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Technical Memorandum

Prepared for: Seattle Public Utilities

Project Title: South Park Pump Station and Water Quality Facility

Project No.: 135668.209

Technical Memorandum

Subject: Stormwater Solids Handling Alternative Evaluation

Date: September 19, 2014

To: Sheila Harrison, Project Manager

From: Bruce Ball, Project Manager

Copy to:

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Section 1: Introduction

Seattle Public Utilities (SPU) is responsible for managing stormwater runoff from the 5th Avenue South basin, also referred to as the South Park basin. Stormwater from the basin is discharged into the Lower Duwamish Waterway. Low-lying areas of the basin are prone to flooding during heavy rainfall events and at certain tidal conditions. Additionally, the basin includes significant industrial development and unpaved streets, which impacts the water quality of runoff from the basin. A flood control pumping station and Water Quality Facility (WQF) were proposed for the basin to address these issues. The Integrated Plan (IP) being developed by SPU for combined sewer overflow and stormwater runoff management identified these projects as providing a significant environmental benefit. In 2013, SPU began a Stage Gate 2 process to hydraulically model and size the South Park WQF and to select a preferred technology option for the facility. Target pollutant load reductions for the WQF for total suspended solids (TSS) and other constituents were developed in a water quality workshop. These load reductions are consistent with the IP. In a subsequent Value Analysis (VA) workshop, the VA panel recommended that SPU also evaluate options for handling solids from the WQF.

This technical memorandum summarizes the solids handling alternatives evaluation. For stormwater treatment, several options are being considered including ballasted sedimentation with microsand (Actiflo® by Krüger), ballasted sedimentation with magnetite (CoMag™ by Evoqua), electro-coagulation, and chitosan-enhanced sand filtration (CESF).   All of these systems produce chemically flocculated sludge that will need to be removed and disposed of off-site. In this evaluation, a business case evaluation (BCE) was conducted to compare the combined effects of capital and operating costs for a number of solids handling options. Only preliminary cost estimates were prepared and included in the BCE. Results of the BCE will be used as basis for selecting the solids handling system.

Section 2: Description of Solids Handling Alternatives

The candidate stormwater treatment systems (ballasted sedimentation, electrocoagulation, and CESF) will separate solids from the liquid stream and produce sludge. The waste sludge from the candidate stormwater treatment systems will generally be fairly wet sludge. Therefore, several approaches for solids handling are considered, including:

- Hauling wet sludge from the stormwater treatment system.
- Adding a sludge thickener and hauling thickened sludge.
- Adding a sludge thickener and dewatering system and hauling dewatered solids.

More detailed descriptions of each of these options are given below. Figure 2-1 shows a site plan with the approximate layout of the stormwater treatment and solids handling systems. The final footprint of the solids handling system will depend on the selected option.

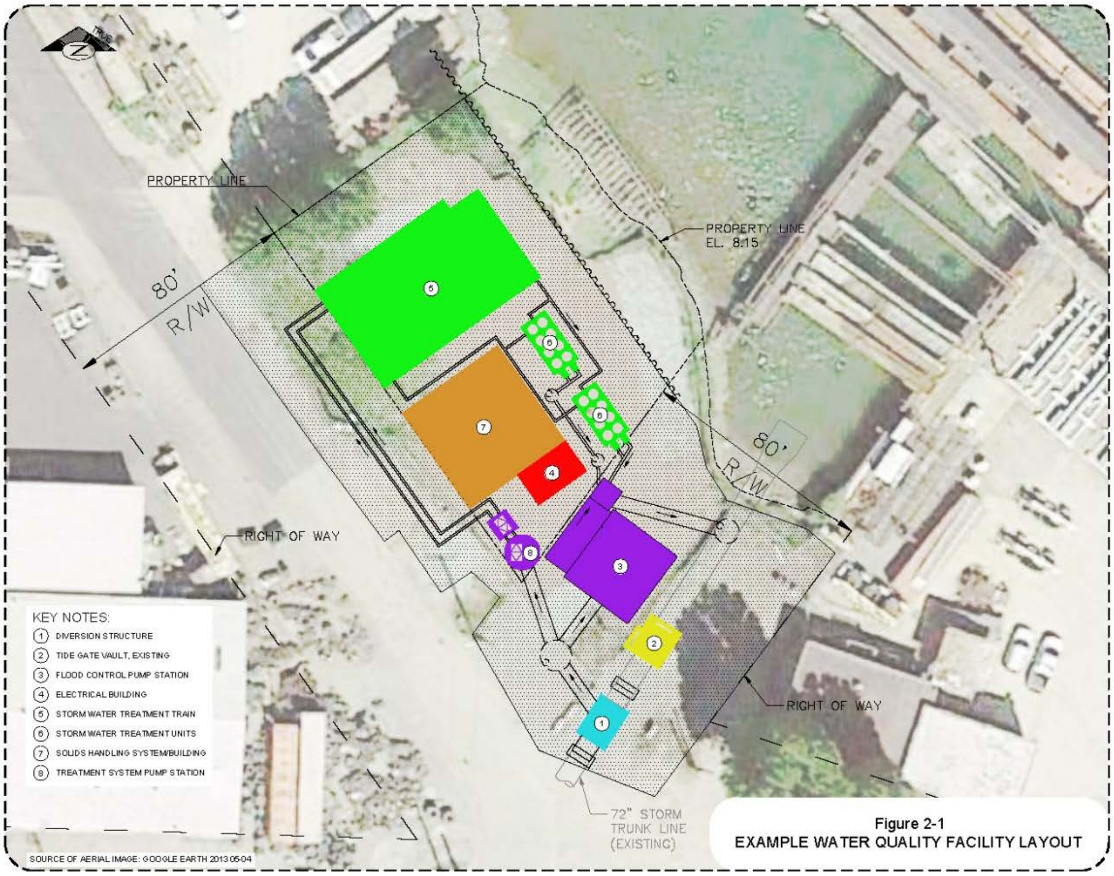

Figure 2-1. Site plan

2.1 Hauling Wet Sludge

This alternative consists of the minimal amount of solids handling equipment as the wet sludge generated from the stormwater treatment system will be hauled off-site without further treatment. A sludge pump, for transferring sludge from the stormwater treatment system and a sludge storage tank would be required. Figure 2-2 shows the process flow schematic for this alternative. The solids content in the wet sludge could vary from approximately 0.5 to 2 percent solids, depending on the stormwater characteristics and the treatment process. The wet sludge generally resembles a very watery clay mixture, with a rusty-reddish color if iron compounds are used in the stormwater treatment system for coagulation. If alum is used, the sludge will have tan-brown dirt color. Figure 2-3 shows a photo of the settled sludge after addition of ferric chloride without any additional thickening and dewatering.

