existing cartridges without need to retrofit the entire system. If this is the case, the new membranes must first receive approval from the TCEQ before they are installed at the plant. The TCEQ may require another pilot test be conducted on the new membranes. If a pilot test is not required, Koch will need to work with the TCEQ to determine what all is needed to gain approval of the newer membranes. Depending on which path to approval the TCEQ requires will determine how long the approval process may take. The City should begin corresponding with the TCEQ immediately so membrane replacement at the plant can occur in a timely manner.

The membrane filters have a life span that is dependent on receiving high quality clarified water. The processes upstream from the filters will affect the time the filters are usable because the membranes deteriorate at a slower rate when they have to remove fewer constituents from the influent water. Each membrane filter begins to deteriorate and produce less water after its initial installation. A failure in any of the process units associated with sending water to the membranes could have an effect on membrane life. Therefore, it is critical that the following units are maintained and checked to ensure efficient operations:

- Intake structure is operated to minimize the sediment entering the plant processes
- Clarifier mixers, weirs and sludge sweeps are maintained so settled water turbidities are low without the need to overfeed coagulant at the rapid mix basins.
- Membrane system pre-filters are never bypassed, and all flow to the membranes is filteredWater softener is maintained to adequately soften water used for cleaning to less than 60 mg/L as calcuim carbonate

To efficiently operate the membrane filter system, it is recommended that:

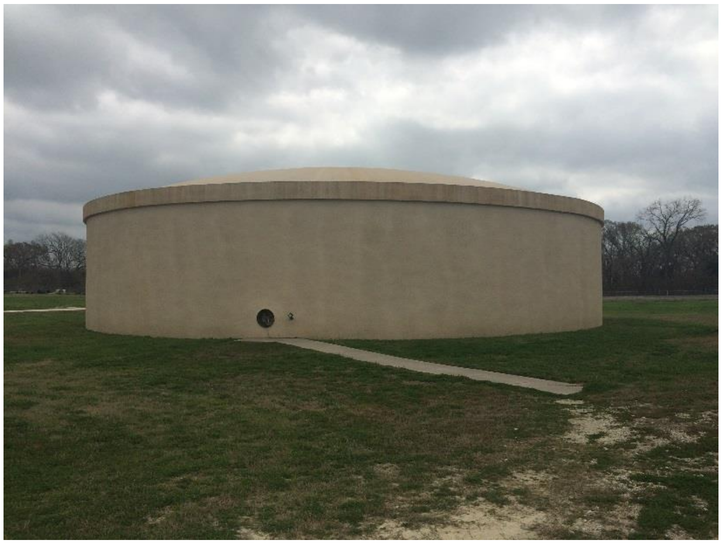
1. **The efficiency recommendations outlined for the clarifiers should be implemented to ensure the membranes receive high quality processed water.**
2. **The membrane cartridges be replaced within the next 3-4 years.**

As stated previously, the membrane system is automatically controlled by its own control system with the exception of the valve controlling flow to either the neutralization tank or the reclaim pond. Currently, monitoring of the membrane system and operation of the valve to direct waste to either the neutralization tank or the reclaim pond is all that is required of plant staff. The city should look to integrating the membrane control system with the plant SCADA since the membrane filters are an automated, integral portion of the SWTP.

Clearwell

The purpose of the clearwell is to store finished water for use during periods when the water treatment plant is not operating and also for the backwash water supply needed for the membrane filters. The clearwell receives flow of finished water from the membrane filters. The clearwell then provides finished water to the high service pump station for transmission to the city and filter backwash.

Photo 6. Clearwell



Water is removed from the clearwell by the high service pumps based on system demands or by a backwash pump based on the need to backwash a filter. No special controls are required for the clearwell. The SCADA system indicates the level of the tank for the operator's information and use.

There are currently no issues with the clearwell, and no items are identified to increase efficiency.

High Service Pumps

The purpose of the high service pumping facilities at the water plant is to convey treated water from clearwell storage to the city's distribution system at useable pressures. Three pumps with VFDs are used to pump finished water from the clearwell to the distribution system. The firm capacity of the high service pump station is 7.49 mgd.

Currently, the operations staff monitor the elevations in elevated storage throughout the distribution system. Based on elevation, the operator turns the high service feed pumps on and off manually via the SCADA system to ensure the elevations in the distribution system tanks are consistent. The high service pumps were originally design to be controlled automatically by the level indication in the elevated tanks. **Controlling these pumps automatically could decrease the amount of time operators are required to observe the elevated tank elevations and only require their attention in an alarm state.**

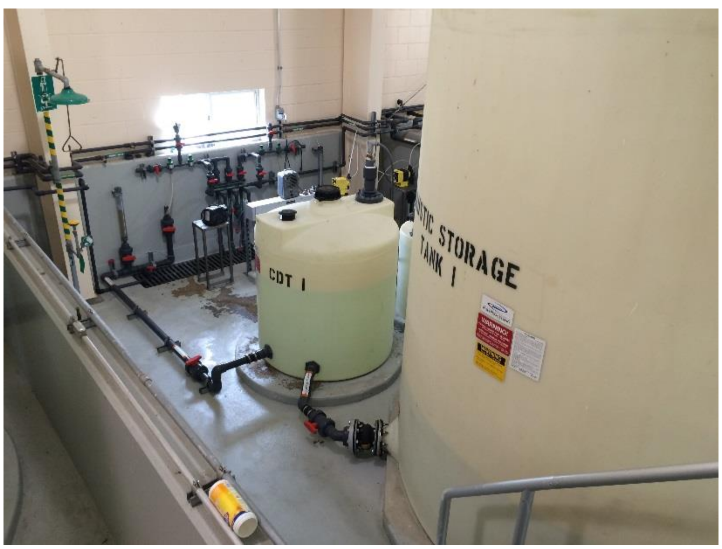
The station also includes two (2) vertical turbine pumps that alternate to provide filter backwash. Both of these pumps have VFDs and are controlled via the Koch ultrafiltration control panel through the SCADA system. Alarms and operating conditions of the pump are displayed on the central computer for the SCADA system. No items were identified to increase the efficiency of the backwash system.

