SYNAPSE DEWATERING INVESTIGATION REPORT

OMNI-INGESTOR PHASE 2
MILESTONE 1
JULY 27, 2012

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INTRODUCTION

This report was created as part of the development effort for the Omni-Ingestor: a modular equipment set designed to extract and process fecal sludge from pit latrines and septic tanks. This work is being performed under a contract with the Bill and Melinda Gates Foundation's Water, Sanitation, and Hygeine department. Its purpose is to explore available dewatering technologies, and analyze their applicability towards the Omni-Ingestor design. Its intention is neither to promote, nor to discredit, any specific vendor, technology, or manufacturer. Please direct comments or inquiries about the contents of this report to the following individuals at Synapse Product Development:

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SUMMARY

One of the critical capabilities of the Omni-Ingestor is the ability to separate the liquid and solid components of septic holding tanks to reduce the quantity of material that must be transported away. The system in the Omni-Ingestor must meet several requirements, as outlined in the "Ejected Material Guidelines D5.pdf" document.[1] To summarize, the requirements are:

- Input liquid septage will be between 0% and 5% solids.
- Output liquid after separation and dewatering must have:
  - Less than 20mg/l TSS
  - Less than 20mg/l BOD
  - Less than 50mg/l COD
  - Turbidity less than 200 NTU
  - pH between 6.0 and 9.0
- Output solids after dewatering must have:
  - All free water be removed (TS value of 12%-15%)
    - The target TS will be 25%
    - Higher TS values are permitted but the cost of the additional performance will need to be relatively low.
- The benefits of the system must be economically justifiable.[2]

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[1] Available on Dropbox, last accessed on July 5, 2012.

[2] Synapse will use a MATLAB logistics model that has been developed to simulate the emptying and transport processes. Synapse will compare the possible dewatering systems using the model and will also compare those to a similar model that has been set-up to calculate the performance of a vacuum truck. For the purposes of this analysis, "economically justifiable" will be defined as being significantly more profitable than a vacuum truck based system, and being below (or close to) the target emptying cost of $\$5/m^3$. PDFs of this code are available upon request.

The system(s) Synapse recommends pursuing meet or come close to meeting these targets. In cases where they do not meet the target requirements, Synapse holds the position that increasing the performance to meet the requirements is either possible through a redesign of the system, reducing system cost via mass production and DFM, or is not practical and would result in a substantial increase in system cost.

PREVIOUS WORK:

In Synapse's "Omni-Ingestor Ph1 M1 Progress Report.docx"[3], many different dewatering options were explored and ultimately rejected for a variety of reasons. These systems included: belt filter presses, screw presses, steam dehydrators, centrifuges, and filtering presses. Typically these devices were rejected due to system size, cost, complexity, or the fact that they were batch process systems. A summary table of this analysis is included in Appendix A of this report.

TESTING ON RUSSELL FINEX LSS:

Synapse performed testing on the Russell Finex Liquid Solids Separator (LSS) (the solution selected at the end of Phase 1) to determine whether the technology would be appropriate for removing solids from septage. Synapse tested the LSS with both the 40 micron and 100 micron screens using the Synapse technical simulant at a 1% solids concentration. In both tests, the filter element clogged very quickly and very watery liquid was discharged from the solids overflow. In spite of adjusting both the impeller speed and the angle of the machine, Synapse was unable to get the LSS to actually separate the solids and liquid fraction of the technical simulant.

In consulting with the Russell Finex technical staff, Synapse determined that in the Synapse technical simulant, a large portion of the suspended solids must be below 40 microns, which was resulting in blinding of the filter. Based on the AIT Rheology Study provided by The Foundation, Synapse was operating under the assumption that a very small percentage (in most cases between 1% and 4%)[4] of the TSS (Total Suspended Solids) in septage was below 70 microns. To validate the AIT report and determine if the technical simulant accurately represents septage, Synapse obtained septage[5] and ran it through filters of varying porosity to attempt to characterize the particle distribution.

