Wastewater Treatment Facility
Facilities Plan

Prepared For The

CITY OF KIEL

CALUMET & MANITOWOC COUNTIES
WISCONSIN

AMENDMENT #2 | 2017 Update
DECEMBER 2015

McM. No. K0015-9-15-00262.00

Prepared By
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- Chapter III -
CURRENT SITUATION & NEEDS ASSESSMENT

A. PLANNING AREA DESCRIPTION

The City of Kiel is located mostly in the far southwest corner of Manitowoc County; the western portion of the City is located in Calumet County. The City is located at the intersection of STH 32/57 and STH 67. The Sheboygan River flows through the southeastern one-third of the City. The 20-Year Comprehensive Plan, prepared by Bay-Lake Regional Planning Commission, was adopted by the City on December 10, 2002. Relevant planning area description information provided in the Comprehensive Plan is included in this Facility Plan document.

1. Topography

The topography of the area surrounding the City of Kiel was molded by the last two sub-stages of the Wisconsin Stage of Glaciation. The till left by the glaciers gives the area a Kettle Moraine type topography with gravely hills, kettle shaped holes and coarse, sandy soils. The northwestern area of the City is relatively flat, and there is more relief in the areas closer to the Sheboygan River and especially on the south side of the River. The elevation within the City ranges between approximately 860 to 950-feet about sea level.

2. Geology, Soil Conditions & Hydrology

As described in the Comprehensive Plan, the two different glacial drifts that covered the area formed the landscape and distribution of the soils of the Kiel area. The glacial geology is characterized by glacial debris that was pushed or deposited by each glacial sub-stage to form plains, depressions, valleys and hills.

The following information is provided in the 20-Year Comprehensive Plan regarding the bedrock geology of the area:

> *"A layer of undifferentiated dolomite bedrock from the Silurian age underlies the entire planning area. This series of sedimentary rocks, approximately 75-feet thick, is underlain by a formation known as Maquoketa Shale. Below the Maquoketa Shale area is a group of rock units consisting of sandstone, shale and dolomite, known collectively as the sandstone aquifer. The Maquoketa formation is estimated to be 400 to 450-feet thick. The sandstone aquifer is estimated to be 800 to 850-feet thick."*

The soils in the area consist of the Hochheim-Theresa-Pella Series. These soils are generally well drained and are well suited to building site development. These soils are susceptible to moderate frost action.

3. Hydrology/Surface Water/Wetlands/Floodplains

a. Watersheds:

A significant majority of the City of Kiel drains to the Sheboygan River Watershed. A small area in the northwest corner of the Village drains to the South Branch of the Manitowoc River.

b. Surface Water:

The Sheboygan River bi-sects the City, and the Wastewater Treatment Facility discharges to the River. There are no other surface waters of note within the City limits.

c. Wetlands & Floodplains:

Mapped wetland areas and floodplains within the City are primarily adjacent to the Sheboygan River, as illustrated on Figure III-1. The wetland areas serve an important function by providing flood control during significant precipitation events and spring runoff, they filter pollutants out of water, offer habitat for a variety of plant and animal life and recharge groundwater systems. Wetlands are designated by the State and Federal governments as environmentally sensitive areas that should be protected from development.

As stated in the Comprehensive Plan, floodplains are often viewed as valuable recreational and environmental resources. These areas provide for storm water retention, groundwater recharge and habitat for various kinds of wildlife unique to the water. The 100-year floodplain in the Kiel area is outlined on Figure III-2 and Figure III-3.

The elevation of the roadway around the Wastewater Treatment Facility is 892.0 or greater. The elevation of the existing grade at the perimeter of the site is higher than the roadway. Therefore, the Treatment Facilities are at least 2.0-feet above the 100-year flood elevation.

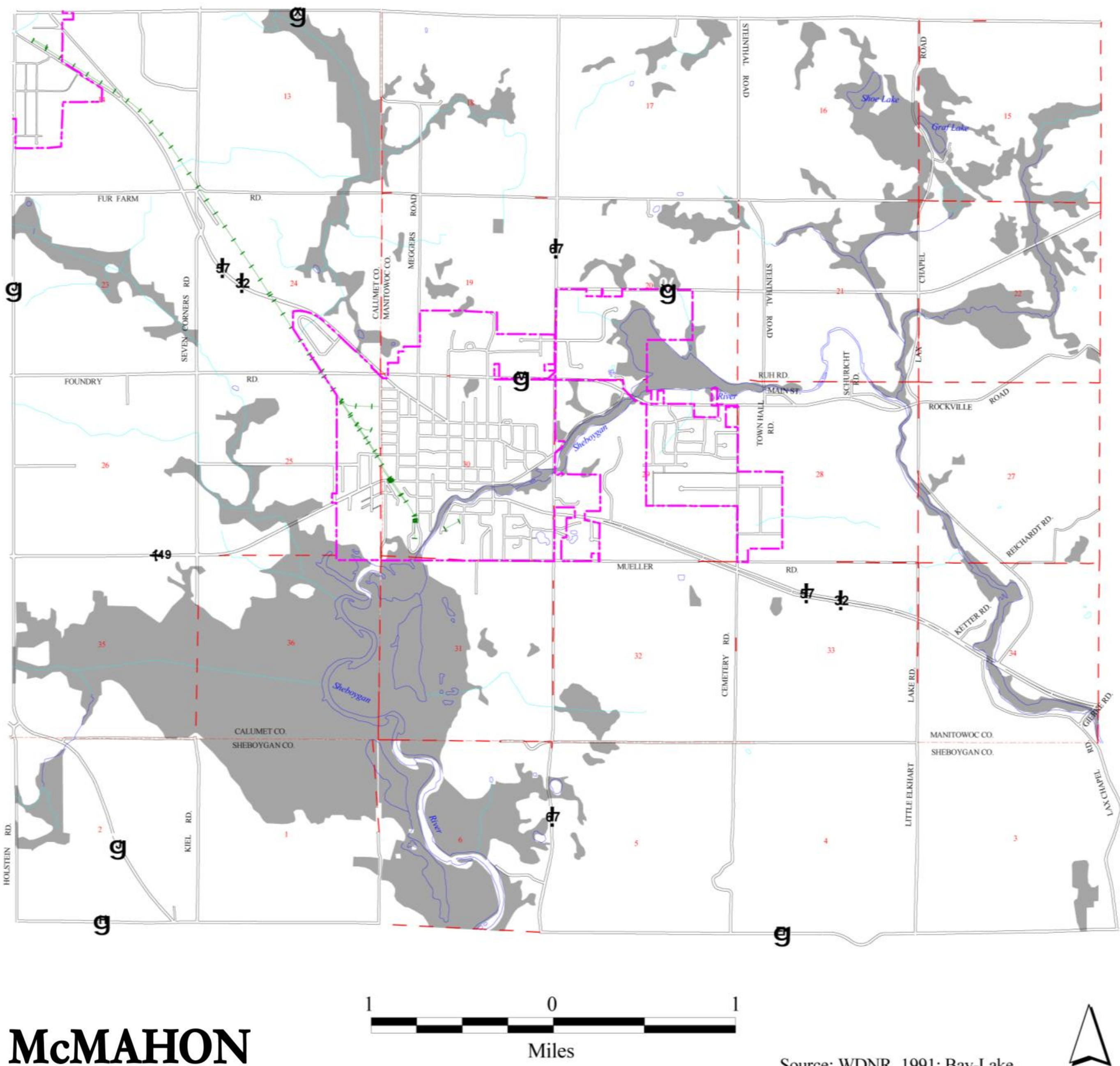
4. Endangered Resources

Information provided on the Wisconsin Department Of Natural Resources (DNR) website, 'Endangered Resources Preliminary Assessment', indicates that no endangered resources have been recorded in the vicinity of the Wastewater Treatment Facility site. No further action is required or recommended with regard to Endangered Resources. A copy of the information obtained from the DNR website is provided in Appendix III-1.

Wetlands

City of Kiel Planning Area

Calumet, Manitowoc & Sheboygan Counties



WDNR Wetlands

Map Features

State Highway

County Highway

City Limits

County Boundary

Local Road

Surface Water Features

Railroad Corridor

Section Line

36 Section Number

Source: WDNR, 1991; Bay-Lake Regional Planning Commission, 2002.

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FIGURE III-1

WETLANDS

FACILITIES PLANNING

CITY OF KIEL, WI

McM #K0015-950262.00 4/29/2015

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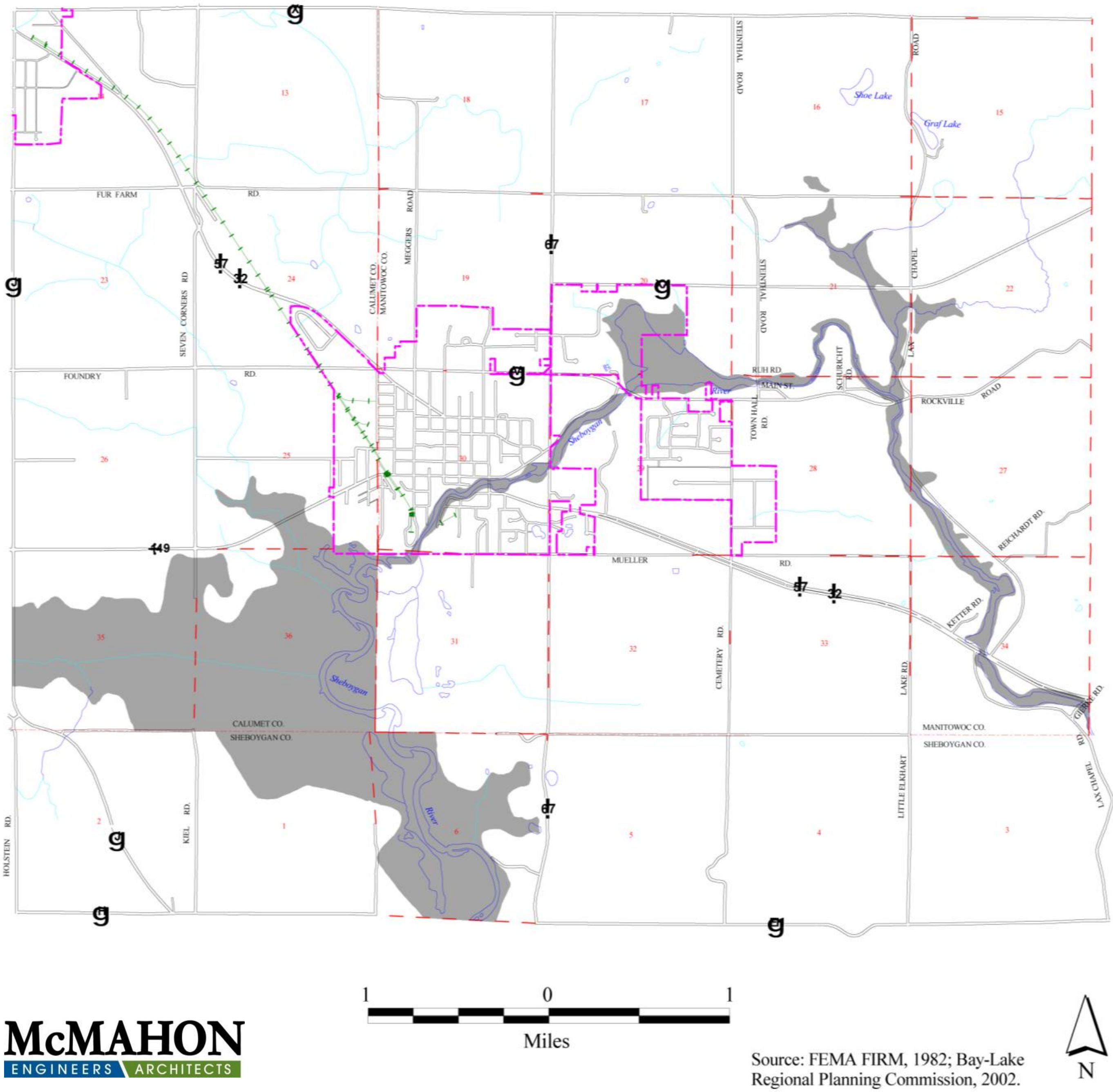

Floodplains

City of Kiel Planning Area

Calumet, Manitowoc & Sheboygan Counties

100 - Year Floodplain*

*Kiel Marsh Wildlife Area is not included in Manitowoc County's Floodplain.

Map Features

- State Highway
- County Highway
- City Limits
- County Boundary
- Local Road
- Surface Water Features
- Railroad Corridor
- Section Line
- 36 Section Number

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Source: FEMA FIRM, 1982; Bay-Lake Regional Planning Commission, 2002.

FIGURE III-2

FLOODPLAINS

FACILITIES PLANNING

CITY OF KIEL, WI

McM #K0015-950262.00 4/29/2015

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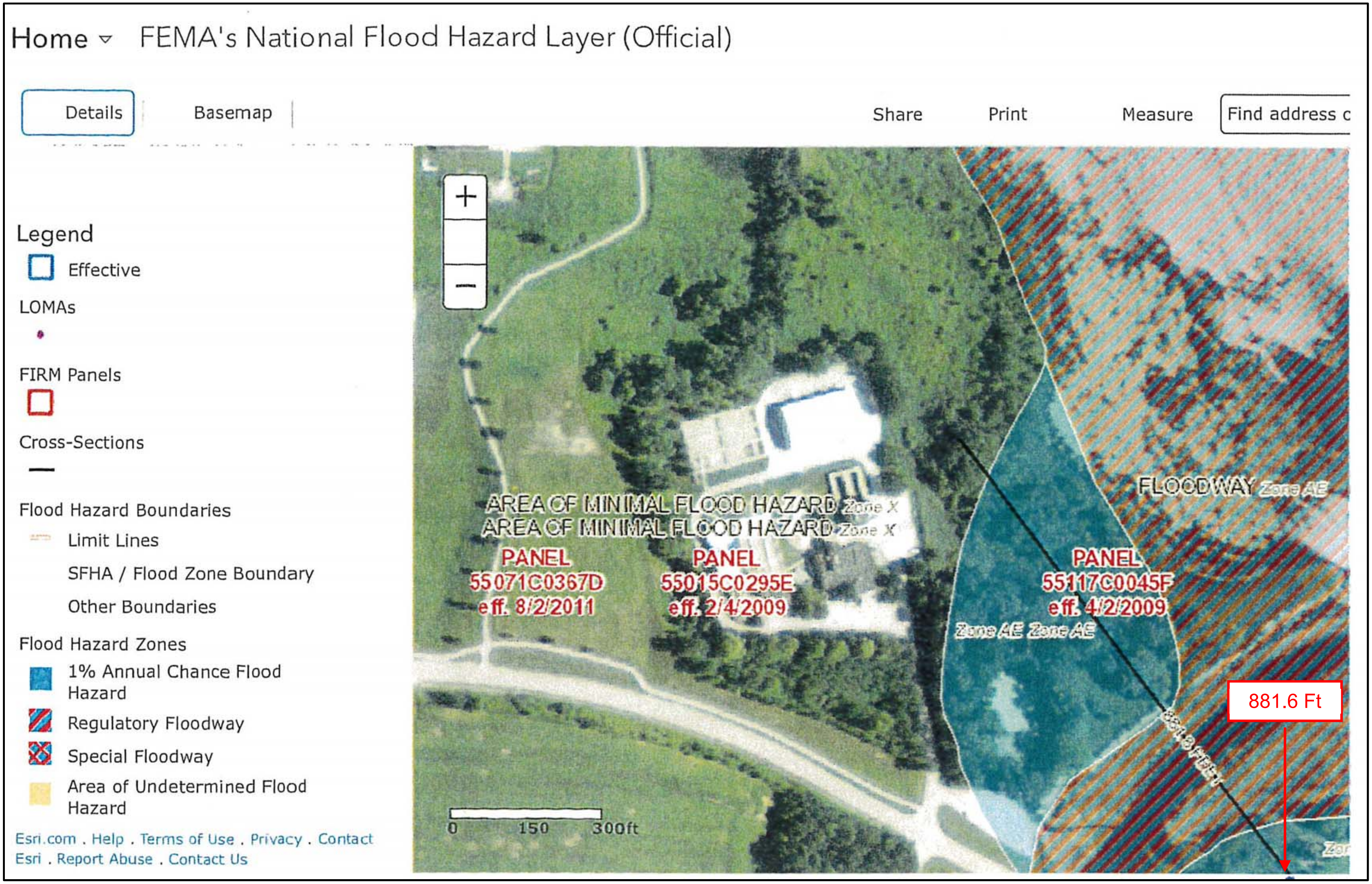


FIGURE III-3
FLOODPLAIN ELEVATION 881.6 Ft
FACILITIES PLANNING
CITY OF KIEL, WI
McM. No. K0015-9-17-00949 | 10/2017 Update

5. Archaeological/Historical/Cultural Resources

A request was made of the DNR Archaeologist to determine if any archaeological sites or historic structures/sites are present in the vicinity of the Kiel Wastewater Treatment Facility. The response received was that there are no recorded historic properties reported to occur within the project location. A copy of the response letter from the DNR is provided in Appendix III-2.

6. Land Use & Demographics

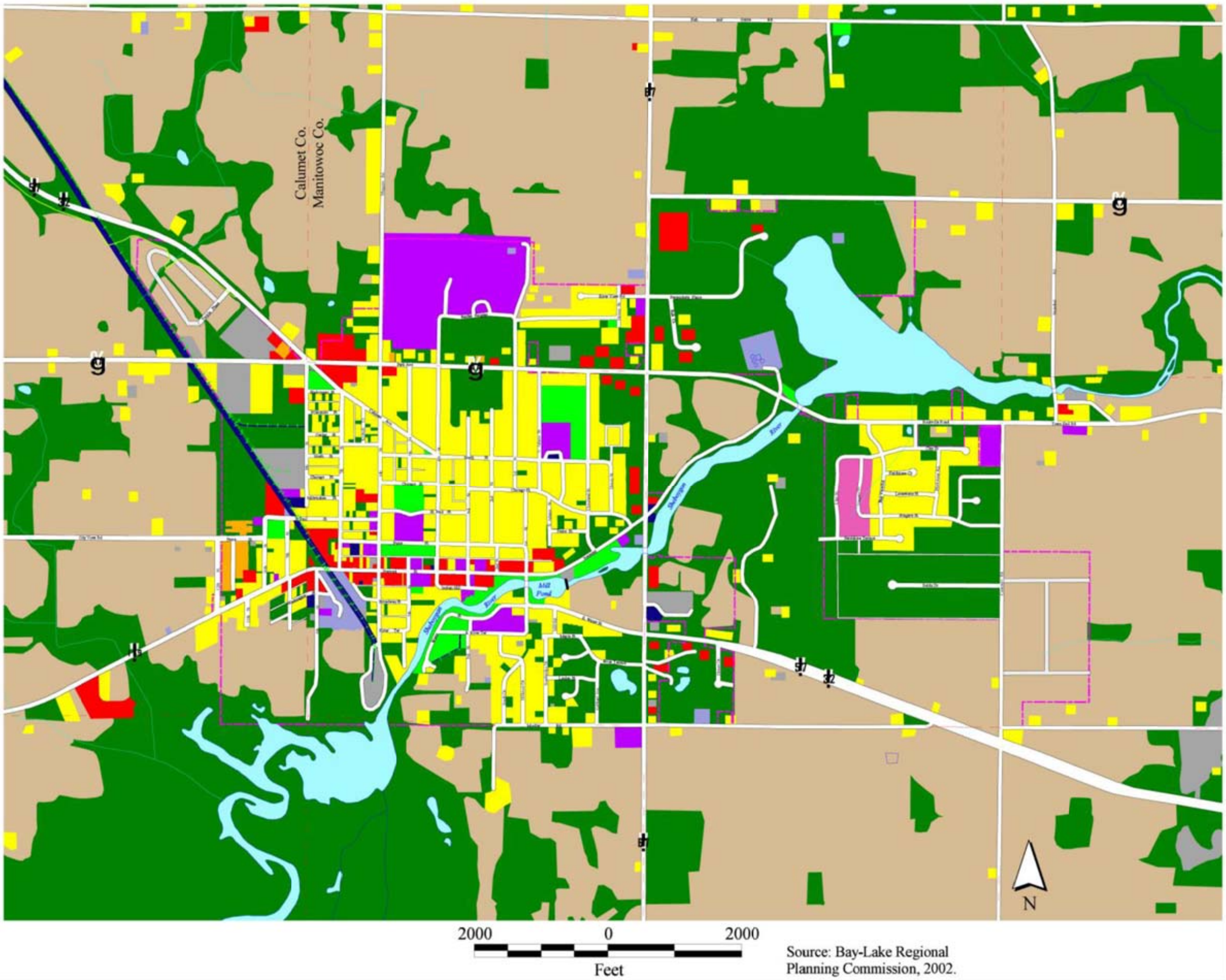
Existing land use within the City of Kiel was identified during the development of the 20-Year Comprehensive Plan in 2001. A map of the existing land use was developed from a field survey conducted in September 2001 by Bay-Lake Regional Planning Commission, and is included as Figure III-4.