Liquid Chemical Feed Systems

The chemical feed at the plant was originally designed to pace chemical feed based on the influent flow. Many of the original chemical feed pumps have been taken out and replaced with LMI metering pumps. All chemicals are currently fed manually.

Bulk storage of chemicals is located in concrete containment areas in the membrane filtration building.

Photo 7. Chemical Tank and Piping



Chemicals presently used at the water treatment plant are:

- *Alum*: Aluminum sulfate is used as the coagulant and is applied to the raw water during rapid mixing in the splitter box.
- *Liquid Ammonium Sulfate*: Liquid ammonium sulfate (LAS) is injected after chlorine to form chloramines for disinfection. Injection points include rapid mixing at the splitter box, the filter feed wet well, and the effluent lines from the membrane filters.
- *Caustic*: Caustic is provided primarily for pH adjustment of the finished water. Potential application points include the splitter box, the filter feed wet well, the pipelines leading from the membrane filters, and the

neutralization tank. Caustic is also utilized by the membrane filtration system for chemical backwashes and CIPs. Operations staff noted that caustic is added to adjust finished water pH; this occurs rarely.

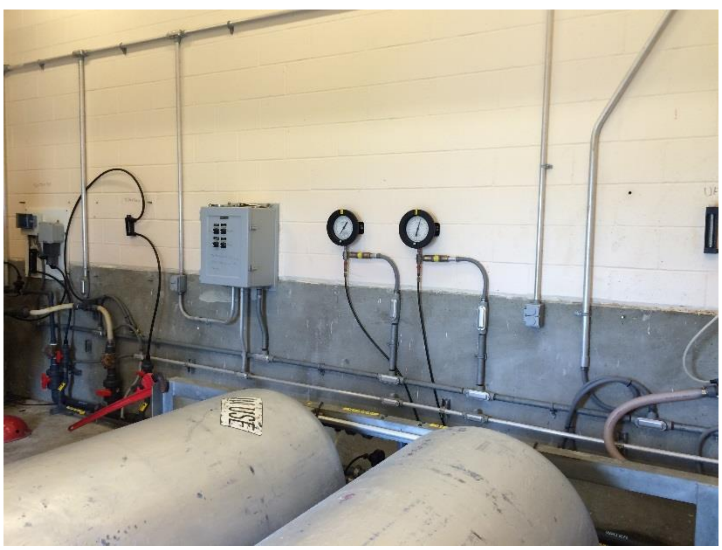
- *Fluoride*: Fluoride is added into the filtered water prior to the clearwell.
- *Citric Acid*: Citric acid is used in the cleaning process of the membrane filters and also at the neutralization tank. Metering pumps feed the chemical to the membrane filters and the neutralization tank.
- *Sodium Hypochlorite*: Sodium hypochlorite is used in the cleaning process of the membrane filters. It is fed to the filters by metering pump.

Instead of feeding each chemical to each process manually, an automated system could be reinstated if original pumps with VFDs, correctly adjusted to include turndown to lower feed rates, were installed per previous design of flow-paced control with dosage trim (based on pH and fluoride meters).

Chlorine Feed System

The purpose of the chlorine handling facility is to take gaseous chlorine from the chlorine cylinders and make a chlorine solution with sufficient strength to disinfect the water and provide chlorine residual in the distribution system. The chlorine gas is delivered in a liquid state in one-ton containers, fed to the chlorinators as a gas under vacuum, and mixed with potable water at an injector. The chlorinators are controlled manually to feed the required amount of chlorine.

Photo 8. Chlorine Feed System



Chlorine can be added prior to the clarifier at the splitter box, at the filter feed wet well, and prior to the clearwell in the two effluent lines from the membrane filters.

The primary application points are at the clarifier splitter box prior to the clarifiers and after filtration in the finished water lines to the clearwell.

The chlorinator feed rate is currently controlled manually by the operators.

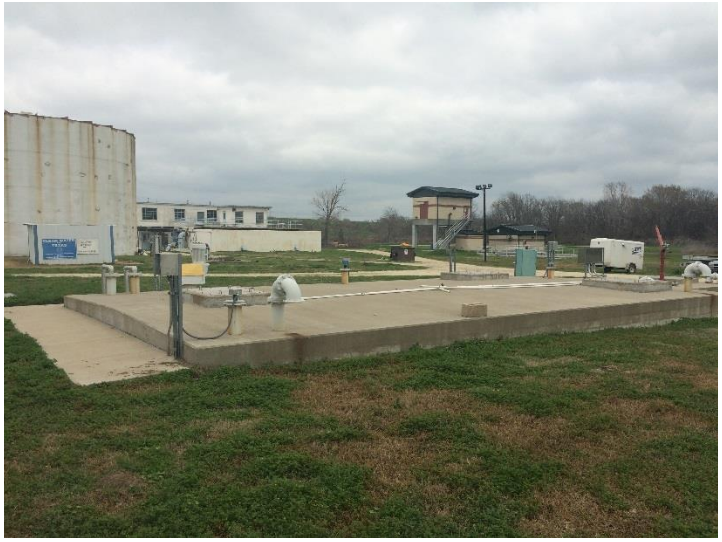
The system was originally installed to be controlled by a Hands-Off-Auto selector. When in hand position, the chlorinator would be controlled by the operator using a Hand Controller. When in the automatic position, the chlorinator would be controlled through the SCADA computer either automatically or manually. If set to be controlled automatically, the chlorinators are controlled based on the raw water flow rate. If manual, the operator may control the chlorinators via the SCADA computer.