Because of the low solids content for the sludge generated without further treatment, the required storage volume and the volume hauled for disposal are the highest for this alternative compared to the other alternatives.

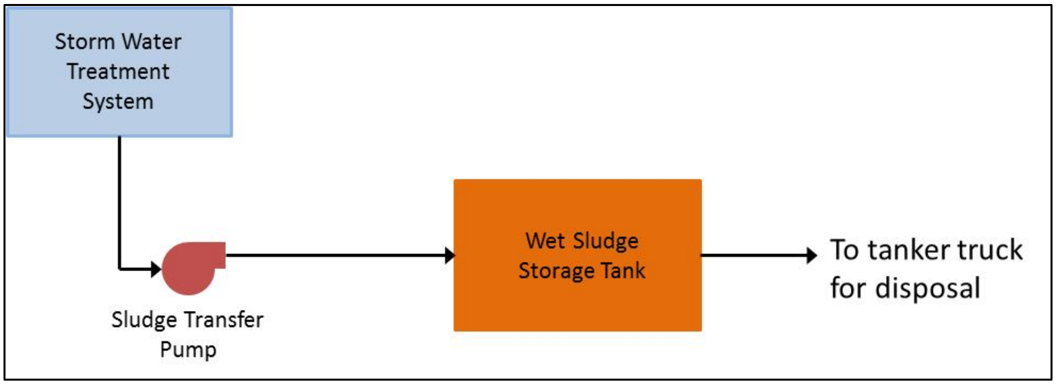

Figure 2-2. Process flow schematic for hauling wet sludge

Figure 2-3. Photo of wet sludge after ferric chloride addition

(wet sludge in beaker)

2.2 Adding Sludge Thickener and Hauling Thickened Sludge

In this alternative, a sludge thickening system is added to thicken the sludge from the stormwater treatment system to about 3 to 4 percent prior to disposal. This reduces the volume of sludge hauled off-site. Two different thickening systems are considered for this alternative: a gravity thickener and a rotary drum thickener (RDT). In both cases, the thickened sludge is stored in a thickened sludge tank until it is hauled and disposed of off-site.

In a gravity thickener, the wet sludge is introduced into the center feed well of the thickener tank. Solids separation occurs by gravity and the settled solids are withdrawn from the bottom of the tank. Polymer can be added to improve solids capture. A typical gravity thickener is shown on Figure 2-4 A process flow schematic for a treatment train including gravity thickener is shown on Figure 2-5.

Figure 2-4. Typical gravity thickener

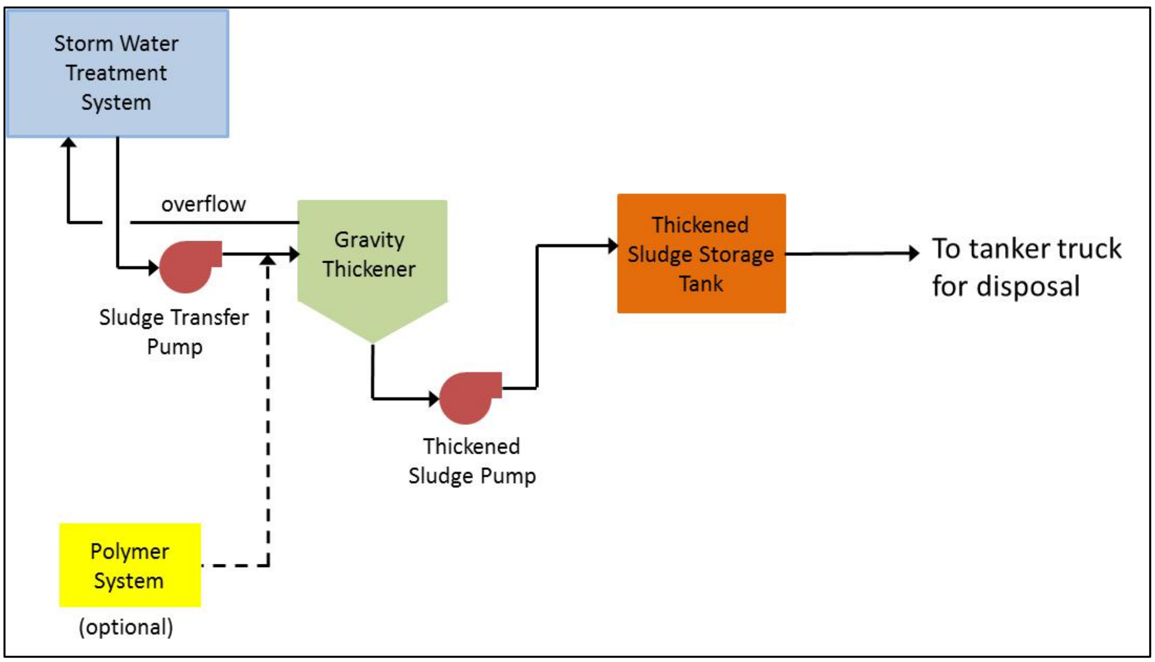

Figure 2-5. Process flow schematic for adding gravity thickener and hauling thickened sludge

In a RDT, sludge is conditioned with polymer in a flocculation tank before being introduced into a rotating drum screen. Free water drains through the screen openings and collects in a trough underdrain and the floc particles collect on the screen. The thickened sludge is conveyed through the rotating drum via a continuous internal screw or angled flights and is discharged at the outlet chute. Sludge concentration increases as the sludge travels along the length of the screen. The drum is sometimes inclined to aid in dewatering/ thickening. Spray water cleans the screen. The benefits of RDT include small footprint, ease of operation, and low odor potential. A typical RDT is shown on Figure 2-6, while the process flow schematic for this treatment train is shown on Figure 2-7. Thickened sludge from the RDT will resemble a wet clay material, reddish in color if iron compounds are used in the stormwater treatment system, as shown in the photo on Figure 2-8.

