June 20, 2011 (3:00–3:45PM), Aurora, OH

2012 Ohio WEA Conference

Evaluation of Dewatering Technologies for 4 WWTP Nutrient Reduction Projects: BFP, Centrifuge, Rotary Fan Press, and Inclined Screw Press

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DISCUSSION TOPICS

- Dewatering Alternatives
- Methods for Evaluation
- Technology Selection
  - FMC WWTP – Fredericksburg, VA
  - Lock Haven WWTP – Lock Haven, PA
  - Parkins Mills WWTF – Winchester, VA
  - South Central WWTP – Petersburg, VA

DEWATERING ALTERNATIVES

Dewatering Alternatives

- Belt Filter Press
- Centrifuge
- Rotary Fan Press
- Inclined Screw Press

- Others….
  - Volute Dewatering Press
  - Electro-Dewatering
  - Plate & Frame
  - Etc.

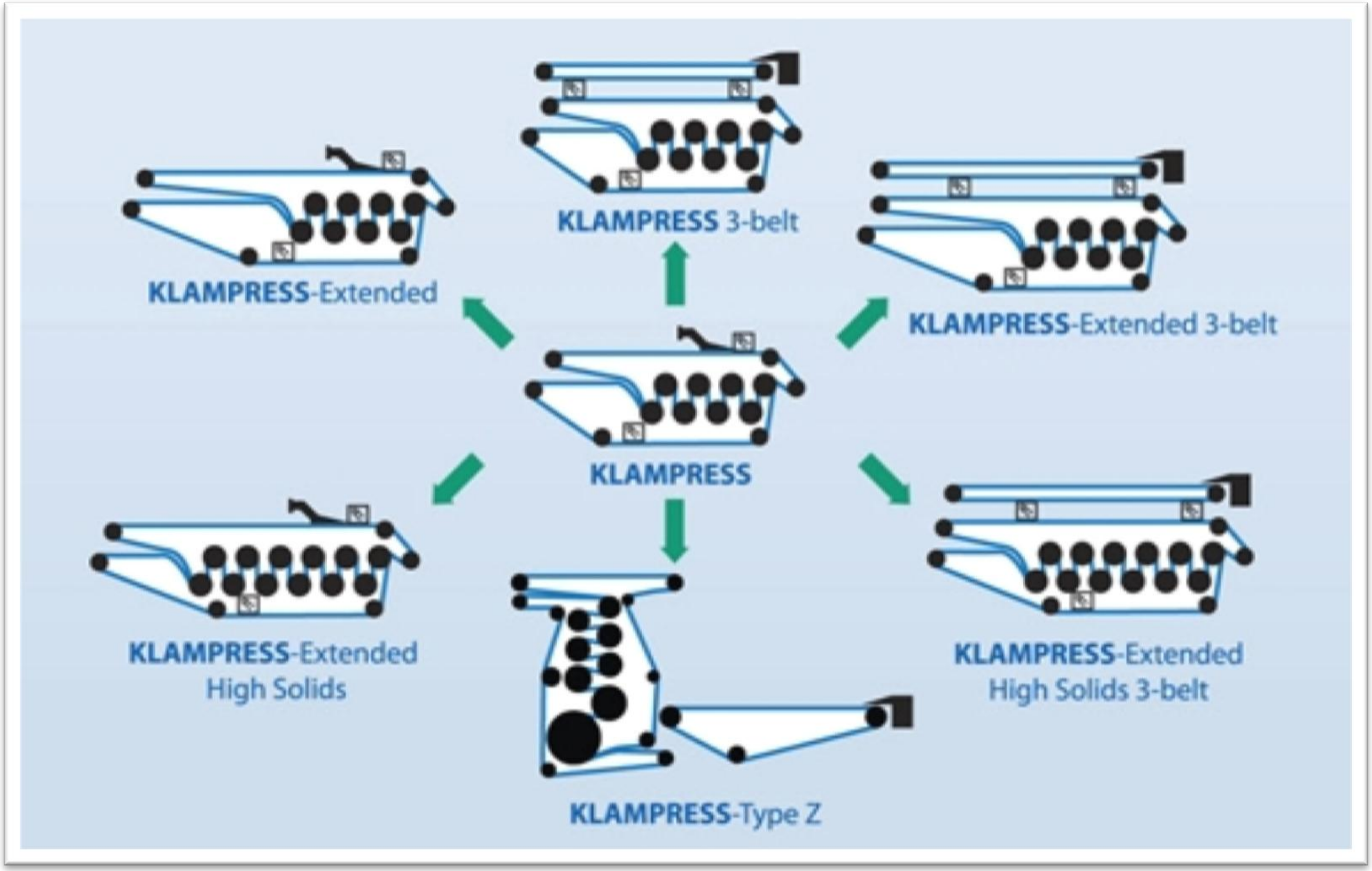
Belt Filter Press

- Principle of Operation
  - Gravity dewatering followed by pressure zone
  - Sludge squeezed between two porous belts inducing liquid separation).
  - Hydraulic Power Pack

- Typical Performance
  - 15% to 30% solids

- Configurations
  - 2 or 3 belts
  - varying # of rollers
  - Orientation of rollers

Belt Filter Press



Courtesy Ashbrook Simon-Hartley – www.ashbrookcorp.com

Belt Filter Press - Performance

- Performance is tied to influent feed type, %solids
- Increase in # of belts, rollers can increase solids loading capacity and cake dryness

Typical Performance Results

Municipal Sludge Dewatering Spectrum for 2VP

Sludge Type	Feed Consistency	Solid Loading Rate	Cake Dryness	Polymer Consumption
	%	lbs/hr, m	%	lbs/dt
Aerobically Digested	1 - 3	540 - 810	15 - 20	13 - 20
Waste Activated	.7 - 1.5	540 - 810	14 - 18	11 - 16
Anaerobically Digested	2 - 5	810 - 1350	16 - 22	9 - 13
Primary + WAS	3 - 5	810 - 1620	16 - 24	7 - 11
Primary + WAS + RBC	3 - 5	900 - 1800	18 - 24	11 - 20
Primary + WAS +Trickling Filter	3 - 5	900 - 1980	20 - 25	11 - 18
Primary + RBC	4 - 6	1080 - 2250	20 - 27	9 - 16
Primary + Trickling Filter	4 - 6	1080 - 2250	22 - 27	7 - 15
Raw Primary	4 - 8	2250 - 3150	25 - 31	3 - 6
SBR	1 - 1.5	540 - 720	13 - 16	11 - 16
MBR	.8 - 1	450 - 630	13 - 16	11 - 16

*** Polymer consumption is based on 100 percent active ingredients**

Because influents, processes and operation vary greatly, processing results have a wide range.
The ratio of blends will also have an impact on dewatering. The above represent the ranges that might be expected.