A SCADA-controlled system could be reinstated if automated control valves and SCADA controls were placed into service. The chlorinator would be automated based on raw water flow and desired chlorine dosage. The dosage could also be trimmed by utilizing chlorine residual feedback to the chlorinator.

Neutralization Tank

The neutralization tank adjusts the pH of the chemical backwash water prior to being released to the sewer system. The operator has to pay close attention to the pH meters so that the proper amount of caustic or citric acid is used to adjust the pH of the water before releasing it to the sewer system. The operator also has to pay close attention to the level in the neutralization tank as this is not monitored by SCADA. There are currently no operation or control issues with the neutralization tank.

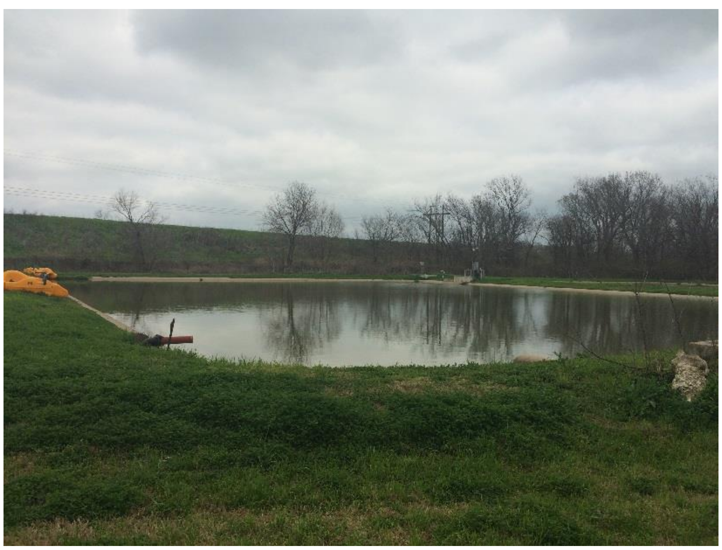
Photo 9. Neutralization Tank



Reclaim Ponds

Filter backwash water flows from the filters by gravity to a manhole where it then flows to the reclaim pond via gravity and held until it is pumped back to the head of the plant for treatment with the raw water or sent back to the lake. In most instances, water is pumped back to the head of the plant for treatment.

Photo 10. Reclaim Pond

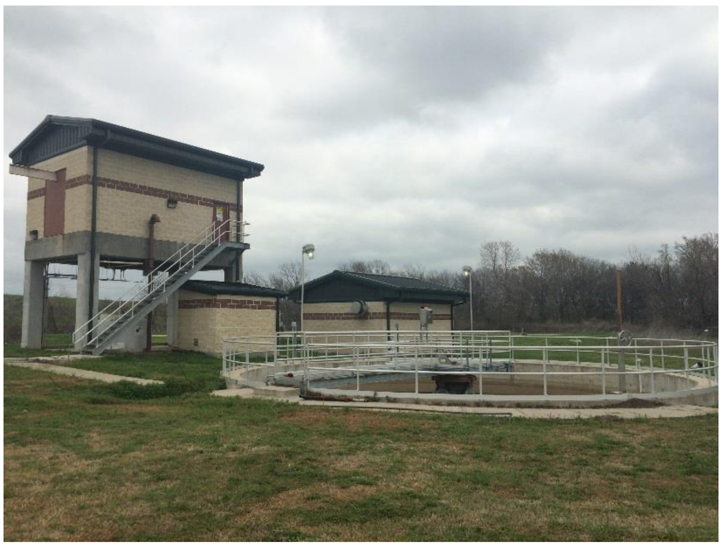


The level of water in the reclaim ponds is monitored closely by the operators as it is not monitored by the SCADA system. Water is pumped to the head of the plant or the lake when desired by the plant operators; however, flow is limited to 10% of the raw water flowrate when pumped to the head of the plant. There are currently no issues with the operation and control of the reclaim ponds.

Sludge Handling Processes

The water treatment plant was upgraded in 2009 to include a sludge thickener, centrifuge, and associated sludge pump station. Currently, the city does not operate the centrifuge but instead disposes of the sludge through a land application permit. Due to centrifuge energy and chemical usage, this equipment is not used. While chemical and energy usage is lower with the sludge land application disposal method, the land application process is more time-intensive for the operators.

Photo 11. Centrifuge Building and Sludge Thickener



The sludge thickener receives drain water from the reclaim ponds and the filter feed wet well, decant water from the centrifuge, sludge blowdown from the two clarifiers, and the initial sludge/water mixture when a clarifier is drained.

The purpose of the sludge pump station is to transfer sludge from the sludge thickener to the centrifuge for dewatering and ultimate disposal. The sludge pump station contains one (1) grinder to protect downstream equipment (i.e. pumps and centrifuge) and two (2) positive displacement progressive cavity pumps, each available for use. The pump motors have variable frequency drives (VFDs). The rate of sludge flow to the centrifuge is controlled as part of the centrifuge operation.

The two progressive cavity pumps located in the sludge pump station will deliver flow from the sludge thickener to the sludge dewatering centrifuge. A sludge grinder is located ahead of the pumps for protection of the pumps and centrifuge. A polymer feed system is also provided. Dewatered sludge from the centrifuge is dropped into a dumpster or dump truck.

The following recommendations should be implemented to efficiently operate the sludge handling:

1. **The centrifuge and sludge pump station should be operated at minimum once per year to ensure these units are operational and do not deteriorate through non-usage**
2. **The sludge land application permit should be maintained and kept up to date.**

B. Water Treatment Plant Controls

The Marlin SWTP underwent an expansion in 2009. Control systems for plant automation were a part of the expansion. This section summarizes the modifications to the controls that were implemented with plant construction and items that have been identified to increase efficiency of plant operation.

Controls Implemented with Plant Construction

While most of the treatment processes can be operated manually, this plant was originally designed to operate as "automatically" as possible. The plant includes a Supervisory Control and Data Acquisition System (SCADA). This computer system provides vital information to the successful operation of the plant. The SCADA computer is located in the Filter Building along with the Membrane Filter Monitor. In addition to the SCADA computer, the membrane filtration system is run by a separate computer.