Figure 2-6. Typical RDT

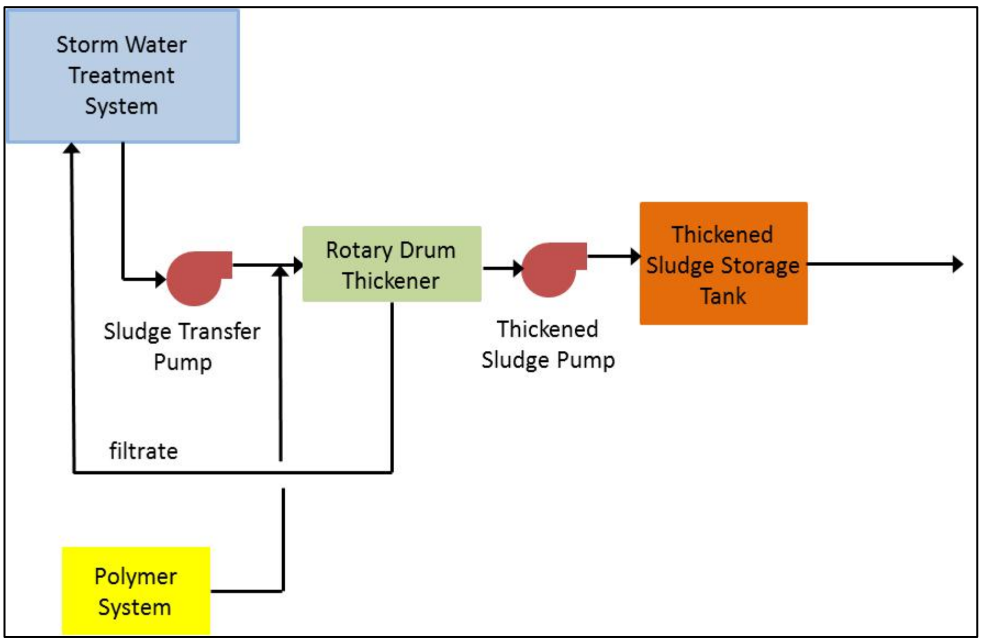

Figure 2-7. Process flow schematic for adding rotary drum thickener and hauling thickened sludge

Figure 2-8. Photo of RDT thickened sludge (after ferric chloride addition)

2.3 Adding Sludge Thickener and Dewatering System and Hauling Dewatered Sludge

In this alternative, the wet sludge from the stormwater treatment system is treated in a two-step process. It is first thickened to about 3 to 4 percent solids using one of the processes discussed in Section 2.2 above. Then the thickened sludge is dewatered to about 20 to 25 percent solids. For this analysis, a screw press was assumed for the dewatering system. Other dewatering technologies are available, such as centrifuges and belt filter presses. Screw press was used in this analysis as it represents a dewatering system with a small footprint and generally good performance, and that can be provided by the same manufacturer as the RDT. This alternative produces the driest sludge and thus smallest volume for off-site disposal, but requires more equipment. A common polymer system will be included for sludge conditioning for both the thickening and dewatering systems. Dewatered sludge will be stored in a dewatered sludge tank until it is hauled off-site, but because of the high solids content, the tank will be considerably smaller than the corresponding storage tanks for the other two alternatives.

For this analysis, an RDT is assumed for the thickening process and a screw press is assumed for the dewatering process. A screw press consists of a tapered screw shaft inside a cylindrical housing. In a screw press, sludge is first conditioned with polymer in a flocculation tank. The conditioned sludge is then fed into a horizontal or inclined drum with a rotating screw shaft. Dewatering occurs by compressing the material between the screw shaft and housing as it is conveyed from the inlet to the discharge end of the screw press. Liquid gravity drains out the inlet side. Similar to an RDT, the dewatering process in a screw press is fully enclosed, minimizing odor release, and it can be operated with low washwater requirements and minimal operator attention. A typical screw press is shown on Figure 2-9. Figure 2-10 shows a process flow schematic of the two-step thickening-dewatering process. Figure 2-11 shows a photo of dewatered sludge that was processed in a screw press. The dewatered cake is shown to resemble soft clay dirt clods, slightly sticky, with a slightly greasy feel.

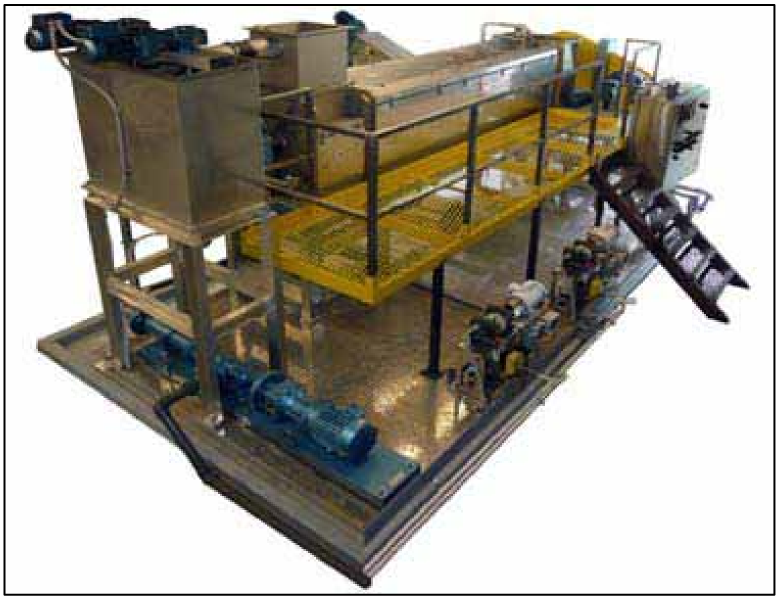

Figure 2-9. Screw press

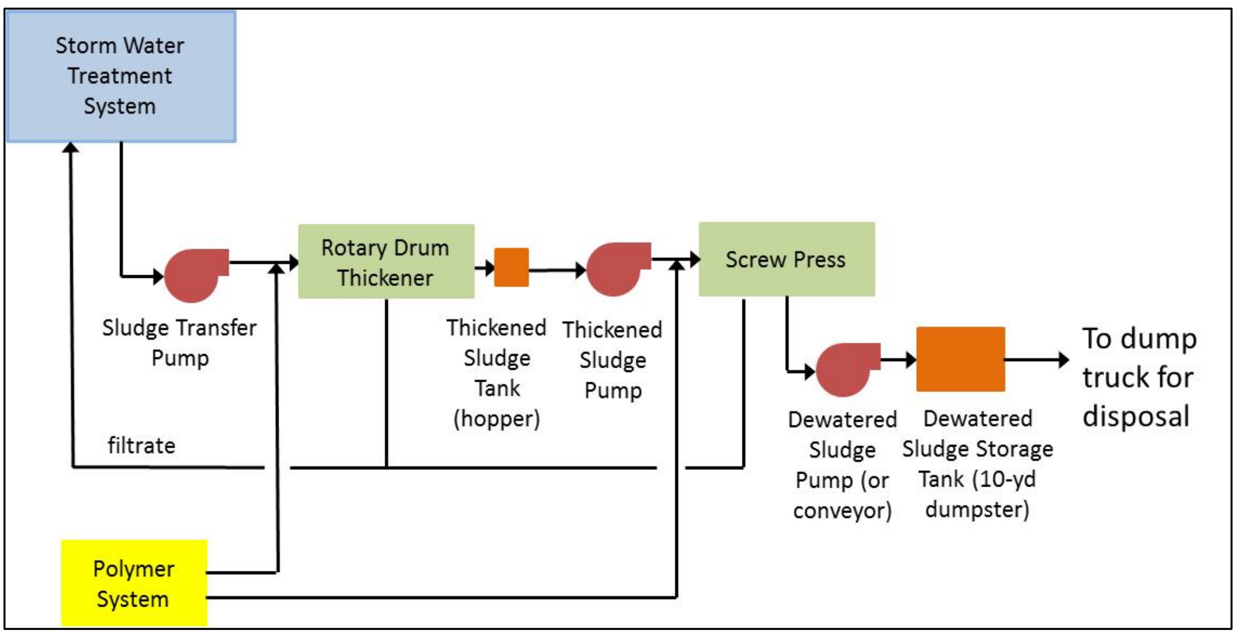

Figure 2-10. Process flow schematic for adding rotary drum thickener and screw press and hauling dewatered sludge