In testing the septage, Synapse gravity fed septage through filters under approximately 1 psi of head. Synapse tested the septage by running it through 5, 50, and 100-micron filters. In all cases, the filter element blinded before the sample had finished filtering and it was observed that the clarity of the filter effluent was qualitatively very similar to the control (unfiltered) septage. From this, Synapse concluded that a large portion of the TSS in the septage[6] was at least below 50 microns and that a significant

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[3] Available on Dropbox. Last accessed on July 5, 2012.
[4] *Assessment of Faecal Sludge Rheological Properties*, Environmental Engineering Program School of Environment, Resources and Development Asian Institute of Technology. January 31, 2012. Pg. 32-33. Last accessed on July 5, 2012.
[5] The septage used for the testing was obtained from Northwest Cascade Inc. Based on qualitative examination, the president of the company and truck operator estimated the septage to be about 1% TSS.
[6] Although TSS and turbidity (NTU) do not have a specific correlation, they are generally found through experimental testing to trend with one another. Because TSS testing is nearly impossible to do without laboratory equipment, turbidity testing (NTU) is often performed in the field as a quick assessment of the TSS value of liquid waste.

portion was also below 5 microns (because the visual clarity of the 5-micron filtrate was still so dirty). This hypothesis is bolstered by the fact that the standard test for TSS is performed with a 2-micron filter, indicating that the lower particle size cut-off for suspended solids is 2 microns. Based on this analysis, the Russell Finex technical staff felt that there was no adjustment that could be made to the LSS that would result in satisfactory results. Synapse also concluded from this that the AIT report data may need to be re-validated and samples may need to be re-tested.[7]

FILTERING WITHOUT FLOCCULATION

Because the ideal separation and dewatering approach for the OI system is one that does not require chemical additives, Synapse investigated further options that use filtration on the septage to remove the solids without the use of chemicals. In selecting a potential filter, the first step is to determine the degree of solids loading, the required solids reduction in the filtrate, and the pore size of the filter needed to meet those requirements.

The average TSS in “septage”, as given by the EPA, is 12,862 mg/liter (expressed as a percent, this would be 1.2% solids).[8] The requirements for jettisoned water stipulate that the TSS must be reduced to less than 20 mg/liter, which represents a 99.85% reduction in TSS for the average septic system. The EPA maximum TSS for septage is 93,378 mg/liter. In this case, the required reduction would be 99.98%. To achieve such a reduction, the numbers suggest that the minimum pore size of any filter element being used to filter the liquid be at the low end of the range of possible particle sizes for TSS. When testing for TSS, a 2-micron glass fiber filter is used for capturing solids. Thus, in order to achieve a TSS reduction of greater than 99%, it is necessary to use a filter nearly this fine to retain the solids.

The challenge involved in such a fine degree of filtration is that preventing the filter from blinding is very difficult. Synapse performed testing on septage when analyzing the performance of the Russell Finex LSS (see previous section) and found that when septage was poured through a 5 micron filter, the filter was blinded almost instantly. Synapse also found that the filtrate that did go through still had a very noticeable level of turbidity.

Because a filter would need to be tolerant of such high solids loading, it is necessary to use a filter that is able to be purged of the captured particulates, rather than rely on a disposable filter. Filters are typically costly, and a disposable filter that could tolerate our flow rate and be fine enough to capture the solids to meet the discharged water requirements would need to be replaced very frequently.

Synapse investigated several self-cleaning filter options and reached the conclusion that filters with complex mechanical cleaning methods were not capable of handling the solids loading that would be placed on the filter screen. For instance, Hectron, a French filter company, makes a line of filters where the element is cleaned with a suction arm. This filter, while capable of meeting the overall flow-rate requirements, has a maximum solids loading of only 2000 mg/l[9] -- 25-times less than the OI requires.

[7] Synapse also learned from this testing that animal feces is much more fibrous and subsequently is easier to dewater than human septage. In many cases, animal feces can be dewatered without the addition of polymer flocculants. The LSS had been shown in Russell Finex’s testing to work on pig manure.
[8] *Guide to Septage Treatment and Disposal,* US EPA. Pg. 5.
[9] http://www.hectron.com/en/Produits/Filtres-nettoyage-automatique/Hectron-automatic-self-cleaning-filters.pdf

Another self-cleaning filter design that uses a similar cleaning technique can be seen in the Orival ORE/A Series high solids filter.[10] A representative of Orival indicated that their filters could theoretically tolerate up to 10000 mg/l (or 1%) TSS, but said that anything beyond this would be far too much for their filter to tolerate. In addition, these filters typically do not have very fine pore sizes and would allow a considerable amount of solids through with the effluent.

