Is Geotube® Technology a Good Fit for Residuals Management at your Facility?

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ABSTRACT

Municipalities across the Midwest typically operate at greater than 80% capacity and run out of biosolids and back-filter (lime and alum) residual storage capacity when land application contractors (if applicable), drying beds, and storage lagoons are unable to keep up with volume demands. Land application may not be economically or operationally available, an operations timeline for solids removal prompts onsite dewatering, and residuals may be contaminated with metals (e.g., Cu, Fe, Hg, Mo, Ni, Pb, Zn, etc.), oil and grease (O&G), nutrients, pathogens, or pesticides. Several mechanical dewatering options (e.g., belt filter press, centrifuge, etc.) are available as short-term or long-term remedies for onsite dewatering but are capital intensive for municipalities and contractors that already operate on competitive budgets. The objective of this study was to evaluate Geotube® containers as a residuals dewatering option for a municipal wastewater treatment facility (WWTP) and a water filtration plant (WTP) including cost effectiveness, ease of operation, solids retention, handling time, flow and volume rates, and seasonality.

A southern Alabama WWTP treats approximately four million gallons of influent per day (8 to 10 million gallons of biosolids annually at 3 to 5 percent dry weight solids). It was calculated that 1,400 linear feet (lf) of 30-ft circumference Geotube® container would be needed to supplement onsite sand drying beds to dewater and contain this annual volume to 20 percent solids, sufficiently dry to pass a paint filter test and haul off site to an appropriate landfill. The resulting volume and mass of residuals at 20 percent solids would be 3,931 yd^3 and 3,343 tons, respectively.

A southeast Ohio WTP produces approximately 1.19 million gallons (5,874 yd^3) of back-filter residual per year at 1.0 percent dry weight solids. It was calculated that 96 lf of 45-ft circumference Geotube® container would be needed to complement onsite equalization basins to dewater and contain this annual volume to 20 percent solids, sufficiently dry to pass a paint filter test and haul off site to an appropriate landfill. The resulting volume and mass of residuals at 20 percent solids would be 345 yd^3 and 248 tons, respectively.

WaterSolve performed bench-top dewatering trials for biosolids and back-filter residual samples collected from the WWTP's liquids storage tank and WTP's equalization basin, respectively. Dewatering polymers were evaluated based on water release rate, water clarity, settling rate, and flocculent appearance. In addition, dosing rate(s) were determined during these bench-top dewatering experiments and recommendations provided to the facilities during this phase of the program. We recommended using Solve 9244 at a dose rate of 200 ppm (7.4 lb/dry ton) for dewatering this WWTP's biosolids and Solve 152 at a dose rate of 100 ppm (15.0 lb/dry ton) for dewatering the WTP's back-filter residuals. Water release rate and volume during pumping to a Geotube® container were evaluated by adding 150-mL flocculated residual samples to a filter apparatus with a GT500 Geotube® filter. Water release rate and volume were measured with a 250-mL graduated cylinder over 12 hours. Remaining solids were collected and measured for percent dry solids by U.S. EPA Method 160.3.

Geotube® containers, with the aid of dewatering polymers, were recommended to and implemented by the WWTP and WTP into which solids were pumped directly from an above ground storage tank and equalization basin, respectively. After inline flocculation, the permeable textile that forms the Geotube® container allows efficient dewatering while containing the fine grain solids and the filtrate water returns to the head-works of the WWTP and is discharged via sand filters from the WTP. Overall, this dewatering methodology greatly reduced the volume and mass of residual solids and costs associated with hauling and disposal while allowing continual operation of the facilities. For containment and dewatering of biosolids and back-filter residual, Geotube® dewatering (including polymer and feed equipment) cost less than $0.02/gallon, required minimal technical assistance to install and operate, retained greater than 99 percent solids, solids dried sufficiently for hauling and disposal (18 to 40 percent cake solids), and did not interfere with plant operations. Compared to the previous management techniques (i.e., belt filter press, sand drying beds, or hauling to a landfill), these Geotube® projects saved both facilities nearly $25,000 after the first year of operations.

KEYWORDS

Geotubes®, dewatering, polymers, biosolids, back-wash residual, WWTP, WTP.

INTRODUCTION

Belt filter presses, centrifuges, and other common mechanical dewatering techniques are used to remove water from liquid wastewater water residuals and produce a non-liquid material or "cake" (U.S.EPA 2000a, 2000b). Thickening and dewatering residuals from wastewater treatment facilities provides 1) a reduced residuals mass and volume to be stored and transported, 2) eliminates free liquids before landfill disposal, 3) reduces fuel requirements, 4) eliminates ponding and runoff, and 5) optimizes air drying and many other stabilization processes (U.S.EPA 2000a, 2000b). Disadvantages of these mechanical techniques may include odors, excessive noise, high energy requirements, increased operator attention, blinding and short-circuiting due to a lack of optimal flocculation, high daily maintenance time, expensive spare parts, and major repair work that may take several days to weeks to complete (Henderson and Schultz 1999). Overall capital costs of a belt filter press or centrifuge range from $47,500 (500 dry pounds per hour capacity) to $81,250 (750 dry pounds per hour capacity) plus construction of a building, conveyor, truck loading area, polymer, polymer feed system, power and fuel requirements, operations, and maintenance (U.S.EPA 2000a, 2000b). With an increase in influent volume without a comparable increase in operations budgets for most water filtration plants and wastewater treatment plants, superintendents and utilities directors are searching for innovative residuals management options without the associated costs.