Figure 2-11. Photo of dewatered sludge from screw press

Section 3: Basis of Design and Assumptions

The sludge handling systems were sized and operating requirements were calculated from estimated sludge production rates. The design basis and assumptions used in this analysis are summarized in Table 3-1 below. Tables 3-2 and 3-3 provide sizing criteria for each solids handling process and assumptions used in developing capital and operating costs for the BCE, respectively. The BCE calculations were performed for the period from 2021 to 2043, assuming the capital costs would be expended in 2021 to 2023 and the system would begin operation in 2024.

In this analysis, operating and maintenance (O&M) costs for the sludge handling systems are assumed to consist of the costs for hauling and disposing the sludge, cost of polymer added to the thickening and dewatering systems, and labor costs associated with operation and maintenance of the equipment. In practice, O&M costs will also include power costs and costs for any replacements part for equipment. However, these costs are expected to be relatively insignificant compared to the other O&M costs and are thus not included in the BCE cost calculations.

Table 3-1. Design Basis for Stormwater Treatment System

Parameter	Unit	Value
Stormwater Treatment System		
Peak flow capacity	mgd	3.9
	cfs	6.0
Average flow basis for solids sizing[a]	mgd	2.9
	cfs	4.5
Maximum influent total suspended solids (TSS) concentration	mg/L	100
Nominal TSS removal	%	90
Volume treated		
Maximum	Mgal/yr	131
Average	Mgal/yr	100
Minimum	Mgal/yr	74
Annual average stormwater solids load removed	kg/yr	24,750
Chemical Addition (to Stormwater Treatment System)[b]		
Chemical dose		
Alum	mg/L as Al	3
Ferric chloride	mg/L as Fe	4
Polymer	mg/L	1

[a] *Sizing basis for solids system is 100 Mgal/yr. Solids sizing flow basis is annual volume averaged over operating period assuming 75 events per year with 11 hours average event duration.*

[b] *To estimate sludge production rates, it was assumed that chemicals in the form of either alum or ferric chloride, as well as polymer, are added in the stormwater treatment system. Dosages given are based on data given in proposal by Evoqua for the CoMag™ system dated April 2014. The higher of the sludge production rates associated with alum or ferric chloride (not both) was used in sizing the solids handling system. The solids processing load includes removed stormwater solids as well as chemicals added for treatment.*

Table 3-2. Solids System Sizing Criteria

Parameter	Gravity Thickener	Rotary Drum Thickener	Screw Press [b]
Sludge loading rate (lb/hr)[a]			
Maximum	143	143	143
Average	82	82	82
Feed % solids	0.5	0.5	3.5
Maximum hydraulic flow rate (gpm)	57	57	8
Design unit loading rate (lb/ft^2-hr)	0.5	-	-
Design hydraulic loading rate (gal/ft^2/hr)	20	-	-
Thickened or dewatered sludge % solids	3.0	3.5	20
Thickened or dewatered sludge storage tank residence time (day)	3	3	3

[a] *Sludge loading rates accounting for chemicals added in the stormwater treatment system. Because alum sludge loading rates calculated per the assumed dosages given in Table 1 is higher than ferric sludge loading rates, the alum sludge loading rates were used to size the solids handling system.*

[b] *Screw press sized assuming 100 percent solids capture in the thickening system (i.e., with same solids loading rates as the thickening system) to provide a conservative estimate. The thickening and dewatering systems will operate sequentially during a storm event, such that no storage between the two processes is required.*

Table 3-3. BCE Cost Development Assumptions	
Parameter	**Value**
Capital Cost Development	
Concrete tank unit cost (including installation)	$2.50/gal
Equipment building unit cost (including installation and with minimal architectural features)	$200/sq ft
Equipment costs	Per vendor quotes
Equipment installation cost (% vendor quote)	30%
Sales Tax	9.5%
Miscellaneous hard costs [a]	$100,000
Soft costs (% total construction cost)[b]	30%
Contingency reserve (% total base cost)	20%
Management reserve (% total base cost)	10%
Hauling and Disposal Cost Development [c]	
Hauling frequency during storm events	Every 3 days
Tanker truck	
Capacity	6,000 gal
Rental rate	$140/hr
Wet sludge disposal unit cost	$100/wet ton
Dump truck	
Capacity	9 cu yd
Rental rate	$140/hr
Dewatered sludge disposal unit cost	$50/wet ton
Polymer Cost Development (for thickening and dewatering)	
Polymer type [d]	Emulsion
% active	47
Dosage (active lb/dry ton) [d]	
RDT	15
Gravity thickener	10
Screw press	15
Unit cost ($/lb)	$2.50
Labor Cost Development	
Labor rate ($/hr)	$80
Escalation rate	2%
Discount rate	4%

[a] Miscellaneous hard costs include costs for permitting , surveying and materials testing.

[b] Soft costs include costs for engineering, legal, and administration.

[c] Hauling and disposal costs provided by Bravo Environmental. It was assumed that the raw and thickened sludge are both considered wet sludge and will be hauled in tanker trucks to the LaFarge facility for further processing. The sludge can be vacuumed into the tanker trucks, so that a separate sludge pump for transferring the sludge to the trucks is not required. The dewatered sludge is assumed to be hauled in dump trucks to Waste Management and can then be taken to a landfill without additional processing.

[d] Emulsion polymer is assumed for sludge conditioning. The dosages given (except for gravity thickener) are estimated dosages provided by FKC, Inc. For the two-step thickening-dewatering process, it was assumed that 15 lb/DT of polymer will be added at the RDT and then another 15 lb/DT will be added at the screw press.

Section 4: Business Case Evaluation

Capital and O&M costs were estimated per the assumptions given in Section 3 above for each alternative and subsequently used as inputs to the BCE. The capital costs for the alternatives incorporating sludge thickening and/or dewatering include budgetary prices provided by equipment manufacturers. The budgetary quotes are included in Attachment A. Results of the BCE are summarized in Table 4-1. The results indicate that while Alternative 3 has the highest capital costs, it has the lowest total net present worth due to its low hauling and disposal costs.