The other major problem with self-cleaning or back-washing filters is that they do not normally concentrate the solids in any way. Because they are used primarily for obtaining clear water rather than for dewatering solids, the backwash or cleaning cycles do not normally result in thickened sludge.

COAGULATION AND FLOCCULATION:

A common practice used to separate solids from septage is to dose the contents with a chemical agent that causes suspended particles to clump together into larger particles (flocks), speeding up and enhancing any settling or separation process. This process of coagulation and flocculation is the precursor in virtually all commercially available septage or wastewater dewatering processes that do not use either more time or space than is practical in a mobile application.

The coagulation process can be accomplished by the addition of charged particles to waste water. This causes the fecal particles to coalesce into much larger “fluffy” particles. There are two major techniques that can be used for initiating the coagulation reaction. The most common method is via the addition of chemicals in liquid or solid powder form to the waste stream. The chemicals are typically either metal salts or cationic polymers (organic or inorganic).

Because of the nature of the chemical coagulation reaction, it is necessary that the polymer be added in a controlled manner and be rapidly and thoroughly mixed with the waste stream. Failure to do so will result in improper and incomplete flock formation and would subsequently require overdosing of the waste stream to obtain the same desired level of separation. Overdosing the polymer results in increased consumable cost and renders the dewatered sludge excessively sticky, potentially causing problems for downstream processes. Usually dosing is accomplished by a simple feed or eductor pump that injects the polymer into the waste stream where it is then mixed through turbulent flow and in then in a flocculation tank. The flocculation tank is sized such that for the intended system flow rate, the waste will have approximately 60 to 90 seconds mixing in the flocculation tank. For a system capable of processing 1l/second, the flocculation tank will be approximately 35 gallons.

Synapse explored two alternatives for this style of flocculation. The first was simply adding and mixing the flocculant directly in the septic tank. The major advantage of this idea is that it would eliminate the need for an eductor pump and the flocculation tank. However, this design had several shortcomings that ultimately caused Synapse to reject it. The main challenge would be that the Omni-Ingestor operator would not necessarily know the volume of the tank and subsequently would not know the appropriate

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Accessed on 8 July, 2012

[10] http://www.orival.com/products/howitworks.asp?product=ORE/A%20Series#focus)
Accessed on 8 July, 2012

dose. If the tank were overdosed, there would be no recovery. Starting with a conservatively low dose and gradually incrementing the polymer addition would be an unacceptably lengthy process.
The other method Synapse investigated for creating the coagulation reaction is to use a process called electro-coagulation. In an electro-coagulation system, two electrodes made of dissimilar metals are lowered into the septage and high current is applied. This action results in an electrolysis reaction where charged metal ions move from one electrode to another. As they move through the septage, they essentially create the same reaction as when adding metal ions to the septage (through a chemical coagulant). While this results in lower consumable costs, the significant drawback of these systems is the capital costs. An electro-coagulation system that is capable of meeting the demands of the Omni-Ingestor's 1 l/sec flow rate would be approximately $200k. For this reason, it is simply not economically feasible for a mobile platform such as the Omni-Ingestor.

SYNAPSE RECOMMENDED SYSTEM SELECTION:

Synapse has identified three potential low-tech systems that would be capable of meeting the flow requirements and eventually the system cost targets. All of these systems are capable of producing concentrated solids with a TS of 10%-15% and can take input sludge that contains TSS between 1% and 5% (technically higher, but this is the range of TSS provided by The Foundation). The three systems are the FCK 315 Rotary Thickener, Integrated Engineers CFU-20 belt thickener, and the FloTrend Polymate and Sludgemate gravity dewatering box. In the following table, Synapse has summarized the highlights of each system.

