December 2013

Tewksbury Water Treatment Plant

EVALUATION OF SLUDGE HANDLING SYSTEMS

FINAL Report

TABLE OF CONTENTS

List of Tables

List of Attachments

This memorandum is to supplement the report entitled, *"Final Report: Tewksbury Water Treatment Plant Engineering Evaluation", AECOM*, December 2012, hereafter referred to as the "December 2012 Report".

The December 2012 Report summarized the assessment of the Tewksbury Water Treatment Plant (TWTP) infrastructure and process components, with a focus on the treated water and plant facilities. Since a sludge processing upgrade was recently completed at the TWTP (2005), the December 2012 Report emphasized the finished water quality rather than residuals handling components. Also, the risk to the sludge handling system has historically been mitigated by the provision of an emergency sludge disposal line to the City of Lowell sewer system, to act as a disposal location in the event of downtime on the sludge transfer and dewatering equipment.

Since finalization of the December 2012 Report, the Town of Tewksbury was notified by the City of Lowell that emergency sludge disposal to the City's sewer system will not be allowed. The inability to dispose of sludge in an emergency situation exposes the TWTP to a potential processing restriction, because inability to dispose of sludge will eventually result in shut down of the main process, and ultimately a discontinuation of finished water. Therefore, it is recommended that a new back-up solution be available to the Town and thus the purpose of this supplemental study is to evaluate the condition of the sludge processing system, with a focus on risk reduction, and to evaluate options for emergency sludge storage.

This Technical Memorandum is organized in the following way:

1) Overview of Existing Sludge Handling Process
2) Sludge Storage Options
3) Upgrade Recommendations for Existing Sludge Processing Equipment

A concept site plan and concept level cost estimate for suggested improvements is also included.

1.0 OVERVIEW OF EXISTING SLUDGE HANDLING PROCESS.

Figure 1 of Attachment A shows a process schematic of the existing sludge handling system, Figure 2 shows a yard piping schematic, and Figure 3 shows an as-built drawing of the sludge handling system (CDM 2005). Sludge is collected on a daily basis by drawing off of the settled sludge from the sedimentation basins hopper using telescopic valves. Typically, 4,000 to 8,000 gallons of sludge is drawn on a daily basis. The volume drawn off is determined empirically, based on plant flow and alum dosages in use. On a weekly basis, this totals anywhere from 28,000 to 56,000 gallons of sludge.

When the sludge is drawn from the basin it falls into "silo tanks" where the operators will hold the sludge for a short period of time. The sludge is then pumped from the silo tanks using 5 HP pumps (capable of approximately 100 gpm) through a 3-inch PVC pipeline into the 40,000 gallon main sludge storage tank. In each silo, an air release and pneumatically controlled pinch valve combination is used to drain the 3-inch line, which is essential especially during cold periods because the 3-inch line is shallow and subject to freezing. Also, in between the silos and the 40,000 gallon tank, an intermediate manhole is used to control the sludge flow to either the storage tank, or directly to sludge processing via a tank bypass line comprised of 2-inch diameter PVC buried pipes. However, the ends of the 2-inch lines are prone to clogging and are not reliable. Normally, the silos are kept empty. The main sludge storage tank contains two submersible mixers used to homogenize the sludge just before processing. The tank contains a larger 15 HP submersible mixer and a smaller 5 HP submersible mixer.

Dry pit submersible pumps (5 HP) deliver sludge to the vacuum filters on demand. The sludge passes through a cross over system which allows the operator to use one pump for both vacuum filters in case of pump failure. A 3-inch ductile iron (DI) overflow and drain return line is used as a common return drain back from the vacuum filter building into the main sludge tank. This is used for the vacuum filter overflows and to return the final cleanup to the main tank for eventual processing. Another 4-inch DI pipe return line discharges back to Silo tank No. 1 which was used until the main sludge tank was converted from its original use as PAC storage. The line is still in place and is available for use as a potential spare force main from the silos to the vacuum filters, if needed.

In addition to the series of pumps that are permanently installed, there is a backup system which will allow for transferring sludge from the silos using an electric submersible pump. Sludge can be moved to and from the silos using this portable submersible pump which runs off 220 volts single phased power. An outlet for this purpose is located on the PAC building and this has worked well in the past.

1.1 Processing Capacity. The processing capacity of the vacuum filters is determined by two main factors.

A. Sludge concentration- typically the sludge is anywhere from 0.5 % solids to 2% solids. The viscosity will have a deleterious effect as a thick sludge does not percolate well through the diatomaceous earth (DE) media that is used with the vacuum filters.
B. Temperature – A low temperature will increase the viscosity of the sludge. This reduces throughput and percolation rate. Fortunately the low temperatures of the winter are balanced off by the lower solids content of the sludge.

Typical processing capacity is about 20,000 to 25,000 gallons per night. The vacuum filters are operated typically three nights per week.