Large-diameter geotextile tubes have been used to contain and dewater dredge materials from river channels and harbors for decades (Fowler et al. 1995). In these applications, coarse-grain sediments pumped into the geotextile tube settle rapidly and slurry water is discharged through ports in the top of the tube. Geotextile tubes deployed in such settings have been used to form berms and alternative disposal sites to contain additional dredge materials. Sand-filled geotextile tubes are also used to stabilize dunes on beaches, as levees, and as manmade peninsulas to establish harbors. In these applications, confinement of the geotextile fabric adds shear strength to the sediment fill, resulting in a structure that is stable and resistant to erosion. Use of geotextile tubes to thicken and dewater fine grained sediments is a developing field and has had limited application in the municipal and industrial markets (Miratech 2005). This new and innovative technology has been successfully used to dewater fine-grained, contaminated wastewater material that contained dioxins, polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), pesticides, metals (with lithic biogeochemical cycles), and other hydrophobic materials (Fowler et al. 1996, Taylor et al. 2000).

Geotube® Containment and Dewatering Technology is a high volume, high flow containment option. It provides facilities an efficient on-site, cost effective dewatering option that requires no special equipment or permitting, low operations and maintenance costs, and residuals excavation and disposal may be deferred to subsequent fiscal quarters. Geotube® containers, which are manufactured from high strength polypropylene fabric, are designed to allow effluent water to escape through the pores of the fabric while retaining the fine-grain solids. With the addition of a chemical conditioning agent(s), excess water drains from the Geotube® container through the geotextile resulting in effluent that is clear and safe enough to be returned to the plant. Volume reduction within the container allows for repeated filling of the Geotube® container. After the final cycle of filling and dewatering, retained fine grain materials continue to consolidate by desiccation because residual water vapor escapes through the geotextile. Excavation of the dried cake residuals and subsequent disposal occur when retained solids meet dryness goals (e.g., 18-20% cake solids, sufficient to pass a paint filter test) or excavation and disposal may be deferred to a more economically feasible time.

Geotube® dewatering technology was evaluated at a WWTP in a small town north of Mobile, Alabama with approximately 30,000 residences and several small manufacturing facilities. The WWTP is currently contract operated and treats approximately four million gallons of influent per day through aerobic digestion. Digester biosolids from this facility were designed to be dewatered onsite with ten sand drying beds, but were not generating permit compliant effluent (e.g., TSS and ammonia). Southern Alabama is one of the wettest regions of the country and rendered the drying beds inefficient and ineffective as the volume of residuals has increased over time. Additionally, the excavation of dried cake from the drying beds was labor intensive and time consuming. In order to manage the increased volume of residuals, a truck-mounted belt press was rented several times a year at an annual cost of $45,000 to dewater the remaining biosolids from liquids storage tanks. An alternative method for containment and dewatering of biosolids was sought by the facility superintendent that not only reduced costs associated with biosolids processing but required less facility resources to operate. Smith Industrial Services and the facility superintendent recommended Geotube® containment and dewatering technology to the city council as a cost effective and efficient method for managing biosolids in storage as well as for continuous operations in the shortest amount of processing time.

Geotube® dewatering technology was evaluated at a WTP in a small town in southeast Ohio, with approximately 4,460 residences. The WTP currently treats approximately one million gallons of ground water per day through an US Filter AERALATER® Iron Removal and Memcor® CMF Microfiltration treatment system. Back-wash residual contaminated with iron and manganese from this facility was designed to be contained and dewatered in two concrete equalization basins and subsequently polished through sand filter beds. However, the equalization basins were ineffective except as storage basins. As the volume of residuals increased in the basins over time, breakthrough was observed and Fe- and Mn-contaminated residuals blinded off the sand filter beds. Additionally, the equalization basins were inefficient for dewatering and excavation of dried cake was labor intensive and arduous. An alternative method for containment and dewatering of back-wash residuals was sought by the facility superintendent that not only reduced costs associated with processing but required less facility resources to operate. WaterSolve and the facility superintendent recommended Geotube® containment and dewatering technology to the city council as a cost effective and efficient method for handling solids in the shortest amount of processing time.

The objectives of this study were to evaluate Geotube® dewatering technology as a biosolids and back-wash residuals dewatering option for a southern Alabama WWTP and southeast Ohio WTP, respectively, including cost effectiveness, ease of operation, solids retention, solids handling time, flow and volume rates, seasonality, and footprint required to operate.