The raw water pumps were meant to control the flow to the plant in response to the flow of the filter-feed pumps. However, since the plant is currently operating in gravity feed mode and at a near continuous flow rate, this type of automation is not necessary. However, automation helps reduce operator error when changes to the plant flow rate occur on a regular basis.

The speed of the mixers at the raw water splitter box/rapid mixers are adjustable by VFDs which are remotely adjustable by SCADA, thereby allowing the operators to only use the amount of energy necessary to obtain desired mixing energy.

The controls for the solids contact clarifiers are monitored in the plant's SCADA system. The SCADA system monitors which components are operating and also for any alarm conditions. Specifically, the sludge blow down valves were originally controlled locally by a three position open/close/remote selector switch installed near the valve. If set on remote, the operator can control the valve via the SCADA system. The operator can select manual control or automatic control. If set on automatic control, the operator can set the frequency and duration of the sludge blow down valve operation. The clarifier rake drive motor is controlled manually through a remote-off-run selector switch. When set on remote, the rake drive motor can be controlled via the plant's SCADA system.

The level of water in the filter feed wet well is measured by an ultrasonic level transducer. This device transmits information to the SCADA computer where it is monitored. Different alarm set points are available to the operators.

The filter feed pumps are controlled by VFDs that are linked to and controlled by the Membrane Filtration computer system. If one or more of the Ultrafiltration units fails, the filter feed pumps will cut off. The VFD includes a hand-off-auto selector switch. The speed of the pump can be controlled locally and manually by a hand-indicating controller in the "hand" position, though it is not recommended. When set in the "auto" position, the pumps are controlled remotely by the Membrane Filter's computer system. The pumps are controlled by the membrane filtration computer and monitored via the SCADA system.

The membrane filtration computer controls all components of the membrane filters plus the filter feed pumps and the backwash pumps. While the SCADA system may not control these units, it can monitor them.

No special controls were required or implemented with the clearwell. The SCADA system indicates the level of the tank for the operator's information and use.

Control of the high service pumps was intended to be automatic by setting the H-O-A selector switches on "A" at the panels located at the pump stations. The operator is also capable of selecting automatic or manual control via the central computer for the SCADA system. The intended control was to have one or two of the pumps run to meet the demands at the Pump Station. When set on automatic control, the pumps would run based on levels in two elevated storage tanks (Royal Street and Depot Street EST). The Depot tank was selected as the control tank for the pumps. The control tank can be changed via the SCADA system, if necessary. When the control tank falls below a predetermined low level, the lead pump could be turned on and ramped up to full speed until the tank reaches a preset operator determined level. If the level continued to fall, the lead pump will be ramped down and the lag pump would be started, and the speed of both pumps would be ramped up to a preset minimum speed. This speed will be less than one pump operating at full speed. If the tank level continued to fall, the speed of both pumps would be ramped up to full speed. If the tank reaches a preset operating level, the pumps would be decreased to minimum speed and the reverse procedure would take place to utilize one pump. The three pumps would be alternated based on accumulated run time to maintain even wear. When any one of the tanks rises above a predetermined high level, the pumps would ramp down and turn off.

Control of the backwash pumps is automatic and is based on the filter control console. The needed flow rate is sent to the VFD controller to allow automatic adjustment of the flow to the desired set point. Manual manipulation of the VFD is not necessary unless electrical controls were to temporarily fail.

Modifications Completed to Controls

Controls originally installed to automate the operation of the plant have for the most part been removed. Systems that operate in remote are controlled manually at the plant SCADA system. Much of the equipment has been changed or altered, and without additional equipment and control changes, the plant cannot be automated. Items identified in the previous section could be reinstated; however another detailed look at the plant SCADA system would be required to determine the specific capabilities of the current system. The current plant SCADA system does not allow the operator to view historical data and view trends in the data.

Recommendations to Plant Controls and SCADA

The membrane controls should be consolidated with the rest of plant SCADA. The SCADA system should be reworked/programmed to allow the operators to both view logs for historical data retrieval and parameter trending as well as monitor and control the membrane filtration system from a single plant SCADA computer.

SECTION II

WATER TREATMENT PLANT OPERATIONS

This section focuses on the water treatment plant operations and provides recommendations and tools for efficiently operating the plant. A focus is placed on providing the operators tools and materials that will help promote access to needed data along with worksheets to record data. Efficient operations promotes record keeping that help identify trends.

A. Operations and Maintenance Manuals

Operating the water treatment plant requires the operators to understand the treatment process and complete regular operational activities along with regularly scheduled maintenance activities. The operational tasks ensure the plant produces water that meets TCEQ requirements while the maintenance activities ensure the equipment is running efficiently. Multiple documents are needed for reference to assist with these activities. These documents include:

1. Treatment plant record drawings
2. Overall treatment plant operations and maintenance manuals
3. Approved shop drawings for equipment installed during construction
4. Equipment operations and maintenance manuals
5. Updated records on work completed on each piece of equipment

Operations and maintenance manuals were provided at the completion of the 2009 SWTP project that included both an updated plant O&M manual and equipment O&M manuals for each installed unit. These operations and maintenance manuals provide a list of equipment along with recommendations from the manufacturers for maintenance. As a part of this study, the operations and maintenance manuals were reorganized in electronic format and provided in Appendix A. To correspond with the asset management plan, asset documents were developed that group each asset's record drawings, specifications, and associated O&M manual pages together. These asset documents should be used in conjunction with the O&M manuals and are included in Appendix B. A maintenance schedule provided from the 2009 O&M manual is included in Appendix C.