Table 4-1. Summary of BCE Results

Parameter	Alternative 1: Haul wet sludge	Alternative 2a: Add RDT and haul thickened sludge	Alternative 2b: Add gravity thickener and haul thickened sludge	Alternative 3: Add RDT and screw press and haul dewatered sludge
Capital costs (2014 $)	$571,000	$682,000	$732,000	$1,203,000
Annual O&M costs (2014 $)				
Hauling and disposal costs	$718,000	$103,000	$120,000	$15,000
Polymer costs	-	$2.800	$1,800	$5,500
Labor costs [a]	$5,500	$11,000	$11,000	$22,100
Total	$723,000	$117,000	$133,000	$43,000
Total net present worth (2014 $)[b]	$10,457,000	$2,200,000	$2,453,000	$1,617,000
Payback period compared to alt 1[c]	-	1 year	1 year	1 year
Payback period compared to alt 2a [c]	-	-	-	8 years

[a] Labor costs calculated assuming the following for each alternative: 1 hr/d (Alt 1), 2 hr/d (Alt 2a), 2 hr/d (Alt 2b), and 4 hr/d (Alt 3), all on days when the system is in operation.

[b] Total net present worth (NPV) calculated for period from 2021 to 2043, assuming capital costs expended from 2021 to 2023 (costs split evenly among the three years) and that the system will begin operation in 2024. NPV calculated based on escalation rate of 2% and discount rate of 4%.

[c] Payback period from end of 2023.

For alternative 1, while a sludge thickening or dewatering system is not included, a large storage tank is needed to store the wet sludge prior to hauling and disposal. The estimated volume of the storage tank is about 87,000 gallons. The estimated hauling and disposal costs associated with this alternative is substantial, requiring more than 10 tanker trucks every three days on average when the stormwater treatment system is in operation. In a typical year, the system will treat between 70 and 90 individual runoff events between October and May.

Alternatives 2a and 2b would both reduce the storage tank volume and the number of tanker trucks down to about 2 truckloads every 3 days for hauling the thickened sludge. Because it was assumed that the RDT can produce slightly thicker sludge than the gravity thickener (3.5 versus 3 percent solids), alternative 2a has a slightly smaller storage volume and also lower hauling and disposal requirements. The capital costs for both alternatives also include costs for an equipment building. For alternative 2a, the building houses the RDT, polymer system, sludge pumps, and control/electrical panels, while for alternative 2b, a smaller building houses the sludge pumps, control/electrical panels, and polymer system if it is used for the gravity thickener. The estimated building footprints are 30-feet by 15-feet for alternative 2a, and 20-feet by 10-feet for alternative 2b. The buildings are assumed to consist of slab on grade and have minimal architectural features. For both alternatives, the payback period for the additional capital costs to include the sludge thickener is less than a year compared to alternative 1.

Alternative 3 requires the most mechanical equipment and the largest equipment building, thus resulting in the highest capital costs. This alternative also has the highest polymer (for the thickening and dewatering processes) and labor costs to operate and maintain the equipment. But by producing a dewatered sludge at 20 percent solids, the hauling and disposal costs are considerably lower. It was estimated that on average only one dump truck every 3 days would be required for hauling the dewatered sludge. For sludge storage, a 10-yard dumpster would have adequate capacity. Alternative 3 includes a building with an estimated footprint of 30-feet by 25-feet. The building would house the RDT, screw press, polymer system, sludge pumps, and control/electrical panels. The total net present worth is the lowest among the four alternatives, and payback periods of 1 and 7 years were calculated when compared to alternatives 1 and 2a, respectively.

Figures 2-12 to 2-14 show preliminary layouts for alternatives 2a, 2b, and 3. The layout for alternative 1 is not shown as it would consist of just a large sludge storage tank. For all alternatives, it was assumed that the sludge pumps transferring solids from the stormwater treatment system to the sludge treatment/storage system are located at the stormwater treatment area. For alternative 3, the screw press will be raised such that the dumpster can fit underneath for collecting and storing the dewatered sludge and can be easily moved into and out of the building through the roll-up door.

For all alternatives except for alternative 1 and 2b, polymer is typically flow-paced based on the feed sludge flow but the ratio would be set by the operator. Generally, a couple times a day when the system is in operation, the operator would need to check and adjust the polymer feed ratio as required to optimize the quality of the floc. The polymer dosage ratio will be dependent on the characteristics of the sludge solids of the stormwater, the type and amount of coagulant used, and the concentration of the feed sludge. For both the RDT and screw press, the system can be started up and optimized in an hour or so and shut down quickly. Because the amount of coagulant used in the stormwater treatment system and the concentration of the sludge generated in that system will largely affect the polymer dosage in the sludge thickening and dewatering system, consistent coagulant dosing and solids content of the sludge are preferred and will help provide a more stable process. Upstream equalization, for example, would thus facilitate startup, operation and shutdown of the sludge treatment processes. For alternative 3, based on an assumed polymer dosage rate of 15 pounds per dry ton of solids each for the thickening and dewatering process, about 250 gallons of polymer (as emulsion polymer) would be required for each wet weather season. These could be delivered in bulk (in totes) or in smaller quantities (in drums). The polymer would need to be made down to more dilute concentration (0.2 to 0.5 percent) before it is applied to the thickening and dewatering systems. Figure 2-15 shows the photo of a typical polymer feed system used for a sludge thickener.