A Sewer Service Area Plan has not been developed for the City. Due to the City being under a population of 10,000, the City is not required to develop a Sewer Service Area Plan, as described in NR 121.

The Wisconsin Department of Administration (DOA) annually produces population estimates for Wisconsin municipalities based on prior Census, and analysis of contemporary data including housing units, automobile registrations, residential electric meters and other indicators of population change. The DOA also develops population projections for Wisconsin municipalities. The estimates and projections provided by the DOA are presented in Table III-1, and as illustrated graphically in Figure III-5. The interpolated projected population for 2037 is 4,250. The population projections were submitted to the Bay-Lake Regional Planning Commission for review and comment. The Commission indicated these are the same projections they would use for planning purposes. (Angela Pierce, Natural Resources Planner, Email May 1, 2015). The projected population change from 2017 to 2037 is an increase of 396 persons.

Table III-1

Population Projection - City Of Kiel	
1990 Census	2,910
1995 DOA Estimate	3,047
2000 Census	3,450
2005 DOA Estimate	3,570
2010 Census	3,738
2014 DOA Estimate	3,773
2020 DOA Projection	3,935
2025 DOA Projection	4,075
2030 DOA Projection	4,195
2035 DOA Projection	4,260
2040 DOA Projection	4,235



Source: Bay-Lake Regional Planning Commission, 2002.

2001 Land Use

City of Kiel

Calumet & Manitowoc Counties

- Residential
- Mobile Homes
- Commercial
- Industrial
- Roads
- Transportation
- Communications/Utilities
- Governmental/Institutional
- Parks and Recreation
- Open Space/Fallow Fields
- Agricultural
- Water Features
- Woodlands, Wetlands, Undeveloped Natural Areas
- Land Under Development
- Solomon (Kiel/New Holstein) Trail

Map Features

- State Highway
- County Highway
- City Limits
- County Boundary
- Local Road
- Surface Water Features
- Railroad Corridor
- Section Line
- 36 Section Number

FIGURE III-4

LAND USE

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FACILITIES PLANNING

CITY OF KIEL, WI

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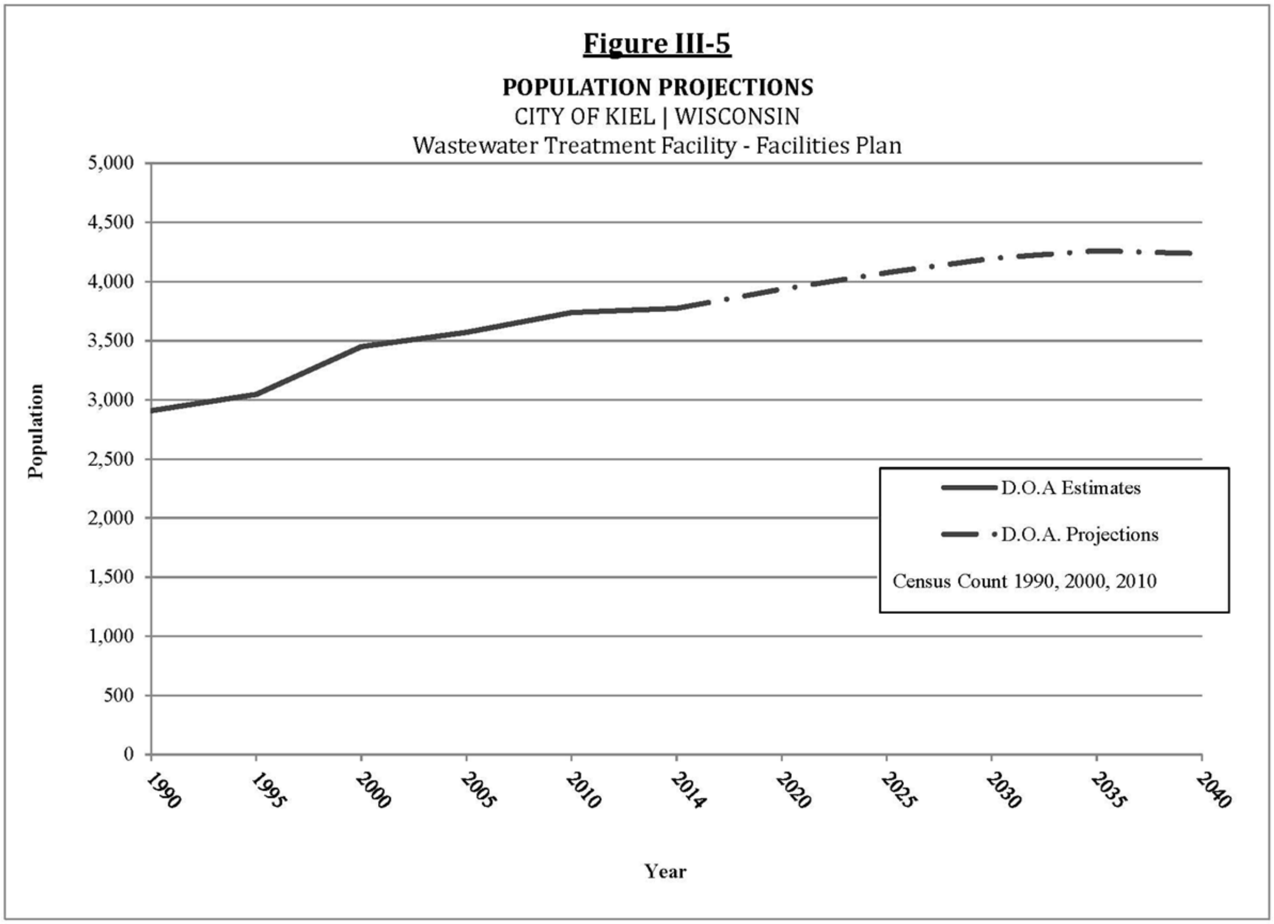


W:\WP\Facility-Plan\K0015\9-17-00949 Amendment #2 (10-2017 Update)\Figures\Figure III-5 - Population Projections.xlsx
10/26/2017

B. INFRASTRUCTURE DESCRIPTION

1. Public Water System

The City of Kiel owns and operates a public water system that serves the properties in the City. Below is a brief summary of various features of the system:

Number Of Customers & Sales Of Water 2014

Type	Number	Gallons Sold
Residential	1,550	64,547,000
Commercial	142	9,797,000
Industrial	16	92,328,000
Public Authority	19	3,292,000
Multifamily Residential	10	2,100,000
Totals	1,737	172,064,000

Water Usage

Total Pumpage Into The System	
Average Day	659,050 gpd
Maximum Day	952,000 gpd
Total GPCD	175 gpcd based on total pumpage to system
Residential GPCD	47 gpcd based on residential metered sales

Water System Infrastructure

Supply - Four Wells	
Well #1	Washington Street
Well #3	North First Street
Well #4	STH 'XX'
Well #5	Clay Street

Storage - Elevated Tanks	
North Tank	200,000-gallons / Constructed 1971
South Tank	200,000-gallons / Constructed 1986

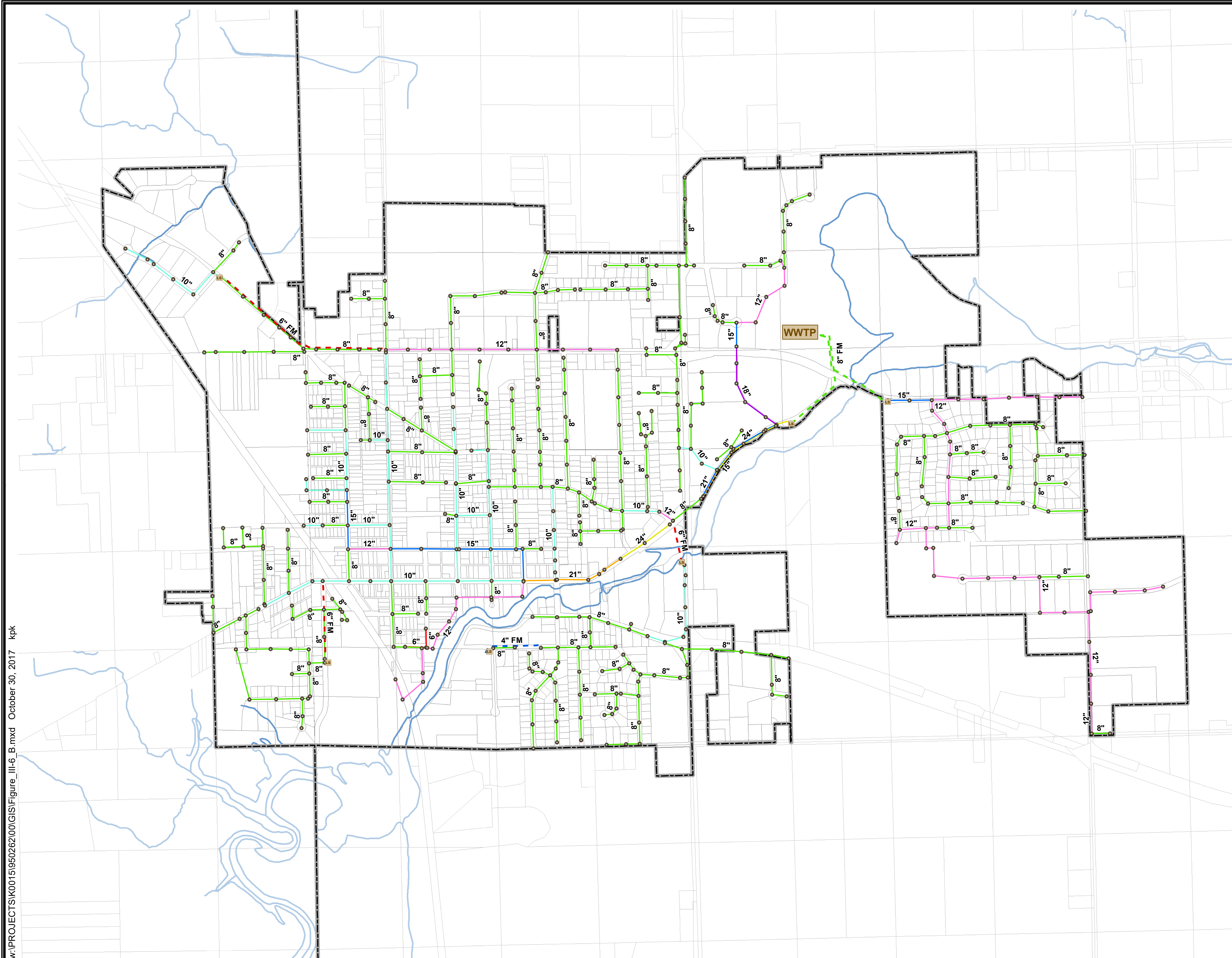
Water Main	Approximately 29-miles, ranging in size from 4-inch diameter to 18-inch diameter

2. Sanitary Sewer Collection System

The City of Kiel owns and operates the sanitary sewer collection system that collects and transports wastewater to the Wastewater Treatment Facility. A map of the system is provided on Figure III-6. The City provides sewer service to the residential, commercial, industrial and public authority properties within the City limits. Sewer service has been provided since the early 1900's. Generally, flow in the system drains from the west to the east to the Wastewater Treatment Facility. There is also an area of the City located south and east of the Facility that is served.

The sanitary sewer system consists of vitrified clay, truss, concrete and PVC pipe, ranging in size from 6-inches to 24-inches in diameter. Generally speaking, from the mid 1970's to present, sanitary sewers were constructed of PVC pipe. Sewers constructed from the mid-1950's to the mid-1970's were constructed of concrete pipe or truss pipe. Prior to the 1950's, sanitary sewers and laterals were constructed of 3-foot long sections of vitrified clay or concrete pipe.

There are six Lift Stations in the system; the largest of which is the River Road Lift Station, which pumps wastewater from the western three-fourths of the City. The locations of the Lift Stations are identified on Figure III-6.



Kiel
WISCONSIN

Sanitary Sewer System

- Lift Station
- Sanitary Manhole
- 4" Forcemain
- 6" Forcemain
- 8" Forcemain
- 6" Gravity Main
- 8" Gravity Main
- 10" Gravity Main
- 12" Gravity Main
- 15" Gravity Main
- 18" Gravity Main
- 21" Gravity Main
- 24" Gravity Main

Other Mapped Features

- Municipal Boundary
- Parcel Line
- Stream/River

Source: Calumet County, 2014-15; Manitowoc County, 2009-2013.

Disclaimer: The property lines, right-of-way lines, and other property information on this drawing were developed or obtained as part of the County Geographic Information System or through the County property tax mapping function. McMAHON does not guarantee this information to be correct, current, or complete. The property and right-of-way information are only intended for use as a general reference and are not intended or suitable for site-specific uses. Any use to the contrary of the above stated uses is the responsibility of the user and such use is at the user's own risk.

N

0 1,250 2,500 Feet

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FIGURE III-6
SANITARY SEWER SYSTEM
CITY OF KIEL
CALUMET AND MANITOWOC
COUNTIES, WISCONSIN

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3. Description Of Wastewater Treatment Facility

a. Liquid Train:

Flow arrives at the Wastewater Treatment Facility via force mains; an 8-inch and 12-inch force main from the River Road Lift Station transports wastewater generated from the majority of the service area, while the smaller Rockville Road Lift Station has a 4-inch force main and serves a residential area southeast of the Treatment Facility.

The River Road Lift Station and force mains are equipped with magnetic flow meters, which are utilized for influent flow recording. The Rockville Road Lift Station has no flow meter, and utilizes a wet well calculation to add the flow volume pumped, to the Wastewater Treatment Facility influent flow.

The force mains discharge upstream of two (2) parallel fine screens. The incoming flows are split between two (2) channels, each equipped with a spiral type fine screen utilizing a perforated basket with ¼-inch openings. Each screen is rated at 4.3 mgd, which is the firm capacity of the screening system. One (1) ultrasonic level sensor provides liquid level control of the screens. Flows combine after the fine screens are sampled flow proportionally.

A 12'x 12'x 12' Sidewater Depth (SWD) aerated grit chamber follows the sampling point. At maximum day design flow, the hydraulic detention time is 6.0-minutes, which is double the time allowable per NR 110. The grit chamber equipment dates back to 1979, while the remainder of the pretreatment facilities were constructed in 1996.

Settled grit is removed via air lift, and is transported via a 4-inch pipe to a grit classifier located in the adjacent Service Building. There is no grit washer to separate organic and inorganic materials. Originally built in 1965, the Service Building previously provided the pretreatment functions. A more detailed discussion of the Service Building will follow. A bypass channel provided around the grit chamber.

Downstream of the aerated grit chamber, a 16-inch pipe transports forward flows to a primary clarifier splitter box. The primary splitter box does not use any weirs to split the flow evenly, rather there are two (2) 16-inch pipes exiting the splitter box. One (1) pipe discharges into the stilling well of the north clarifier, which was originally constructed in 1965, and modified in 1979. The 1979 modifications included additional concrete wall height and mechanisms, along with construction of the south primary clarifier and splitter box / sludge / scum handling systems. Uneven flow splitting between the two (2) clarifiers can lead to operational inefficiencies and difficulties.

The primary clarifiers are each 28-feet in diameter with a SWD of 12.31-feet. Maximum hourly flows in excess of 1.847 mgd exceed the allowable surface setting basin rate of 1,500-gal/sq.ft./day per NR 110.

The 16-inch primary effluent piping from the north and south clarifiers is combined into a single 16-inch diameter pipe that extends to the aeration system splitter box, located at the southwest corner of the north aeration basins. Normally, secondary influent is split between three (3) aeration trains: the original 1965 'south' aeration train, and two (2) 'north' aeration trains constructed in 1985. When flows exceed 2.0 mgd, some forward flow is diverted away from the splitter box and directed to the south aeration train, which is at a lower elevation, alleviating a hydraulic limitation.

The aeration systems are designed to provide biological phosphorus removal. Hyperbolic mixers in anoxic zones provide mixing energy to keep the process active. Fine bubble ceramic diffusers provide air within the aerobic zones for mixing and oxygen transfer. The south aeration system consists of Aeration Basins #7, #8 and #9. Basin #7 is divided in two (2) parts by a curtain baffle wall; one (1) side equipped with a hyperbolic mixer, and one (1) side with fine bubble diffusers. Similarly, the north aeration trains are set up with three (3) basins each. The westerly train consists of Aeration Basins #1, #3 and #5; and the easterly train consists of Aeration Basins #2, #4 and #6. Basins #1 and #2 are equipped with hyperbolic mixers and curtain baffle walls, similar to the south train.

The north aeration basin trains have dimensions of 65'L x 32'W x 14'SWD, and include a 30'L anoxic zone at the influent end of Basins #1 and #2. The south aeration train has dimensions of 64'L x 28'W x 14'SWD, and contains a 30'L anoxic zone at the influent end of Basin #7. Each north train has approximately 90,500-gallons more than the south train.

The four (4) aeration blowers are located in the Solids Handling Building, and the 24-inch air main is buried en route to the aeration basins. Two (2) blowers date back to the 1997 project, while two (2) were included in the 2008 project. The older blowers are 100-HP, each, and rated for 1,680 scfm @ 8 psig, while the two (2) newer blowers are 150-HP with a 2,520 scfm, 8 psig capacity. Only the two (2) newer 150-HP positive displacement blowers are on Variable Frequency Drives (VFD's) and modulate in response to Dissolved Oxygen (D.O.) setpoints within the basins. The firm capacity of the blower system is 5,880 scfm, with one (1) of the new blowers out of service. The older 100-HP blowers have difficulty coming on-line when the dynamic backpressure increases due to diffuser fouling, and they experience motor overloading. Air splitting between the north and south basins is difficult to control, and the buried air main has leaking joints.

Mixed Liquor Suspended Solids (MLSS) from the three (3) trains is combined in a splitter box adjacent to the east side of the south aeration tanks. A single 10-foot wide weir is provided and, as such, does not evenly split flows between the two (2) final clarifiers; rather, the hydraulics of the 16-inch influent pipe to each clarifier is controlling the flow to each.

Two (2) final clarifiers, each 40-feet diameter with a SWD of 14.25-feet, provide clarified effluent and a thickened sludge for return or wasting from the process. The December 2014 Master Plan notes that the maximum hour solids loading rate is 55.7 lbs./sq.ft./day, which exceeds the NR 110 limit of 48.0. Settled sludge is removed from each clarifier via an organ pipe style mechanism, and transferred to a sludge well via a telescopic valve. Two (2) Return Activated Sludge (RAS) pumps, each rated at 1,400 gpm @ 22-feet Total Dynamic Head (TDH), are provided. There is no common section header for the RAS pumps, rather they are each connected to an individual clarifier's sludge well. While there is a normally open gate separating the two (2) sludge wells, there is no other means of pump backup.

Waste sludge is drawn through a 2-inch line tapped into each pump's suction pipe. A single rotary lobe pump provides Waste Activated Sludge (WAS) pumping. At 60-Hz, the WAS pump is rated for 60 gpm @ 10 psig, and there is no backup pump. The pump can be run up to 90-Hz and discharge 90 gpm. In the event the 2-inch WAS pump is out of service, the RAS pumps can discharge WAS to the aerated sludge holding tanks. Flow metering of RAS and WAS is provided by magnetic flow meters dated back to 1979.