METHODOLOGY

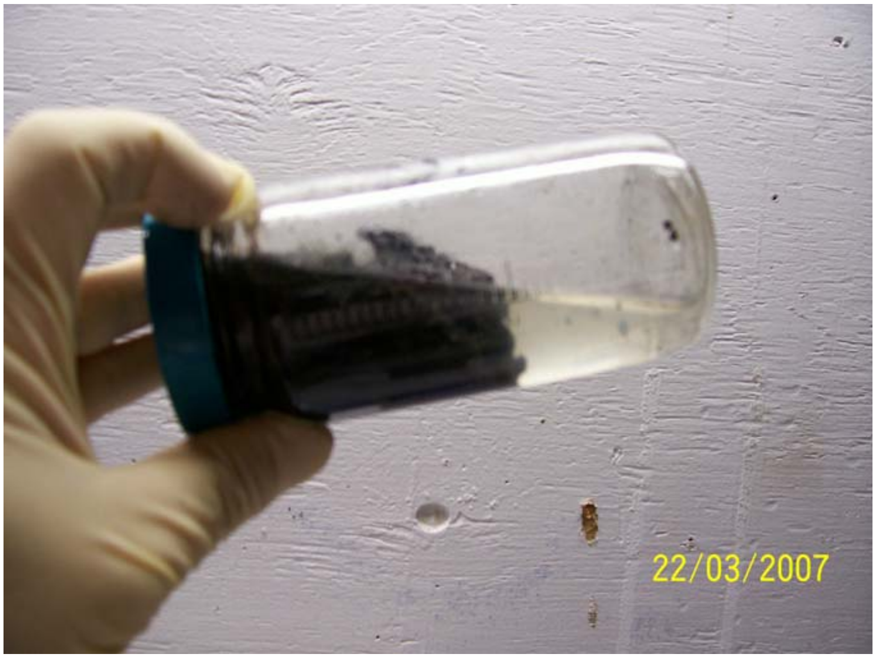
Wastewater Treatment Plant

This southern Alabama WWTP produces approximately 8 to 10 million gallons (39,500 to 49,500 yd^3) of biosolids per year at 3 to 5% dry wt solids. It was calculated that 1,400 linear feet of 30-ft circumference Geotube® container would be needed to dewater and contain this annual volume to 20% solids, sufficiently dry to pass a paint filter test and haul off site to an appropriate landfill. The resulting volume and mass of residuals at 20% solids would be 3,931 yd^3 and 3,343 tons, respectively. Smith Industrial Services (SIS) competitively bid and won the contract to dewater this WWTP residual using Geotube® technology. At the start of this pump-out project, sufficient drying bed space was not available for the excess biosolids volume in liquid storage. SIS used 30-ft circumference x 50-ft long Geotube® units placed in the existing sand drying beds to increase the vertical dewatering capacity from one foot in the drying beds to six feet in the Geotubes®.

WaterSolve performed bench-top dewatering trials for a sample collected by SIS from the WWTP's liquids storage tank (22 March 2007). Dewatering polymers were evaluated based on water release rate, water clarity, and flocculent appearance. In addition, dosing rate(s) were determined during these bench-top dewatering experiments and recommendations provided to the facility during this phase of the program.

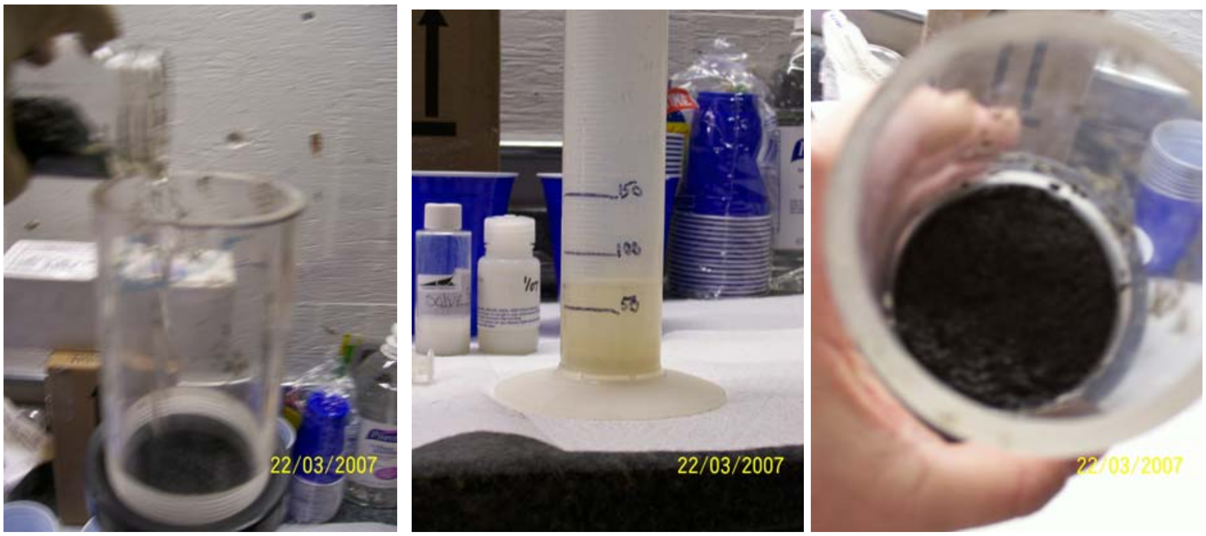
A four-gallon sample of biosolids residual was homogenized and 150-ml samples were placed in glass jars. Cationic polymers were “made-down” (200 mL) at a 0.5% concentration for this dewatering trial. Polymer (5 mL, 165 ppm) was added to a residual sample with a 10-mL plastic syringe and moderately tumbled three to five times. Polymer(s) that flocculated and dewatered this residual most effectively were re-evaluated with lower doses in order to isolate the most efficient dewatering and flocculating polymer (Figure 1).