Typical Performance Results

Municipal Sludge Dewatering Spectrum for 3DP

Sludge Type	Feed Consistency	Solid Loading Rate	Cake Dryness	Polymer Consumption
	%	lbs/hr, m	%	lbs/dt
Aerobically Digested	1 - 3	600 - 900	17 - 22	12 - 18
Waste Activated	.7 - 1.5	600 - 900	16 - 20	10 - 15
Anaerobically Digested	2 - 5	900 - 1500	18 - 25	8 - 12
Primary + WAS	3 - 5	900 - 1800	18 - 27	6 - 10
Primary + WAS + RBC	3 - 5	1000 - 2000	20 - 27	10 - 18
Primary + WAS +Trickling Filter	3 - 5	1000 - 2200	22 - 28	10 - 16
Primary + RBC	4 - 6	1200 - 2500	22 - 30	8 - 15
Primary + Trickling Filter	4 - 6	1200 - 2500	24 - 30	6 - 14
Raw Primary	4 - 8	2500 - 3500	28 - 35	3 - 5
SBR	1 - 1.5	600 - 800	15 - 18	10 - 15
MBR	.8 - 1	500 - 700	15 - 18	10 - 15

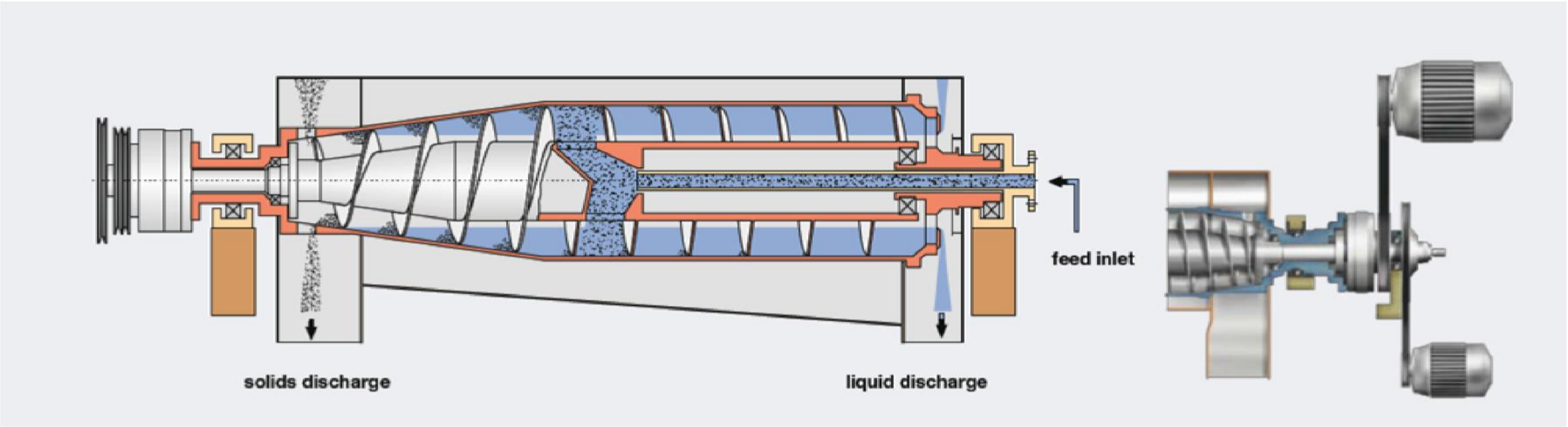
*** Polymer consumption is based on 100 percent active ingredients**

Because influents, processes and operation vary greatly, processing results have a wide range.
The ratio of blends will also have an impact on dewatering. The above represent the ranges that might be expected.

Courtesy BDP Industries – www.bdpindustries.com

Centrifuge

- Principle of Operation
  - Centrifugal Force – 3000 x G typical
  - Solids collect on the bowl surface
  - Scroll conveyor removes solids



Liquid-solid separation – FLOTTWEG DECANTER with gravity overflow

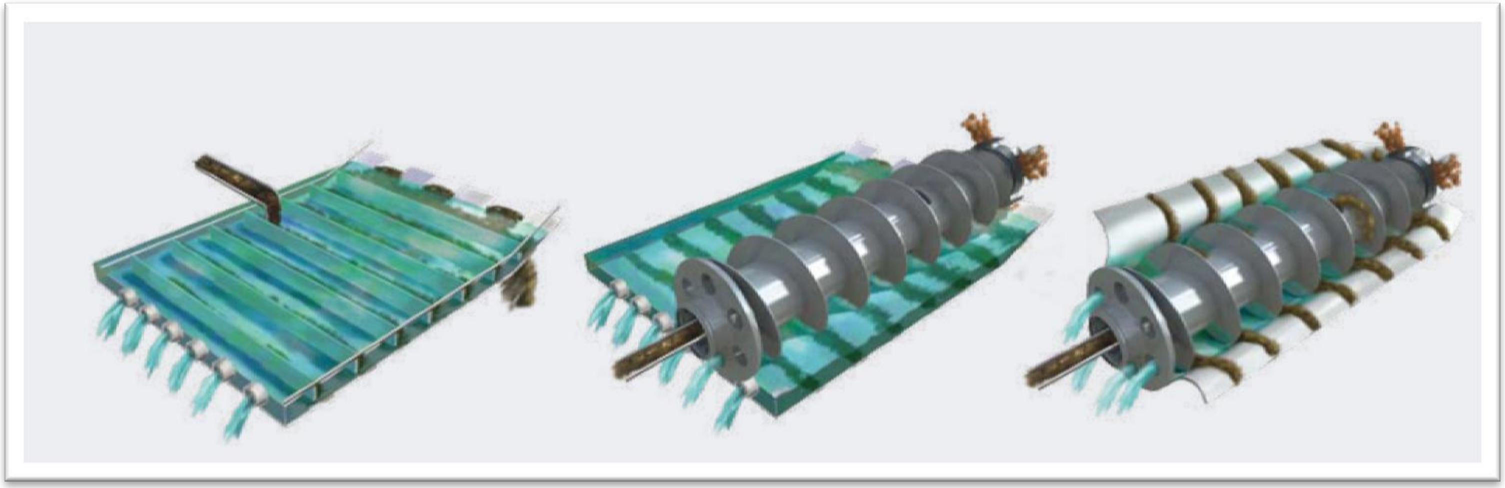
FLOTTWEG SIMP-DRIVE®

Courtesy Flottweg Separation Technology – www.flottweg.de/usa

Centrifuge

- Typical Performance
  - 15% – 30% Solids

- Configurations
  - Electric Drive, VFD
  - Hydraulic Drive



Courtesy Flottweg Separation Technology – www.flottweg.de/usa

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Centrifuge Performance vs. Belt Filter Press