1.2 Summary of Sludge Handling System. With the exception of the new vacuum filters, the remainder of the sludge handling components, though functional, are aged and prone to failure. Plugging of pipelines, loss of pumping capacity, and corrosion of piping and pumps (including some of the newer systems) has been reported. The risks to sludge disposal as imposed by these problems have been offset by the ability to discharge sludge to the City of Lowell sewer system. However, since this is now unavailable, a "hardening" of the system is necessary.

2.0 EMERGENCY SLUDGE STORAGE OPTIONS.

The existing process has little storage time for holding the sludge. At best, assuming the 40,000 gallon tank is empty, this would provide less than a week of storage meaning that any repairs to the vacuum filter if required would need to be completed very quickly, which may not always be possible depending on the nature of the repair. This is a concern because inability to process sludge will eventually create a situation whereby the finished water production would be restricted, because if sludge cannot be withdrawn from the clarifiers, the clarified water quality will diminish, and thus the plant finished water quality would be diminished. Rather than installing additional vacuum filters (which would require, in addition to the equipment itself, an electrical system, architectural and structural modifications, chemical feed equipment, and I&C components), it is considered more cost effective to install an emergency sludge storage tank. In selection of a storage tank size and location, the following criteria were considered.

- It is preferable to be able to pump into this emergency tank with the silo pumps, and then flow by gravity back to the silos or 40,000 gallon tank, rather than have a gravity feed into the emergency tank and then have to pump out. The latter would require a new set of pumps.
- The location of the tank would be ideally suited for the area east of the garage and PAC building. This area is essentially flat and adjacent to the silos. Also, the PLC in the PAC building is currently being upgraded, and there will be available relays and I/O slots in this for taking in: level from the main sludge tank (via the existing level sensor), level from the silos via a new ultrasonic, level from the emergency tank via a new ultrasonic,

valve status and control of new sludge pneumatic valves in the manhole so that the filling of either the silo or the main sludge tank can be controlled. The proximity of the emergency sludge tank to the PAC building will minimize the cost of this I/C integration.

- The preferred volume of sludge storage should be in the range of 80,000 gallons. Assuming an average weekly sludge volume of 42,000 gallons, an 80,000 gallon tank plus the 40,000 gallon storage in the existing tank would yield approximately 3 weeks of sludge storage. This is considered ample time to make any necessary repairs on the sludge processing system.

Two tank styles were evaluated: a below grade precast concrete tank and an above ground glass lined steel tank.

2.1 Precast Concrete Below-Grade Tank. The precast tank has the benefit of being delivered to the site in sections. However, significant excavation and sheeting work would be required to install the tank. Also, the below grade tank would fill by gravity and would then be pumped out, which is not the preferred mode of operation. Therefore, the cost of the below-grade precast concrete tank would also need to include the cost of the new sludge transfer pumps, the excavation, sheeting, backfill, and anchoring (to counter buoyancy). AECOM contacted Shea Concrete for an approximate price for two (2) 40,000 gallon precast tanks. These would operate in parallel for a total storage of 80,000 gallons. These precast tanks are assembled by joining 8-ft sections that are 11' wide by 9'-4" tall. This would require 8 sections for a capacity of 40,000 gallons. The cost to purchase the tanks would be approximately $45,000 each, delivered. The estimated cost for sheeting, excavation, backfill, and anchoring is approximately $60,000, and the cost for the transfer pumps (2 at 5 HP, 150 gpm) estimated at another $20,000 for the pumps and $5,000 for electrical and I&C. This totals approximately $175,000 depending on the extent of sheeting and anchoring required. Additionally, installing these tanks in the desired location would cause disruption of the plant operations and would incur O&M costs for maintaining the transfer pumps .

2.2 Above Ground Tank. Option 2 satisfies the desire to be able to flow by gravity out of the emergency tank and into the silo or the 40,000 gallon tank. AECOM has obtained a budget price from Aquastore, manufacturer of glass lined steel tanks. The glass lining is considered an advantage due to its ability to protect the tank from corrosive properties of the sludge. A budget price of $170,000 was provided by the vendor, based on an 82,000 gallon tank, 31 ft. diameter, 15 ft. tall. The budget quote included the tank foundation and geodesic dome cover (the cover is optional).

In summary, considering only the emergency storage tank costs and neglecting site work costs and other common items, the below grade or the glass lined steel tank are comparable on a preliminary cost basis. However, the above grade glass lined tank offers the ability for gravity flow out (one less set of pumps to maintain) and will be less disruptive to the plant operations to install. Another advantage to pumping into the tank and allowing gravity discharge out, is that the tank can actually act as a pre-thickener, and a floating decant mechanism can someday be added to this tank to capture decant which can be recycled. For these reasons, AECOM recommends the glass line steel tank for use as emergency sludge storage. Attachment B to the technical memo contains the budgetary quote provided by Statewide Aquastore.