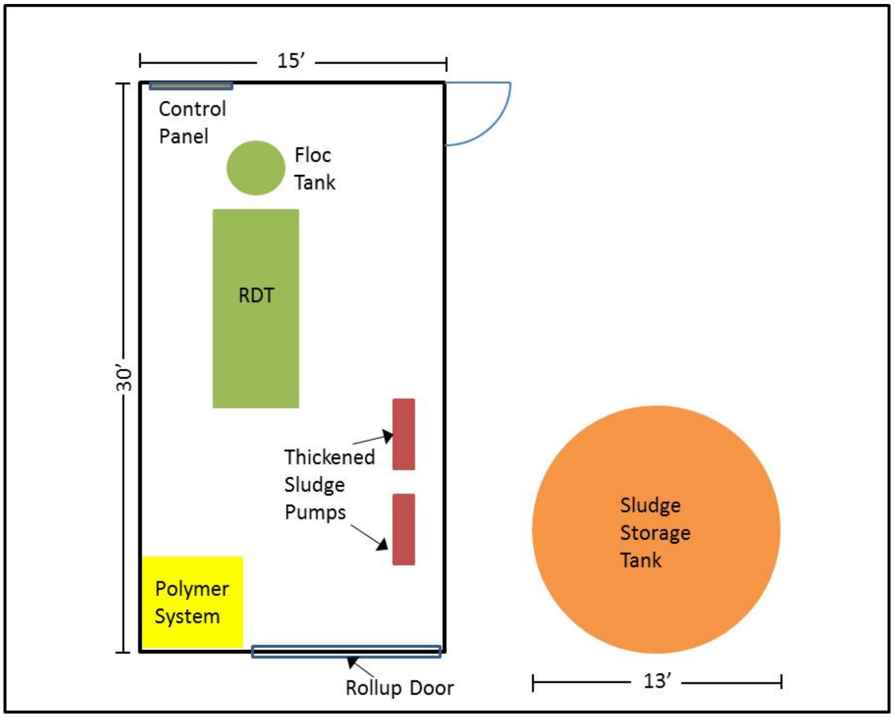

Figure 2-12. Preliminary layout of Alternative 2a

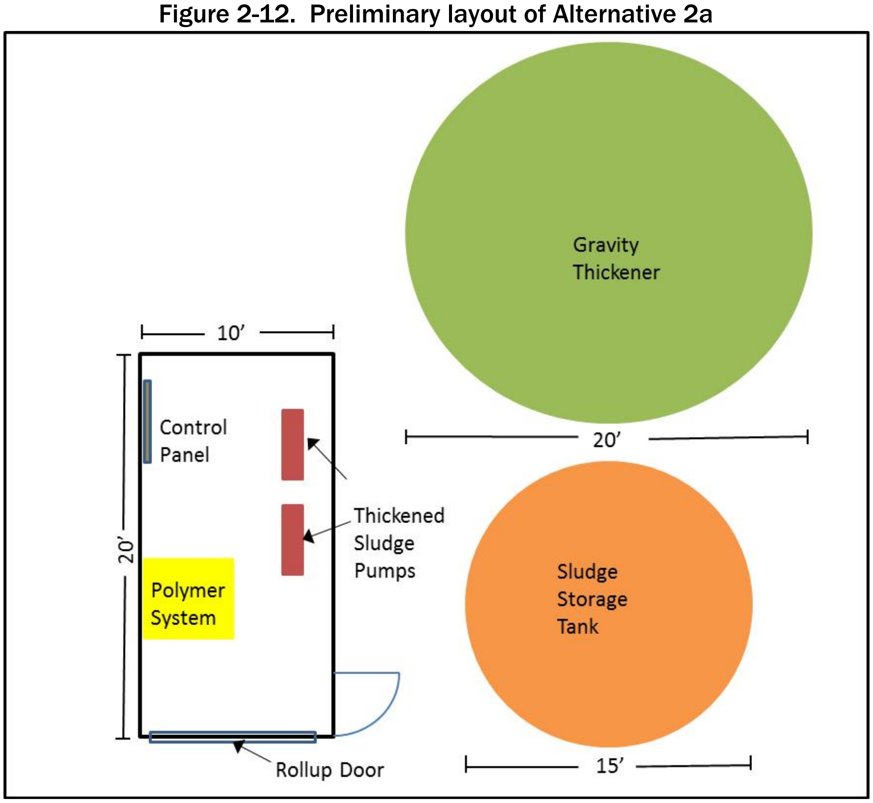

Figure 2-13. Preliminary layout of Alternative 2b

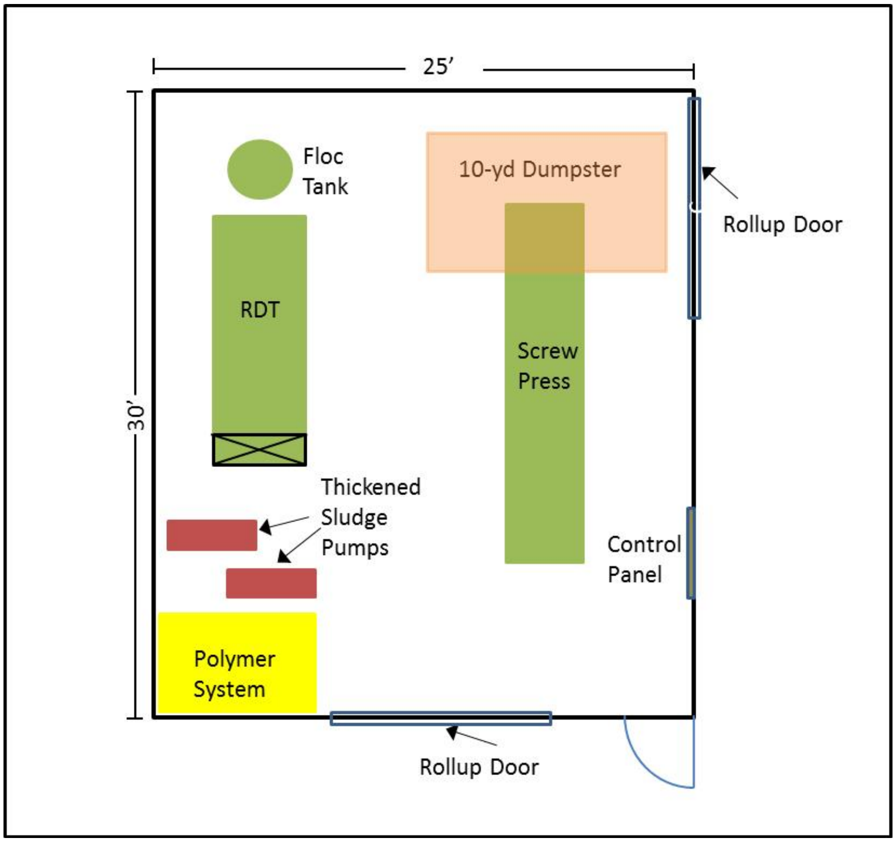

Figure 2-14. Preliminary layout of Alternative 3

Figure 2-15. Photo of typical polymer feed system

Section 5: Summary

A solids handling alternative evaluation was conducted for the SPU South Park WQF. The alternatives include hauling wet sludge from the stormwater treatment system, adding a sludge thickener (either a gravity thickener or RDT) and hauling thickened sludge, and adding a dewatering system (screw press) and hauling dewatered sludge. A BCE was performed to compare the combined effects of capital and operating costs for those options. The BCE results show that the alternative of adding a thickening and a dewatering system and hauling dewatered sludge has the lowest net present worth of the combined capital and hauling and disposal costs. Even though this alternative has the highest capital costs, the most mechanical equipment, and the largest footprint (mainly to accommodate an equipment building), the savings in hauling and disposal costs were estimated to result in payback periods of about 1 year when compared to the costs for the alternative of hauling wet sludge and about 8 years when compared to those for the alternative of hauling thickened sludge. Therefore, the alternative of adding thickening and dewatering systems and hauling dewatered sludge is recommended.