Scum removed from the final clarifiers is collected in a common wet well, adjacent to the north clarifier. Two (2) centrifugal pumps, each rated at 150 gpm @ 30-feet TDH, discharge scum to the aerated sludge tanks.

Clarified final effluent leaves each clarifier via a 16-inch diameter pipe, and is combined in a single pipe of the same diameter prior to entering the sand filter influent wet well. The sand filter is divided into four (4) cells, each 12'x 12', with 30-inches of mono-media. Three (3) dry pit centrifugal feed pumps with extended motor shafts and VFD's are each rated for 1,300 gpm @ 35-feet TDH. Backwash is provided by two (2) vertical turbine pumps, each rated for 2,900 gpm @ 16.5-feet TDH. Backwash air scour is provided by a single 25-HP rotary lobe blower.

Filtered effluent flows by gravity from a filter effluent wet well to a chlorine contact chamber for disinfection. Flows drop over a weir into a chlorine mix chamber, where chlorine solution is diffused into the flow stream. Two (2) submerged 36"x 36" cast iron gates are utilized to split flows between two (2) chlorine contact chambers. These gates are in need of repair or replacement to provide a tight seal. Each contact chamber consists of five (5) passes, each with a L/W ratio of 26:2.5, which exceeds 40:1 required by NR 110. Upon exiting the contact chambers, an effluent structure combines the two (2) flow streams and dechlorination is provided with sulfur dioxide. 150 lb. cylinders are utilized for both chlorine and sulfur dioxide gas.

Downstream of the disinfection system, a 16-inch pipe conveys flow to a post-aeration tank to ensure adequate Dissolved Oxygen (DO) levels prior to discharge. The 32-foot diameter tank has a SWD of 8-feet, and utilizes EPDM membrane fine pore diffusers to aerate the effluent prior to discharge.

The Service Building was originally constructed in 1965, and functioned as the Headworks and provided space for the Office/Laboratory, as well as equipment. Currently, the blowers for the sludge holding tanks are housed in the Service Building, along with the grit system, post-aeration and channel aeration blowers. Non-potable water pumps are housed in the lower level, and a grit classifier is installed in former garage space.

High strength waste may be +received at the Wastewater Treatment Facility via local haulers. Due to high influent loadings, hauled in waste has been curtailed. A bar screen precedes a converted aeration basin, which serves as a storage tank. Located at the north end of the south aeration train, the tank has a total volume of nearly 188,000-gallons at a 14-foot SWD. The high strength wastes are equalized in the tank, and fed upstream of the two (2) fine screens, un-metered, but sampled with the influent flow stream. The Treatment Facility also has a 280 kW engine/generator to utilize the digester gas to create electricity and hot water for digester/supplemental heating.

b. Solids Train:

WAS from the final clarifiers is co-thickened in the primary clarifiers. Primary scum flows by gravity into a scum wet well, which can also receive primary sludge via telescopic valves. Typical operation utilizes a direct connection between the clarifier center sludge pit and the sludge pump; once per day the telescopic valve is utilized to check the sludge thickness and to clear the suction piping.

Two (2) air driven diaphragm pumps, located in the digester complex, are used to transfer primary sludge/scum to the primary digester. The east pump (SP6) is the principle pump for transferring primary sludge into the primary digester. The west pump (SP5) is on a common suction header with SP6, but is utilized primarily as a sludge transfer pump to send sludge to the aerated sludge holding tanks.

The anaerobic digestion system consists of two (2) 45-foot diameter tanks; one (1) designated as a primary, and one (1) designated as a secondary digester. The primary digester has an operating SWD of 21-feet, while the secondary digester has an operating SWD of 26-feet. Total volumetric capacities of the primary and secondary digesters is 269,652-gallons and 342,537-gallons, respectively. The primary digester is heated via a single boiler/heat exchanger and mixed via a gas mixing system. The secondary digester is unheated and unmixed, and functions as a storage vessel prior to dewatering. The primary digester has a fixed cover, while the secondary has a floating cover; both covers are in need of replacement.

A single 150 gpm centrifugal pump is utilized for recirculation of the primary digester contents. The combination boiler/heat exchanger has a boiler capacity of 825,000 btu/hour and a heat exchanger capacity of 375,000 btu/hour. Sludge transfer from the primary to the secondary may be accomplished with the recirculation pump, but is typically a gravity flow operation via an overflow box. Supernatant is decanted and flows by gravity to a submersible pump station, which transfers the flows to the effluent end of the grit removal system via two (2) separate force mains.

Stabilized sludge is transferred with one (1) of the air driven diaphragm pumps to a pair of aerated sludge holding tanks. The holding tanks are 62'x 25'x 16'SWD, each, and provide a combined total aerated storage capacity of 371,000-gallons. The sludge holding tanks can be decanted to the recycle wet well in order to maximize the storage volume and minimize the volume of sludge to be dewatered. The recycle wet well has two (2) dry pit centrifugal pumps, each rated for 560 gpm @ 36-feet TDH, which transfer flows to the effluent end of the grit removal system or to the aeration basin splitter box.

The storage tanks are mixed via coarse bubble diffused aeration. Six (6) drop legs per storage tank provide a spiral roll aeration pattern. A separate 8-inch air main extends from the Service Building blowers to each sludge storage tank. Three (3) positive displacement blowers are provided; two (2) duty blowers, and one (1) swing blower for backup. The capacities of the duty and backup blowers are different, as are the manufacturers and age. This may lead to operational problems when one (1) blower cannot overcome the operating pressure of the other in the event supplemental air is required.

Sludge dewatering is accomplished with a single 2.0 m belt press. There is no redundancy or backup unit. Two (2) belt press feed pumps transfer sludge from the sludge holding tanks to the belt press; one (1) pump is a progressive cavity type, while the other is a rotary lobe style. Each belt press feed pump is rated for a 150 gpm flow rate, while the press is limited to a 125 gpm/1,000 lbs./hour capacity. Filtrate is discharged to the effluent end of the grit removal system via gravity.

Dewatered sludge ranges from 14% to 17% solids. A conveyor system transfers the cake from the press to a lime pasteurization system. The pasteurization system is rated for 800 lbs./hour, and produces a Class A biosolids product. A lime storage silo provides 10 to 12-days of lime storage. However, the Operations Staff has been utilizing fly ash to reduce costs. The fly ash substitution requires approximately twice as much when compared to lime and the available storage in the silo is approximately 4 to 7-days.

The pasteurized biosolids are loaded into a 5 cubic yard dump truck. 3 to 4-times each day, the truck transports the biosolids from the load-out garage bay to the Cake Storage Building. The Cake Storage Building is approximately 80'W x 140'L and has 9,260 square feet of available floor space to store biosolids. A front-end loader is utilized to stack and load-out biosolids; a stack height of 12-feet is achievable, but can vary depending on the solids content.

c. Electrical:

1) Utility Service

The Wastewater Treatment Facility receives electrical service from the City of Kiel Electric Utility. High voltage (24.9 kV) is routed to the site, and to a pad-mounted transformer on the east side of the Treatment Facility. That transformer steps the voltage down from 24.9 kV to 4160V. From there, an underground service lateral extends westward to a transclosure / transformer located near the Solids Handling Building (Building #700). The transclosure contains three (3) single-phase transformers, 250 kVA each, which step the voltage down from 4160V to 480V. Metering takes place on the secondary (480V) side of the single-phase transformers.

a) Electric Utility Service, Summary Information:

(1) Serving Utility: City of Kiel, Electric Utility
(2) Primary Voltage: 4160V
(3) Secondary Voltage: 480V
(4) Service Transformer Capacity: 750 kVA
(5) Service Amp Rating: 1,600-amp plug with ampere setting of 0.7; or 1,120-amps
(6) Maximum available Fault Current at Utility Service Point: 50,119-amps.

b) Assessment:

The Electric Utility has stated that the existing service configuration to the Wastewater Treatment Facility is undesirable, and they desire to change it. The Electric Utility does not wish to sustain having two (2) transformer settings, nor do they wish to maintain the existing transclosure and single-phase transformers. The Electric Utility's long-term intention is to remove both existing transformer settings, and replace them with one (1) new pad-mounted transformer in place of the existing transclosure.

Of particular concern regarding the utility service is the existing maximum available fault current. The 'maximum available fault current' is the amount of electric current that would be expected to flow in the event of an accidental 3-phase short circuit. According to the Electric Utility, the available fault current at the point of utility service from the Kiel Electric Utility is 50,119-amps. At the location of the main service equipment (MCC-7), the available fault current drops to approximately 48,000-amps. Unfortunately, the main service equipment MCC-7 is rated for a maximum short circuit current of only 42,000-amps. The existing main electrical equipment is, therefore, underrated, when compared to the 48,000-amps of available fault current. In the worst-case scenario, if a 3-phase short circuit were to occur within the electrical service gear, the electrical equipment might be subjected to levels of electrical energy beyond its ability to sustain it, and possible violent destruction of equipment could occur. In addition, such an incident would represent a safety hazard to personnel, and the Treatment Facility could be rendered without power for an indefinite period of time. The electrical equipment short circuit rating should be addressed in the near future.

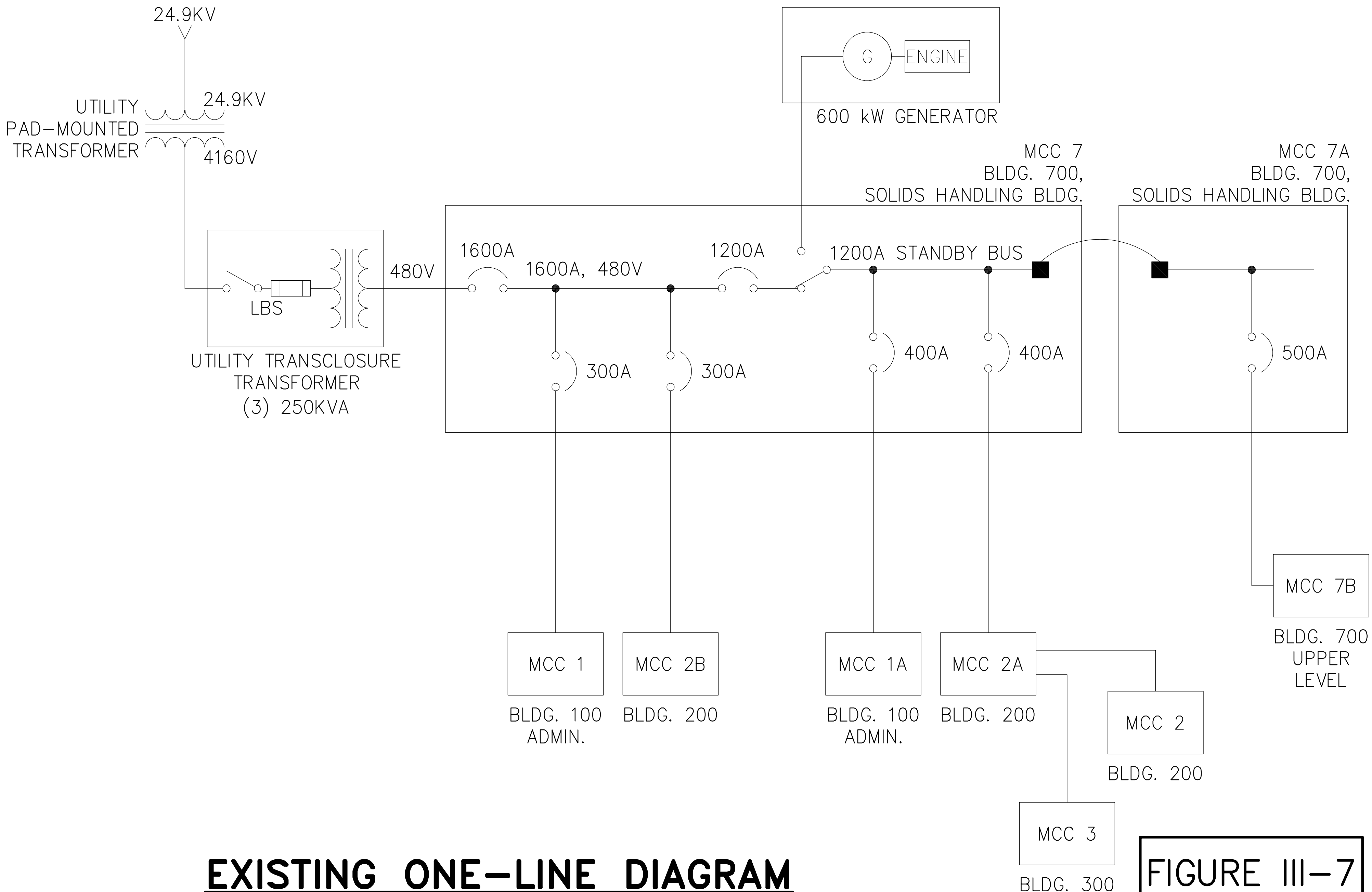
2) Electrical Distribution Equipment

The existing Wastewater Treatment Facility power distribution system is depicted in single-line diagram form in Figure III-7. Power distribution, as well as motor control, is accomplished with Motor Control Centers (MCC's) distributed throughout the Treatment Facility campus. Existing Wastewater Treatment Facility MCC's are listed in Table III-2.

Table III-2

EXISTING TREATMENT FACILTY MOTOR CONTROL CENTERS (MCC's)
CITY OF KIEL | WISCONSIN
Wastewater Treatment Facility - Facilities Plan

MCC No.	Location	Installed	Manufacturer	Model	Amp Rating
1	Administration Building	1985	Square D	Model 4	300A
1A	Administration Building	1985	Square D	Model 4	400A
2	Service Building	1982	Cutler Hammer	Unitrol	300A
2A	Service Building	1985	Square D	Model 4	400A
2B	Service Building	1985	Square D	Model 4	300A
3	Digester Building	1985	Square D	Model 4	300A
7	Solids Handling Building	1985	Square D	Model 4	1,600A
7A	Solids Handling Building	1985	Square D	Model 4	1,200A
7B	Solids Handling Building	1997	Allen Bradley	Centerline	500A



EXISTING ONE-LINE DIAGRAM

FIGURE III-7

With the exception of MCC-7B, the MCC's are more than 30-years old. They are Square D, Model 4, MCC's, which have long been obsolete. Some parts are available for Model 4 MCC's, but new structures are not available. Adding VFD's to an existing Model 4 MCC is not practical. MCC-2, located in the Service Building, is an older Cutler Hammer - Unitrol MCC, and predates even the Square D, Model 4's. Like the Model 4's, the Unitrol MCC is also obsolete. Replacing the existing obsolete MCC's with new structures should be considered.

The existing circuit breaker panelboards are mostly of the same vintage as the MCC's. Several of them were manufactured as integral to the MCC's themselves, thus necessitating their replacement if the MCC's are replaced. The existing dry type transformers are also of the same age as the majority of the Treatment Facility electrical equipment; that is, over 30-years of service. In general, dry type transformers have a life expectancy of 25 to 30-years. Expected life increases if the transformer is operating in a cool and dry location; expected life drops if the transformer is operating in warm and humid location. While the indoor environmental conditions vary from building to building, the Wastewater Treatment Facility generally has conditions that are less than ideal for transformer longevity. Replacement of the older dry type power transformers should be considered.

3) <u>Standby Power</u>

Standby power is provided at the Wastewater Treatment Facility by means of an on-site diesel generator. The generator is 600 kW, 750 kVA, as manufactured by Marathon Electric. The generator connects to the Facility electrical distribution system at MCC 7 (in the Solids Handling Building). The connection is made at an Automatic Transfer Switch (ATS), located at a mid-point of the MCC 7 bus. With this configuration, MCC 7 is, therefore, comprised of a normal-power bus and a standby bus. Only equipment that is connected to the standby bus can operate on standby power.

The existing ATS is integrated into the existing MCC 7. As such, the transfer switch represents a single point of failure for the electrical distribution system. In the event of a 3-phase short circuit at the ATS, neither utility or generator power can be provided to the Treatment Facility load. In the event of a failure of the transfer switch, there are no existing bypass provisions to maintain power to the standby bus. A new ATS, which includes isolation and bypass provisions, should be considered.

4) Hazardous Locations

The digester structure is an National Electric Code (NEC) Classified Hazardous location. As such, all electrical equipment within the hazardous space must comply with NEC requirements for such locations. No electrical switching is permitted within the hazardous space, junction boxes must be approved for the application, and seal fittings must be provided in conduit runs to prevent migration of explosive gases to spaces outside of the hazardous area.

The existing electrical equipment in the Digester Building is not compliant with the NEC requirements for classified hazardous locations. The MCC, which contains electrical switching components, must not be located in the hazardous area. An existing pump control panel in the room is non-compliant with hazardous location requirements. Light switches are not to be located in the hazardous area. Existing lights and exit signs are not compliant for hazardous locations. In general, the entire Digester Facility should be electrically reconfigured, and rewired, for full compliance with the hazardous location requirements of NEC Article 500.

d. Controls:

The existing controls consist of Programmable Logic Controllers (PLC's) in various parts of the Wastewater Treatment Facility. The PLC's are from various manufacturers: Allen-Bradley, Siemens and Automation Direct (Koyo). Of these, some are obsolete, in that they are no longer manufactured and there is no Manufacturer's support. Others are classified as 'active mature' by the Manufacturer, which is defined as the product being fully supported, but a newer replacement product or family exists and the mature product will soon start to be phased-out.

Some controls are provided by vendors with their equipment and contain either stand-alone controllers (not a PLC) or consist of hardwired relays.

On the front of the Main Control Panel (MCP) are mounted approximately 50 indicator lights, a lighted graphic of the Wastewater Treatment Facility, an alarm annunciator light box and some selector switches. Several sections have plates covering holes from devices that were removed. Most of the items mentioned in the preceding paragraphs are obsolete; either the devices themselves or the technology currently employed.

A MCP is located in the Operator Control Room (OCR) in the Administration and Filtration Building. The MCP covers most of one wall, and is both front and rear accessible.

Internally, the MCP contains two (2) PLC's; a Siemens Simatic TI405 PLC, and an Automation Direct 405 PLC with an expansion rack. The output points from these PLC's drive indicator lights and graphic-mounted indicators, all of which are mounted on the front of the MCP. It also has eight (8) outputs for triggering inputs to the alarm autodialer.

The Wastewater Treatment Facility has an older Public Address (PA) system that annunciates critical alarms by means of a tone. A local telephone is located adjacent to each PA speaker. This system provides coverage for most internal areas of the Treatment Facility. In addition, each Operator carries a City-provided cellular telephone, but there are some areas of the Treatment Facility in which these telephones do not have sufficient signal to receive calls.

The PLC's input some analog process signals; mostly signals that had been used to drive circular chart recorders. Some MCP-mounted selector switches are input to these PLC's, but the MCP is mostly used as a process monitoring tool and collection point for data that is read by the Supervisory Control and Data Acquisition (SCADA) Personal Computer (PC).

The MCP also acts as a central communication hub. There is some inter-building Ethernet communication over Category 5 copper cable. An Ethernet switch is mounted in the MCP. The switch has eight (8) ports available for connecting copper Ethernet cables. Currently, six (6) of the eight (8) ports are used:

1) Blower Panel PLC
2) Effluent Pumps PLC
3) Automation Direct 405 PLC
4) Siemens Simatic TI405 PLC
5) SCADA PC
6) Hach PC

Two (2) PC's are located in the OCR. One (1) PC runs Wonderware SCADA software, which was purchased in 2008. The other PC runs Hach Water Information Management Solutions (WIMS) software.

The Wonderware SCADA software can only monitor processes that it can communicate with; the Blower Control Panel and the Effluent Pumps Control Panel. The only supervisory control the current SCADA has is partial control of the RAS.

Five (5) of the six (6) remote Lift Stations utilize copper telephone lines to communicate with the Wastewater Treatment Facility. This type of line is being phased-out by telephone companies, and usually is no longer available for a new communication service. Consideration should be given to upgrading the communication media, as well as the controls for each Lift Station.