Figure 1 – Dewatering biosolids in a 250-mL sample jar after addition of Solve 9244 (7.4 lb/dry ton) and release of free water.



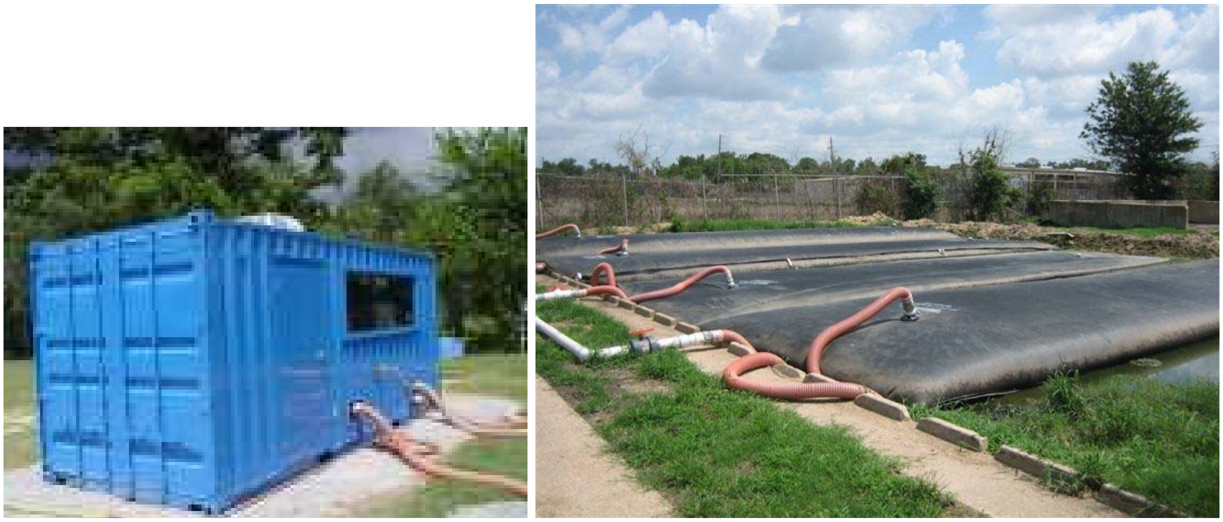
Solve 9244 and Solve 9233 were determined to flocculate and dewater the facility’s biosolids residuals most effectively compared to the other products. In both cases, water release rate, release volume, and clarity were excellent. Re-evaluation with 4-mL (133 ppm) polymer doses was used to select Solve 9244 as the recommended polymer for dewatering these biosolids residuals. We recommend using Solve 9244 for dewatering this biosolids residual in a Geotube® application in order to achieve greater than 20% dry weight solids and subsequent passing of a Paint Filter Test for solids hauling. Due to the potential thickness of this residual during pumping, mixing of the polymer with the sludge will be vital in achieving the desired flock and water release. Recommendations include a mixing manifold, inline static mixing, and/or injecting the made-down polymer on the suction side of the transfer pump (e.g., centrifugal). After passing a 150-mL flocked sample (165-ppm Solve 9244) through a GT500 Geotube® filter, 75-mL of water was released in five minutes (Figure 2).

Figure 2 – A 150-mL digester residual sample flocked with 165-ppm Solve 9244 and subsequently passed through a GT500 Geotube® filter (left). Seventy-five milliliters of water was released in five minutes (middle). Residuals remaining on the Geotube® filter after 15 minutes drying time (right).



One million gallons of biosolids were chemically conditioned (Solve 9244) and pumped into the seven Geotube® containers at 400 gpm over 30 days (Figure 3). With initial polymer feed rates of 13.3-14.5 lb/dry ton, inline polymer shearing was suspected and the injection port was moved downstream, closer to the Geotube® container. Additional parameters that were evaluated at the initiation of this project included mixing energy (e.g., inline static mixer, manifold, etc.), water flow rate (10-30 gpm), water pressure (30-95 psi), initial make-down concentration of polymer (0.25 to 1.0%), biosolids flow rate (200-500 gpm), addition of post-dilution water, and dual polymer injection ports. As the first Geotube® container approached 50% solids capacity, a second Geotube® container was brought online. The first container was pulse-filled to capacity and the remaining volume was pumped to the second Geotube® container. This pulse-filling cycle continued until all seven Geotubes® were filled to capacity with solids. Excavation of the first seven containers occurred 60 days after project startup with cake residuals of an average of 18-20% dry weight solids hauled to the landfill.