	FKC SCREWPRESS	INTEGRATED ENGINEERS	FLOTREND
SYSTEM NAME	RST-315	CFU-20	Polymate-250 Polymer injection system 15 cubic yard gravity dewatering dumpster (Sludgemate)
FLOCCULATION SYSTEM	Fluid Dynamics Mini-Blend polymer mixing system and 35 gallon flocculation tank.	Integrated polymer injection and flocculation tank.	Polymer injection system and 120-gallon flocculation tank.
DEWATERING MECHANISM	Rotary thickener: Flocculated sludge is loaded into one side of a rotating mesh cylinder. As it moves from one end to the other, the liquid component drains from the solids. Thickened sludge is discharged at the far end.	Belt thickener: Flocculated sludge is discharged onto a disposable filter paper that is slowly advancing on reels. Water is discharged through the paper, while the solids fall off the end of the filter.	Gravity box: Flocculated sludge is fed into a gravity dewatering box

	FKC SCREWPRESS	INTEGRATED ENGINEERS	FLOTREND
PROS	Most contained unit. Least potential for operator exposure. In-line process. Mechanically simple.	Completely integrated unit. Claim to be gearing up to set up manufacturing in other countries and are preparing to start making Floccin in other countries. In-line process.	Lowest system capital cost.No moving parts. Simplest design.
CONS	Higher off the shelf cost. Requires 8GPM of wash water (can use recirculated effluent)	High cost of Floccin polymer which seems to be more of a “boutique” chemical. System is easily the most complicated and least modular of the three. Filter paper is an added consumable. Received a more negative response from technical contacts at the company than received from president (in terms of performance)	12 hours to reach full dewatered potential. Batch process. Must remain on site Large size
CHEMICAL AND CONSUMABLE COSTS (PER 1000 GALLONS OF TREATED SEPTIC TANK CONTENTS)	ZETAG 7879FS40 (BASF Corporation): Cost is $2.81	Floccin: cationic, ionic, nonionic inorganic polymer blend. Cost is: $8.00	PHC-6000L: Cost is: $3.60-$5.00
NON-CHEMICAL CONSUMABLE COSTS	None	Requires a $144 roll of filter paper that will be required	None
ELECTRICAL REQUIREMENTS	1.8kW	20 Amps @ 120 Volts 2.4kW	Passive system. Power required only to inject and mix flocculant
PROCESS CHARACTERISTICS	25 GPM Input of sludge between 1% and 5% TSS. Output liquid should have TSS of around 150 mg/l and turbidity below 200. Confirmed with testing on actual septage. Output solids will have 10% or more of TS Estimated volume reduction 2x - 10x	20 GPM Input of sludge between 1% and 5% TSS. Claimed output turbidity below 200 NTU Output solids will have 10% or more of TS Estimated volume reduction of 2x - 10x	Not limited to a specific flow rate, but at a rate of 20 GPM, our technical contact estimated that we would need a 15m^3 dumpster

	FKC SCREWPRESS	INTEGRATED ENGINEERS	FLOTREND
SIZE	~2m long, 1m wide, 1m high	~2.8m long, ~1.5m wide, ~2.4m high	~3.6m long, ~2.5m wide, 2.6m high
MASS	~2100 lbs when full	More than 2000 lbs when full	Depends on how full the dumpster is allowed to get. Probably quite heavy.
SYSTEM COST (OTS)	$49,000	$40,000 Wholesale	$25,000
ESTIMATED SYSTEM COST AT LARGER QUANTITIES[11]	$15,000	$14,000	$10,000
ESTIMATED COST PER M^3 USING SYNAPSE ECONOMIC ANALYSIS (LOWER IS BETTER)	$5.40/m^3$	$7.39/m^3$	$6.23-$6.58/m^3$
ESTIMATED DAILY REVENUE USING SYNAPSE ECONOMIC ANALYSIS (HIGHER IS BETTER)[12]	$215/day	$134/day	$156-165/day

Based on this analysis, the FKC system provides the best performance in terms of cost. It is also the most compact system and could easily fit onto a small trailer. For these reasons, Synapse recommends pursuing this product in the test system and alpha prototypes.