Figure 4 in Attachment A shows the location of the tank. The tank would best be located east of the garage and the PAC building. The area here is nearly flat, but it will be necessary to cut back the hillside to the east of the garage to create a finish grade of about 159 feet. This will require the use of a retaining wall. A flat paved surface surrounding the tank is recommended for ease of access. Alternatively, this surface could be gravel or crushed stone. The tank finish floor would be at elevation 160 ft, which is below the elevation of the adjacent garage slab at approximately elevation 161 ft. This elevation difference and a gently graded paved area, pitched to the catch basin, will prevent water from running off of the paved area and into the garage.

A single 4-inch SCH 80 polyvinyl chloride(PVC) line could serve as the feed to the emergency sludge tank from the silo pumps, and then back to the intermediate manhole through the same pipeline when the time comes for emptying the tank. A new pinch valve and series of isolation valves is needed to allow the stored sludge to empty back into the silos or all the way to the 40,000 gallon main sludge tank.

3.0 UPGRADE RECOMMENDATIONS FOR EXISTING SLUDGE PROCESSING EQUIPMENT.

Other recommendations for hardening the sludge handling system are summarized in Table 1. This table separates the sludge handling system components into 3 categories. Each category is described below.

3.1 Sludge Transfer Piping. The piping from the silos to the 40,000 gallon main sludge tank is 3-inch PVC and the bypass piping is 2-inch polyethylene (PE). The 2-inch pipe is prone to blockages and the 3-inch piping is shallow and prone to surface loads and freezing. It is recommended that all of this piping be converted to Schedule 80 PVC. This is durable thick-walled, and well suited to sludge characteristics.

Inside the silo tanks and the intermediate manhole, a complex arrangement of small diameter piping, fittings, and valves exists, most of which is 2-inch PVC. Operators have repaired these systems repeatedly. It is recommended that the piping in the silos and intermediate manhole be upgraded to 4-inch PVC. A new pinch valve and manual bypass valve is required to allow the new emergency storage tank to fill either the silos or the 40,000 gallon main sludge tank. This is needed so that control of the emergency sludge discharge can be provided, to minimize risk of overflowing the silos or 40,000 gallon tank. The pneumatic pinch valve will communicate with the level in the tanks so that the valve will shut when the tanks or silos are full.

In the event that a silo pump is out of service, the use of an existing portable sludge pump is available. This requires laying a temporary pipeline on the ground to convey sludge to the 40,000 gallon main sludge tank. Alternatively, the existing 4-inch DI pipe that drains the vacuum filter areas into Silo No. 1 can be fitted with a portable pump quick-disconnect fitting for use as a force main from the silos, to the vacuum filter area, and then down through the existing 3-inch washdown drain and into the 40,000 main sludge tank. This will avoid the need to lay a temporary pipe on the ground.

Table 1. Recommendations for Hardening the Sludge Handling System.

Component	Condition Grading	AECOM suggested solution
Piping		
3" PVC line between intermediate manhole and main storage tank	1	Redundant pipeline recommended due to frequency of blockage in primary line. Also, upgrade to 4-inch.
Internal piping in the two silo tanks	1	Piping should be 4-inch SCH 80 and replaced as part of pipeline upgrade
Air relief system in silo tanks	1	Existing air release is not reliable and pinch valves are critical to operation of pipeline. Replace.
Piping inside the intermediate manhole	1	Piping should be SCH 80 and replaced as part of upgrade. Install new pinch valve to communicate with level in silos and 40,000 gal tank.
Galvanized piping for vacuum filters	1	Galvanized piping is corroded. Suggest replacing with copper.
Mechanical		
Vacuum pumps	1	Vacuum pumps are corroding. Suggest rebuilding pumps (3 of 4).
Silo pumps	2	Pumps are functional, but are aged and are critical to the sludge handling system. Recommend a shelf spare which will enable operators to quickly repair the system
DE bag breaker motor and mixer	2	Suggest shelf spare for both. Inability to open DE bags will effectively shut down the dewatering process.
Reeves drives	2	Reeves drives are obsolete. VFD controlled drives are preferred.
Tank mixers	2	Retain the larger mixer in the 40,000 gal sludge tank but replace the smaller mixer, and install 2 new mixers in emergency sludge storage tank
Controls		
Vacuum filter PLC's	1	PLC's are not integrated with plant PLC, and do not allow operators to effectively monitor the process. Refurbish the PLC's with new components and integrate into plant-wide system.
Level sensors	1	Install ultrasonic level sensors for silo tank (1), new emergency storage tank (2), and integrate existing level from 40,000 gal tank
SCADA	1	Install new scada monitoring and controls for new sludge storage, silo pinch valves, new pinch valve in manhole. Integrate vacuum filter PLC's with plant PLC.

Condition Grading Scale

1- Repair and Replace Immediately
2- Repair and Replace Soon
3 - Good Condition
4 - Excellent Condition

Finally, the galvanized piping on the vacuum filter systems is rusted and with failed fittings. Approximately 100 linear feet of ¾ to 1-1/2" piping and fittings is installed. This piping should be replaced with copper.

3.2 Mechanical Systems. The vacuum pumps that work in conjunction with the vacuum filters are reported to be internally corroded. One of the vacuum pumps was recently refurbished, and it is recommended that the remaining pumps (3 of 4) be refurbished with new seals and bearings.

The silo pumps are critical to the operation of the system, and are reaching the end of their useful life. A spare silo submersible pump is recommended, however, it may not be necessary to install the pump initially. Rather, a "shelf" spare is recommended so that operators can relatively quickly remove the failed silo pump and install the new one. Using this same logic, the diatomaceous earth (DE) bag breaker and mixer is another key component, and a shelf spare motor and mixer are recommended.

The vacuum filter Reeves Vari-Speed drives are outdated, less efficient compared to VFD's and should be replaced.

The 40,000 gallon main sludge tank has two mixers, a large 15 HP mixer and a smaller 5 HP mixer. The large mixer is reported to be in satisfactory condition, but the smaller mixer should be replaced with 5HP submersible mixer wit anti vortex shield. Two additional, identical mixers will be required for the new tank, for a total of 3 new mixers.

The air compressor for pneumatic controls is new and can be left unchanged.

3.3 Controls. The two vacuum filter control panels are not in communication with the main plant PLC. The sludge handling system should be configured to allow operators complete monitoring and control. Therefore, it is recommended that the vacuum filter control panels be upgraded to allow for communication with the main plant PLC. SCADA integration of the new control panels will be required. The recommended upgrade for each control panel is to replace the Allen Bradley SLC/503 with SLC/505 controller containing a minimum of two ether net connections (one for the OIT one for the network), installation of a Panel View plus color 1250 with keypad and Ethernet, input and output cards. The cabinets and remainder of the PLC equipment is adequate.

Level sensors for the new emergency tank and the silos are required to allow for level control. An existing level sensor in the 40,000 gallon main sludge tank should also be brought into a common control scheme for complete level monitoring and control in the emergency tank, the silos, and the 40,000 gallon main sludge tank. A new pinch valve is required in the intermediate manhole. Currently, a new PLC control system for the PAC building is being designed, the “PAC PLC” (this is a separate system from the vacuum filters PLC’s described above). It is based on an Allen Bradley Micrologix 1100 with a 1762-OF4 extension module for pacing signals output. When completed, this PLC will be attached to the plant’s intranet and will communicate with the chemical feed PLC and the main PLC. There will also be 6 relays, two of which will be used for the two PAC chemical feed pumps and the other four shall be reserved for the pneumatic pinch valves proposed for use in the new sludge tank. Since there are also 9 inputs available on the PLC, the level sensors can be tied into the PAC PLC to prevent overflows. The 40,000 gallon main sludge storage tank would also be brought into this PLC.

4.0 Conceptual Level Cost Estimate

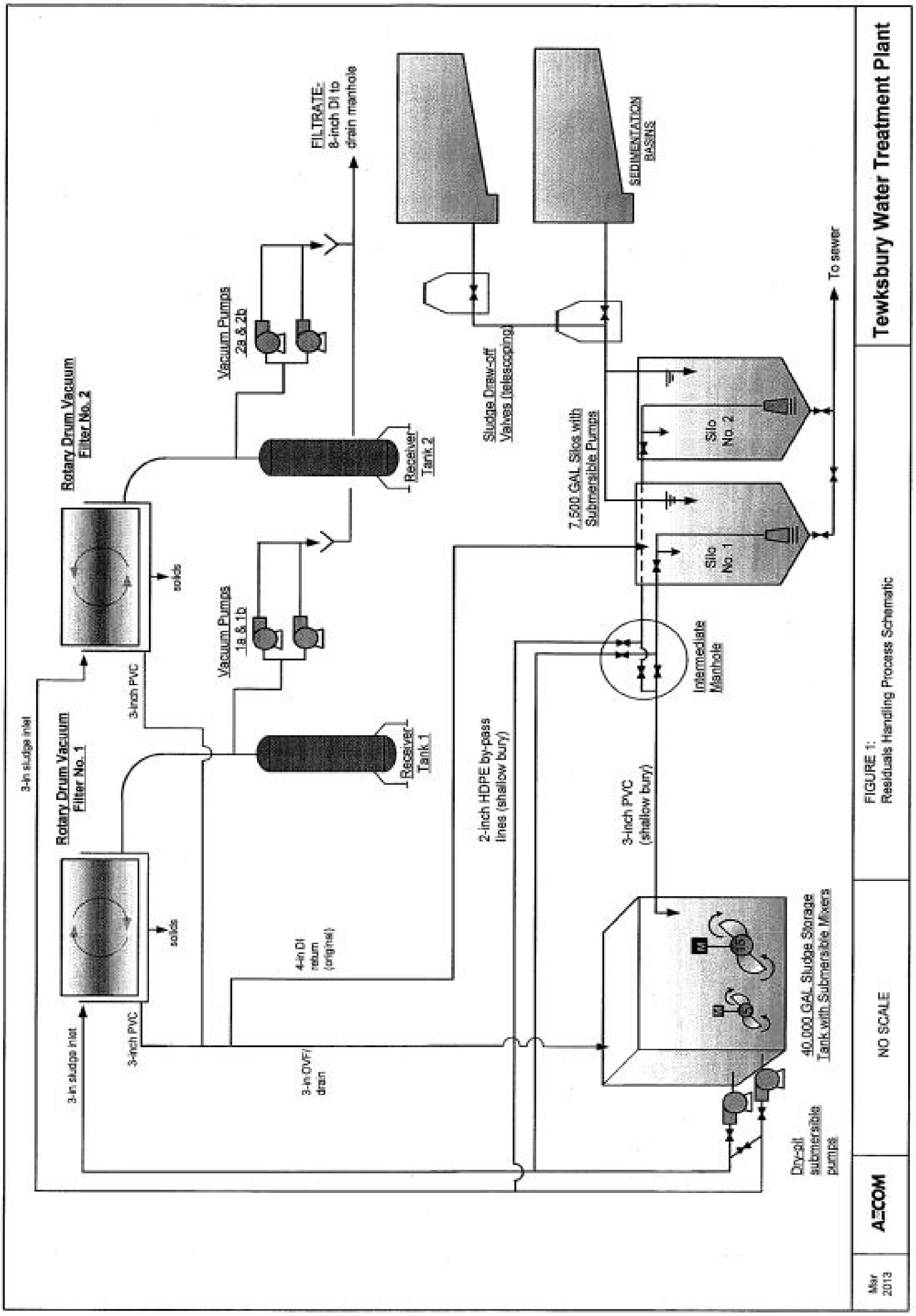
The planning level opinion of estimated capital costs associated with the recommendations summarized in Table 1 is approximately $798,000. The majority of this cost is comprised of the sludge storage tank and associated civil works. The cost information is included in Attachment C.

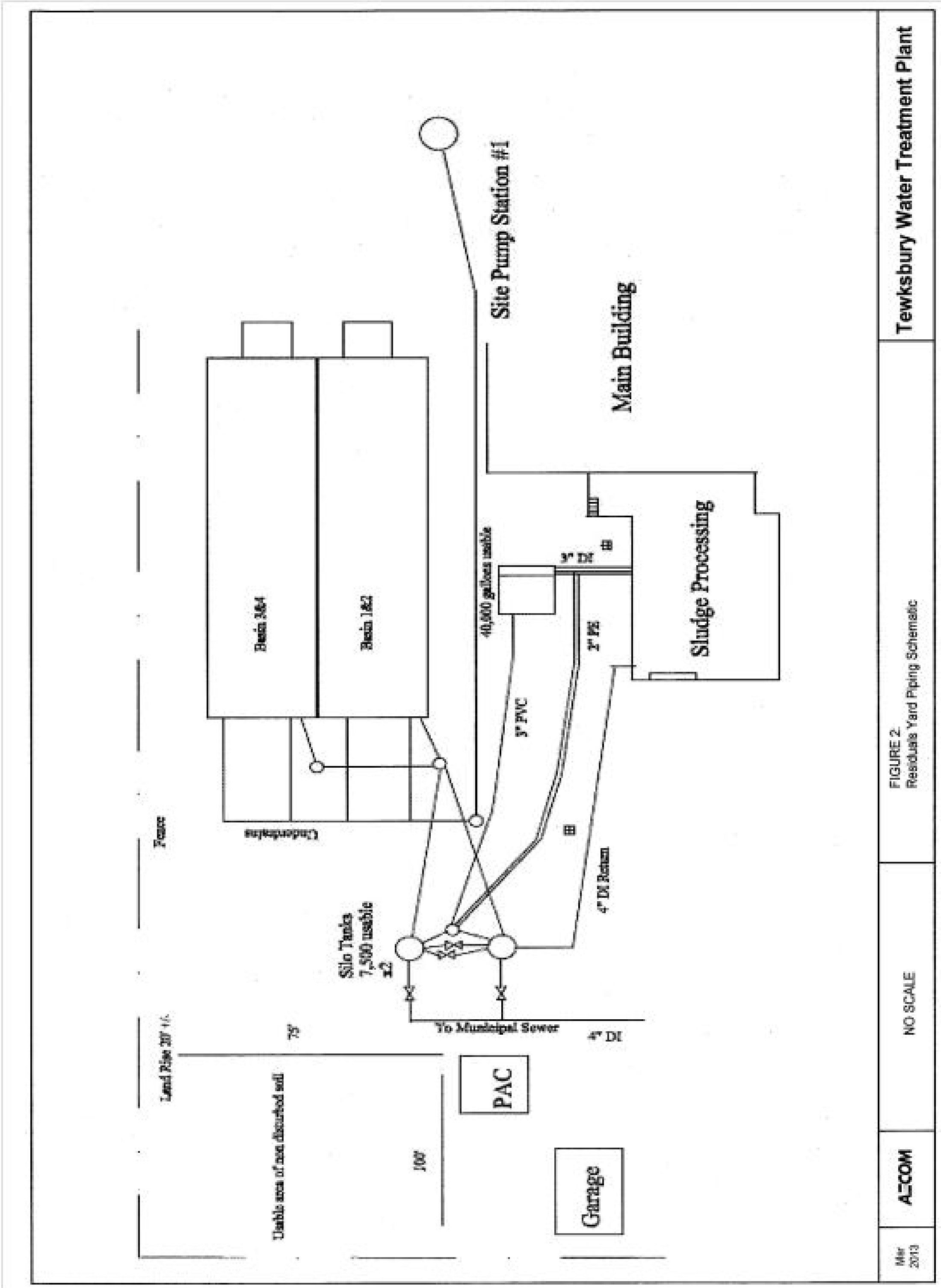
Costs reflect the current ENR construction cost index as of November 2012. An average wage rate of $85.45 was calculated from 2012 RS Means Labor rates (ENR of 9398) based on costs in the Boston area. The estimate includes contractor overhead and profit, a 30% allowance for final design elements, and an additional 40% for engineering and contingency.

Although the purpose of this evaluation is to recommend capital improvements, it is also important to consider maintenance costs. Regular maintenance, including preventative maintenance, is important to day to day operations and will extend the life of the facility. Operating budgets should account for regular maintenance expenditures that will protect the investment made as part of the capital improvements plan.

ATTACHMENT A

FIGURES


Tewksbury Water Treatment Plant
FIGURE 1:
Residuals Handling Process Schematic
NO SCALE
AECOM
Mar 2013
Rotary Drum Vacuum Filter No. 1
Rotary Drum Vacuum Filter No. 2
3-in sludge inlet
3-inch PVC
solids
Receiver Tank 1
Receiver Tank 2
Vacuum Pumps 1a & 1b
Vacuum Pumps 2a & 2b
FILTRATE: 8-inch DI to drain manhole
3-in OVF/ drain
4-in DI return (original)
2-inch HDPE by-pass lines (shallow bury)
3-inch PVC (shallow bury)
Intermediate Manhole
7,500 GAL Silos with Submersible Pumps
Silo No. 1
Silo No. 2
Sludge Draw-off Valves (telescoping)
SEDIMENTATION BASINS
To sewer
40,000 GAL Sludge Storage Tank with Submersible Mixers
Dry-pit submersible pumps


Tewksbury Water Treatment Plant
FIGURE 2
Residuals Yard Piping Schematic
NO SCALE
AECOM
Mar 2013
Site Pump Station #1
Main Building
Sludge Processing
40,000 gallons usable
3" DI
2" PE
3" PVC
4" DI Return
Basin 3&4
Basin 1&2
Underdrains
Fence
Silo Tanks
7,500 usable
x2
To Municipal Sewer
4" DI
75'
100'
PAC
Garage

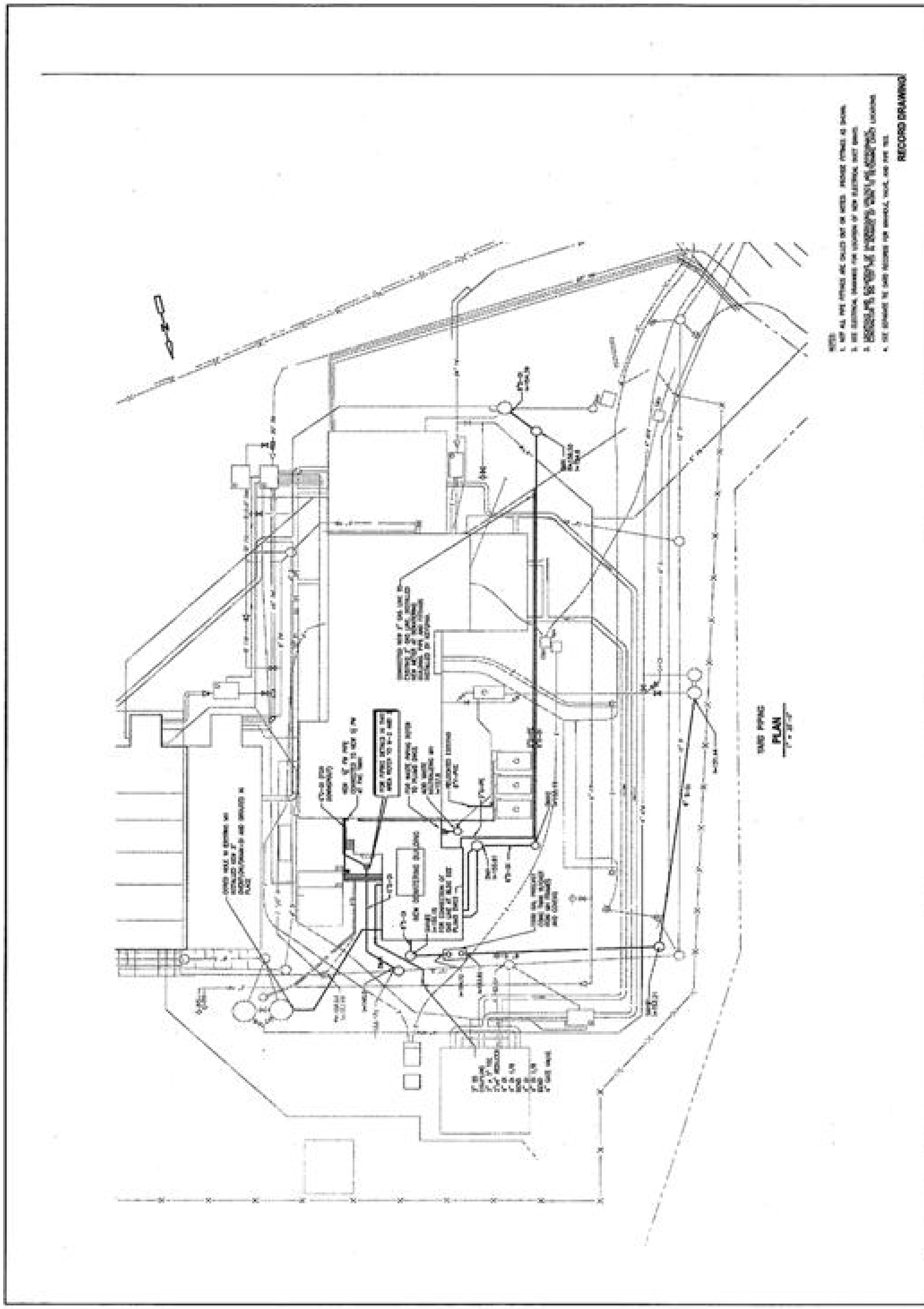


FIGURE 3:
Record Drawing of Residuals Yard Piping (CDM 2005)