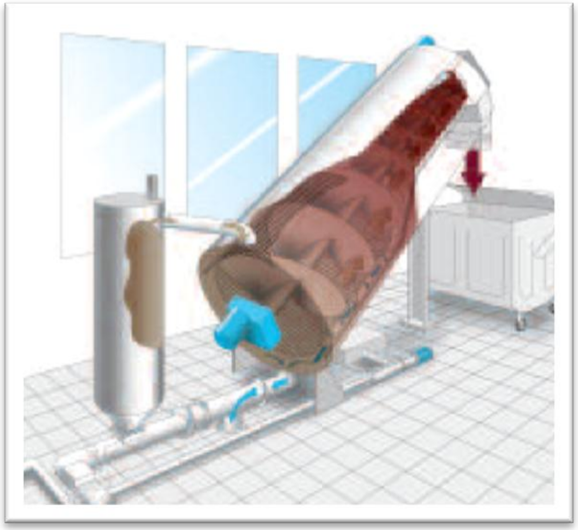
MUNICIPAL WASTEWATER SLUDGE PROCESSING					
	Common Sludge Type Performance - Conventional Dewatering				
				Digested	
	Primary	P:S/1:1	WAS	Anaerobic	Aerobic
EQUIPMENT	Cake Dryness, % w/w ts				
BFP/M	23 - 30	18 - 25	12 - 20	18 - 25	12 - 20
Decanter	20 - 28	18 - 24	12 - 18	18 - 24	15 - 20

MUNICIPAL WASTEWATER SLUDGE PROCESSING					
	Common Sludge Type Performance - High Solids Dewatering				
				Digested	
	Primary	P:S/1:1	WAS	Anaerobic	Aerobic
EQUIPMENT	Cake Dryness, % w/w ts				
BFP/M	25 - 33	20 - 28	12 - 20	20 - 28	14 - 23
Centrisys HS	32 - 40	28 - 34	16 - 25	25 - 37	18 - 26

Courtesy Centrisys Centrifuge Systems – www.centrisys.us

Inclined Screw Press

- Principle of Operation
  - Sludge conveyed upward through a cylindrical wedge wire basket by a screw
  - free water drains through the basket
  - Filtration pressure regulated by a cone at the sludge discharge
- Typical Performance
  - 12% to 28% solids



Courtesy Huber Technology – www.huber.de

Typical Performance Results – Screw Press

Sludge Type	Feed Consistency wt %	Solid Loading lbs/hr, m	Cake Dryness wt %	Polymer Dosage lbs/ton
Aerobically Digested	1 to 3	110 to 150	12 to 18	12 to 18
Waste Activated	1.5 to 1.7	110 to 150	12 to 18	12 to 18
Anaerobically Digested	2 to 5	130 to 170	15 to 20	9 to 11
Primary + WAS	3 to 5	150 to 180	15 to 22	6 to 10
Primary + RBC	3 to 5	160 to 200	15 to 23	11 to 15
Raw Primary	4 to 8	300 to 240	22 to 28	4 to 6
SBR	1 to 1.5	90 to 110	12 to 17	12 to 18
MBR	0.8 to 1	90 to 110	12 to 17	12 to 18

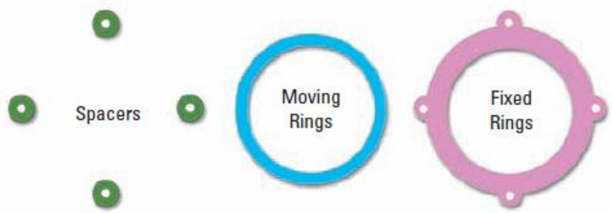
Courtesy BDP Industries – www.bdpindustries.com

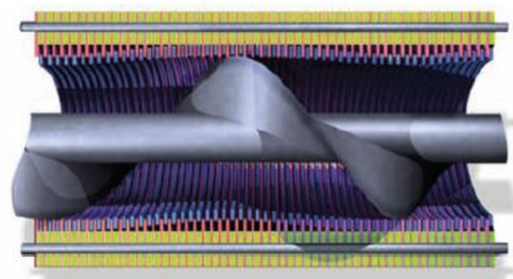
Volute Dewatering Press

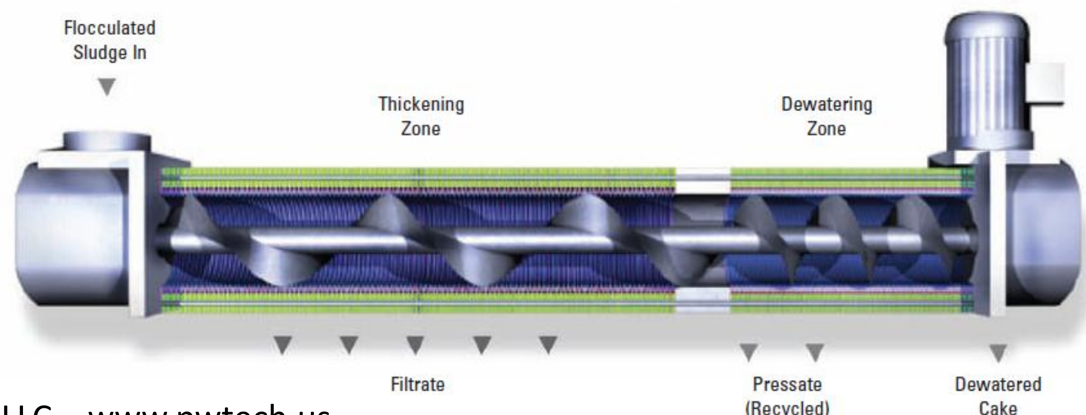
- Principles of Operation
  - Dewatering drum w/screw
  - Spacers and fixed rings are held in place on tie rods.
  - Moving rings are located between the fixed rings and are moved by the screw, cleaning the fine gaps between the moving and fixed rings
  - This prevents clogging and allows additional surface area for the release of moisture