Figure 3 – Twenty eight 30-ft circumference x 50-ft long Geotube® containers were installed in existing drying beds to contain and dewater approximately four million gallons of biosolids over four months.



Water Treatment Plant

This WTP produces approximately 1.19 million gallons (5,874 yd^3) of back-filter residual per year at 1.0 percent dry weight solids. It was calculated that 96 lf of 45-ft circumference Geotube® container would be needed to supplement onsite equalization basins to dewater and contain this annual volume to 20 percent solids, sufficiently dry to pass a paint filter test and haul off site to an appropriate landfill. The resulting volume and mass of residuals at 20 percent solids would be 345 yd^3 and 248 tons, respectively. Prior to mobilization, the north basin residual was pumped into the south basin with a two-inch trash pump to provide an accessible lay-down area for the Geotubes®. WaterSolve and WTP personnel laid out a 45-ft circumference x 100-ft long and a 30-ft circumference x 72-ft long Geotube side-by side in the remaining six inches of back-wash residual in the north basin.

WaterSolve performed dewatering trials for this iron (Fe) and manganese (Mn) contaminated backwash sludge sample collected from the WTP's Red Water Basin (19 September 2005). Dewatering polymers were evaluated based on water release rate, water clarity, and flocculent appearance. In addition, dosing rate(s) were determined during these bench-top dewatering experiments and recommendations provided as a part of this report for a Geotube® dewatering application.

A two-gallon sample of backwash sludge was collected, homogenized, and 150-ml samples were placed in glass jars. Anionic polymers were "made-down" (200 mL) at a 0.5% concentration for this dewatering trial. Polymer (5 mL) was added to a sample with a 10-mL plastic syringe and moderately tumbled five to ten times. Polymer(s) that flocculated and dewatered this sludge most effectively were re-evaluated with lower doses in order to isolate the most efficient dewatering and flocculating polymer.

Solve 152 and Solve 9325 were determined to flocculate and dewater this back-wash sludge most effectively compared to the other products. In both cases, water release rate and clarity were excellent. Re-evaluation with 2- to 4-mL polymer doses was used to select Solve 152 as the recommended anionic polymer for dewatering this sludge. The sludge sample used for testing was not representative of the influent for a potential Geotube® container and probably contained more suspended solids than expected during pumping operations. We recommended using Solve 152 for dewatering backwash sludge at a dose rate of 25-100 ppm (15.0 lb/dry ton) in order to achieve 20% solids and subsequent passing of a Paint Filter Test for solids hauling. Minimal mixing energy was required to flocculate the solids and two to three 90 degree elbows should be sufficient for inline mixing prior to entering the Geotube® container. On-line testing and feed system calibration were required to dial-in the appropriate feed rate for this project.

Five hundred thousand gallons of back-wash residuals were chemically conditioned (Solve 152) and pumped into the first Geotube® container @ 300 gpm over three days (Figure 4). Although inline flocculation (via WaterSolve's LP5-30 make-down unit) and Geotube® dewatering appeared to be effective, polymer use was twice the predicted concentration. Irregular facility water flow (volume and pressure) to the make-down unit resulted in inefficient polymer mixing and activation. Use of a 1,000 gallon water storage tank mounted on a flatbed trailer was used as a polymer make-down tank. A lightning mixer was used to mix the tank and a 30-gpm chemical-feed pump was installed for polymer delivery to the discharge line (Figure 5). As the first Geotube® container approached 75% solids capacity, a second Geotube® container was brought online (Figure 6). The first container was pulse-filled to capacity and the remaining volume was pumped to the second Geotube® container. Excavation of the first container is scheduled for the spring of 2007 and a third Geotube® container will be brought online at that time.

Figure 4 – A 30-ft circumference x 72-ft long Geotube® and a 45-ft circumference x 100-ft long Geotube® were installed in the north equalization basin to contain and dewater approximately five hundred thousand gallons of residuals accumulated in the south basin.

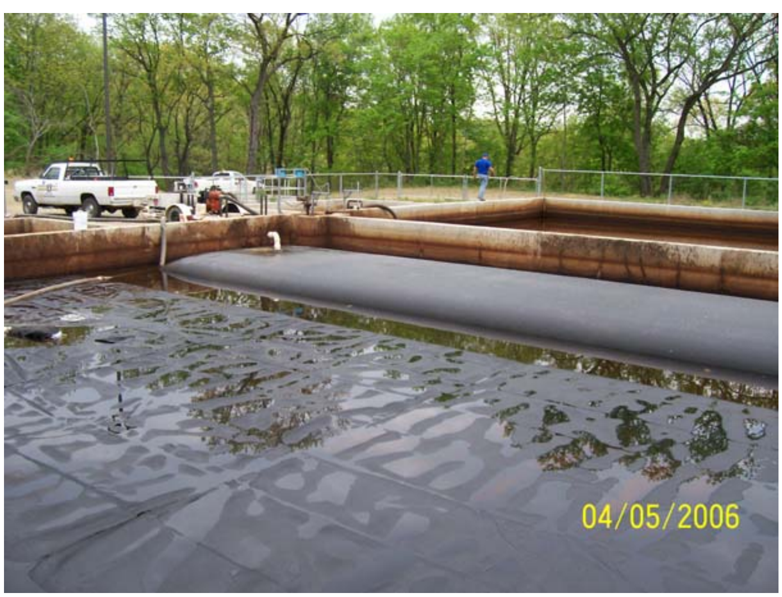


Figure 5 – A 1,000 gallon water tank was used as a polymer batch tank to make-down Solve 152 at 0.5% concentration and delivered with a 30-gpm chemical feed pump.