For comparison, using the same set of distance variables, a vacuum truck will need to spend $6.42/m^3 on extraction and will have a daily profit of only $102. While all of these systems yield higher per day profits (this is because they can extract the contents of more pits before needing to make a trip to the dump site and are charging a fixed rate of $50/pit), only the dewatering box and the rotary thickener outperform the vacuum truck in terms of price per cubic meter extracted.

Although the FloTrend system is simpler and costs less, Synapse believes that successfully implementing a dewatering box (or dewatering bags, which rely on a nearly identical process) will be very challenging. Because of the security and logistical issues involved in leaving a dewatering box

[11] This is based on a Synapse analysis of the complexity of the system and the number of units that are being sold per year. In the case of the Integrated Engineers system, this price was the estimate of the company president. In addition, all of these systems are significantly over-engineered for the OI application. Synapse feels that these estimated costs are conservative and could be even lower, especially if a new device was designed from the ground up and larger quantities.

[12] These numbers are based on the Synapse economic analysis model. The model uses data provided by The Foundation such as: average distances between locations, average driving speed, fuel costs, dumping costs, revenue per pumped pit, etc. These revenue figures are intended to be a rough estimate used for comparing various different solutions. It also serves as a method for performing a relative comparison between the OI and a vacuum truck.

overnight at a site, Synapse does not feel that this technology is appropriate. Instead we recommend the following approach using the FKC system as the primary component in the OI dewatering system:

RECOMMENDATIONS:

- Phase 2, Dewatering Part 2
  - A complete system from FKC should be purchased for use in the remainder of Phase 2 and for re-use in any pilot OI units that are sent to countries in the developing world for user testing (dependent on equipment lead time)
  - Explore opportunities to improve performance, decrease size and weight, and optimize for mass production.
  - Design a sludge-feed and flocculant dosing system that can adapt to varying input flows.
  - Determine need for post-filtration of the effluent to reduce TSS to below 20mg/l. FKC guarantees a reduction of 95%, but further testing will determine whether this is necessary.
- Phase 3:
  - Once the system has demonstrated success in testing, Synapse will either work with FKC or engage a third party manufacturer to design and build the rotary thickener at a significantly reduced cost.

FKC SYSTEM IN THE OI:

The FKC system would be mounted directly to the OI trailer. The operator would need to visually inspect the flocculation tank to insure that the system was being properly dosed. Minor adjustments could be made to insure that proper flocculation was occurring. Once the sludge was discharged from the end of the thickener, it would either fall into a sludge dump truck, or would be lifted there with a sludge pump or a conveyor. The discharged water would be pumped either to a post filter, or to the Synapse thermal sterilization system. **FIGURE 1** shows the layout of the FKC System as it would appear on the OI Trailer.

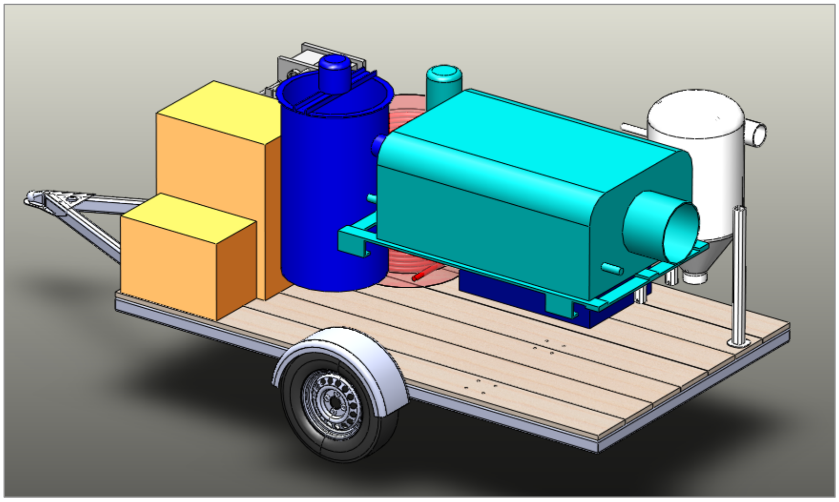

FIGURE 1: FKC System on OI Trailer (flocculation tank shown in dark blue and rotary thickener in teal)