B. Water Treatment Plant Operations Recording Keeping Practices

Currently, the operators at the plant have lab records that are maintained with individual sheets for turbidity and chlorine residual. Turbidities of the raw, coagulated, settled, filtered, treated, and finished waters are recorded every 2 hours. Chlorine residuals are measured and recorded at each clarifier, at the filter feed basin, at the effluent of each membrane skid, at the clearwell, and at distribution every 2 hours. A daily water chemistry worksheet records the temperature and pH at the raw water pump station, the two clarifiers, the filter feed basin, the effluent of the two membrane skids, and the finished water. The alkalinity and dissolved oxygen of the raw and finished water are measured and recorded daily. The total ammonia concentration of the raw water is measured and recorded daily as are the total chlorine, monochloramine, free ammonia, and fluoride concentrations in the finished water.

Each shift currently records the raw water flow, chlorine dosage, ammonia dosage, coagulant dosage, caustic feed, fluoride concentration, and when high service pumps are turned on and off for distribution system supply.

In addition to the above records, each shift or operator should maintain a daily operations log with information pertaining to date and time, day of week, weather conditions, raw water flow, and comments pertaining to each activity completed, including items requiring maintenance, equipment calibration, membrane system parameter changes or repairs, or any unusual events or emergencies that occurred at the plant. Descriptions should be simple and accurate. An example daily operations log is located in Appendix D.

C. Water Treatment Plant Maintenance Recording Keeping Practices

The purpose of a maintenance program is to reduce cost and maintain peak efficiency of the plant. Maintenance should be an integral part of daily plant operation. If maintenance is not performed on a regular basis, equipment may fail prematurely, leading to process failure.

An equipment record system should be used to maintain specific information on each item of equipment.

The maintenance information should include a list of preventive maintenance functions to be performed and their frequencies. As these preventive maintenance items are performed, they should be recorded with the date the work is accomplished along with any related cost information. As corrective maintenance work is performed, this information should also be recorded with the date the work is accomplished, cost information, and any pertinent comments.

A system should be developed to regularly compile this information for use in determining cost and for future use in budget development. Adequate maintenance records assist in equipment evaluation, aid in establishing budgets for manpower and materials, and help ensure an efficient schedule for preventive maintenance functions.

At the very least, the maintenance records for each item of equipment should include the following:

- Name and location of equipment or structure
- Name of manufacturer, supplier, or builder
- Cost and installation date
- Type, style, model
- Capacity, size, rating
- Serial and code numbers
- Nature and frequency of maintenance
- Proper lubricants, coatings

All maintenance work should be scheduled in the same manner as the facility's operating routine. Preventive maintenance should not be a haphazard procedure to be done if time permits or “if it rains." Indoor and outdoor maintenance should be scheduled to take advantage of weather, low demand periods, and other variable conditions beyond the control of the operating staff.

Some maintenance tasks must be scheduled for the once-a-year opportunity when the plant load normally is at its lowest because of weather-related water demands. This may be the time to drain, check, repair, and paint the clarifier or other submerged items of equipment.

Plant management should also review job tasks and possible emergency conditions which plant personnel cannot handle due to either a lack of skills or proper equipment. These tasks should be reviewed and advance arrangements made with contractors or a repair service to handle these tasks and be available to aid facility personnel in handling emergency problems.

In emergency conditions involving key units, these units should not be shut down unless there is a need prior to the start of work. Before initiating work, the sequence of steps to complete the task should be developed. Proper planning and scheduling will ensure that sufficient personnel, proper equipment, and parts will be available in the work area to accomplish the task and minimize the actual downtime for the equipment. Once work has started, there should be no interruption that would cause any delays in placing the unit back in service.

In planning and scheduling preventive and corrective maintenance tasks, the facility may use a schedule chart board, work order system, daily or weekly worksheets, and general priority schedule sheets to forward information to the maintenance staff as to what tasks are to be accomplished, the dates, and priorities. A backlog develops when scheduled work is not accomplished. This work backlog should be reviewed and the more critical tasks assigned the highest priority. The general work order sheet may list tasks and priorities as shown in Appendix E.

A work order system should be established to initiate all corrective maintenance tasks. The work order system will aid in identifying work to be accomplished, procedure priority, and information on any special aspects of the job. A log of the work orders will provide a record of when the work order was initiated and completed. The work orders should be numbered to provide a means of maintaining accountability.

Only properly trained personnel can be expected to perform satisfactory inspections, repairs, and preventive maintenance tasks. Properly trained personnel should possess a thorough knowledge of the functions and operations of their equipment and the procedures for servicing it. A good maintenance management program must consider the limitations of plant operators and maintenance personnel.

Specialized maintenance for equipment such as pumps and motors should be handled through outside maintenance companies or factory representatives. However, through proper training, many specialized maintenance tasks can be accomplished using city personnel to help reduce costs and time delays.

A maintenance schedule for all major pieces of equipment was compiled when the SWTP was expanded in 2009. See Appendix C for this list.

SECTION III

WATER TREATMENT PLANT EQUIPMENT

The equipment at the water treatment plant was fully analyzed as a part of the asset management and relied on the findings outlined in the previous section. The purpose of the asset management plan is to determine the following items as outlined in the EPA Best Practices Guide: the current state of the Marlin water system components, the required "sustainable" level of service, which assets are critical to sustained performance, the minimum life cycle costs, and the best long-term funding strategy. This section outlines the recommendations for minimum life cycle costs along with providing commentary on the use of maintenance agreements.

A. Equipment Repairs

The recommendations for minimum life cycle costs are reiterated in this section. Overall, the city is currently spending minimal costs on equipment repairs because the plant has recently installed units (2009). As these units age, the increased maintenance expenditures will be realized. The recommendations for minimum life cycle costs are as follows.

1. The process to replace the membranes will need to begin to ensure the plant flow capacity does not decrease to an unacceptable level. As discussed in Volume I of this report, discussions with TCEQ on membrane replacement will need to begin as soon as possible to allow for sufficient time for the regulatory approval process.