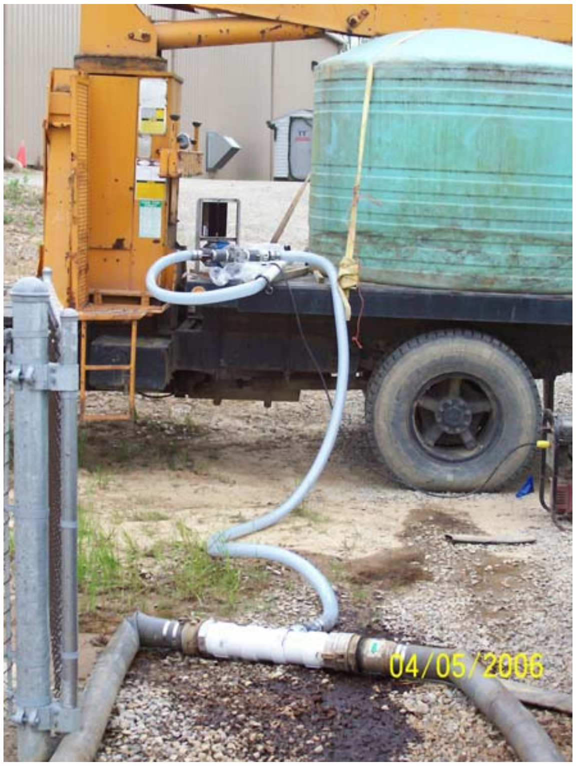


Figure 6 – A 30-ft circumference x 72-ft long Geotube® was pumped to 75% capacity (right) and filling of a 45-ft circumference x 100-ft long Geotube® (left) was initiated for back-wash residual dewatering and consolidation.

RESULTS and DISCUSSION

Cost Effectiveness

In order to initiate these Geotube® projects, SIS, WaterSolve, and the facilities superintendents designed a dewatering program that included site-specific Geotube® containers, rental of a polymer make-down system (Figure 7), site-specific polymer, bench testing, and technical assistance during start-up for less than $0.02/gallon for greater than 150,000 gallons. Excavation, transportation, and disposal of dried solids were not included in calculation of project costs, as these costs would fluctuate depending on the percent solids in the containers and final mass disposed of at the landfill.

Figure 7 – WaterSolve's LP5-30 liquid polymer preparation system delivers 30 gpm made-down Solve 152 (left). SIS's custom polymer make-down unit delivers 10 gph of neat Solve 9244.

Rental of a belt filter press twice in 2004 cost this Alabama WWTP approximately $45,000 (including set up, piping, and polymer) or $0.09/gallon. Biosolids from the belt press were dewatered to 16-20%, consolidated in the existing drying beds, and hauled to the landfill. Although the dewatered solids from the belt press passed a paint filter test and were transportable, disposal fees could be reduced by an additional 25-50% by allowing solids to dry to 30-40% solids. During this project, the WWTP had sufficient time for solids to dry to 30-40% and take advantage of the added savings of excavation and disposal of 50% less residuals mass. Geotube® containment cost approximately $200 per dry ton of solids compared to historical processing which cost between $300 and $400 per dry ton. Many facilities do not have the luxury of waiting for further drying beyond 18-20% solids and must remove solids from their facilities immediately upon removal from storage. In these instances, a mechanical dewatering technique may be more appropriate for efficient and timely results.

The WTP contracted liquid haulers to vacuum-truck wet residuals from the equalization basins and dispose of them at a local landfill, costs ranging from $0.04 to 0.08 per gallon. Geotube®

containment, dewatering, and consolidation cost approximately $50 per dry ton of solids excavated and hauled for disposal.