TESTING ON FKC SYSTEM:

Synapse has been working with the waste-water experts at FKC to determine the characteristics of septage before and after chemical flocculation and separation. Testing samples of septage were collected from Port Angeles, WA and analyzed by Twiss Analytical. Three samples were tested:

- A septage sample from Port Angeles was tested for TSS and turbidity (in NTU).
- A sample of effluent taken after flocculation and screening was tested for TSS and turbidity (in NTU).
- A sample of thickened solids taken after flocculation and screening was tested for total solids (TS).

The results of this study are summarized in the following table:

SAMPLE	TSS	NTU	TS
PORT ANGELES SEPTAGE	11880 mg/l	21600 NTU	3.38%
POST FLOCCULATION AND SEPARATION EFFLUENT	150 mg/l	32 NTU[13]	N/A
POST FLOCCULATION AND SEPARATION THICKENED SLUDGE	N/A	N/A	11.37%

[13] Testing conducted by Twiss Analytical Laboratory and FKC Screwpress. Testing results available upon request.

The testing data demonstrates that chemical coagulation and separation using a screen is a very effective method for reducing both TSS and turbidity. The reduction for both properties was over 99% in this test. While 150 mg/l is not below the target TSS of 20 mg/l, it is close enough that further TSS reduction could be accomplished easily with a filter. This filter will be implemented if the further reduction in TSS can justify the additional cost of the filter.

Synapse was also able to witness a functioning FKC system at a municipal septage treatment plant in Mukilteo, WA. In **FIGURE 2** and **FIGURE 3**, it is possible to see the flocculation tank and the thickened sludge being discharged out of the far end of the device.

FIGURE 2: Flocculation Tank. Note the relative clarity of the separated liquid. Before the polymer mixing process, the liquid entering the system was a thick dark brown color.

FIGURE 3: Discharged thickened sludge

WEFTEC AND IFAT REVIEW:

During visits to the WEFTEC and IFAT conferences Andrew Whitesell identified several potential vendors with interesting or promising dewatering equipment. The summary of these visits can be seen in the document: "WEFTEC_IFAT List DRAFT.pdf".[14] Companies highlighted in green were systems that were of particular interest because their technology was either unique or seemed particularly promising for use in the Omni-Ingestor. Synapse reviewed these companies:

- Läckerby:
  - Läckerby makes a variety of sludge watering equipment for use in municipal plants. Much of their equipment (screw presses, piston presses, and decanters) were either too large, or replicated the performance of systems available from US manufacturers that are known to be very expensive. The Läckerby Drum Screen is a promising product, however, based on their description on the Läckerby website, the product appears to replicate the performance of the FKC Rotary Thickener.

[14] Available on Dropbox. Last accessed on July 5, 2012.

- Klass Filter:
    - Synapse is still waiting to get performance characteristics from Klass Filter. The product requires that polymers be used to coagulate and flocculate the solids before they are put through the filter. The performance and cost appear to be relatively similar to the FKC device.
- Teknofanghi:
    - After investigating the Teknofanghi line of products, Synapse made the decision that their line of products replicated the design of several other pieces of technology that were available from US vendors.
- Blue Water Technologies:
    - Blue Water Technologies makes several smaller screw presses that have flow-rates in the range that we are looking for. Synapse investigated whether the BluePress SP-6[15] would be appropriate for use in the OI system, however a technical representative of Blue Water Technologies indicated that it would not be appropriate for use with septage.
- Simon Moos:
    - The Simon Moos system was an early reference design that Synapse investigated. The Simon Moos system uses a chemical flocculation system that then discharges the flocculated sludge into a dewatering box. While the system shares several similarities to the potential OI system, the major drawback is that it uses a very large truck that would not be maneuverable in narrow streets.
- Hydroswiss:
    - Hydroswiss makes dissolved air flotation (DAF) systems. DAF systems are used to aid in the coagulation and flocculation process. The systems generally consist of a large tank that has a micro-bubble generator in the bottom. As the bubbles rise to the surface of the tank, the flocculated sludge particles attach to them and float to the surface. Usually, the flocks are then skimmed from the top of the tank. Currently Synapse does not believe this process is appropriate for the OI due to the large size of the tank necessary to perform the DAF process.
- Nikuni:
    - Nikuni also makes DAF products.
- Aquen:
    - Aquen makes a product called the FlocFormer, which claims to improve the efficiency of chemical flocculation. The systems works by centrifugally mixing the flocculated sludge through a cyclonic tank. The website claims that the product reduces the quantity of the chemical additives that need to be added to waste water.
    - Synapse’s position on the product is to first implement a coagulation and flocculation based dewatering system, then determine through testing whether the capital cost of this product could be justified with lower long term consumable costs.