2. Since chemicals are a major expenditure, completing flow paced chemical injection has the ability to reduce chemical consumption. See Volume I for further commentary on chemical usage.

3. Electrical consumption is a major expense at the treatment plant. Electrical usage for each plant component needs to be closely monitored to ensure equipment is operating efficiently.

4. The water treatment plant controls are currently set for manual operation. Completing the controls recommendations in Volume I will allow the operators to automate certain units.

5. As discussed in earlier items, short term project should be scheduled to allow the plant to gain operational efficiencies. The city should use the concepts of condition, criticality and lifespan to complete improvement projects along with

consulting Volume I of this report. Short term projects for consideration should include:

a. Controls improvements
b. Chemical flow pacing
c. Clarifier upgrades
d. Intake structure

6. The city should continue to maintain sludge land application permit while also intermittently operating the sludge pump station and centrifuge. By using the sludge land application permit, the city reduces electrical consumption and chemical use. The sludge pump station and centrifuge need to be operated to remain functional.

7. The city will need to anticipate an increased expenses in mechanical repairs due to aging assets. Most likely, the lower machinery equipment repair costs are due to the plant undergoing a major replacement in 2009. As the equipment installed in 2009 ages, the costs for repairs will increase. Deferred maintenance will result in higher long term costs and decreased plant production and/or efficiencies.

8. Long-term assets must be maintained to ensure their life spans do not prematurely decrease. The long-term assets at the plant include tank, concrete structures, and buildings.

9. Long-range financial planning should anticipate major expenditures at the plant to replace equipment installed in 2009 in about 15 years. By keeping accurate records on equipment performance now, the equipment replacement may be correctly prioritized.

B. Maintenance Agreements

The plant could enter into maintenance agreements with the various equipment manufacturers; however, this can become very expensive. All equipment at a SWTP requires preventative maintenance and periodic repairs. Typically, if preventative maintenance is done and repairs are made on a timely basis, there is no need to enter into a maintenance agreement. If the plant staff can be relied upon to conduct routine preventative maintenance and inspection on all pieces of equipment, problems will be discovered before irreparable damage occurs. If plant personnel does not feel comfortable maintaining specialized pieces of equipment, a maintenance contract may be required. However, through proper training, many specialized maintenance tasks can be accomplished using city personnel to help reduce costs and time delays. The primary process at the Marlin SWTP that is specialized and may require a maintenance contract are the membranes. However, if the operating staff can be relied upon for routine maintenance and repair to the membrane systems, outside maintenance or factory representatives for the membrane system will only be required when something outside their range of training needs repair or troubleshooting.

Appendix A:
Equipment Operations and Maintenance Manuals

The equipment operations and maintenance manuals have been scanned in PDF format and have been made available through a file transfer.

Appendix B:
Asset Documents

A summary of each asset has been developed that includes following as they are available: record drawings, design specifications, plant O&M manual relevant sections, and reference to available equipment O&M manuals.

Appendix C:
Maintenance Schedule

Figure 8-3 Maintenance Schedule

Ref. No.	Spec. Section	Shop Draw Ref #	Description	Manufacturer	O&M Manual Title and Description	Sales Rep.	O&M Required	Date Received	Maintenance Schedule
1	M29	06	Precast, Wire-Wound Prestressed Concrete Tanks- Clearwell	Natgun			Yes		Periodically Inspect Tank. No maintenance necessary.
2	C2	07	Steel Reinforcement: Sludge Thickener & Splitter Box				Yes		Sludge Thickener- see #8 Splitter Box- See #13, 22
3	E1	08A	Lighting Fixtures resubmittal	TPC Electric	Lighting Fixtures		Yes	04/14/09	Periodically check fixtures for damage. Check/replace bulbs as necessary
4	M32	14	Sludge Thickener - anchor bolt				Yes		See #8 for Sludge Thickener
5	M7	15	Vertical Turbine Pumps				Yes		Inspect periodically. Change oil annually; Lubricate bearings every 3 months.
6	M17	16	Chlorination Equipment (w/CD)	Hartwell	Chlorination Equipment		Yes	02/16/09	Vacuum Regulator - Check springs and stem after 12000 lbs. of gas have been fed. Rotamater- every 3months. It is recommended that chlorination equipment be serviced at least once annually. See Vendor O&M Manual for specific details.
7	E1	18	Standby Generator				Yes		Daily-Check genset, coolant heater, oil level, coolant level, fuel level, charge air piping. Weekly-Check air cleaner, battery charging system; Drain fuel filter water from fuel tank. Monthly-Check anti-freeze, drive belt, batteries. Semi-annually-Change crankcase oil and filter, coolant filter, air cleaner element, fuel filters; Check hoses. Annually-Test generator insulation resistance and rupture basin leak detect switch; Clean-Cooling system.
8	M32	19	Sludge Thickener (Clarifier Sludge Collectors)	Walker Process Equip.	Sludge Gravity Thickener - Walker Process P80540	Hartwell Env.	Yes	09/03/08	Visually inspect tank and drive unit daily, check skimmer mechanism; check operations of overlaod switches monthly; Observe operation of the skimmer once each day as it passes over the scum box and correct any cause of hesitation, binding or misalignment. Inspect bolts and nuts at regular intervals. Examine gears and all wearing parts periodically for wear. Thest the overload alarm at least once per week. If power is shut off, or mechanism is stopped for longer than hour, by pass flow until machine is started again. Keep machine surroundings clean and touch up rust with paint frequently. Entire mechanism above and below water should be painted once every two years. Annually check paint on Telescoping Valve.
9	M36	20	Sludge Dewatering Equipment	Pebco	Knife Gate - Sludge Dewatering Equipment	Hartwell Env.	Yes	01/14/09	Lubricate gate roller, flange bearings, gear boxes, and rod end bearings every 100 hours of service. Adjust air pressure to pneumatic circuit to normal operating range as necessary. Check filter element and clean or replace monthly or when contaminant buildup is evident. Check lubricator daily. Drain air receiver of water daily unless automatic drain is used. Check air circuitry for leakage annually. Check filter drain periodically. Check lubricator frequently during periods of heavy use. Adjust and/or replace seals as necessary. Check gate/valve mounting bolts and replace and /or adjust bolts annually. Check muffler and clean as necessary. See Maintenance Recommendations of P. 9 of Vendor O&M Manual
10	M35	21	Sludge Polymer Feed System	Dynablend	Fluid Dynamics Polymer System	Hartwell Env.	Yes	05/20/09	Electronic Metering Pumps - Replace elastomeric parts annually; Polymer Check Valve - Inspect and clean monthly; Skinner Solenoid Valve- Clean strainer, inspect and clean internal parts, and operate valve annually.
11	PI-9Q	25	Hydrostatic Pressure Relief Valves	Ferguson Entr.			Yes	10/13/09	Periodically inspect valve to determine how operating conditions are effecting valve. Refer to vendor O&M manual for inspection requirements and any other maintenance needed for this valve.
12	M38	26	Sewer Lift Station Submersible Pumps	Smith Pump	Sewer Lift Station Submersible Pumps	James Windham	Yes	01/14/09	With proper application of the pump/motor unit and proper installation of all the protective devies, no periodic maintenance of the equipoment is necessary. Remove and repair pump as necessary.
13	M12	29	Aluminum Weir, Slide & Canal Gates	Hydro Gate	Slide Gates		Yes	10/15/08	Clean and inspect gate, inspect stem threads and lift nut for wear, check stem for lubricant (add when needed), and pressure grease lift semi-annually. Clean and grease seating faces annually.