Tewksbury Water Treatment Plant

AECOM

Mar
2013

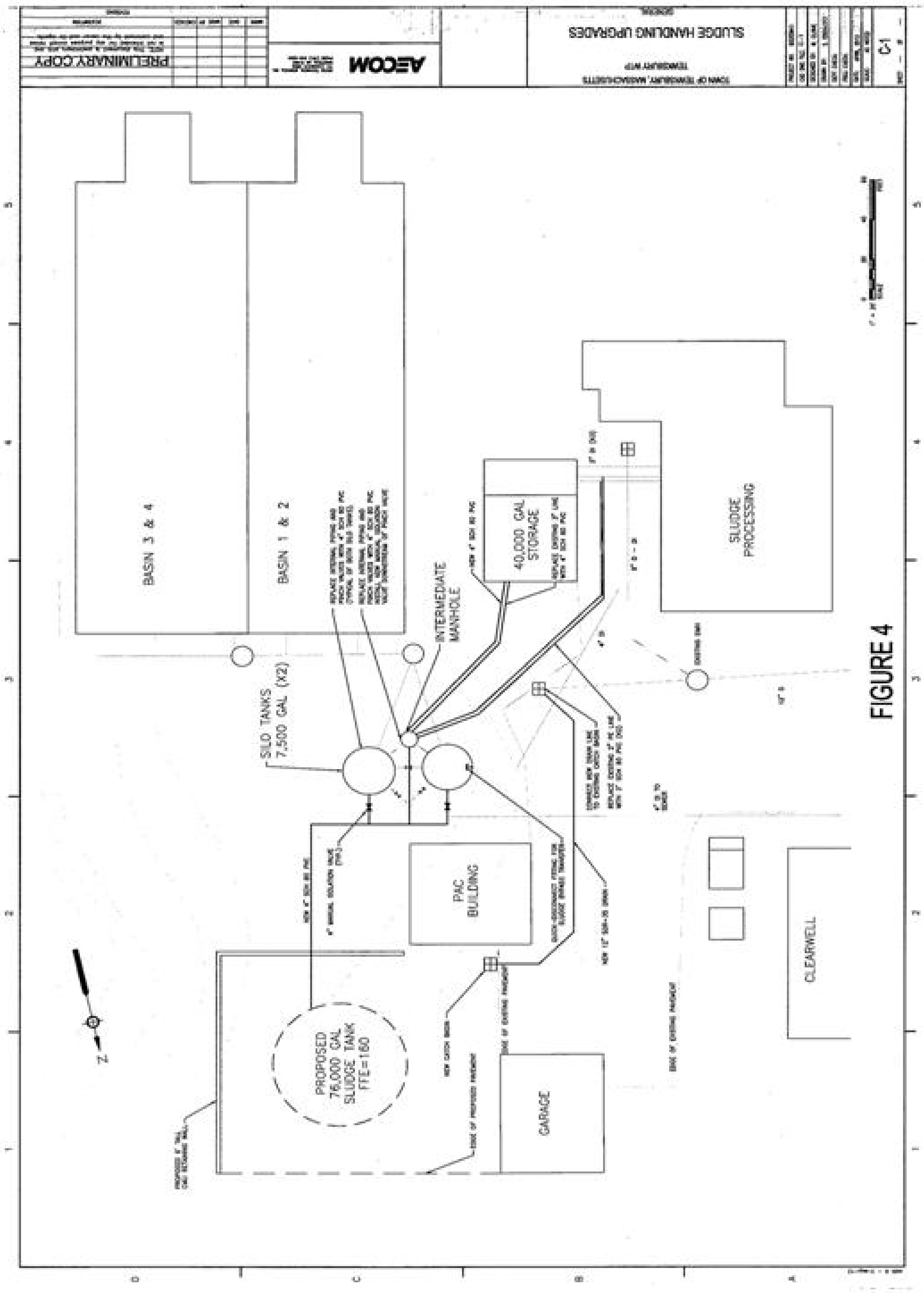

PRELIMINARY COPY
AECOM
SLUDGE HANDLING UPGRADES
C-1
BASIN 3 & 4
BASIN 1 & 2
INTERMEDIATE MANHOLE
40,000 GAL STORAGE
SLUDGE PROCESSING
SILO TANKS 7,500 GAL (X2)
PAC BUILDING
PROPOSED 76,000 GAL SLUDGE TANK FTE=160
GARAGE
CLEARWELL
N

FIGURE 4

ATTACHMENT B

BUDGETARY QUOTE FOR AQUASTORE TANK

STATEWIDE AQUASTORE, Inc.
Premium Water and Wastewater Storage Tanks

6010 Drott Drive
East Syracuse, NY 13057-2943
Toll Free: 800.H2O.TANK
Phone: 315.433.AQUA (2782)
Fax: 315.433.5083
Website: www.besttank.com
Email: aquastore@besttank.com

April 11, 2013

AECOM
701 Edgewater Drive
Wakefield, MA 01880
(781) 224-6032 Phone
(781) 245-6293 Fax

Attention: Stephen Eisenlord (Stephen.eisenlord@aecom.com)

Re: **AQUASTORE®** Waste Water Ground Storage Tank
Tewksbury WTP, Tewksbury, MA

Dear Stephen:

Thank you for your interest in **AQUASTORE®** glass-fused-to-steel storage tank. The following budget price is for the concrete floor, aluminum geodesic dome roof, waste water storage tank that you are interested in. The tank is designed to AISC allowables and manufactured to AWWA standards.

Design parameters for budget purposes are: Seismic based on category III (use group II). Estimated soil bearing capacity of 4,000 PSF – site class C, AWWA wind design and 55 psf ground snow load.

NOTE: Foundation prices are ESTIMATES. Accurate soil bearing capacity, frost depth and any other pertinent information would be required to determine the exact design and costs of the foundation.

Model	Nominal Capacity (Gallons)	Actual Capacity w/Freeboard	Freeboard (Inches) Provided	Diameter (Feet)	Height (Feet)	Tank Price Only *(No Foundation)*	TOTAL PRICE Tank *(with Foundation)*
31 15 SS	81,600	76,000	12"	30.77'	14.68'	$145,000	$170,000

NOT INCLUDED:* *Any and all site work *(including but not limited to) access roads, site preparation, excavation, backfill, backfill materials, rock or organic material removal, compaction/compaction testing), all site pipe (material and installation). Also* ***NOT*** *included: Lightning protection, mixing systems, fencing, any electrical, name sheets and water/disposal for tank testing.* ***Any permits, state or local sales and use taxes and bonds are not included.***

The following items are included in the budget numbers:

- Tan Glass-Fused-To-Steel Shell Assembly with "**Edge Coating™**"
- Aluminum Geodesic Dome Roof Assembly with Gravity Vent and Safety Cable
- Concrete Floor, Foundation and Design (See Foundation Note)
- OSHA Compliant Exterior Ladder, Cage, Platform Assembly and Lockable Ladder Device
- (1) Standard Roof and (1) 24" Bottom Manway
- Aluminum Overflow Piping and Weir Box
- Exterior Protective Caps
- Sacrificial Anode Cathodic Protection System
- Tank Installation, Testing and Freight to Jobsite

A chemical analysis must be provided for the stored liquid to ensure compatibility of the standard tank materials/components. If substitution of standard components is required, pricing may be effected.

ATTACHMENT C

CONCEPTUAL LEVEL COST ESTIMATE

	Conceptual Level Costs
Piping Sch 80 PVC, piping modifications in silos, intermediate manhole, underground piping and vacuum filter galvanized pipe replacement.	**$23,000**
Aquastore Tank Site work, retaining wall, foundations, tank, tank cover, paving, drainage.	**$225,000**
Mechanical Upgrades Vacuum filter rehabs, mixers, spare silo pump, bag breaker mixer and motors, retaining wall, foundations, paving, drainage.	**$48,000**
Control Systems Reeves drives, upgrade to vacuum filert PLCS, integration, additioan to PAC PLC, ultrasonics, allowance for programming.	**$79,000**
Subtotal	**$375,000**
OH & P (17%)	**$63,750**
Construction Cost	**$438,750**
Allowance for Final Design Elements (30%)	**$131,625**
Estimated Construction Cost	**$570,375**
Engineering Contingency (40%)	**$228,150**
PROJECT TOTAL	**$798,525**

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