PROJECT SUMMARY

Wastewater Projects Peer Review

Biosolids Project Viability

City Project No. 15074-121

City Task Order No. 12-07-CH2/W

Prepared for

City of St. Petersburg

December 2015

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List of Acronyms

AADF – Annual Average Daily Flow

ASR – Aquifer Storage Recovery

AWWRF – Albert Whitted Water Reclamation Facility

FDEP – Florida Department of Environmental Protection

gpd – gallons per day

HMI – Human-machine Interface

MAIC – Maximum Available Injection Capacity

MDF – Maximum Day Flow

MMADF – Maximum Month Average Day Flow

mg – million gallon

mgd – million gallons per day

NEWRF – Northeast Water Reclamation Facility

NWWRF – Northwest Water Reclamation Facility

PDR – Preliminary Design Report

PHF – Peak Hour Flow

ppd – pounds per day

RAS – Return Activated Sludge

SPMRS – St. Petersburg Master Reuse System

SWWRF – Southwest Water Reclamation Facility

TAZ - Transportation Analysis Zone

UIC – Underground Injection Control

WAS – Waste Activated Sludge

WRF – Water Reclamation Facility

Executive Summary

CH2M conducted a peer review of the ongoing projects that will consolidate biosolids treatment at the Southwest Water Reclamation Facility (SWWRF). A concurrent CH2M peer review with the City, Liquids Processing and Emergency Operation Peer Review, is evaluating recent peak flow events, projected flows and the overall hydraulic capacity. A project peer review is described by the American Society of Civil Engineers (ASCE) Policy Statement 351. The ASCE supports the use of independent and external peer reviews for projects that are critical to the public and the environment. This peer review will assess the existing solids handling and treatment facilities and validate the solids loadings parameters, the solids process selection and the analysis that supported the decisions.

The projects that will consolidate biosolids treatment include construction of a Waste-to-Energy Facility at the SWWRF, pumping of waste activated sludge (WAS) from the Northeast Water Reclamation Facility (NEWRF) and Northwest Water Reclamation Facility (NWWRF) to the SWWRF sewage collection system, and the addition of primary clarification at the SWWRF. CH2M performed site visits to the NEWRF, NWWRF, and SWWRF to assess the physical condition of the existing solids processing equipment and discuss any operational issues of the facilities with on-site staff. CH2M reviewed the technical memoranda (TMs) produced by Brown & Caldwell (B&C), the preliminary design documents of the Biosolids-to-Energy project, and minutes from preliminary workshops between B&C and the City.

This peer review was divided into three separate milestone TMs: Solids Facilities Observations, Validation of Plant Solids Loading Parameters and Plant Capacity, and Validation of Solids Process Selection and Supporting Analysis. The findings from these three TMs are summarized below.

TM No. 1 – Solids Facilities Observations Memorandum (Attachment A)

A site visit to NEWRF was conducted on September 29, 2015. Site visits to SWWRF and NWWRF occurred on September 30, 2015. All three WRFs were originally designed with similar processes to handle, treat and dispose of waste sludge. Various upgrades and expansions over the years have changed the processes and facilities at each of the WRFs. In addition, aging facilities and failing equipment has forced changes to the operation and the process. Each WRF contains facilities and equipment that appear to be in good condition and operate reliably due to recent upgrades and good maintenance practices. However, each WRF also has facilities and equipment that are currently out of service, in poor condition or past its expected useful life.

The most notable process change occurred at the SWWRF where a lime stabilization process (Bioset) was added. This change was necessary because the floating covers on the anaerobic digesters failed, and another method of sludge stabilization was required. The Bioset process is in good condition, fits within the existing dewatering footprint, and produces a Class AA biosolid. However, the overall amount of solids for disposal is significantly higher with the Bioset process due to the lack of volatile solids reduction and the addition of lime for treatment. In comparison to the former anaerobic digestion process at SWWRF, this Bioset process creates an increase in operational and disposal costs as well as additional truck trips at the SWWRF.

The NEWRF and NWWRF still utilize the originally designed solids treatment processes including thickening, mesophilic anaerobic digestion for stabilization, and dewatering. Both WRFs use gravity belt thickeners for thickening with moderate to good conditions. The NEWRF is only operating with one anaerobic digester due to failing floating covers on Digester No. 2 and Digester No. 3. Therefore, the NEWRF has no onsite redundancy for sludge stabilization. The NWWRF has four total anaerobic digesters, but Digesters No. 3 and No. 4 have been out of service for several years. Both WRFs continue to produce Class B biosolids but have reduced capacity or redundancy due to these out of service facilities.

Dewatering at the NEWRF has sufficient capacity and redundancy with a belt filter press (BFP) available to back the two in-service screw presses. This dewatering facility is in good condition and is operating well. In contrast the dewatering facility at NWWRF is in poor condition. The existing polymer storage and feed system, and the two BFPs require significant maintenance.

TM No. 2 – Validation of Plant Loadings Parameters and Plant Capacity (Attachment B)

The original solids loading data developed for the Biosolids-to-Energy project included WAS and digested sludge production rates of the NEWRF, NWWRF, SWWRF, and the now decommissioned Albert Whitted Water Reclamation Facility (AWWRF). Because B&C and the City chose to proceed with closing the AWWRF, centralizing the biosolids treatment at SWWRF, and adding primary clarification to SWWRF, much of this original solids loading data became irrelevant. The WAS production rates from NEWRF and NWWRF were still used to calibrate WAS flows added to the influent flow at SWWRF. The remaining solids loading parameters were developed using BioWin model calibrated to existing data for some processes and to industry standards for new processes. Influent information for the SWWRF included in B&C's Preliminary Design Report appeared to be reasonable and appropriate.

A preliminary analysis was also made of the projected loadings to the new or modified facilities included in the Biosolids to Energy project: primary clarification, combined sludge thickening, anaerobic digestion and dewatering. No unreasonable loading conditions were observed in this analysis.

TM No. 3 – Validation of Solids Process Selection and Supporting Analysis (Attachment C)

The City of St Petersburg's WRFs required upgrades to their solids handling and treatment facilities due to aging infrastructure, regulatory updates and changing disposal options. The City wished to evaluate a wide range options with a focus on the following criteria:

- Meeting all current and anticipated regulations,
- Cost effective and reliable treatment processes,
- Sustainability in operations and biosolids distribution,
- Flexibility in biosolids distribution and/or disposal

The Biosolids to Energy Project was developed over several years and included evaluating disposal alternatives, treatment technologies, consolidation options, conveyance methods and energy recovery. Working with Brown and Caldwell, the City evaluated several alternatives using present worth analysis and qualitative analysis with a focus on the criteria listed above. For the Biosolids to Energy Project the City selected an alternative that includes the following components:

- Centralization of all biosolids treatment at the SWWRF
- Conveyance of waste activated sludge from the NEWRF and NWWRF via new forcemains into the SWWRF collection system
- Use of temperature phased anaerobic digestion (TPAD) to produce Class A biosolids
- Energy recovery and a biogas upgrading system that can produce pipeline quality fuel for vehicles or onsite power generation

This peer review included an evaluation of the alternatives analysis, cost models, processes and reliability of the design. In TM No. 3 CH2M includes comments on many of the aspects of the Biosolids to Energy Project for the City's consideration.

Supporting Visual Aids (Attachment D)

For visual depiction of the existing NEWRF, NWWRF, and SWWRF, and proposed SWWRF improvements, the following has been included in Attachment D.

- Overall existing facility diagrams for NEWRF, NWWRF, and SWWRF generated by Camp, Dresser, and McKee in August 2011
- Proposed site plan and process flow diagram of SWWRF as shown in Brown and Caldwell's Guaranteed Maximum Price for Biosolids to Energy Project Volume 4 – Biosolids Improvements drawings.

Conclusions

As indicated above this peer review included site visits to observe and document the condition of existing solids handling and treatment facilities as well as an evaluation to validate the solids loadings parameters, the solids process selection and the analysis that supported the decision. Several of the existing solids handling and treatment facilities at the City's WRFs are either out service (for example, anaerobic digesters at each WRF) or in poor condition (dewatering at NWWRF and SWWRF). Based on CH2M's observations modifications and upgrades are needed for these facilities. The evaluation of the solids loading parameters and plant capacity indicated they were reasonable and valid.

The solid process selected meets the criteria as defined by the city which includes utilizing a cost-effective, proven technology to produce Class A biosolids in a sustainable manner. The decision to upgrade Class A biosolids is valid based on regulatory drivers and flexibility in biosolids distribution. The Biosolids to Energy project will centralize all solids handling and treatment at the SWWRF. The decision to centralize treatment at SWWRF was based on a present worth cost analysis of hauling and conveyance options was thorough and valid. The selected treatment process (TPAD) is a proven, cost-effective technology that can reliably produce Class A biosolids and provide digester gas for energy recovery. Overall, CH2M finds the assumptions and analysis used in the process selection to be sound and validates the decision to proceed with the Biosolids to Energy Project.

Attachment A

TM No. 1 – Solids Facilities Observations Memorandum

Solids Facilities Observations Memorandum

PREPARED FOR:	City of St. Petersburg
COPY TO:	Alliance for Bayway Communities, Eckerd College
PREPARED BY:	CH2M
DATE:	October 23, 2015
PROJECT NUMBER:	666518
REVISION NO.:	FINAL

CH2M has been tasked by the City of St. Petersburg to perform a peer review of the ongoing projects that will centralize biosolids treatment at the Southwest Water Reclamation Facility (SWWRF). At the completion of these projects all waste sludge from the Northeast Water Reclamation Facility (NEWRF) and the Northwest Water Reclamation Facility (NWWRF) will be pumped to the SWWRF where it will be treated along with SWWRF sludge to Class A standards in a new treatment process that includes thickening, anaerobic digestion, dewatering and energy recovery.

Each of the existing WRFs were designed to thicken, stabilize to Class B standards with a mesophilic anaerobic digestion process followed by dewatering and truck loading for land application. These facilities are still in place however due to expansion, upgrades and out of service equipment each WRF operates differently to make use of the facilities and equipment available to them. The NWWRF and NWWRF both still utilize the original design process of thickening, anaerobic digestion and dewatering but with different technologies and operational techniques. The SWWRF no longer thickens or digests, but utilizes a proprietary lime stabilization process to produce a Class A biosolid following dewatering.

Objective

The objective of this TM is to summarize findings from site visits to the SWWRF, NWWRF and NEWRF. The site visits and the findings described here focus on current biosolids production and the capacity and condition of existing treatment facilities at each WRF. Pictures taken during these site visits are included in Appendix A.

Site Visit Observations

The site visits occurred over two days with the NEWRF site visit on September 29th and the remaining two on September 30th. Each visit began with a review of the current biosolids process and facilities with the respective chief operator as well as other operators as needed. The facilities were then observed and photographed. Key questions to document from the discussions and observations were:

- How does the current hydraulic and mass loading compare to the design capacity?
- Are there process or capacity limitations?
- How the current processes are operated?
- Is the current operation different from the original design?
- What facilities and/or equipment is out of service?
- What is the expected useful life for the current facilities and equipment?
- Equipment condition was based on:

- Corrosion of the metal surfaces
  - Condition of paint or coatings
  - Signs of leaking
  - Concrete surfaces intact with no cracks and no exposed rebar
  - No signs of concrete weeping
  - No major settlement of the tanks and equipment
  - Piping supports and valves not rusted and no sign of leakage. Paint in good condition
  - Equipment not rusted, no abnormal vibration, no leakage, and no abnormal noise.
  - Control panels not rusted, all lights functional, HMIs working, panels function as intended
  - Field instruments working, no loose wiring, well supported

Definition of Condition Assessment

- Very good condition means that the equipment shows no sign of rust, minimal wear and no leaks. It works as intended with normal maintenance required, equipment was installed recently and will operate for many years without replacement of parts for several years
- Good condition means that the equipment shows minimal signs of rust, normal wear, minor leaks and works as intended but with more maintenance than expected but still acceptable, very serviceable and can continue operation for many years but expect some parts replacement.
- Moderate condition means excessive rust but still operational, more wear than would expect and require upgrading if to be in continued use, more noise and vibration than expected, close to its useful life
- Poor condition means the equipment needs to be replaced or total upgraded to make acceptably operational, expect that rust can cause leaks, excessive maintenance, past its useful life

Southwest WRF

As indicated above the SWWRF previously utilized thickening, anaerobic digestion and dewatering for solids treatment. Due to the poor condition of some of these treatment facilities, a proprietary lime stabilization process (Bioset) was added in 2012 to provide treatment and allow SWWRF to produce a Class A product. Therefore, several solids treatment facilities are not in service, some due to failing equipment and others because they are not required as part of the current process.

Thickening

Waste solids are pumped from the secondary treatment process to the Sludge Storage Tank which is in good condition (Figure SWWRF-1). The Sludge Storage Tank is sized to provide operational flexibility, but it not large enough to store solids if a downstream process were out of service for an extended [eriod. The thickening facility is located in the Gravity Belt Thickener (GBT) Building in the northwest portion of the plant site adjacent to the anaerobic digesters (Figure SWWRF-2). The GBT Building is open on the sides and includes one Ashbrook GBT and auxiliary equipment. The building and equipment is in moderate condition. The current biosolids treatment process does not require thickening, but operations continues to maintain this facility for future use. The City has indicated that a second GBT will need to be installed to meet demand and serve as a backup.

Anaerobic Digestion

The three existing digesters at SWWRF have been out of service for at least three years. The floating cover on each digester is in poor condition and some cracking in the tanks have been observed by operations (Figure SWWRF-3 and SWWRF-4). Auxiliary pumping, piping and mixing associated with these digesters appears in moderate condition and has been well maintained (Figure SWWRF-5 and SWWRF-

6). However the original digester facility was constructed in 1955 and therefore much of the equipment, including the gas heaters and components are past the expected useful life.

Dewatering

The SWWRF utilizes belt filter presses (BFPs) for dewatering prior to the Bioset process (Figure SWWRF-7). The BFPs, installed in the 1980s, are in moderate condition and are at or near the end of their useful life. The polymer includes two dry polymer make-up units installed in 1985, and they appear to be in moderate condition. An upgrade to a new emulsion polymer system is in progress. Some auxiliary equipment in the Sludge Dewatering Building has been upgraded. The dewatered sludge feeds into a screw conveyor system which is in moderate condition.

Lime Stabilization

A Bioset system was installed at SWWRF in 2012 as an interim replacement of the treatment capacity of the failing digesters before the new digesters as part of the Biosolids to Energy Project. The Bioset process operates between 10-12 hours per day, seven days a week by adding lime to the dewatered sludge which maintains elevated temperature and pH levels in order to stabilize the biosolids (Figure SWWRF-8 and SWWRF-9). The Bioset process has been approved to produce Class A biosolids. Operations indicated that this process and the low metals present in the raw wastewater allow SWRF to produce a Class AA biosolid. The addition of the Bioset reactor as part of the conveyance upgraded a portion of the truck loading area which overall appeared in moderate to good condition.

Northeast WRF

The NEWRF continues to utilize thickening, mesophilic anaerobic digestion and dewatering to treat its waste sludge and produce a Class B biosolid. However, due to the poor condition of some facilities and some facility upgrades the operation has been adjusted to meet the current conditions. The solids treatment processes at NEWRF are operated continuously in order to get consistent stabilization in the digester and maximize dewatering capacity.

Thickening

Waste activated sludge from the secondary process is thickened by two Ashbrook GBTs. Both GBTs appear in good condition with one in service approximately 6 years and another in service 15 years. Operations indicated good performance from the GBTs as NEWRF thickens to an average of 8.2% solids with a maximum of 9.2% and a minimum of 7.1% in order to maximize detention time in the one in-service digester. The GBT Building and auxiliary facilities also appeared in good condition (Figure NEWRF-1). Thickened sludge is pumped to the anaerobic digester with one of three progressing cavity pumps. These pumps appear in good condition and operations did not indicate any significant operational or maintenance related issues (Figure NEWRF-2).

Anaerobic Digestion

The NEWRF has three anaerobic digesters. Digesters No. 1 and No. 2 were constructed in 1955 and share a building with auxiliary piping and pumping. Digester No. 3 was added in the 1980s. In 2012 Digester No. 1 was relined and its floating cover rehabilitated (Figure NEWRF-3 and NEWRF-4). Digester No. 1 appears in moderate to good condition. Volatile gas produced in the digester is burned through an adjacent flare which appears in moderate condition (Figure NEWRF-5).

Currently Digester No. 1 is the only digester in service as the poor condition of the floating covers require Digesters No. 2 and No. 3 be out of service (Figure NEWRF-6). Digester No. 2 had a membrane failure causing seepage through the walls; however, Digester No. 3 can be used for storage as needed. The original digester facility was constructed in 1955 and much of the equipment is past its useful life including the gas heater system.

The digested sludge is transferred to dewatering via another progressing cavity pump station. These pumps appeared in good condition and operations did not indicate any operational or maintenance related issues (Figure NEWRF-7).

Dewatering

The dewatering process includes one BFP (in service approximately 30 years) and two screw presses added in 2013 (Figure NEWRF-8). The BFP is maintained as a backup to the two screw presses which operate continuously. The dewatering process includes three Siemens Polyblend polymer blending units. These appear in excellent condition (Figure NEWRF-9). The screw presses are in good condition and operations indicated they can produce a dewatered product with up to 18% solids (Figure NEWRF-10). The City indicated that the hauled sludge from NEWRF had an average solids content of 16.1% with a maximum of 17.8% and a minimum of 14.1% so far during 2015.