C. WPDES PERMIT

The Wisconsin Pollutant Discharge Elimination System (WPDES) Permit limits for Kiel are described in Chapter II – Water Quality Objectives. Key limits include:

BOD	10 mg/L	May thru October
BOD	15 mg/L	November thru April
TSS	10 mg/L	May thru October
TSS	15 mg/L	November thru April
NH_3N	5.3 mg/L	October thru March
NH_3N	2.2 mg/L	April thru May
NH_3N	1.7 mg/L	June thru September
P	1.0 mg/L	

Other effluent limits for conventional parameters, such as pH, fecal coliform, chlorine residual, copper and chlorides, match up with conventional limits seen throughout the State.

D. WASTEWATER TREATMENT FACILITY FLOWS & LOADINGS

Influent flows and loadings for 2012 through 2016 are summarized in Table III-3. Comparing current Wastewater Treatment Facility design criteria to the actual flows and loadings received in 2012, 2013, 2014, 2015 and 2016, the Facility is overloaded on a regular basis.

Table III-3

WASTEWATER TREATMENT FACILITY HISTORICAL INFLUENT FLOWS & LOADINGS
CITY OF KIEL | WISCONSIN
Wastewater Treatment Facility - Facilities Plan

Parameter	2012	2013	2014	2015	2016	Current Design Criteria
Influent Flow, mgd						
Average	0.850	1.014	1.019	0.838	1.145	0.862
Maximum Month	1.248	2.025	1.728	1.114	1.560	1.214
Maximum Day	2.333	3.115	3.088	1.864	2.678	3.095
BOD, mg/L (Average)	830	878	864	922	893	877
BOD, lbs./day						
Average	5,968	6,999	6,741	6,296	8,249	6,000
Maximum Month	7,863	9,309	8,915	6,849	9,923	6,280
Maximum Day	12,358	21,337	17,631	12,957	19,450	9,250
TSS, mg/L (Average)	566	598	522	549	562	559
TSS, lbs./day						
Average	4,042	5,026	4,185	3,760	5,243	2,842
Maximum Month	5,408	9,224	5,521	4,516	6,731	4,480
Maximum Day	10,058	48,746	9,518	9,436	14,240	7,420
Total P, mg/L (Average)	17	17	17	19	21	18
Total P, lbs./day						
Average	121	139	132	126	190	145
Maximum Month	131	209	153	146	214	184
Maximum Day	262	826	275	224	419	247

Table III-4 illustrates the number of times the design criteria has been exceeded each year.

Table III-4

NUMBER OF DAYS EXCEEDING DESIGN CRITERIA
CITY OF KIEL | WISCONSIN
Wastewater Treatment Facility - Facilities Plan

	2012		2013		2014		2015		2016	
Parameter	No. Days Exceed	No. Sampling Days	No. Days Exceed	No. Sampling Days	No. Days Exceed	No. Sampling Days	No. Days Exceed	No. Sampling Days	No. Days Exceed	No. Sampling Days
Flow										
Average	135	366	188	363	226	363	116	365	357	366
Max.Month	1	12	2	12	3	12	0	12	2	12
Max. Day	0	366	1	363	0	363	0	365	0	366
BOD										
Average	46	103	64	104	60	103	53	103	73	104
Max. Month	4	12	10	12	8	12	9	12	12	12
Max. Day	7	103	10	104	15	103	16	103	38	104
TSS										
Average	86	102	94	103	81	104	68	103	94	104
Max. Month	2	12	7	12	2	12	1	12	10	12
Max. Day	5	102	8	103	5	104	2	103	17	104
Total P										
Average	18	101	32	104	31	104	28	103	81	104
Max. Month	0	12	1	12	0	12	0	12	8	12
Max. Day	1	101	2	104	2	104	0	103	15	104

Historic Wastewater Treatment Facility influent and industrial flows and loadings are summarized on Table III -5.

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Table III-5

WASTEWATER TREATMENT FACILITY HISTORICAL INFLUENT & INDUSTRIAL LOADINGS

CITY OF KIEL | WISCONSIN

Wastewater Treatment Facility - Facilities Plan

	2012			2013			2014			2015			2016		
Parameter	WWTF Total	Land O'Lakes	Sargento	WWTF Total	Land O'Lakes	Sargento	WWTF Total	Land O'Lakes	Sargento	WWTF Total	Land O'Lakes	Sargento	WWTF Total	Land O'Lakes	Sargento
Influent Flow, mgd															
Average	0.850	0.306	0.063	1.014	0.301	0.066	1.019	0.300	0.073	0.838	0.314	0.074	1.145	0.342	0.067
Max. Month	1.248	0.330	0.083	2.025	0.355	0.084	1.728	0.333	0.106	1.114	0.354	0.091	1.560	0.483	0.089
Max. Day	2.333	0.393	0.105	3.115	0.426	0.123	3.088	0.381	0.140	1.864	0.496	0.124	2.678	0.541	0.120
BOD, mg/L (Avg.)	830	1,241	2,404	878	1,357	2,209	864	1,119	2,058	893	1,062	1,878	893	1,170	1,877
BOD, lbs./day															
Average	5,968	3,163	1,454	6,999	3,434	1,351	6,741	2,800	1,393	6,296	2,775	1,284	8,249	3,276	1,145
Max. Month	7,863	3,571	2,229	9,309	4,151	2,094	8,915	3,652	2,344	6,849	3,308	1,938	9,923	3,975	1,721
Max. Day	12,358	8,205	6,235	21,337	13,994	6,107	17,631	8,896	7,708	12,957	11,461	3,695	19,450	11,031	3,316
TSS, mg/L (Avg.)	566	318	2,428	598	323	1,859	522	254	1,352	549	299	1,303	562	442	1,202
TSS, lbs./day															
Average	4,042	817	1,533	5,026	813	1,170	4,185	637	924	3,760	782	895	5,243	1,242	747
Max. Month	5,408	971	4,190	9,224	926	2,023	5,521	744	2,259	4,516	976	1,241	6,731	1,659	1,603
Max. Day	10,058	4,237	20,168	48,746	2,365	8,256	9,518	2,919	10,089	9,436	3,087	2,481	14,240	7,897	3,271
Total P, mg/L (Avg.)	17	37	23	17	41	19	17	34	18	19	35	17	21	41	17
Total P, lbs./day															
Average	121	95	13	139	104	11	132	85	12	126	91	11	190	117	10
Max. Month	131	104	17	209	118	18	153	95	19	146	101	17	214	157	15
Max. Day	262	352	35	826	275	45	275	178	36	224	296	66	419	413	32

E. WASTEWATER TREATMENT FACILITY PERFORMANCE

The City of Kiel Wastewater Treatment Facility performance for 2012 through 2016 is summarized in Table III-6.

The Compliance Maintenance Annual Report (CMAR) for 2016 is contained in Appendix III-3. The report is intended to be a report card for the Wastewater Treatment Facility to highlight specific areas of concern and those concerns that require action to correct. Overall, the City of Kiel Wastewater Treatment Facility scored a GPA of 3.54 and is in the 'voluntary range', in which a response is optional. However, based on influent flows and loadings compared to design criteria, the Facility scored an 'F', as flows and loadings routinely exceeded the design values. Relative to flows and loadings, the Facility is in the 'Action Range', which requires a response to the DNR; this Facilities Plan satisfies that requirement. The 2016 CMAR scored an 'A' on all other sections except for 'Biosolids Quantity And Management', which scored a 'B'.

While flows and loadings exceeded the design values on a regular basis in 2016, effluent quality was well within the permit limits. This is indicative of a highly motivated Staff with the knowledge and expertise to maximize the efficiency of the individual unit processes.

Figures III-8, III-9, III-10 and III-11 graphically illustrate the influent flows and loadings, and compare them to available design parameters. Figure III-12 through Figure III-21 illustrate effluent concentrations and loadings of the various discharge permit parameters, and compare them to the permit limits.

F. NEEDS ASSESSMENT

1. General

There are three (3) categories of needs at the City of Kiel Wastewater Treatment Facility, which may be broken down as follows:

a. Capacity
b. Plant Condition
c. Permit Requirements

Each category and the corresponding needs are described as follows.

2. Capacity

Current flows and loadings have been documented in this Chapter. The capacity of the Wastewater Treatment Facility is limited by the capacity of the individual unit processes. Appendix III-4 contains each unit process and its rated capacity, as described in the December 2014 Master Plan, prepared by Donohue & Associates, Inc. A discussion of each unit process and the limitations follows.

Table III-6

WASTEWATER TREATMENT FACILITY PERFORMANCE

CITY OF KIEL | WISCONSIN

Wastewater Treatment Facility - Facilities Plan

MONTHLY AVERAGE

	Effluent BOD, mg/L				
Month	**2012**	**2013**	**2014**	**2015**	**2016**
January	2.11	2.87	3.30	5.55	2.99
February	2.13	3.53	4.64	5.74	3.97
March	3.80	2.84	2.73	5.63	4.86
April	2.06	5.83	4.50	9.43	4.06
May	3.11	3.11	3.76	2.65	2.82
June	2.89	3.17	4.44	3.72	4.11
July	1.73	3.06	3.33	4.49	3.49
August	1.23	2.47	1.78	3.83	2.76
September	2.15	2.59	2.54	2.95	3.79
October	1.70	2.20	1.91	2.24	3.32
November	1.98	3.20	6.13	2.06	2.22
December	2.20	3.00	4.83	2.48	3.52
Annual Avg.	2.26	3.15	3.66	4.23	3.49
Max. Month	3.80	5.83	6.13	9.43	4.86
# of Violations	0	0	0	0	0

	Effluent TSS, mg/L				
Month	**2012**	**2013**	**2014**	**2015**	**2016**
January	2.64	2.07	3.82	7.00	2.65
February	3.02	2.98	4.63	4.45	3.68
March	2.98	1.70	1.78	3.00	3.96
April	1.73	5.16	3.73	3.28	4.50
May	3.44	2.42	1.93	2.55	2.04
June	2.29	1.55	3.16	2.33	2.33
July	1.62	2.29	2.49	2.35	2.40
August	1.33	2.31	2.38	2.11	2.33
September	1.10	2.31	1.98	2.27	3.38
October	2.16	3.98	1.75	2.05	2.33
November	1.80	2.23	2.13	2.49	2.87
December	1.46	3.11	3.20	2.60	3.40
Annual Avg.	2.13	2.67	2.75	3.04	2.99
Max. Month	3.44	5.16	4.63	7.00	4.50
# of Violations	0	0	0	0	0

	Effluent P, mg/L				
Month	**2012**	**2013**	**2014**	**2015**	**2016**
January	0.66	0.41	0.58	0.65	0.42
February	0.65	0.36	0.43	0.36	0.44
March	0.34	0.31	0.28	0.39	0.51
April	0.53	0.46	0.25	0.37	0.31
May	0.56	0.42	0.51	0.56	0.20
June	0.62	0.58	0.58	0.62	0.33
July	0.50	0.70	0.54	0.65	0.49
August	0.60	0.64	0.59	0.54	0.36
September	0.51	0.52	0.69	0.56	0.46
October	0.65	0.42	0.63	0.41	0.45
November	0.59	0.79	0.51	0.54	0.40
December	0.55	0.43	0.43	0.47	0.52
Annual Avg.	0.56	0.50	0.50	0.51	0.41
Max. Month	0.66	0.79	0.69	0.65	0.52
# of Violations	0	0	0	0	0

	Effluent Ammonia, mg/L				
Month	**2012**	**2013**	**2014**	**2015**	**2016**
January	0.37	0.60	0.07	0.07	0.13
February	0.16	0.24	0.10	0.36	0.12
March	0.11	0.04	0.04	0.22	0.40
April	0.05	0.34	0.07	0.49	0.42
May	0.11	0.27	0.06	0.26	0.25
June	0.08	0.06	0.07	0.04	0.13
July	0.06	0.07	0.12	0.07	0.15
August	0.07	0.07	0.87	0.08	0.15
September	0.07	0.07	0.03	0.10	0.16
October	0.06	0.10	0.02	0.06	0.15
November	0.07	0.10	1.94	0.06	0.17
December	0.04	0.09	0.07	0.08	0.33
Annual Avg.	0.10	0.17	0.29	0.16	0.21
Max. Month	0.37	0.60	1.94	0.49	0.42
# of Violations	0	0	0	0	0

	Effluent Copper, µg/L				
Month	**2012**	**2013**	**2014**	**2015**	**2016**
January	18	8	23	18	10
February	16	10	9	9	11
March	11	11	10	12	13
April	12	-	8	8	13
May	10	9	11	8	8
June	9	-	11	12	11
July	15	18	13	17	8
August	14	15	9	17	10
September	14	21	13	13	9
October	11	21	11	15	15
November	8	19	6	16	10
December	7	45	24	13	11
Annual Avg.	12	18	12	13	11
Max. Month	18	45	24	18	15
# of Violations	0	0	0	0	0

	Effluent Chloride, mg/L				
Month	**2012**	**2013**	**2014**	**2015**	**2016**
January	390	370	540	420	390
February	450	460	570	480	---
March	350	397	480	470	320
April	360	410	470	390	340
May	270	350	350	500	440
June	400	440	420	570	400
July	450	540	330	510	300
August	460	520	400	500	300
September	440	510	430	500	390
October	470	510	510	480	330
November	440	480	430	410	370
December	500	560	430	280	410
Annual Avg.	415	462	447	459	363
Max. Month	500	560	570	570	440
# of Violations	0	0	0	0	0

Monthly Average Limits

Effluent BOD

10 mg/L May thru October

15 mg/L November thru April

Effluent TSS

10 mg/L May thru October

15 mg/L November thru April

Effluent Total P

1 mg/L

Effluent NH_3N

2.2 mg/L April thru May

1.7 mg/L June thru September

5.3 mg/L October thru March

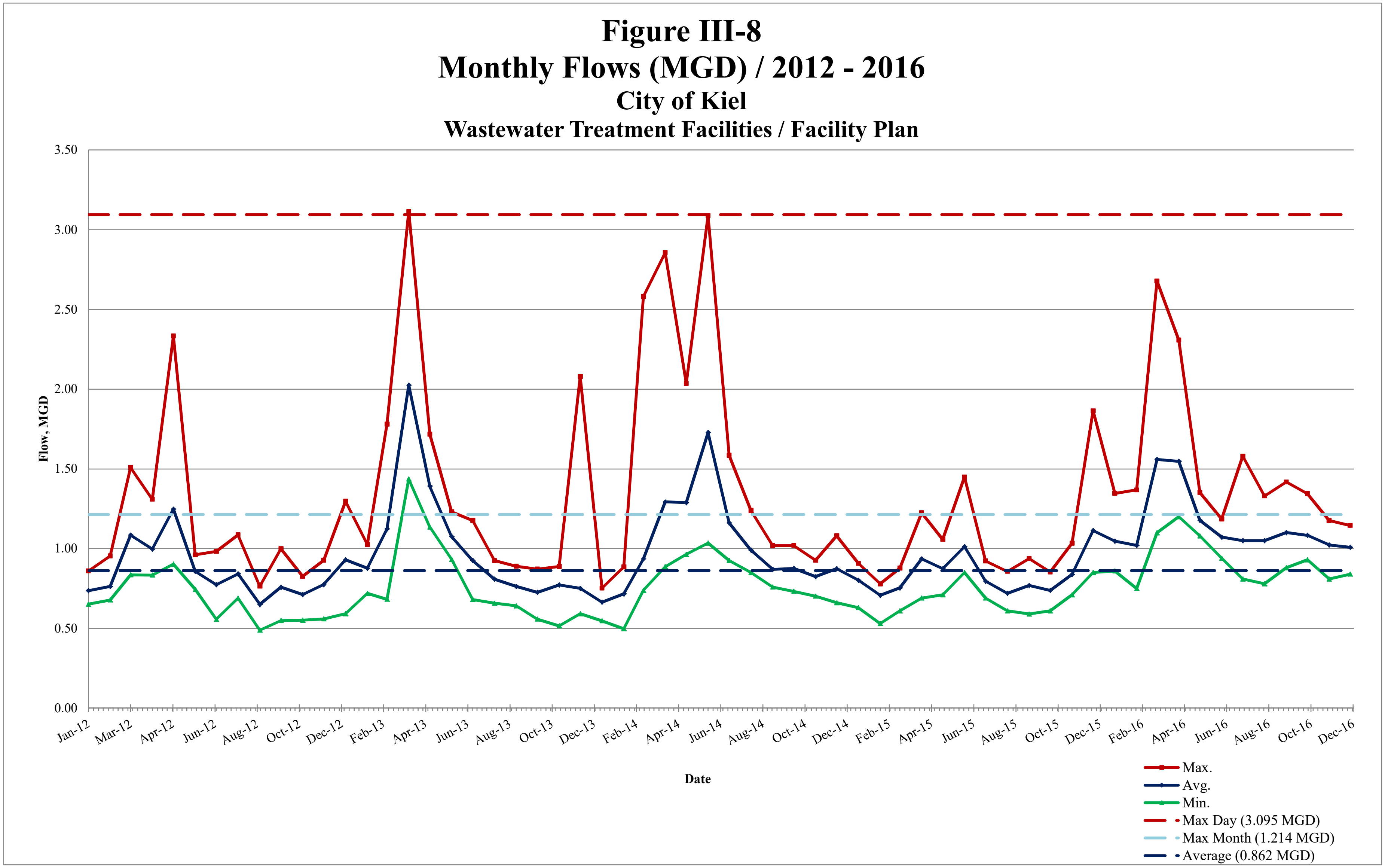
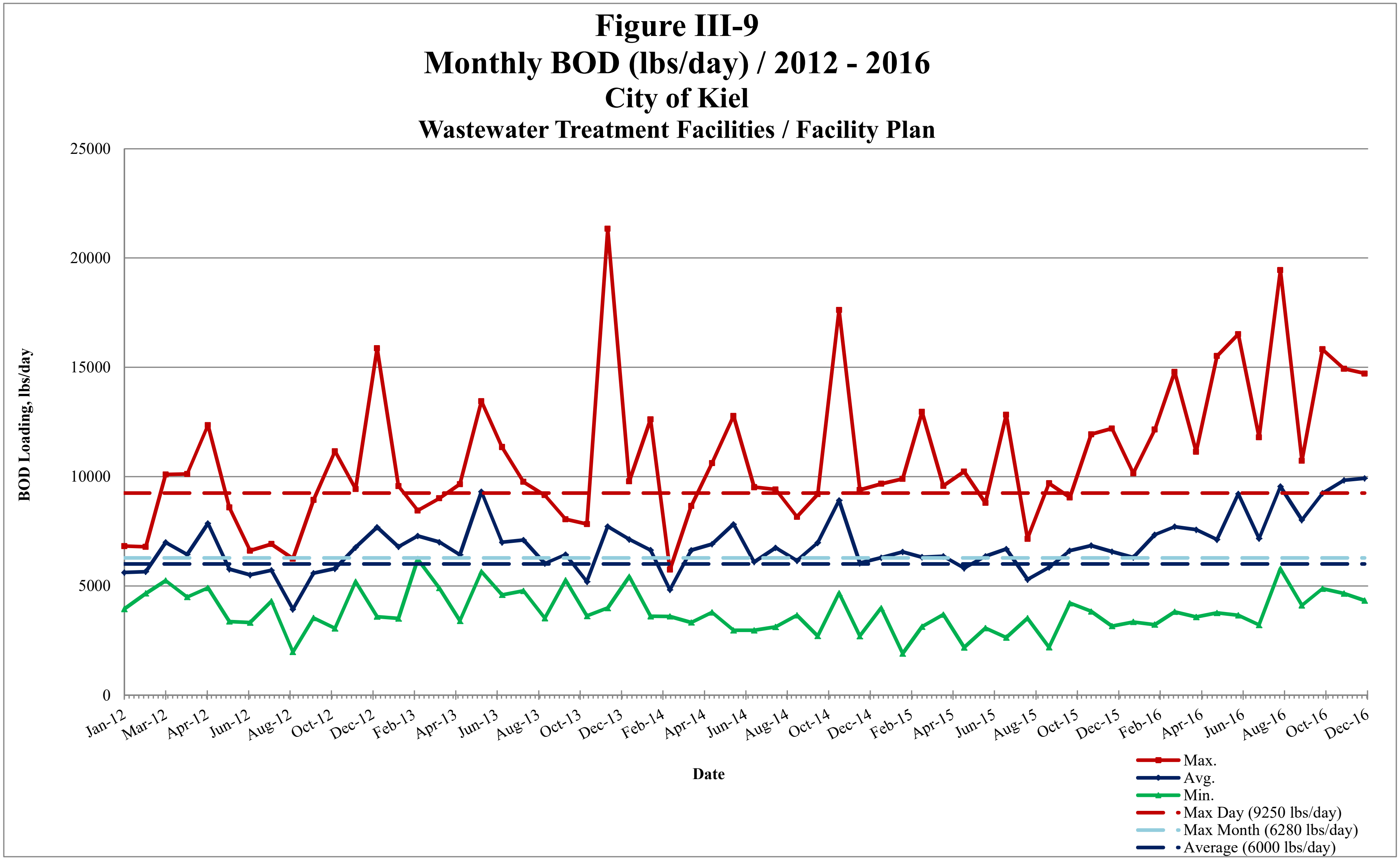