Results Achieved with the Volute Dewatering Press

Sludge Type	Feed Solids (%)	Cake Solids (%)	Solids Recovery (%)	Polymer Use (lb/dry ton of solids)
Municipal & Biological				
Waste Sludge	0.2-1.5	17-25	98	10-22
Digested/Thickened	1.5-6	16-28	97	10-16
Primary	1-4	25-40	95	6-12

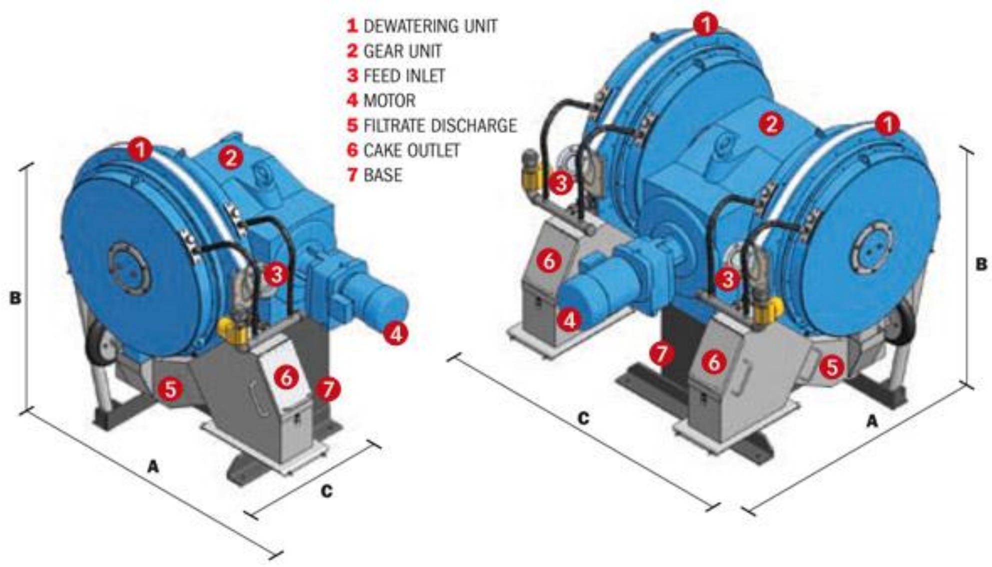






Courtesy Process Wastewater Technologies LLC – www.pwtech.us

Rotary Fan Press



- Liquid sludge is feed into the rotary fan press by a feed pump
- Sludge flows into the inlet end of a circular annular space between two perforated or slotted plates
- The “fan” referred to in the name is simply a circular array of plate supports that are externally visible on some models

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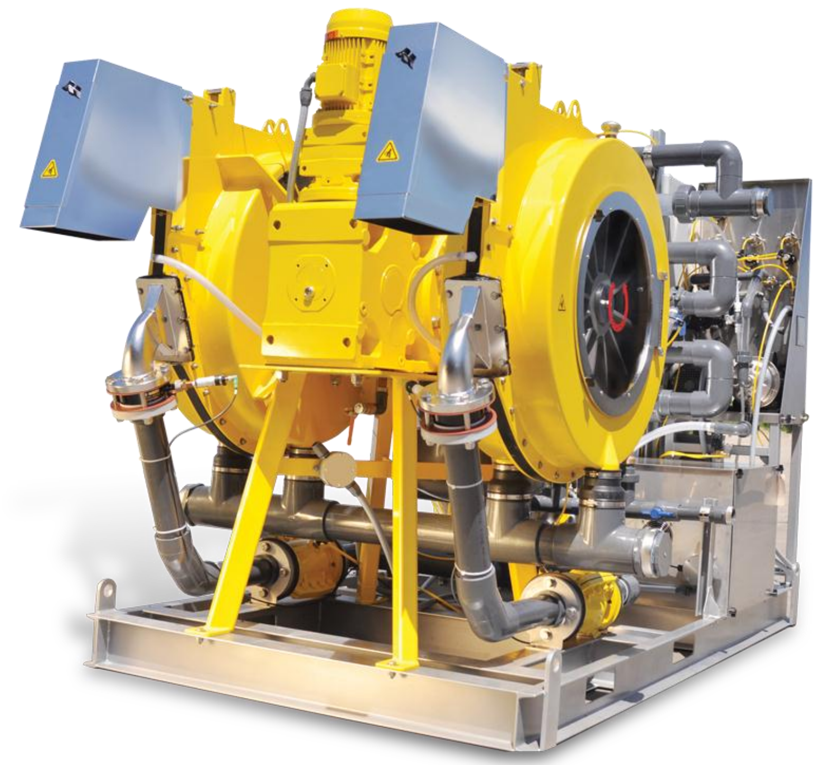
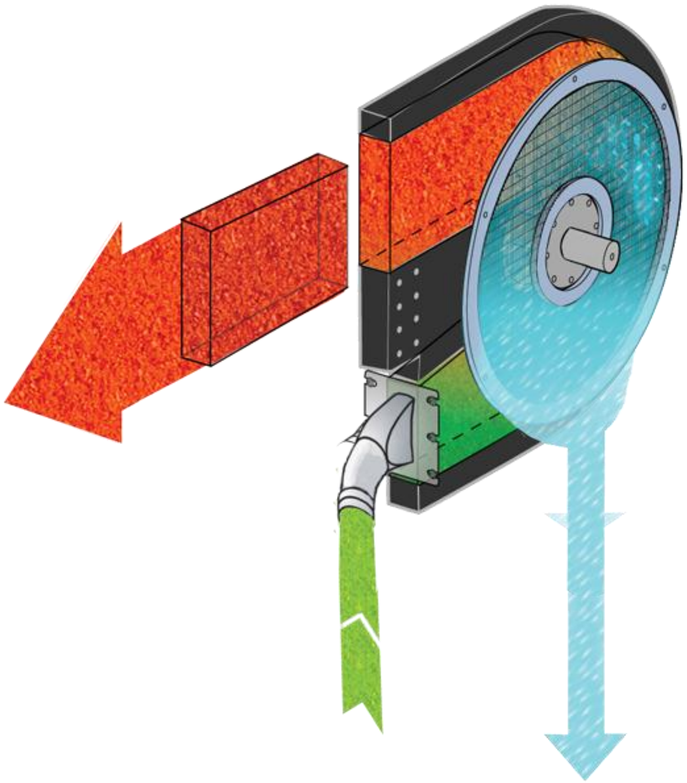
Rotary Fan Press

- Dewatering pressure provided by feed pump
- Pressure regulated by rotational speed and an adjustable discharge orifice
- As sludge turns to cake in the machine it is conveyed by friction with rotating filter plates



Rotary Fan Press

- Filtrate flows through the plates towards the outside of the enclosure (referred to as a channel.)
- Can be fitted with multiple channels.
- Wash water is sprayed on the filter plates
- A start up period is required to allow a cake to build up.
- During startup the discharge orifice is closed.



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EVALUATION METHODS

Pilot Testing

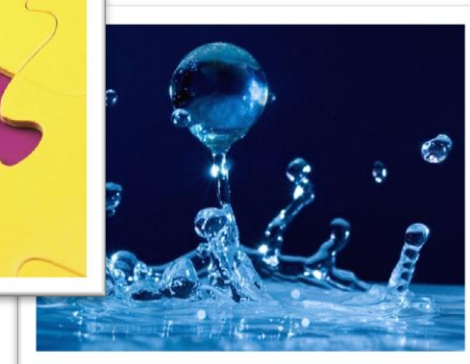
- Equipment Test Drive
- Site Specific Sludge
- Evaluate
  - Cake Solids
  - Polymer Consumption
  - Energy Use
  - Filtrate / Centrate Composition
  - O&M
- Set Full-Scale Design Basis
- Rule out incompatible technologies

Key Evaluation Criteria

- Process Design
  - Thickening, Dewatering
  - Hydraulic versus Solids Loading
  - Stabilization Method / Location in Process Train
  - Recycle load / frequency

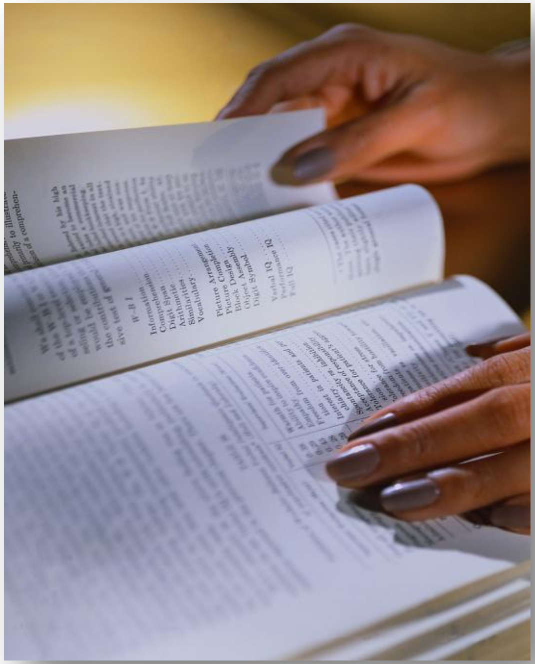
Key Evaluation Criteria

- Physical Criteria
  - Space Constraints
  - Splash Control
  - Odor Control



- O&M
  - Drive Type
  - Energy Consumption
  - Access / Routine Maintenance Schedule

CASE STUDIES



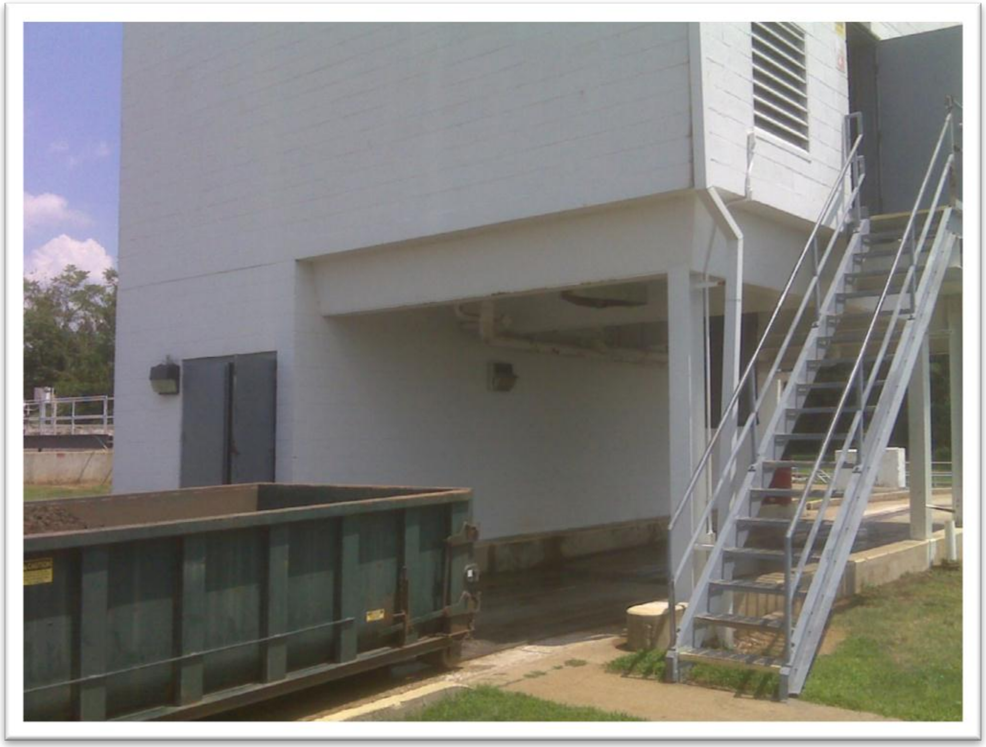
FMC WWTP
FREDERICKSBURG, VA

FMC Dewatering Study

- Study was initiated by Spotsylvania County VA to evaluate various dewatering alternatives to replace an aging belt filter press .

- The technologies evaluated were:
  - Belt Filter Press
  - Inclined Screw Press
  - Rotary Fan Press
  - Centrifuge

- Existing structure to be reused



FMC Dewatering Study

- The study evaluated the cost of each technology over an assumed lifespan of 20 years

- The study also weighed the practical/operational pros and cons of each technology including:
  - Maintenance requirements
    - Daily (washing etc.)
    - Periodical (greasing, alignment)
  - Utility water demand
  - Accessibility

Table 1 - Strengths and Weaknesses for Dewatering Treatment Methods

	Strengths	Weaknesses
Centrifuge	Relatively high solids concentration Performance is somewhat independent of solids loadings Proven Technology Relatively low O&M requirements Relatively small space requirements Flexible to operate in dual modes (thickening and dewatering)	Comparatively high installation cost due to thick floor slabs to dampen equipment vibration and a hoist crane requirements Comparatively high energy cost Relatively constant flow rate required High O&M requirements, due to substantial conditioning (polymer) needs and power requirements Stand-by unit required – most repairs must be done off-site. Grit can cause abrasion of the bowl. Utility water demand may be higher than existing.
Belt Filter Press (BFP)	Proven technology Several manufacturers and models available FMC WWTP operator familiarity Repairs can be done on-site	Moderate space requirements, partly due to need for discharge conveyor(s) Moderate O&M requirements Relatively high solids concentration when compared to other technologies Open process resulting in odor release, spills and sprays Ancillary equipment required Relatively high washwater requirement
Rotary Fan Press	Smaller footprint compared to other technologies Minimal wash water requirement Relatively easy startup and shutdown procedure, though operator attention required. Totally enclosed process, hence release of odor minimized	Potential clogging within dewatering area – Refer to vendor literature Higher equipment costs Fewer reference installations for similar application (see *Pilot Testing* section) Relies on friction of cake to convey sludge, so initial cake % solids immediately after start-up is low
Inclined Screw Press	Suitable for waste that contain large particulate and inorganic material (like grit). Relatively lower operation cost requirements when used these waste-stream.	High maintenance cost requirements due to frequent changing of screens. Maintenance procedures are labor intensive. Equipment operation requires frequent manual adjustments for smooth operation High wash water requirement for system cleaning Few reference installations for similar application Requires large footprint for installation when compared to other technologies because more units are required. High demand for utility water flow and pressure.

FMC Dewatering Study

- There are also technical pro's and con's for each technology including ventilation requirements, space requirements, and structural loads.
- The dewatering performance of each technology was compared, but was not a direct deciding factor other than % solids had to be above 15% to not be considered liquid sludge (Plant used roll off containers, liquid sludge would require tankers, and hazmat)

Table 2 - Dewatering Technology Comparison

	Centrifuge	Belt Filter Press	Rotary Fan Press	Inclined Screw Press
Manufacturer (or Equal)	***Centrisys***	***BDP***	***Prime Solution***	***Huber***
Minimum number of units	2	2	2	3
Solids loading rate (lbs/hr)	900	900	1000	600
Hydraulic capacity (gpm)	130	130	130	60
Polymer consumption (lbs/dry ton)	28	18	19	20
Cake solids concentration (%)	18 - 22%	14 – 18%	15-20%	15 – 17%
Solids capture efficiency (TSS @ 2.0% Feed)	95%	95%	95%	95%

FMC Dewatering Study

- The performance of each technology was an indirect deciding factor . The more efficient the machine, the lower its lifetime operating cost.

- Efficiency criteria included:
  - Chemical usage
  - Electricity usage (at the machine and for ancillary equipment such as wash water booster pumps or sludge feed pumps)
  - Hauling costs (this is where % solids indirectly effected the study outcome)
  - Dewatering Time

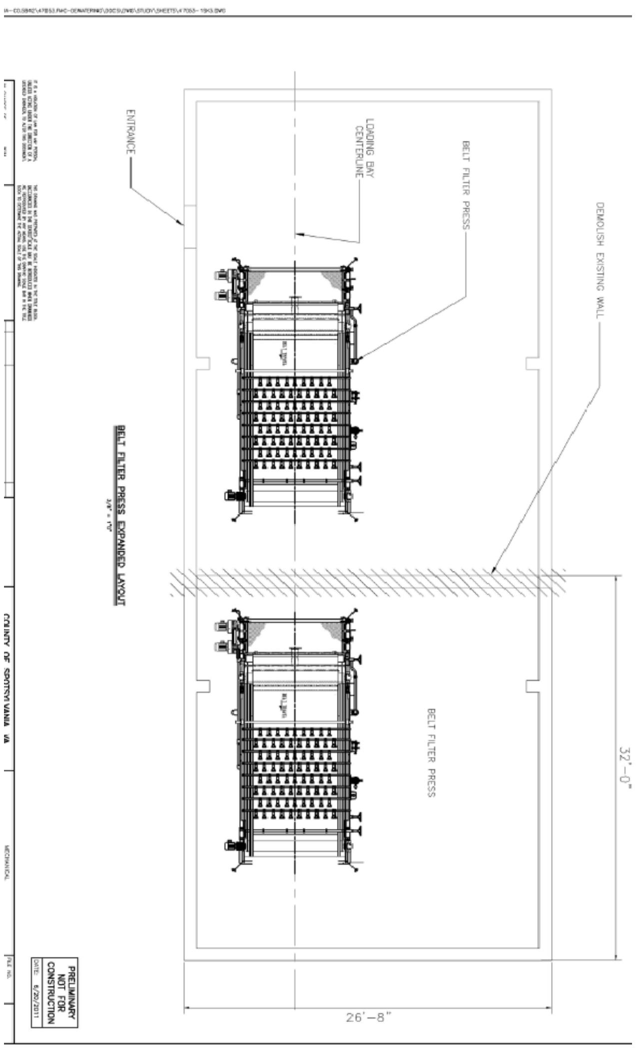
Fut. hrs/day/press		6
Current presses running/day	1	1
of Installed Presses (Fut presses running/day)		2
Days per Week spent dewatering	4.5	3
Current Elec Usage, kW-hr/day	144.38	47.25
Fut. Electrical Usage, kW-hr/day		94.50
Electricity Price, $/kW-hr	$0.06	$0.06
Est. Future Electricity Price, $/kW-hr		$0.09
Current Electricity Price, $/year	$2,038.45	$444.74
Est.Future Electricity Price, $/year		$1,316.65
Polymer Usage, lb/dry ton	26.01	18.97
Polyer Cost, $/lb	$1.15	$1.55
Est. Fut. Polyer Cost, $/lb		$2.29
Current avg. dry solids production, tons/day	1.91	1.91
Future avg. dry solids production, tons/day		3.70
Current Polymer Cost, $/year	$20,910.30	$20,550.74
Est. Fut Polymer Cost, $/year		$58,818.76
Specific Gravity of Dewatered Cake	1.00193	1.00217
Density of cake, tons/yard	0.8436	0.8438
Cake density, lb/gal	8.35	8.36
Density of Dry Solids, lb/gal	8.4	8.4
Cake Density, lb/cf	62.487	62.502
Bulk Density Multiplier	0.909	0.909
Cake Bulk Density, tons/cy	0.767	0.767

FMC Dewatering Study

	Existing Belt Press	Rotary Fan Press	High Solids Belt Filter Press	Centrifuge	Inclined Screw Press
Current Electricity Price, $/year	$2,038.45	$444.74	$615.12	$3,188.63	$523.60
Current Polymer Cost, $/year	$20,910.30	$20,550.74	$21,671.24	$30,339.73	$21,671.24
Current Annual Hauling Cost	$28,500.00	$25,350.00	$26,850.00	$24,000.00	$28,500.00
Current Annual Operating Cost, $/yr	$51,448.75	$46,345.48	$49,136.36	$57,528.36	$50,694.84
*Est. Future Annual Operating Cost, $/yr		$121,972.61	$129,347.65	$154,782.64	$133,848.40
Capital Cost for Dewatering Equipment		$1,055,000.00	$438,960.00	$840,000.00	$1,350,000.00
Est. Dewatering Building Addition Cost		$0.00	$544,050.00	$0.00	$0.00
Est 20 Year Total Cost		$4,017,316.58	$4,055,508.50	$4,307,381.41	$4,589,200.16

FMC Dewatering Study

- Study included a pilot test for the rotary fan press
- Study also evaluated the financial feasibility of dewatering a nearby plant's sludge at FMC
- Study Conclusion
  - Replace aging BFP with two rotary fan presses
  - Belt filter press came in close second



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PARKINS MILLS WWTF
WINCHESTER, VA

Parkins Mills - Winchester, VA

- Existing Plant
  - Design Capacity = 2.0 MGD
  - Primary Treatment = N/A
  - Secondary Treatment = Oxidation Ditch (BOD / Nitrification)
  - Dewatering Method =
    - Primary = Centrifuge (Westfalia)
    - Backup = Belt Filter Press
  - Stabilization Method = N/A

- Issues
  - Press not reliable as backup
  - Minimal sludge storage (< 2 days @ ADF)
  - No Stabiliztion

Parkins Mills - Winchester, VA

- Reason for Plant Upgrade
  - Liquid Process?
    - Nutrient Removal to meet new Waste Load Allocation
  - Solids Process?
    - Desire for Unit Redundancy
    - Additional sludge generated

- Key Decision Criteria
  - Technology Consistency
  - Ability to consolidate operations in one building
  - Similar spare parts
  - Seamless Control Integration

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Parkins Mills - Winchester, VA

- Plant Upgrade Summary
  - Increase design capacity to 5 MGD
  - New Primary Clarifiers (High TSS/TP from Industry)
  - New Secondary Treatment Process = Plug Flow Bioreactors
  - New thickening step prior to sludge storage
  - Maintain Dewatering Method = Centrifuge
  - New Stabilization Method = Class B Lime Stabilization

File Location

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Parkins Mills - Selection

- Design Basis –
  - Westfalia Centrifuge
  - One new larger unit
    - relocation of existing as backup
  - Dual Mode
    - Primary Use for Dewatering
    - Thickening - Alternate discharge to Thickened Sludge Pumps (back to SST) when not dewatering
  - Thickening
    - Take 2% WAS to 6%
    - 10 days storage
  - Dewatering
    - Take 6% digested WAS to 28%

CITY OF LOCK HAVEN STP
LOCK HAVEN, PA

Lock Haven, PA

- Existing Plant
  - Design Capacity = 3.75 MGD
  - Primary Treatment = None
  - Secondary Treatment = Contact Stabilization
  - Stabilization Method = Anaerobic Digestion (prior to press)
  - Dewatering Method = Belt Filter Press
    - Solids Loading Capacity =
- Issues
  - Old Equipment
  - No redundancy
  - Messy / Labor Intensive
  - Located in operations building

Lock Haven, PA

- Reason for Plant Upgrade
  - Liquid Process?
    - Nutrient Removal to meet new Waste Load Allocation
  - Solids Process?
    - Desire for Unit Redundancy
    - End of useful life
    - Additional sludge generated

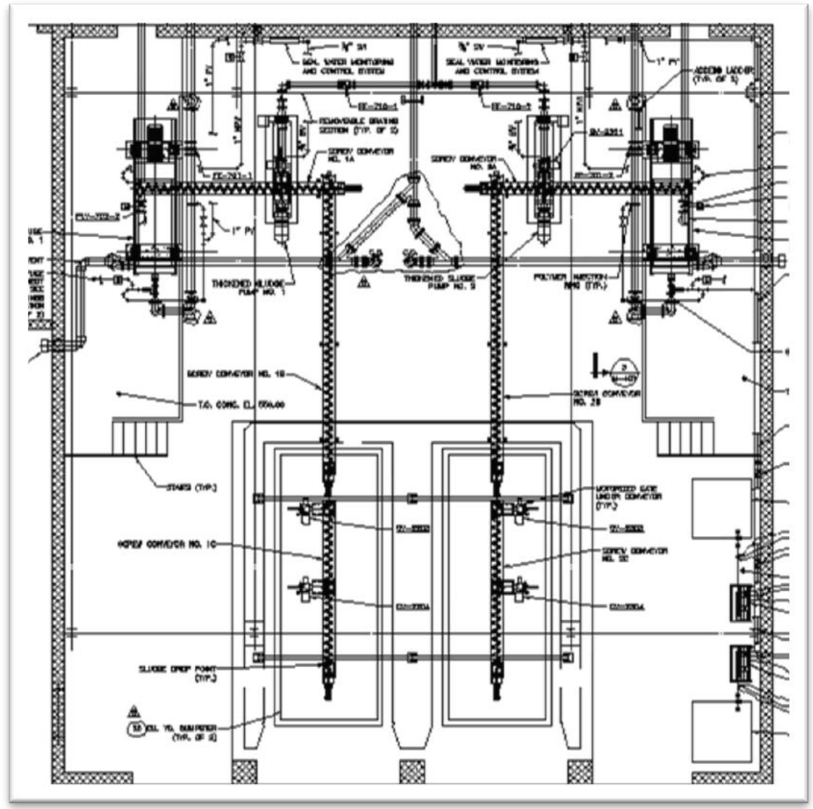
- Key Decision Criteria
  - O&M Friendly
    - Automated operation
    - Mess contained
  - Local service / parts
  - Good references

Lock Haven, PA

- Plant Upgrade Summary
  - Maintain design capacity
  - New Secondary Treatment Process = Sequencing Batch Reactors
  - New thickening step prior to stabilization
  - New Stabilization Method = Aerobic Digestion
  - New Dewatering Method = Centrifuge

Lock Haven - Selection

- Design Basis –
  - Andritz Decanter Centrifuge D
  - Two Units
  - Thickening & Dewatering with each
    - Conveyor Layout / Controls
    - Thickened Sludge Pumps
  - Thickening
    - Take 2% WAS to 6%
  - Dewatering
    - Take 6% digested WAS to 28%



SOUTH CENTRAL WWTP
PETERSBURG, VA

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South Central WWTP – Petersburg, VA

- Existing Plant
  - Design Capacity = 23 MGD
  - Primary Treatment = Rectangular
  - Secondary Treatment = Plug Flow Bioreactors (A/O Process)
  - Thickening Method = Gravity Belt Thickener (2)
  - Dewatering Method = Belt Filter Press (2)
  - Stabilization Method = Class B Lime Stabilization (post press)

- Issues
  - Old Equipment – end of useful life
  - Messy / Labor Intensive
  - Odors / Heat in summer
  - Poor distribution to stabilization process
  - Limited sludge storage volume

South Central WWTP – Petersburg, VA

- Reason for Plant Upgrade
  - Liquid Process?
    - Nutrient Removal to meet new Waste Load Allocation
  - Solids Process?
    - Desire for new equipment
    - Additional sludge generated by upgraded liquid process
    - Reduce mess, odors, and labor
- Key Decision Criteria
  - O&M Friendly
    - Automated operation, Mess containe
  - Small footprint
  - Ability to thicken and dewater
  - Pilot testing

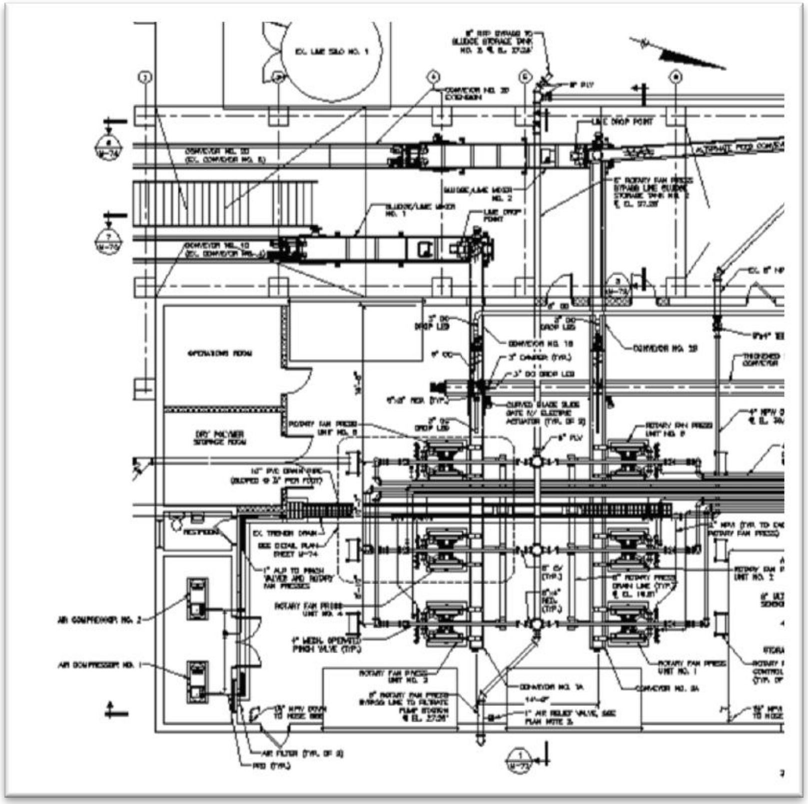
South Central WWTP – Petersburg, VA

- Plant Upgrade Summary
  - Maintain design capacity
  - Upgraded Secondary Treatment Process = Plug Flow (A^2O)
  - Maintain thickening step prior to sludge storage
  - New Dewatering Method = Rotary Fan Press (6)
  - Upgraded Stabilization Method = Class B Lime Stabilization

- Pre-Purchase contracting vehicle used to set design-basis technology / manufacturer.
  - Limited manufacturers
  - Schedule / Sequencing Constraints

South Central WWTP – Petersburg, VA

- Design Basis –
  - Prime Solution Rotary Fan Press
    - Six Units
  - Thickening & Dewatering with each
    - Conveyor Layout / Controls
    - Centralized hopper for thickened sludge
    - RFP Feed Pumps double as thickened sludge transfer
  - Thickening
    - Take 2% WAS to 6%
  - Dewatering
    - Take 6% digested WAS to 28%



CONCLUSIONS

- Dewatering solution is site specific
- Degree of dewatering depends on upstream and downstream processes
- Piloting valuable tool to confirm technology selection
- Thickening and dewatering possible using same technology



ACKNOWLEDGMENTS

- Doug Crooks – County of Spotsylvania – Director
- Bob Fessler & Tim Jenkins – Chief Operators

- Jesse Moffett – FWSA - Owner, Parkins Mills WWTF
- Greg Grim – FCSA - Chief Operator, Parkins Mills WWTF

- Jason Dershem – City of Lock Haven – City Engineer
- Mike Glantz – City of Lock Haven - WWTP Superintendant

- Alan Harrison – SCWWA – Assistant Executive Director
- Ray Burpoe – SCWWA – WWTP Superintendant

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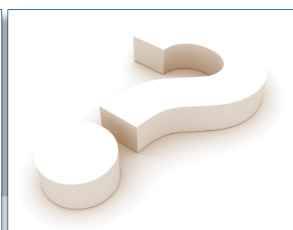
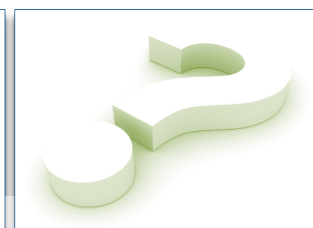
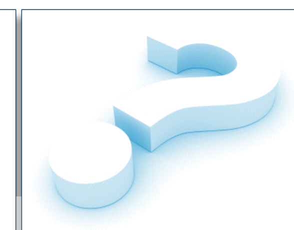
QUESTIONS?





THANK YOU





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