The dewatered sludge is fed into a screw conveyor which shows some wear on the trough and screw but no significant corrosion. The conveyor system includes a flat section which receives the dewatered biosolids, an inclined shaftless screw that transfers the product to the truck loading area, and a final section which can rotate and has a reversing motor to fill either of the two truck bays. Operations indicated there were no major operational or maintenance related issues with the conveyors (Figure NEWRF-11 and NEWRF-12).

Northwest WRF

The NWWRF also utilizes thickening, mesophilic anaerobic digestion and dewatering to treat its waste sludge to a Class B biosolid.

Thickening

Waste activated sludge from the secondary process is thickened by two Ashbrook GBTs. Both GBTs appear in moderate to good condition and no major operational or maintenance issues were discussed. The PLC that controls both GBTs contains controls that are in poor condition. The City has indicated that there are constant problems with sequencing control and ancillary equipment. The GBTs have recently yielded an average solids content of 6.4% with a minimum of 5.4% and a maximum of 7.2%.

The auxiliary equipment (for example, polymer storage feed system and wash water system) in the thickening process has not been upgraded and did show some wear (Figure NWWRF-1 and NWWRF-2). The polymer feed system currently uses a dry polymer, which requires excess dosing. The City has indicated that a new liquid polymer mixing and feed system is purchased and ready to be installed.

Anaerobic Digestion

The NWWRF has four anaerobic digesters onsite, however only two are in service. Digester No. 1 and No. 2, originally constructed in the 1950s, continue to produce Class B biosolids through a reduction in volatile solids (Figure NWWRF-3 and NWWRF-4) although Digester No. 1 has a hole in the gas collector skirt. Digesters No. 1 and No. 2 have gas collector style covers.Volatile gas produced in the digesters is burned through an adjacent flare which appears in moderate condition.

Digesters No. 3 and No. 4 have been out of service for several years. Digesters No. 3 and No. 4 had floating covers. These floating covers were in poor condition, collapsed, and have been removed. Digester No. 3 is used for sludge storage as needed (Figures NWWRF-5, NWWRF-6 and NWWRF-7).

The auxiliary equipment that supports Digester No. 3 and No. 4 includes a gas heater with the capability to generate heat using natural gas or digester gas. The equipment appeared in poor condition. Operations had no working knowledge of that equipment as they have not been operated in several years (Figure NWWRF-8, NWWRF-9 and NWWRF-10).

Dewatering

The dewatering process at NWWRF consists of two Ashbrook BFPs, a polymer storage and feed system, conveyors and truck loading. The BFPs are in moderate to poor condition and near the end of their useful life (Figure NWWRF-11, NWWRF-12 and NWWRF-13). Operations indicated the BFPs require frequent maintenance to remain in service. The BFPs have recently yielded an average solids content of 13.5% with a minimum of 11.2% and a maximum of 14.9%. This dewatering performance is lower than the other facilities and on the low end of expected BFP performance, which is likely due to the poor condition of the equipment.

The electrical equipment at dewatering is in poor condition and at the end of the useful life. Operations indicated that many parts are obsolete and difficult to find. The polymer storage and feed system is also in moderate to poor condition and near the end of its useful life. An ongoing project will upgrade the existing system to liquid polymer blending system similar to that at SWWRF and NEWRF (Figure NWWRF-14 and NWWRF-15).

The conveyor system is similar to the NEWRF, but shows more signs of wear and corrosion (Figure NWWRF-16 and NWWRF-17).

Summary

All three WRFs were designed with similar processes to handle, treat and dispose of waste sludge. Various upgrades and expansions over the years have changed the processes and facilities at each of the WRFs. In addition, aging facilities and failing equipment has forced changes to the operation and the process. At each WRF there exists facilities and equipment that continues to appear in good condition and operates reliability due to recent upgrades and good maintenance practices. However, each WRF also has facilities and equipment that is currently out of service, in poor condition or past its expected useful life.

The most notable process change occurred at the SWWRF where a lime stabilization process (Bioset) was added. This change was necessary because the floating covers on the anaerobic digesters failed and another method of stabilization was required. The Bioset process is in good condition, fits within the existing dewatering footprint and produces a Class AA biosolid. The process does have drawbacks however, the overall amount of solids for disposal is significantly higher with the Bioset process due to the lack of volatile solids reduction and the addition of lime for treatment. This creates an increase in operational and disposal costs as well as additional truck trips at the WRF.

The NEWRF and NWWRF still utilize the design solids treatment processes including thickening, mesophilic anaerobic digestion and dewatering. Both WRFs use GBTs for thickening with moderate to good conditions. The NEWRF is only operating with one anaerobic digester due to failing floating covers on Digester No. 2 and Digester No. 3. Therefore, the NEWRF has no onsite redundancy for sludge stabilization. The NWWRF has four total anaerobic digester, but Digesters No. 3 and No. 4 have been out of service for several years. Both WRFs continue to produce Class B biosolids but have reduced capacity due to these out of service facilities.

Dewatering at the NEWRF has sufficient capacity and redundancy with a BFP available to back the two in-service screw presses. This dewatering facility is in good condition and is operating well. In contrast the dewatering facility at NWWRF is in poor condition. The existing polymer storage and feed system and the two BFPs require significant maintenance.

Appendix A
Site Visit Pictures

SWWRF

Figure SWWRF-1. Sludge Storage Tank
Southwest WRF

Figure SWWRF-2. Gravity Belt Thickener
Southwest WRF

Figure SWWRF-3. Anaerobic Digester No. 1 Floating Cover
Southwest WRF

Figure SWWRF-4. Anaerobic Digester No. 2 Floating Cover
Southwest WRF

Figure SWWRF-5. Anaerobic Digester No. 1 and No. 2 Piping
Southwest WRF

Figure SWWRF-6. Anaerobic Digester Decant No. 3 Piping and Draft Tube Mixer
Southwest WRF

Figure SWWRF-7. Belt Filter Press
Southwest WRF

Figure SWWRF-8. Bioset System
Southwest WRF

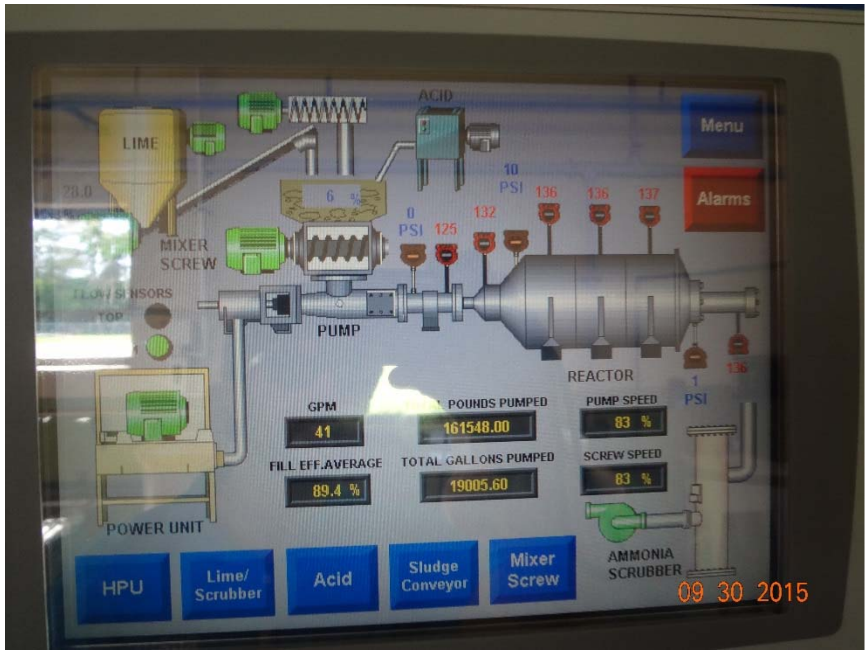


Figure SWWRF-9. Bioset Control Panel
Southwest WRF

NEWRF

Figure NEWRF-1. Gravity Belt Thickener
Northeast WRF

Figure NEWRF-2. Sludge Transfer Pump Station
Northeast WRF

Figure NEWRF-3. Anaerobic Digester No. 1
Northeast WRF

Figure NEWRF-4. Anaerobic Digesters No. 1 and No. 2 Pumping
Northeast WRF

Figure NEWRF-5. Anaerobic Digester Gas Flare
Northeast WRF

Figure NEWRF-6. Anaerobic Digester No. 2 Floating Cover
Northeast WRF

Figure NEWRF-7. Sludge Feed Pump Station
Northeast WRF

Figure NEWRF-8. Dewatering Building
Northeast WRF

Figure NEWRF-9. Dewatering Polymer Blending Units
Northeast WRF

Figure NEWRF-10. Screw Presses
Northeast WRF

Figure NEWRF-11. Screw Conveyor
Northeast WRF

Figure NEWRF-12. Truck Loading
Northeast WRF

NWWRF

Figure NWWRF-1. Gravity Belt Thickener
Northwest WRF

Figure NWWRF-2. Gravity Belt Thickener Piping
Northwest WRF

Figure NWWRF-3. Anaerobic Digester No. 1
Northwest WRF

Figure NWWRF-4. Anaerobic Digester No. 1 and No. 2 Pumping
Northwest WRF

Figure NWWRF-5. Anaerobic Digester No. 3
Northwest WRF

Figure NWWRF-6. Anaerobic Digester No. 4
Northwest WRF

Figure NWWRF-7. Anaerobic Digester No. 4 Draft Tube Mixer
Northwest WRF

Figure NWWRF-8. Anaerobic Digesters No. 3 and No. 4 Building Second Floor
Northwest WRF

Figure NWWRF-9. Anaerobic Digesters No. 3 and No. 4 Gas-fired Heater
Northwest WRF

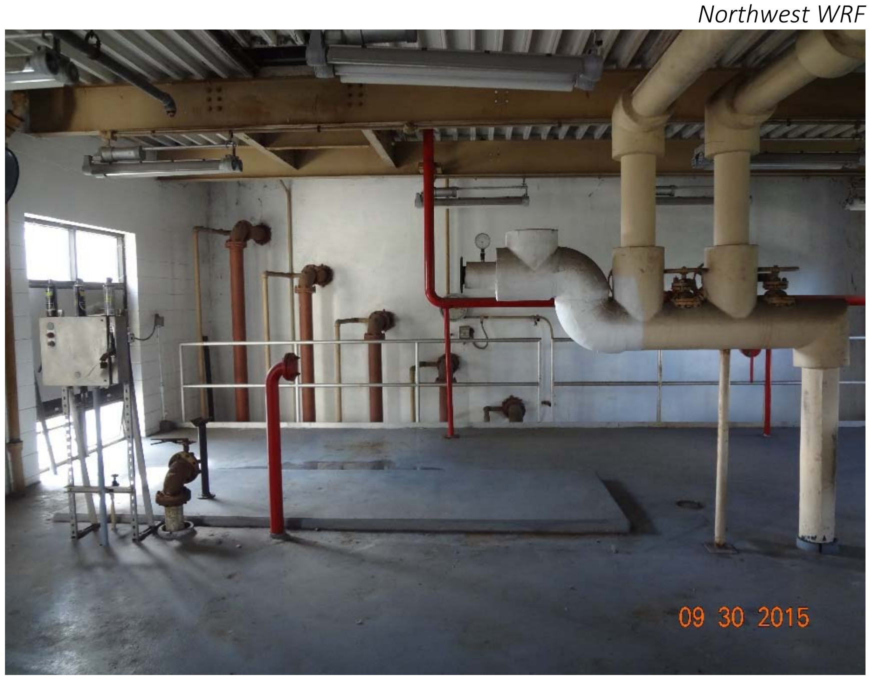


Figure NWWRF-10. Anaerobic Digester Building Third Floor
Northwest WRF

Figure NWWRF-11. Belt Filter Press
Northwest WRF

Figure NWWRF-12. Belt Filter Press
Northwest WRF

Figure NWWRF-13. Belt Filter Press Electrical Room
Northwest WRF

Figure NWWRF-14. Dewatering Polymer Pumping
Northwest WRF

Figure NWWRF-15. Dewatering Polymer Storage and Feed
Northwest WRF

Figure NWWRF-16. Dewatered Sludge Conveyer
Northwest WRF

Figure NWWRF-17. Truck Loading
Northwest WRF

Attachment B

TM No. 2 – Validation of Plant Loadings Parameters and Plant Capacity

Validation of Plant Solids Loadings Parameters and Plant Capacity

PREPARED FOR:	City of St. Petersburg
COPY TO:	Alliance for Bayway Communities, Eckerd College
PREPARED BY:	CH2M
PROJECT NAME:	Wastewater Projects Peer Review
CITY PROJECT No.:	15074-121
CITY TASK ORDER No.:	12-07-CH2/W
DATE:	October 27, 2015
CH2M PROJECT NUMBER:	666518
REVISION NO.:	FINAL

CH2M has been tasked by the City of St. Petersburg to perform a peer review of the Biosolids to Energy Project that will centralize biosolids treatment at the Southwest Water Reclamation Facility (SWWRF). At the completion of these projects, all waste sludge from the Northeast Water Reclamation Facility (NEWRF) and the Northwest Water Reclamation Facility (NWWRF) will be pumped to the SWWRF where it will be treated along with SWWRF sludge to Class A standards in a new treatment process that includes thickening, anaerobic digestion, dewatering and energy recovery. Flows, including waste sludge, from the Albert Whitted WRF (AWWRF) collection basin have already been diverted to SWWRF for treatment, and these additional flows influent flows to SWWRF have been permitted by the Florida Department of Environmental Protection (FDEP).

Objective

The objective of this Technical Memorandum ™ will be to validate the solids loadings parameters used in the selection of the centralized solids treatment processes and any impacts to overall capacity at the Southwest WRF.

Documents

The following documents were reviewed as part of the evaluation:

- TM No. 1: Basis of Conceptual Design of Evaluation for Sludge and Yard Waste Production Rates, August 26th, 2010 (TM1)
- TM No. 3: Evaluation of WRF Sludge Consolidation/Conveyance Options to SWWRF and NW/NEWRF Conversion to Class-A Biosolids/Beneficial Reuse to Land Disposal, January 20th, 2011 (TM3)
- TM No. 4: Recommended Plan for Biosolids Waste to Energy, July 18th, 2011 (TM4)
- Preliminary Design Report, Biosolids to Energy Project, June 19th, 2015, (PDR)
- Southwest Water Reclamation Facility Biosolids to Energy Project, Volume 4 – Drawings Biosolids Improvements. Guaranteed Maximum Price. (GMP Biosolids Drawings)

Findings

Design Flows and Loads

The Biosolids to Energy Project will centralize solids treatment at the SWWRF; therefore, the solids handling and treatment facilities at SWWRF must be designed for the projected solids at all three WRFs. The NEWRF and NWWRF will pump waste activated sludge (WAS) into the SWWRF collection system where it will be treated initially as part of the liquid stream. Due to this higher solids loading into the SWWRF, the Biosolids to Energy Project includes modifications to the liquid treatment stream at SWWRF with the addition of primary clarification. The development of the design flows and loads for this project included both an evaluation of historical data and projections from a calibrated process model. The evolution of this process is described below.

Evaluation of Historical WRF Data

NEWRF and NWWRF

The key design parameter for the Biosolids to Energy Project of the NEWRF and NWWRF is WAS generation. Initially WAS generation rates were determined for each facility from 2007-2009 operating data and included in TM1. This included four conditions: annual average day (AAD), maximum month average day (MMAD), maximum week average day (MWAD), and maximum day (MD). The values were used to develop peaking factors for each of these loading conditions.

The AAD WAS values were also compared with the influent (5-day carbonaceous biological oxygen demand) $CBOD_5$ to determine the net sludge yield for each WRF. The data analyzed for the NEWRF provided a net sludge yield of 0.9 lb-VS (volatile solids)/lb-BOD_5, which is consistent with typical values seen for plants operating at similar conditions. Similar data for the NWWRF resulted in a net sludge yield of 1.17 lb-VS/lb-BOD_5, which is considered high but was used further in the analysis.

The procedures used in determining the WAS rates and sludge yield are reasonable and typical of those used in this type of evaluation. However, standard engineering practices typically utilize five or more years of data when available, and therefore additional years of data would provide a higher level of confidence.

SWWRF

Initially the development of the design loadings for SWWRF in TM1 included WAS generation rates determined via the same manner as described above for NEWRF and NWWRF. As the project developed however, these WAS generation rates were not relevant due to the addition of primary clarification at SWWRF and the addition of the flow from the AWWRF that is no longer in service. Primary clarification at SWWRF was first described in TM3 as part of the evaluation on the consolidation/conveyance options of the Biosolids to Energy Project. The results of this evaluation led to the selection of an alternative that included conveyance of WAS from NEWRF and NWWRF to the SWWRF collection system. In order to mitigate impacts to the secondary treatment processes at SWWRF due to the higher influent loadings—and increase gas production in the digestion process due to a higher percentage of volatile solids—primary clarification was included. The addition of primary clarification will significantly impact the existing secondary treatment process, and therefore historical data on WAS production at SWWRF is not relevant to the Biosolids to Energy Project moving forward. Due to the lack of relevant historical data, design loadings for the project were determined by process modeling which is described below.