Figure III-8
Monthly Flows (MGD) / 2012 - 2016
City of Kiel
Wastewater Treatment Facilities / Facility Plan
Flow, MGD
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Jan-12
Mar-12
Apr-12
Jun-12
Aug-12
Oct-12
Dec-12
Feb-13
Apr-13
Jun-13
Aug-13
Oct-13
Dec-13
Feb-14
Apr-14
Jun-14
Aug-14
Oct-14
Dec-14
Feb-15
Apr-15
Jun-15
Aug-15
Oct-15
Dec-15
Feb-16
Apr-16
Jun-16
Aug-16
Oct-16
Dec-16
Date
Max.
Avg.
Min.
Max Day (3.095 MGD)
Max Month (1.214 MGD)
Average (0.862 MGD)



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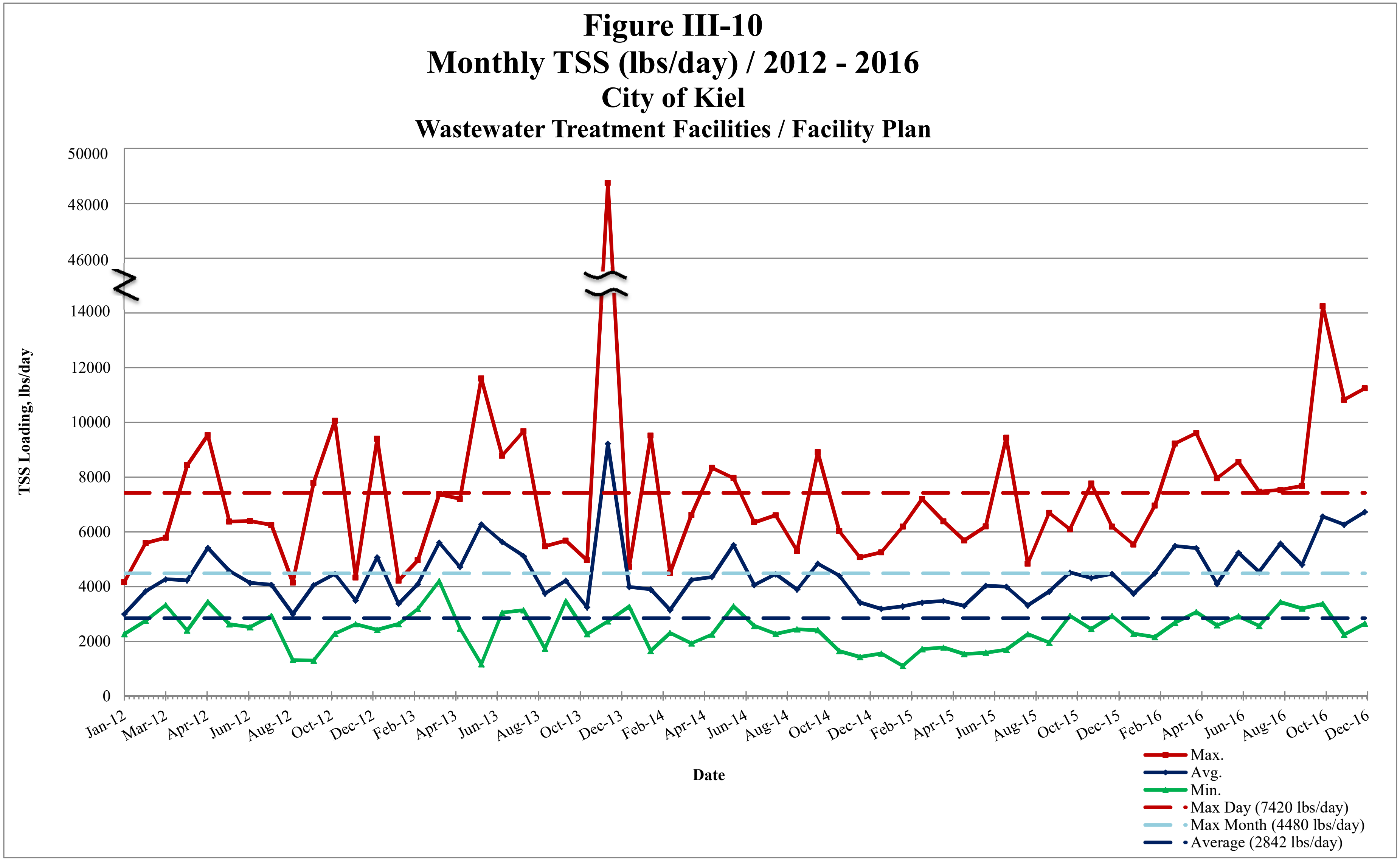
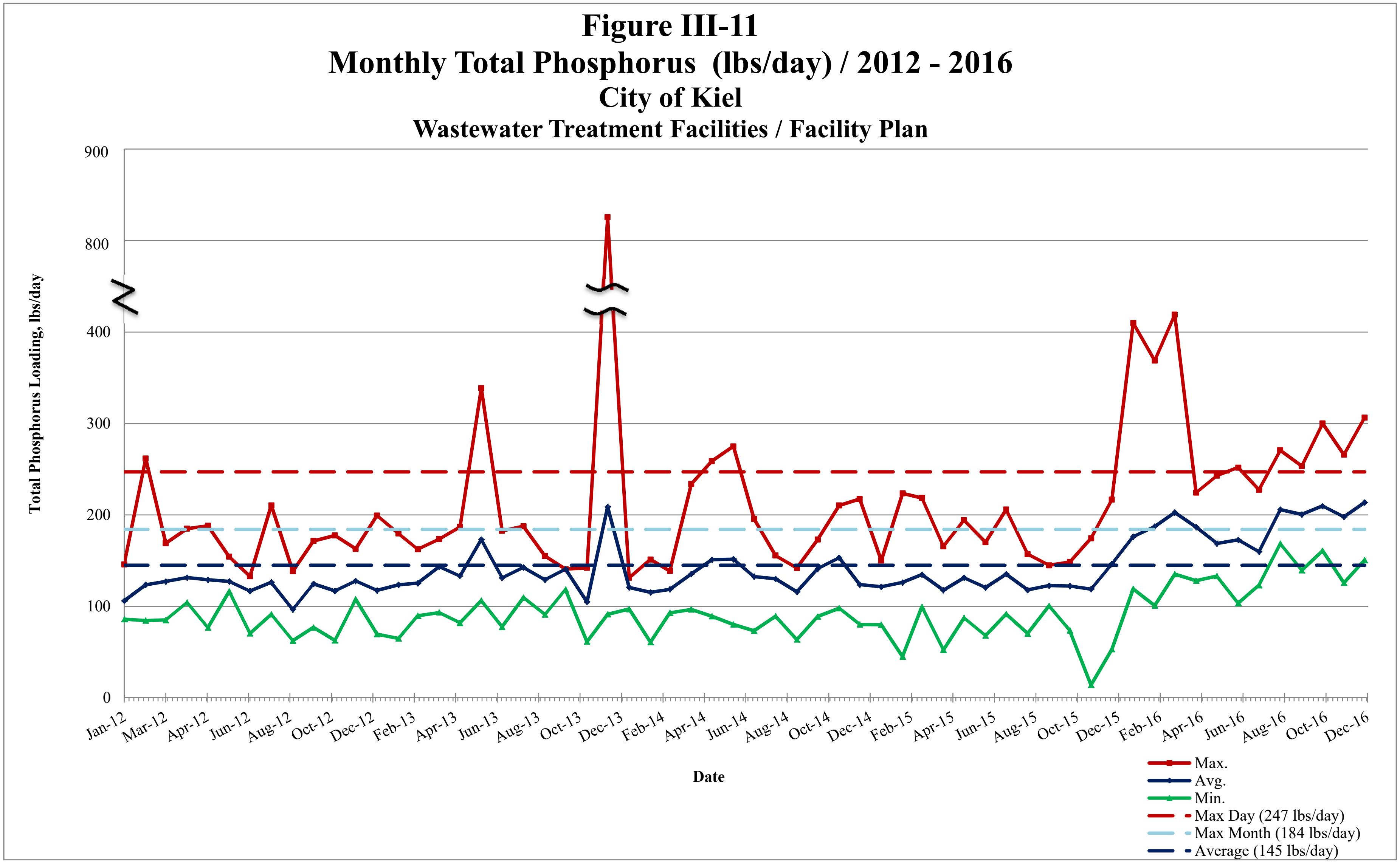
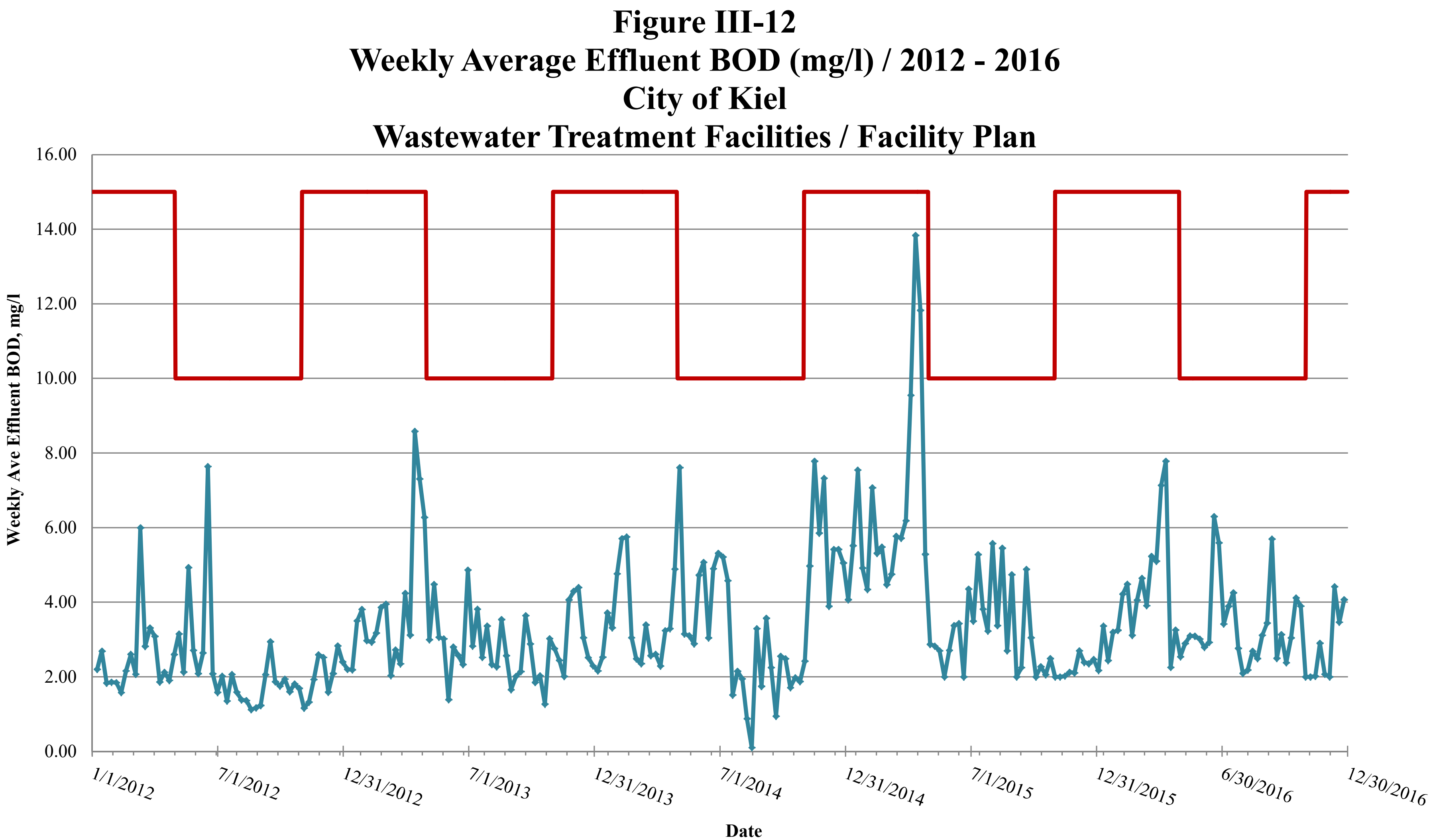


Figure III-10
Monthly TSS (lbs/day) / 2012 - 2016
City of Kiel
Wastewater Treatment Facilities / Facility Plan
TSS Loading, lbs/day
Date
Max.
Avg.
Min.
Max Day (7420 lbs/day)
Max Month (4480 lbs/day)
Average (2842 lbs/day)



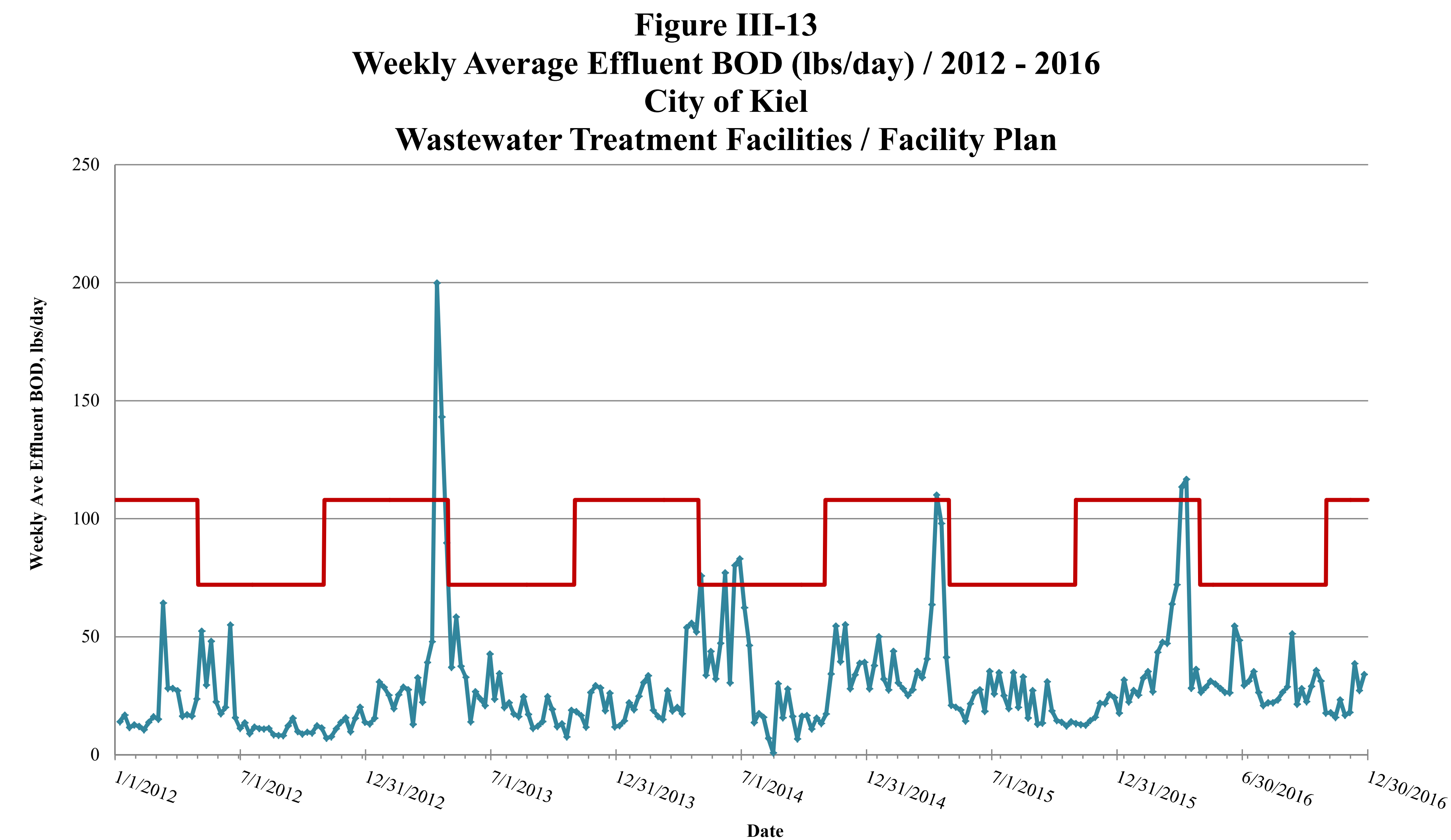
W:\WP\Facility-Plan\K0015\9-17-00949 Amendment #2 (10-2017 Update)\Figures\Figure III-8 thru 11.xlsx
10/27/2017



NOTE: Weekly Average Effluent BOD Limits:

May through October = 10 mg/l

November through April = 15 mg/l

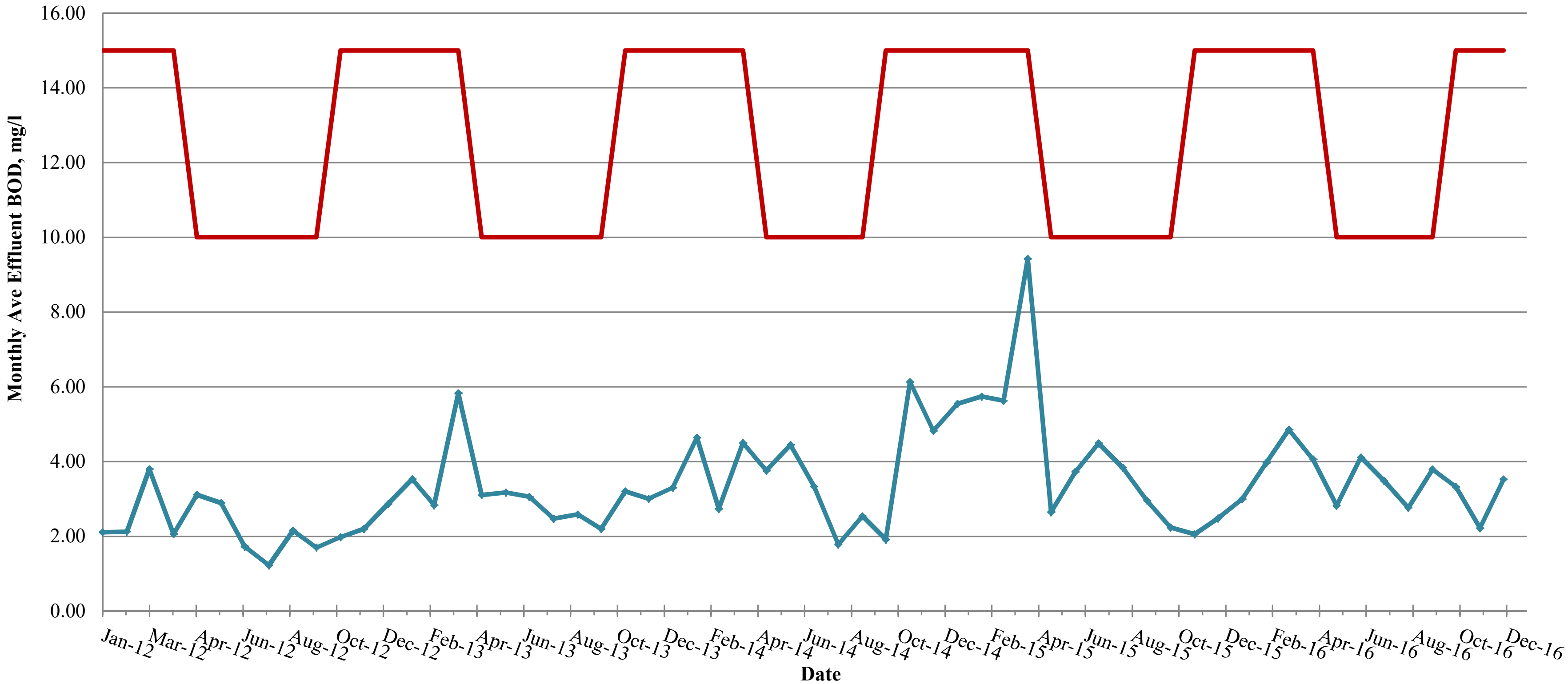


NOTE: Weekly Average Effluent BOD Limits:

May through October = 72 lbs/day

November through April = 108 lbs/day

Figure III-14
Monthly Average Effluent BOD (mg/l) / 2012 - 2016
City of Kiel
Wastewater Treatment Facilities / Facility Plan

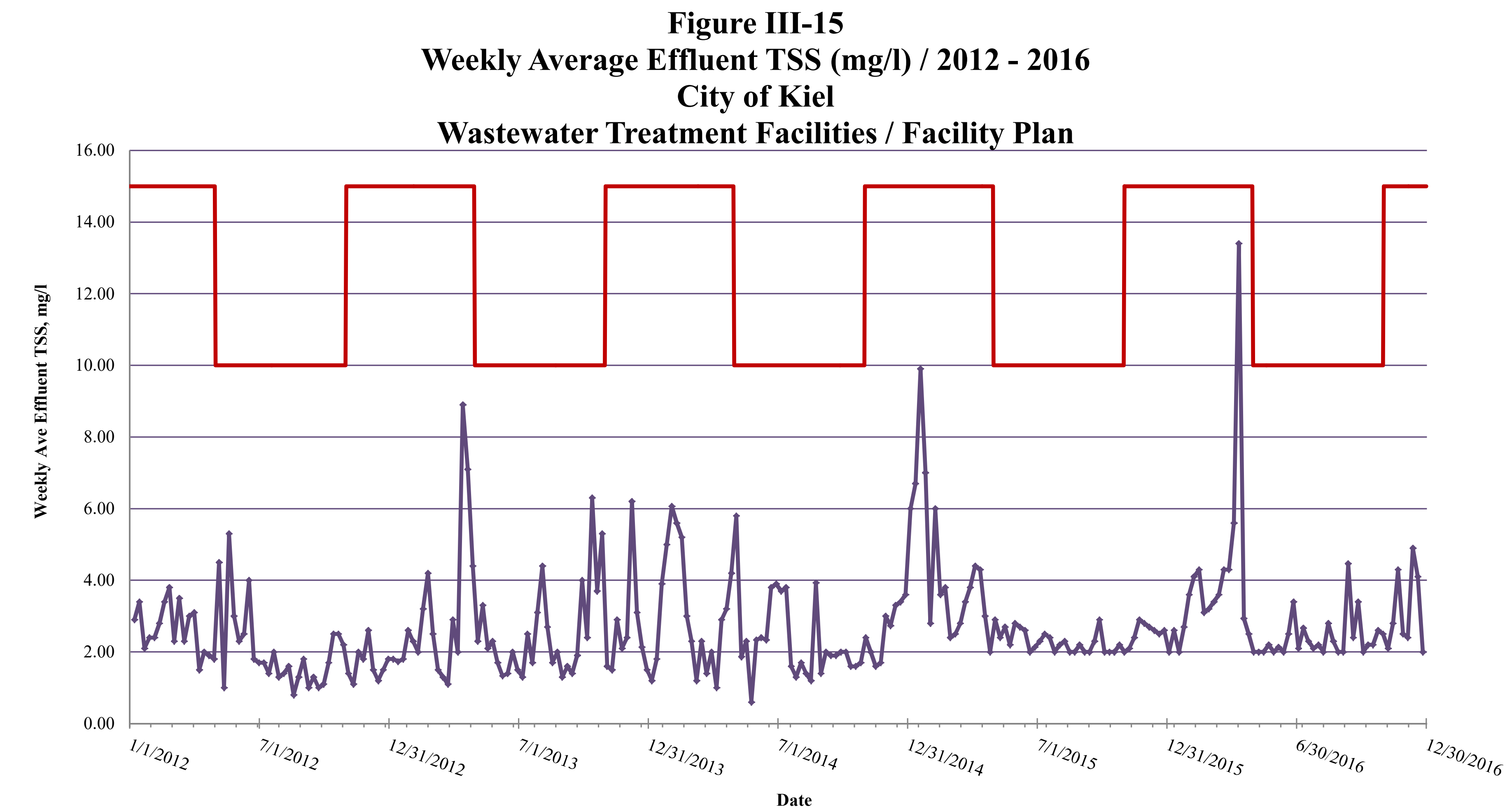


NOTE: Monthly Average Effluent BOD Limits:

May through October = 10 mg/l

November through April = 15 mg/l

W:\WP\Facility-Plan\K0015\9-17-00949 Amendment #2 (10-2017 Update)\Figures\Figure III-12 thru 21.xlsx.xls
10/27/2017

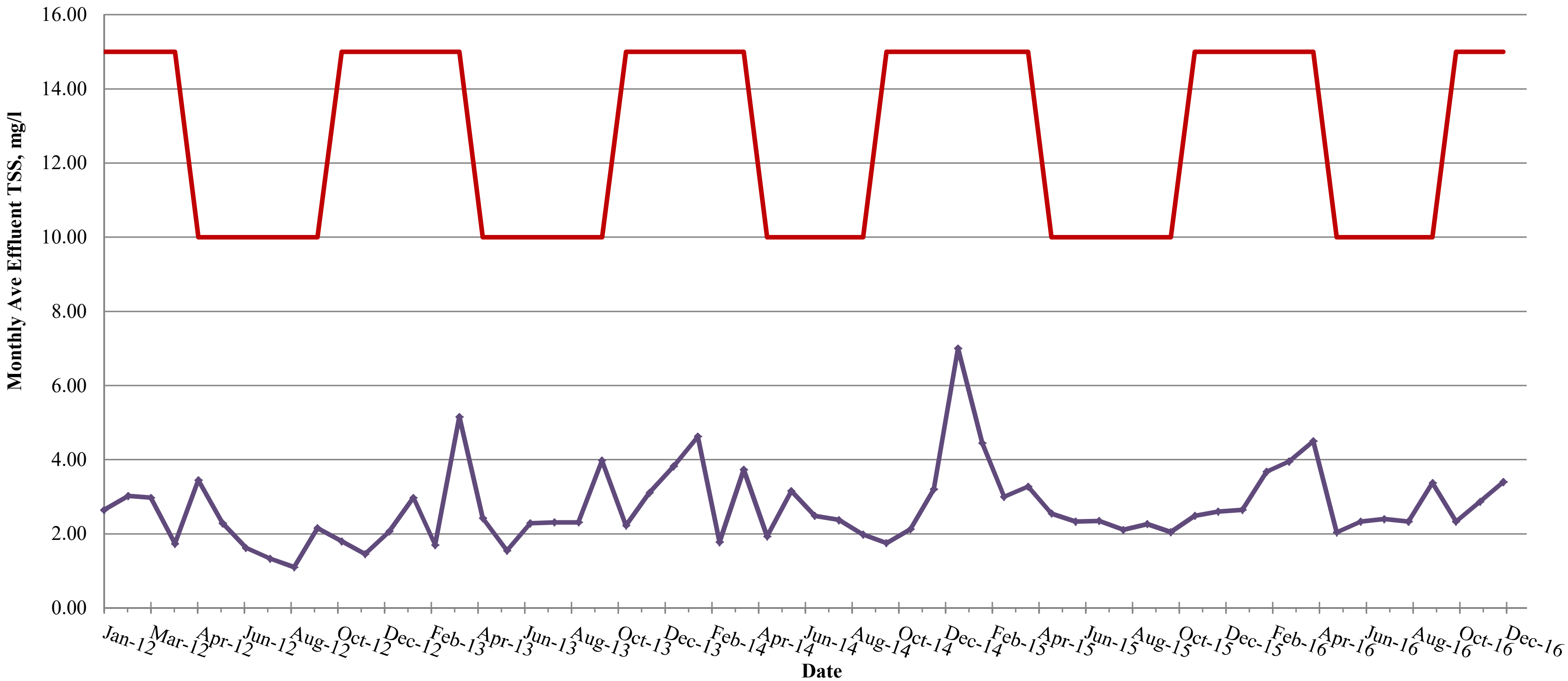


NOTE: Weekly Average Effluent TSS Limits:

May through October = 10 mg/l

November through April = 15 mg/l

Figure III-16
Monthly Average Effluent TSS (mg/l) / 2012 - 2016
City of Kiel
Wastewater Treatment Facilities / Facility Plan



NOTE: Monthly Average Effluent TSS Limits:

May through October = 10 mg/l

November through April = 15 mg/l

W:\WP\Facility-Plan\K0015\9-17-00949 Amendment #2 (10-2017 Update)\Figures\Figure III-12 thru 21.xlsx.xls
10/27/2017

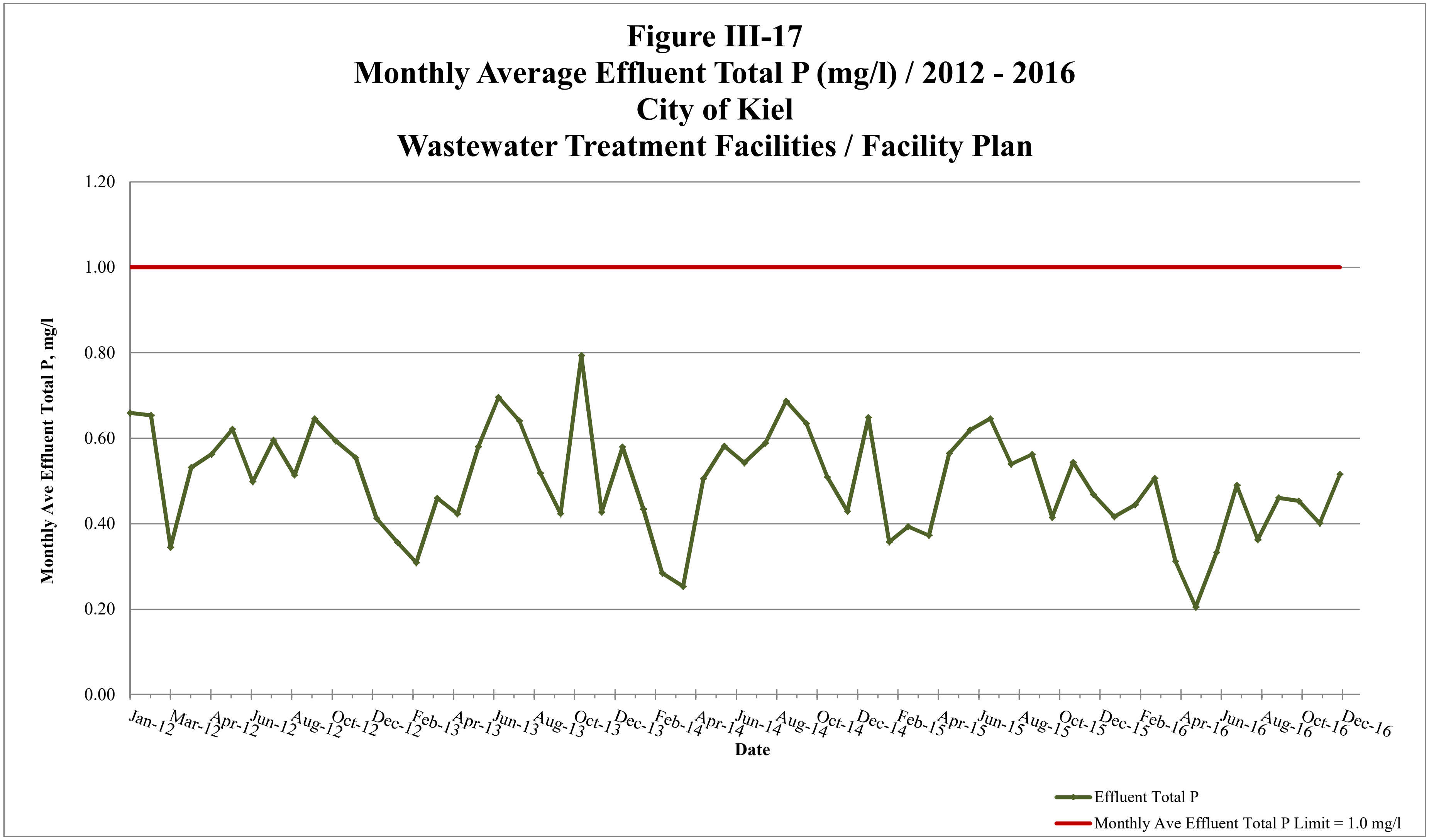
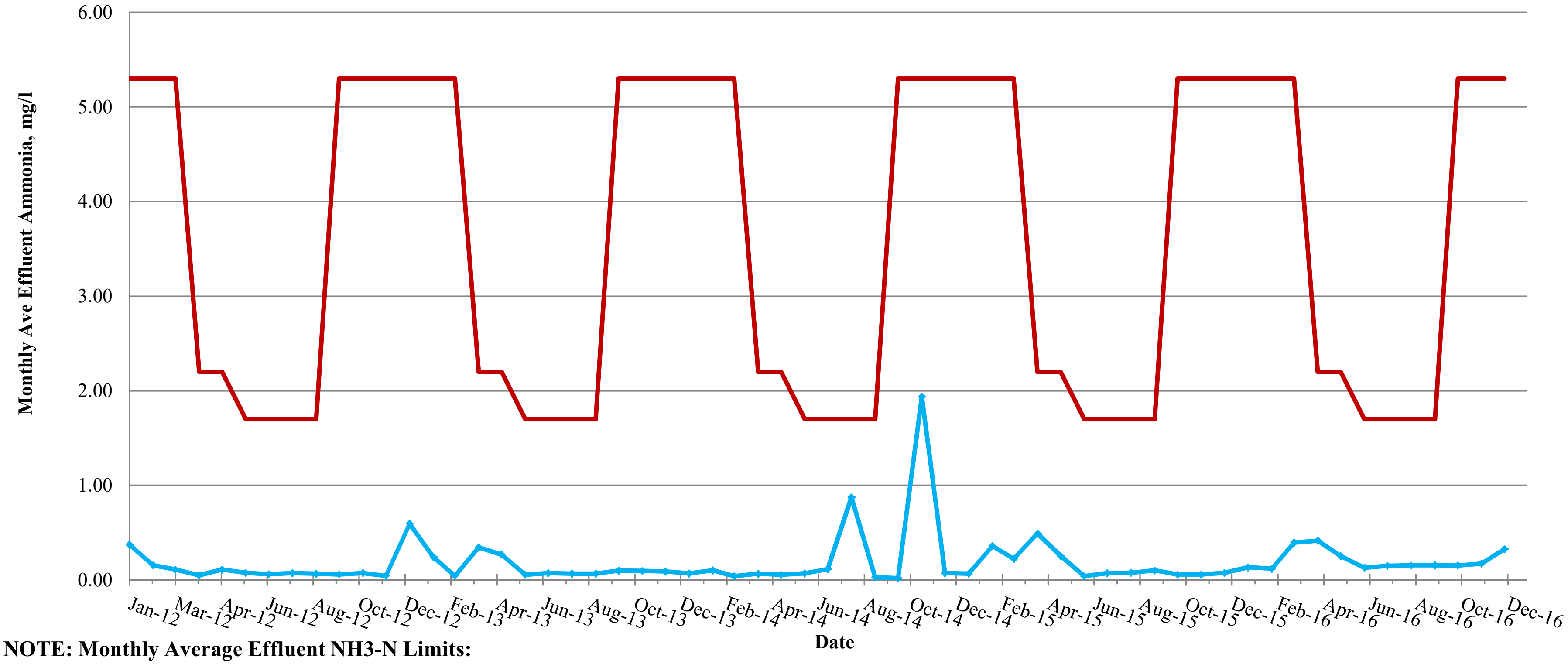


Figure III-17
Monthly Average Effluent Total P (mg/l) / 2012 - 2016
City of Kiel
Wastewater Treatment Facilities / Facility Plan
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Monthly Ave Effluent Total P, mg/l
Jan-12 Mar-12 Apr-12 Jun-12 Aug-12 Oct-12 Dec-12 Feb-13 Apr-13 Jun-13 Aug-13 Oct-13 Dec-13 Feb-14 Apr-14 Jun-14 Aug-14 Oct-14 Dec-14 Feb-15 Apr-15 Jun-15 Aug-15 Oct-15 Dec-15 Feb-16 Apr-16 Jun-16 Aug-16 Oct-16 Dec-16
Date
Effluent Total P
Monthly Ave Effluent Total P Limit = 1.0 mg/l

Figure III-18
Monthly Average Effluent Ammonia (mg/l) / 2012 - 2016
City of Kiel
Wastewater Treatment Facilities / Facility Plan



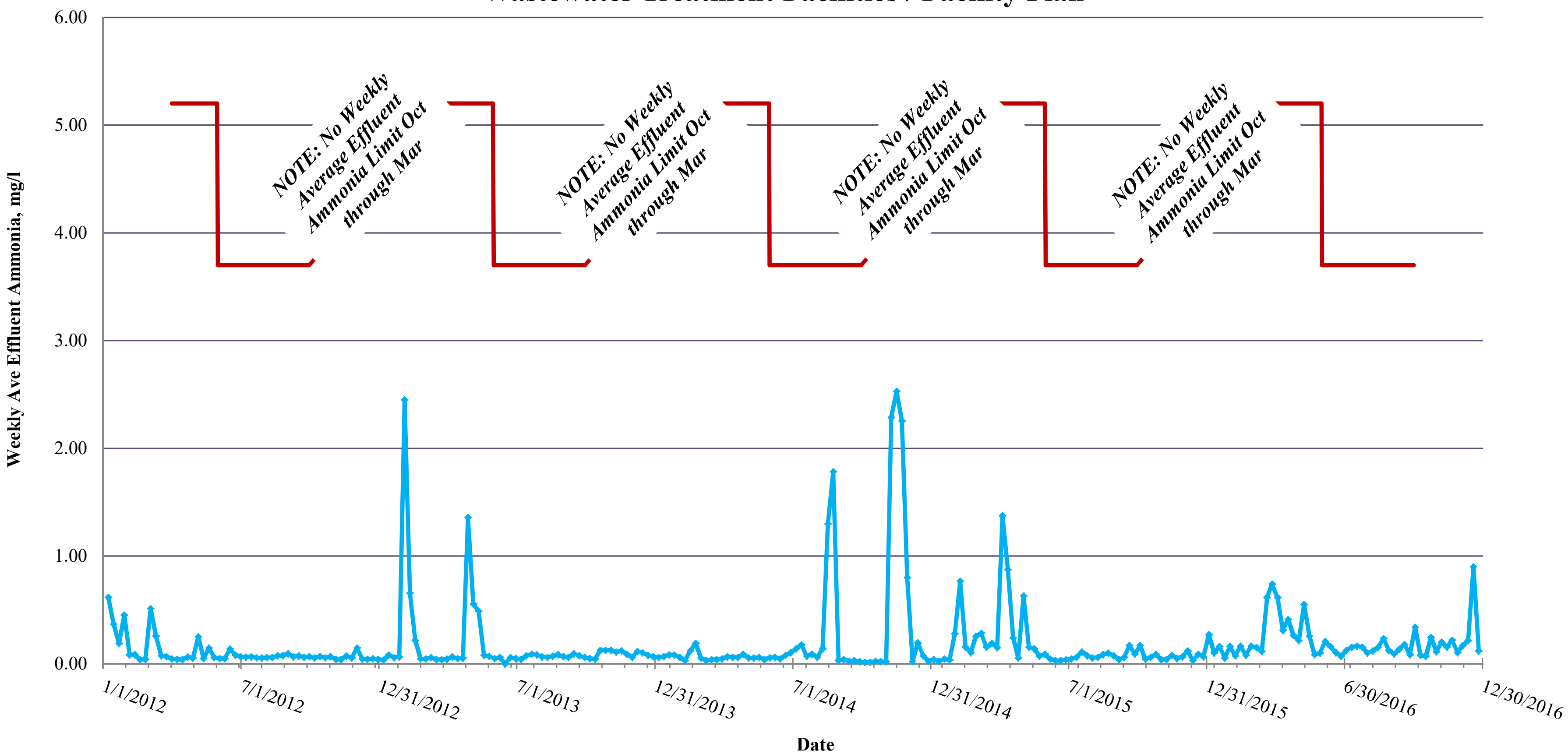
NOTE: Monthly Average Effluent NH3-N Limits:

April through May = 2.2 mg/l

June through September = 1.7 mg/l

October through March = 5.3 mg/l

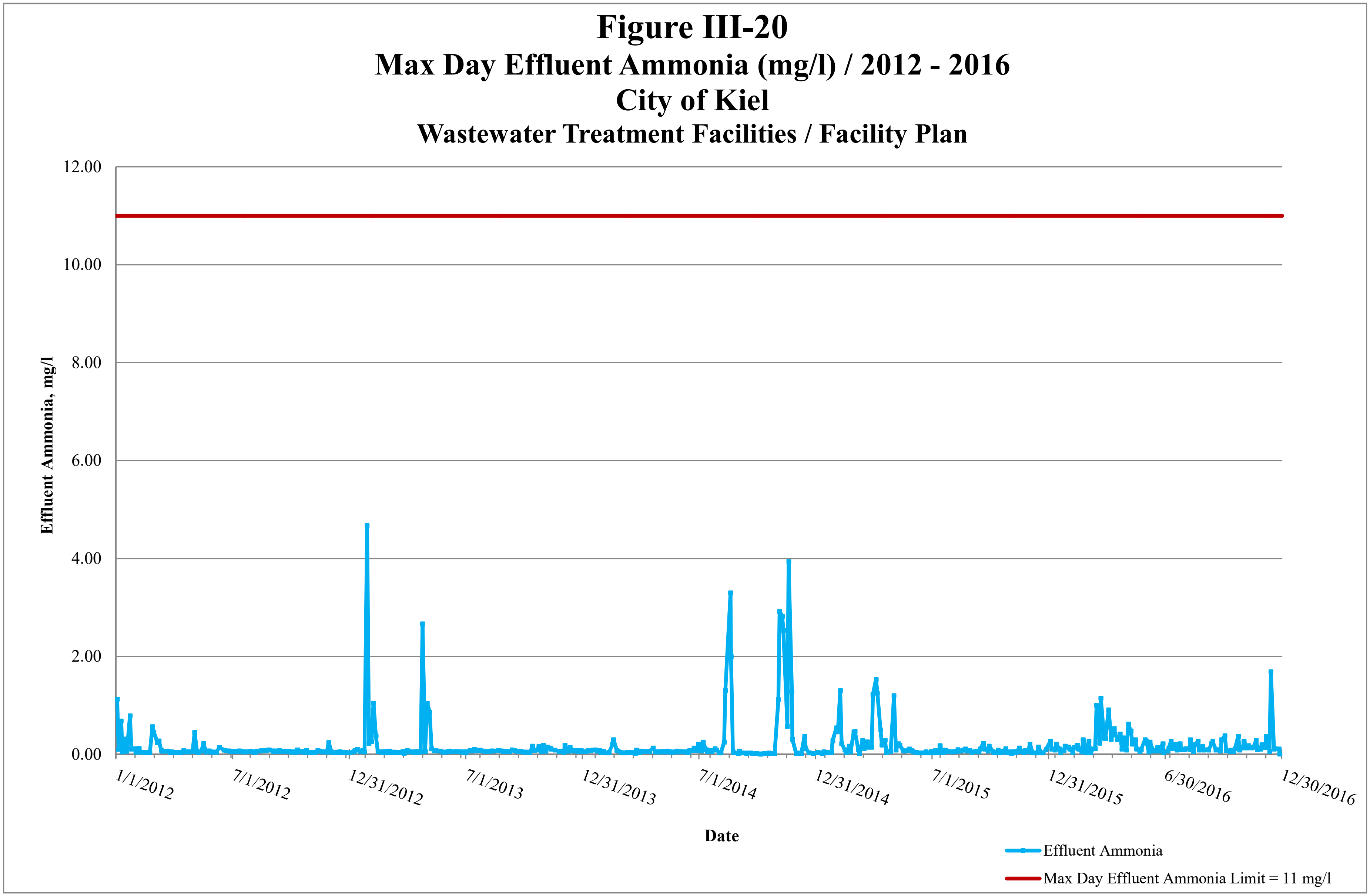
Figure III-19
Weekly Average Effluent Ammonia (mg/l) / 2012 - 2014
City of Kiel
Wastewater Treatment Facilities / Facility Plan



NOTE: Weekly Average Effluent Ammonia Limits:

April through May = 5.2 mg/l

June through September = 3.7 mg/l



W:\WP\Facility-Plan\K0015\9-17-00949 Amendment #2 (10-2017 Update)\Figures\Figure III-12 thru 21.xlsx.xls
10/27/2017

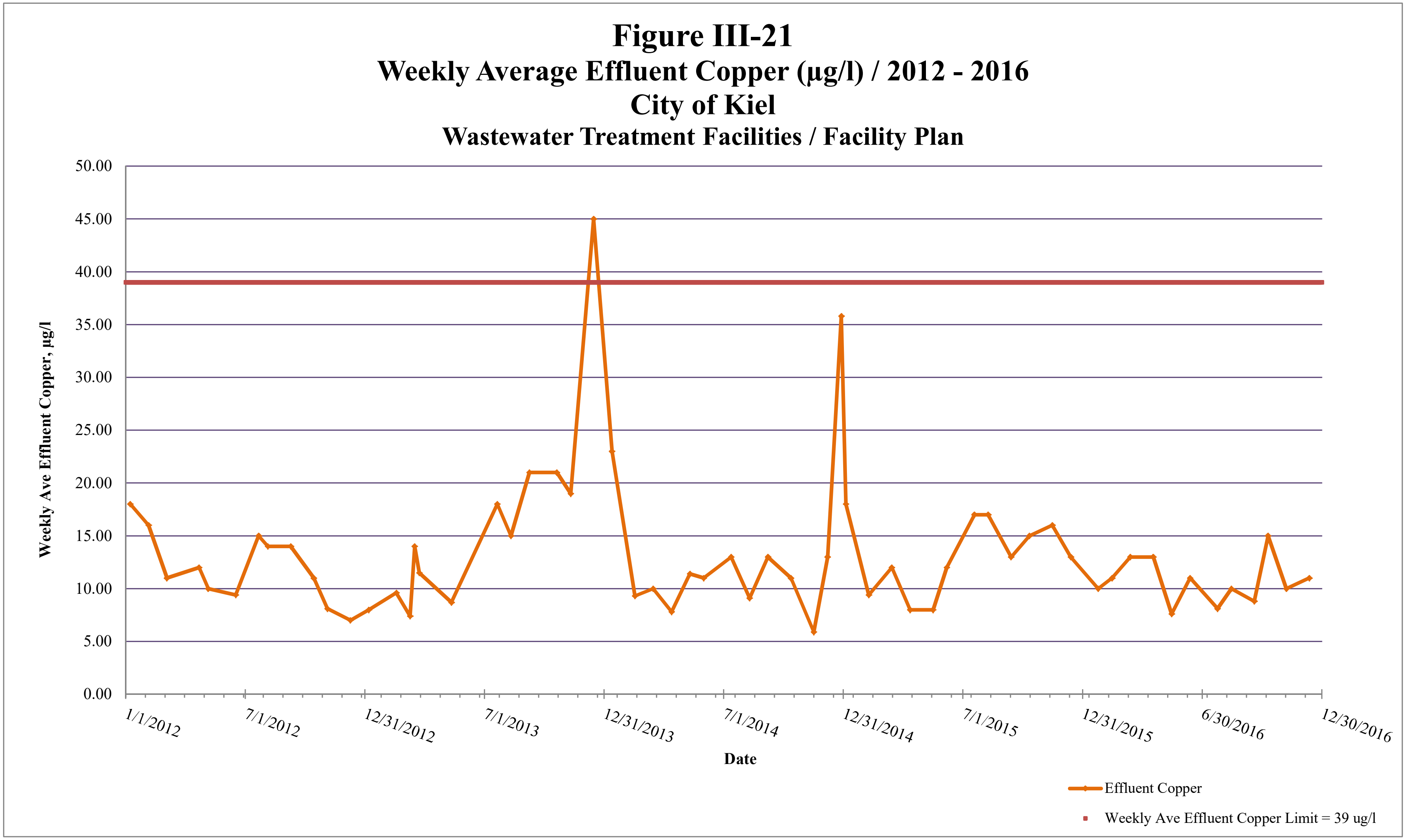


Figure III-21
Weekly Average Effluent Copper (µg/l) / 2012 - 2016
City of Kiel
Wastewater Treatment Facilities / Facility Plan
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Weekly Ave Effluent Copper, µg/l
1/1/2012
7/1/2012
12/31/2012
7/1/2013
12/31/2013
7/1/2014
12/31/2014
7/1/2015
12/31/2015
6/30/2016
12/30/2016
Date
Effluent Copper
Weekly Ave Effluent Copper Limit = 39 ug/l

The River Road Pump Station has a firm capacity of 2.42 mgd, with one (1) pump out of service. The peak hour design value is 4.26 mgd, which exceeds the firm capacity of the Pump Station. NR 110 of the Administrative Code requires a firm capacity of 4.26 mgd. Therefore, additional capacity is required.

The screening system has a firm capacity of 4.30 mgd, which exceeds the peak hour design flow of 4.26.

The aerated grit system has a peak hour design flow rate of 6.2 mgd, which results in a Hydraulic Retention Time (HRT) of 3.0-minutes. NR 110 requires an HRT of 3-minutes or less, at the design peak hour flow rate.

NR 110 requires primary clarifiers to have a surface overflow rate of 1,000 gpd/sq.ft. at the design average flow rate. This results in an average design flow capacity of 1.23 mgd for the primary clarifiers.

The 16-inch piping from the primary clarifiers to the aeration system splitter box is a hydraulic bottleneck, which limits forward flow to approximately 2 mgd. Additional capacity should be provided to eliminate the restriction.

During periods of high Biochemical Oxygen Demand (BOD) loadings, the aeration system experiences episodes of low Dissolved Oxygen (DO). The aeration system has been re-rated to allow a loading rate of 23.5 lbs. BOD/1,000 cu.ft. of basin volume, yielding a capacity of 4,970 lbs. BOD/day. Typical loadings exceed this value on a regular basis. In addition to requiring more tank volume, upgrading the blower system and/or air diffuser system to provide more oxygen will be necessary to achieve desired DO levels. The aeration blowers have a firm capacity of 5,880 scfm with one (1) large blower out of service. 4,227 scfm is required for mixing, per NR 110, and does not govern the air requirement when compared to the oxygen demand.

The piping between the aeration system and the final clarifiers is 16-inch diameter, and is hydraulic limiting during periods of high flows. Additional capacity is required to remove this restriction.

NR 110 limits the peak hour design surface settling rate to 1,000 gpd/sq.ft., which results in a final clarifier capacity of 2.51 mgd. This flow rate is exceeded during periods of high flows. Additionally, NR 110 limits the average design and peak hour solids loading rate to 1.2 and 2.0 lbs./sq.ft./hour, respectively. The resultant capacities of the final clarifiers are, therefore, 28.8 and 48.0 lbs./sq.ft./hour (average design and peak hour, respectively). The current loading rates are 25.4 lbs./sq.ft./hour (average) and 55.7 lbs./sq.ft./hour. The peak hour loading rate is in excess of the allowable 48.0 value, per NR 110. Although two (2) final clarifiers are utilized, the redundancy is ineffective, as the effluent quality deteriorates significantly with one (1) clarifier out of service. Additional clarifier capacity is required.

The firm capacity of the RAS pumping system is 2.016 mgd, with one (1) of two (2) pumps out of service. The NR 110 requirement is 1.72 mgd.

NR 110 requires a peak hour design filtration rate of 5 gpm/sq.ft., or less, with one (1) cell out of service. This results in a firm capacity of 3.095 mgd. However, the capacity of the filters with all cells in use is 2.0 mgd, based on actual operating experience. Maximum day flows exceed this value. The filters are in need of maintenance/repairs and are not suited to achieve low phosphorus limits; consideration should be given to upgrading to higher capacity cloth/mesh type filters or alternative technology.

The chlorine contact chamber has an average design capacity of 1.26 mgd, based on an HRT of 60-minutes; the peak hour design capacity is 2.53 mgd based on an NR 110 requirement of an HRT of 30-minutes.

With only one (1) primary digester that is heated and mixed, on a volumetric basis the anaerobic digestion system has a capacity of 17,977 gpd per the NR 110 requirement of a 15-day HRT. From a solids loading perspective, the capacity is 2,884 lbs. Volatile Suspended Solids (VSS)/day, based on the NR 110 loading rate of 80 lbs. VSS/1,000 cu.ft.

The sludge dewatering system is limited to the throughput capacity of the sole belt press, which is 125 gpm and 1,000 lbs. TSS/hour.

The Class A pasteurization system has a capacity of 800 lbs. TSS/hour.

The Cake Storage Facility has a capacity of 111,120 cu.ft. with a stack height of 12-feet, which exceeds the Administrative Code requirement of 180-days of storage (29,160 cu.ft.).

3. Wastewater Treatment Facility Condition

Originally built in 1965, the Wastewater Treatment Facility has been upgraded numerous times. 1979 and 1985 Phase I and Phase II upgrades resulted in the major treatment systems currently in use today. These upgrades were followed by Headworks additions in 1996, and aeration and sludge handling modifications in 1997. Lastly, aeration system upgrades in 2008 and conversion to enhanced Bio-P in 2012 resulted in the current treatment works. As such, there are buildings, pipes, tanks and treatment systems that date back 50-years.

In general terms, the following needs have been identified:

a. General

1) Instrumentation and controls (flow meters, etc.)
2) SCADA, control systems
3) Administration Building HVAC system

4) Laboratory countertops
5) Storage, maintenance space, vehicle storage

b. Headworks (Preliminary Treatment)

1) Address Class I, Division 1 compliance
2) Replace aerated grit system
3) Replace grit classifier

c. Primary Clarifiers

1) Repair structural cracks
2) Replace mechanisms and drives
3) Replace weirs and baffles
4) Address influent flow splitting
5) Provide dedicated / redundant positive displacement sludge pumps

d. Aeration System

1) Consider tying RAS pipe into the primary effluent line to facilitate mixing
2) Replace buried air main with new overhead air main
3) Provide new DO / pH ORP monitoring
4) Structural repair of spalled / cracked concrete, railings
5) Replace weir gates
6) Address flow splitting at splitter box

e. Final Clarifiers

1) Address flow splitting at splitter box
2) Provide redundant RAS and WAS pumps
3) Consider replacing Fiberglass-Reinforced Plastic (FRP) domes
4) Replace mechanisms and drives
5) Replace weirs and baffles

f. Tertiary Sand Filters

1) Repair steel components
2) Upgrade controls
3) Replace valves

g. Disinfection System

1) Repair / replace two (2) leaking gates

h. Post-Aeration System

1) Repair / modify step at walkway

i. High Strength Waste Tank

1) Consider addition of an automated card reader for high strength waste / septage / grease
2) Provide a separate grease tank and pump system to feed directly to digester

j. Digesters

1) Consider thickening WAS
2) Optimize use of biogas
3) Replace covers on both digesters
4) Replace mixing system and add mixing to secondary digester
5) Replace pumps and provide redundancy
6) Replace boiler / heat exchanger
7) Address Class I, Division 1 compliance
8) Relocate flare
9) Relocate condensate drain in Service Building
10) Address structural cracks and brick maintenance; consider insulated metal panels
11) Replace instrumentation

k. Sludge Dewatering

1) Replace belt press with new redundant dewatering system
2) Consider alternatives to pasteurization to achieve Class A biosolids
3) Provide additional lime / fly ash storage
4) Replace dump truck utilized to transport sludge with larger capacity vehicle

l. Electrical

1) Implement electrical utility service improvements.
2) Provide new main electrical service equipment with a short circuiting rating of 65 kA.
3) Demolish and replace existing, obsolete MCC's.
4) Resolve non-compliance in Classified Hazardous Locations:
    a) Remove electrical equipment from the Digester Building that is not Underwriters Laboratories (UL)-approved for hazardous locations.
    b) Provide new electrical equipment in hazardous locations that is UL-approved for hazardous locations.

c) Locate new electrical equipment intended for ordinary locations, so it is outside of classified hazardous atmosphere.

d) Provide new MCC-3, to replace existing MCC-3, in the Digester Building. Locate new MCC-3 in a new, non-hazardous location in the digester complex.

5) Provide new electrical distribution equipment, as required, to support the Wastewater Treatment Facility process improvements.

m. Controls Needs

Parts of the existing controls are old technology, and should be upgraded to take advantage of the operational tools available with new controllers and SCADA. Some of the existing PLC's are no longer manufactured, and support for them is becoming less and less available. In view of this, the following needs have been identified:

1) Communications:

a) Install a redundant fiber optic cable between all Treatment Facility buildings.

b) Install a secure firewall with remote access capability via a VPN (Virtual Private Network).

c) Allow vendors limited remote access for equipment support via a VPN.

d) Install Ethernet switches to connect fiber optic control network to individual building control networks.

2) Programmable Logic Controllers (PLC's):

a) Standardize on a PLC from a specific Manufacturer.

b) Replace obsolete PLC's with current-technology PLC's.

c) Formulate plan to replace 'mature active' PLC's.

d) Require new equipment vendors whose equipment needs a PLC for control to provide a PLC from the selected standard Manufacturer.

e) Each control panel with a PLC to have an Operator Interface Terminal (OIT) and an Ethernet managed switch.

3) Alarming:

a) Control panels containing a PLC to have an alarm horn for annunciating alarms occurring in its area. Alarm horn is silenced when the local Alarm Silence pushbutton is pressed or the alarm is acknowledged at the SCADA.

b) OIT's to display alarms generated by the PLC in its control panel and allows the Operator to acknowledge the alarm locally.

c) SCADA also annunciates alarms and retains alarm status. If the alarm is acknowledged at the local OIT, the SCADA alarm is also acknowledged. All alarms logged to its Historian.

d) Alarms detected by the SCADA are also annunciated via WIN911 alarm notification software. SCADA shall have a screen that allows the Operator to inhibit individual alarms from being annunciated by WIN911.

4) Supervisory Control & Data Acquisition (SCADA):

a) Two (2) PC's; one (1) designated as the Primary, and one (1) designated as the Secondary.

(1) Secondary PC acts as a 'hot backup' to the Primary PC, directly connected via a cross-over Ethernet cable.

(2) WIN911 alarm notification software and the Historian reside on the Primary PC.

(3) Both PC's to have two (2) solid-state drives with RAID 1 mirrored-array configuration.

(4) Large screen monitor that can display screens from either PC.

In addition to the above items, the existing MCP in the Operator Control Room should be demolished and a wall put in its place. Any required communication equipment or PLC that would be required to support Wastewater Treatment Facility control functions in the OCR would be housed in a considerably smaller panel. The space gained could be put to other uses. Putting a window in this wall and mounting the large screen monitor on the opposite wall will allow the Operator to assess Treatment Facility operation during a walk-by.

4. Permit Requirements

The City of Kiel Wastewater Treatment Facility operates under Wisconsin Pollutant Discharge Elimination System (WPDES) Permit No. WI-0020141. This permit, like many others throughout the State of Wisconsin, is expired. The Wisconsin Department of Natural Resources (DNR) anticipates issuing new permits on a watershed-wide basis in the near future. A copy of the expired permit, which regulates the Kiel Wastewater Treatment Facility, was located in Chapter II - Appendix II-1.

In anticipation of permit issuance, the DNR has issued a Memorandum regarding Water Quality Based Effluent Limitations (WQBEL) for the Kiel Wastewater Treatment Facility, dated September 30, 2013. A copy of the Memorandum was located in Chapter II - Appendix II-2. The purpose of the Memorandum is to provide calculated water quality based effluent limitations for the Kiel Wastewater Treatment Facility discharge into the Sheboygan River.