Attachment A: Equipment Budgetary Cost Quotes

WESTECH
an employee-owned company

Proposal For:
SPU South Park WTP

Equipment:
Thickener Mechanism

Engineer:
Brown and Caldwell

Represented By:
Goble Sampson Associates
Contact: John Simon
Phone: (425) 392-0491
Fax: (425) 392-9615

Furnished By:
WesTech Engineering, Inc.
Salt Lake City, Utah 84115
Contact: Tyler Drzycimski,
Direct: 801.290.7019
Phone: 801.265.1000
Fax: 801.265.1080

WesTech Proposal: 1430250
Friday, June 06, 2014

ITEM: "A" - One (1) 20' Dia. x 10' SWD Thickener Mechanism
WesTech Model No. THS10P

DESIGN PARAMETERS:

Average thickener feed concentration: 0.5%

EACH UNIT FURNISHED COMPLETE WITH THE FOLLOWING COMPONENTS:

DRIVE
One (1) WesTech standard shaft drive unit rated for a minimum 4,100 ft-lbs continuous torque, with steel housing, forged alloy steel precision main bearing and integral spur gear, cycloidal or helical speed reducer, and 1/2 hp TEFC motor suitable for 230/460 V, 3 phase, 60 Hz power.

One (1) WesTech Torkmatic overload control with two (2) adjustable switches for alarm and motor cutout.

SHAFT
One (1) 304 stainless steel pipe center shaft to transmit torque from the drive unit to the rake arms. Shaft will include a steel cone scraper to scrape the sludge sump twice per revolution.

FEEDWELL
One (1) circular 304 stainless steel feedwell, 4' diameter x 3' deep fabricated of 3/16" thick plate. Feedwell will be supported by the walkway.

INFLUENT PIPE
One (1) 4" diameter 304 stainless steel influent pipe will be supplied with minimum 1/4" wall thickness.

RAKE ARMS
Two (2) 304 stainless steel rake arms, with thickening pickets, blades, and adjustable 304 stainless steel squeegees arranged to scrape the tank bottom twice per revolution.

BRIDGE / WALKWAY / PLATFORM
One (1) mechanism support bridge supported by the tank wall on one both ends. Bridge will be designed not to exceed a deflection of 1/360 of the span applying all dead loads and a live load of 50 lbs per square foot. One (1) 36" wide walkway with handrails will extend from one end of the bridge to the equipment platform. Walkway and equipment platform will be floored with 1-1/4" aluminum I-bar grating with 1-1/2" dia., double row, 42" high aluminum handrail with 4" high toe plates provided at the base of handrail. The center drive platform will provide a minimum of 24" clearance around the center drive components.

WEIRS
FRP v-notch weirs will be supplied for installation on the peripheral concrete launder.

ANCHOR BOLTS AND FASTENERS
304 stainless steel anchor bolts and 304 stainless steel assembly fasteners will be provided.

SURFACE PREPARATION AND PAINTING

All submerged stainless steel:

Passivated.

All non-submerged fabricated steel:

Sandblasted to SSPC-SP6 / NACE 3 commercial blast, painted with
(1) coat of Tnemec N140-1255, 3 to 7 mils DFT, and
Finish coats to be by others.

Drive units:

Sandblasted to SSPC-SP6 / NACE 3 commercial blast, painted with
(1) coat Tnemec N140F-1255 3 to 9 mils DFT, and
(1) coat Tnemec 1074U-B5712 Dark Blue Aliphatic Acrylic Polyurethane enamel, 2 to 5 mils DFT.

CONTROL PANEL
One Hoffman NEMA 4X (304) stainless steel enclosure. The control panel will be provided with door mounted operators and status lights. One (1) magnetic combination motor starter 1/2 hp, with internally reset thermal overloads, fail safe relays, terminal blocks, timers, repeat cycle timers, fuse and fuse blocks and other supporting hardware is provided. A control power transformer will provide 120 VAC for internal controls. The transformer will have both primary legs and one secondary leg fused.

A top mounted red light with horn shall provide indication of a high torque condition. A door mounted reset pushbutton clears all interlocks after the torque conditions have been removed.

The control panel is wired to accept a single 480 VAC, 3 phase, 60 Hz power feed from the customer. A 3 pole circuit breaker with padlockable disconnect handle is provided for short circuit protection. All wiring for field connections will be brought to a terminal strip. All interconnecting wiring to be by others.

FIELD SERVICE
Total field service to include two (2) trips and three (3) days for installation inspection, startup, instruction of plant personnel, and observation of torque testing.

NOTE: ANY ITEM NOT LISTED ABOVE TO BE FURNISHED BY OTHERS.

ITEMS NOT BY WESTECH
Electrical wiring, conduit, or electrical equipment, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, assembly of component handrail, detail shop fabrication drawings, performance testing, bonds, unloading, storage, concrete work, or field service (except as specifically noted).

This proposal section has been reviewed for accuracy and is approved for issue:

By: Tyler Drzycimski   Date: June 6, 2014

BUDGET PRICING

ITEM	EQUIPMENT	PRICE (U.S.)
"A"	(1) 20' Dia. x 10' SWD Thickener Mechanism THS10P	$115,000

The above mentioned equipment was designed according to the information which we received. The dimensions may vary slightly depending on the plant's actual design parameters. Assumed values may have been used, therefore, all information shall be verified by the Engineer.

Unless otherwise indicated, prices listed are for equipment only. All optional items will be offered with the purchase of the scoped equipment only. No optional items will be sold separately.

Prices are for a period not to exceed 30 days from date of proposal.

Warranty: A written supplier's warranty will be provided for the equipment specified in this section. The warranty will be for a minimum period of (1) year from start-up or 18 months from time of equipment shipment, whichever comes first. Such warranty will cover all defects or failures of materials or workmanship which occurs as the result of normal operation and service except for normal wear parts (i.e. squeegees, skimmer wipers, etc.).

Terms: Terms for equipment are 15 percent payment of the purchase price with submittal drawings, 35 percent upon release for fabrication, and 50 percent net **30 days** from shipment. Retentions are not allowed.

Sales Tax: No sales taxes, use taxes, or duties have been included in our pricing.

Freight: Prices quoted are **F.O.B. shipping point** with freight allowed to a readily accessible location nearest to jobsite. All claims for damage or loss in shipment shall be initiated by purchaser.

Submittals: Submittals will be made approximately **6 to 8 weeks** after purchase order is received in our office.

Shipment: Estimated shipment time is **18 to 20 weeks** after approved submittal drawings are received in our office.

Field Service: Prices do not include field service unless noted in equipment description. Additional field service is available at $960.00 per day plus expenses.