[15] http://www.blueh2o.net/products/bluepress.html

- RO Systems:
    - While not recommended by Andrew Whitesell, several reverse osmosis system were summarized in the report.
    - While reverse osmosis systems are capable of removing extremely fine particles, they are not used for gross filtration. In fact, before waste-water enters a reverse osmosis (or membrane) based system, it usually must be pre-filtered to 1 micron or smaller. The membranes in RO systems are also sensitive to biofilm growth that will accumulate and eventually foul the membrane.

APPENDIX A:

FINDINGS FROM PHASE 1

During Phase 1 of the OI project, Synapse investigated many types of separation and dewatering technologies. While these were examined from the standpoint of finding a technology that could potentially dewater to a much higher solids-content (the requirements for solids content in the discharged sludge was more stringent at the time), some of the technology is still relevant to the current requirements. The following table summarizes some of the systems that Synapse investigated in Phase 1. *All of these systems were ultimately rejected for a variety of reasons including: cost, complexity, size, infrastructure requirements, or power consumption.*

TYPE	FEED REQUIREMENT NOTES	MAX CLAIMED OUTPUT WATER CONTENTS	VOLUME REDUCTION % (STARTING FROM 5%)	MANUFACTURER/SYSTEM	COD-BOD REDUCTION	SIZE OF MACHINE	COMPLEXITY OF MACHINE	COST OF MACHINE	EASE OF INTEGRATION	EASE OF OPERATION	TYPE OF ENERGY REQUIRED	POWER REQUIRED
Simon Moos Gravity Drain	40m^3 per hour	50%	95.00	Simon Moos	95%	Large	Low	Low	High	High	Gravitational (could be assisted with pneumatic, hydraulic or mechanical)	Low
Air-Assist Flocculation Skimmer	30 GPM	10%	50.00	Ecologix		Large	Medium	High	Low	Medium	Mechanical	Medium
Rotary Press		30%	83.33	Fournier		Large	Medium	High	Medium	Medium	Mechanical	Medium
Sludge Dehydrator		22%	77.27	VoR		Medium	Medium	High	Medium	Medium	Mechanical	Medium
Somat Press	1-3% Solids at 20-50GPM, continuous operation	25%	80.00	Somat		Medium	Medium-Low	Medium	High	Medium	Mechanical	Medium
Rotary Fan Press		28%	82.14	Prime		Large	Medium	High	High	Medium	Mechanical	Medium
Bio Scrub Dryer	Requires Pre-dewatered sludge min. 12%	90%	94.44			Large	High	High	Low	Low	Mechanical/ Heat	Very High
Electro-Osmosis Belt Press	Fitted with belt press for as low as .5% dry solids, or 12% for no included belt press	65%	92.31	Aqua Treat	Claims to significantly reduce pathogen count	Medium / Large	High	High	Medium	Unknown	Mechanical/ Electrical	High
Electro Kinetic Bags	Increases dewater sludge content by 10%	x+10%	N/A	Electro Kinetics		Small	Low	High	High	High	Electrical	High
Steam Dryer		99	99.95	Exergy		Very Large	Very High	High	Low	Low	Mechanical, Heat (superheat), Pressure	High
Filter Press	Batch Process	40	99.88	Beckhart		Large	High	High	Low	Low	Mechanical/Hydraulic	Medium

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