14	M25	30	Liquid Chemical Storage Tanks	Hartwell	Liquid Chemical Storage Tanks		Yes	03/03/09	Inspect exterior and interior of tank for cracking, crazing, and brittle appearance at least annually Inspect fittings, flexible connection hoses, and gaskets for leaks and corrosion or deterioation at least annually. Inspect vents and fume scrubbers to ensure adequate venting for pressure and vacuum at least annually. More frequent visual inspectios are recommended.
15	M36	31	Sludge Dewatering Equipment-Centrifuge				Yes		Centrifuge - Lubricate main and conveyor bearings at least monthly; Check/Change gearbox oil 1000/2000 hours; Change seals and shafts at 4000 hours; Change shaft bearings at 8000 hours; Lubricate main motor at 2000 hours; or as specified in separate motor manual Check/Change V-belts at 2000/16000 hours; Check for bowl wear at 1000 hours; Check solids discharge busing at 1000 hours; Check alarm devices and safety equipment at 2000 hours. Check foundation bolds and vibration dampers at 4000 hours.
16	M-18-24	33	Chemical Feed Systems- Alum, Caustic, LAS, Spare, Fluoride, NaOCL, Citric Acid	Pulsafeeder		Hartwell Env.	Yes		Periodically inspect and replace diaphragm, as necessary; inspect check valve for solids accumulation and wear; inspect and replace oil seals as necessary. Perform first oil change after six months of continuous operation or approximately 4500 hours and thereafter every twelve months or 900 hours for normal service (clean/dry atmosphere and a gearbox operating temp. between 40 and 100 degrees Fahrenheit)
17	M-18-24	33A	Metering Pumps				Yes		see # 16
18	M-18-24	33A.1					Yes		
19	M33	34	Sludge Grinder	Hartwell	Sludge Grinder		Yes	10/15/08	Visual Inspection- Monthly. Cutter Wear Inspection- After first 3 months, then annually. Cutter Stack Tightness Inspection- After first three months, then annually. Fasteners Inspection- After first three months, then annually. Greasing of Gears- 36 months or 17,500 hours of run time (equal to 24 months of continuous operation), whichever occurs first. Drive Assembly Inspection- After first three motnhs, then annually
20	M34	35	Sludge Pregressing Cavity Pumps	Hartwell	Progressing Cavity Pumps		Yes	10/15/08	The pumps should be regularly rinsed or cleaned; Motor should be kept clean. Lubricate motor according to Vendor O&M Manual Change oil in reducer every 10,000 service hours or after two years. Bearings should be cleaned and regreased or replaced according to the O&M Manual.
21	M7	38A	Vertical Turbine Pumps -				Yes		see #5
22	M-13	40A	Rapid Mixers	Hartwell	Rapid Mixers		Yes	10/15/08	Periodically inspect rapid mixer to determine need for greasing and/or other maintenance. Lubrication frequency of motor and gear drive depends on use. See Vendor O&M Manual to determine the proper frequency for lubrication. Bolts should be retightened 12 hours after assembly and at each scheduled shut down thereafter.
23	A8	42	Aluminum Overhead Doors				Yes		
24	A16	43	A/C and Furnace Units	Trane / Friedrich / Greenheck / Berko	Note: CD's received 10/26/09. HVAC	Garland Heating & Air	Yes	10/13/09	Replace filters as necessary. Call vendor for inspection at least once each year for routine inspection. Routine inspection should include inspection of air filter, inspectio and cleaning of blower, wheel, housing, and motor, inspection and cleaning of indoor and outdoor coils, inspection of indoor coil drain pan, check of all electrical wiring, check for secure physical connections of individual components, and operational check of outdoor unit.
25	M9	44	Jib Crane and Hoists				Yes		Hoist cable- Inspect & lubricate monthly; Electrical Controls- (If applicable) Inspect every 1-3 months; Upper & Lower Block- Inspect semi-annually; Motor Brake & Actuating Mechanisms- Inspect Anually.