In order to develop the process model, influent flows and loads at the SWWRF are required. In an earlier version of the PDR (September 6, 2013), Brown and Caldwell (BC) analyzed influent flow and load projections based on historic City service area information, multiple population projections, and historic flow and load information at each WRF. The influent flow projections during dry and wet weather conditions and subsequent peaking factors will be reviewed and analyzed in another report as part of another ongoing project (City Project No. 15073-121).

The City service area information utilized the US Census Bureau to obtain year 2010 population information. The City of St. Petersburg Planning Commission's and the City Council's *2007 Evaluation and Appraisal Report* was used to determine that "because the City is nearly fully developed (less than 6% vacant), the land use within the City is not anticipated to change significantly within the planning period for this project which is through the year 2035." This assumption, which seems reasonable, provides for constant peaking factors to be used throughout the future influent flows and loads projections as the population and land uses are not expected to change significantly over time.

The multiple population projections used in BC's earlier version of the PDR were used to determine annual average wastewater flow percentage increases. The language of the multiple population projections was not included in BC's Final PDR, but the annual average wastewater flow percentage increases noted in each report were the same (0.026% for NEWRF and NWWRF Services Areas, and 0.400% for AWWRF and SWWRF Service Areas). The Final PDR noted that these values were recommended by the City.

The following assumptions were used to develop pollutant loadings in Table 2-7 in the PDR for Temperature, $CBOD_5$, total suspended solids (TSS), total Kjeldahl nitrogen (TKN), and total phosphorus (TP):

- The permitted AADF of 20-mgd (millions gallons per day) will be used despite a projected flow of 17.91-mgd in 2035
- There will be no new significant industrial loads
- The influent wastewater into SWWRF will be primarily domestic
- Influent pollutant concentrations would not change in the future due to infiltration and inflow rehabilitation in the collection system or reduced water consumption
- Influent concentration and loadings for SWWRF and AWWRF from January 2007 through December 2011.
- Utilization of SWWRF Design Loading Rates (chemical oxygen demand (COD) to $CBOD_5$, $CBOD_5$ to TSS, volatile suspended solids (VSS) to TSS, COD to TKN, ammonia (NH_3-N) to TKN, COD to TP, phosphate (PO_4-P) to TP) from a wastewater characterization study conducted by BC and report submitted by BC on March 18, 2013 entitled *City of St. Petersburg's Southwest Water Reclamation Facility Treatment Process and Hydraulic Evaluation*.

Significant upgrades to the collection system that reduce infiltration and inflow could reduce influent flow and thus increase the influent pollutant concentrations. However, this types of upgrades do not impact the population served or the influent loadings to the WRF. The loadings for the SWWRF provided in Table 2-7 were developed using a reasonable approach and appear to be conservative based on the historical data and industry standards.

Design Loading to the Biosolids to Energy Facilities

As indicated above, the addition of primary clarification at the SWWRF made the historical sludge production data less relevant and required process modeling to determine the design loadings to the new solids processes which was described in the PDR. The BioWin model included the secondary treatment processes at the NEWRF and NWWRF along with the proposed primary/secondary processes at SWWRF. A schematic of the model is included in the PDR as Figure 2-7. The PDR indicates that the historical WAS data from the NEWRF and the NWWRF was used to calibrate these components of the model. Design influent AADFs in 2035 of 11.57-mgd and 10.11-mgd for the NEWRF and the NWWRF respectively were presented in Table 2-1 in the PDR. These flowrates assumed a 0.026% per year increase in the AADF. The influent loading conditions to the NEWRF and the NWWRF were not presented in the PDR however. The influent loading and the subsequent WAS production for the NEWRF and NWWRF will be confirmed as part of the ongoing review of the calibrated BioWin model.

The influent flows and loads to the SWWRF were included in the PDR as described above. The PDR indicated that a range of primary clarifier performance was modeled and the sludge production rates at 65%, 70% and 80% performance (per TSS removal) were presented in Table 2-11. The WAS production rates were determined using the BioWin model with an approximate net sludge yield of 0.5 lb-VS/lb-BOD_5, which is consistent with WRFs using similar processes. The final design loadings to the new consolidated solids treatment facilities included in the Biosolids to Energy Project were presented in Table 2-12, which matched the values listed in the Mass Balance included in the GMP Biosolids Drawings. The PDR indicated a primary clarifier performance of 80% was assumed along with the addition of ferric chloride to enhance settling. This level of performance provides a conservative approach for sizing primary sludge handling facilities, but may impact other parameters such as gas production in digestion and secondary treatment performance.

Centralized Solids Processing and Handling Facilities

Primary Clarification

The initial concept for adding primary clarification to SWWRF was described in TM3 and utilized repurposed tanks and high surface overflow rates. However, as the project progressed it was determined that new primary clarifiers would be constructed and sized to provide surface overflow rates more typical to industry standards. The primary clarification facilities included in the Biosolids to Energy Project design are described in the PDR and key parameters are summarized in the following table.

Table 1. Primary Clarification
Biosolids to Energy Project Peer Review

Parameter	Value	Note
Primary Clarifiers		
Maximum Design Flow	40-mgd (combined)	
Number of Units	2	
Diameter	100-ft	
Surface Area	7,584-ft^2 (each)	
Surface Overflow Rate	Average: 1,295-gpd/ft^2 Peak: 2,585-gpd/ft^2	Installed capacity
Maximum Fe Addition	5 mg/L	As Ferric Chloride
Target TSS Removal	AADF: 85% MMADF: 80%	MMADF value per Mass Balance in GMP Biosolids Documents

Notes: gpd – gallons per day; mg/L – milligrams per liter

Primary clarification was designed to treat flows up to 40-mgd or two times the design AADF. It was indicated that flows above 40-mgd are due to wet weather events and are not expected to increase the loading to the WRF and thus not impact downstream liquid processes. In addition, WAS storage is provided at NEWRF and NWWRF and operations can limit or cease pumping WAS during peak wet weather flow events, which eliminates any impacts the Biosolids to Energy Project has on the hydraulic capacity at SWWRF. These assumptions seem reasonable for this application.

The surface loading rates listed are for the installed capacity and therefore significantly higher rates would be seen with one unit out of service. The expected performance with one unit of service was not included in the PDR. Any impacts to secondary treatment with a reduction in performance in this condition will be determined as part of the ongoing review of the calibrated BioWin model used in the design of the Biosolids to Energy Project and a thorough evaluation on the process selection will be included in TM 3 Validation of Solids Process Selection and Supporting Analysis as part of this Wastewater Project Peer Review.

WAS Pumping and Holding

The existing WAS pumping and WAS Holding Tank will continue to be utilized in the new process but the WAS grinders and some WAS and secondary scum pumping will be relocated. The modifications to the liquid processes will not impact the capacity of the WAS system.

Thickening

All primary and secondary sludge produced at the SWWRF will be pumped to the existing WAS Storage Tank before thickening. The modification to the thickening process at SWWRF includes the addition of a second 2-meter gravity belt thickener (GBT), enclosing the existing Thickening Building and connecting the facility to the new odor control system. The thickening modifications were detailed in Appendix B of the PDR.

Table 2. Thickening
Biosolids to Energy Project Peer Review

Parameter	Value	Note
Gravity Belt Thickeners		
Number of Units	Two	
Size	2-meter (each)	
Loading	200-gpm 300-gpm	AADF (PS + WAS) PHF (PS + WAS)
Thickened Sludge Performance	6%	

Notes: gpm – gallons per minute

The modifications to the thickening process also include additional auxiliary equipment for the new GBT including a thickened sludge transfer pump, a wash water pump and an emulsion polymer system. The modifications to the thickening process utilize existing facilities and equipment where possible and provide a reasonable level of service and redundancy.

Anaerobic Digestion and Gas Handling

Anaerobic Digestion
The proposed anaerobic digestion process utilizes a thermophilic digester, followed by batch tanks and finally a mesophilic digester which will produce a Class A biosolid and provide gas for energy recovery. Some key design criteria and process parameters for the digesters are summarized in the table below.

Table 3. Anaerobic Digestion
Biosolids to Energy Project Peer Review

Parameter	Value	Note
Design Criteria		
Thermophilic Volatile Solids Loading Rate	Less than 0.35-lb VS/ft^3 day	At Peak week per PDR
Thermophilic Hydraulic Retention Time	Greater than 7 days	At AADF conditions
Mesophilic Volatile Solids Loading Rate[1]	Less than 0.20 lb VS/ft3 day	At MWAD
Mesophilic Hydraulic Retention Time	Greater than 10 days	At AADF conditions
Digester 1 Thermophilic		
Diameter	100-ft	
Operating Volume	1.76-MG	
Hydraulic Retention Time	10.4 days	AAD
	8.9 days	MMAD
	7.4 days	MD
Volatile Solids Loading Rate[2]	0.33 lb-VS/ft^3 day	MMAD
	0.40 lb-VS/ft^3 day	MD
Batch Tanks		
Length / Width	Six 21-ft x 21-ft cells	
Operating Volume	0.247-MG	Combined
Hydraulic Retention Time	34.9 hours	AAD
	29.8 hours	MMAD
	24.6 hours	MD
Digester 2 Mesophilic		
Diameter	105-ft	
Operating Volume	2.3-MG	
Hydraulic Retention Time	13.5 days	AAD
	11.5 days	MMAD
	9.5 days	MD
Volatile Solids Loading Rate[3]	0.13 lb-VS/ft^3 day	MMAD
	0.15 lb-VS/ft^3 day	MD

Note: 1. Recommended by CH2M. 2. Approximated based on 78.5% VSS/TSS in combined sludge. 3. Approximated assuming 50% VSS reduction in thermophilic digester

The volatile solids loading criteria defined in the PDR is based on a maximum week condition. However, neither the mass balance in the PDR or in the GMP Biosolids Drawings included maximum week loading conditions so this design criteria could not be validated. The digesters do meet the hydraulic retention time criteria specified in the PDR, but since the retention times are within 7-13 days the maximum week retention time would also be relevant to this analysis. A thorough evaluation on the process selection will be included in TM 3 Validation of Solids Process Selection and Supporting Analysis as part of this Wastewater Project Peer Review.

Digester Gas Production and Handling

A key component of the Biosolids to Energy project is the ability to recover energy both as gas from the digestion process and the potential biosolids as a future fuel source. A combined waste to energy facility utilizing yard waste and biosolids as feedstocks is not included in the current project, but was included as a potential second phase in the future. The current project does include new facilities to collect, upgrade and use gas produced in the digesters.

An evaluation of predicted digester performance, gas production and the overall worth will be included in TM 3 Validation of Solids Process Selection and Supporting Analysis as part of this Wastewater Project Peer Review.

Dewatering

In the final process of the Biosolids to Energy Project the digested sludge will be dewatered prior to hauling to land application sites. The initial technology selected for this application was centrifuge dewatering. However after a technology review the decision was made to not use centrifuges primarily due to the potential for pathogen reactivation and regrowth following the Temperature-Phased Anaerobic Digestion (TPAD) process. Potential dewatering technologies were reviewed again and screw presses were selected for this project. Due to this change the PDR does not contain the same level of detail for the dewatering processes as compared to the other process. The information included in the table below was compiled from the PDR and the GMP Biosolids Drawings.

Table 4. Dewatering
Biosolids to Energy Project Peer Review

Parameter	Value	Note
Design Criteria	159-gpm 2,821-lbs/hr 3.6% solids	Maximum day conditions per PDR Appendix C
Operating Time	24 hours/day 7 days/week	
Screw Presses		
Number of Units	Three	
Dewatered Sludge Performance	15%	Per GMP Biosolids Drawings

Notes: lbs/hr – pounds per hour

The selection of screw presses for dewatering is reasonable based on the technology review provided in the PDR and based on CH2M project experience. Additional information on the process selection will be included as needed in TM 3 Validation of Solids Process Selection and Supporting Analysis as part of this Wastewater Project Peer Review.

Overall Southwest WRF Capacity

The secondary treatment process at SWWRF will be impacted by the Biosolids to Energy Project due to the additional loads from the WAS conveyed from NEWRF and NWWRF, the addition of primary clarification and the increased recycle flows due to larger solids treatment and handling facilities. The potential impacts will be evaluated as part of the ongoing review of the calibrated BioWin model.

Summary

The original solids loading data developed for this project included WAS and digested sludge production rates of the then four operating WRFs. Based on the selected alternative which included a centralized solids treatment facility at SWWRF, conveyance of WAS from NEWRF and NWWRF to the SWWRF collection system and the addition of primary treatment at SWWRF much of this initial data was no longer relevant. The WAS production rates from NEWRF and NWWRF were still used to calibrate WAS flows added to the influent flow at SWWRF. The remaining solids loading parameters were developed using BioWin model calibrated to existing data for some processes and to industry standards for new processes. Influent information for the SWWRF included in the PDR appeared to be reasonable and appropriate. An evaluation of the BioWin model is ongoing, and a peer review of any information relevant to this model will be included in TM 3 – Validation of Solids Process Selection and Supporting Analysis.

A preliminary analysis was also made of the projected loadings to the new or modified facilities included in the Biosolids to Energy project: primary clarification, combined sludge thickening, anaerobic digestion and dewatering. No unreasonable loading conditions were observed in this analysis, however a more thorough evaluation of the selected process will be included in TM 3 as part of this Wastewater Project Peer Review.

Attachment C

TM No. 3 – Validation of Solids Process Selection and Supporting Analysis

Validation of Solids Process Selection and Supporting Analysis

PREPARED FOR:	City of St. Petersburg
COPY TO:	Alliance for Bayway Communities, Eckerd College
PREPARED BY:	CH2M
DATE:	November 30, 2015
CITY PROJECT NUMBER:	15074-121
TASK ORDER NUMBER:	12-07-CH2/W
REVISION NO.:	FINAL

CH2M has been tasked by the City of St. Petersburg to perform a peer review of the Biosolids to Energy Project that will centralize biosolids treatment at the Southwest Water Reclamation Facility (SWWRF). At the completion of these projects, all waste activated sludge from the Northeast Water Reclamation Facility (NEWRF) and the Northwest Water Reclamation Facility (NWWRF) will be transferred into the SWWRF collection system and conveyed by gravity to the head of the plant. Primary clarification will be added to treat the additional load prior to secondary treatment and to enhance the solids processes downstream. The upgraded solids treatment train at SWWRF will produce biosolids to Class A standards utilizing a process that includes thickening, temperature phased anaerobic digestion, dewatering and energy recovery.

Objective

The objective of this Technical Memorandum (TM) is to review and validate the selection of the solids treatment processes, the decision to centralize the facilities at the SWWRF and the parameters and analysis that supported these decisions.

Documents

The following documents produced by Brown and Caldwell (B&C) were reviewed as part of the evaluation:

- TM No. 2: Evaluation of Heat Drying System at SWWRF – Post Mechanical Sludge Dewatering/Pre Proposed Energy Recovery Process; January 20th, 2011. (B&C TM No. 2)
- TM No. 3: Evaluation of WRF Sludge Consolidation/Conveyance Options to SWWRF and NW/NEWRF Conversion to Class-A Biosolids/Beneficial Reuse to Land Disposal; January 20th, 2011. (B&C TM No. 3)
- TM No. 4: Recommended Plan for Biosolids and Yard Waste to Energy; July 18th, 2011. (B&C TM No. 4)
- TM No. 5: Evaluation of Centralization of Solids Projects; March 20th, 2013. (B&C TM No. 5)
- TM No. 6: FOG and Gas Treatment Evaluation; June 9th, 2014. (B&C TM No. 6)
- PDR: Biosolids to Energy Project; June 19th, 2015. (B&C PDR)

- Southwest Water Reclamation Facility Biosolids to Energy Project, Volume 2 – Technical Specifications. Guaranteed Maximum Price; September 2015. (B&C GMP Biosolids Specifications)
- Southwest Water Reclamation Facility Biosolids to Energy Project, Volume 4 – Drawings Biosolids Improvements. Guaranteed Maximum Price; September 2015. (B&C GMP Biosolids Drawings)

Findings

Regulatory Discussion

In B&C TM No. 3, the regulatory discussion begins by stating that 'Florida Statute 62-640 requires that biosolids processing be improved to Class-A treatment levels or for all practical purposes bans land application of those biosolids.' B&C continues by describing the level of treatment required to produce Class A and benefits of producing Class A biosolids including public relations, disposal options, and long term cost effectiveness. The City currently produces Class B biosolids at the NEWRF and NWWRF and distributes the solids for land application. In order to produce Class A biosolids a higher level of treatment is required, but the resulting product can be used as a fertilizer product with fewer restrictions for use as compared to Class B biosolids.

CH2M offers the following comments on the regulatory aspects of the Biosolids to Energy Project as part of this peer review:

1. The Florida Department of Environmental Protection (FDEP) has increased the requirements for land application sites that receive Class B solids. All land application sites must now be permitted by the FDEP through one responsible party (for example, site owner, biosolids hauler) according to the *Biosolids in Florida: 2013 Summary* (FDEP December 2014, http://www.dep.state.fl.us/water/wastewater/dom/docs/BiosolidsFlorida-2013-Summary.pdf). However, these changes have not banned Class B biosolids or significantly reduced the amount of land application to date. According to the FDEP summary, in 2013 32% of all biosolids produced in Florida were used in land application as compared to 33% used for Class AA marketing and 35% disposed in landfills.
2. The production of Class A biosolids does have advantages over land application of Class B some of which are described in B&C TM No. 3. The decision for the City to produce Class A solids does provide greater flexibility in the future and is reasonable for this project.

Alternatives Analysis

Range of Treatment and Disposal Options

Based on review of the documents listed above, B&C TM No. 3 includes the primary evaluation of alternatives for the handling and treatment of biosolids with some updated information and a follow-up evaluation included in B&C TM No. 4. Seven alternatives were identified and evaluated in B&C TM No. 3:

Alternative 1 – Class A treatment at each WRF

Alternative 2 – Consolidated Treatment at SWWRF

Alternative 2a – No digestion with thermal energy recovery

Alternative 2b – Class B digestion with thermal energy recovery

Alternative 2c – Class A digestion without thermal energy recovery

Alternative 2d – Class A digestion thermal energy recovery

Alternative 3 – Dewatered Sludge Cake Hauling

Alternative 3a – Haul raw dewatered cake to SWWRF

Alternative 3b – Haul Class B digested, dewatered cake sludge to SWWRF

These alternatives did provide a reasonable range of conveyance and treatment options, however the following comments were developed during this peer review:

1. B&C TM No. 3 stated that municipal wastewater agencies have tended to implement lower-cost technologies for produced Class A as compared to higher-cost options such as composting or heat-drying. During CH2M's review of the Class A biosolids producers in Florida listed in the 2014 FDEP report two utilities were identified using digestion, while the majority used heat drying, composting, or lime stabilization. Based on the widespread use and success of these other technologies, including them in the high level economic evaluation and triple-bottom-line assessment (financial, social and environmental included in B&C TM No. 3) would have provided more support for B&C's ultimate recommendation of anaerobic digestion.
2. All alternatives included in B&C TM No.3 (and listed on page 2) that utilized Class A digestion included the temperature phased anaerobic digestion (TPAD) process. Additional digestion processes (thermal hydrolysis followed by mesophilic digestion, batch thermophilic digestion, and multi-stage thermophilic digestion) were evaluated in previous workshops, but not in the present worth analysis shown in B&C TM No. 3. The TPAD process is an established, reasonable process for this application.
3. Two options for biosolids distribution were included within the evaluated alternatives: land application and use as a feedstock along with yard waste to the proposed thermal energy facility. Additional options that could have been evaluated include utilizing a third party vendor or landfill disposal. Landfill disposal does not provide some of the benefits that Class A or land application does, but inclusion would provide a baseline cost for comparison. Utilizing a third party biosolids vendor to further treat and distribute the City's biosolids was mentioned in B&C TM No. 3 (H&H facility in Clewiston, FL), however there was not expected to be sufficient capacity for the City's solids. It was not indicated whether other third party vendors were evaluated, but the amount of solids produced by the City would provide a significant baseload for a vendor attempting to develop a regional facility in the Bay area.

Evaluation of Selected Alternative

In the conclusions of B&C TM No. 3, Alternative 2d (Consolidated Class A Digestion at SWWRF with Thermal Energy Recovery) was recommended, but with a phased approach to implement the biosolids improvements first and the energy recovery facility sometime in the future. The first phase of this approach is essentially Alternative 2c (Consolidated Class A Digestion at SWWRF without Thermal Energy Recovery). Neither alternative included using the Class A product as a feedstock to the energy recovery facility and assumed the biosolids would be land applied. In the follow-up evaluation included in B&C TM No. 4 the recommended alternatives were updated and referred to as Phase 1 (Alternative 2c) and Phase 2 (Alternative 2d). The recommended approach consisted of:

- Conveyance of WAS from the NEWRF and the NWWRF via force mains into the SWWRF sanitary sewer collection system
- Addition of primary clarification and the ability to step feed into secondary treatment with auxiliary facilities and equipment
- Upgrading thickening facilities
- Fats, oils and grease (FOG) receiving
- New TPAD process including a thermophilic digester, batch tanks and a thermo/mesophilic digester
- Combined heat and power recovery systems

- New dewatering and truck loading facilities

The selection of WAS conveyance via the sanitary sewer, the addition of primary clarification, and the new FOG receiving facility are discussed more in the following section.

The upgraded thickening facilities will expanded the existing thickening building at SWWRF, relocate existing equipment from NEWRF and install new auxiliary equipment (for example, polymer storage and feed systems). The new facility will also include odor control.

As indicted TPAD was selected as the preferred technology for producing Class A biosolids during workshops and was included in the selected alternative for the Biosolids to Energy Project. The TPAD process includes two new digesters, batch tanks and equipment for sludge transfer, mixing, gas collection and energy recovery. The key parameters for sizing the TPAD process presented in the B&C PDR include:

- Peak week organic loading rate of less than 0.35 lb-VS/ft3-day in thermophilic digester
- Hydraulic retention time of greater than 7 days at average loading condition in thermophilic digester
- Hydraulic retention time of greater than 10 days at average loading condition in mesophilic digester
- 24 hours retention time at least 131 deg F in batch tanks

Centrifuge dewatering was initially selected as the dewatering technology for this project. However, during the design process it was determined that the potential for pathogen regrowth in high solids centrifuges following the TPAD process would potentially be too great a risk and may not allow the City to consistently produce a Class A product. Other dewatering technologies, such as belt filter presses (BFP) and screw presses have shown less likelihood for pathogen regrowth and thus may be more appropriate for use at SWWRF following the TPAD process. Ultimately, screw presses were selected as preferred dewatering equipment.

The following comments are provided as part this peer review by CH2M in relation to the biosolids handling and treatment processes included in the selected alternative:

1. The continued use of gravity belt thickeners (GBTs) is reasonable and valid based on the historic use of this technology at each of the City's WRFs and the condition of the existing equipment.
2. The hydraulic retention times were presented in the PDR for the design conditions and meet the above criteria. However, the maximum week loading criteria was not included in the mass balance. Maximum week conditions were determined based on the following:
    1) Primary sludge (80,900 lb-TS/day) and WAS (21,600 lb-TS/day) rates from Table 2-11 in PDR assuming 80% TSS removal in primary treatment
    2) Primary scum value of 2,500 lb/day (assumed value between maximum month and maximum day values from mass balance in GMP Design Drawings)
    3) Design FOG loading rate of 4,050 lb-VS/day
    4) 95% GBT solids retention
    5) 83% VSS/TSS in Primary Sludge and 75% VSS/TSS in WAS (TM No. 4)

    This results in a maximum week loading of 0.36 lb-VS/ft3-day which is higher than the 0.35 lb-VS/ft3-day criteria listed in the B&C PDR. The maximum week loading rate corresponds to the hydraulic retention time of the thermophilic digester at peak conditions and is an appropriate period for a design criteria. The fact that the current design results in a loading rate that exceeds the stated criteria in the B&C PDR is a concern. Thermophilic digesters can accept loading rates significantly higher than mesophilic digesters. The designer should consider enlarging the capacity of the thermophilic digester or justifying the loading rate greater than the criteria stated in the B&C PDR.

3. The use of screw presses for dewatering in this project is reasonable due to the lower potential for pathogen regrowth and the low maintenance requirements and consistent operation.

The current Biosolids to Energy Project also includes a Biogas Upgrading System (BUS) that will provide pipeline quality gas for use in onsite combined heat and power uses or a new fueling facility. The creation of fuel for vehicles can offset operating costs and potentially qualify the project for alternate funding sources. In B&C TM No. 6 a number of technologies and systems for biogas upgrading were identified, evaluated and scored based on nine criteria. From this scoring three options were evaluated in further detail:

- Option 1 - the use of a Guild pressure swing adsorption (PSA) system to treat the entire stream for use as biomethane for vehicle fuel, cogeneration or boilers
- Option 2 - the use of a Guild PSA to treat ~60% of the gas to biomethane for fueling and another system to 40% of the gas for cogeneration or boilers (Cogeneration system do not require the same level of treatment as vehicle fuel)
- Option 3 - the use of a water solvent system to the entire stream for use as biomethane for vehicle fuel, cogeneration or boilers

A present worth analysis indicated that a single Guild PSA system, would be most cost effective for the City assuming additional hydrogen sulfide removal was not required. Further analysis was conducted including site visits to PSA and water solvent type systems. Additionally B&C contacted the manufacturer Guild which indicated that the expected hydrogen sulfide levels would be acceptable for their system. Ultimately, the Guild PSA was selected as the BUS technology and was included in the Biosolids to Energy Project design (GMP Biosolids Specifications).

The following comments relate to the BUS system as part of the CH2M peer review:

1. In B&C TM No. 6 it was indicated that the BUS Option 2 with separate systems for fuel and cogeneration would have the lowest operating costs, but the operating costs for this option were higher than BUS Option 1 Guild PSA in the comparison of net present values (B&C TM No. 6, Table 5-2).

2. Elevated hydrogen sulfide levels can be a concern for the Guild PSA, however B&C’s follow up with Guild and the site visits validated the selection.

3. The inclusion of a BUS as part of this project allows the City to produce a higher quality fuel which gives them greater flexibility and qualifies them for additional funding. The analysis provided as part of the design processes included a present worth between various BUS options and Option 1 Guild PSA is a reasonable technology for this application.

Impact of Parameters in Selection

A key parameter to review during the evaluation of the alternatives and in the design of the Biosolids to Energy Project is the amount of gas produced and the value of that gas for energy recovery. The amount of energy used and produced was part of the alternatives analysis. The modeling results were included as Appendix A in B&C TM No. 3. A comment related to gas production is included below:

1. A heating value range of 530 – 580 BTU/scf was included in the PDR for the biogas upgrading system. This is a valid range for gas production in the TPAD process.

Centralization of Solids Processing and Handling

Centralization of biosolids treatment facilities was included in six of the seven alternatives in B&C TM3 with only Alternative 1 maintaining separate handling and treatment capacities. The recommended approach by B&C included centralization and conveyance of WAS via forcemains and the existing collection system. The location for centralizing biosolids treatment was further evaluated in B&C TM5. The infrastructure required for conveyance and biosolids treatment was determined assuming centralization at each of the three WRFs. Cost estimates were prepared and the present worth was compared for each location. The cost for the onsite biosolids treatment facilities was similar between the three WRFs, but the SWWRF had the lowest costs for the conveyance of WAS due to the location of each facility in relation to the service areas.

Therefore, the recommended approach by B&C was to centralize biosolids treatment at the SWWRF and discontinue all solids treatment and handling at the NEWRF and the NWWRF. Waste activated sludge (WAS) will be transferred into the SWWRF sanitary sewer collection system and enter at the headworks of the plant.

The following comments are provided by CH2M as part of this peer review:

1. Centralization of biosolids treatment is a common approach for utilities with multiple treatment plants, and provides greater efficiency for process and equipment sizing, allows operations to focus on key processes at their plant, and provides a single location for biosolids distribution.
2. Centralization showed economic advantages and additional benefits including less truck hauling traffic at all WRFs with the SWWRF having the lowest present worth costs.

Additional Treatment Facilities

WAS Pumping and Storage at NEWRF and NWWRF

The NEWRF and NWWRF will no longer treat or handle biosolids in the proposed biosolids improvements as WAS will be directly pumped to SWWRF (as part of the sanitary sewer collection system).

This approach is reasonable and provides economic and non-economic benefits. Two comments about these facilities are included below as part of CH2M's peer review:

1. The force main sizing included in B&C TM No. 3 indicated it would be sized for twice the maximum month WAS flow (resulted in an 8-in diameter). Providing additional capacity can be beneficial, but the expected velocities will be less than 2 feet per second (fps). Flushing system to be included in force main design to reduce settling concerns.
2. To avoid impacting the overall treatment capacity at the SWWRF, pumping of WAS will not occur during peak flow or other events that could jeopardize performance. Therefore the existing digesters at the NEWRF and NWWRF will be available for storage during these periods. The days of storage available was quantified in the B&C PDR based on just the smallest digester at each WRF and the corresponding maximum month WAS flow (assuming 1.5% solids) and was less than 3 days. Recent flow data has indicated that peak flow events at SWWRF can last considerably longer than 3 days (a concurrent CH2M project with the City, Liquids Processing and Emergency Operation Peer Review, is evaluating these peak flow events, projected flows and the overall hydraulic capacity). However, this storage only includes one digester at each facility and NEWRF currently has three digesters, and NWWRF has four digesters. Therefore, additional digesters should remain available for storage as needed during peak flow events. A backup option is available as the City has contracts in place that allow for local hauling companies to dispose of liquid sludge, Class B biosolids, and Class A biosolids. Liquid hauling was not needed during the July/August 2015 peak flow event.

Primary Clarification

Primary clarification at the SWWRF will be added as part of the Biosolids to Energy Project, in order to provide benefits including: 1) primary clarification potentially negates any deleterious impacts to secondary treatment due to the additional load from the NEWRF and NWWRF WAS, and 2) primary sludge provides a greater level of volatile solids destruction in the digestion process and thus provides more for energy recovery.

CH2M believes the inclusion of primary clarification will provide for a more stable secondary treatment process and enhance the proposed TPAD process. Additional comments regarding the evaluation of primary clarification at SWWRF are listed below as part of CH2M's peer review:

1. In B&C TM No. 3 it was proposed to repurpose two (2) existing 75-ft diameter aeration basins as primary clarifiers. This concept provided cost advantages, but resulted in hydraulic loading rates significantly higher than is typically found in the industry. As the project progressed, this concept was not used. The B&C PDR proposes two (2) new primary clarifiers sized to achieve more typical loading rates, which resulted in additional construction costs.
2. The expected primary clarifier performance for total suspended solids (TSS) removal used in sizing the biosolids improvements processes was aggressive at 80%, particularly for an influent stream that includes WAS from the other WRFs which typically does not settle as efficiently. Ferric addition will enhance settling, but maintaining 80% removal at all hydraulic and loading conditions could be challenging. In addition:
    a. Using this high rate of performance for design criteria results in conservative sizing for primary sludge handling and digestion facilities.
    b. This high performance, however, could over predict gas production and energy recovery in the digester.
    c. In addition, the primary clarifier performance impacts the liquid processes as well. If primary clarification does not perform as predicted, secondary treatment facilities will experience higher solids loadings and increased aeration demand. A review of the calibrated BioWin model used in the B&C design indicated that the existing secondary treatment facilities can handle increased loading based on a minimum primary clarifier performance of 65% (the minimum evaluated in the B&C PDR). The SWWRF routinely operates with short solid retention times (SRTs) (~4 days) to avoid nitrification, and the SWWRF could operate at these lower SRTs as needed if primary clarifier performance was lower than predicted.

FOG Receiving Facility

The feasibility of a FOG receiving facility was evaluated in B&C TM No. 6. Brown and Caldwell began by assessing the market for collecting and utilizing FOG in the City of St Petersburg. It was estimated that up to 4 MG of FOG was produced within the City's service area annually. Currently this FOG is utilized by private companies or a regional solid waste incinerator. They indicated that there would be competition for FOG, but there could be market or municipal mechanisms for securing FOG generated in the City. It was recommended by B&C that a small FOG receiving facility be included at SWWRF as part of the Biosolids to Energy Project, which was described in the B&C PDR and shown in the GMP Design Drawings. The FOG will be added to the thermophilic digester along with the combined thickened sludge.

CH2M offers the following comments related to inclusion of a FOG facility:

1. A FOG receiving facility can provide benefits to the community as well as plant operations by removing these materials from the liquids processes.
2. A FOG stream can also provide significant energy recovery as it has more than twice the energy value as the combined sludge. B&C's TM No. 6 indicated that approximately 10% of the total energy production could be from FOG.

3. Although the market for receiving FOG is somewhat unknown, the benefit of the potential energy value that could come from a FOG stream makes the inclusion of this facility reasonable.

Cost Model

A 20-year present worth analysis was performed to make an economic evaluation between the seven alternatives and was presented in B&C TM No. 3. An updated present worth analysis was also included in B&C TM No. 4. The present worth analysis included:

- Construction costs
  - Near-term
  - 10-year CIP
  - Engineering – 16% (B&C TM No. 3), 15% (B&C TM No. 4)
  - Contingency – 25%
- Operation and maintenance costs
  - Material handling
  - Power – $0.10/kW-hr
  - Natural gas
  - Chemicals
  - Operations
- Discount rate – 4.4% (B&C TM No. 3), 5% (B&C TM No. 4)
- Escalation – 1.7% (B&C TM No. 3), 3% (B&C TM No. 4)

The following comments related to the cost model as part of CH2M's peer review are provided below:

1. The overall cost model concept is reasonable and includes all of the key parameters that would be expected as part of present worth analysis.
2. The specific parameters related to the present worth analysis (for example, time frame, discount rate) are reasonable and relevant to this analysis. The contingency should be considered a minimum for this level of cost estimate and a higher value (30%) could provide a more appropriate level of conservatism for planning level analyses.
3. The construction costs included in B&C TM No. 3 were described as probable cost opinions. Despite these cost estimates being used for comparison between alternatives, a more thorough approach would provide greater clarity in the planning level and the ability to compare estimates more accurately in later stages of the project. For example, defining the estimate in a 'class' of estimate according to Department of Energy or the AACEI would identify a range of accuracy to better define the estimates.
4. The cost estimate for Alternative 2a in B&C TM No. 3 included upgrades to thickening, but it was not clear why thickening would be required if no digestion was occurring.
5. The 10% increase for operations costs included for the new TPAD process is lower than expected for a complex operation.
6. The land application disposal rates of $16/wet ton (WT) of biosolids appears significantly lower compared to other rates seen in Florida (typically $40/WT). However, the City currently pays $17.5/WT to dispose of the lime stabilized Class A product from SWWRF, so this value may be relevant for this analysis.
7. Six of the alternatives evaluated in B&C TM No. 3 included a thermal energy recovery facility that could distribute biosolids as a feedstock for energy along with yard waste. The inclusion of the thermal energy facility in the evaluation and cost analysis was reasonable since it impacted the ability to distribute biosolids for several of the alternatives. However, the thermal energy

facility had a high construction cost which impacted the sensitivity of the overall cost model. Additional present worth analysis included in B&C TM No. 4 included additional three alternatives without a thermal energy recovery option.

8. A BUS is included in the project as described in the B&C PDR and shown in the GMP Design Drawings will provide pipeline quality gas for fueling fleet vehicles and cogeneration or boilers. The present worth analyses included in B&C TM No. 3 and B&C TM No.4 did not include the costs for the BUS as it was not part of the project at that time.
9. The gas production estimates included in the B&C TM No. 6 was approximately 10% higher than the later estimates included in the design (B&C PDR). This change would lower the expected power generated and energy costs offset or revenue generated.

Reliability and Redundancy of Selected Alternative

A key component of this peer review was to evaluate the reliability and redundancy included in the proposed facilities. Biosolids treatment facilities are not required to have the same reliability and redundancy as liquid treatment processes. Solids treatment often has additional flexibility as alternative disposal options exist (for example, the backup sludge hauling contract previously described). However, due to the significant investment of these new processes and the commitment to producing a Class A product, the City wants to ensure a reasonable amount of reliability and redundancy exists in the proposed biosolids improvements. To assess the current amount of redundancy, it was assumed that the current flows and loads are 85% of the design (2035) conditions based on the flow projections included in the B&C PDR.

Primary Clarification

There are two new primary clarifiers in the proposed biosolids improvements each sized to treat up to 20-mgd for a combined capacity of 40-mgd. Therefore, with one primary clarifier out of service, the remaining primary clarifier can still reliability treat the permitted annual average daily flow (AADF) of 20-mgd providing a degree of redundancy.

The following comment related to the reliability and redundancy of primary clarification was noted during the CH2M peer review:

1. Primary treatment is required for the successful operation of the SWWRF following the Biosolids to Energy Project. If flows above 20-mgd are experienced with one unit out of service, it is expected that clarifier performance will decrease which impacts liquid and solids treatment facilities downstream. These impacts were discussed above. In addition, the ability to hydraulically pass peak flows with one primary clarifier out of service will be confirmed in the concurrent peer review project.
2. A concurrent CH2M project with the City, Liquids Processing and Emergency Operation Peer Review, is evaluating recent peak flow events, projected flows and the overall hydraulic capacity.

Thickening

Thickening will continue to utilize gravity belt thickeners (GBTs) prior to digestion as is currently done at NEWRF and NWWRF and was previously done at SWWRF before the conversion to the Bioset process. The B&C PDR presents the expected flows and sludge loading rates based on a seven day/week, 23 hours/day operation. Two units were required to meet the manufacturer's recommendation for a 'safe maximum' loading based on the combined sludge solids content of 1.7% (as defined by manufacturer in B&C PDR) at the design peak hour conditions. Therefore, a third GBT would be required for complete redundancy. The GMP Design Drawings indicate that two GBTs are included in the proposed Biosolids to Energy Project.

The following comments related to the reliability and redundancy of thickening were noted during the peer review:

1. One GBT is sufficient to operate up to design AADF conditions allowing for maintenance and service of the non-operating unit during much of the year. Two units will be needed for all flow and load conditions at the MMADF level and higher.
2. From the loading rates listed in the PDR, the anticipated loading rates to a single GBT with one unit out of service will be higher than the 'safe maximum' at MMADF, MDF and PHF conditions. While GBTs can accept higher loading rates performance will likely suffer which could then also impact the detention times in the TPAD process. Operations will have to closely monitor the condition and performance of the GBTs and schedule maintenance periods as efficiently as possible.

TPAD Process

The TPAD process will typically operate by sending thickened sludge first to the thermophilic digester, then to one of three batch tanks and a finally to a mesophilic digester. If one digester is out of service, the process will operate using a single thermophilic digester followed by the batch tanks. In order to accomplish this with only two digesters, the second digester was designed to also operate in the thermophilic range if needed. This provides some operational flexibility in order to take digesters out of service when required or as needed. Both digesters include four draft tube mixers with three required for adequate mixing which is a reasonable amount of redundancy.

The following comments related to the reliability and redundancy of the TPAD process were noted by CH2M during the peer review:

1. High temperature digestion processes require operational attention and experience to consistently achieve the desired performance. One advantage of the TPAD process is the mesophilic stage which provides a more consistent operation following the thermophilic stage. This is particularly appropriate for the SWWRF as operations has utilized mesophilic digestion for several decades. Operating solely as a single-stage thermophilic digester (along with the batch tanks) the process can achieve the required time and temperature needed for Class A, but will require significant operator attention during these periods.
2. In addition, the lack a mesophilic stage increases odor concerns downstream. Odor control is included downstream in the dewatering facility which should limit any additional odors when operating in this mode. In addition, this would not be a common occurrence, as it is expected that planned maintenance would require taking a digester down for up to 6 weeks once every 5 years.
3. Despite the challenges listed above, additional digesters to enhance reliability would significantly increase construction costs and space requirements. As stated above, the concept for operation with one digester out of service is reasonable and can produce Class A biosolids with proper operation.

Dewatering

The digested sludge from the TPAD process will be dewatered prior to disposal. Historically the City's WRFs utilized belt filter presses (BFPs) for dewatering, but the NEWRF has recently converted to screw presses. The original concept for dewatering as part of the Biosolids to Energy project was to replace the existing BFPs with centrifuges for maximum performance. However, this concept was changed due to the potential for pathogen regrowth in high solids centrifuge dewatering units that follow the TPAD process. Therefore, the dewatering technology selected for this project was screw presses. Due to the timing of this design change, the B&C PDR did not contain significant detail on the dewatering equipment. A review of the GMP Design Drawings indicates that three screw presses will be installed with all units operating for continuous operation.

The following comment related to the reliability and redundancy of the dewatering process was noted during CH2M's peer review:

1. Based on the information in the GMP Design Drawings it appears that the dewatering process will be operated continuously in the same manner as thickening with no installed backup. Screw press dewatering has not been used at the SWWRF, but it has been used successfully at the NEWRF in recent years. In addition, one key advantage of screw press dewatering is less maintenance requirements as compared to BFPs and more reliable operation.
2. It was assumed that the screw presses are sized such that three installed units are required for MDF conditions based on the specification section included in the GMP Design. At this sizing, a redundant unit would be available at the AADF conditions with all three units required for higher loading conditions.

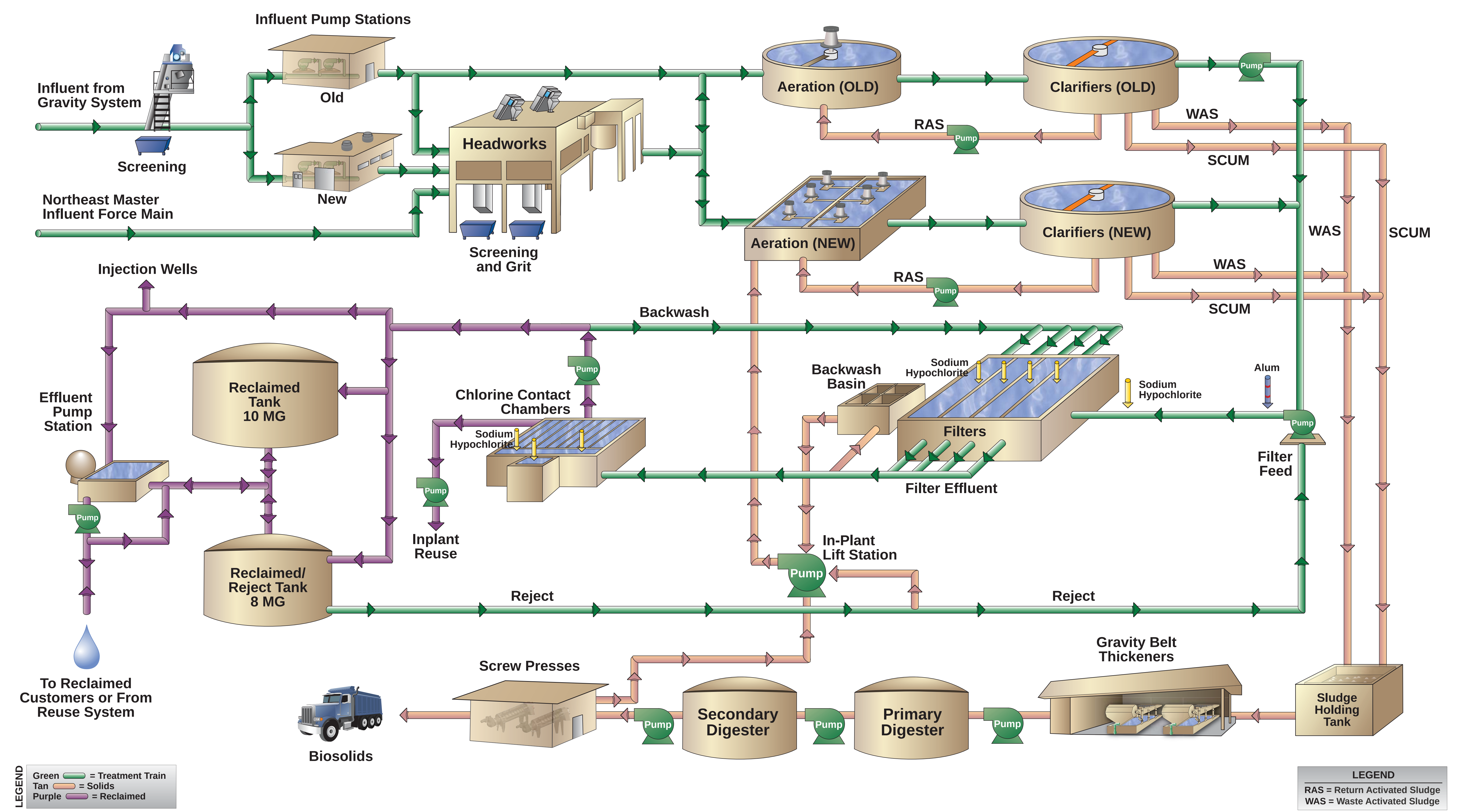
Summary

The Biosolids to Energy Project was developed by the City over several years and involved the evaluation of a matrix of options including multiple treatment processes, biosolids distribution methods, and conveyance methods. The key aspects of the selected Biosolids to Energy project included production of a Class A biosolids, use of Temperature Phased Anaerobic Digestion (TPAD), and centralization at SWWRF. CH2M has reviewed and provided comments on each of the aspects including regulatory impacts, gas production, cost analysis and reliability and redundancy. Based on the peer review, the Biosolids to Energy Project includes the criteria requested by the City including sustainability, energy recovery, ability to use alternate funding and increased flexibility in biosolids disposal. The project includes a reasonable, proven process for centralizing biosolids treatment at the SWWRF in order to produce Class A biosolids.

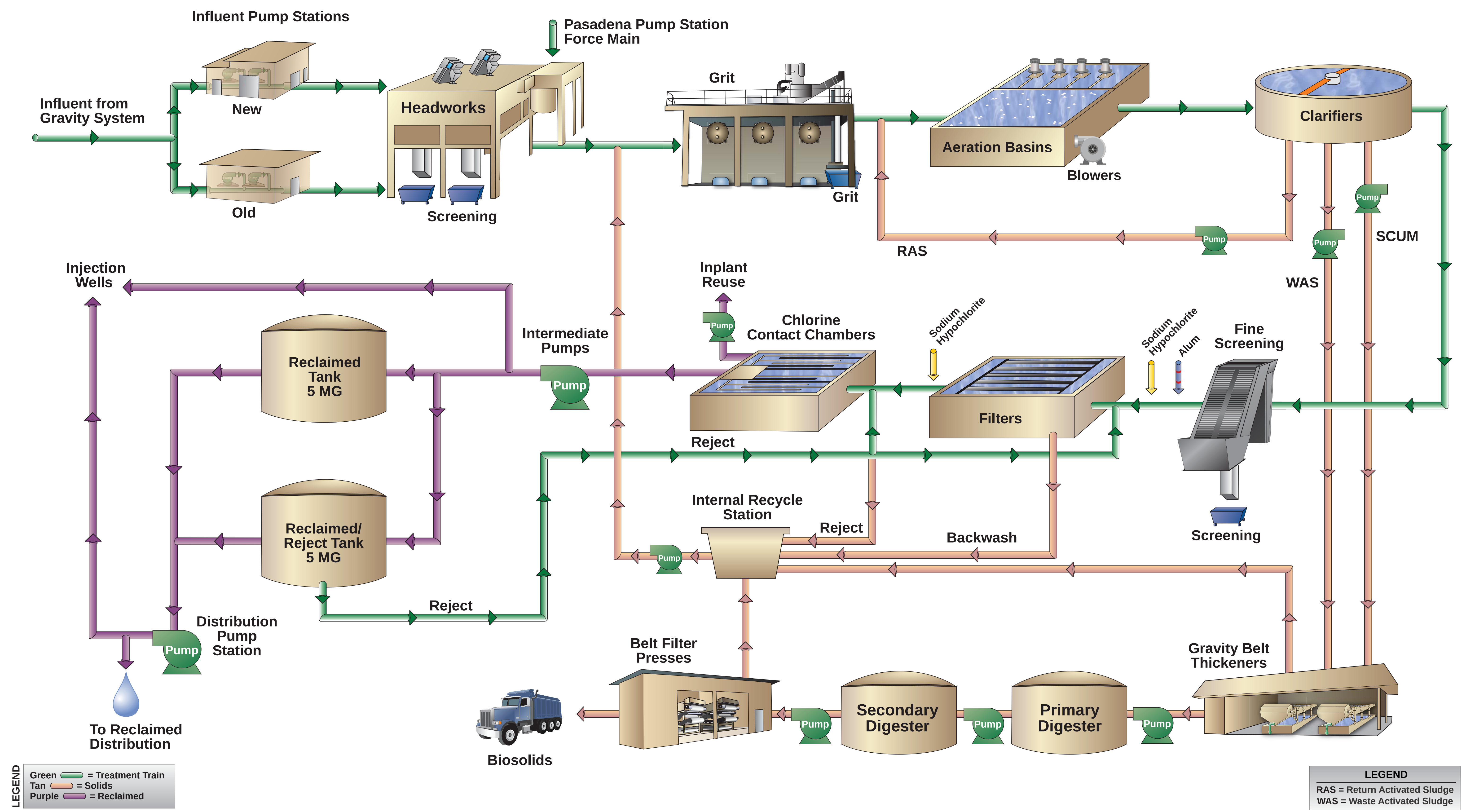
Attachment D

Supporting Visual Aids

Northeast Water Reclamation Facility



Northwest Water Reclamation Facility

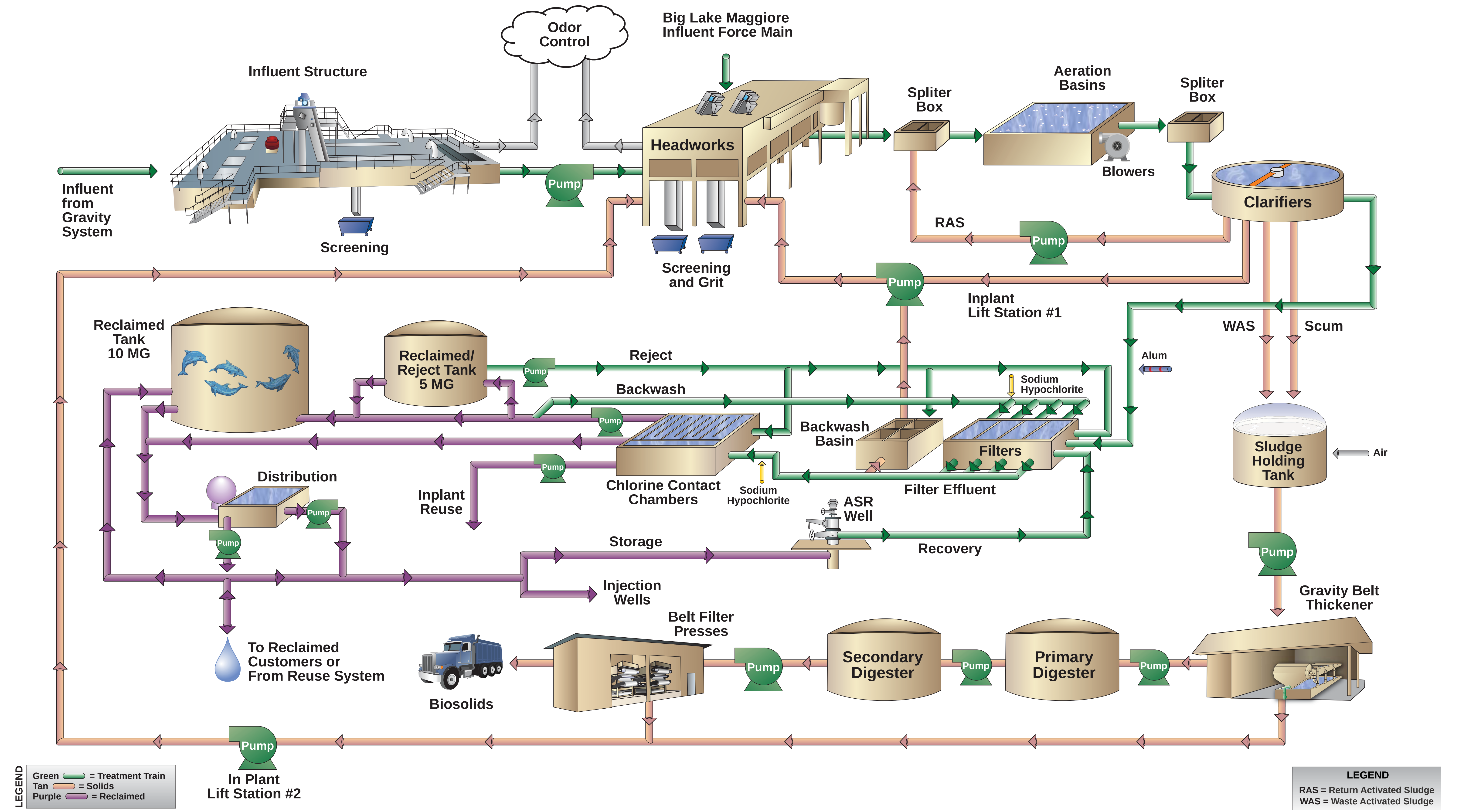


City of St. Petersburg

CDM

August 2011

Southwest Water Reclamation Facility



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August 2011

GENERAL NOTES

1. ABBREVIATIONS FOR THE ENTIRE PROJECT EXCEPT ELECTRICAL ARE PROVIDED IN THESE GENERAL SHEETS.
2. ALL MECHANICAL SYMBOLS ARE IDENTIFIED IN THESE GENERAL SHEETS. GENERAL SHEETS DO NOT PROVIDE SYMBOLS NOR DETAILS FOR FOR ANY DISCIPLINE OTHER THAN MECHANICAL SYMBOLS. REFERENCE THE INDIVIDUAL DISCIPLINE SHEETS FOR ADDITIONAL DISCIPLINE-SPECIFIC SYMBOLS.

PIPING SYSTEM ABBREVIATIONS

FLOW STREAM ABBREVIATIONS

A	AERATION AIR
ABE	AERATION BASIN EFFLUENT
ABI	AERATION BASIN INFLUENT
BFPF	BELT FILTER PRESS FILTRATE
CD	CHEMICAL DRAIN
CHEM	CHEMICAL
CEN	CENTRATE
CGR	CHILLED GLYCOL RETURN
CGS	CHILLED GLYCOL SUPPLY
CS	CONTACT STABILIZATION
CULV	CULVERT
CW	COLD WATER
CWR	COLD WATER RETURN
CWS	COLD WATER SUPPLY
D	DRAIN
DG	DIGESTER GAS
DG/OF	DIGESTER GAS/ OVERFLOW
DS	DIGESTED SLUDGE
DSF	DIESEL FUEL
FA	FOUL AIR
FBW	FILTER BACKWASH
FECL	FERRIC CHLORIDE
FOG	FATS OIL GREASE
GBTF	GRAVITY BELT THICKENER FILTRATE
HDG	HIGH PRESSURE DIGESTER GAS
HPA	HIGH PRESSURE AIR
HW	HOT WATER
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
IA	INSTRUMENT AIR
ML	MIXED LIQUOR
NGA	NATURAL GAS
NIT	NITROGEN
OA	OUTSIDE AIR
ODO	ODORANT
OF	OVERFLOW
PD	GRAVITY PROCESS DRAIN
PE	PRIMARY EFFLUENT
PE-CS	PRIMARY EFFLUENT - CONTACT STABILIZATION
PE-SF	PRIMARY EFFLUENT - STEP FEED
PLW	CHLORINATED PLANT WATER
POL	POLYMER
PS	PRIMARY SLUDGE
PSC	PRIMARY SCUM
PPD	PUMPED PROCESS DRAINAGE
PW	POTABLE WATER
RAS	RETURN ACTIVATED SLUDGE
RD	ROOF DRAIN
RNG	RENEWABLE NATURAL GAS
RS	RAW SEWAGE
SD	SANITARY DRAIN OR STORM DRAIN
SE	SECONDARY EFFLUENT
SF	STEP FEED
SLW	SEAL WATER
SPW	SPRAY WATER
SRS	SCREENED RAW SEWAGE
SS	SANITARY SEWER
SSC	SECONDARY SCUM
STD	STORM DRAIN
STM	STEAM
THS	THICKENED SLUDGE
TD	TANK DRAIN (PROCESS UNIT TANK DRAIN)
UG	UNDERDRAIN
V	VENT
VC	CHEMICAL VENT
W	WATER
WAS	WASTE ACTIVATED SLUDGE
WGA	WASTE GAS

PIPING TYPE ABBREVIATIONS

304SS	304 STAINLESS STEEL
316SS	316 STAINLESS STEEL
CI	CAST IRON
CIS	CAST IRON SOIL PIPE
CMLS	CEMENT LINED STEEL
CMP	CORRUGATED METAL PIPE
CPVC	CHLORINATED POLYVINYL CHLORIDE
CU	COPPER PIPE
CUK	COPPER PIPE - TYPE K
CUL	COPPER PIPE - TYPE L
DI	DUCTILE IRON
DIGL	GLASS LINED DUCTILE IRON
ELS	EPOXY LINED STEEL
FRP	FIBER REINFORCED PLASTIC
HDPE	HIGH DENSITY POLYETHYLENE
PCCP	PRESTRESSED CONCRETE CYLINDER PIPE
PE	POLYETHYLENE
PP	POLYPROPYLENE
PVC	POLYVINYL CHLORIDE
RCP	REINFORCED CONCRETE PIPE
ST	STEEL
VCP	VITRIFIED CLAY PIPE

EQUIPMENT ABBREVIATIONS

A	AERATOR
AB	AERATION BASIN
ACC	AIR CONDITION COIL
ACU	AIR CONDITIONING UNIT
AD	AIR DRYER
AF	AIR FILTER
AHC	AIR HANDLING UNIT
W/COIL	
AHU	AIR HANDLING UNIT
APU	AIR PURIFICATION UNIT
ASC	ADJUSTABLE SPEED
CONTROL	
ASD	ADJUSTABLE SPEED DRIVE
ARV	AUTOMATIC AIR RELEASE VALVE
B	BLOWER
BFP	BELT FILTER PRESS
BLR	BOILER
BNR	BURNER
C	COIL
CCT	CHLORINE CONTACT TANK
CDR	CONDENSER
CFR	CHEMICAL FEEDER
CHR	CHILLER
COL	COLLECTOR
COM	COMMINUTOR
CON	CONVEYOR
CP	COMPRESSOR
CPUL	CARBON POLISHER
CRN	CRANE
CT	COOLING TOWER
CTF	CENTRIFUGE
CU	CONDENSING UNIT
CV	CONTROL VALVE
CVR	FLOATING COVER
CYL	CYLINDER
DIS	DISTRIBUTOR
DPR	DAMPER
DS	DISCONNECT SWITCH
DU	DRIVE UNIT
E	ENGINE
EB	ENGINE BLOWER MODULE
ED	EQUIPMENT DRAIN
EF	EXHAUST FAN
EPR	EVAPORATOR
F	FAN
FAR	FLAME ARRESTER
FCT	FERRIC CHLORIDE TANK
FLT	FILTER
FPU	FLUID POWER UNIT
FT	FOG TANK
FUR	FURNACE
GBT	GRAVITY BELT THICKENER
GDR	GRINDER
GEN	GENERATOR
GT	GATE
H	HOIST
HEX	HEAT EXCHANGER
HOP	HYDRAULIC OPERATOR
HP	HEAT PUMP
HPU	HYDRAULIC POWER UNIT
HTR	HEATER
HTT	HEAT TRACE TAPE
HV	HAND OPERATED VALVE
INJ	INJECTOR
IW	INJECTION WELL
LCP	LOCAL CONTROL PANEL
LVR	LOUVER
M	MOTOR
MME	MISC. MECHANICAL EQUIPMENT
MOP	MOTOR OPERATOR
MSP	MOTOR STARTER PANEL
MUX	MULTIPLEXER
MX	MIXER
MZ	MULTIZONE UNIT
ORT	ODOR REMOVAL TOWER
P	PUMP
PC	PROCESS OR PERSONAL COMPUTER OR
PRIMARY	CLARIFIER
PLC	PROGRAMMABLE LOGIC CONTROLLER
POP	PNEUMATIC OPERATOR
PRV	PRESSURE/VACUUM RELIEF VALVE OR PRESSURE REGULATING VALVE
PVL	PRESSURE VESSEL
RAD	RADIATOR
REC	RECEIVER
SC	SECONDARY CLARIFIER
SCR	SCRUBBER
SEP	SEPARATOR
SF	SUPPLY FAN
SFP	SLUDGE FEED PUMP
SLG	SLIDE GATE
SLR	SILENCER
SMP	SAMPLER
ST	STEAM TRAP
STDP	STANDPIPE
STN	STRAINER
STP	SEDIMENT TRAP
SUB	SUBSTATION
SWBD	SWITCHBOARD
T	TANK
TBN	TURBINE
TCV	TEMPERATURE CONTROL
VALVE	
TFR	TRANSFORMER
TM	TIMER
TRP	TRAP
TRS	TRANSFER SWITCH
TSP	THICKENED SLUDGE PUMP
UH	UNIT HEATER
VE	VESSEL
VEN	VENTILATOR
VP	VACUUM PUMP
WCC	WATER CONTROL CABINET
WGB	WASTE GAS BURNER
WH	WATER HEATER
WHR	WASHER
WSR	WATER SOFTENER UNIT

GENERAL ABBREVIATIONS

A	AMPERE OR AERATOR
AB	AERATION BASIN
ABAND	ABANDONED
ACC	AIR CONDITION COIL
ACU	AIR CONDITIONING UNIT
AD	AIR DRYER
ADJ	ADJUSTABLE
AF	AIR FILTER
AFD	ADJUSTABLE FREQUENCY DRIVE
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AHC	AIR HANDLING UNIT W/COIL
AHU	AIR HANDLING UNIT
AL	ALUMINUM
APPROX	APPROXIMATE
ASC	ADJUSTABLE SPEED CONTROL
ASD	ADJUSTABLE SPEED DRIVE
ASPH	ASPHALT
ASR	AQUIFER SURFACE RECHARGE
ASSOC	ASSOCIATION
ASTM	AMERICAN SOCIETY OF TESTING MATERIALS
ATS	AUTOMATIC TRANSFER SWITCH
AUTO	AUTOMATIC
AUX	AUXILIARY
AVG	AVERAGE
AWG	AMERICAN WIRE GAGE
B	BLOWER
BC	BOTTOM OF CURB
BEL	BELOW
BF	BLIND FLANGE
BFPF	BELT FILTER PRESS FILTRATE
BFPV	BACKFLOW PREVENTER
BFV	BUTTERFLY VALVE
BHP	BRAKE HORSEPOWER
BK	BACK
BL	BASE LINE
BLDG	BUILDING
BLR	BOILER
BM	BENCH MARK
BNR	BURNER
BOT	BOTTOM
BRG	BEARING
BRK	BRICK
BT	BACKWASH TANK OR BATCH TANK
BTDPS	BATCH TANK DISCHARGE PUMP STATION
BUS	BIOGAS UPGRADE SYSTEM
BV	BALL VALVE
C	CELSIUS OR COIL
CAB	CABINET
CATV	CABLE TELEVISION
CB	CATCH BASIN
CC	CENTER TO CENTER
CCT	CHLORINE CONTACT TANK
CDR	CONDENSER
CE	CONSTRUCTION EASEMENT
CF	CUBIC FOOT
CFM	CUBIC FEET PER MINUTE
CFR	CHEMICAL FEEDER
C&G	CURB AND GUTTER
CHAN	CHANNEL
CHR	CHILLER
CI	CAST IRON
CIR	CIRCLE
CIRCUM	CIRCUMFERANCE
CJ	CONSTRUCTION JOINT
CL	CENTERLINE OR CLASS
CLG	CEILING
CLR	CLEAR
CMU	CONCRETE MASONRY UNITS
CO	CLEANOUT
COL	COLUMN OR COLLECTOR
COM	COMMINUTOR
COMB	COMBINED
CON	CONVEYOR
CONC	CONCRETE / CONCENTRIC
CP	COMPRESSOR OR COMPUTED POINT
CPLG	COUPLING
CR	CRANE
CS	COMBINED SEWER
CT	CURRENT TRANSFORMER
CTF	CENTRIFUGE
CTG	COATING
CULV	CULVERT
CYL	CYLINDER
D1	DIGESTER 1
D1PS	DIGESTER 1 DISCHARGE PUMP STATION
D1RPS	DIGESTER 1 RECYCLE PUMP STATION
D2	DIGESTER 2
D2PS	DIGESTER 2 DISCHARGE PUMP STATION
D3	DIGESTER 3
D3PS	DIGESTER 3 DISCHARGE PUMP STATION
DB	DUCT BANK
DC	DIRECT CURRENT
DEMO	DEMOLITION / DEMOLISH
DEPT	DEPARTMENT
DI	DROP INLET
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DIS	DISTRIBUTOR
DPR	DAMPER
DS	DISCONNECT SWITCH
DU	DRIVE UNIT
DWG	DRAWING
DWL	DOWEL
DWY	DRIVEWAY
E	EAST OR ENGINE
EA	EACH
EB	ENGINE BLOWER MODULE
ECC	ECCENTRIC
ECF	EQUIPMENT CONNECTION FITTING
ED	EQUIPMENT DRAIN
EF	EACH FACE
EL	ELEVATION
ELEC	ELECTRICAL / ELECTRIC
ELEV	ELEVATION
EMH	ELECTRICAL MANHOLE
ENGR	ENGINEER
EOP	EDGE OF PAVEMENT
EPR	EVAPORATOR
EPS	EFFLUENT PUMP STATION
EQ	EQUAL
EQUIP	EQUIPMENT
ES	ELECT3RICAL SERVICE
ESMT	EASEMENT
EW	EACH WAY
EST	ESTIMATE / ESTIMATED
EXIST	EXISTING
EXP	EXPANSION
EXT	EXTERIOR
EXIST	EXISTING
F	FAHRENHEIT OR FAN
FBW	FILTER BACKWASH
FC	FAIL CLOSED
FCO	FLOOR CLEANOUT
FCPS	FERRIC CHLORIDE PUMP STATION
FCT	FERRIC CHLORIDE TANK
FD	FLOOR DRAIN
F-F	FACE TO FACE
FFE	FINISH FLOOR ELEVATION
FG	FINISHED GRADE
FH	FIRE HYDRANT
FL	FLOW LINE
FLEX	FLEXIBLE
FLR	FLOOR
FLT	FILTER
FM	FORCEMAIN
FO	FAIL OPEN
FP&L	FLORIDA POWER & LIGHT
FPM	FEET PER MINUTE
FPS	FOG DISCHARGE PUMP STATION
FPU	FLUID POWER UNIT
FR/FPS	FOG RECYCLE FEED PUMP STATION
FSPS	FOAM SUPPRESSION PUMP STATION
FT	FEET / FOOT OR FOG TANK
FTP	FLAME TRAP
FUR	FURNACE
FURN	FURNISHED
G	GAS
GC	GRANITE CURB
GBFT	GRAVITY BELT THICKENER FILTRATE
GBV	GLOBE VALVE
GDR	GRINDER
GEN	GENERATOR
GFI	GROUND FAULT INTERRUPTER
GM	GAS METER
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GR	GRADE
GRT	GROUT OR GRATE
GSKT	GASKET
GT	GATE
GV	GATE VALVE OR GAS VALVE
H	HIGH OR HOIST
HC	HEADER CURB
HGL	HYDRAULIC GRADE LINE
HGR	HANGER
HOA	HAND-OFF-AUTO
HOP	HYDRAULIC OPERATOR
HOR	HORIZONTAL
HP	HEAT PUMP OR HIGH POINT
HPU	HYDRAULIC POWER UNIT
HTR	HEATER
HTT	HEAT TRACE TAPE
HV	HAND OPERATED VALVE
HZ	HERTZ
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IN	INCH
INSUL	INSULATION
INV	INVERT
IPS	INFLUENT PUMP STATION
IW	INJECTION WELL
JB	JUNCTION BOX
JT	JOINT
JT FLR	JOINT FILLER
KW	KILOWATT
L	LENGTH
LB	POUND
LCP	LOCAL CONTROL PANEL
LF	LINEAR FEET
LOC	LOCATION
LP	LIGHT POLE / LIGHTING PANEL
LPNG	OPENING
LS	LIMIT SWITCH OR LIFT STATION
L/S	LANDSCAPE STRIP
LT	LEFT
M	MOTOR
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE
MIN	MINIMUM / MINUTE
MISC	MISCELLANEOUS
MON	MONUMENT
MOP	MOTOR OPERATOR
MPH	MILES PER HOUR
MSL	MEAN SEA LEVEL
MSP	MOTOR STARTER PANEL
MUX	MULTIPLEXER
MZ	MULTIZONE UNIT
N	NORTH
N/A	NOT APPLICABLE
NAVD	NATIONAL AMERICAN VERTICAL DATUM
N.C.	NORMALY CLOSED
NE	NORTHEAST
NEC	NATIONAL ELECTRICAL CODE
NEG	NEGATIVE
NEUT	NEUTRAL
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NO	NUMBER
N.O.	NORMALLY OPEN
NOM	NOMINAL
NTS	NOT TO SCALE
NW	NORTHWEST
OA	OUTSIDE AIR
OD	OUTSIDE DIAMETER
OH	OVERHEAD
OHP	OVERHEAD POWER
OPER	OPERATOR
OPNG	OPENING
P	POWER
PAR	PARALLEL
PC	PROCESS OR PERSONAL COMPUTER OR PRIMARY CLARIFIER
PE-CS	PRIMARY EFFLUENT - CONTACT STABILIZATION
PE-SF	PRIMARY EFFLUENT - STEP FEED
PH	PHASE
PL	PROPERTY LINE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PLT	PLANT
PLYWD	PLYWOOD
PNL	PANEL
POI	POINT OF INTERSECTION
POL	POLYMER
POP	PNEUMATIC OPERATOR
POT	POINT OF TANGENCY
PP	POWER POLE
PROP	PROPOSED
PRPS	PUBLIC REUSE PUMP STATION
PS	PUMP STATION
PSA	PRESSURE SWING ABSORPTION
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PT	POINT
PTS	PRELIMINARY TREATMENT STRUCTURE
PV	PLUG VALVE
PVL	PRESSURE VESSEL
PVMT	PAVEMENT
Q	FLOW
QTY	QUANTITY
R	RADIUS
R/W	RIGHT OF WAY
RA	RETURN AIR
RC	REINFORCED CONCRETE
RD	ROOF DRAIN
RE	RIM ELEVATION
REC	RECEIVER
REF	REFERENCE
REINF	REINFORCE / REINFORCED / REINFORCING
RP	REFERENCE POINT
REQD	REQUIRED
REV	REVISED OR REVISION
RPM	REVOLUTIONS PER MINUTE
RT	RIGHT
R/W	RIGHT OF WAY
S	SOUTH
SA	SUPPLY AIR
SAN	SANITARY
SB	SOIL BORING
SC	SECONDARY CLARIFIER
SCD	SCUPPER DRAIN
SCH	SCHEDULE
SCPS	SCUM PUMP STATION
SCR	SCREEN OR SCRUBBER
SD	STORM DRAIN OR SANITARY DRAIN
SE	SOUTHEAST OR SECONDARY EFFLUENT
SEC	SECTION
SEP	SEPARATOR
SHT	SHEET
SLR	SILENCER
SMP	SAMPLER
SPEC	SPECIFICATION
SSC	SECONDARY SCUM
SSK	SERVICE SINK
ST	STEAM TRAP OR STREET
STA	STATION
STD	STANDARD
STL	STEEL
STM	STEAM
STRUC	STRUCTURE / STRUCTURAL
STRW	STORAGE REJECT WATER
SUB	SUBSTATION
SV	SOLENOID VALVE
SW	SOUTHWEST OR SIDEWALK
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SWK	SIDEWALK
SYM	SYMMETRICAL
T	TELEPHONE
TBN	TURBINE
TC	TOP OF CURB
TCV	TEMPERATURE CONTROL VALVE
TEL	TELEPHONE
TEMP	TEMPORARY / TEMPERATURE
TFR	TRANSFORMER
TM	TIMER
T.O.	TOP OF
TP	TRAP PRIMER
TPS	TRANSFER PUMP STATION
TRS	TRANSFER SWITCH
TS	TEMPERATURE SWITCH
TYP	TYPICAL
TW	TOP OF WALL
UG	UNDERGROUND
UH	UNIT HEATER
US	UTILITY STATION
V	VOLTS OR VENT
VAC	VACUUM OR VOLT ALTERNATING CURRENT
VAR	VARIABLE / VARIES
VCP	VENDOR CONTROL PANEL
VE	VESSEL
VEL	VELOCITY
VEN	VENTILATOR
VERT	VERTICAL
VOL	VOLUME
VP	VACUUM PUMP
VTR	VENT THROUGH ROOF
W	WEST OR WIDTH
w.c.	WATER COLUMN
WCO	WALL CLEANOUT
W/	WITH
WM	WATER METER
W/O	WITHOUT
WB	WET BULB
WH	WATER HEATER
WHR	WASHER
WL	WATER LEVEL
WSR	WATER SOFTENER UNIT
WT	WATER TABLE
WV	WATER VALVE
XFMR	TRANSFORMER
XP	EXPLOSION PROOF
YCO	YARD CLEANOUT
YR	YEAR
ZS	POSITION SWITCH

Brown AND Caldwell
TAMPA, FLORIDA

SUBMITTED: ______ PROJECT MANAGER DATE
APPROVED: ______ BROWN AND CALDWELL DATE

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED:	B ELEAZER
DRAWN:	T DIMICELI
CHECKED:	B ELEAZER
CHECKED:	G ANIPSITAKIS
APPROVED:	B ELEAZER

EXTERNAL REFERENCE FILES
144490-TBK-0000-01.dwg

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.

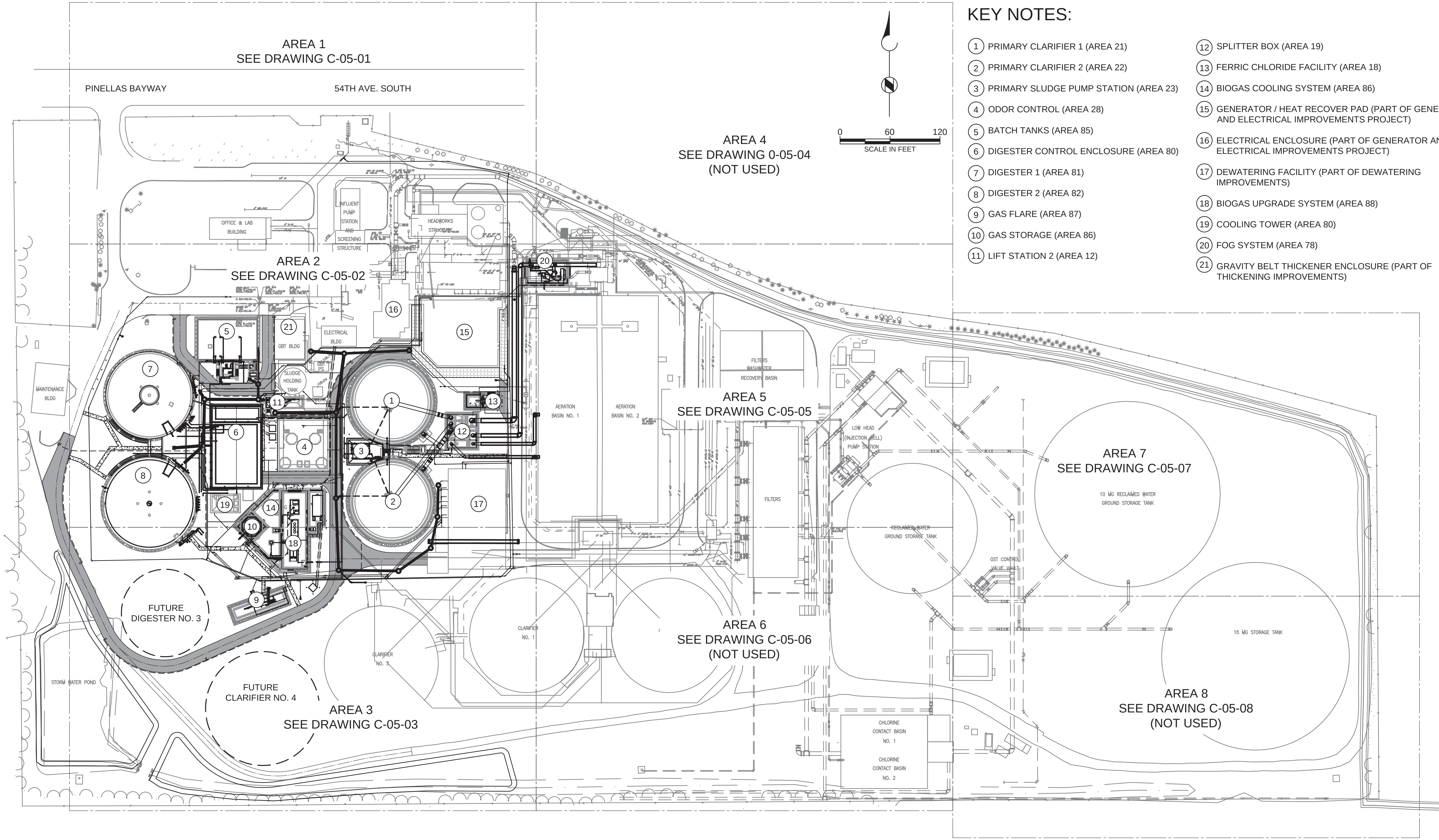
CITY OF St. PETERSBURG
3800 54th AVE. S
St. PETERSBURG, FL. 33711

BIOSOLIDS IMPROVEMENTS
GUARANTEED MAXIMUM PRICE

GENERAL
ABBREVIATIONS

FILENAME	144490-G-00-04.dwg
BC PROJECT NUMBER	144490
CLIENT PROJECT NUMBER	13057-111
SHEET NUMBER	G-00-04
CITY DRAWING NUMBER	10938-4

SEPTEMBER 2015



KEY NOTES:

1. PRIMARY CLARIFIER 1 (AREA 21)
2. PRIMARY CLARIFIER 2 (AREA 22)
3. PRIMARY SLUDGE PUMP STATION (AREA 23)
4. ODOR CONTROL (AREA 28)
5. BATCH TANKS (AREA 85)
6. DIGESTER CONTROL ENCLOSURE (AREA 80)
7. DIGESTER 1 (AREA 81)
8. DIGESTER 2 (AREA 82)
9. GAS FLARE (AREA 87)
10. GAS STORAGE (AREA 86)
11. LIFT STATION 2 (AREA 12)
12. SPLITTER BOX (AREA 19)
13. FERRIC CHLORIDE FACILITY (AREA 18)
14. BIOGAS COOLING SYSTEM (AREA 86)
15. GENERATOR / HEAT RECOVER PAD (PART OF GENERATOR AND ELECTRICAL IMPROVEMENTS PROJECT)
16. ELECTRICAL ENCLOSURE (PART OF GENERATOR AND ELECTRICAL IMPROVEMENTS PROJECT)
17. DEWATERING FACILITY (PART OF DEWATERING IMPROVEMENTS)
18. BIOGAS UPGRADE SYSTEM (AREA 88)
19. COOLING TOWER (AREA 80)
20. FOG SYSTEM (AREA 78)
21. GRAVITY BELT THICKENER ENCLOSURE (PART OF THICKENING IMPROVEMENTS)

Brown AND Caldwell
TAMPA, FLORIDA

SUBMITTED: ______ PROJECT MANAGER DATE
APPROVED: ______ BROWN AND CALDWELL DATE

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED:	D VARJABEDIAN
DRAWN:	D VARJABEDIAN
CHECKED:	B ELEAZER
CHECKED:	J MAZZEI
APPROVED:	T BOSSO

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BIOSOLIDS IMPROVEMENTS
GUARANTEED MAXIMUM PRICE

CIVIL

YARD PIPING
KEY PLAN

FILENAME 144490-C-05-00.dwg
BC PROJECT NUMBER 144490
CLIENT PROJECT NUMBER 13057-111
SHEET NUMBER C-05-00
CITY DRAWING NUMBER 10938-32

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SEPTEMBER 2015

LEGEND:

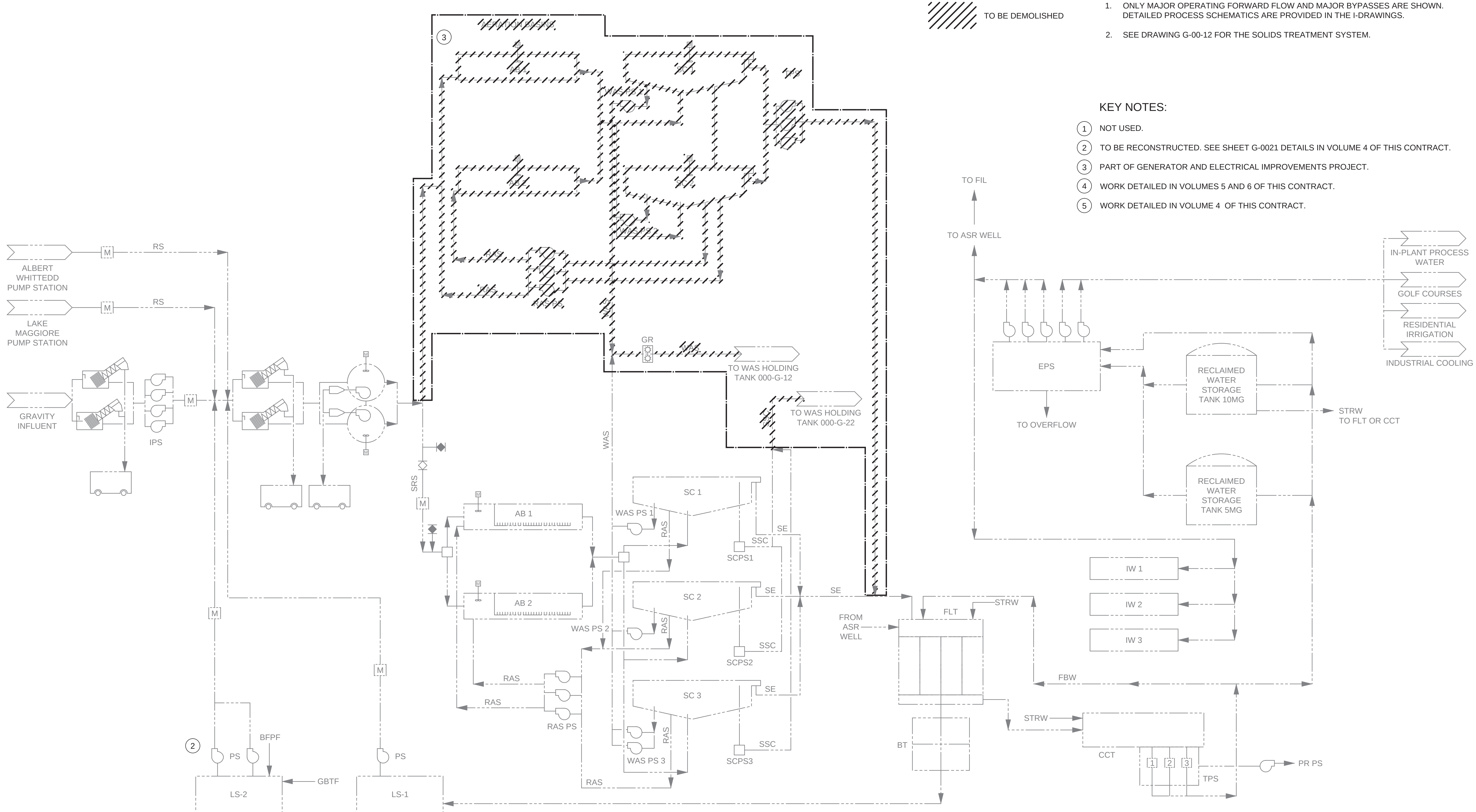
(hatched) TO BE DEMOLISHED

GENERAL NOTES:

1. ONLY MAJOR OPERATING FORWARD FLOW AND MAJOR BYPASSES ARE SHOWN. DETAILED PROCESS SCHEMATICS ARE PROVIDED IN THE I-DRAWINGS.
2. SEE DRAWING G-00-12 FOR THE SOLIDS TREATMENT SYSTEM.

KEY NOTES:

1. NOT USED.
2. TO BE RECONSTRUCTED. SEE SHEET G-0021 DETAILS IN VOLUME 4 OF THIS CONTRACT.
3. PART OF GENERATOR AND ELECTRICAL IMPROVEMENTS PROJECT.
4. WORK DETAILED IN VOLUMES 5 AND 6 OF THIS CONTRACT.
5. WORK DETAILED IN VOLUME 4 OF THIS CONTRACT.