Ease of Operation

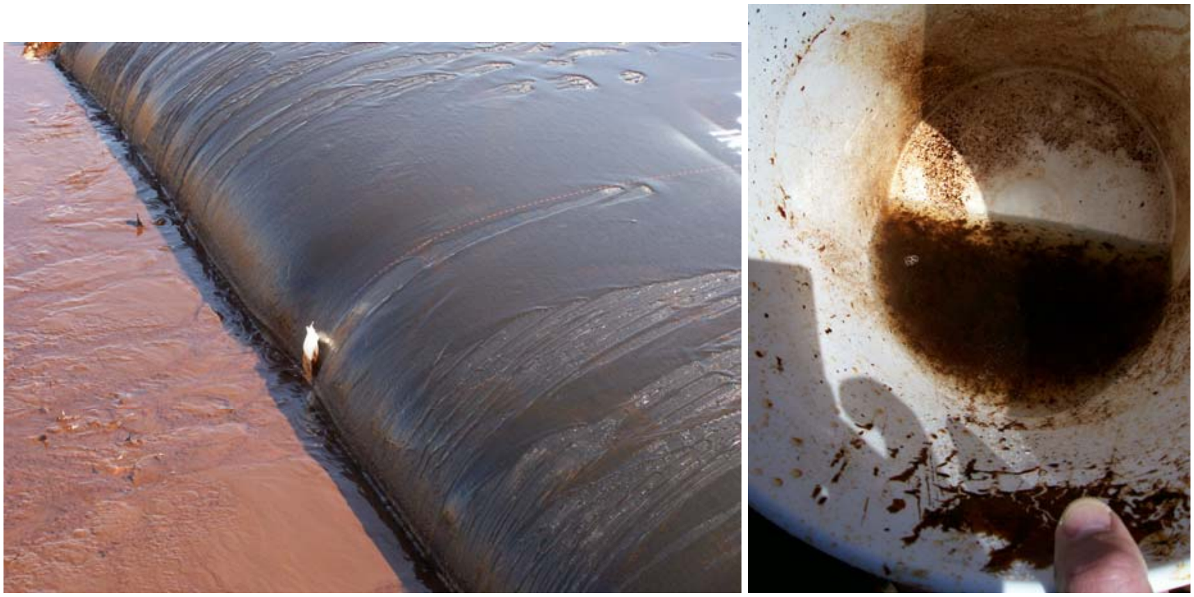
Start up of both of these projects required ten man hours, including installation of the Geotube® container and manifold system, set up of the polymer make-down unit, time to initiate solids pumping, and calibration of the inline polymer feed rate. Once the system was calibrated to an optimal solids flow rate and sufficient inline flocculation was observed, the system was monitored once per hour and adjustments made to the polymer feed rate. Throughout the start up process, the solids flow rate to the Geotube® container was neither reduced nor stopped. Geotube® containers continued to dewater and solids consolidated even as the percent solids of the sludge and strength of flocculation fluctuated during pump-out.

In comparison to mechanical dewatering operations, Geotube® dewatering systems require little to no operation and maintenance time. Rental of a belt press or centrifuge requires full time monitoring and constant adjusting, particularly with an influent that fluctuates in percent solids and/or organic matter concentration. In order to pump-out and process one million gallons of solids from a liquid storage tank with a belt press (maximum flow rate of 150 gpm), 6,250 man hours would be required by facility personnel. In addition, belt press operations would need to run continuously, regardless of weather, in order to minimize the time the belt press was onsite and reduce rental fees and operations expenses. Again, if sufficient time is not available for a Geotube® system to dewater stored solids, use of a mechanical dewatering technique may be more appropriate.

Solids Retention

Greater than 99% of total suspended solids (TSS) were retained within the Geotube® containers. As pumping of solids was initiated to a new container, a layer of solids covers the inside of the geotextile and decreases the loss of solids due to surface tension. This process typically occurs within one to five minutes of solids flow to the Geotube® container and clear weep water was observed for the rest of the pump-outs. Comparable results were obtained from the belt press and free water was collected in the drying beds and returned to the WWTP facility within compliance for TSS and ammonia concentrations. Filtrate from the WTP Geotubes® was compliant with facility discharge permits, flowed over the basin weir, through sand filter beds, and subsequently discharged into an adjacent creek (Figure 8).

Figure 8 – Clean filtrate from the Geotube® containers was discharged from the equalization basins via the sand filters.



Solids Handling Time

An advantage of using Geotube® technology was these dewatering systems were closed loop and solids were only handled one time, during excavation of full containers. A closed loop system eliminates odors, potential for spills, and solids handling, as well as decreases risk(s) of operator(s) exposure to pathogens and other solids contaminants. Also, Geotube® operations of this magnitude typically occur over one to three days compared to a week of continuous operations with a belt press. With a belt press system, sludge is open to the atmosphere, potentially releases volatiles and associated odors, are excessively noisy, can spill off the belt onto the ground if blinding occurs due to insufficient flocculation, and increases potential risk(s) of operator exposure to solids contaminants.

Flow and Volume Rates

Flow rates (100 to 2,000 gpm) to Geotube® containers are dependant on equipment available on site, hiring of a contractor, or by renting from an equipment company. Solids from these projects were pumped with onsite equipment to Geotube® containers at 300-500 gpm (18,000 to 30,000 gallons/hr). In comparison, a 0.5-m belt press (a typical belt size for a truck mounted rental unit) has a maximum solids flow rate of 150 gpm (9,000 gallons/hr). There are very few reasons to stop the flow of solids to a Geotube® system except potentially changing an empty polymer drum, shifting solids flow from a full container to a new container, and during shut down of operations to make inline design changes. In comparison, belt press operations are typically considered efficient at >75% working operations.

Seasonality

Pumping of solids to a new Geotube® container can occur during any time of the year as long as polymer feed lines and solids lines are freeze protected. Pumping of solids to a partially filled container with frozen solids is not recommended due to inefficient dewatering and filling and the potential for overfilling. However, allowing a full or partially full Geotube® container to sit outside during a freeze/thaw cycle typically “cracks out” (i.e., releases) additional free water and will not harm the container.