Paint: If your equipment has paint included in the price, please take note of the following. Primer paints are designed to provide only a minimal protection from the time of application (usually for a period not to exceed 30 days). Therefore, it is imperative that the finish coat be applied within 30 days of shipment on all shop primed surfaces. Without the protection of the final coatings, primer degradation may occur after this period, which in turn may require renewed surface preparation and coating. If it is impractical or impossible to coat primed surfaces within the suggested time frame, WesTech strongly recommends the supply of bare metal, with surface preparation and coating performed in the field. All field surface preparation, field paint, touch-up and repair to shop painted surfaces are not by WesTech.

From: Roger J Olson <rjolson@fkcscrewpress.com>
Sent: Tuesday, May 20, 2014 12:02 PM
To: Tam, Patricia
Cc: victor@pedroni-co.com
Subject: RE: RE: Request for proposal for RDT and screw press for storm water treatment sludge

Patricia,

Sorry for the delayed response. For the lower numbers FKC proposes the following:

For a Rotary Screen Thickener:

165 lbs per hour max at 0.5% would require equipment capable of handling 66 gpm. For 66 gpm FKC could provide a model RST-S630x2000L Rotary Screen with 175 gallon flocculation tank. I will try to get a reference drawing sent this afternoon.

A budget delivered price for the RST-S630x2000L and 175 gallon floc tank only is $56,000. A budget price for a polymer system and sludge feed pump would be an additional $25,000. A control panel will be an additional $25,000 to $60,000 depending on the specifications.

Regarding performance, depending on the properties of the solids precipitated out of the storm water, the RST discharge dryness could range from 3.5% to 9% total solids depending on the sludge.

For a Screw Press:

As with the previous proposal, I think we would have to thicken the 0.5% sludge with the Rotary Screen Thickener system proposed above first before feeding it to a screw press system. The Rotary Screen Thickener proposed above could reduce the original 66 gpm at 0.5% to 9.43 gpm at 3.5% which is 165 dry lbs per hour. FKC would propose a model BHX-600x4000L screw press for dewatering 165 dry lbs per hour of alum sludge. A budget price for a BHX-600x4000L screw press with floc tank only would be about $158,000. A budget price for a polymer system and sludge feed pump for the screw press would be an additional $22,000. The screw press controls could be added to the RST control panel for an additional $10,000. A screw press reference drawing will also be sent this afternoon.

Regards,

Roger Olson
FKC Co., Ltd.
2708 W. 18th St.
Port Angeles, WA 98363
Office: (360) 452-9472
Fax: (360) 452-6880
rjolson@fkcscrewpress.com

From: Tam, Patricia [mailto:ptam@brwncald.com]
Sent: Tuesday, May 20, 2014 8:36 AM
To: rjolson
Cc: victor@pedroni-co.com
Subject: RE: RE: Request for proposal for RDT and screw press for storm water treatment sludge

Roger,

Have you had a chance to look at this and come up with the revised sizing? I would like to get the new numbers incorporated into the calcs and layout as soon as possible.

Thanks.
Patricia

From: Tam, Patricia
Sent: Wednesday, May 14, 2014 2:52 PM
To: 'rjolson'
Cc: victor@pedroni-co.com
Subject: RE: RE: Request for proposal for RDT and screw press for storm water treatment sludge

Roger,

We have some revised design criteria based on the latest stormwater modeling. The solids loading and hydraulic loading rates for the solids system have been reduced. The latest calculated max solids loading rate (including chemical precipitates) is about 165 lb/hr. Average loading rate is estimated to be about 100 lb/hr. The feed sludge is still assumed to contain about 0.5% solids.

Based on these loading rates, can you re-size both the RDT and screw press for both the thickening only and the two-step thickening/dewatering systems. As before, I would need information on equipment sizing, footprint, and budgetary quotes.

Thanks.
Patricia

Tam, Patricia

From: Roger J Olson <rjolson@fkcscrewpress.com>
Sent: Monday, June 30, 2014 4:40 PM
To: Tam, Patricia
Cc: 'Victor Pedroni'
Subject: RE: Revised design load for RDT and screw press for storm water treatment sludge

Patricia,

After reviewing the new capacity numbers and data from previous thin (0.5% to 1.0%TS) alum sludge thickening pilot tests, I believe that the currently proposed RDT and Screw Press are still the best choices with the slightly reduced flow rate. As discussed, I am basing this equipment selection on the assumption that the sludge will only gravity drain to 3.5% or 4.0% in the RDT. If I can test a representative sample and achieve better drainage then I will be able to quote smaller equipment. If the next smaller screw press (a 550 mm press) would work then the price would decrease by $8,000.

Regarding the RDT, the published maximum flow rates are based on fibrous sludges which form strong, round, well-draining floc such as septage or primary sludge. Strong floc allows for faster drum speeds and thus higher hydraulics. Thin alum sludges tend to form weak, stringy, gelatinous floc which must be drained slowly. The RDT drum speed must be kept low to avoid breaking the floc so the hydraulics are limited.

Please let me know if you have additional questions.

Roger Olson
FKC Co., Ltd.
2708 W. 18th St.
Port Angeles, WA 98363
Office: (360) 452-9472
Fax: (360) 452-6880
rjolson@fkcscrewpress.com

From: Tam, Patricia [mailto:ptam@brwncald.com]
Sent: Monday, June 30, 2014 12:03 PM
To: Roger J Olson (rjolson@fkcscrewpress.com)
Cc: Victor Pedroni (victor@pedroni-co.com)
Subject: Revised design load for RDT and screw press for storm water treatment sludge

Roger,

Hope you had a nice vacation.

Regarding the South Park stormwater treatment project, I had to make some adjustments to the chemical sludge production rates and as a result, the solids loading rates for the solids system are now a bit lower. The revised max solids loading rate is now about 145 lb/hr, while the average loading rate is about 85 lb/hr. Previously, the max and average loading rates are 165 and 100 lb/hr, respectively. Would these changes in solids loading rates change the sizing of the RDT and screw press? If so, can you send me a revised proposal (including budgetary prices and drawings).

Also, I noticed that previously, for the 165 lb/hr max loading rate number, which equates to 66 gpm for 0.5% feed sludge, you had selected the RST-S630x2000L RST model. The RST brochure shows that that model can handle a max flow of 125 gpm. The next model down (RST-S480x2000L) can handle a max flow of 80 gpm. Why was the larger model selected?

I need to finish up the analysis and the tech memo for this within the next couple of days. Would it be possible to get the revised proposal by tomorrow (as soon as possible)?

Thanks for your help!

Patricia Tam
Brown and Caldwell | Seattle, WA
PTam@brwncald.com
T(direct) 206.749.2264 | **T(main)** 206.624.0100

Brown AND Caldwell