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TAMPA, FLORIDA

SUBMITTED: PROJECT MANAGER DATE
APPROVED: BROWN AND CALDWELL DATE

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED:	A MODY
DRAWN:	T DIMICELI
CHECKED:	B ELEAZER
CHECKED:	G ANIPSITAKIS
APPROVED:	B ELEAZER

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CITY OF St. PETERSBURG
3800 54th AVE. S
St. PETERSBURG, FL. 33711

BIOSOLIDS IMPROVEMENTS

GUARANTEED MAXIMUM PRICE

GENERAL

EXISTING AND DEMOLITION PROCESS FLOW DIAGRAM

FILENAME	144490-G-00-11.dwg
BC PROJECT NUMBER	144490
CLIENT PROJECT NUMBER	13057-111
SHEET NUMBER	G-00-11
CITY DRAWING NUMBER	10938-8

SEPTEMBER 2015

Sep 18, 2015 - 3:05pm
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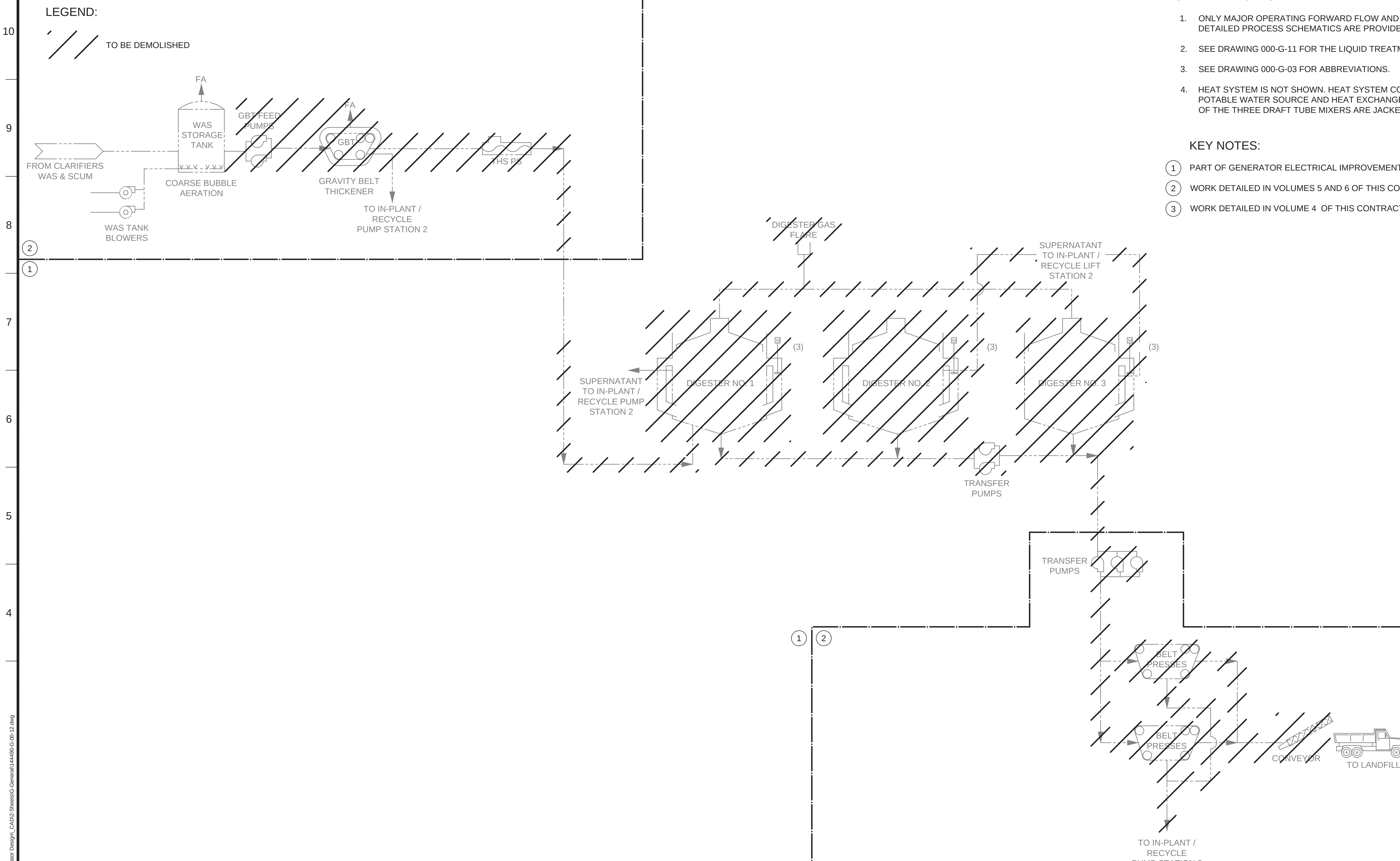
GENERAL NOTES:

1. ONLY MAJOR OPERATING FORWARD FLOW AND MAJOR BYPASSES ARE SHOWN. DETAILED PROCESS SCHEMATICS ARE PROVIDED IN THE I-DRAWINGS.
2. SEE DRAWING 000-G-11 FOR THE LIQUID TREATMENT SYSTEM.
3. SEE DRAWING 000-G-03 FOR ABBREVIATIONS.
4. HEAT SYSTEM IS NOT SHOWN. HEAT SYSTEM CONSISTS OF A WATER BOILER, A POTABLE WATER SOURCE AND HEAT EXCHANGERS. FOR EACH DIGESTER, TWO OF THE THREE DRAFT TUBE MIXERS ARE JACKETED WITH HOT WATER.

KEY NOTES:

(1) PART OF GENERATOR ELECTRICAL IMPROVEMENTS PROJECT.
(2) WORK DETAILED IN VOLUMES 5 AND 6 OF THIS CONTRACT.
(3) WORK DETAILED IN VOLUME 4 OF THIS CONTRACT.



Brown AND Caldwell
TAMPA, FLORIDA

SUBMITTED: ______ PROJECT MANAGER DATE
APPROVED: ______ BROWN AND CALDWELL DATE

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED:	A MODY
DRAWN:	T DIMICELI
CHECKED:	B ELEAZER
CHECKED:	G ANIPSITAKIS
APPROVED:	B ELEAZER

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BIOSOLIDS IMPROVEMENTS
GUARANTEED MAXIMUM PRICE

GENERAL

EXISTING AND DEMOLITION SOLIDS TREATMENT SYSTEM

FILENAME 144490-G-00-12.dwg
BC PROJECT NUMBER 144490
CLIENT PROJECT NUMBER 13057-111
SHEET NUMBER G-00-12
CITY DRAWING NUMBER 10938-9

Sep 18, 2015 - 3:05pm
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SEPTEMBER 2015

GENERAL NOTES:

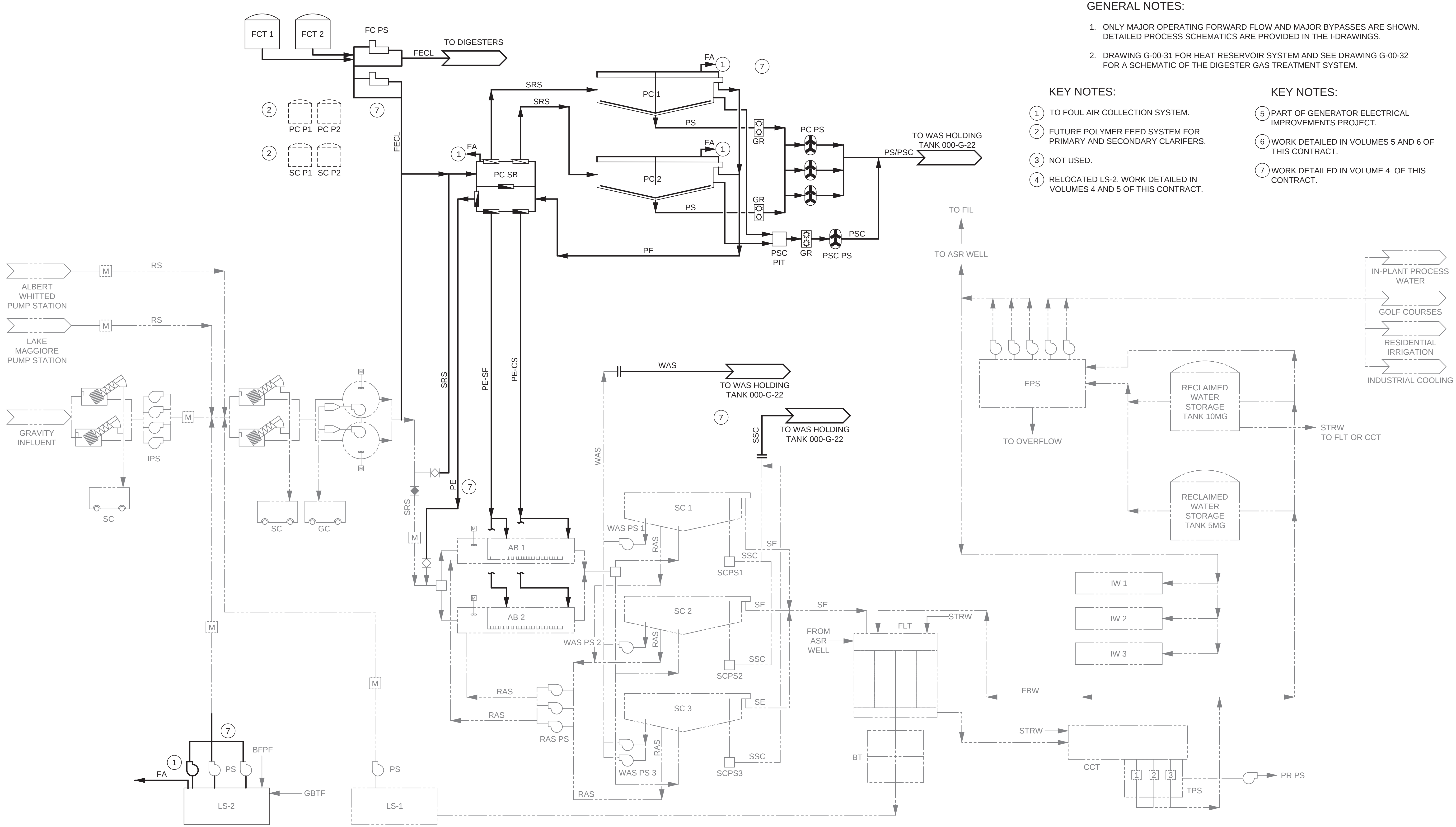
1. ONLY MAJOR OPERATING FORWARD FLOW AND MAJOR BYPASSES ARE SHOWN. DETAILED PROCESS SCHEMATICS ARE PROVIDED IN THE I-DRAWINGS.
2. DRAWING G-00-31 FOR HEAT RESERVOIR SYSTEM AND SEE DRAWING G-00-32 FOR A SCHEMATIC OF THE DIGESTER GAS TREATMENT SYSTEM.

KEY NOTES:

1. TO FOUL AIR COLLECTION SYSTEM.
2. FUTURE POLYMER FEED SYSTEM FOR PRIMARY AND SECONDARY CLARIFERS.
3. NOT USED.
4. RELOCATED LS-2. WORK DETAILED IN VOLUMES 4 AND 5 OF THIS CONTRACT.

KEY NOTES:

5. PART OF GENERATOR ELECTRICAL IMPROVEMENTS PROJECT.
6. WORK DETAILED IN VOLUMES 5 AND 6 OF THIS CONTRACT.
7. WORK DETAILED IN VOLUME 4 OF THIS CONTRACT.



Brown AND Caldwell	LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)	EXTERNAL REFERENCE FILES
TAMPA, FLORIDA	DESIGNED: B ELEAZER	144490-TBK-0000-01.dwg
SUBMITTED: PROJECT MANAGER DATE	DRAWN: T DIMICELI	
APPROVED: BROWN AND CALDWELL DATE	CHECKED: B ELEAZER	
	CHECKED: G ANIPSITAKIS	
	APPROVED: B ELEAZER	

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BIOSOLIDS IMPROVEMENTS
GUARANTEED MAXIMUM PRICE

GENERAL
NEW PROCESS FLOW DIAGRAM 1

FILENAME	144490-G-00-21.dwg
BC PROJECT NUMBER	144490
CLIENT PROJECT NUMBER	13057-111
SHEET NUMBER	G-00-21
CITY DRAWING NUMBER	10938-10

SEPTEMBER 2015

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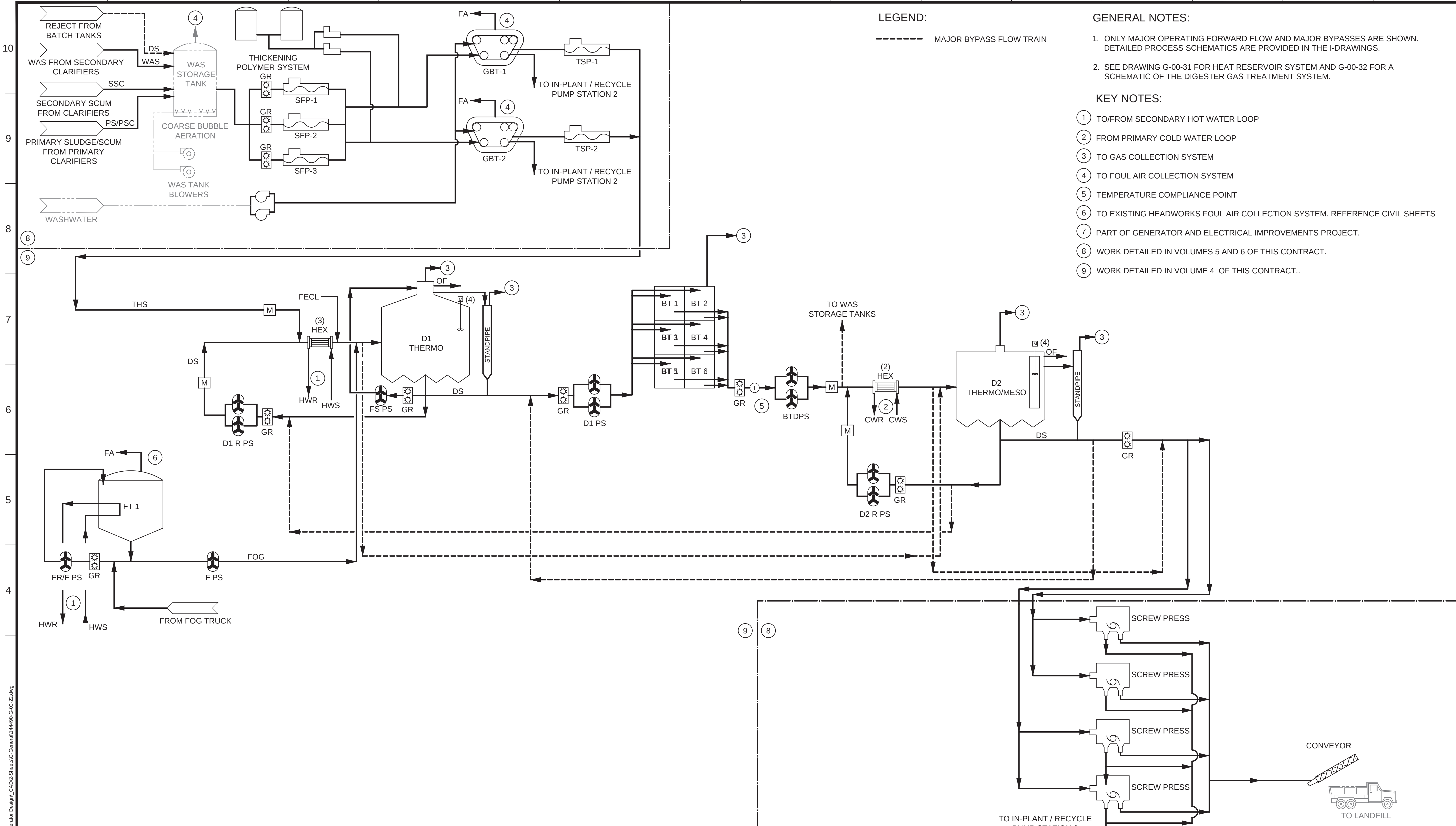

LEGEND:

- - - - - - MAJOR BYPASS FLOW TRAIN

GENERAL NOTES:

1. ONLY MAJOR OPERATING FORWARD FLOW AND MAJOR BYPASSES ARE SHOWN. DETAILED PROCESS SCHEMATICS ARE PROVIDED IN THE I-DRAWINGS.
2. SEE DRAWING G-00-31 FOR HEAT RESERVOIR SYSTEM AND G-00-32 FOR A SCHEMATIC OF THE DIGESTER GAS TREATMENT SYSTEM.

KEY NOTES:

1. TO/FROM SECONDARY HOT WATER LOOP
2. FROM PRIMARY COLD WATER LOOP
3. TO GAS COLLECTION SYSTEM
4. TO FOUL AIR COLLECTION SYSTEM
5. TEMPERATURE COMPLIANCE POINT
6. TO EXISTING HEADWORKS FOUL AIR COLLECTION SYSTEM. REFERENCE CIVIL SHEETS
7. PART OF GENERATOR AND ELECTRICAL IMPROVEMENTS PROJECT.
8. WORK DETAILED IN VOLUMES 5 AND 6 OF THIS CONTRACT.
9. WORK DETAILED IN VOLUME 4 OF THIS CONTRACT..

Brown AND Caldwell
TAMPA, FLORIDA

SUBMITTED: PROJECT MANAGER DATE
APPROVED: BROWN AND CALDWELL DATE

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED:	B ELEAZER
DRAWN:	T DIMICELI
CHECKED:	B ELEAZER
CHECKED:	G ANIPSITAKIS
APPROVED:	B ELEAZER

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BIOSOLIDS IMPROVEMENTS
GUARANTEED MAXIMUM PRICE

GENERAL

NEW PROCESS FLOW DIAGRAM
SOLID STREAM

FILENAME 144490-G-00-22.dwg
BC PROJECT NUMBER 144490
CLIENT PROJECT NUMBER 13057-111
SHEET NUMBER G-00-22
CITY DRAWING NUMBER 10938-11

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SEPTEMBER 2015