A belt press is capable of operating through all seasons, as long as the polymer feed lines and solids lines are freeze protected. A belt press requires constant operator supervision, regardless of the weather (e.g., rain, snow, freezing temperatures, etc.). In comparison, a Geotube® system is hands off after daily startup and calibration and an operator may not have to revisit the system during his/her shift, depending on the variability of the biosolids feed rate and inline percent solids. However, permanent inline mechanical dewatering techniques that are situated in a climate-controlled designated building are capable of operations 365 days per year.

Footprint

The footprint required for a 30-ft circumference x 50-ft long Geotube® container is 600 ft^2, sufficient to collect weep water from the Geotube® containers and channel it back to the facility. Geotube® containers were site-specific manufactured to fit the facility’s available footprint. For solids dewatering, containers are manufactured in 15-ft to 90-ft circumferences with lengths of 50-ft to 200-ft (Table 1). Standard Geotube® sizes designed for containment of biosolids can hold between 20 and 1,750 yd^3 of material.

Table 1 – Standard Geotube® container capacities, recommended fill heights, and required footprints.

Circumference	2008 Pump Height	2008 Dewatered Vol. per Cu Yd/ Lin Ft	Lay-down (width)
22.5’	5.5’	1.26	9’
30’	6.5’	2.07	12’
40’	7.0’	3.24	16’
45’	7.0’	3.78	19’
50’	7.0’	4.32	21’
55’	7.5’	5.13	25’
60’	7.5’	5.76	26’
65’	7.5’	6.30	28’
70’	8.0’	7.29	31’
75’	8.0’	7.92	33’
80’	8.5’	9.03	36’
85’	8.5’	9.72	38’
90’	8.5’	10.39	41’
95’	8.5’	11.07	44’
100’	8.5’	11.79	46’
105’	9.0’	13.05	48’
110’	9.0’	13.77	51’
115’	9.0’	14.49	53’
120’	9.0’	14.60	56’

In comparison, a mechanical dewatering technique may be better suited for facilities with a large volume of solids or facilities that have limited space for an appropriately sized Geotube® lay-down area. Large volume facilities can typically store months to years of solids production, millions of gallons annually. A difficulty of using Geotube® containers in these situations is the large footprint required to contain the volume as well as being able to keep up with the production rate of these solids. Facilities in urban settings typically do not have the space available for a Geotube® dewatering system and would have to make some capital improvements to accommodate these systems. Geotube® systems are typically utilized at these larger facilities to contain solids from a digester or storage tank clean-out and as back-up storage capacity to a mechanical dewatering device that may be down for repairs or maintenance.

CONCLUSIONS

Geotube® containers were evaluated as a solids dewatering option and compared to a belt press operation at an Alabama WWTP and Ohio WTP including cost effectiveness, ease of operation, solids retention, solids handling time, flow and volume rates, seasonality, and footprint required to operate. Geotube® containers, with the aid of dewatering polymers, were recommended to and implemented by a WWTP into which biosolids were pumped directly from an above ground liquids storage tank. Geotube® dewatering methodology reduced the volume and mass of residual solids by greater than 75% for four million gallons and is expected to save the city 50% of the costs associated with hauling and disposal while allowing continual operation of the facility.

One million gallons of biosolids were chemically conditioned with Solve 9244 and pumped into seven Geotube® containers at 400 gpm over 30 days. With initial polymer feed rates of 13.3-14.5 lb/dry ton, inline polymer shearing was suspected and the injection port was moved downstream, closer to the Geotube® container. The first container was pulse-filled to capacity and the remaining volume was pumped to the second Geotube® container. This pulse-filling cycle continued until all seven Geotubes® were filled to capacity with solids. Excavation of the first seven containers occurred 60 days after project startup with cake residuals of an average of 18-20% dry weight solids hauled to the landfill. As a result of both WaterSolve's and the superintendent's ability to work through several challenges, the municipality will save nearly $25,000 after this first year of operations with the first pair of Geotube® containers and greater than $35,000 annually in subsequent years.

Five hundred thousand gallons of back-wash residuals were chemically conditioned with Solve 152 and pumped into a Geotube® container at 300 gpm over three days. Use of a 1,000 gallon water storage tank mounted on a flatbed trailer was used as a polymer make-down tank. A lightning mixer was used to mix the tank and a 30-gpm chemical-feed pump was installed for polymer delivery to the discharge line. The first container was pulse-filled to capacity and the remaining volume was pumped to the second Geotube® container.

Overall, containment and dewatering of solids with Geotube® containers (including dewatering polymer and feed equipment) costs less than $0.02/gallon, requires minimal technical assistance to install and operate, retained greater than 99% solids, solids were only handled once they were dried sufficiently for hauling and disposal (18 to 40% cake solids), did not interfere with plant operations, and the lay-down area for containment of one million gallons of biosolids or 0.5 million gallons of back-wash residual was 6,050 ft^2.

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