26	I1, M6, M8, M37	48	Flow Meters (Raw water, high service, Decant and Return Flow), Ultrasonic Level and LCD transmitters (Filter Feed Wet Well, Lift Station, Clear well, Fluoride Bulk Tank, LAS Bulk Tank, Caustic Bulk Tank, Alum Bulk Tank #1, #2), Level/Pressure Transmitter (Depot, Royal and Foster EST), Instruments, Analytical Instruments, Accessories (Fluoride, pH, and Chlorine analyzer, Turbidity meters, and other equipment)	Richardson Logic Control	Instrumentation, Mag Meters, Ultrasonic Flow Meters	TPC Electric	Yes	07/01/09	Mag Meters Generally no maintenance. Periodically clean surface with cleaning agents that do not attack the surface of the housing and seals. Seals of the Promag H sensor must be replaced periodically. Ultrasonic Flow Transmitter- Generally maintenance free. See Vendor O&M Manual for troubleshooting. Ultrasonic Level Detector- Recalibrate and clean annually. Level/Pressure Transmitter- Check condition of units annually. Fluoride Analyzer- Replenish reagents once a month, Refill electrode inner fill solution once three months, replace pump tubing once three to six months (see manual), replace analyzer tubing once a year, replace lanthanum crystal tip once six months, clean sample screen every three months and replace working and reference electrode once a year. pH Analyzer and sensor- Periodically check operating status of th analyzer, sensor, and relays. Keep sensor clean. Chlorine Analyzer- Replace buffer and indicator solution after one month. Replace pump tubing once every three to six months depending on temperature. Replace analyzer tubing annually. Keep colorimeter clean.Turbidimeter- Clean sensor before each calibration and as needed. Calibrate sensor per agency-dictated schedule.
27	M11	50	Dewatering Manhole Sump Pump				Yes		The pump should be inspected twice a year and overhauled in a service shop oncea year. Periodically check/change oil.
28	M-32	53	Sludge Thickener Control Panel				Yes		See #8
29	P-1	57	Valves - Slanted Disc Check, Pressure Relief & Surge Anticipator	Ferguson Entr.			Yes	10/13/09	Slanting Disc Check Valve (Apco Series 800)- periodically inspect and grease pivot pins, and occasionally observe the disc position indicator to ensure disc is opening. Slanting Disc Check Valve With Top Mounted Oil Dashpot(Apco Series 800T)- inspect and grease pivot pins periodically. Through course of operation, the upper half of dashpot piping must be checked for the loss of pressure. If system is losing oil pressure, check for oil leaks. Slanting Disc Check Valve With Bottom Mounted Buffer(Apco Series 800B)-Lubricate Buffer Rod once every six to twelve months. Refill oil as necessary. Check level of oil in oil reservoir every 3 to 4 months. Check oil in Hydro-Pneumatic Tank every time the tank is checked. Lubricate disc pivot pins quarterly. Pressure Relief and Surge Anticipator Valve- periodically disassemble valve and inspect valve for wear, corrosion, or any other abnormal condition.
30	M-15	60	Water Softener				Yes		
31	P-1	61	Butterfly Valves with Electric and Pneumatic Operators	Ferguson Entr.			Yes	10/13/09	Actuator-annually check actuator electrical enclosure and lubrication level. Replace seals as necessary. Butterfly Valve- cycle valve to verify operation and check for leakage annually.
32	A-14	65	Fans, Louvers, Grills, Dampers, & Accessories				Yes		
33	P-1	67	Eyewash Stations				Yes		
34	M-7	72	Vertical Turbine Pumps				Yes		see #5
35	M-7	72A	Vertical Turbine Pumps High Service				Yes		see #5
36	A-16	74	Split System Air Conditioning Unit (small)	Berko		Garland Heating & Air	Yes	10/13/09	Replace filters as necessary. Call vendor for inspection at least once each year for routine inspection. Routine inspection should include inspection of air filter, inspectio and cleaning of blower, wheel, housing, and motor, inspection and cleaning of indoor and outdoor coils, inspection of indoor coil drain pan, check of all electrical wiring, check for secure physical connections of individual components, and operational check of outdoor unit.
37	M2	1, 1A, 2, 2A, 3, 3A, 4, 4A, 5	Koch membrane Filters	Koch Membrane Systems, Inc.			Yes		Regular cleaning and maintenance of Membrane Filters should follow procedures outlined by Vendo O&M Manual.
38			Existing Sludge Contact Clarifiers						Periodically grease and oil all rotating parts (motors, gear reducers, gear racks, etc.) Annually inspect and service as required.
39			VFDs						Routinely ensure connections are seucre. Check/replace batteries and battery assemblies as necessary
40			Instrumentation and SCADA						Routinely ensure connectiosn are secure. Check/replace batteries and battery assemblies as necessary

Appendix D:
Daily Operations Log Example

DAILY OPERATING LOG (EXAMPLE FORM)

CITY OF MARLIN – MARLIN SURFACE WATER TREATMENT PLANT

Day of Week:	Monday
Date:	April 6, 2015
Weather Conditions:	Partly Cloudy
Temperature:	68° F
Rainfall:	Trace
Treated Water Produced:	3 mgd
Operator:	J. Doe

Comments:

8:00 a.m.	Made Plant check-out, checked totalizer
8:45 a.m.	Started raw water pumps
10:00 a.m.	Complete daily maintenance and lubrication
10:15 a.m.	Performed jar testing
11:00 a.m.	Received two cylinders of chlorine (1 ton ea.), returned two empty cylinders.
11:30 a.m.	Collected samples for analysis
1:15 p.m.	Checked clarifier sludge blanket

(Log should continue in this fashion for all major daily activities)

Appendix E:
Facility Work Order Forms

WORK ORDER FORM

(EXAMPLE)

WORK ORDER NO. ______________________ DATE: ______________________

WORK TO BE PERFORMED:

MATERIALS REQUIRED:

WORK PERFORMED BY:

1. ____ ______________________Hours
2. ____ ______________________Hours
3. ____ ______________________Hours
4. ____ ______________________Hours

WORK COMPLETED:

SIGNED ________________________________

DATE: ________________________________

COMMENTS: