- Chapter VI -
ALTERNATIVES EVALUATION & PRELIMINARY SCREENING

A. INTRODUCTION

Prior to evaluating specific wastewater treatment alternatives, wastewater management options require evaluation on the planning level. The options typically include the 'Regional Treatment' alternative and the 'No Action' alternative.

The City of Kiel has recently evaluated joint treatment with the City of New Holstein, and determined it was not cost effective. Therefore, Regional Treatment as an option will be dropped from further consideration, as there are no other suitable regional possibilities.

This Chapter evaluates and summarizes planning level alternatives. A preliminary screening is undertaken to identify those alternatives that are applicable to the Kiel facilities. Those alternatives surviving the screening process are evaluated for cost effectiveness in Chapter VII. Each unit process will be discussed, as well as the need or lack thereof for expansion or modification.

B. 'NO ACTION' ALTERNATIVE

The 'No Action' alternative consists of maintaining 'status quo' conditions at the Wastewater Treatment Facility. Under this alternative, no improvements or modifications would be recommended.

The current treatment facilities have reached or exceeded their design capacities for numerous unit processes. Hydraulic limitations exist, hampering the treatment process as flows increase. Many unit processes and equipment have reached or exceeded their service life, and are in need of repair or replacement.

Therefore, the 'No Action' alternative is impractical, and will be dropped from further consideration.

C. LIQUID TRAIN TREATMENT ALTERNATIVES

1. General

The Wisconsin Department Of Natural Resources (DNR) is considering changes to the City of Kiel's Wisconsin Pollutant Discharge Elimination System (WPDES) permit. Changes include Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Ammonia, Phosphorus (P) and Dissolved Oxygen (DO). Treatment system improvements will be evaluated to meet the new, changed limits being proposed. Potential restrictions regarding temperature and chlorides may need to be addressed with a variance, in the event they are

not dropped from consideration by the DNR; data suggests a temperature limitation is not warranted, and chlorides are not removed by conventional technologies.

2. Pump Station

The River Road Pump Station utilizes three (3) dry pit pumps with a combined pumping capacity of 4.27 mgd. The firm capacity, with the largest pump out of service, is 2.42 mgd. In addition to the three (3) pumps in service, the Pump Station also has two (2) spare pumps stored in the Pump Room. This allows for a quick change out of a pump in the event of a failure.

Flow data from the past 4-years indicates the peak hour flow rate to the River Road Pump Station is 1.58 mgd (refer to Appendix VI-1 for data). This required pumping rate is less than the projected future peak hour flow rate of 4.96 mgd. The City of Kiel has an on-going Infiltration/Inflow (I/I) Reduction Program, as noted in Chapter IV. The City of Kiel intends to continue with I/I reductions within the collection system and, as such, believes the peak hour flows can be held to the current levels.

As the Pump Station has two (2) spare pumps available, and the City of Kiel has an I/I Reduction Program, and the current peak hour flows are less than the Pump Station capacity, the City of Kiel will forego any change in the pumping capacity at this time. Should conditions warrant at a future date, the City of Kiel may expand pumping capacity at that time.

3. Headworks

The building encompassing the fine screens is a Class I, Division 1, Classified Hazardous Area. The electrical systems, including controls, need to be upgraded to meet safety requirements. The City of Kiel intends to address the issue separately, and not include it in the treatment system upgrade project.

The firm capacity of the fine screens is close to the future peak hour flow rate. As such, it is not recommended to replace or upgrade the existing fine screens at this time. They are serviceable, and the combined capacity of both screens is sufficient for current peak hour events. The 4.30 mgd capacity of the screens exceeds the 4.27 mgd River Road Pump Station capacity. Additionally, the screens tilt out of the flow stream to provide an emergency bypass. In the event of a major equipment failure in the future, a larger capacity screen should be installed.

The ability of the grit chamber to effectively remove grit is unknown. A very small amount of grit is removed from the influent flow on a daily basis. Considering the surge in flows during rain events, one would expect a larger quantity. The grit classifier is serviceable at this time. When the digesters are taken out of service and cleaned out, the quantity of grit in the bottom of the vessels can be quantified and consideration of replacing the aerated

grit system with a more efficient vortex type grit system may be evaluated. Upon failure of the current grit classifier, replacement with a grit washer should be considered at that time.

4. Primary Clarifiers

Continued use of the primary clarifiers will require repair of the structural cracks to extend the service life of the concrete. Mechanically, new mechanisms with rapid sludge removal headers and new drives will replace the existing equipment.

The weirs and baffles will be considered for replacement, as well. The projected weir overflow rate at average design conditions is 5,492 gpd/LF, which is below the NR 110 maximum value of 10,000 gpd/LF.

The projected surface settling rate at average conditions is 1,089 gpd/sq.ft., which is close to the NR 110 maximum value of 1,000 gpd/sq.ft.; the peak hour projected value is 4,114 gpd/sq.ft., which exceeds the NR 110 maximum value of 1,500 gpd/sq.ft. However, the activated sludge process, final clarifiers and tertiary filters follow the primary clarifiers, and any inefficiencies with the primaries may be accommodated in downstream processes. As such, primary clarifier removal efficiencies of 50% for TSS and 21% for BOD will be utilized for design of downstream processes. Additionally, 3% solids concentration will be assumed for primary sludge generated with the new sludge removal equipment.

Redundant, dedicated sludge pumps should be provided. Pumps should be positive displacement type for use with the 3% primary solids that may be expected with the future upgrades.

5. Activated Sludge

Expansion of the existing aeration system will be required to effectively treat the projected flows and loadings for the next 20-years. Influent / effluent piping to / from the aeration basins will need to have an increase in hydraulic capacity. Flow splitting at the existing splitter box will need to be addressed, as well. An additional aeration tank may be added to each of the three (3) trains.

Continued use of aeration tankage will require structural repairs to concrete, as necessary to extend their service life.

The buried air main, which leaks, should be replaced with a new, buried air main. The old, 100-HP and 150-HP blowers are recommended to be replaced with more energy efficient units.

Retrofitting the aeration system with an Integrated Film Activated Sludge (IFAS) system was previously considered as an alternative to increasing the existing conventional activated sludge system in the original Facilities Planning document. An IFAS system combines both

attached biological growth and suspended biological growth treatment in the same tank. Media is added to the aeration tankage, which provides a surface for growth of additional attached biomass. Advantages of IFAS include:

- Allows capacity expansion with same aerobic volume.
- Increases Biological Nutrient Removal (BNR).
- Improves solids settleability.
- Greater resistance to hydraulic washout.
- Increased resilience to slug loadings.
- Reduced solids loading to final clarifiers.

However, the previous Facilities Planning document found the IFAS system to be significantly higher in initial capital costs and Operation & Maintenance (O&M) costs, when compared to other viable alternatives. Therefore, IFAS will be dropped from further consideration.

Consideration should be given to Membrane Bio-Reactor (MBR) systems. Factory-assembly of submerged units consisting of air diffusers assemblies, membrane cassettes, and common permeate manifolds provide simpler installation in the field.

MBR systems operate at a higher mixed liquor concentration, and require a significantly smaller footprint. Advantages of an MBR system include:

- Smaller footprint; fits in existing tankage.
- Multiple barriers; membranes and biofilm.
- Physical barrier to exclude viruses, bacteria and cysts; reducing need to expand disinfection system or existing filters.
- No need to rebuild or expand final clarifiers.

With the use of an expanded conventional activated sludge system, the existing final clarifiers will be utilized. Replacement of the mechanisms and drives, weirs and baffles is required. In addition, two (2) new 40-foot diameter final clarifiers are required to handle the projected hydraulic capacity and solids loading. In lieu of replacing the Fiberglass-Reinforced Plastic (FRP) domes, effluent trough covers are proposed. Redundant Return Activated Sludge (RAS) and Waste Activated Sludge (WAS) pumps are recommended. Final clarifiers are not required for the MBR alternative.

6. Tertiary Filtration

The capacity of the filter system must be increased, and efficiencies increased to allow removal of Phosphorus. The ability to remove Phosphorus down to 0.1 mg/L at 4.96 mgd in a retrofit of the existing sand filters is highly unlikely and impractical. Options utilizing ballasted high rate sedimentation (Actiflo and Co-Mag) do not allow for installation within the existing filter footprint while providing system redundancy, and are dropped from

consideration. Instead, installation of disc type filters, located outside on a concrete slab, will be evaluated with the expanded conventional activated sludge option. Filters are not required with the MBR option.

7. Disinfection

The detention time in the chlorine contact tanks is 70-minutes at the 1.24 mgd average design flow, while it is only 17.5-minutes at the peak hour flow. NR 110.23(2)(e)2 notes that contact tanks shall "*…be sized to provide a detention time of 60-minutes at average design flow or 30-minutes at maximum hour design flow*."

The existing contact tanks comply with the 60-minute/average design flow requirement. Additionally, a filtration step precedes the disinfection system, which minimizes the solids reaching the contact tanks. Chlorine dosage (and de-chlorine dosage) can be adjusted as necessary to achieve adequate kill. The current facilities have a good record of compliance with disinfection requirements. Therefore, it is not recommended that the disinfection system be expanded due to the future peak hour flows.

Separation of the chlorine gas and sulfur dioxide gas systems should be provided, as they are not compatible.

8. High Strength Waste

The City of Kiel currently pumps hauled-in waste to the Headworks and high strength waste to the digesters. The Facility is going to stop accepting hauled-in and high strength wastes in the future. Therefore, it is not recommended to expand or upgrade the high strength waste system at the Facility.

D. SOLIDS TRAIN TREATMENT ALTERNATIVES

1. Anaerobic Digesters

A biogas conditioning system and a 280 kW engine / generator have been purchased utilizing a Focus On Energy grant. The resultant project will reduce electrical costs and heating costs associated with the digesters. The project is self-funded without the use of Clean Water Fund (CWF) financing, and is not increasing user rates charged to customers. The engine/generator can utilize up to 73 scfm of biogas.

Current practice includes co-thickening WAS in the primary clarifiers. The resultant primary sludge is typically 1.5% to 2.5% total solids. The maximum month digester Hydraulic Retention Time (HRT) is projected to be less than 14-days with continued co-thickening WAS and no additional HSW added.

Mechanically thickening the WAS stream prior to digestion would reduce the volume and increase the digester HRT. However, mechanically thickening WAS and anaerobically digesting WAS has disadvantages:

- Only a small increase in digester volume is made available.
- Significant costs are associated with thickening equipment, pumps, polymer system, and tankage.
- A building enclosing the equipment is required for protection from the elements.
- Formation of struvite, which has previously caused pipe plugging, will continue.
- Phosphorus removed in the Enhanced Biological Phosphorus Removal (EBPR) process will be released, requiring removal again.

Completely removing the WAS stream from the anaerobic digestion process increases the HRT and provides operational flexibility and benefits.

Therefore, the continuation of anaerobically digesting WAS will be dropped from further consideration. Treatment alternatives instead will consider thickening WAS while keeping it aerobic, and combining it with anaerobically digested primary sludge. The combined sludges will be thickened and sent to a dewatering step, followed by a Class A stabilization process.

Both digester covers are in need of replacement. Steel gas holding covers versus membrane type gas holding covers may be considered.

Due to limited room on the site, rooftop linear motion mixers will be provided on each digester cover. A new Digester Equipment Room will be constructed to enclose recirculation and transfer pumps and heat exchanger equipment. The existing flare will be relocated to provide the necessary setback distance. New instrumentation will be provided to optimize operation of the digestion and gas utilization systems.

Structural cracks and brick maintenance are required on the digester exterior walls. Insulated wall panels may be an option in lieu of brick maintenance for a long-term repair. The City of Kiel intends to address this issue and include it in the treatment system upgrade process.

2. Thickening

The existing sludge holding tanks provide a location to store WAS and anaerobically digested sludge prior to dewatering. To optimize the sludge handling systems downstream, thickening will be provided. Gravity Belt Thickeners (GBT's), drum thickeners, centrifuges and membranes could be considered for thickening. However, the sludge holding tanks are currently set-up for decanting. A solids concentration of 2% is achievable via the decanting option. The additional thickening of the sludge with a mechanical process does not provide

significant benefit when coupled with a dewatering step. Therefore, until such point in time that additional storage volume is required, thickening will not be provided.

3. Dewatering & Class A Dryer

The City of Kiel retained Donohue to evaluate options for dewatering and providing a Class A dried biosolids product. This evaluation is summarized in a report, dated 02/22/2017, located in Appendix VI-2.

The evaluation considered the following alternatives:

a. Location:

1) Locating the dewatering and drying in the Solids Handling Building (050).
2) Locating the dewatering and drying in the Solids Storage Building (080).

b. Dewatering:

1) Belt filter press.
2) Screw press.
3) Centrifuge.

c. Dryer:

1) Belt dryer with vacuum.
2) Paddle dryer.
3) Belt dryer.
4) Fluid bed dryer.

A 20-year Present Worth Analysis concluded that a screw press and belt dryer with vacuum, located in the Solids Storage Building (080), is the recommended alternative, when considering both economic and non-economic factors.

E. SUMMARY OF ALTERNATIVES

Primary clarifiers will be refurbished, including new mechanisms and drives. Weirs and baffles will be replaced, and new dedicated Positive Displacement (P.D.) sludge pumps will be provided for each clarifier.

Expanding the activated sludge process to include an additional treatment cell per each of the three (3) trains, and two (2) new 40-foot diameter final clarifiers is Option #1. Option #2 utilizes MBR technology installed in the last cell of the south train, along with modifications to the north trains; no clarifiers are required for Option #2. Increases in hydraulic capacity from the primary clarifiers to the activated sludge tanks, and from the activated sludge tanks to the downstream process, are

included in all options. Buried air main replacement and new aeration blowers are also included in each option. New sludge pumps are required for each option, as well.

Replacement of the existing filters with disk type filters is required for activated sludge Option #1. MBR technology does not require filters.

Separation of the chlorine gas and sulfur dioxide gas systems is required for all options.

Additional space will be added to the existing Administration Building garage area to accommodate a growing need for maintenance and storage of vehicles and equipment.

The anaerobic digesters will be upgraded with new covers and mixers, an additional boiler heat exchanger, dedicated sludge pumps, and optimized for use with the Combined Heat & Power (CHP) system.

Dewatering and drying of biosolids will be relocated to the Solids Storage Building (080), as recommended by Donohue. Screw press technology and belt drying with vacuum technology will be utilized.

Electrical and control systems throughout the Wastewater Treatment Facility will be upgraded. The Supervisory Control & Data Acquisition (SCADA) system will also receive an upgrade to current technology.

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F. PROPOSED DESIGN CRITERIA

Proposed criteria for individual unit processes are summarized in Table VI-1.

Table VI-1

PROPOSED WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
INFLUENT PUMPING (River Road Lift Station)	
▪ Number Of Pumps	3
▪ Capacity, each pump, gpm	1,150
▪ Station Firm Capacity, mgd	2.42
▪ Type Of Pump	Dry Pit-Immersible
INFLUENT SCREENING	
▪ Number Of Units	2
▪ Type	Spiral
▪ Capacity, each unit, mgd	4.30
▪ Clear Opening, mm	6
GRIT REMOVAL	
▪ Type Of Unit	Aerated
▪ Number Of Units	1
▪ Capacity, each unit, mgd	6.2
PRIMARY CLARIFIERS	
▪ Number Of Units	2
▪ Diameter, each unit, feet	2@28
▪ Sidewater (SWD) Depth, each unit, feet	2@12.31
▪ Surface Overflow Rate, gpd/sq.ft.	
▪ Average Flow, 1.34 mgd	2@1,089
▪ Peak Hour Flow, 5.06 mgd	2@4,114
▪ Weir Loading Rate, gpd/ft.	
▪ Average Flow, 1.34 mgd	2@4,542
▪ Detention Time, hours	
▪ Average Flow, 1.34 mgd	2@2.0
▪ Maximum Day Flow, 3.85 mgd	2@0.7
▪ Removal Efficiencies	
▪ BOD, %	21
▪ SS, %	50
▪ TKN	10
▪ Primary Sludge, lbs./day	
▪ Average Day	2,552
▪ Maximum 30-Day	3,694
▪ Volatile Sludge, lbs./day	
▪ Average Day (78% VSS)	1,991
▪ Maximum 30-Day (78% VSS)	2,881
▪ Primary Sludge, gpd @ x% solids	3
▪ Average Day	10,200
▪ Maximum 30-Day	14,764

Table VI-1

PROPOSED WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
SECONDARY TREATMENT SYSTEM	
▪ Design Loadings To Secondary, lbs./day	
▪ Biochemical Oxygen Demand (BOD)	
▫ Average Day	6,517
▫ Maximum Day	16,501
▫ Maximum 30-Day	8,389
▪ Total Kjeldahl Nitrogen (TKN) (includes sidestreams), lbs./day	
▫ Average Day	775
▫ Maximum Day	1,783
▫ Maximum 30-Day	1,240
▪ Phosphorus (P), lbs./day	
▫ Average Day	174
▫ Maximum Day	563
▫ Maximum 30-Day	221
▪ Existing Aeration Tanks, size, ft.	6@65x32 + 3@64x28
▪ Proposed Aeration Tanks, size, ft.	2@65x32 + 1@64x28
▪ SWD, ft.	14
▪ Total Tank Volume, cu.ft.	333,312
▪ Anoxic Selector, ft.	1@30x28 + 2@30x32
▪ Anoxic Volume, cu.ft.	38,640
▪ Anoxic / Aerobic Ratio	0.13
▪ Aerobic Volume, cu.ft.	294,672
▪ BOD Loading, lbs./1,000 cu.ft.	
▪ Average Day	22.1
▪ Maximum 30-Day	28.5
▪ Design MLSS, mg/L	
▪ Average	3,275
▪ Maximum Month	3,510
▪ Design F:M	
▪ Average	0.10
▪ Design Sludge Retention Time (SRT), Days	
▪ Average	20
▪ Volatile Solids, %	75%
▪ Total Sludge Production, lbs. SS/lb. BOD	0.67
▪ Secondary Sludge, lbs./day	
▪ Average	4,366
▪ Maximum 30-Day	5,621
▪ WAS To Dewatering, gpd @ 1%	
▪ Average	52,350
▪ Maximum Month	67,398
▪ Oxygen Requirements, lbs./day @ 1.5 lb. O2/lb. BOD Applied & 4.6 lb. O2/lb. TKN Applied	
▪ Average Day	13,341
▪ Maximum Day	32,953
▪ Maximum Month	18,288

Table VI-1

PROPOSED WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
SECONDARY TREATMENT SYSTEM (continued)	
▪ Air Requirements, scfm	
▪ Average Day	4,581
▪ Maximum Day	12,745
▪ Maximum Month	6,545
▪ Blowers	
▪ Number Of New PD Blowers (3-Duty + 1 Standby)	4
▪ Capacity, each new unit, scfm	4,249
▪ Discharge Pressure, psig	8.0
▪ Firm Capacity, scfm	12,747
SECONDARY CLARIFIERS	
▪ Number Of Units	4
▪ Diameter, ft.	4@40
▪ SWD, ft.	14.25
▪ Surface Settling Rate, gpd/sq.ft.	
▪ Average Flow, 1.24 mgd	247
▪ Peak Hour Flow, 4.96 mgd	987
▪ Weir Loading, gpd/ft.	
▪ Average Flow, 1.24 mgd	1,396
▪ Peak Hour Flow, 4.96 mgd	5,586
▪ Detention Time, hours	
▪ Average Flow, 1.24 mgd	10.4
▪ Peak Hour Flow, 4.96 mgd	2.6
▪ Solids Loading, lbs./hour/sq.ft.	
▪ Average Flow, 1.24 mgd	0.56
▪ Peak Hour Flow, 4.96 mgd	2.10
FILTERS	
▪ Filtration Rate, gpm/sq.ft.	
▪ Average Flow, 1.24 mgd (firm)	0.92
▪ Peak Hour Flow, 4.96 mgd (firm)	3.66
DISINFECTION	
Number Of Tanks	2
Total Volume, gallons	60,250
Detention Time, minutes	
▪ Average Flow, 1.24 mgd	70.0
▪ Peak Hour Flow, 4.96 mgd	17.5
ANAEROBIC DIGESTION	
▪ Number Of Digesters	
▪ Primary	2
▪ Secondary	0
▪ Diameter, feet	2@45

Table VI-1

PROPOSED WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
ANAEROBIC DIGESTION (continued)	
▪ Maximum SWD, feet	
▪ North Digester	26
▪ South Digester	21
▪ Maximum Volume, gallons	
▪ North Digester	342,537
▪ South Digesters	269,652
Total	612,189
▪ Mixing System	Linear Motion
▪ Cover Type	
▪ North Digester	Gas Holder
▪ South Digester	Gas Holder
▪ Maximum Month HRT, days	
▪ North Digester	8.4
▪ South Digester	6.6
Total	15.0
▪ Digestion Capacity, gpd	40,812
▪ Maximum Month VSS Loading, lbs. VSS/KCF	35.2
▪ VSS Destruction, %	50
▪ Heat Exchanger Capacity, gpd	41,000
▪ Sludge To Dewatering, lbs./day	
▪ Average	1,556
▪ Maximum Month	2,253
▪ Anaerobic Sludge To Dewatering, gpd @ 1.83%	
▪ Average	10,195
▪ Maximum Month	14,764
SLUDGE HOLDING TANKS	
▪ Number Of Tanks	2
▪ Size, ft.	2 @ 62'x 25'x 16' SWD
▪ Volume, gallons, each	185,500
▪ Volume, gallons, total	371,000
▪ Solids, % After Decanting	2.0
▪ 2% Sludge From Outside Sources, gallons/week	0
▪ Sludge To Dewatering, lbs./day	
▪ Average	5,922
▪ Maximum Month	7,874
▪ Sludge To Dewatering, gpd @ 2%	
▪ Average	35,504
▪ Maximum Month	47,206
SLUDGE DEWATERING [(1)]	
▪ Number Of Units	1
▪ Capacity, each	
▪ gpm	49.5
▪ lbs./hour	247
▪ lbs./day	5,922
▪ Hours Of Operation/Day	24
▪ Average Days Of Operation/Week	4
▪ Cake Solids, %, minimum	18.5

Table VI-1

PROPOSED WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
CLASS A DRYING PROCESS (Belt Dryer w/Vacuum) [1]	
▪ Number Of Units	1
▪ Minimum % Solids	90
▪ Hours Of Operation/Day	24
▪ Days Of Operation/Week	4

[1] By Donohue & Associates

APPENDIX VI-1

PEAK HOUR FLOW DATA

	A	B	C
1	Date	MGD	MGD
2		Influent Flow	Effluent Flow
3		2	114
4	4/10/2013	3.12	3.12
5	6/18/2014	3.09	3.09
6	4/11/2013	3.05	3.05
7	4/14/2014	2.86	2.86
8	4/12/2013	2.79	2.79
9	4/9/2013	2.79	2.79
10	4/13/2014	2.60	2.60
11	3/25/2014	2.58	2.58
12	4/26/2011	2.50	2.50
13	4/18/2013	2.49	2.49
14	6/20/2014	2.39	2.39
15	4/13/2013	2.38	2.38
16	4/22/2011	2.37	2.37
17	6/19/2014	2.37	2.37
18	5/3/2012	2.33	2.33
19	4/23/2011	2.30	2.30
20	4/19/2013	2.26	2.26
21	6/25/2014	2.26	2.26
22	4/17/2013	2.23	2.23
23	6/2/2014	2.22	2.22
24	6/24/2014	2.22	2.22
25	4/14/2013	2.20	2.20
26	4/8/2013	2.20	2.20
27	4/21/2011	2.19	2.19
28	4/27/2011	2.17	2.17
29	4/15/2013	2.15	2.15
30	6/23/2014	2.13	2.13
31	4/16/2013	2.11	2.11
32	6/21/2014	2.09	2.09
33	12/18/2013	2.08	2.08
34	5/12/2014	2.04	2.04
35	4/15/2014	2.03	2.03
36	4/28/2011	2.00	2.00
37	6/26/2014	2.00	2.00
38	4/20/2013	1.98	1.98
39	4/24/2011	1.97	1.97
40	6/17/2014	1.97	1.97
41	5/13/2014	1.96	1.96
42	6/22/2014	1.96	1.96
43	4/16/2011	1.96	1.96
44	4/3/2011	1.93	1.93
45	4/25/2011	1.92	1.92
46	4/7/2013	1.91	1.91
47	4/29/2011	1.90	1.90
48	4/6/2013	1.90	1.90
49	4/21/2013	1.90	1.90
50	4/4/2013	1.89	1.89
51	6/27/2014	1.88	1.88
52	4/5/2013	1.88	1.88
53	4/4/2011	1.87	1.87
54	4/22/2013	1.87	1.87
55	5/6/2012	1.87	1.87
56	4/20/2011	1.83	1.83

← MAX DAY (MGD)

Max Hour Flow

Date	Time	Raw Influent (GPM)
4/9/2013	0:03:00	1430
4/9/2013	0:18:00	1410
4/9/2013	0:33:00	1520
4/9/2013	0:48:00	1405
4/9/2013	1:03:00	1520
4/9/2013	1:18:01	1435
4/9/2013	1:33:00	1380
4/9/2013	1:48:00	1550
4/9/2013	2:03:00	1495
4/9/2013	2:18:00	1560
4/9/2013	2:33:00	1555
4/9/2013	2:48:00	1580
4/9/2013	3:03:01	1595
4/9/2013	3:18:00	1580
4/9/2013	3:33:00	1550
4/9/2013	3:48:00	1660
4/9/2013	4:03:00	1710
4/9/2013	4:18:00	1715
4/9/2013	4:33:00	1575
4/9/2013	4:48:01	1510
4/9/2013	5:03:00	1480
4/9/2013	5:18:00	1445
4/9/2013	5:33:00	1505
4/9/2013	5:48:00	1490
4/9/2013	6:03:00	1460
4/9/2013	6:18:00	1570
4/9/2013	6:33:01	1530
4/9/2013	6:48:00	1540
4/9/2013	7:03:00	1525
4/9/2013	7:18:00	1525
4/9/2013	7:33:00	1575
4/9/2013	7:48:00	1600
4/9/2013	8:03:00	1540
4/9/2013	8:18:01	1480
4/9/2013	8:33:00	1440
4/9/2013	8:48:00	1420
4/9/2013	9:03:00	1440
4/9/2013	9:18:00	1425
4/9/2013	9:33:00	1475
4/9/2013	9:48:00	1510
4/9/2013	10:03:01	1520
4/9/2013	10:18:00	1600
4/9/2013	10:33:00	1610

4/9/2013	10:48:00	1625
4/9/2013	11:03:00	1645
4/9/2013	11:18:00	1590
4/9/2013	11:33:00	1575
4/9/2013	11:48:01	1680
4/9/2013	12:03:00	1650
4/9/2013	12:18:00	1680
4/9/2013	12:33:00	1620
4/9/2013	12:48:00	1590
4/9/2013	13:03:00	1630
4/9/2013	13:18:00	1570
4/9/2013	13:33:01	1540
4/9/2013	13:48:00	1615
4/9/2013	14:03:00	1660
4/9/2013	14:18:00	1690
4/9/2013	14:33:00	1785
4/9/2013	14:48:00	1990
4/9/2013	15:03:00	2075
4/9/2013	15:18:01	2100
4/9/2013	15:33:00	2260
4/9/2013	15:48:00	1795
4/9/2013	16:03:00	1850
4/9/2013	16:18:00	2030
4/9/2013	16:33:00	2025
4/9/2013	16:48:00	2020
4/9/2013	17:03:01	2135
4/9/2013	17:18:00	2165
4/9/2013	17:33:00	2170
4/9/2013	17:48:00	2125
4/9/2013	18:03:00	2120
4/9/2013	18:18:00	2115
4/9/2013	18:33:00	2120
4/9/2013	18:48:01	2115
4/9/2013	19:03:00	2115
4/9/2013	19:18:00	2115
4/9/2013	19:33:00	2030
4/9/2013	19:48:00	2025
4/9/2013	20:03:00	2145
4/9/2013	20:18:00	2135
4/9/2013	20:33:01	2110
4/9/2013	20:48:00	2110
4/9/2013	21:03:00	2125
4/9/2013	21:18:00	2190
4/9/2013	21:33:00	2185
4/9/2013	21:48:00	2085

4/9/2013	22:03:00	2095
4/9/2013	22:18:01	2115
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4/9/2013	22:48:00	2110
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4/9/2013	23:48:00	2130
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4/10/2013	0:18:00	2065
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4/10/2013	0:48:00	2135
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4/10/2013	2:03:00	2140
4/10/2013	2:18:00	2130
4/10/2013	2:33:00	2115
4/10/2013	2:48:00	2135
4/10/2013	3:03:00	2145
4/10/2013	3:18:00	2150
4/10/2013	3:33:01	2165
4/10/2013	3:48:00	2185
4/10/2013	4:03:00	2210
4/10/2013	4:18:00	2255
4/10/2013	4:33:00	2250
4/10/2013	4:48:00	2240
4/10/2013	5:03:00	2225
4/10/2013	5:18:01	2230
4/10/2013	5:33:00	2240
4/10/2013	5:48:00	2130
4/10/2013	6:03:00	2230
4/10/2013	6:18:00	2245
4/10/2013	6:33:00	2240
4/10/2013	6:48:00	2270 ← 1.576 MGD PEAK HOUR
4/10/2013	7:03:01	2240
4/10/2013	7:18:00	2140
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4/10/2013	8:18:00	2205

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4/10/2013	9:33:00	2200
4/10/2013	9:48:00	2185
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4/10/2013	10:18:00	2185
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4/10/2013	13:33:00	2165
4/10/2013	13:48:00	2175
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4/10/2013	16:33:00	2190
4/10/2013	16:48:00	2195
4/10/2013	17:03:00	2180
4/10/2013	17:18:00	2195
4/10/2013	17:33:01	2185
4/10/2013	17:48:00	2175
4/10/2013	18:03:00	2205
4/10/2013	18:18:00	2200
4/10/2013	18:33:00	2205
4/10/2013	18:48:00	2195
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4/10/2013	19:18:01	2205

4/10/2013	19:33:00	2200
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4/10/2013	21:48:00	2175
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4/10/2013	22:18:00	2065
4/10/2013	22:33:00	2170
4/10/2013	22:48:01	2170
4/10/2013	23:03:00	2165
4/10/2013	23:18:00	2045
4/10/2013	23:33:00	2155
4/10/2013	23:48:00	2155

4/11/2013	0:03:00	2155
4/11/2013	0:18:00	2155
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4/11/2013	5:03:00	2150
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4/11/2013	5:33:00	2145
4/11/2013	5:48:01	2155

4/11/2013	6:03:00	2035
4/11/2013	6:18:00	2150
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4/11/2013	7:03:00	2150
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4/11/2013	15:33:00	2185
4/11/2013	15:48:00	2180
4/11/2013	16:03:00	2175
4/11/2013	16:18:01	2160
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4/11/2013	17:03:00	2165

4/11/2013	17:18:00	2160
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4/11/2013	18:33:00	2180
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4/11/2013	22:48:00	2170
4/11/2013	23:03:00	2145
4/11/2013	23:18:00	2150
4/11/2013	23:33:00	2140
4/11/2013	23:48:01	2140

APPENDIX VI-2

2017 UPDATE TO WASTEWATER TREATMENT FACILITIES PLAN
Prepared By Donohue | 02/22/2017

Biosolids Handling
Dewatering and Drying Evaluation Report
City of Kiel WWTP

Date: February 22, 2017

To: Kris August, General Manager, City of Kiel

Copy: Steve Rabe, City of Kiel
Mike Gerbitz, Donohue
Stephen Matthias, Donohue

From: Eric Lynne, Donohue

Re: 2017 Update to Wastewater Treatment System Facilities Plan

Purpose and Background

The purpose of this technical memorandum is to summarize the preliminary design of a sludge dryer system that will replace the City's current RDP lime-heat stabilization process.

Within the Solids Handling Building the City of Kiel WWTP currently utilizes a belt filter press dewatering unit that feeds into a lime-heat stabilization process. The dried product is then stored for up to 3 months in an existing Solids Storage Facility on site until it is loaded and trucked from the facility. In concurrence with the City's '2017 Update' and the 'Wastewater Treatment Facility Master Plan' that was prepared in 2014, a dryer is recommended to meet the future biosolids handling needs of the facility. The current pasteurization process is causing equipment failure from air-borne lime/ash dust which personnel at the treatment plant has already noticed.

Design Basis

Donohue's future design criteria is based on a 2037 design year. Below is the design criteria outlined in McMahon's 2017 Update report:

Sludge to Dewatering, lbs./day	Proposed Design 2037
▪ Average	5,922
▪ Maximum Month	7,874

This design criteria uses a peaking factor of 1.33 which Donohue used in its design for finding a dryer size capable of processing the incoming loads. Based on the current influent loadings for Biological Oxygen Demand (BOD), Donohue was able to calculate an evaporative capacity that would determine the size and type of dryer needed to handle the future design loads entering the WWTP. Table 1 highlights the design criteria used in this determination.

Table 1 – 20-year Design Criteria for Kiel WWTP

Description	Units	2037 Average	2037 Max Month		
		Average (18.5% TS)	Aggressive (20% TS)	Average (18.5% TS)	Conservative (17% TS)
Influent BOD	lb/d	7,899	10,506	10,506	10,506
Dewatering Operation	gpm	49.5	53.8	49.7	45.4
	hrs/d	24	24	24	24
	d/wk	4	4.9	5.3	5.8
	hr/wk	96	118	127	139
Avg %TS	%	1.83	1.83	1.83	1.83

Table 2 summarizes the dryer size by evaporation rates that governed the rest of the preliminary evaluation that is discussed in the rest of this memorandum. The dewatering technologies as well as influent BOD loads controlled the dryer size.

Table 2 – Proposed Dryer Size

Description	Belt Filter Press	Screwpress	Centrifuge
Target Dryness	90%	90%	90%
Min. Evaporation Capacity (lb water/hour)	2,438	1,993	1,618
Min. Evaporation Capacity (tons water/day)	30	24	20

Alternatives Evaluation Method

Donohue identified three decision groups that controlled that preliminary design and layouts for the dryer system.

1. **Dewatering and Drying Facility Location**
2. **Dewatering Technology**
3. **Dryer technology/manufacturer**

The subsections to follow will detail the alternatives for each decision group as well as explain how some selections of one decision group controlled on the selection of within another group.

1.0 Dewatering and Drying Facility Location

Currently the WWTP is considering two options to house the dewatering and drying equipment for the upgraded solids processing system. The current dewatering and lime-heat stabilization processes solids within the Solids Handling Building to the south. The Solids Storage Building to the north currently holds the dry product from the lime-stabilization process and is the other building being considered for the updated dewatering and drying. Figure 1 shows where these two building are located within the treatment plant grounds.

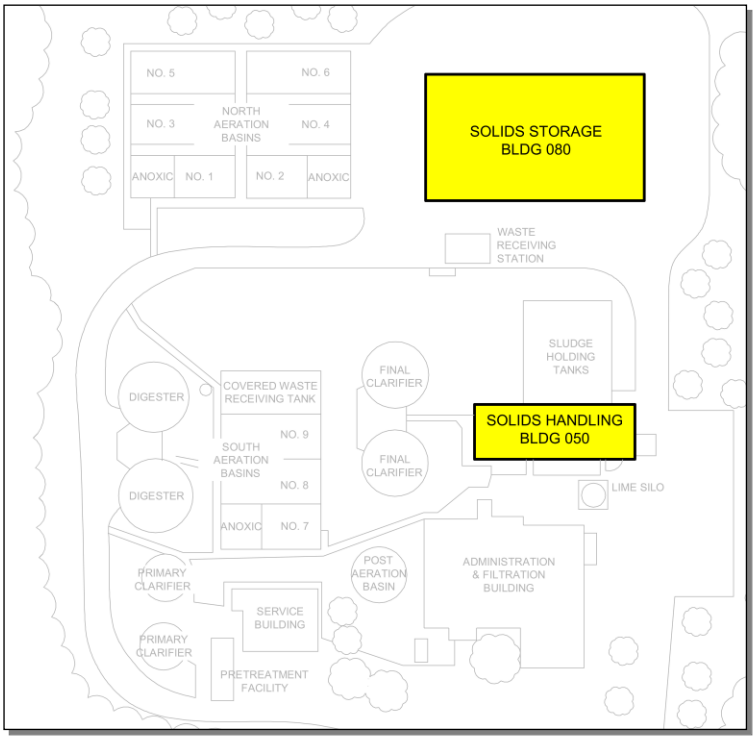


Figure 1 – On-site Solids Handling Building and Solids Storage Building Locations

Both building locations had advantages and disadvantages that are best described using the following table, Table 3. The following symbols are used indicating how the Building characteristic was categorized using a plus-minus system.

- -	-	o	+	+ +
Major Disadvantage		**Neutral**		**Major Advantage**

Table 3 – Building Location Comparison

Solids Handling Building		Solids Storage Building	
+	Belt filter press can be reused	+	Can use lime stabilization system until dryer is fully installed
+	No additional construction to convey sludge to dewatering	+	No need to truck dried product for storage
-	Some dryers have too large of footprint to fit in building (i.e. belt dryer)	o	All dryer sizes fit in building
-	Alteration to outside wall on upper floor to install dewatering	-	Added construction costs to refurbish building
- -	Longer downtime during installation	-	Loss of biosolids storage space
-	Loss of heated storage on grade level		

1.1 Summary

Key considerations in favor of Solids Storage Building include the ability to use the existing lime-heat stabilization during construction and as a back-up to the dryer system as well as the spatial flexibility to select dryer and dewatering types without space constraints.

Because of the complexity of having three decision groups, a final recommendation will be made regarding the building choice in the summary section of this memorandum in place of an intermediate recommendation in this section.

2.0 Biosolids Dewatering Equipment

In addition to the current belt filter press (BFP) dewatering technology the WWTP already uses, screwpress and centrifuge dewatering technologies were also evaluated. Per the design criteria, each dewatering unit must have a minimum solids loading capacity of 432 lb/hr. This loading capacity is based on a 24 hour/4 day operating schedule during average conditions. This section will describe each dewatering technology and conclude with a comparison table similar to that in Section 1.0.

2.1 Belt Filter Press Dewatering

For the City of Kiel, the BFP offers the most familiarity, as their current practices already include this technology. In addition to the familiarity, this type of dewatering requires the lowest amount of polymer. Donohue estimates that the BFP for the WWTP will require 12 lb polymer/dry ton of solids. However, keeping this dewatering technology will require upgrading to the next size in dryers due to the lower solids content achievable by a BFP. This will add additional capital costs to the dryer system compared to a screwpress or centrifuge dewatering unit. Even though there

Figure 2 – Alfa Laval BFP

could be a potential increase in capital costs for the dryer, there would be no additional cost to the owner if Kiel continued its current BFP practices in conjunction with the new dryer in Building 050. A major disadvantage with the BFP technologies is the lack of expansion or redundancy in dewatering. Donohue agrees with the 2017 Facilities Plan that space limitations would not permit having a second unit in the existing building.

2.2 Screwpress Dewatering

Figure 3 – Schwing Screwpress

The screwpress dewatering would allow the City to use a dryer model smaller than the model that would be used with BFP because of the increase in solids content after dewatering. The screwpress also has a design that allows for simpler unattended operation and a smaller footprint. The screwpress dewatering would easily fit in either the existing building on the upper floor where current dewatering practices occur or in the Solids Storage Building. Unlike the BFP, the screwpress would have to be newly installed and furnished to fit the existing structure or the Solids Storage Building. If the screwpress was used in the Solids Handling Building, the lime-stabilization unit would require shut down(s) to allow for construction of the new systems. The City would have to provide interim solids handling processes or on-site storage until the dryer is fully commissioned. Additionally, the screwpress unit requires about 30 lb/dry ton of solids in polymer to dewater solids. This adds additional operation costs that would not be incurred with the existing BFP.

2.3 Centrifuge Dewatering

Figure 4 – Andritz Centrifuge

The centrifuge dewatering unit will provide the highest solids content between the three technologies. However, a centrifuge will require more polymer during operation—about 45 lb/dry ton of solids and requires the highest electrical demand. This technology will therefore be the most costly to operate, but will be potentially offset by reduced operating costs in the drying process. Like the screwpress, this technology has a smaller footprint than the BFP, which enables considerations for redundancy without space limitations in either building if Kiel should want a backup unit for future dewatering. Unfortunately, centrifuge dewatering has never been pilot tested with Kiel WWTP, so the actual solids content achievement is unknown at this time. A pilot demonstration is scheduled for April 2017. Centrifuge operational data from similar WWTPs was used as the basis of dewatering capability for Kiel.

2.4 Summary

Table 4 provides a summary of the information regarding each dewatering technology and how it was viewed as an advantage or disadvantage.

Table 4 – Dewatering Technology Comparison

Belt Filter Press		Screw Press		Centrifuge	
+	Familiarity	+	Offers higher % solids than BFP	+ +	Offers highest % solids
+	Lowest polymer demand	+	Simple unattended operation	+	Smallest dryer size and runtime
o	No additional cost	o	Smaller footprint	o	Smallest footprint
-	Lowest % solids	o	Unknown actual % solids (pilot testing based)	o	Needs to be furnished and installed
-	Requires larger dryer size (increased cost)	-	Needs to be furnished and installed	o	Unknown actual % solids (theoretically based)
-	Large footprint limits redundancy opportunity	-	High polymer demand	- -	Highest polymer demand

3.0 Biosolids Drying Equipment

Four types of dryers were evaluated for Kiel WWTP. Each was assessed based on economic and non-economic factors. The main non-economic factors that were evaluated include preliminary layouts of the dryers in the two potential buildings and achievable dryness provided by the manufacturer. The following is the list of dryers and their prospective manufacturer that were evaluated:

1. Belt dryer with vacuum – *Gryphon Environmental* or equal
2. Paddle dryer – *Komline-Sanderson* or equal
3. Belt dryer – *Huber Technology* or equal
4. Fluidized bed dryer – *Schwing Bioset* or equal

3.1 Belt Dryer with Vacuum

Gryphon's belt dryers are designed in 10-foot expandable segments that uses a continuous belt drive. This dryer uses positive and negative pressures which allows the dryer to have the best thermal efficiency among the four. The Gryphon controls allows the operator to adjust the air volume, air temperature, and belt speed to maximize the drying performance. The unit also has the capability of recirculating air which removes the need for air permitting the exhaust air. The dryer is the newest technology with the company being founded in 2007 and only industrial installations to date.

Figure 5 – Gryphon Belt Dryer with Vacuum

3.2 Paddle Dryer

The paddle dryer utilizes an indirect heating system from steam or thermal fluid (hot oil). There are two shafts running down both sides of the bed as shown in Figure 6. These shafts rotate opposite directions from each other in order to break up the cake as it passes through and improve contact with the product. These technique of drying also helps mix the product as well as produce a self-cleaning effect. The hollow paddles and heated trough dry the material via conduction and insulation of the dryer limits the amount of heat loss in the dryer.

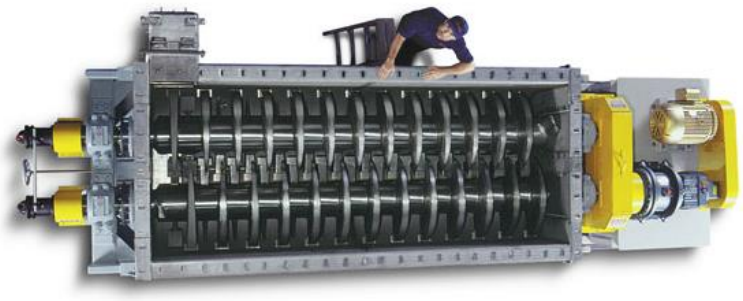


Figure 6 – Komline Paddle Dryer

3.3 Belt Dryer

The Kruger and Huber belt dryer have an extruder prior to the sludge reaching the belt. Sludge is pumped to the pelletizer where it is evenly distributed on the belt. The internal knife breaks up any hairs and fibers, and the sludge is extruded into “noodle” shaped segments to increase drying surface area. Hot air enters the drying chamber and is exhausted at the opposite end. The dried product is discharged below the feed point. Figure 7 shows the Huber dryer with the inlet/discharge end in the lower left side.

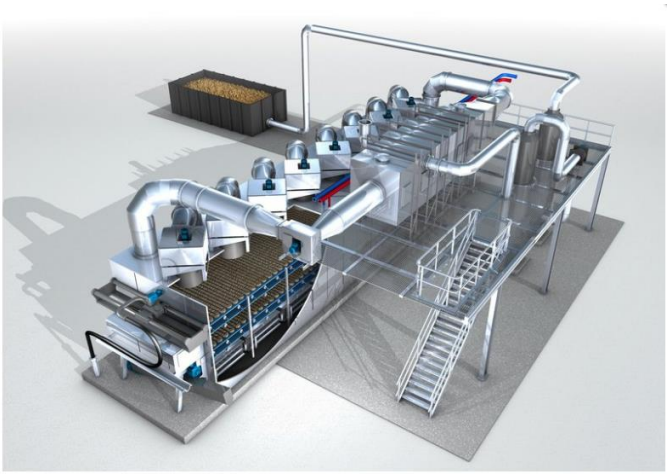


Figure 7 – Huber Belt Dryer

3.4 Fluid Bed Dryer

The fluid bed dryer uses a convective drying approach which eliminates the need for a re-circulating heated thermal fluid or steam similar to other dryer designs. This dryer technology is designed to use a closed-loop where exhaust gas from the dryer is re-circulated by a dust-recovery cyclone, gas cooler-condenser, gas fan, heater unit, and ductwork back to the fluid bed dryer-cooler unit. This closed-loop increases efficiencies by limiting the amount of air that is exhausted to the outside.

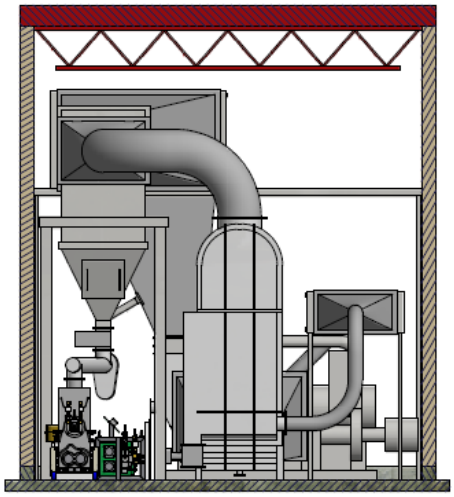


Figure 8 – Schwing Fluid Bed Dryer

Summary

In order to provide a comprehensive evaluation, multiple packages were developed for each option by selecting a building location, dewatering unit, and dryer. Possible package options that were evaluated are shown in Figure 9. In total, 24 options were examined.

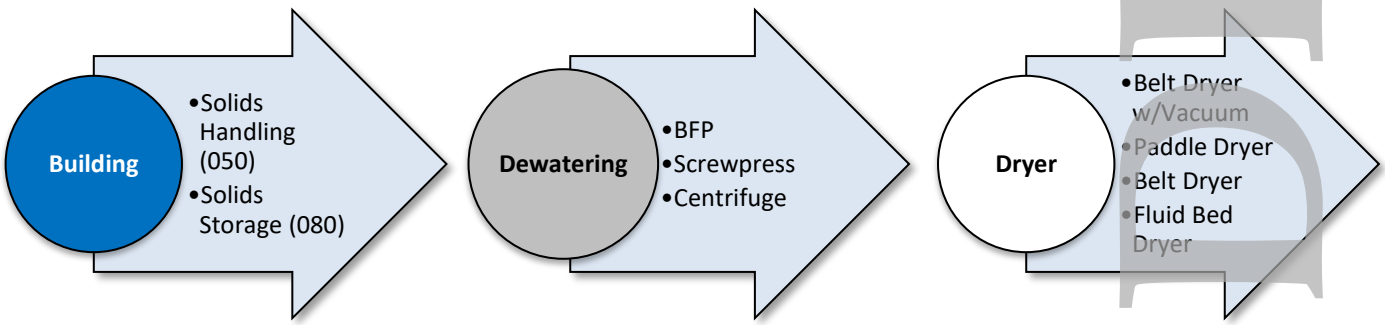


Figure 9 – Dryer Package Matrix

Cost was weighted the highest in the evaluation. The detailed cost opinion can be found in Attachment A, and the summary is outlined in Table 5. The capital costs included a 20% contingency to reflect the preliminary layout phase, a 25% contractor markup for overhead & profit, and an administration and engineering markup of 15% to account for the design, bidding, and construction of the selected dryer package. Donohue evaluated the potential options on a 20-year present worth basis which used a discount

rate of 4.125%. Overall, the Gryphon unit was least costly when compared to other dryers in similar buildings and with similar dewatering units.

Table 5 – Summary of Cost Opinion with 20-year PW

Alternative	Dryer Package	Initial Cost ($)	Annual Cost ($)	20-year PW ($)
1A	BLDG 050: BFP + Belt Dryer with Vacuum	3,700,000	182,000	**6,100,000**
2A	BLDG 050: BFP + Paddle Dryer	6,400,000	196,000	**9,000,000**
3A	BLDG 050: BFP + Belt Dryer	8,300,000	183,000	**10,800,000**
4A	BLDG 050: BFP + Fluid Bed Dryer	5,100,000	196,000	**7,700,000**
5A	BLDG 050: Screwpress + Belt Dryer with Vacuum	3,600,000	207,000	**6,400,000**
6A	BLDG 050: Screwpress + Paddle Dryer	6,000,000	217,000	**8,900,000**
7A	BLDG 050: Screwpress + Belt Dryer	8,200,000	207,000	**11,000,000**
8A	BLDG 050: Screwpress + Fluid Bed Dryer	5,000,000	218,000	**7,900,000**
9A	BLDG 050: Centrifuge + Belt Dryer with Vacuum	3,600,000	201,000	**6,300,000**
10A	BLDG 050: Centrifuge + Paddle Dryer	6,000,000	210,000	**8,800,000**
11A	BLDG 050: Centrifuge + Belt Dryer	8,300,000	201,000	**11,000,000**
12A	BLDG 050: Centrifuge + Fluid Bed Dryer	5,100,000	210,000	**7,900,000**
1B	BLDG 080: BFP + Belt Dryer with Vacuum	4,900,000	182,000	**7,300,000**
2B	BLDG 080: BFP + Paddle Dryer	7,500,000	196,000	**10,100,000**
3B	BLDG 080: BFP + Belt Dryer	9,400,000	183,000	**11,900,000**
4B	BLDG 080: BFP + Fluid Bed Dryer	6,300,000	196,000	**8,900,000**
5B	BLDG 080: Screwpress + Belt Dryer with Vacuum	4,100,000	207,000	**6,900,000**
6B	BLDG 080: Screwpress + Paddle Dryer	6,500,000	217,000	**9,400,000**
7B	BLDG 080: Screwpress + Belt Dryer	8,700,000	207,000	**11,500,000**
8B	BLDG 080: Screwpress + Fluid Bed Dryer	5,500,000	218,000	**8,400,000**
9B	BLDG 080: Centrifuge + Belt Dryer with Vacuum	4,200,000	201,000	**6,900,000**
10B	BLDG 080: Centrifuge + Paddle Dryer	6,600,000	210,000	**9,400,000**
11B	BLDG 080: Centrifuge + Belt Dryer	8,900,000	201,000	**11,600,000**
12B	BLDG 080: Centrifuge + Fluid Bed Dryer	5,600,000	210,000	**8,400,000**

Since space was limited in both buildings, preliminary layouts aided in the dryer selection process. Attachment B contains the layouts of the potential dewatering/drying combinations. Alternatives 1A and 3A did not have adequate space to fit in the building and were eliminated from any other further consideration. Donohue recognizes the benefit of the additional space that the Solids Storage Building provides. This will allow optimum space around equipment for operator maintenance. In the Solids Handling Building, construction sequence would require downtime of the lime-stabilization system to allow for the installation of the dewatering units on the upper floor. There would have to be alternative storage and handling of sludge during this time that would not be required if dewatering and drying moved to Building 080.

Recommendation

Donohue recommends that the City of Kiel select the following for its sludge drying system:

- Move biosolids dewatering and drying to the Solids Storage Building (080)
- Dewater biosolids with a screwpress dewatering unit with the option to add an additional unit for future redundancy
- Dry biosolids with *the Gryphon Environmental* Belt Dryer with Vacuum

Alternative 9A has the lowest 20-year present worth among the evaluated options. Alternative 5B provides capital and present worth costs within 10%, and exhibits significant non-economic benefits. The main non-economic factor in favor of alternative 5B was that Building 080 allowed for greater maintenance and operation space than the existing building. Additionally, by using Building 080 for drying and dewatering, the current lime stabilization system can continue to run as construction of the new building is being done. The owner will not have to find an alternative solution for biosolids handling since there will be no impact to the current BFP/pasteurization process during installation and startup.

Other Issues and Considerations

Donohue recognizes that Kiel currently stores Class A biosolids up to 90 days at a time and would like to increase storage time to 180 days. If dewatering and drying operate in the Solids Storage Building, 180 days of storage will be achievable without expanding the building or storing solids at an additional location. Figure 10 shows how biosolids would be stacked to achieve the 100 days of possible dried product storage in Building 080. To obtain 180 days of storage, additional space would need to be provided if dewatering and drying operations take place in Building 080. Considerations to achieve additional storage include:

- Expanding the current building
- Construction of a new building

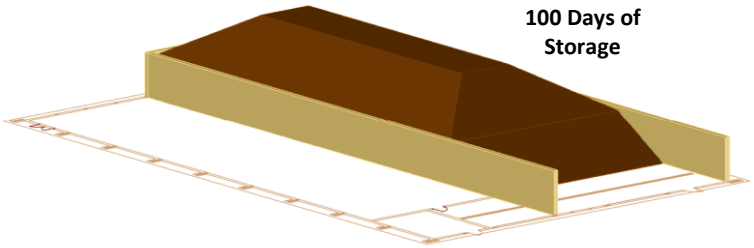


Figure 10 – Maximum Dried Product Storage in Building 080

Last, Kiel has the ability to keep their existing lime-stabilization system in place even after the new dryer system is running. The lime-stabilization could be used as a backup system during any extended maintenance of the dryer system. Furthermore, Kiel would defer demolition and removal costs related to any of the existing equipment in Building 050.

Attachment A

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Belt Dryer with Vacuum

INITIAL COST ESTIMATE

General Description
Continuous-operation belt-driven dryer that recirculates air in a closed-loop system. This dryer has an evaporation rate of at least 2,600 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			0
Metals	See Worksheet for Detailed Cost Breakdown			0
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Model 1040 or Equivalent	Each	1	1,060,000	1,060,000
Installation	Each	1	212,000	212,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	133,000	133,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	5,000	5,000
HVAC	Lump Sum	1	10,000	10,000
Subtotal				1,865,000
Contingency			20%	373,000
Subtotal				2,238,000
Contractor Overhead & Profit			25%	559,500
Total Construction Cost				**2,797,500**
Engineering			15%	419,625
Spare Parts				530,000
Total Initial Cost				**3,700,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Belt Dryer with Vacuum

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**0**
Metals: Aluminum Grating	sq ft		100	0
Metals: Aluminum Handrail	ft		100	0
Metals: Aluminum Stairway	risers		100	0
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**0**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Belt Dryer with Vacuum

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	BFP	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	133	3	22
Total Bhp	133		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	161	3	22
Wire Kilowatts	114	2	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	0		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	664,547	0.080	53,164
Maintenance	hours	0	35	0
Natural Gas	therms	126,996	0.65	82,548
Polymer	lb	40,613	1.15	46,705
Total Annual Cost				**182,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,450,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Paddle Dryer

INITIAL COST ESTIMATE

General Description
Paddle Dryer that uses counter-rotating agitators with heated paddles. Thermal fluid enters and exits paddles. Evaporation rate of 2800 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			12,000
Metals	See Worksheet for Detailed Cost Breakdown			0
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
BT18 or SD6315 Belt Dryer	Each	1	2,400,000	2,400,000
Installation	Each	1	720,000	720,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	105,000	105,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	5,000	5,000
HVAC	Lump Sum	1	10,000	10,000
Subtotal				3,697,000
Contingency			20%	739,400
Subtotal				4,436,400
Contractor Overhead & Profit			25%	1,109,100
Total Construction Cost				**5,545,500**
Engineering			15%	831,825
Total Initial Cost				**6,400,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Paddle Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds	9	1,350	12,000
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**12,000**
Metals: Aluminum Grating	sq ft		100	0
Metals: Aluminum Handrail	ft		100	0
Metals: Aluminum Stairway	risers		100	0
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**0**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Paddle Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	BFP	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	105	3	22
Total Bhp	105		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	127	3	22
Wire Kilowatts	91	2	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	546,824	0.080	43,746
Maintenance	hours	24	35	840
Natural Gas	therms	160,695	0.65	104,452
Polymer	lb	40,613	1.15	46,705
Total Annual Cost				**196,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,630,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Belt Dryer

INITIAL COST ESTIMATE

General Description
Belt Dryer utilizes a pelletizing system that moves perpendicular to the belt. The Pelletizer pumps sludge onto belt system, and the dried sludge discharges at the same end as the inlet. The belt dryer has an evaporation rate of 2,600 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			0
Metals	See Worksheet for Detailed Cost Breakdown			0
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
BT14 or Equivalent	Each	1	3,250,000	3,250,000
Installation	Each	1	975,000	975,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	128,000	128,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	5,000	5,000
HVAC	Lump Sum	1	10,000	10,000
Subtotal				4,813,000
Contingency			20%	962,600
Subtotal				5,775,600
Contractor Overhead & Profit			25%	1,443,900
Total Construction Cost				**7,219,500**
Engineering			15%	1,082,925
Total Initial Cost				**8,300,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Belt Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**0**
Metals: Aluminum Grating	sq ft		100	0
Metals: Aluminum Handrail	ft		100	0
Metals: Aluminum Stairway	risers		100	0
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**0**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Belt Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	BFP	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	128	3	22
Total Bhp	128		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	155	3	22
Wire Kilowatts	110	2	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	640,716	0.080	51,257
Maintenance	hours	24	35	840
Natural Gas	therms	129,898	0.65	84,434
Polymer	lb	40,613	1.15	46,705
Total Annual Cost				**183,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,460,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Fluid Bed Dryer

INITIAL COST ESTIMATE

General Description
This Dryer utilizes a Fluid Bed Drying-Cooling technology. The design includes a convective approach where heating/cooling energy is transferred directly to the wet cake material. The fluidized gas is recycled in a closed-loop system. The evaporation rate of the dryer is 2,600 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			0
Metals	See Worksheet for Detailed Cost Breakdown			0
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
2,600 lb/hr Fluid Bed Dryer or Equivalent	Each	1	1,870,000	1,870,000
Installation	Each	1	561,000	561,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	94,000	94,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	5,000	5,000
HVAC	Lump Sum	1	10,000	10,000
Subtotal				2,985,000
Contingency			20%	597,000
Subtotal				3,582,000
Contractor Overhead & Profit			25%	895,500
Total Construction Cost				**4,477,500**
Engineering			15%	671,625
Total Initial Cost				**5,100,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Fluid Bed Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**0**
Metals: Aluminum Grating	sq ft		100	0
Metals: Aluminum Handrail	ft		100	0
Metals: Aluminum Stairway	risers		100	0
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**0**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: BFP + Fluid Bed Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	BFP	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	94	3	22
Total Bhp	94		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	114	3	22
Wire Kilowatts	81	2	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	499,206	0.080	39,936
Maintenance	hours	24	35	840
Natural Gas	therms	167,608	0.65	108,945
Polymer	lb	40,613	1.15	46,705
Total Annual Cost				**196,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,630,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Belt Dryer with Vacuum

INITIAL COST ESTIMATE

General Description
Continuous-operation belt-driven dryer that recirculates air in a closed-loop system. This dryer has an evaporation rate of at least 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			0
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Model 1030 or Equivalent	Each	1	813,000	813,000
Installation	Each	1	162,600	162,600
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Screwpress Dewatering 700 lb/hr rated	Each	1	275,000	275,000
Installation	Each	1	55,000	55,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	70,000	70,000
Electrical	Lump Sum	1	5,000	5,000
Instrumentation and Control	Lump Sum	1	10,000	10,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				1,847,050
Contingency			20%	369,410
Subtotal				2,216,460
Contractor Overhead & Profit			25%	554,115
Total Construction Cost				**2,770,575**
Engineering			15%	415,586
Spare Parts				406,500
Total Initial Cost				**3,600,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Belt Dryer with Vacuum

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**0**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Belt Dryer with Vacuum

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Screwpress	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	106	4	22
Total Bhp	106		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	128	4	22
Wire Kilowatts	94	3	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	564,012	0.080	45,121
Maintenance	hours	24	35	840
Natural Gas	therms	103,828	0.65	67,488
Polymer	lb	81,226	1.15	93,410
Total Annual Cost				**207,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,780,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Paddle Dryer

INITIAL COST ESTIMATE

General Description
Paddle Dryer that uses counter-rotating agitators with heated paddles. Thermal fluid enters and exits paddles. Evaporation rate of 2000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			12,000
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Komline 8W-600 or Equivalent	Each	1	2,000,000	2,000,000
Installation	Each	1	600,000	600,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Screwpress Dewatering 700 lb/hr rated	Each	1	275,000	275,000
Installation	Each	1	55,000	55,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	70,000	70,000
Electrical	Lump Sum	1	5,000	5,000
Instrumentation and Control	Lump Sum	1	10,000	10,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				3,483,450
Contingency			20%	696,690
Subtotal				4,180,140
Contractor Overhead & Profit			25%	1,045,035
Total Construction Cost				**5,225,175**
Engineering			15%	783,776
Total Initial Cost				**6,000,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Paddle Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds	9	1,350	12,000
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**12,000**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Paddle Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Screwpress	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	84	4	22
Total Bhp	84		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	101	4	22
Wire Kilowatts	74	3	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	467,766	0.080	37,421
Maintenance	hours	24	35	840
Natural Gas	therms	131,379	0.65	85,396
Polymer	lb	81,226	1.15	93,410
Total Annual Cost				**217,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,920,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Belt Dryer

INITIAL COST ESTIMATE

General Description
Belt Dryer utilizes a pelletizing system that moves perpendicular to the belt. The Pelletizer pumps sludge onto belt system, and the dried sludge discharges at the same end as the inlet. The belt dryer has an evaporation rate of 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			0
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
BT10 or Equivalent	Each	1	3,000,000	3,000,000
Installation	Each	1	900,000	900,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Screwpress Dewatering 700 lb/hr rated	Each	1	275,000	275,000
Installation	Each	1	55,000	55,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	70,000	70,000
Electrical	Lump Sum	1	5,000	5,000
Instrumentation and Control	Lump Sum	1	10,000	10,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				4,771,450
Contingency			20%	954,290
Subtotal				5,725,740
Contractor Overhead & Profit			25%	1,431,435
Total Construction Cost				**7,157,175**
Engineering			15%	1,073,576
Total Initial Cost				**8,200,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Belt Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**0**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Belt Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Screwpress	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	102	4	22
Total Bhp	102		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	123	4	22
Wire Kilowatts	90	3	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	544,529	0.080	43,562
Maintenance	hours	24	35	840
Natural Gas	therms	106,200	0.65	69,030
Polymer	lb	81,226	1.15	93,410
Total Annual Cost				**207,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,780,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Fluid Bed Dryer

INITIAL COST ESTIMATE

General Description
This Dryer utilizes a Fluid Bed Drying-Cooling technology. The design includes a convective approach where heating/cooling energy is transferred directly to the wet cake material. The fluidized gas is recycled in a closed-loop system. The evaporation rate of the dryer is 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			0
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
2,000 lb/hr Fluid Bed Dryer or Equivalent	Each	1	1,580,000	1,580,000
Installation	Each	1	474,000	474,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Screwpress Dewatering 700 lb/hr rated	Each	1	275,000	275,000
Installation	Each	1	55,000	55,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	70,000	70,000
Electrical	Lump Sum	1	5,000	5,000
Instrumentation and Control	Lump Sum	1	10,000	10,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				2,925,450
Contingency			20%	585,090
Subtotal				3,510,540
Contractor Overhead & Profit			25%	877,635
Total Construction Cost				**4,388,175**
Engineering			15%	658,226
Total Initial Cost				**5,000,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Fluid Bed Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**0**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Screwpress + Fluid Bed Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Screwpress	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	75	4	22
Total Bhp	75		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	91	4	22
Wire Kilowatts	67	3	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	428,835	0.080	34,307
Maintenance	hours	24	35	840
Natural Gas	therms	137,031	0.65	89,070
Polymer	lb	81,226	1.15	93,410
Total Annual Cost				**218,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,930,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Belt Dryer with Vacuum

INITIAL COST ESTIMATE

General Description
Continuous-operation belt-driven dryer that recirculates air in a closed-loop system. This dryer has an evaporation rate of at least 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			0
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Model 1030 or Equivalent	Each	1	813,000	813,000
Installation	Each	1	162,600	162,600
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Centrifuge Dewatering 700 lb/hr rated	Each	1	290,000	290,000
Installation	Each	1	58,000	58,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	70,000	70,000
Electrical	Lump Sum	1	5,000	5,000
Instrumentation and Control	Lump Sum	1	10,000	10,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				1,865,050
Contingency			20%	373,010
Subtotal				2,238,060
Contractor Overhead & Profit			25%	559,515
Total Construction Cost				**2,797,575**
Engineering			15%	419,636
Spare Parts				406,500
Total Initial Cost				**3,600,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Belt Dryer with Vacuum

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**0**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Belt Dryer with Vacuum

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Centrifuge	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	90	21	22
Total Bhp	90		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	109	21	22
Wire Kilowatts	76	15.6	16.4
Operating Hours Per Day	24	24	1
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	208
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	460,634	0.080	36,851
Maintenance	hours	24	35	840
Natural Gas	therms	84,299	0.65	54,795
Polymer	lb	94,764	1.15	108,979
Total Annual Cost				**201,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,700,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Paddle Dryer

INITIAL COST ESTIMATE

General Description
Paddle Dryer that uses counter-rotating agitators with heated paddles. Thermal fluid enters and exits paddles. Evaporation rate of 2000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			12,000
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Komline 8W-600 or Equivalent	Each	1	2,000,000	2,000,000
Installation	Each	1	600,000	600,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Centrifuge Dewatering 700 lb/hr rated	Each	1	290,000	290,000
Installation	Each	1	58,000	58,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	70,000	70,000
Electrical	Lump Sum	1	5,000	5,000
Instrumentation and Control	Lump Sum	1	10,000	10,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				3,501,450
Contingency			20%	700,290
Subtotal				4,201,740
Contractor Overhead & Profit			25%	1,050,435
Total Construction Cost				**5,252,175**
Engineering			15%	787,826
Total Initial Cost				**6,000,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Paddle Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds	9	1,350	12,000
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**12,000**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Paddle Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Centrifuge	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	74	21	22
Total Bhp	74		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	89	21	22
Wire Kilowatts	60	15.6	16.4
Operating Hours Per Day	24	24	1
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	208
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	382,491	0.080	30,599
Maintenance	hours	24	35	840
Natural Gas	therms	106,668	0.65	69,334
Polymer	lb	94,764	1.15	108,979
Total Annual Cost				**210,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,820,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Belt Dryer

INITIAL COST ESTIMATE

General Description
Belt Dryer utilizes a pelletizing system that moves perpendicular to the belt. The Pelletizer pumps sludge onto belt system, and the dried sludge discharges at the same end as the inlet. The belt dryer has an evaporation rate of 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			0
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
BT10 or Equivalent	Each	1	3,000,000	3,000,000
Installation	Each	1	900,000	900,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Centrifuge Dewatering 700 lb/hr rated	Each	1	290,000	290,000
Installation	Each	1	58,000	58,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	70,000	70,000
Electrical	Lump Sum	1	5,000	5,000
Instrumentation and Control	Lump Sum	1	10,000	10,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				4,789,450
Contingency			20%	957,890
Subtotal				5,747,340
Contractor Overhead & Profit			25%	1,436,835
Total Construction Cost				**7,184,175**
Engineering			15%	1,077,626
Total Initial Cost				**8,300,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Belt Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**0**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Belt Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Centrifuge	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	87	21	22
Total Bhp	87		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	105	21	22
Wire Kilowatts	73	15.6	16.4
Operating Hours Per Day	24	24	1
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	208
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	444,816	0.080	35,585
Maintenance	hours	24	35	840
Natural Gas	therms	86,225	0.65	56,047
Polymer	lb	94,764	1.15	108,979
Total Annual Cost				**201,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,700,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Fluid Bed Dryer

INITIAL COST ESTIMATE

General Description
This Dryer utilizes a Fluid Bed Drying-Cooling technology. The design includes a convective approach where heating/cooling energy is transferred directly to the wet cake material. The fluidized gas is recycled in a closed-loop system. The evaporation rate of the dryer is 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			0
Concrete	See Worksheet for Detailed Cost Breakdown			0
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			0
Demoltion	See Worksheet for Detailed Cost Breakdown			0
2,000 lb/hr Fluid Bed Dryer or Equivalent	Each	1	1,580,000	1,580,000
Installation	Each	1	474,000	474,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Centrifuge Dewatering 700 lb/hr rated	Each	1	290,000	290,000
Installation	Each	1	58,000	58,000
Civil	Lump Sum	1	0	
Process-Mechanical Piping	Lump Sum	1	70,000	70,000
Electrical	Lump Sum	1	5,000	5,000
Instrumentation and Control	Lump Sum	1	10,000	10,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				2,943,450
Contingency			20%	588,690
Subtotal				3,532,140
Contractor Overhead & Profit			25%	883,035
Total Construction Cost				**4,415,175**
Engineering			15%	662,276
Total Initial Cost				**5,100,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Fluid Bed Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Excavation	cu yds		100	0
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**0**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	ft		100	0
Concrete				**0**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**0**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 050: Centrifuge + Fluid Bed Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Centrifuge	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	64	21	22
Total Bhp	64		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	77	21	22
Wire Kilowatts	54	15.6	16.4
Operating Hours Per Day	24	24	1
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	208
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	350,882	0.080	28,071
Maintenance	hours	24	35	840
Natural Gas	therms	111,257	0.65	72,317
Polymer	lb	94,764	1.15	108,979
Total Annual Cost				**210,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,820,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Belt Dryer with Vacuum

INITIAL COST ESTIMATE

General Description
Continuous-operation belt-driven dryer that recirculates air in a closed-loop system. This dryer has an evaporation rate of at least 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Model 1040 or Equivalent	Each	1	1,060,000	1,060,000
Installation	Each	1	212,000	212,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
BFP Dewatering 700 lb/hr rated	Each	1	325,000	325,000
Installation	Each	1	65,000	65,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	153,000	153,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				2,549,480
Contingency			20%	509,896
Subtotal				3,059,376
Contractor Overhead & Profit			25%	764,844
Total Construction Cost				**3,824,220**
Engineering			15%	573,633
Spare Parts				530,000
Total Initial Cost				**4,900,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Belt Dryer with Vacuum

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Belt Dryer with Vacuum

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	BFP	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	133	3	22
Total Bhp	133		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	161	3	22
Wire Kilowatts	114	2	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	0		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	664,547	0.080	53,164
Maintenance	hours	0	35	0
Natural Gas	therms	126,996	0.65	82,548
Polymer	lb	40,613	1.15	46,705
Total Annual Cost				**182,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,450,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Paddle Dryer

INITIAL COST ESTIMATE

General Description
Paddle Dryer that uses counter-rotating agitators with heated paddles. Thermal fluid enters and exits paddles. Evaporation rate of 2000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
BT18 or SD6315 Belt Dryer	Each	1	2,400,000	2,400,000
Installation	Each	1	720,000	720,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
BFP Dewatering 700 lb/hr rated	Each	1	325,000	325,000
Installation	Each	1	65,000	65,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	125,000	125,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				4,369,480
Contingency			20%	873,896
Subtotal				5,243,376
Contractor Overhead & Profit			25%	1,310,844
Total Construction Cost				**6,554,220**
Engineering			15%	983,133
Total Initial Cost				**7,500,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Paddle Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Paddle Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	BFP	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	105	3	22
Total Bhp	105		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	127	3	22
Wire Kilowatts	91	2	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	546,824	0.080	43,746
Maintenance	hours	24	35	840
Natural Gas	therms	160,695	0.65	104,452
Polymer	lb	40,613	1.15	46,705
Total Annual Cost				**196,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,630,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Belt Dryer

INITIAL COST ESTIMATE

General Description
Belt Dryer utilizes a pelletizing system that moves perpendicular to the belt. The Pelletizer pumps sludge onto belt system, and the dried sludge discharges at the same end as the inlet. The belt dryer has an evaporation rate of 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
BT14 or Equivalent	Each	1	3,250,000	3,250,000
Installation	Each	1	975,000	975,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
BFP Dewatering 700 lb/hr rated	Each	1	325,000	325,000
Installation	Each	1	65,000	65,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	148,000	148,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				5,497,480
Contingency			20%	1,099,496
Subtotal				6,596,976
Contractor Overhead & Profit			25%	1,649,244
Total Construction Cost				**8,246,220**
Engineering			15%	1,236,933
Total Initial Cost				**9,500,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Belt Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Belt Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	BFP	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	128	3	22
Total Bhp	128		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	155	3	22
Wire Kilowatts	110	2	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	640,716	0.080	51,257
Maintenance	hours	24	35	840
Natural Gas	therms	129,898	0.65	84,434
Polymer	lb	40,613	1.15	46,705
Total Annual Cost				**183,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,460,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Fluid Bed Dryer

INITIAL COST ESTIMATE

General Description
This Dryer utilizes a Fluid Bed Drying-Cooling technology. The design includes a convective approach where heating/cooling energy is transferred directly to the wet cake material. The fluidized gas is recycled in a closed-loop system. The evaporation rate of the dryer is 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
2,600 lb/hr Fluid Bed Dryer or Equivalent	Each	1	1,870,000	1,870,000
Installation	Each	1	561,000	561,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
BFP Dewatering 700 lb/hr rated	Each	1	325,000	325,000
Installation	Each	1	65,000	65,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	114,000	114,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				3,669,480
Contingency			20%	733,896
Subtotal				4,403,376
Contractor Overhead & Profit			25%	1,100,844
Total Construction Cost				**5,504,220**
Engineering			15%	825,633
Total Initial Cost				**6,300,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Fluid Bed Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: BFP + Fluid Bed Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	BFP	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	94	3	22
Total Bhp	94		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	114	3	22
Wire Kilowatts	81	2	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	499,206	0.080	39,936
Maintenance	hours	24	35	840
Natural Gas	therms	167,608	0.65	108,945
Polymer	lb	40,613	1.15	46,705
Total Annual Cost				**196,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,630,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Belt Dryer with Vacuum

INITIAL COST ESTIMATE

General Description
Continuous-operation belt-driven dryer that recirculates air in a closed-loop system. This dryer has an evaporation rate of at least 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Model 1030 or Equivalent	Each	1	813,000	813,000
Installation	Each	1	162,600	162,600
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Screwpress Dewatering 700 lb/hr rated	Each	1	275,000	275,000
Installation	Each	1	55,000	55,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	126,000	126,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				2,166,080
Contingency			20%	433,216
Subtotal				2,599,296
Contractor Overhead & Profit			25%	649,824
Total Construction Cost				**3,249,120**
Engineering			15%	487,368
Spare Parts				406,500
Total Initial Cost				**4,100,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Belt Dryer with Vacuum

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Belt Dryer with Vacuum

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Screwpress	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	106	4	22
Total Bhp	106		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	128	4	22
Wire Kilowatts	94	3	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	564,012	0.080	45,121
Maintenance	hours	24	35	840
Natural Gas	therms	103,828	0.65	67,488
Polymer	lb	81,226	1.15	93,410
Total Annual Cost				**207,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,780,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Paddle Dryer

INITIAL COST ESTIMATE

General Description
Paddle Dryer that uses counter-rotating agitators with heated paddles. Thermal fluid enters and exits paddles. Evaporation rate of 2000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Komline 8W-600 or Equivalent	Each	1	2,000,000	2,000,000
Installation	Each	1	600,000	600,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Screwpress Dewatering 700 lb/hr rated	Each	1	275,000	275,000
Installation	Each	1	55,000	55,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	104,000	104,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				3,768,480
Contingency			20%	753,696
Subtotal				4,522,176
Contractor Overhead & Profit			25%	1,130,544
Total Construction Cost				**5,652,720**
Engineering			15%	847,908
Total Initial Cost				**6,500,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Paddle Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Paddle Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Screwpress	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	84	4	22
Total Bhp	84		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	101	4	22
Wire Kilowatts	74	3	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	467,766	0.080	37,421
Maintenance	hours	24	35	840
Natural Gas	therms	131,379	0.65	85,396
Polymer	lb	81,226	1.15	93,410
Total Annual Cost				**217,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,920,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Belt Dryer

INITIAL COST ESTIMATE

General Description
Belt Dryer utilizes a pelletizing system that moves perpendicular to the belt. The Pelletizer pumps sludge onto belt system, and the dried sludge discharges at the same end as the inlet. The belt dryer has an evaporation rate of 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
BT10 or Equivalent	Each	1	3,000,000	3,000,000
Installation	Each	1	900,000	900,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Screwpress Dewatering 700 lb/hr rated	Each	1	275,000	275,000
Installation	Each	1	55,000	55,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	122,000	122,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				5,086,480
Contingency			20%	1,017,296
Subtotal				6,103,776
Contractor Overhead & Profit			25%	1,525,944
Total Construction Cost				**7,629,720**
Engineering			15%	1,144,458
Total Initial Cost				**8,800,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Belt Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Belt Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Screwpress	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	102	4	22
Total Bhp	102		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	123	4	22
Wire Kilowatts	90	3	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	544,529	0.080	43,562
Maintenance	hours	24	35	840
Natural Gas	therms	106,200	0.65	69,030
Polymer	lb	81,226	1.15	93,410
Total Annual Cost				**207,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,780,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Fluid Bed Dryer

INITIAL COST ESTIMATE

General Description

This Dryer utilizes a Fluid Bed Drying-Cooling technology. The design includes a convective approach where heating/cooling energy is transferred directly to the wet cake material. The fluidized gas is recycled in a closed-loop system. The evaporation rate of the dryer is 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
2,000 lb/hr Fluid Bed Dryer or Equivalent	Each	1	1,580,000	1,580,000
Installation	Each	1	474,000	474,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Screwpress Dewatering 700 lb/hr rated	Each	1	275,000	275,000
Installation	Each	1	55,000	55,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	95,000	95,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	15,000	15,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				3,213,480
Contingency			20%	642,696
Subtotal				3,856,176
Contractor Overhead & Profit			25%	964,044
Total Construction Cost				**4,820,220**
Engineering			15%	723,033
Total Initial Cost				**5,500,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Fluid Bed Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Screwpress + Fluid Bed Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Screwpress	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	75	4	22
Total Bhp	75		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	91	4	22
Wire Kilowatts	67	3	16
Operating Hours Per Day	24	24	24
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	4,992
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	428,835	0.080	34,307
Maintenance	hours	24	35	840
Natural Gas	therms	137,031	0.65	89,070
Polymer	lb	81,226	1.15	93,410
Total Annual Cost				**218,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,930,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Belt Dryer with Vacuum

INITIAL COST ESTIMATE

General Description
Continuous-operation belt-driven dryer that recirculates air in a closed-loop system. This dryer has an evaporation rate of at least 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Model 1030 or Equivalent	Each	1	813,000	813,000
Installation	Each	1	162,600	162,600
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Centrifuge Dewatering 700 lb/hr rated	Each	1	290,000	290,000
Installation	Each	1	58,000	58,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	90,000	90,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	110,000	110,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				2,243,080
Contingency			20%	448,616
Subtotal				2,691,696
Contractor Overhead & Profit			25%	672,924
Total Construction Cost				**3,364,620**
Engineering			15%	504,693
Spare Parts				406,500
Total Initial Cost				**4,300,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Belt Dryer with Vacuum

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Belt Dryer with Vacuum

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Centrifuge	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	90	21	22
Total Bhp	90		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	109	21	22
Wire Kilowatts	76	15.6	16.4
Operating Hours Per Day	24	24	1
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	208
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	460,634	0.080	36,851
Maintenance	hours	24	35	840
Natural Gas	therms	84,299	0.65	54,795
Polymer	lb	94,764	1.15	108,979
Total Annual Cost				**201,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,700,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Paddle Dryer

INITIAL COST ESTIMATE

General Description
Paddle Dryer that uses counter-rotating agitators with heated paddles. Thermal fluid enters and exits paddles. Evaporation rate of 2000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Komline 8W-600 or Equivalent	Each	1	2,000,000	2,000,000
Installation	Each	1	600,000	600,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Centrifuge Dewatering 700 lb/hr rated	Each	1	290,000	290,000
Installation	Each	1	58,000	58,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	71,000	71,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	91,000	91,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				3,829,480
Contingency			20%	765,896
Subtotal				4,595,376
Contractor Overhead & Profit			25%	1,148,844
Total Construction Cost				**5,744,220**
Engineering			15%	861,633
Total Initial Cost				**6,600,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Paddle Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Paddle Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Centrifuge	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	71	21	22
Total Bhp	71		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	86	21	22
Wire Kilowatts	60	15.6	16.4
Operating Hours Per Day	24	24	1
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	208
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	382,491	0.080	30,599
Maintenance	hours	24	35	840
Natural Gas	therms	106,668	0.65	69,334
Polymer	lb	94,764	1.15	108,979
Total Annual Cost				**210,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,820,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Belt Dryer

INITIAL COST ESTIMATE

General Description
Belt Dryer utilizes a pelletizing system that moves perpendicular to the belt. The Pelletizer pumps sludge onto belt system, and the dried sludge discharges at the same end as the inlet. The belt dryer has an evaporation rate of 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
BT10 or Equivalent	Each	1	3,000,000	3,000,000
Installation	Each	1	900,000	900,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Centrifuge Dewatering 700 lb/hr rated	Each	1	290,000	290,000
Installation	Each	1	58,000	58,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	87,000	87,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	107,000	107,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				5,161,480
Contingency			20%	1,032,296
Subtotal				6,193,776
Contractor Overhead & Profit			25%	1,548,444
Total Construction Cost				**7,742,220**
Engineering			15%	1,161,333
Total Initial Cost				**8,900,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Belt Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Belt Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Centrifuge	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	87	21	22
Total Bhp	87		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	105	21	22
Wire Kilowatts	73	15.6	16.4
Operating Hours Per Day	24	24	1
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	208
Maintenance Hours Per Year	24		

ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	444,816	0.080	35,585
Maintenance	hours	24	35	840
Natural Gas	therms	86,225	0.65	56,047
Polymer	lb	94,764	1.15	108,979
Total Annual Cost				**201,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,700,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Fluid Bed Dryer

INITIAL COST ESTIMATE

General Description
This Dryer utilizes a Fluid Bed Drying-Cooling technology. The design includes a convective approach where heating/cooling energy is transferred directly to the wet cake material. The fluidized gas is recycled in a closed-loop system. The evaporation rate of the dryer is 2,000 lb per hour.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Architectural/Structural				
Earthwork	See Worksheet for Detailed Cost Breakdown			9,330
Concrete	See Worksheet for Detailed Cost Breakdown			49,700
Metals	See Worksheet for Detailed Cost Breakdown			6,450
Buildings	See Worksheet for Detailed Cost Breakdown			64,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
2,000 lb/hr Fluid Bed Dryer or Equivalent	Each	1	1,580,000	1,580,000
Installation	Each	1	474,000	474,000
Dried Product Conveyors and Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by others)	Each	0	0	
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural and Lifting Modifications	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Centrifuge Dewatering 700 lb/hr rated	Each	1	290,000	290,000
Installation	Each	1	58,000	58,000
Cake Solids Conveyor	Each	1	20,000	20,000
Civil	Lump Sum	1	25,000	25,000
Process-Mechanical Piping	Lump Sum	1	50,000	50,000
Electrical	Lump Sum	1	64,000	64,000
Instrumentation and Control	Lump Sum	1	60,000	60,000
Plumbing	Lump Sum	1	84,000	84,000
HVAC	Lump Sum	1	100,000	100,000
Subtotal				3,269,480
Contingency			20%	653,896
Subtotal				3,923,376
Contractor Overhead & Profit			25%	980,844
Total Construction Cost				**4,904,220**
Engineering			15%	735,633
Total Initial Cost				**5,600,000**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Fluid Bed Dryer

ARCHITECTURAL/STRUCTURAL WORKSHEET

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Earthwork: Dewatering	lump sum		100	0
Earthwork: Trench Excavation & Backfill	cu yds	311	30	9,330
Earthwork: Underdrain System	sq yds		100	0
Earthwork: Pile Foundation	ft		100	0
Earthwork: Flood Protection Levee	cu yds		100	0
Earthwork: Flood Protection Gravel Road	sq yds		100	0
Earthwork:			100	0
Earthwork				**9,330**
Concrete: Footings	cu yds		100	0
Concrete: Base Slab	cu yds		100	0
Concrete: Walls	cu yds		100	0
Concrete: Floor Slabs	cu yds		100	0
Concrete: Structural Slabs	cu yds		100	0
Concrete: Columns	cu yds		100	0
Concrete: Channels	cu yds		100	0
Concrete: Precast Roof	sq ft	4,970	10	49,700
Concrete				**49,700**
Metals: Aluminum Platform	sq ft	60	30	1,800
Metals: Aluminum Handrail	ft	30	50	1,500
Metals: Aluminum Stairway	risers	7	450	3,150
Metals: Baffles and Weirs	sq ft		100	0
Metals:			100	0
Metals				**6,450**
Building: 12" Masonry Wall with Insulation	sq ft	3,200	20	64,000
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Building:	sq ft		100	0
Buildings				**64,000**
Demolition:	cu ft		100	0
Demolition:	cu ft		100	0
Demolition:	lump sum		100	0
Demolition:	lump sum		100	0
Demoltion				**0**

CITY OF KIEL
KIEL WWTP - BIOSOLIDS DRYER SYSTEM
KIEL, WI

BLDG 080: Centrifuge + Fluid Bed Dryer

ANNUAL O&M COST ESTIMATE

General Description

	Belt Dryer	Centrifuge	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	64	21	22
Total Bhp	64		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	77	21	22
Wire Kilowatts	54	15.6	16.4
Operating Hours Per Day	24	24	1
Operating Days Per Week	4	4	4
Operating Weeks Per Year	52	52	52
Operating Hours Per Year	4,992	4,992	208
Maintenance Hours Per Year	24		

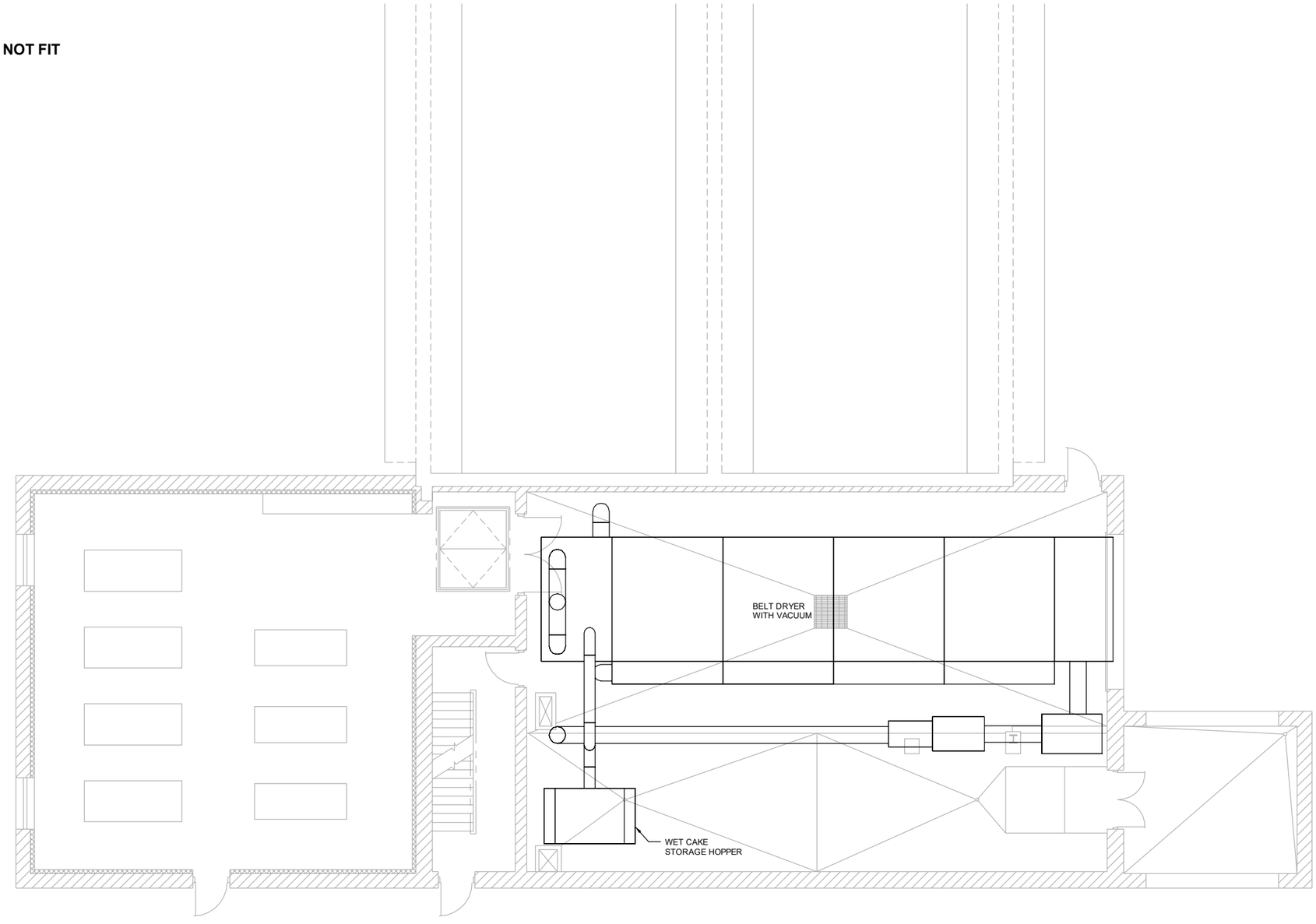
ITEM	Units	Annual Quantity	Unit Cost ($)	Annual Cost ($)
Electricity	Kw-hrs	350,882	0.080	28,071
Maintenance	hours	24	35	840
Natural Gas	therms	111,257	0.65	72,317
Polymer	lb	94,764	1.15	108,979
Total Annual Cost				**210,000**

Present Worth Analysis

Interest Rate Per Year	4.13%
Number of Years	20
Present Worth Factor	13.441
Present Worth of Total Annual Cost	**2,820,000**

Attachment B

DRYER DOES NOT FIT



GRADE PLAN

0 3' 16'

Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	SAM
Drawn By	SAM
Checked By	EJL
Approved By	EJL
Filename	050MP1_10X40.DWG
Project No.	12193.11
Project Date	FEB 2017

PRELIMINARY

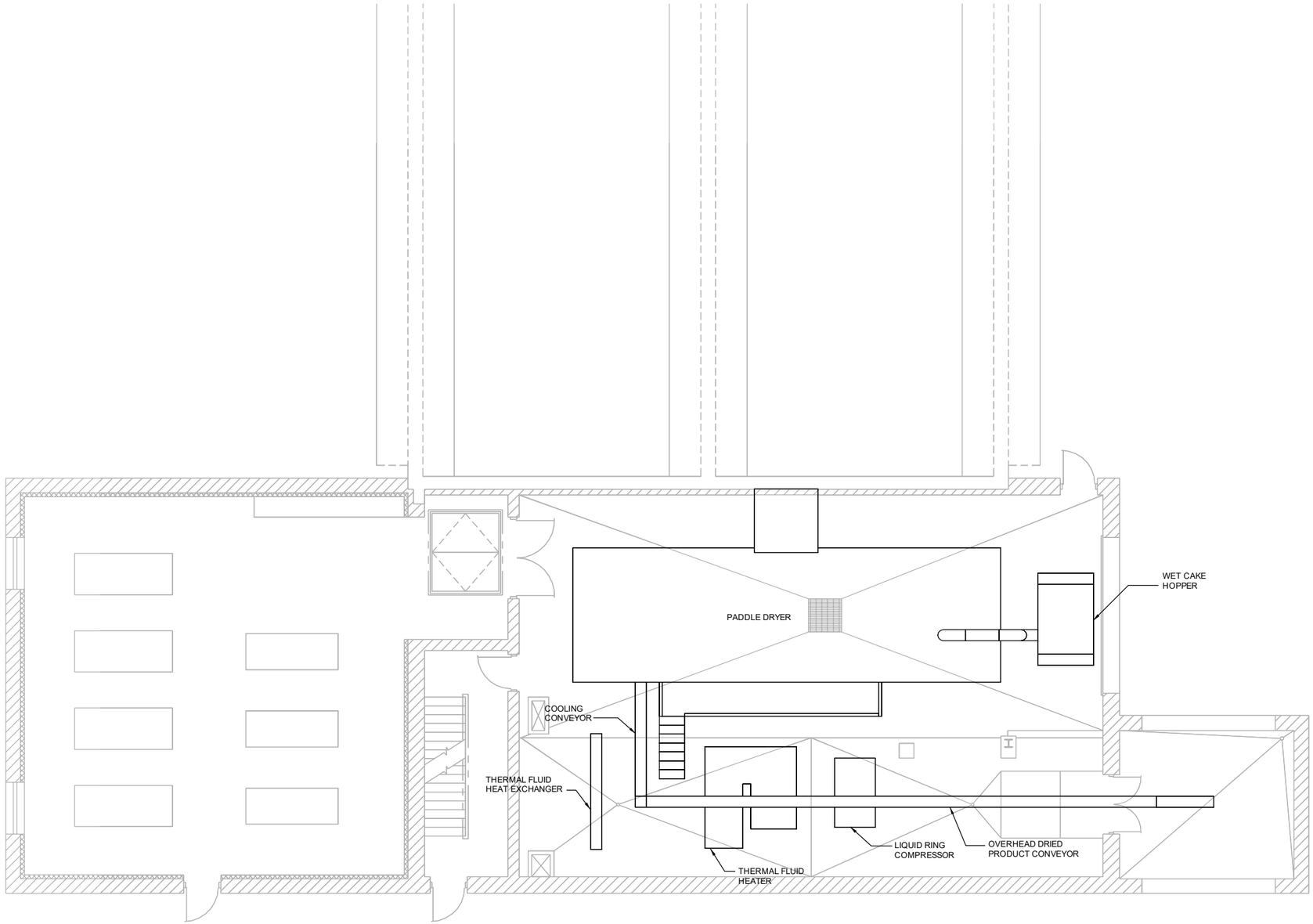
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-G-BFP

DONOHUE

Sheet No.

Drawing No.



GRADE PLAN

0 3' 16'

Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	SAM
Drawn By	SAM
Checked By	EJL
Approved By	EJL
Filename	050MP1.DWG
Project No.	12193.11
Project Date	FEB 2017

CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

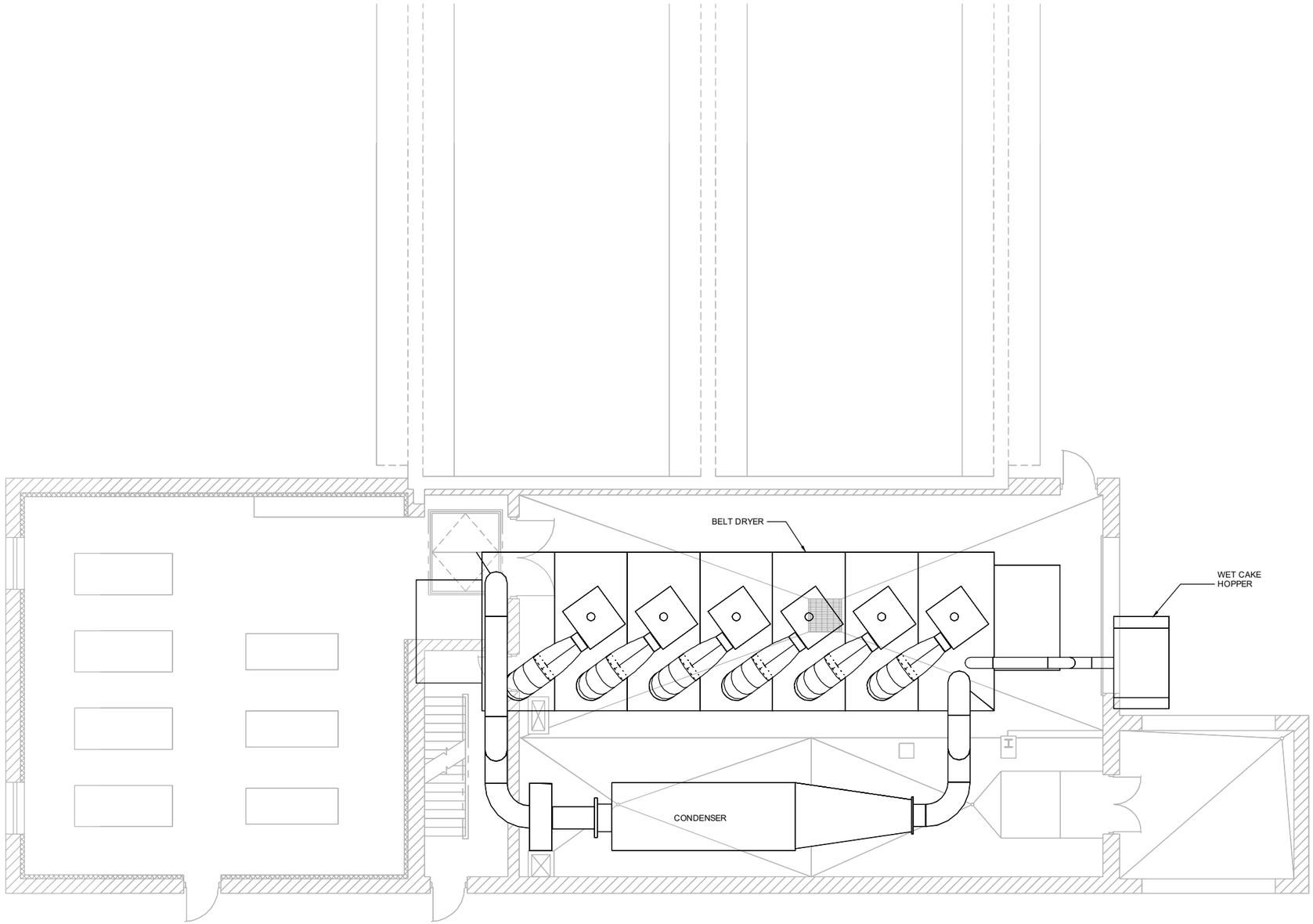
SOLIDS HANDLING BUILDING
50-K-BFP

DONOHUE

Sheet No.

Drawing No.

DRYER DOES NOT FIT



GRADE PLAN

0 3' 16'

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Designed By	SAM
Drawn By	SAM
Checked By	EJL
Approved By	EJL
Filename	050MP1.DWG
Project No.	12193.11
Project Date	FEB 2017

CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-H-BFP

DONOHUE

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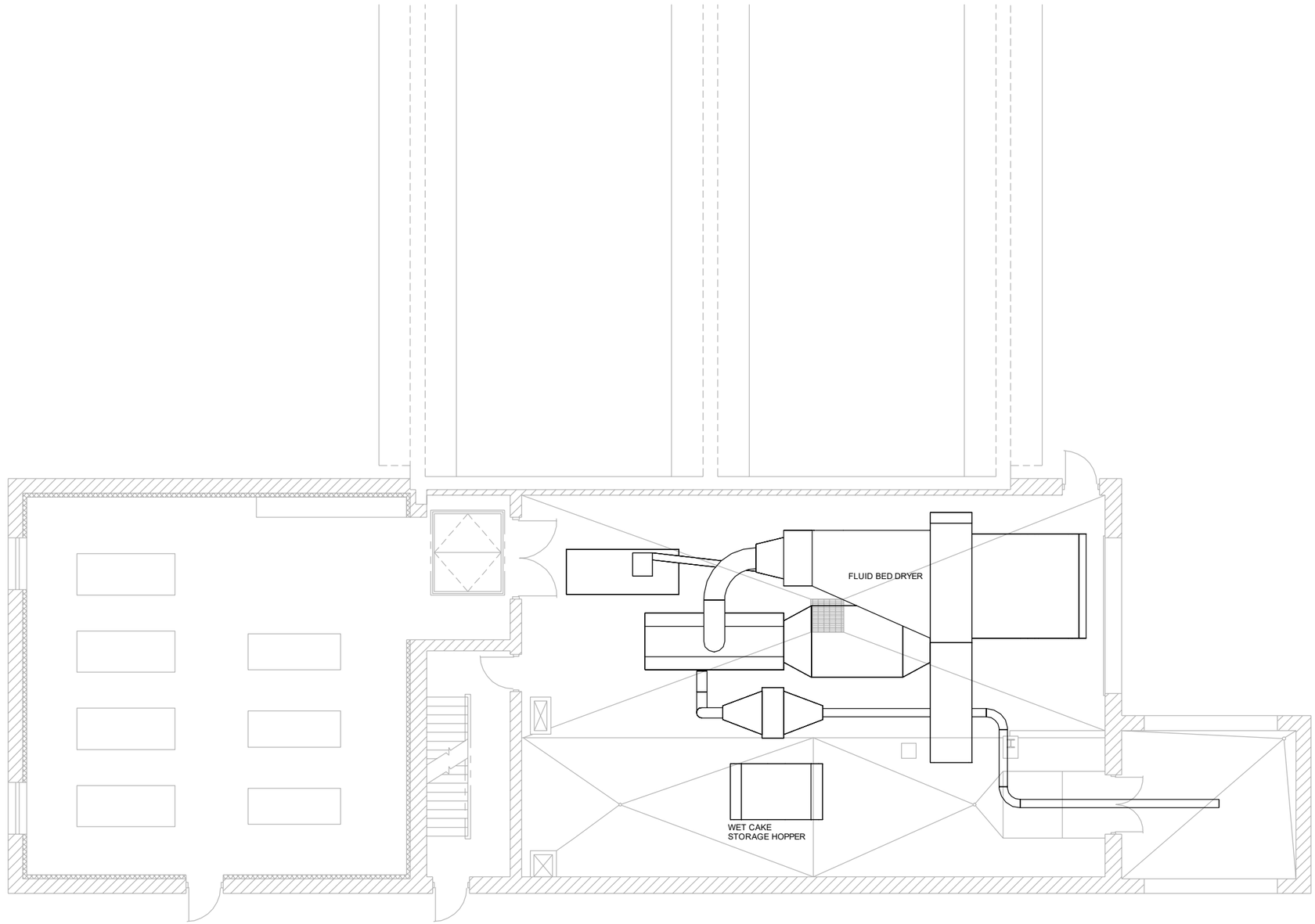

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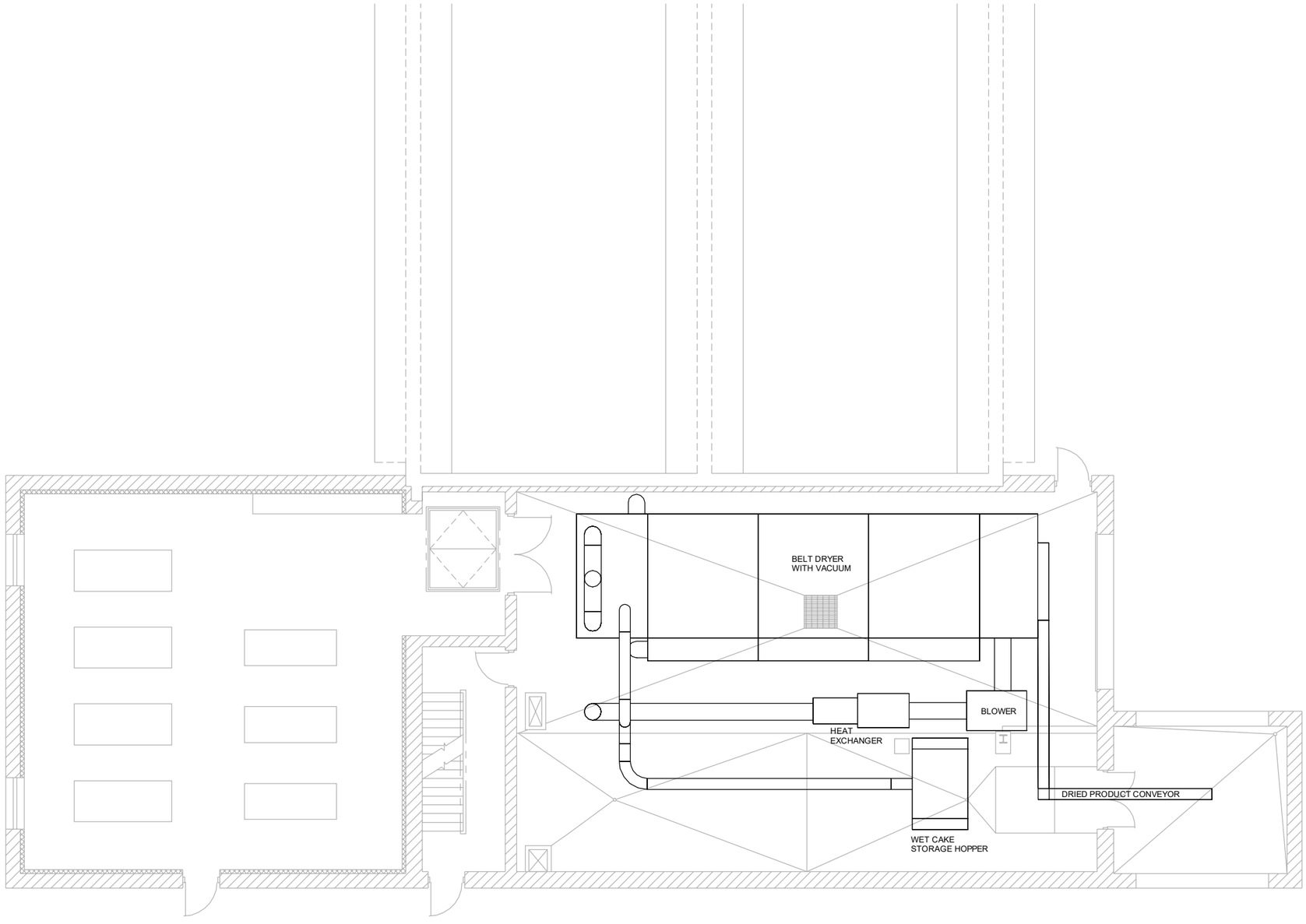

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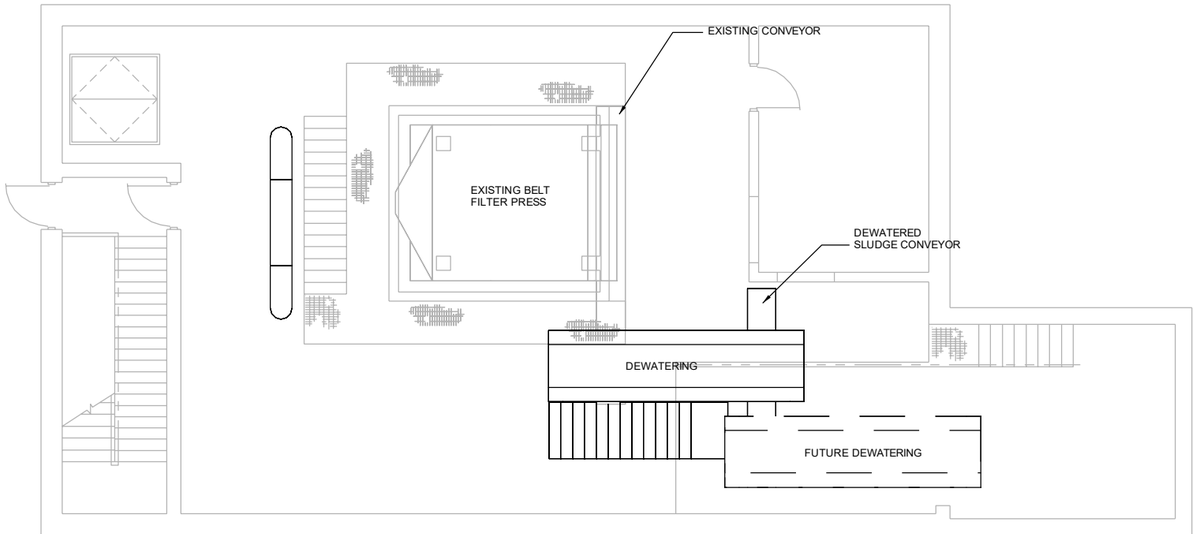

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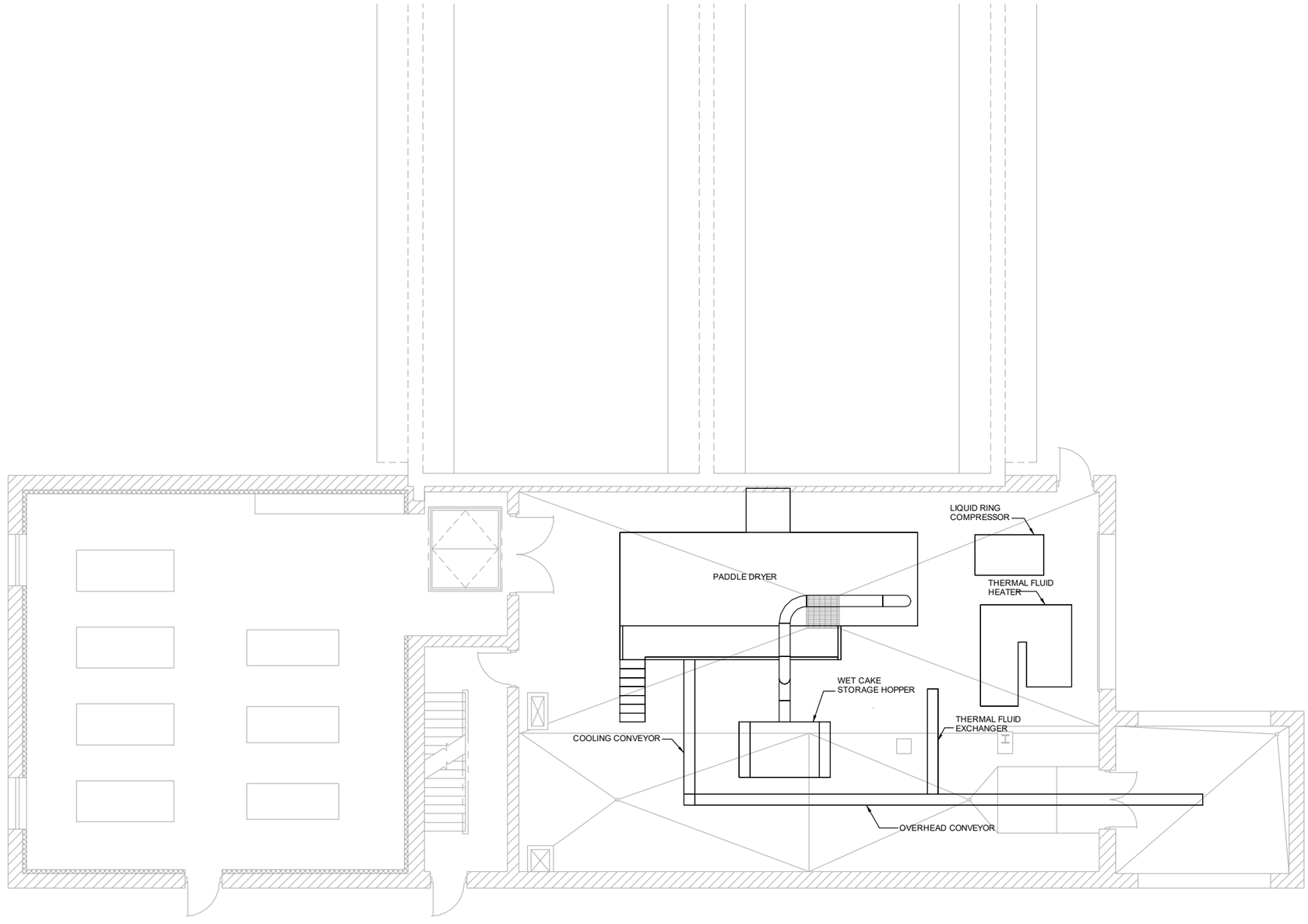

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Approved By	EJL
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KIEL, WI

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50-K-SP

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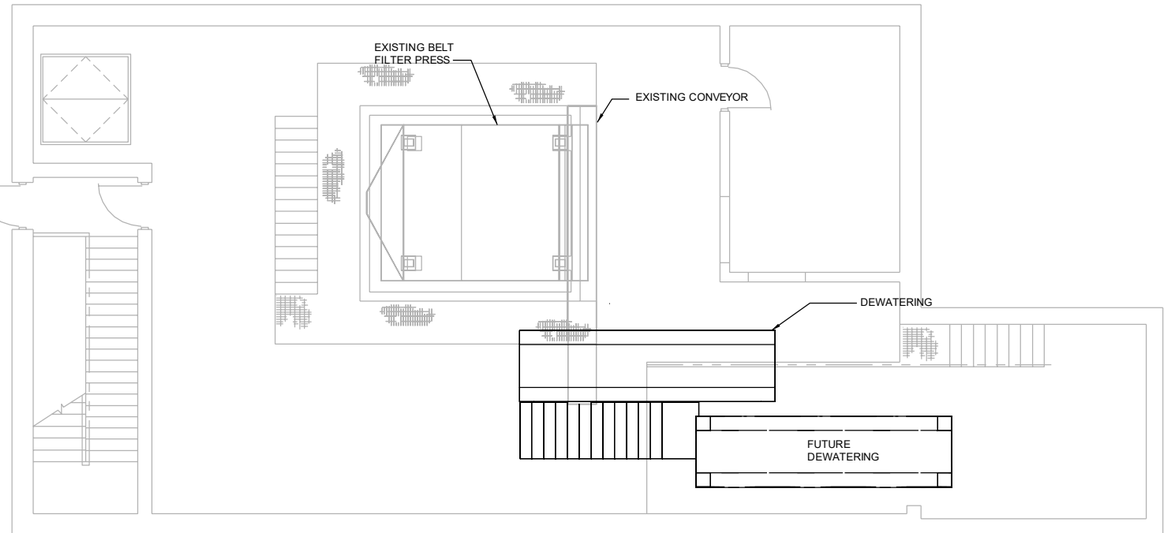

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Drawn By	EJL
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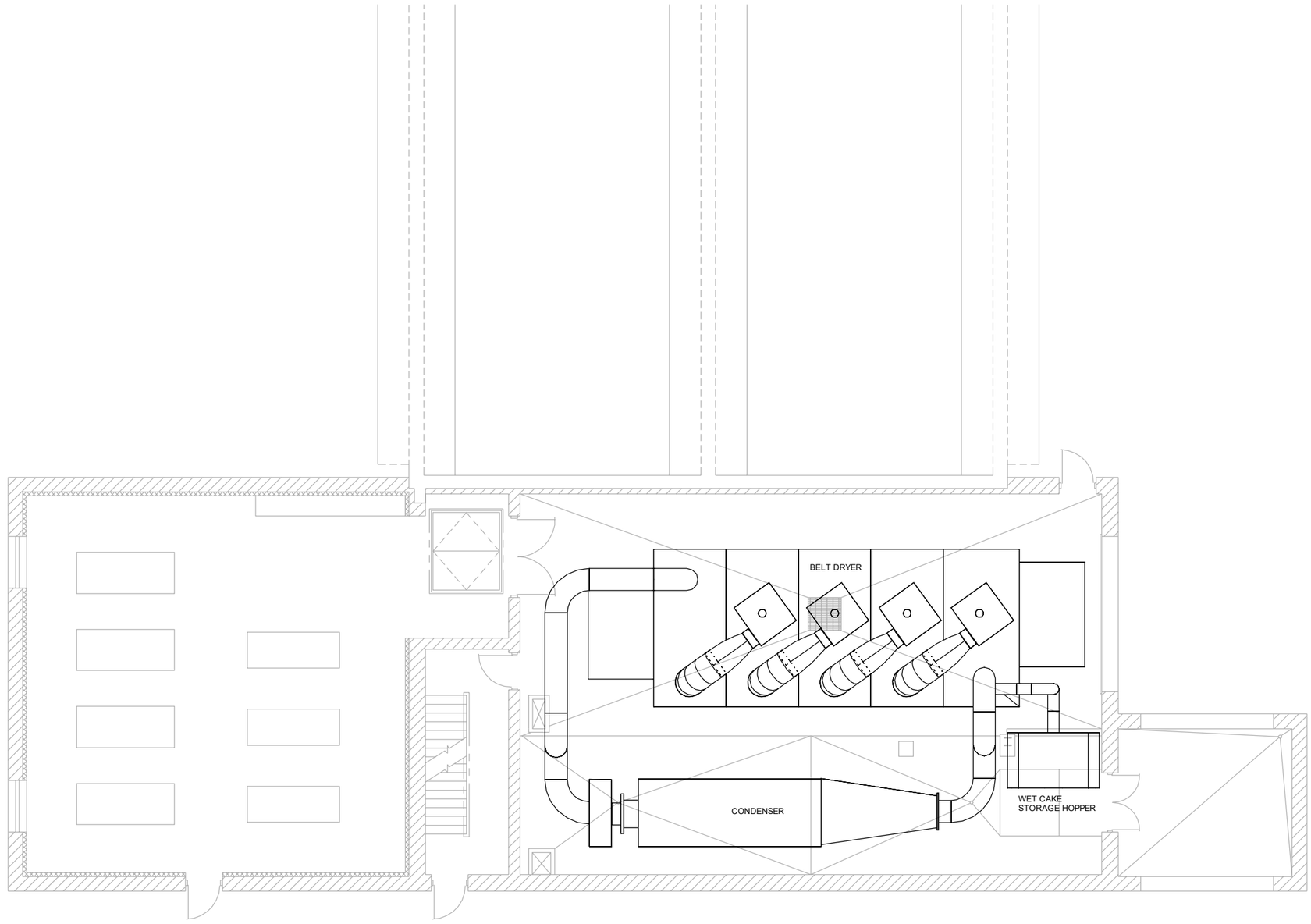

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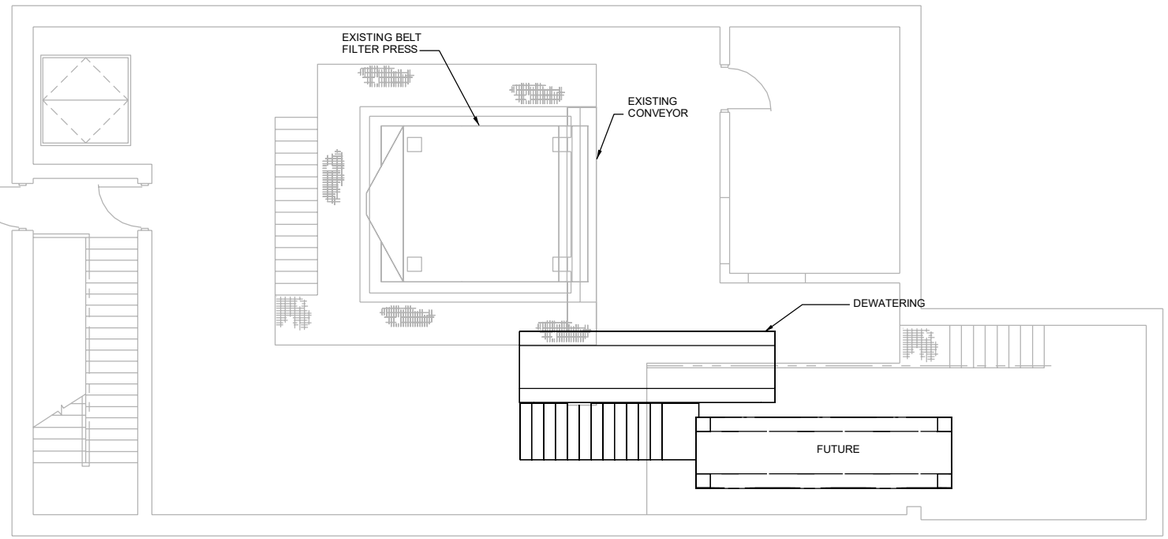

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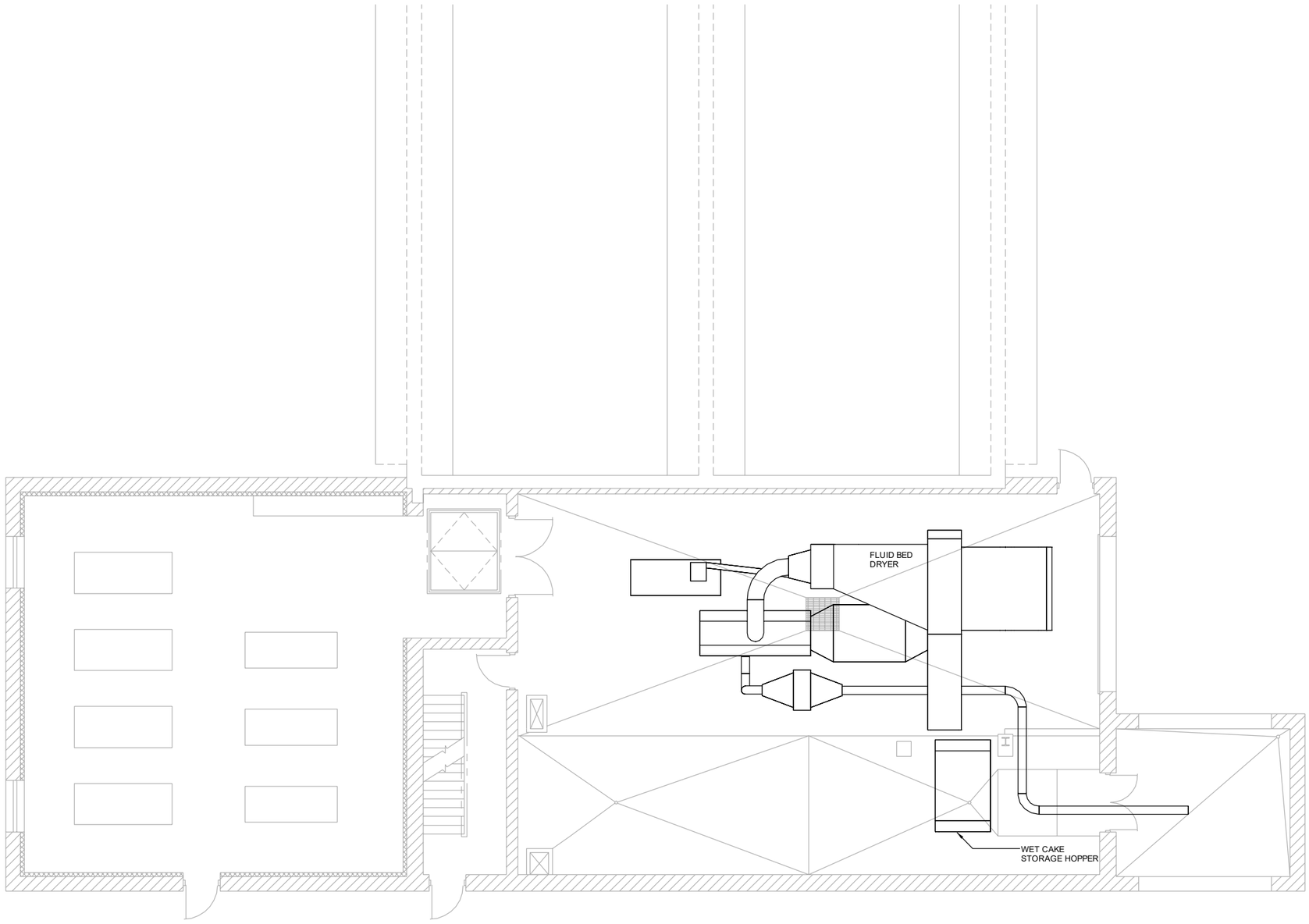

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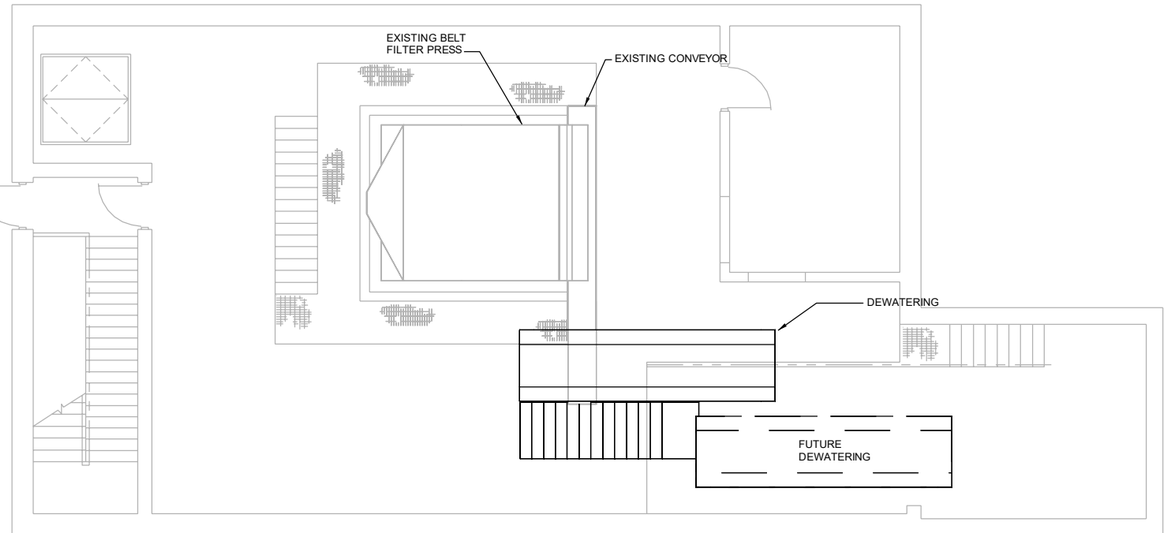

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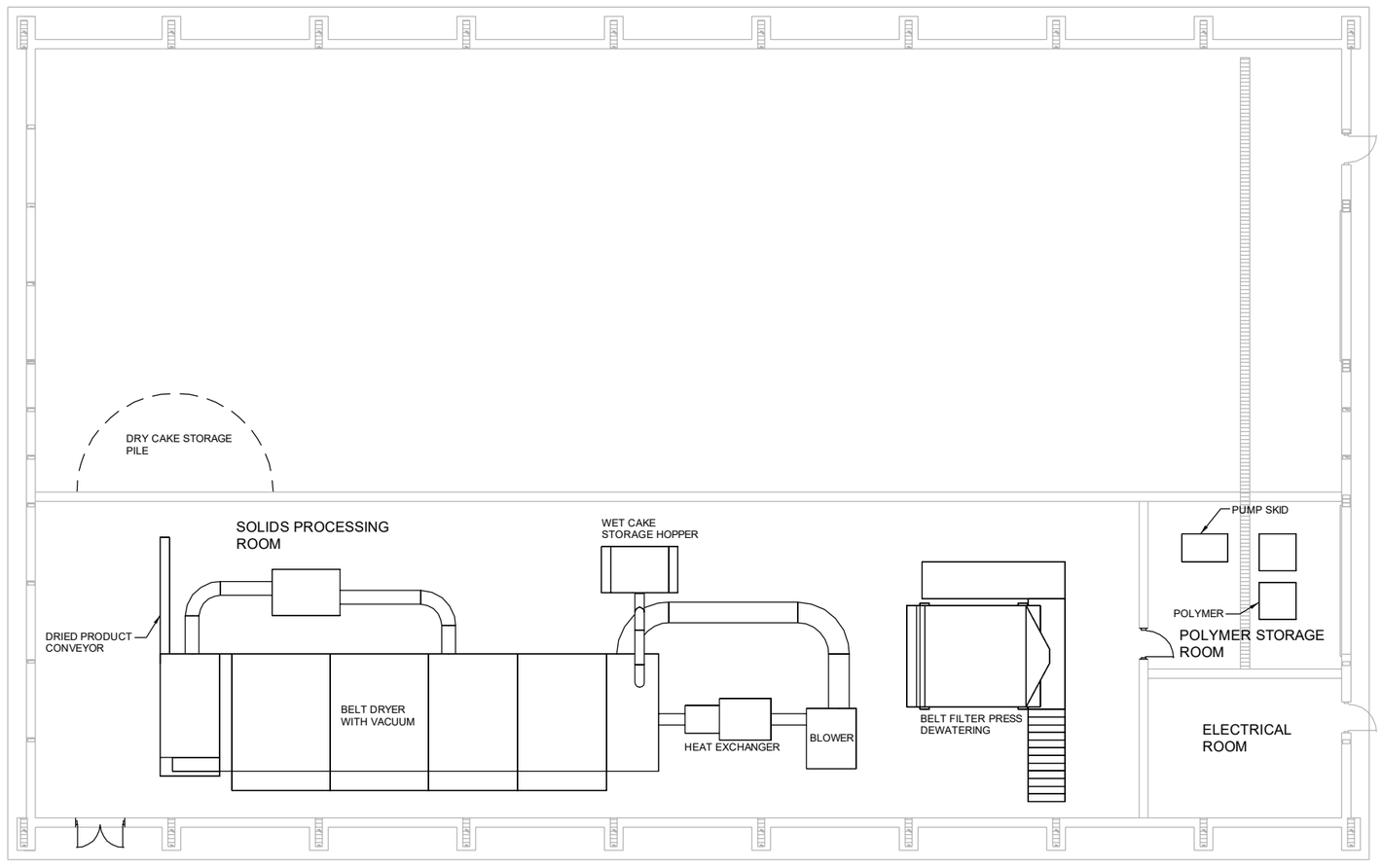

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Filename	080MP2_10X40.DWG
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SOLIDS STORAGE BUILDING
80-G-BFP

DONOHUE

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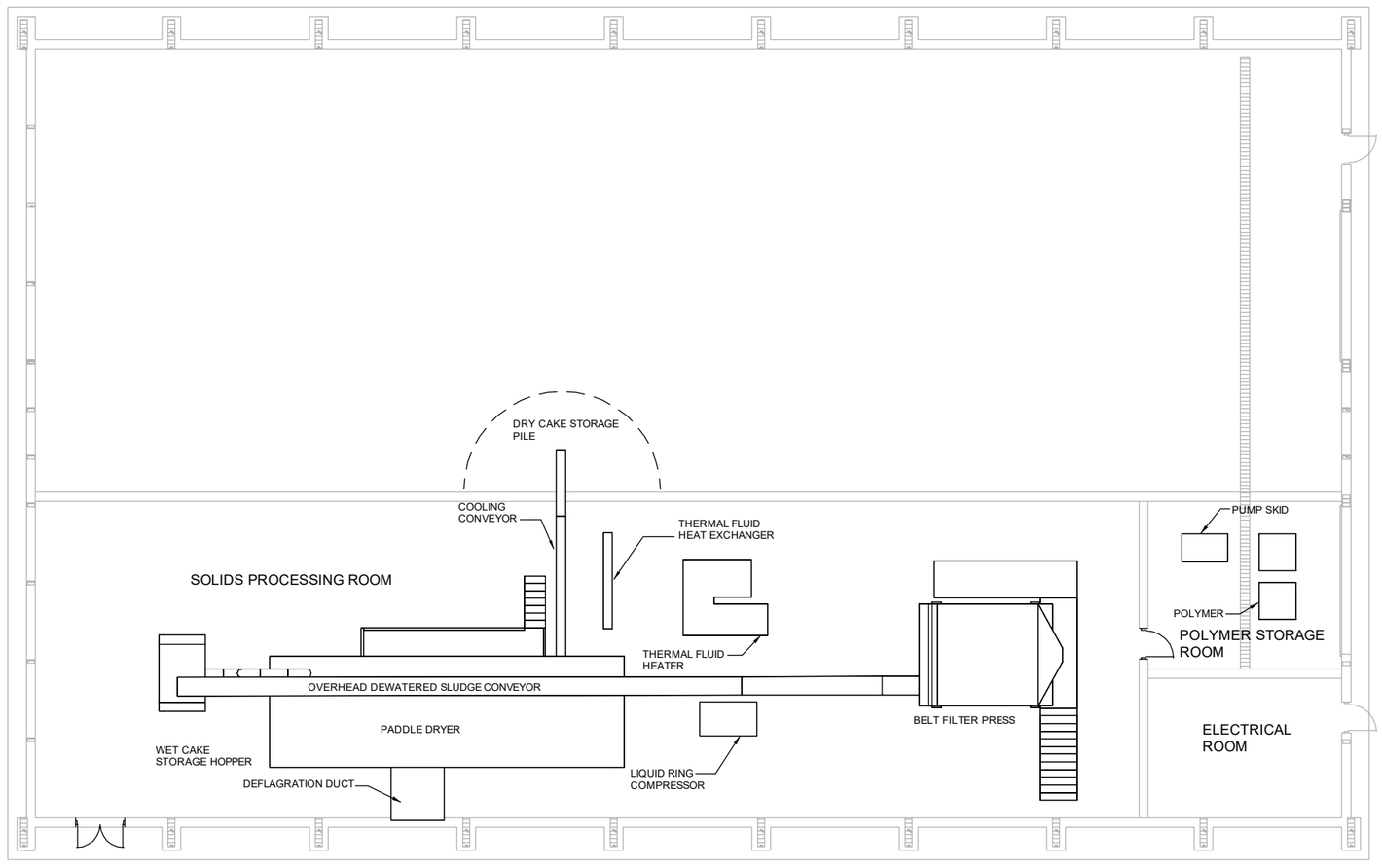

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DONOHUE

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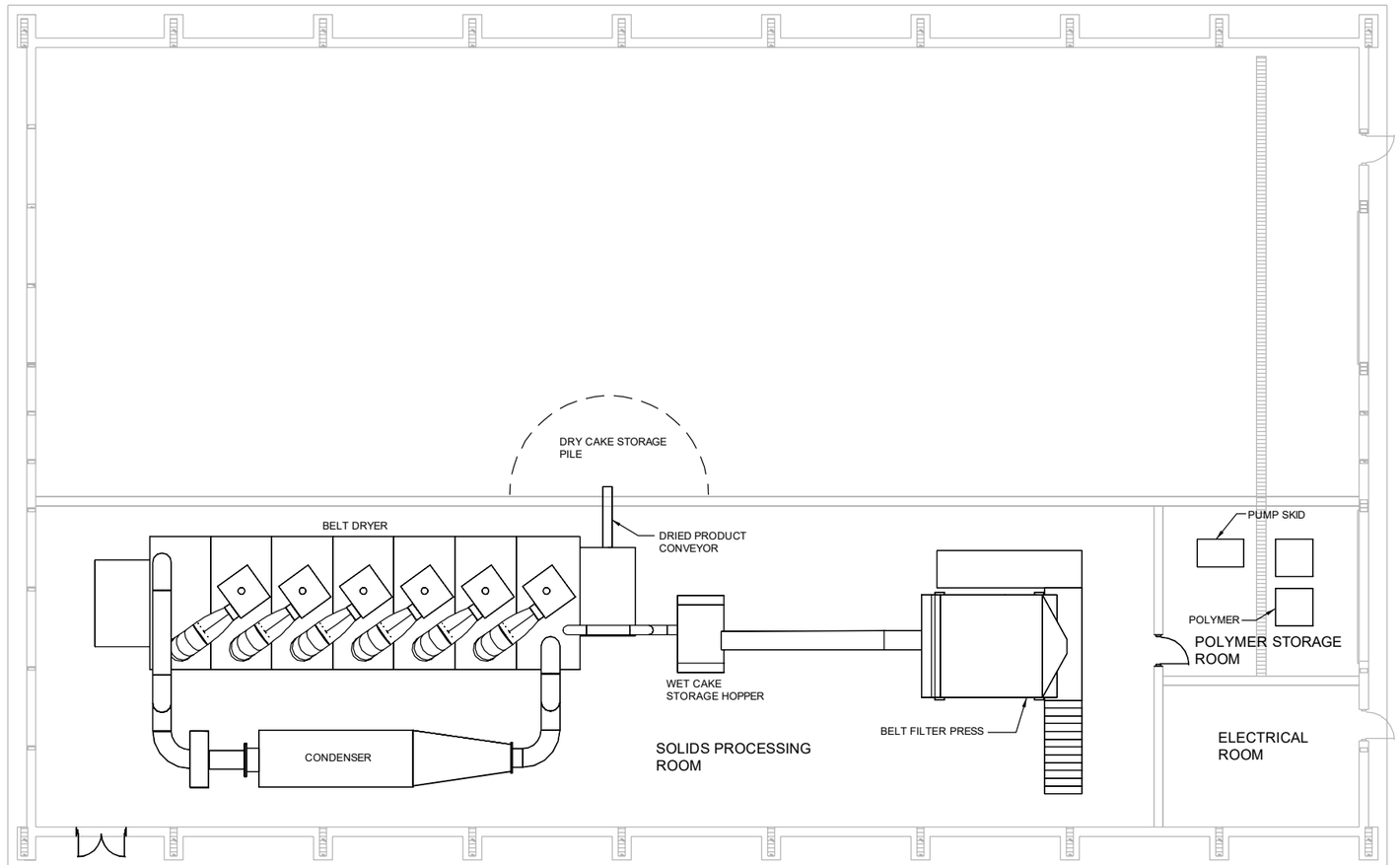

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SOLIDS STORAGE BUILDING
80-H-BFP

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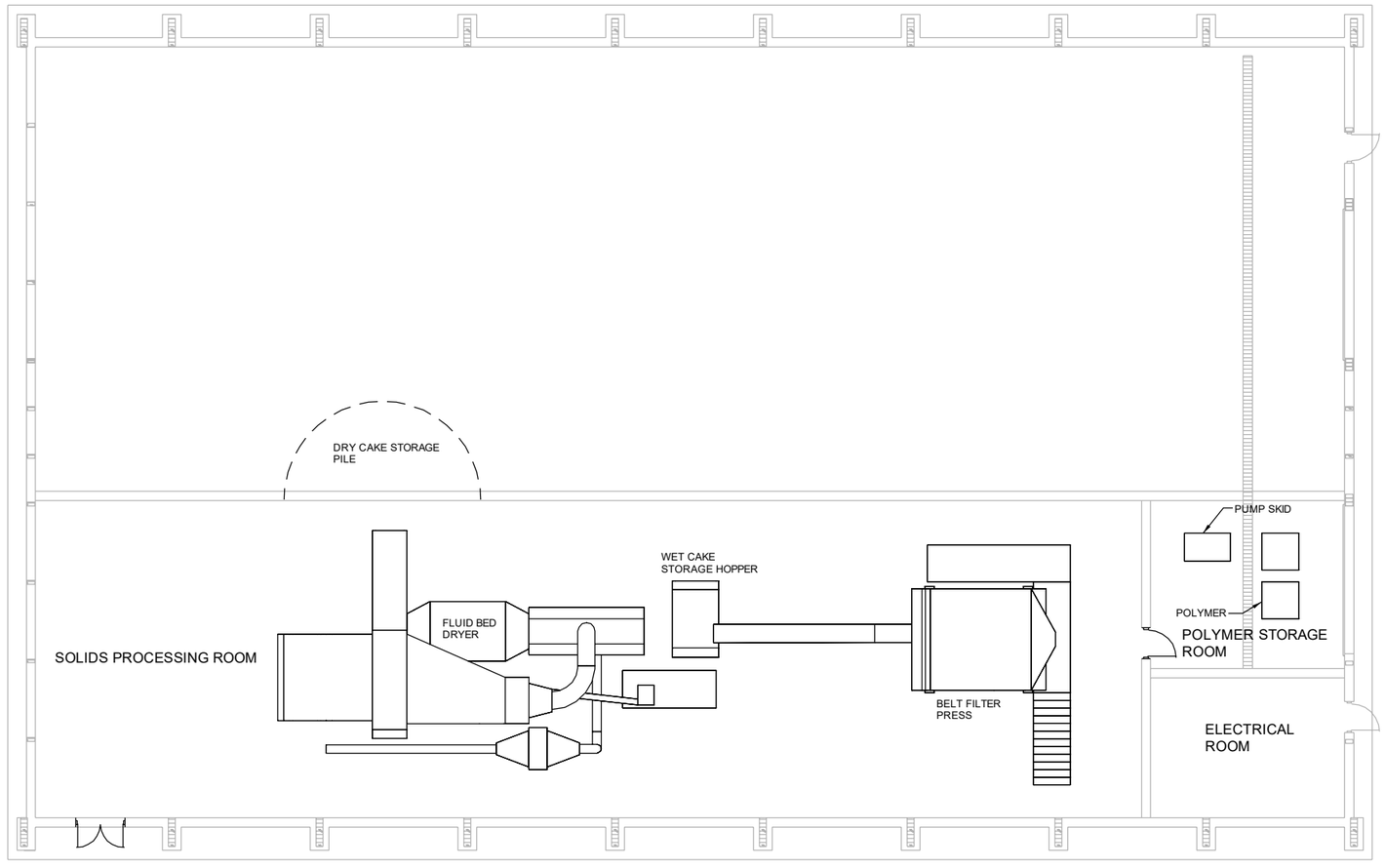

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SOLIDS STORAGE BUILDING
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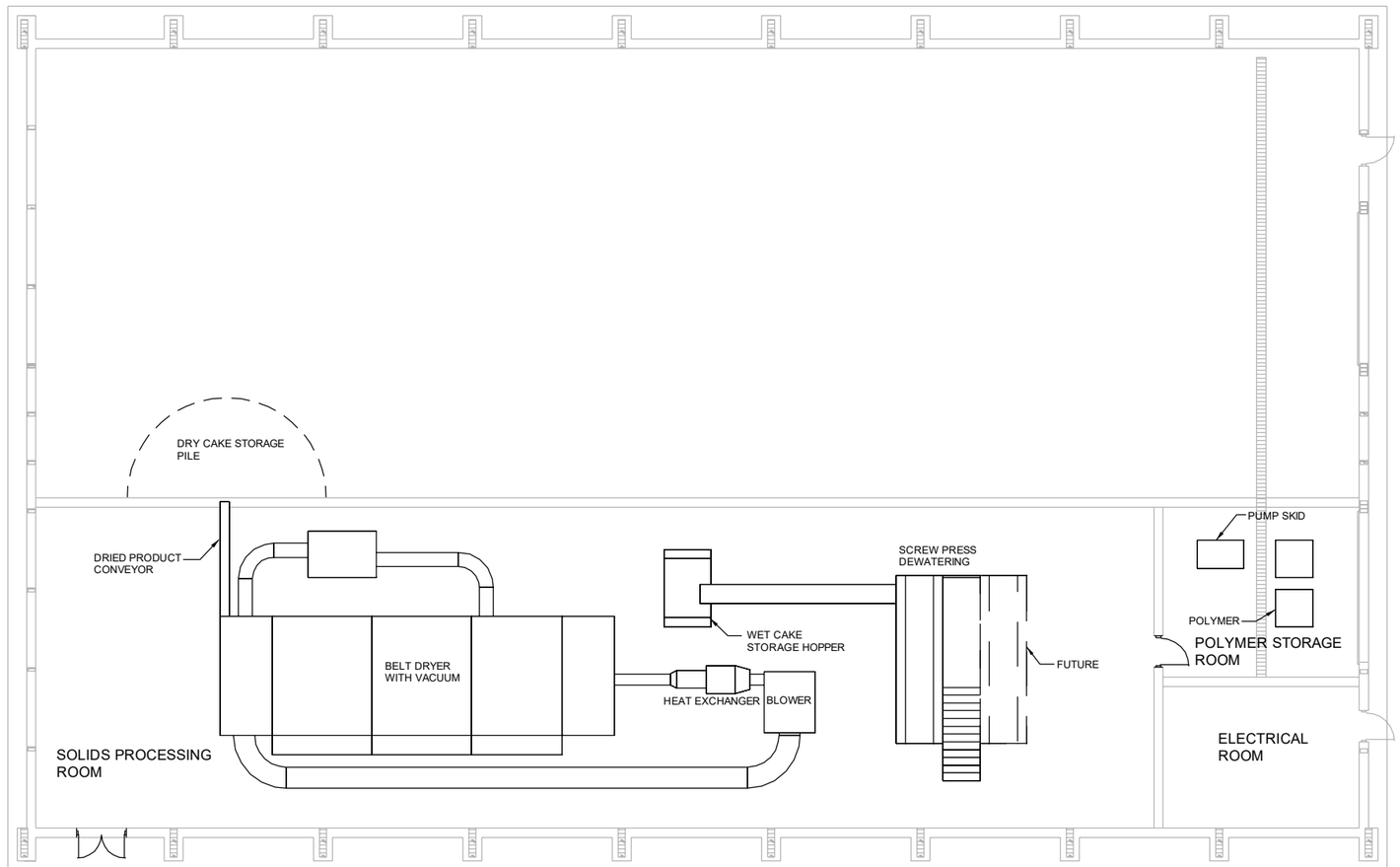

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SOLIDS STORAGE BUILDING
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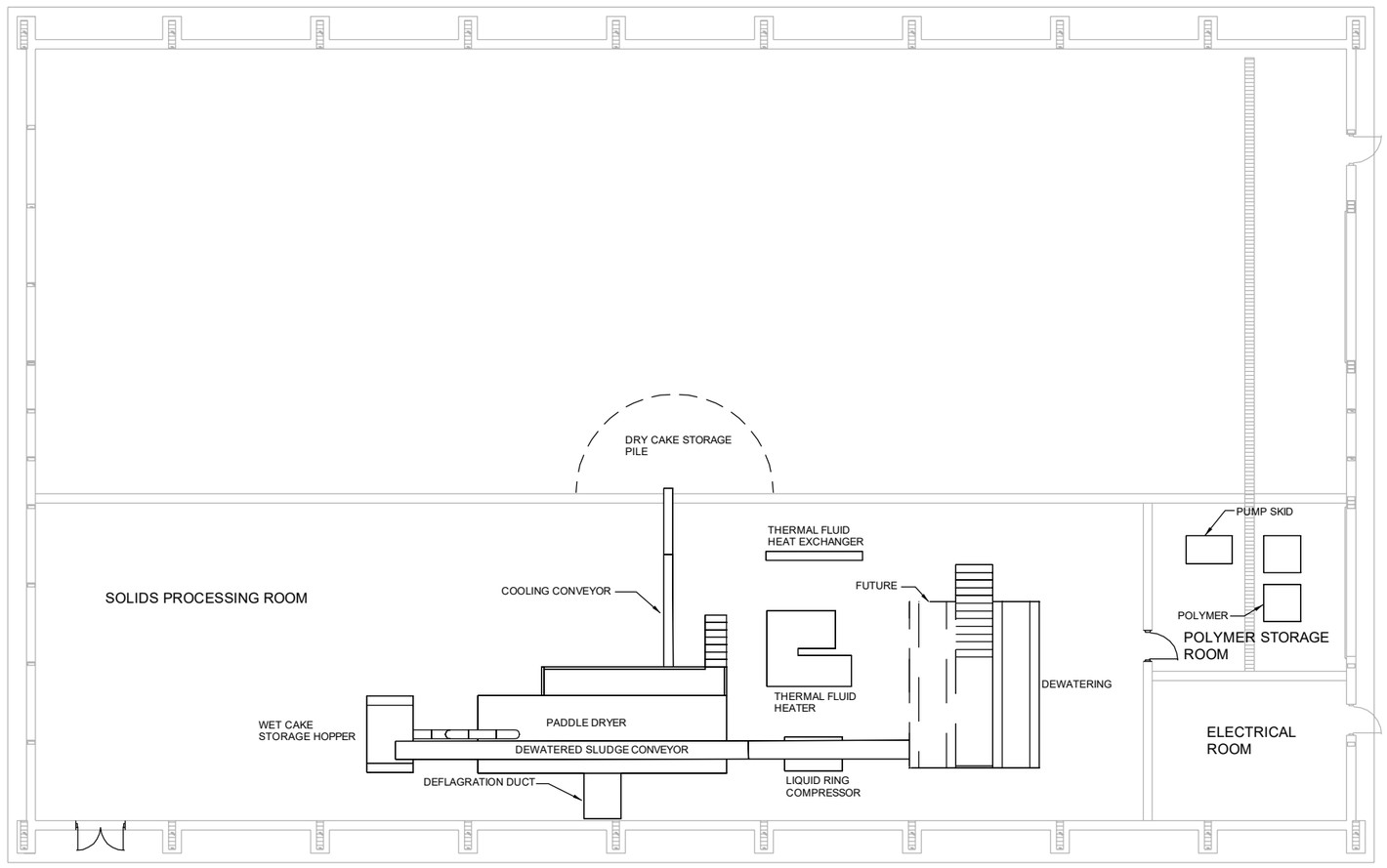

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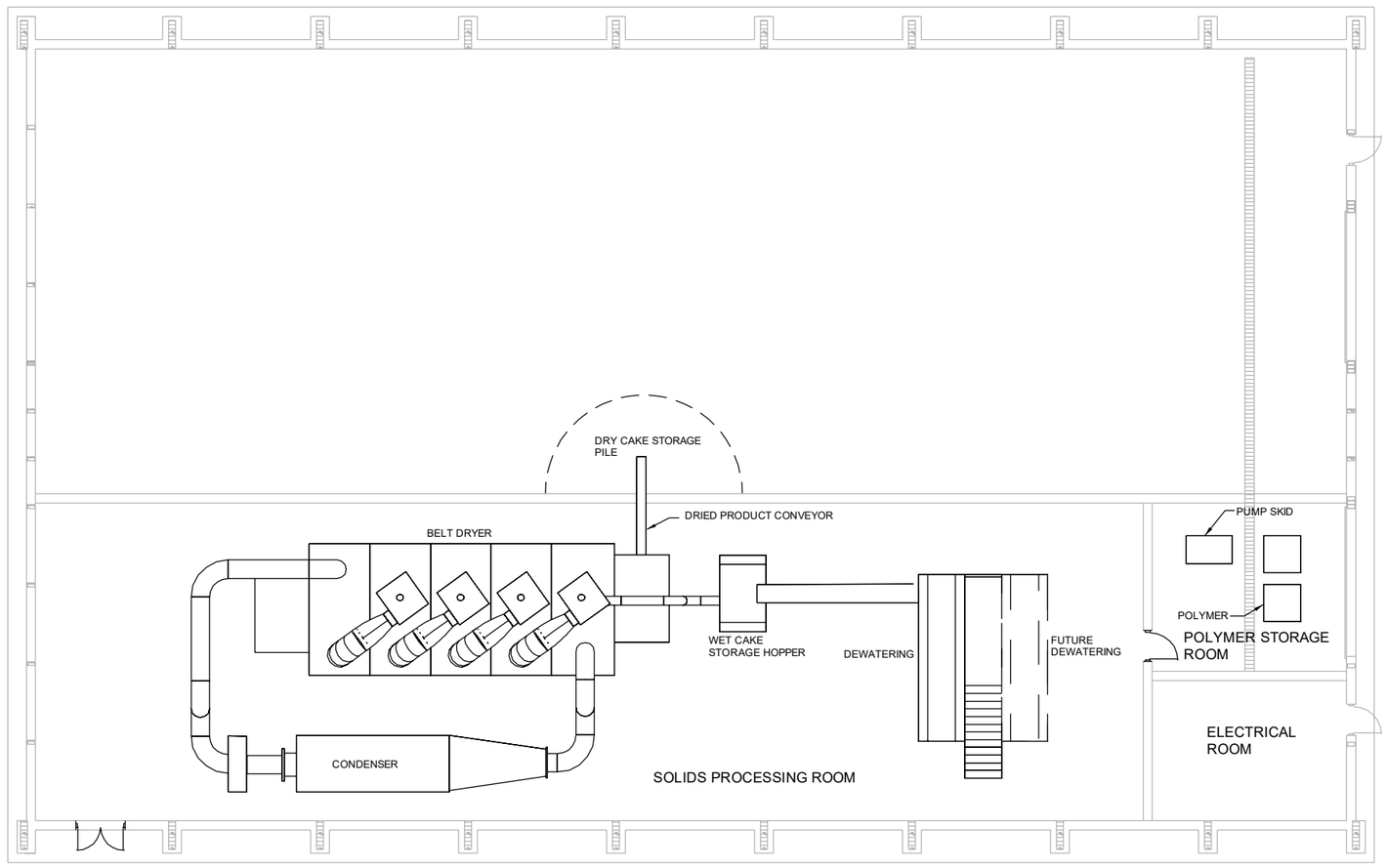

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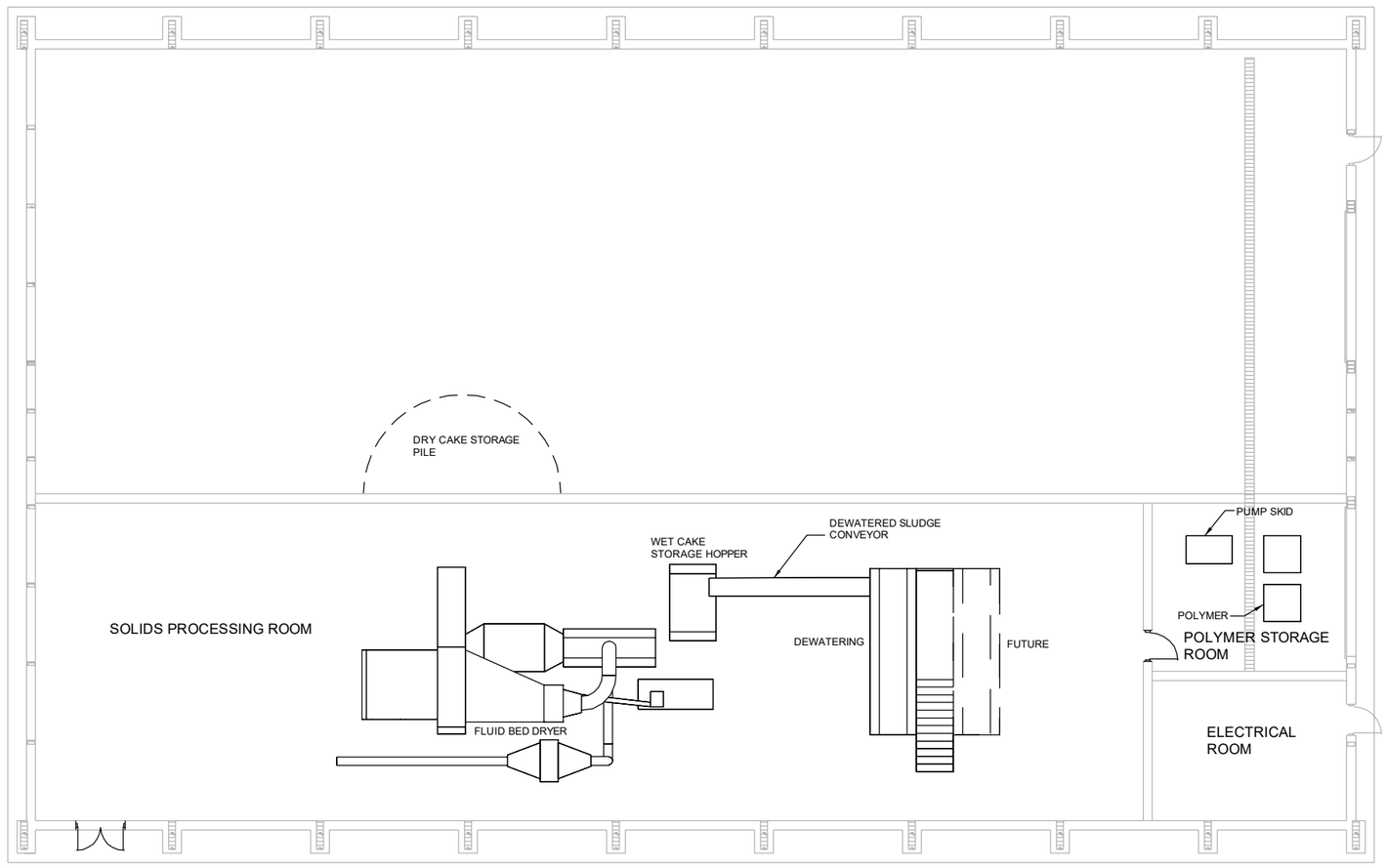

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KIEL, WI

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80-S-SP

DONOHUE

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Drawing No.

- Chapter VII -
COST EFFECTIVE ANALYSIS

A. INTRODUCTION

Justification for selection of wastewater treatment alternatives is based upon a Cost Effective Analysis. Cost effectiveness takes into consideration both monetary and non-monetary factors. Monetary factors include capital (first costs) and operation and maintenance costs over the entire planning period. Non-monetary factors include such items as primary and secondary environmental effects, implementation capability (social and institutional), operability, performance, reliability and flexibility.

B. COST ESTIMATING PROCEDURES

Capital construction cost items used in the Cost Effective Analysis include the following:

- Equipment costs.
- Construction and installation costs, including Contractor's overhead and profit.
- Cost of engineering, design, field exploration, construction management, on-site field representative and start-up services.
- Cost of administration and legal services, including costs of bond sales.
- Interest during construction.

Prices of components and installation are estimated on the basis of market prices as of the last quarter of 2016, with no allowance for inflation of wages or prices.

Additional project costs (engineering, contingencies, legal, fiscal and administrative) are estimated at 30% of capital costs; which includes 15% contingencies, and 15% for engineering, legal, fiscal, administrative and interest costs.

Since the Cost Effective Analysis is computed on a present worth basis, the salvage value of structure and equipment are computed on a straight line depreciation basis, if there is a use for the structure at the end of the design period and it can be demonstrated that the item can be reused. The design period over which the Cost Effective Analysis occurs is 20-years. Future replacement costs for equipment with a life expectancy of less than 20-years is also included in the analysis.

The useful life of the various structures and equipment is estimated according to the following:

Item	Useful Life
Land	Permanent
Wastewater Conveyance Structures (i.e., pipes, interceptors)	40-years
Structures, Tankage, Basins	40-years
Process Equipment	10 to 20-years
Auxiliary Equipment	1 to 20-years

Operation & Maintenance (O&M) costs include all annual costs (operation and maintenance, labor, equipment parts, repairs and supply costs, chemical, power and fuel costs) necessary to operate and maintain the treatment facility. The costs utilized include:

- Labor: Existing Labor Costs Are Utilized
- Electricity: $0.07/kWH
- Polymer $1.44/lb.
- Natural Gas: $0.83/therm

O&M Costs are based upon the design criteria for each alternative and the personnel required to operate and maintain these facilities.

Annual O&M costs, future costs and salvage values are calculated to total present worth values using a discount rate of 4.125%.

C. ALTERNATIVE ANALYSIS

Based upon the Preliminary Screening Process, which is summarized in the previous chapter, the following alternatives will be subject to a Cost Effective Analysis:

- Activated Sludge Process
- Biosolids Dewatering & Drying (By Donohue; refer to Appendix VI-1).

1. Activated Sludge Process

a. General:

The following viable alternatives for the Activated Sludge Process will be considered:

1) Expand Existing System
2) Membrane Bio-Reactor (MBR)

A diagram of each activated sludge alternative is shown in Figure VII-1 and Figure VII-2. The detailed description of each alternative was previously noted in Chapter VI.

b. Analysis:

Table VII-1 and Table VII-2 contain the Present Worth Analysis of each of the alternatives. The Recommended Plan, by Donohue, for biosolids dewatering and drying is incorporated into each activated sludge option considered. The potential capital construction costs are summarized as follows:

Option #1 - Expand Existing System $17,109,996
Option #2 - MBR $16,057,704

The Present Worth Total of the potential capital construction costs are as follows:

Option #1 - Expand Existing System $17,443,811
Option #2 - MBR $16,275,028

The potential annual O&M costs of each alternative were estimated for comparison purposes. The potential annual O&M costs are:

Option #1 - Expand Existing Facilities $906,764
Option #2 - MBR $913,726

The present worth of each O&M cost is noted below:

Option #1 - Expand Existing Facilities $12,187,934
Option #2 - MBR $12,281,511

A summary of the Present Worth Total of the potential capital construction and O&M costs is presented below:

Total Present Worth
Option #1 - Expand Existing Facilities $29,631,745
Option #2 - MBR $28,556,539

On a 20-year Present Worth basis, taking into account capital construction, salvage and O&M potential costs, the MBR option is within 4% of the expansion of the existing Wastewater Treatment Facility option.

c. Conclusions:

1) The expansion of the existing system is within 9.4% of the MBR initial construction cost, although the MBR option may have the lowest Present Worth of the capital costs.
2) The expansion of the existing system may have the lowest annual O&M and lowest Present Worth of the O&M cost.
3) The Total Present Worth for the expansion of the existing system may be 4% more than the MBR option over a 20-year period.
4) The Wisconsin Department Of Natural Resources (DNR) considers Present Worth Values that are within 10% of each other to be essentially equal in monetary value due to normal variability in costs at the planning level.

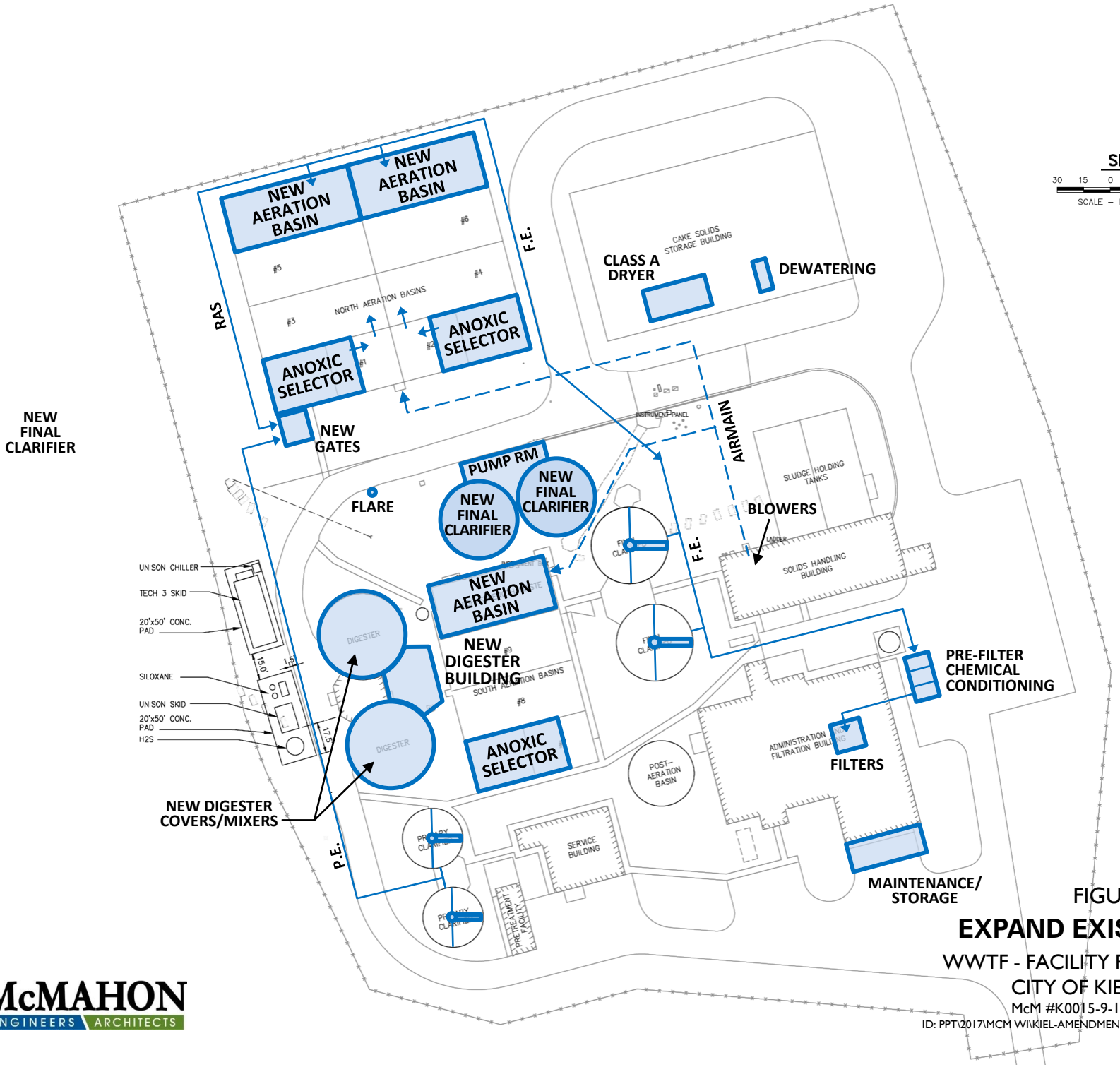

FIGURE VII-1

EXPAND EXISTING SYSTEM

WWTF - FACILITY PLAN AMENDMENT #1

CITY OF KIEL, WISCONSIN

McM #K0015-9-16-00949.02 3/20/2017

ID: PPT\2017\MCM WI\KIEL-AMENDMENT 1 TO WWTF FACILITIES PLAN.PPTX TJK:jmk

McMAHON ENGINEERS ARCHITECTS

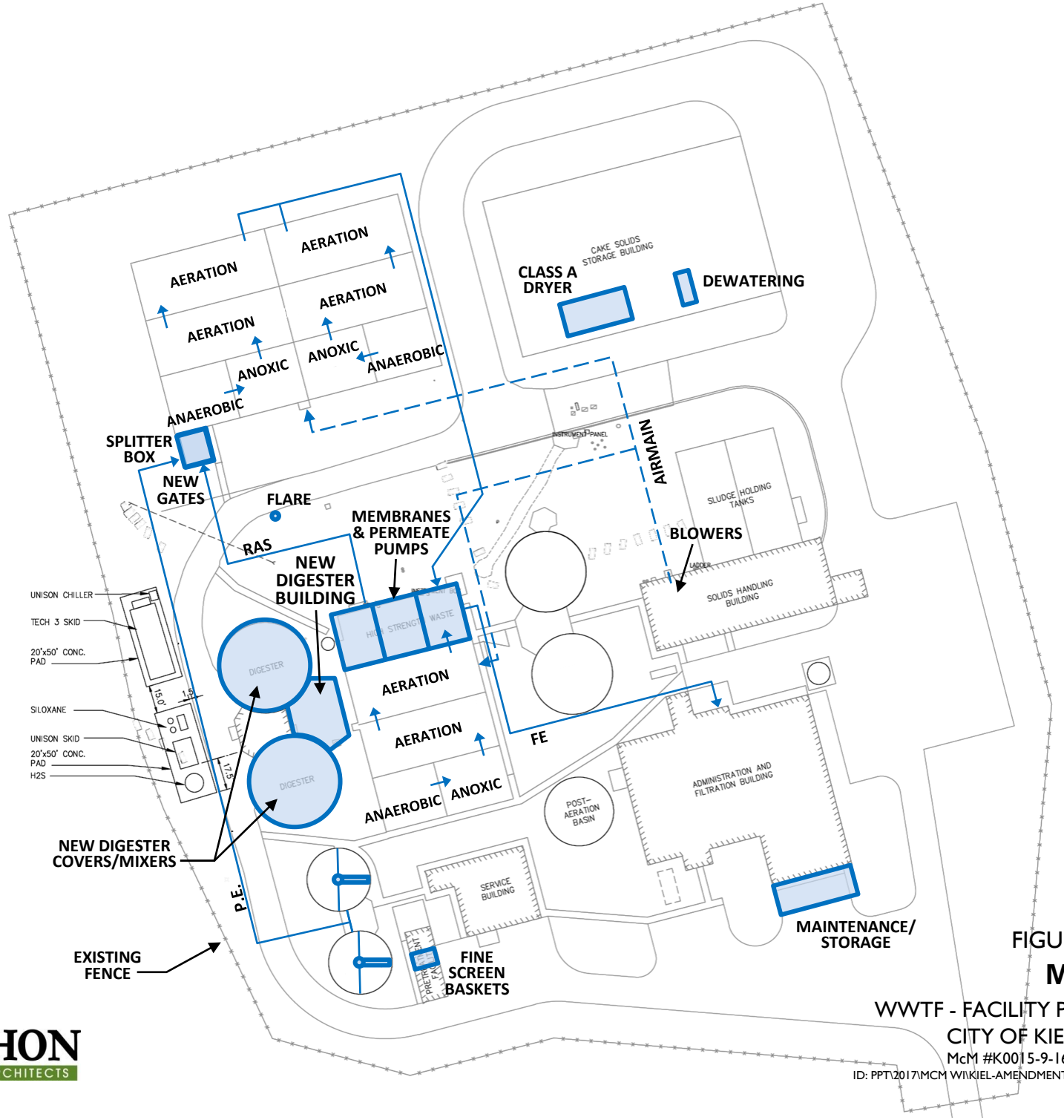

FIGURE VII-2

MBR

WWTF - FACILITY PLAN AMENDMENT #1
CITY OF KIEL, WISCONSIN
McM #K0015-9-16-00949.02 3/20/2017
ID: PPT\2017\MCM WI\KIEL-AMENDMENT 1 TO WWTF FACILITIES PLAN.PPTX TJK:jmk

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Table VII-1
OPTION #1 - AERATION BASIN EXPANSION
Opinion Of Probable Construction And O&M Costs
CITY OF KIEL, WISCONSIN
Wastewater Treatment System - Facilities Plan | 2017 Update

Capital Construction Costs Item		Service Life	Replacement Cost	Salvage Value
Miscellaneous				
▪ Mechanical and Structural Demolition	$26,000	--	--	--
▪ Dewatering	$30,000	--	--	--
▪ Tank Cleaning (Pri. Clar., AB, Sec. Clar., Digesters)	$126,000	--	--	--
▪ Miscellaneous Metals (grating, railing, hatches, etc.)	$57,000	20	$0	$0
▪ Painting (Digesters, Digester Bldg. Expansion)	$253,000	20	$0	$0
Site Work				
▪ Underground Piping (20" P.E., 18" AB, 18" FE, 20" FE, 8" RAS, 4" WA	$156,000	40	$0	$78,000
▪ Buried Air Main Replacement (24" Main, 20" to N, 16" to S)	$140,000	40	$0	$70,000
▪ Relocate Flare	$10,000	--	--	--
▪ Grading and Landscaping	$53,000	40	$0	$26,500
▪ Paving	$196,000	20	$0	$0
Structures				
▪ Primary Clarifier Repairs	$30,000	20	$0	$0
▪ Aeration Basin Repairs	$10,000	20	$0	$0
▪ North Aeration Basins (65' x 32' x 14' swd x 2)	$552,000	40	$0	$276,000
▪ Tunnel Structure/Secondary Clarifiers (2 x 40' diameter)	$490,000	40	$0	$245,000
▪ South Aeration Basin (Convert HSW Tank)	$50,000	40	$0	$25,000
▪ Chlor/Dechlor Gas Storage Room Modifications	$10,000	40	$0	$5,000
▪ Digester Building Expansion	$420,000	40	$0	$210,000
▪ Admin. Bldg. Maintenance Addition	$173,000	40	$0	$86,500
Equipment				
▪ Pri. Clarifier Drives, Mechanisms, Weirs, Baffles (2)	$201,000	20	$0	$0
▪ Primary Sludge Pumps (3)	$75,000	10	$75,000	$0
▪ Aeration Splitter Box Gates (3)	$39,000	40	$0	$19,500
▪ Aeration Systems (3 Trains)	$160,000	20	$0	$0
▪ New Aeration Blowers (4 @250 hp)	$660,000	20	$0	$0
▪ Sec. Clarifier Drives, Mechanisms, Weirs, Baffles (Typ 4)	$525,000	20	$0	$0
▪ Sec. Clarifier Launder Covers	$80,000	20	$0	$0
▪ RAS Pumps (6)	$150,000	10	$150,000	$0
▪ WAS Pumps (2)	$50,000	10	$50,000	$0
▪ Scum Pump (2)	$30,000	10	$30,000	$0
▪ Disc Filters	$906,000	20	$0	$0
▪ Digester Covers and Mixers	$585,000	20	$0	$0
▪ Digester Recirc Pumps (2)	$50,000	10	$50,000	$0
▪ Sludge Transfer Pumps (2)	$50,000	10	$50,000	$0
▪ Boiler/Heat Exchanger (2)	$310,000	20	$0	$0
Equipment Subtotal	**$3,871,000**			
Equipment Installation (20% of Equipment)	$774,200	--	$81,000	$0
Mechanical (Process Piping, Plumbing, HVAC) (30% Equip.)	$1,161,300	40	$0	$580,650
Electrical	$893,000	40	$0	$446,500
Controls and SCADA	$630,000	10	$630,000	$0
Biosolids Infrastructure (Donohue)	$396,000	40	$0	$198,000
Biosolids Equipment & Material (Donohue)	$1,710,000	20	$0	$0
Biosolids Instruments & Controls (Donohue)	$60,000	10	$60,000	$0
Subtotal	$12,277,500	--	$1,176,000	$2,266,650
General Conditions, Bonds, Insurance (7%)	$859,425	--	--	--
Total	$13,136,925	--	$1,176,000	$2,266,650
Contingencies (15% of Total)	$1,970,539	--	--	--
Engineering (15% of Total)	$1,970,539	--	--	--
Grand Total	$17,078,003	--	$1,176,000	$2,266,650
Present Worth of Total	**$17,413,010**	--	$784,977	$449,970

Present Worth (P) = Future (F) x $(1+i)^{-n}$

i = **4.125 %**
n = **10 (Replacement)**
n = **40 (Salvage)**

$(1 + i)^{-n}$ = **0.667497826 (Replacement)**
$(1 + i)^{-n}$ = **0.198517786 (Salvage)**

Operation and Maintenance Costs	
Labor/Maintenance	$56,900
Power	$184,575
Chemical	$113,800
Replacement (5% Equipment) Update	$232,260
Parts & Supplies (2% Equipment) Update	$92,904
Biosolids Polymer (Donohue)	$93,400
Biosolids Parts (Donohue)	$20,325
Biosolids Power (Donohue)	$112,600
Total Annual	$906,764
O&M Present Worth	$12,187,934
Capital Present Worth	$17,413,010
Total Present Worth	**$29,600,943**

Present Worth (P) = Annual Cost (A) x $\frac{(1+n)^{n}-1}{i(1+i)^{n}}$

i= **4.125%**
n= **20**

$\frac{(1+i)^{n}-1}{ix(1+i)^{n}}$ **13.44113095**

Table VII-2
OPTION #2 - MEMBRANE BIOREACTORS
Opinion Of Probable Construction And O&M Costs
CITY OF KIEL, WISCONSIN
Wastewater Treatment System - Facilities Plan | 2017 Update

Capital Construction Costs **Item**		**Service Life**	**Replacement Cost**	**Salvage Value**
Miscellaneous				
▪ Mechanical and Structural Demolition	$26,000	--	--	--
▪ Dewatering	$30,000	--	--	--
▪ Tank Cleaning (Pri. Clar., AB, Digesters)	$105,000	--	--	--
▪ Painting (Digesters, Digester Bldg. Expansion)	$253,000	20	$0	$0
Site Work				
▪ Underground Piping (20" P.E., 20" FE, 16" RAS, 6" WAS)	$73,000	40	$0	$36,500
▪ Buried Air Main Replacement (24" Main, 20" to N, 16" to S)	$140,000	40	$0	$70,000
▪ Relocate Flare	$10,000	--	--	--
▪ Grading and Landscaping	$42,000	40	$0	$21,000
▪ Paving	$196,000	20	$0	$0
Structures				
▪ Primary Clarifier Repairs	$30,000	20	$0	$0
▪ Aeration Basin Repairs	$10,000	20	$0	$0
▪ Aeration Basin Modifications	$21,000	40	$0	$10,500
▪ MBR Equipment Building	$158,000	40	$0	$79,000
▪ Chlor/Dechlor Gas Storage Room Modifications	$10,000	40	$0	$5,000
▪ Digester Building Expansion	$420,000	40	$0	$210,000
▪ Admin. Bldg. Maintenance Addition	$173,000	40	$0	$86,500
Equipment				
▪ Replace Fine Screen Baskets	$16,000	20	$0	$0
▪ Pri. Clarifier Drives, Mechanisms, Weirs, Baffles (Typ 2)	$201,000	20	$0	$0
▪ Primary Sludge Pumps (3)	$75,000	10	$75,000	$0
▪ Aeration Splitter Box Gates (3)	$39,000	40	$0	$19,500
▪ MBR Equipment	$2,040,000	20	$0	$0
▪ Aeration Systems (3 Trains)	$160,000	20	$0	$0
▪ New Aeration Blowers (4 @ 250hp)	$660,000	20	$0	$0
▪ Digester Covers and Mixers	$585,000	20	$0	$0
▪ Digester Recirc Pumps (2)	$50,000	10	$50,000	$0
▪ Sludge Transfer Pumps (2)	$50,000	10	$50,000	$0
▪ Boiler/Heat Exchanger (2)	$310,000	20	$0	$0
Equipment Subtotal	**$4,186,000**			
Equipment Installation (20% of Equipment)	$837,200	--	$35,000	$0
Mechanical (Process Piping, Plumbing, HVAC) (30% Equip.)	$1,255,800	40	$0	$627,900
Electrical	$819,000	40	$0	$409,500
Controls and SCADA	$583,000	10	$583,000	$0
Biosolids Infrastructure (Donohue)	$396,000	40	$0	$198,000
Biosolids Equipment and Material (Donohue)	$1,710,000	20	$0	$0
Biosolids Instruments and Controls (Donohue)	$60,000	10	$60,000	$0
Subtotal	$11,544,000	--	$853,000	$1,773,400
General Conditions, Bonds, Insurance (7%)	$808,080	--	--	--
Total	$12,352,080	--	$853,000	$1,773,400
Contingencies (15% of Total)	$1,852,812	--	--	--
Engineering (15% of Total)	$1,852,812	--	--	--
Grand Total	$16,057,704		$853,000	$1,773,400
Present Worth of Total	**$16,275,028**		$569,375.65	$352,051.44

Present Worth (P) = Future (F) x $(1+i)^{-n}$

i = **4.125 %**
n = **10 (Replacement)**
n = **40 (Salvage)**

$(1 + i)^{-n}$ = **0.667497826 (Replacement)**
$(1 + i)^{-n}$ = **0.198517786 (Salvage)**

Operation and Maintenance Costs	
Labor/Maintenance	$56,900
Power	$206,650
Chemical	$72,227
Replacement (5% Equipment)	$251,160
Parts & Supplies (2% Equipment)	$100,464
Biosolids Polymer (Donohue)	$93,400
Biosolids Parts (Donohue)	$20,325
Biosolids Power (Donohue)	$112,600
Total Annual	$913,726
O&M Present Worth	$12,281,511
Capital Present Worth	$16,275,028
Total Present Worth	**$28,556,539**

Present Worth (P) = Annual Cost (A) x $\frac{(1+n)^n-1}{i(1+i)^n}$

i= **4.125%**
n= **20**

$\frac{(1+i)^n-1}{ix(1+i)^n}$ **13.44113095**

- Chapter IX -
RECOMMENDED PLAN

A. INTRODUCTION

Based upon the 'Alternatives Evaluation & Preliminary Screening', 'Cost Effectiveness Analysis', and 'Environmental Assessment', the Recommended Plan for the City of Kiel Wastewater Treatment Facility improvements include:

- Upgrading and expanding the existing activated sludge process;
- Upgrading the anaerobic digestion process to utilize two (2) primary digesters;
- Utilizing only primary sludge in the anaerobic digestion process, and diverting Waste Activated Sludge (WAS) to dewatering;
- Upgrading biosolids dewatering to screw press technology and incorporating a dryer as the Class A biosolids process, and locating the equipment in the existing Sludge Storage Building (080);
- Upgrading to disc-type filters to comply with changed phosphorus limits, at a future date;
- Continuing with on-going Infiltration/Inflow (I/I) reduction programs; and
- Phasing construction to allow fiscally-responsible spending to coincide with future increases in flows and loadings, and requirements related to permit changes.

B. DESCRIPTION

Figure IX-1 is a graphic representation of the liquid flow train through the treatment process. Figure IX-2 is a graphic representation of the solids handling and biosolids management train. The biogas management train is depicted in Figure IX-3. The design criteria for the Recommended Plan is summarized in Table IX-1. A detailed description of the Recommended Plan follows.

1. Plant-Wide

a. Instrumentation & Controls
b. Supervisory Control & Data Acquisition (SCADA) System
c. Administration Building HVAC
d. Laboratory Countertops
e. Storage, Maintenance Space, Vehicle Storage
f. Tank Cleaning (primaries, aeration, secondary clarifiers, digesters)
g. Tank Painting (digesters)
h. Grading & Landscaping
i. Site Paving
j. Primary Effluent Piping
k. Final Effluent Piping
l. Electrical Gear

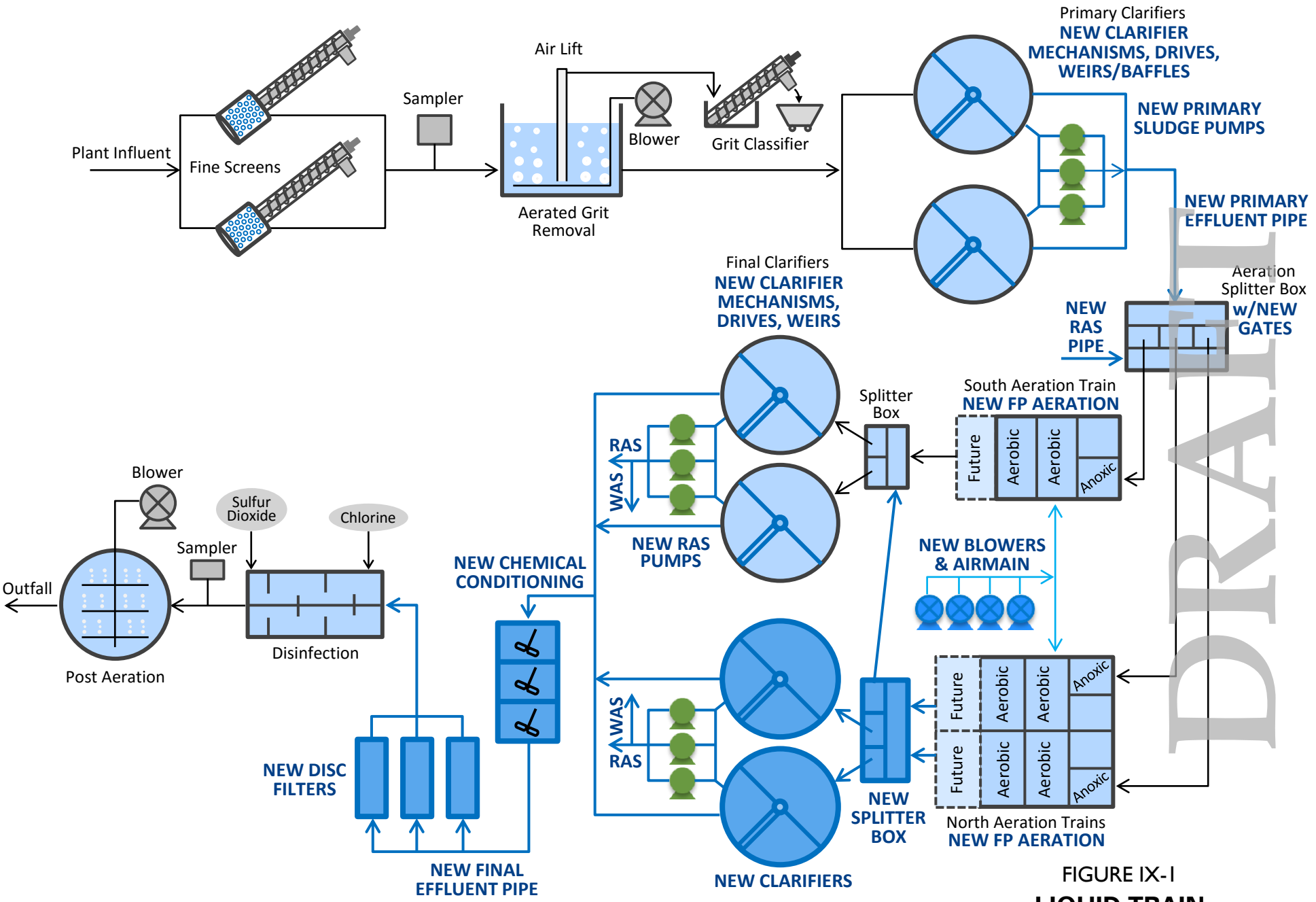

FIGURE IX-1

LIQUID TRAIN

WWTF - FACILITY PLAN AMENDMENT #1
CITY OF KIEL, WISCONSIN
McM #K0015-9-16-00949.02 3/20/17
ID: PPT\2017\MCM WI\KIEL-AMENDMENT 1 TO WWTF FACILITIES PLAN.PPTX TJK:jmk

McMAHON ENGINEERS ARCHITECTS

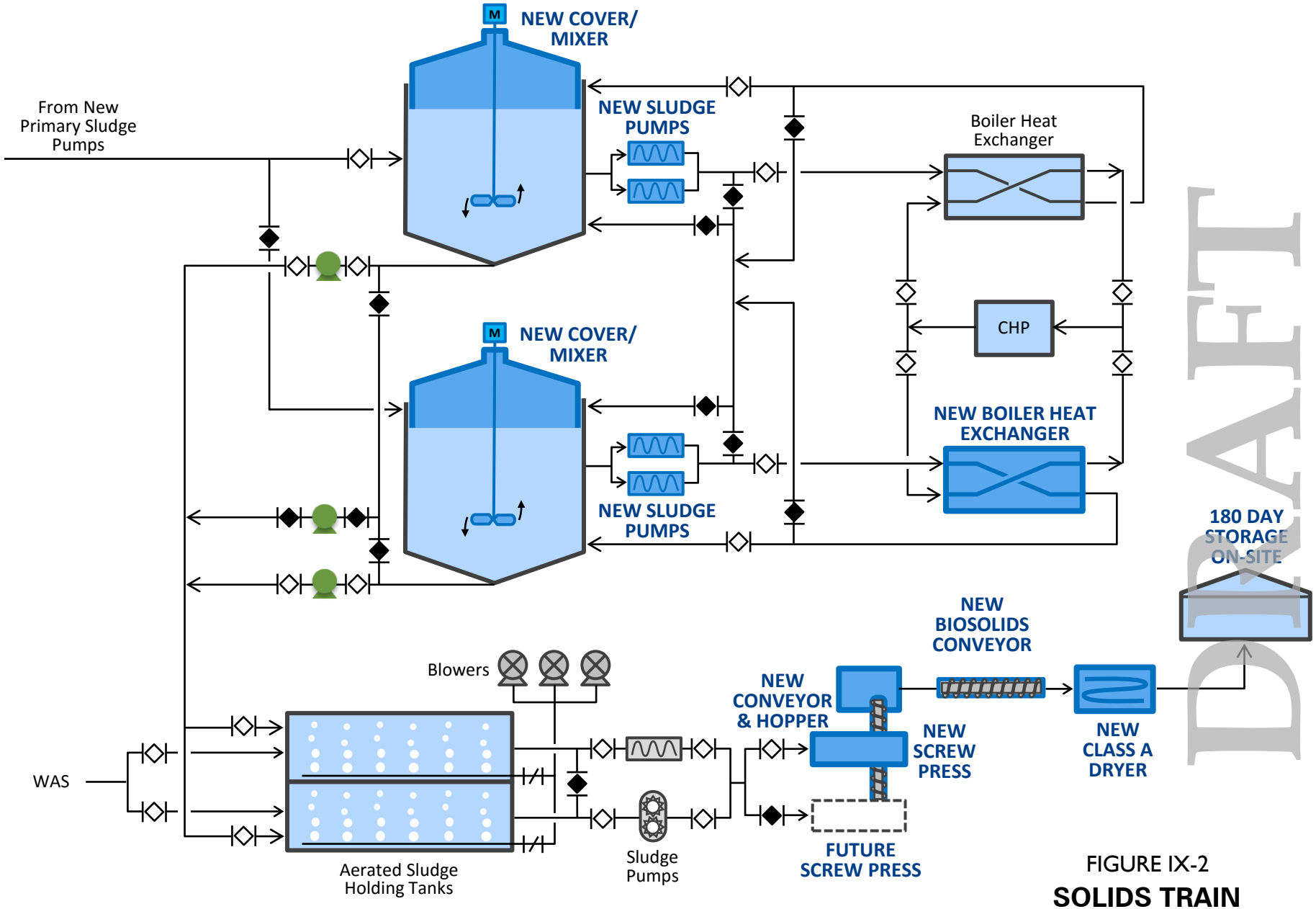

FIGURE IX-2

SOLIDS TRAIN

WWTF - FACILITY PLAN AMENDMENT #1
CITY OF KIEL, WISCONSIN
McM #K0015-9-16-00949.02 3/20/17
ID: PPT\2017\MCM WI\KIEL-AMENDMENT 1 TO WWTF FACILITIES PLAN.PPTX TJK:jmk

McMAHON ENGINEERS ARCHITECTS

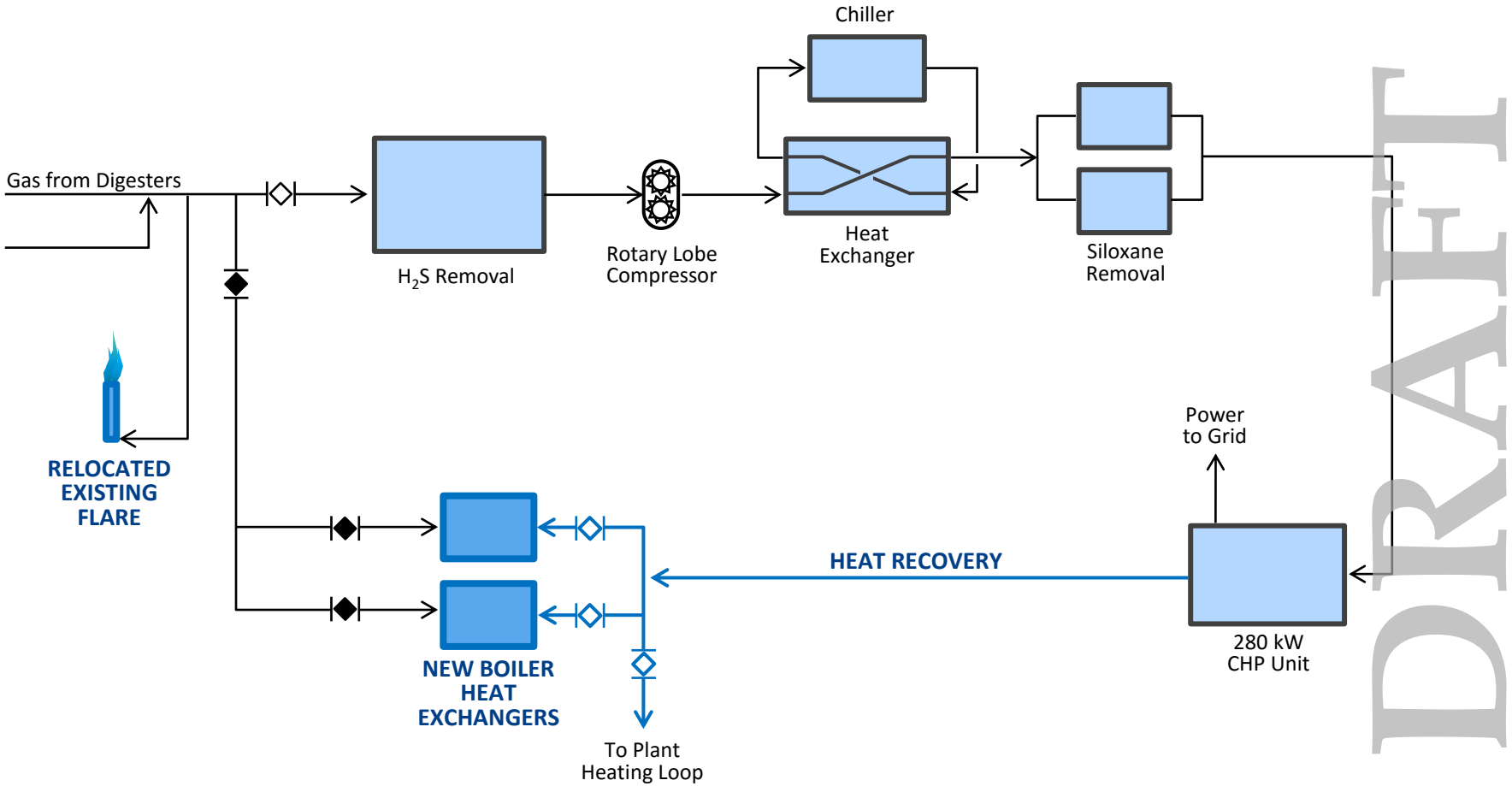

FIGURE IX-3

BIOGAS SCHEMATIC

WWTF - FACILITY PLAN AMENDMENT #1

CITY OF KIEL, WISCONSIN

McM #K0015-9-16-00949.02 3/20/17

ID: PPT\2017\MCM WI\KIEL-AMENDMENT 1 TO WWTF FACILITIES PLAN.PPTX TJK:jmk

McMAHON ENGINEERS ARCHITECTS

2. Primary Clarifiers

a. Repair Structural Cracks
b. Replace Clarifier Mechanisms & Drives
c. Replace Weirs & Baffles
d. Provide Three (3) New Positive Displacement (PD) Sludge Pumps

3. Activated Sludge System

a. Replace Splitter Box Gates
b. Repair Spalled Concrete
c. Buried Air Main
d. Aeration System Headers & Diffusers In Existing Tankage
e. Aeration Blowers
f. Add Two (2) 40-foot Diameter Secondary Clarifiers
g. Replace Mechanisms/Weirs/Baffles In Existing Secondary Clarifiers
h. Aeration Tank Cleaning

4. Effluent Filters

a. Add Chemical Conditioning System
b. Replace Existing Filters With Disk-Type

5. Disinfection System

a. Gas Storage Room Modifications.

6. Digesters

a. Replace Covers
b. Add Mixing Systems
c. Address Class I, Division 1 Compliance
d. Add Boiler / Heat Exchanger
e. Recirculation Pumps
f. Relocate Flare
g. Relocate Condensate Drain In Service Building
h. Clean & Coat Tank Interiors
i. Cover Exterior Brick With Insulated Cladding

7. Dewatering

a. Screw Press With Consideration For A Second, Future System
b. Biosolids Conveyor
c. Hoisting Equipment

8. Class A Process

a. Hot Air Dryer System With Vacuum
b. Feed Hopper
c. Conveyors

9. 180-Day Biosolids Storage

a. Continued Use Of Existing Building.

Table IX-1

RECOMMENDED PLAN
WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
INFLUENT PUMPING (River Road Lift Station)	
▪ Number Of Pumps	3
▪ Capacity, each pump, gpm	1,150
▪ Station Firm Capacity, mgd	2.42
▪ Type Of Pump	Dry Pit-Immersible
INFLUENT SCREENING	
▪ Number Of Units	2
▪ Type	Spiral
▪ Capacity, each unit, mgd	4.30
▪ Clear Opening, mm	6
GRIT REMOVAL	
▪ Type Of Unit	Aerated
▪ Number Of Units	1
▪ Capacity, each unit, mgd	6.2
PRIMARY CLARIFIERS	
▪ Number Of Units	2
▪ Diameter, each unit, feet	2@28
▪ Sidewater (SWD) Depth, each unit, feet	2@12.31
▪ Surface Overflow Rate, gpd/sq.ft.	
▪ Average Flow, 1.34 mgd	2@1,089
▪ Peak Hour Flow, 5.06 mgd	2@4,114
▪ Weir Loading Rate, gpd/ft.	
▪ Average Flow, 1.34 mgd	2@4,542
▪ Detention Time, hours	
▪ Average Flow, 1.34 mgd	2@2.0
▪ Maximum Day Flow, 3.85 mgd	2@0.7
▪ Removal Efficiencies	
▪ BOD, %	21
▪ SS, %	50
▪ TKN	10
▪ Primary Sludge, lbs./day	
▪ Average Day	2,552
▪ Maximum 30-Day	3,694
▪ Volatile Sludge, lbs./day	
▪ Average Day (78% VSS)	1,991
▪ Maximum 30-Day (78% VSS)	2,881

Table IX-1

RECOMMENDED PLAN
WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
PRIMARY CLARIFIERS (continued)	
▪ Primary Sludge, gpd @ x% solids	3
▪ Average Day	10,200
▪ Maximum 30-Day	14,764
SECONDARY TREATMENT SYSTEM	
▪ Design Loadings To Secondary, lbs./day	
▪ Biochemical Oxygen Demand (BOD)	
▫ Average Day	6,517
▫ Maximum Day	16,501
▫ Maximum 30-Day	8,389
▪ Total Kjeldahl Nitrogen (TKN) (includes sidestreams), lbs./day	
▫ Average Day	775
▫ Maximum Day	1,783
▫ Maximum 30-Day	1,240
▪ Phosphorus (P), lbs./day	
▫ Average Day	174
▫ Maximum Day	563
▫ Maximum 30-Day	221
▪ Existing Aeration Tanks, size, ft.	6@65x32 + 3@64x28
▪ Proposed Aeration Tanks, size, ft.	2@65x32 + 1@64x28
▪ SWD, ft.	14
▪ Total Tank Volume, cu.ft.	333,312
▪ Anoxic Selector, ft.	1@30x28 + 2@30x32
▪ Anoxic Volume, cu.ft.	38,640
▪ Anoxic / Aerobic Ratio	0.13
▪ Aerobic Volume, cu.ft.	294,672
▪ BOD Loading, lbs./1,000 cu.ft.	
▪ Average Day	22.1
▪ Maximum 30-Day	28.5
▪ Design MLSS, mg/L	
▪ Average	3,275
▪ Maximum Month	3,510
▪ Design F:M	
▪ Average	0.10
▪ Design Sludge Retention Time (SRT), Days	
▪ Average	20
▪ Volatile Solids, %	75%
▪ Total Sludge Production, lbs. SS/lb. BOD	0.67
▪ Secondary Sludge, lbs./day	
▪ Average	4,366
▪ Maximum 30-Day	5,621
▪ WAS To Dewatering, gpd @ 1%	
▪ Average	52,350
▪ Maximum Month	67,398

Table IX-1

RECOMMENDED PLAN
WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
SECONDARY TREATMENT SYSTEM (continued)	
▪ Oxygen Requirements, lbs./day @ 1.5 lb. O2/lb. BOD Applied & 4.6 lb. O2/lb. TKN Applied	
▪ Average Day	13,341
▪ Maximum Day	32,953
▪ Maximum Month	18,288
▪ Air Requirements, scfm	
▪ Average Day	4,581
▪ Maximum Day	12,745
▪ Maximum Month	6,545
▪ Blowers	
▪ Number Of New PD Blowers (3-Duty + 1 Standby)	4
▪ Capacity, each new unit, scfm	4,249
▪ Discharge Pressure, psig	8.0
▪ Firm Capacity, scfm	12,747
SECONDARY CLARIFIERS	
▪ Number Of Units	4
▪ Diameter, ft.	4@40
▪ SWD, ft.	14.25
▪ Surface Settling Rate, gpd/sq.ft.	
▪ Average Flow, 1.24 mgd	247
▪ Peak Hour Flow, 4.96 mgd	987
▪ Weir Loading, gpd/ft.	
▪ Average Flow, 1.24 mgd	1,396
▪ Peak Hour Flow, 4.96 mgd	5,586
▪ Detention Time, hours	
▪ Average Flow, 1.24 mgd	10.4
▪ Peak Hour Flow, 4.96 mgd	2.6
▪ Solids Loading, lbs./hour/sq.ft.	
▪ Average Flow, 1.24 mgd	0.56
▪ Peak Hour Flow, 4.96 mgd	2.10
FILTERS	
▪ Filtration Rate, gpm/sq.ft.	
▪ Average Flow, 1.24 mgd (firm)	0.92
▪ Peak Hour Flow, 4.96 mgd (firm)	3.66
DISINFECTION	
Number Of Tanks	2
Total Volume, gallons	60,250
Detention Time, minutes	
▪ Average Flow, 1.24 mgd	70.0
▪ Peak Hour Flow, 4.96 mgd	17.5
ANAEROBIC DIGESTION	
▪ Number Of Digesters	
▪ Primary	2
▪ Secondary	0
▪ Diameter, feet	2@45

Table IX-1

RECOMMENDED PLAN
WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
ANAEROBIC DIGESTION (continued)	
▪ Maximum SWD, feet	
▪ North Digester	26
▪ South Digester	21
▪ Maximum Volume, gallons	
▪ North Digester	342,537
▪ South Digesters	269,652
Total	612,189
▪ Mixing System	Linear Motion
▪ Cover Type	
▪ North Digester	Gas Holder
▪ South Digester	Gas Holder
▪ Maximum Month HRT, days	
▪ North Digester	8.4
▪ South Digester	6.6
Total	15.0
▪ Digestion Capacity, gpd	40,812
▪ Maximum Month VSS Loading, lbs. VSS/KCF	35.2
▪ VSS Destruction, %	50
▪ Heat Exchanger Capacity, gpd	41,000
▪ Sludge To Dewatering, lbs./day	
▪ Average	1,556
▪ Maximum Month	2,253
▪ Anaerobic Sludge To Dewatering, gpd @ 1.83%	
▪ Average	10,195
▪ Maximum Month	14,764
SLUDGE HOLDING TANKS	
▪ Number Of Tanks	2
▪ Size, ft.	2 @ 62'x 25'x 16' SWD
▪ Volume, gallons, each	185,500
▪ Volume, gallons, total	371,000
▪ Solids, % After Decanting	2.0
▪ 2% Sludge From Outside Sources, gallons/week	0
▪ Sludge To Dewatering, lbs./day	
▪ Average	5,922
▪ Maximum Month	7,874
▪ Sludge To Dewatering, gpd @ 2%	
▪ Average	35,504
▪ Maximum Month	47,206
SLUDGE DEWATERING [1]	
▪ Number Of Units	1
▪ Capacity, each	
▪ gpm	49.5
▪ lbs./hour	247
▪ lbs./day	5,922
▪ Hours Of Operation/Day	24
▪ Average Days Of Operation/Week	4
▪ Cake Solids, %, minimum	18.5

Table IX-1

RECOMMENDED PLAN
WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
CLASS A DRYING PROCESS (Belt Dryer w/Vacuum) [1]	
▪ Number Of Units	1
▪ Minimum % Solids	90
▪ Hours Of Operation/Day	24
▪ Days Of Operation/Week	4

(1) By Donohue & Associates

C. IMPLEMENTATION

The Recommended Plan includes two (2) phases of construction.

1. Phase I

Phase I of the Recommended Plan includes work associated with the activated sludge process and related electrical and SCADA improvements, and the Administration Building maintenance area. Specifically, the following items are included in Phase I:

a. PTFE-coated fine pore membrane aeration system for existing aeration tankage.
b. Four (4) new aeration blowers.
c. Two (2) new secondary clarifiers.
d. Two (2) new mechanisms, weirs, baffles for existing secondary clarifiers.
e. Administration Building maintenance area addition.
f. Electrical and SCADA system upgrades for items noted above.
g. Replace splitter box gates.
h. Repair spalled aeration basin concrete.
i. Buried ductile iron air main.

By including the above items into Phase I, the most pressing needs of the treatment works can be addressed first, while minimizing the initial project cost.

Additionally, the City of Kiel proposes to directly procure the following major equipment items related to Phase I:

a. PTFE-coated fine pore membrane aeration system for the existing aeration tankage.
b. Four (4) aeration blowers.
c. Four (4) secondary clarifier mechanisms, drives, weirs, baffles.

2. Phase II

Phase II of the Recommended Plan includes the remaining items, which are not part of Phase I. Specifically, the following items are included in Phase II:

a. Miscellaneous:

1) Plant-wide instrumentation and controls.
2) Plant-wide SCADA system.
3) Primary clarifier and digester cleaning.
4) Grading/landscaping.
5) Primary effluent and final effluent piping.
6) Plant-wide electrical gear.
7) Administration Building HVAC.
8) Laboratory countertops.
9) Site paving.

b. Primary Clarifiers:

1) Repair structural cracks.
2) Replace mechanisms, drives, weirs, baffles.
3) Provide three (3) new positive displacement sludge pumps.

c. Disinfection System:

1) Gas Storage Room modifications.

d. Digesters:

1) Replace covers.
2) Add mixing systems.
3) Address Class I, Division 1 compliance.
4) Two (2) boiler / heat exchangers.
5) Recirculation pumps.
6) Relocate flare.
7) Relocate condensate drain in Service Building.
8) Clean and coat digester interior.
9) Cover exterior brick with insulated cladding.

e. Dewatering:

1) One (1) new screw press.
2) Biosolids conveyor.
3) Hoisting equipment.

f. Class A Process:

1) Hot air dryer with vacuum.
2) Feed hopper.
3) Conveyors.

g. Activated Sludge:

1) Additional aeration tankage and diffusers.

Upon completion of the Phase I improvements, the Phase II upgrades address the most pressing needs of the treatment works.

D. CAPITAL COST

The Opinion Of Probable Construction Costs [(1)] for the Recommended Plan, including engineering and contingencies, is summarized below for each of the two (2) phases. A detailed breakdown of these costs is provided for each phase in Table IX-2.

1. Phase I

Capital Cost	$4,040,000
Engineering, Legal, Administration, Contingencies	1,514,700
TOTAL	$5,554,700

2. Phase II

Capital Cost	$8,237,500
Engineering, Legal, Administration, Contingencies	3,220,800
TOTAL	$11,458,300

[The remainder of this page was left blank intentionally.]

Table IX-2

RECOMMENDED PLAN
Opinion Of Probable Construction Cost - Phase I

Miscellaneous	
▪ Dewatering	$15,000
▪ Tank Cleaning (aeration basins, secondary clarifiers)	$63,000
▪ Miscellaneous Metals	$35,000
Site Work	
▪ Underground Piping (18-inch AB, 8-inch RAS, 4-inch WAS)	$66,000
▪ Buried Ductile Iron Air Main	$140,000
▪ Grading & Landscaping	$30,000
Structures	
▪ Aeration Basin Repairs	$10,000
▪ Secondary Clarifiers & Pump Room	$490,000
▪ Administration Building Maintenance Area	$173,000
Equipment	
▪ Aeration Splitter Box Gates	$39,000
▪ Aeration Systems	$160,000
▪ Aeration Blowers	$660,000
▪ Secondary Clarifier Drives, Mechanisms, Weirs, Baffles	$525,000
▪ Secondary Clarifier Launder Covers	$80,000
▪ RAS Pumps	$150,000
▪ WAS Pumps	$50,000
▪ Scum Pumps	$30,000
Equipment Subtotal	**$1,694,000**
Equipment Installation (20% of Equipment)	$338,800
Mechanical Piping (30% of Equipment)	$508,200
Electrical	$225,000
Controls & SCADA	$252,000
Subtotal	**$4,040,000**
General Conditions, Bonds, Insurance (7% of Subtotal)	$282,800
Total	**$4,322,800**
Contingencies (15% of Total)	$648,400
Engineering	$583,500
GRAND TOTAL	**$5,554,700**

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Table IX-2
(continued)

RECOMMENDED PLAN
Opinion Of Probable Construction Cost - Phase II

Miscellaneous	
▪ Mechanical & Structural Demolition	$26,000
▪ Dewatering	$15,000
▪ Tank Cleaning (primaries, digesters)	$63,000
▪ Miscellaneous Metals	$22,000
▪ Painting (digesters, Digester Building)	$253,000
Site Work	
▪ Underground Piping (20-inch PE, 20-inch FE)	$90,000
▪ Relocate Flare	$10,000
▪ Grading & Landscaping	$23,000
▪ Paving	$196,000
Structures	
▪ Primary Clarifier Repairs	$30,000
▪ North Aeration Basins	$552,000
▪ South Aeration Basin Conversion	$50,000
▪ Chlorination/Dechlorination Storage Room Modifications	$10,000
▪ Digester Building	$420,000
Equipment	
▪ Primary Clarifier Drives, Mechanisms, Weirs, Baffles	$201,000
▪ Primary Sludge Pumps	$75,000
▪ Disc Filters	$906,000
▪ Digester Covers & Mixers	$585,000
▪ Digester Recirculation Pumps	$50,000
▪ Sludge Transfer Pumps	$50,000
▪ Boiler / Heat Exchangers	$310,000
Equipment Subtotal	**$2,177,000**
Equipment Installation (20% of Equipment)	$435,400
Mechanical Piping (30% of Equipment)	$653,100
Electrical	$668,000
Controls & SCADA	$378,000
Biosolids Infrastructure	$396,000
Biosolids Equipment	$1,710,000
Biosolids Instruction / Controls	$60,000
Subtotal	**8,237,500**
General Conditions, Bonds, Insurance (7% of Subtotal)	$576,600
Total	**$8,814,100**
Contingencies (15% of Total)	$1,322,100
Engineering (15% of Total)	$1,322,100
GRAND TOTAL	**$11,458,300**

E. POTENTIAL COST IMPACT

The City of Kiel is utilizing private financing for the projects, and will not be utilizing Clean Water Fund (CWF) program funding. The City Of Kiel has prepared a sewer user rate study utilizing the two (2) phase project approach. The results are summarized in Appendix IX-1.

F. SCHEDULE

A proposed Implementation Schedule is shown below:

- Public Hearing..... _____
- Submit Facility Plan To Wisconsin DNR..... _____
- Begin Equipment Procurement Process..... _____
- Wisconsin DNR Facility Plan Approval..... _____
- Phase I -
  - Equipment Procurement Bidding ..... _____
  - Drawings & Specification Submittal..... _____
  - Bidding ..... _____
  - Secure Project Financing..... _____
  - Substantial Completion..... _____
  - Project Close-Out..... _____
- Phase II -
  - Equipment Procurement Process ..... _____
  - Equipment Procurement Bidding ..... _____
  - Drawings & Specification Submittal..... _____
  - Bidding ..... _____
  - Substantial Completion..... _____
  - Project Close-Out..... _____

(1) The Opinion Of Probable Cost was prepared for use by the Owner in planning for future costs of the project. In providing Opinions Of Probable Cost, the Owner understands that the Design Professional has no control over costs or the price of labor, equipment or materials, or over Construction Professionals' method of pricing, and that the Opinions Of Probable Cost provided herewith are made on the basis of the Design Professional's qualifications and experience. It is not intended to reflect actual costs, and is subject to change with the normal rise and fall of the local area's economy. This Opinion must be revised after every change made to the project or after every 30-day lapse in time from the original submittal by the Design Professional.

APPENDIX IX-1

CITY OF KIEL
PROJECTED SEWER RATES

Appendix IX-1

WASTEWATER UTILITY SEWER USER RATE STUDY
Summary of Results 2015 to 2022
CITY OF KIEL
Wastewater Treatment Facility - Facility Plan

To Be Replace With New Data

Three (3) Clean Water Fund Loans Construction Complete 2018, 2020, 2022 @2.7%

Year	2015	2016	2017	2018	2019	2020	2021	2022
Capital Upgrades		$1,300,000		$3,500,000		$9,000,000		$6,000,000
O&M Expenses	$1,142,769	$1,099,811	$1,154,802	$1,251,305	$1,595,988	$1,591,250	$1,623,075	$1,655,537
Revenue Requirement	$1,682,830	$1,691,311	$1,750,224	$1,934,293	$2,182,817	$2,898,665	$2,897,595	$3,360,368
Annual Dept Payment on Capital Upgrades	$192,039	$243,477	$243,559	$281,070	$281,070	$878,358	$878,358	$1,270,550
Replacement Fund 5% of Total Active Loan	$80,000	$74,348	$74,356	$78,107	$78,107	$137,836	$137,836	$177,055
User Rate								
Fixed								
5/8	$12.88	$13.26	$13.78	$14.45	$16.40	$23.29	$24.40	$28.90
3/4	$12.88	$13.26	$13.78	$14.45	$16.40	$23.29	$24.40	$28.90
1	$15.28	$15.73	$16.40	$17.20	$19.51	$27.71	$29.04	$34.39
1 1/2	$17.46	$17.98	$18.75	$19.66	$22.30	$31.67	$33.18	$39.39
2	$19.65	$22.03	$20.95	$21.97	$24.93	$35.40	$37.09	$43.92
3	$26.19	$26.96	$27.98	$29.34	$33.29	$47.28	$49.53	$58.66
4	$36.02	$37.08	$38.60	$40.47	$45.92	$65.21	$68.32	$80.91
6	$58.04	$60.67	$62.99	$66.05	$74.94	$106.43	$111.51	$132.05
Volumetric Rate	$2.03	$2.10	$2.11	$2.20	$2.51	$3.42	$3.41	$3.95
BOD Rate/lb	$0.20	$0.24	$0.28	$0.35	$0.39	$0.54	$0.56	$0.68
TSS Rate/lb	$0.31	$0.37	$0.38	$0.47	$0.51	$0.66	$0.68	$0.95
Phos Rate/lb	$2.40	$3.09	$6.77	$7.37	$7.55	$8.66	$9.22	$12.40
Single Family Monthly Average with 600 cubic feet usage	$25.06	$25.86	$26.44	$27.65	$31.46	$43.81	$44.86	$52.60
Percentage Increase for Average Single Family Home		3.09%	2.19%	4.38%	12.11%	28.19%	2.34%	14.71%