Key changes to the Kiel discharge permit being considered by the DNR include:

a. Temperature Limits (September - April)
b. Total Phosphorus Limits
    1) 0.1 mg/L (May - October)
    2) 0.3 mg/L (November - April)
c. Chlorides, 460 mg/L
d. Ammonia, 6.7 mg/L daily maximum
e. Dissolved Oxygen (DO), 7.0 mg/L (July - September)
f. Biochemical Oxygen Demand (BOD)
    1) 8.9 mg/L (June)
    2) 9.5 mg/L (July)
    3) 8.7 mg/L (August)
    4) 9.9 mg/L (September)
    5) 9.3 mg/L (October)
g. Total Suspended Solids (TSS)
    1) 8.9 mg/L (June)
    2) 9.5 mg/L (July)
    3) 8.7 mg/L (August)
    4) 9.9 mg/L (September)
    5) 9.3 mg/L (October)

APPENDIX III-1

WISCONSIN DEPARTMENT OF NATURAL RESOURCES (DNR)
ENDANGERED RESOURCES PRELIMINARY ASSESSMENT

Endangered Resources Preliminary Assessment

Created on **8/8/2017**. This report is good for one year after the created date.

Results

No actions required/recommended. No endangered resources have been recorded in this area. For additional information on Endangered Resources (ER) Reviews, please visit: http://dnr.wi.gov/topic/ERReview/Review.html

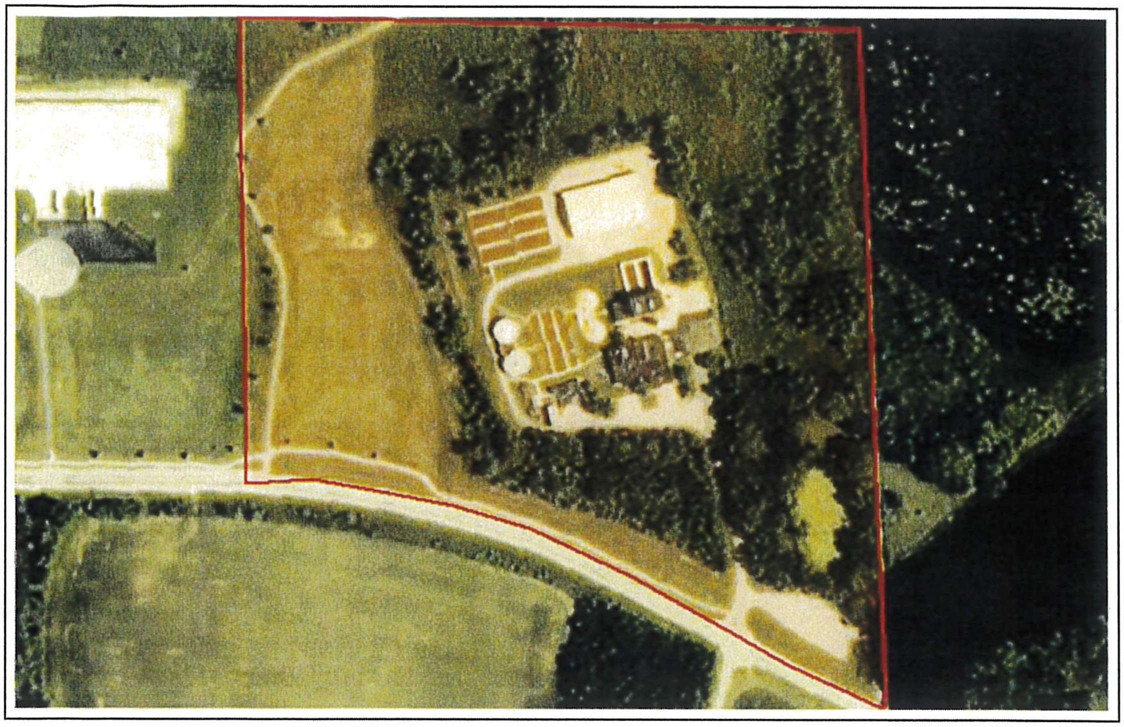
Project Information

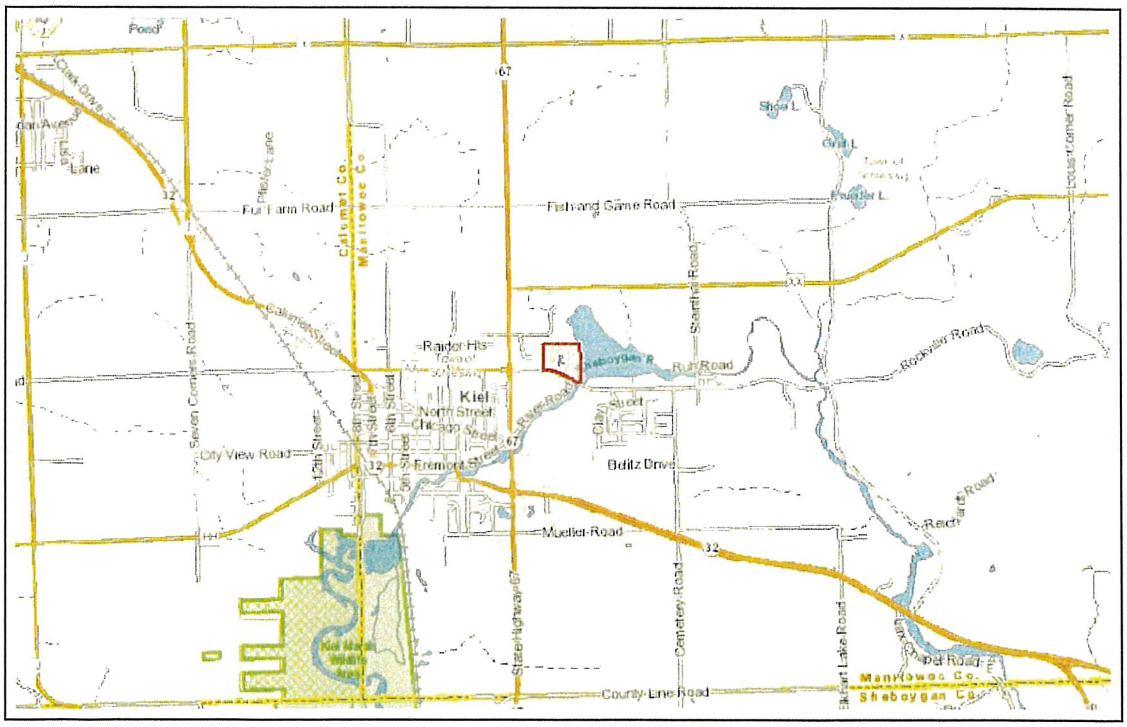
Landowner name	City of Kiel
Project address	100 E. Park Avenue, Kiel, Wi
Project description	Kiel Wastewater Treatment Plant

Project Questions

Does the project involve a public property?	Yes
Is there any federal involvement with the project?	Yes
Is the project a utility, agricultural, forestry or bulk sampling (associated with mining) project?	Yes
Is the project property in Managed Forest Law or Managed Forest Tax Law?	No

Project Area Maps





The information shown on these maps has been obtained from various sources, and is of varying age, reliability and resolution. These maps are not intended to be used for navigation, nor are these maps an authoritative source of information about legal land ownership or public access. Users of these maps should confirm the ownership of land through other means in order to avoid trespassing. No warranty, expressed or implied, is made regarding accuracy, applicability for a particular use, completeness, or legality of the information depicted on this map. For more information, see the DNR Legal Notices web page: http://dnr.wi.gov/legal/.

APPENDIX III-2

WISCONSIN DEPARTMENT OF NATURAL RESOURCES (DNR)
ARCHAEOLOGICAL / HISTORICAL SIGNIFICANCE RESPONSE

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

101 S. Webster St.
Madison, Wisconsin 53707-7921
Phone/voicemail: 608.266.3462
E-mail: mark.dudzik@wisconsin.gov
FAX 608.267.2750

March 31, 2015

Amy Vaclavik, PE
McMahon Associates
1445 McMahon Drive
Neenah, WI 54956

Subject: *City of Kiel – WWTP Improvements, Manitowoc County (T17N/R21E/S20)*

Dear Ms. Vaclavik,

DNR has completed a review of the above project.

For cultural resource (per WI stats) issues only, the project is cleared to proceed (i.e., no *recorded* historic properties reported to occur within target parcels/locations).

Please forward this letter to other parties, as needed, and retain a copy for project files.

Do not hesitate to get in touch for additional information or clarification.

Sincerely,

Mark J. Dudzik
Departmental Archaeologist

McMAHON
ENGINEERS \ ARCHITECTS

March 26, 2015

Mr. Mark Dudzik
Department Archaeologist
Wisconsin Department Of Natural Resources
101 South Webster Street
P.O. Box 7921
Madison, WI 53707-7921

Re: City Of Kiel, Wisconsin
Wastewater Facilities Planning
McM. No. KK0015-950262.00

Dear Mark:

We are preparing a Wastewater Facilities Plan for the City Of Kiel, Wisconsin. We request a review of the site be conducted to determine if there are potential archaeological or historic sites in the area. Figures showing the location of the Wastewater Treatment Facility are provided. The site is located as follows:

City Of Kiel
Township Seventeen (17) North, Range Twenty-One (21) East
Southwest Quarter (1/4) Of Section Twenty (20)
Manitowoc County, Wisconsin

Thank you for your consideration of this request. Please call if there are questions or if additional information is needed.

Very truly yours,

McMAHON

Amy J. Vaclavik

Amy J. Vaclavik, P.E., BCEE
Associate / Senior Project Engineer

AJV:smdt
Enclosure

APPENDIX III-3

COMPLIANCE MAINTENANCE ANNUAL REPORT (CMAR)
2016

Compliance Maintenance Annual Report

Kiel Wastewater Treatment Facility | Last Updated: 6/19/2017 | Reporting For: **2016**

DNR Response to Resolution or Owner's Statement

Name of Governing Body or Owner: City of Kiel

Date of Resolution or Action Taken: 2017-06-13

Resolution Number: 2014-5

Date of Submittal: 6/19/2017

ACTIONS SET FORTH BY THE GOVERNING BODY OR OWNER RELATING TO SPECIFIC CMAR SECTIONS (Optional for grade A or B. Required for grade C, D, or F):

Influent Flow and Loadings: Grade = F

Permittee Response:

Approved Facility Plan 2015 by McMahon is schedule for bidding between June 2017-January 2018 for work to address the influent flow and loading shortfalls. The final completion of the project is scheduled for fall of 2019.
A revision of the project into 2 phases is submitted to DNR for approval.

DNR Response:

A revised Facility Plan to address the influent flow and loading has been submitted to the Department for review.

Effluent Quality: BOD: Grade = A

Permittee Response:

DNR Response:

Effluent Quality: TSS: Grade = A

Permittee Response:

DNR Response:

Effluent Quality: Ammonia: Grade = A

Permittee Response:

DNR Response:

Effluent Quality: Phosphorus: Grade = A

Permittee Response:

DNR Response:

Biosolids Quality and Management: Grade = B

Compliance Maintenance Annual Report

Permittee Response:

DNR Response:

Staffing: Grade = A

Permittee Response:

DNR Response:

Operator Certification: Grade = A

Permittee Response:

DNR Response:

Financial Management: Grade = A

Permittee Response:

DNR Response:

Great future planning and energy efficient practices.

Collection Systems: Grade = A

(Regardless of grade, response required for Collection Systems if SSOs were reported)

Permittee Response:

DNR Response:

The Department recommends a minimum of 10% per year sewer line televisingof the sanitary sewer collection system.

ACTIONS SET FORTH BY THE GOVERNING BODY OR OWNER RELATING TO THE OVERALL GRADE POINT AVERAGE AND ANY GENERAL COMMENTS

(Optional for G.P.A. greater than or equal to 3.00, required for G.P.A. less than 3.00)

G.P.A. = 3.54

Permittee Response:

DNR G.P.A. Response:

DNR CMAR Overall Response:

Thank you for submitting the CMAR on time.

DNR Reviewer: Haas, David | **Phone:** (920) 662-5401

Address: 2984 Shawano Avenue, Green Bay, WI 54313-6727 | **Date:** 9/7/2017

APPENDIX III-4

UNIT PROCESS DESCRIPTIONS
December 2014 Master Plan

Appendix C: Unit Process Description

Existing Unit Processes
WWTP Capacity Evaluation
City of Kiel, WI

Raw Wastewater Pumping

Number of Pumps (River Road PS)	3	
Type	KSB Dry-Pit Submersible - Non-clog centrifugal	
Motor	33	HP
Drive	Variable-Frequency	
One Pump Capacity w/ 8" FM	1.84	mgd
Two Pump Capacity w/ 12" FM	2.42	mgd
Three Pump Capacity w/ 8" and 12" FM	4.27	mgd
Firm Pumping Capacity	2.42	mgd

Raw Wastewater Screening

Screen Type	Fine Screens - Hycor HLS500 Helisieve Spiral Screen	
Total Number of Screens	2	
Opening Size	0.25	inch
Each Screen Peak Capacity	2,986	gpm
Firm Screen Capacity	4.3	mgd

Aerated Grit Removal Basins

Number of Basins	1	
Dimensions		
Length	12.0	ft
Width	12.0	ft
Sidewater Depth	12.0	ft
Volume per Basin	12,925	gal
Total Volume	12,925	gal
Hydraulic Capacity @ 3 min DT	6.20	mgd
Grit Pump		
Number	1	
Type	Air Lift	
Grit Handling		
Number	1	
Type	Classifier	

Primary Clarifiers

Total Number of Basins	2	
Type	Circular	
Dimensions		
Diameter	28.0	ft
Weir Length	324	ft
Sidewater Depth	12.0	ft
Surface Area per Unit	616	sf
Total Surface Area	1,232	sf
Hydraulic Capacity @ 1000 gpd/sf	1.2	mgd

Aeration Basins

Number of Parallel Trains	3.0	
Dimensions		
Train 1 (Basins 1-4)		
Anoxic Zone		
Length (Total of 1 Zones)	30.0	ft
Width	28.0	ft
Sidewater Depth	14.0	ft
Volume	87,965	gal
Percent of Train 1 Volume	19%	
Aerobic Zone		
Length (Total of 3 Zones)	162.0	ft
Width	28.0	ft
Sidewater Depth	14.0	ft
Volume	475,010	gal
Tank 4 HSW Aerobic Zone		
Length	64.0	ft
Width	28.0	ft
Sidewater Depth	14.0	ft
Volume	187,658	gal
Train 2 (Basins 5,7,9)		
Anoxic Zone		
Length (Total of 1 Zones)	30.0	ft
Width	32.0	ft
Sidewater Depth	14.0	ft

Volume	100,531	gal
Percent of Train 1 Volume	18%	
Aerobic Zone		
Length (Total of 3 Zones)	165.0	ft
Width	32.0	ft
Sidewater Depth	14.0	ft
Volume	552,922	gal
Train 3 (Basins 6,8,10)		
Anoxic Zone		
Length (Total of 1 Zones)	30.0	ft
Width	32.0	ft
Sidewater Depth	14.0	ft
Volume	100,531	gal
Percent of Train 1 Volume	18%	
Aerobic Zone		
Length (Total of 3 Zones)	165.0	ft
Width	32.0	ft
Sidewater Depth	14.0	ft
Volume	552,922	gal
Anoxic Zone Mixing		
Type	Hyperbolic Mixer	
Number	3 (one per zone)	
Motor	3	HP
Disk Diameter	98	in
Aeration Type	Fine Bubble - Ceramic	
Type	Tapered Diffuser Density	
Total Number of Diffusers		3242 diffusers
Aeration Control		
Blower Control	Proportional to D.O. Setpoint	
Zone Control	Manually Adjusted Valves	

Aeration Blowers

Total Number of Blowers	4	
Total Number of "New" Blowers	2	
Blower Type	Positive Displacement	
Capacity Each	2,520	scfm @ 8 psi
Motor	150	hp
Drive	Variable-Frequency	
Total Number of "Old" Blowers	2	
Capacity Each	1,680	scfm @ 8 psi
Motor	100	hp
Drive	Variable-Frequency	
Total Capacity	8,400	scfm
Capacity (Measured with one 100 hp out of service)	6,356	scfm
Total Firm Rated Capacity	5,880	scfm

Final Clarifiers

Total Number of Basins	2	
Type	Circular	
Dimensions		
Diameter	40.0	
Sidewater Depth	14.0	ft
Weir Length	474.4	ft
Surface Area per Unit	1,257	sf
Total Surface Area	2,513	sf

Return Activated Sludge Pumping

Number of Pumps	2	
Type	Dry-pit centrifugal	
One Pump Capacity	1400	gpm @ 22 ft TDH
Motor	15	HP
Drive	Variable-Frequency	
Total Pumping Capacity	2,800	gpm

Final Clarifier Scum Pumping

Number of Pumps	2	
Type	Dry-pit centrifugal	
One Pump Capacity	150	gpm @ 30 ft TDH
Motor	5	HP

Tertiary Filtration

Type	Rapid, Mono media Sand	

Number of Cells	4	
Dimensions		
Length	12.0	ft
Width	12.0	ft
Area per Cell	144	sq ft
Total Area	576	sq ft
Media Depth	2.5	ft
TSS Removal	70	%
Backwash % of Forward Flow	3	%

Filter Feed Pumps

Number of Pumps	3	
Type	Extended Shaft Dry-pit centrifugal	
One Pump Capacity	1300	gpm @ 35 ft TDH
Motor	20	HP
Drive	Variable-Frequency	
Firm Pumping Capacity	3.74	mgd

Filter Backwash Supply Pumps

Number of Pumps	2	
Type	Vertical Turbine	
One Pump Capacity	2900	gpm @ 16.5 ft TDH
Motor	20	HP
Backwash Capacity	20	gpm/sq ft of one cell

Filter Backwash Waste Pumps

Number of Pumps	2	
Type	Dry-Pit Centrifugal	
One Pump Capacity	150	gpm @ 36 ft TDH
Motor	10	HP

Filter Backwash Air Scour Blower

Number of Blowers	1	
Type	Positive Displacement - Rotary Lobe	
Motor	25	HP

Disinfection

Type	Chlorine	
Number of Basins	2	
Total Volume	72,000	gal
Chemical Feed		
Type	100 lb Chlorine Gas Cylinders	
Dechlorination		
Type	100 lb Sulfur Dioxide Cylinders	

Anaerobic Solids Digestion

Number of Digesters	2	
Number of Primary Digesters	1	
Number of Secondary Digesters	1	
Digester No. 1		
Diameter	45.0	ft
Sidewater Depth	21.0	ft
Cone Volume	2.7	kcf
Volume	36.0	kcf
Volume	269,652	gal
Cover Type	Fixed Steel with Insulation	
Mixing	Gas Mixing - Perth	
Motor	7.1	HP
Digester No. 2		
Diameter	45.0	ft
Sidewater Depth	26.0	ft
Cone Volume	4.4	kcf
Volume	45.8	kcf
Volume	342,537	gal
Cover Type	Vertically Guided Floating Gas Holder	

Digester Heating

Number	1	
Type	Combination Boiler/Heat Exchanger	
Boiler Capacity	825,000	BTU/hr
Max Digester Gas Flow	1,720	cf/hr
Heating Control	Manual	
Heat Exchanger Capacity	375,000	BTU/hr
Sludge Tube Area	27	sq ft

Sludge Recirculation Pumping	Primary Digester	
Number	1	
Type	Non-Clog Dry-Pit Centrifugal	
Capacity	150	gpm

Primary Sludge and Digester Sludge Transfer Pumping

Number	2	
Type	Air Operated Diaphragm	

Digester Supernatant Recycle Pump

Type	Submersible Centrifugal	
Discharge Location	Grit Basin Effluent	

Sludge Holding Tank

Type	Aerated	
Number of Units	2	
Dimensions		
Length	62	ft
Width	25	ft
Sidewater Depth	16	ft
Total Volume	50,000	cf
	374,000	gal

Sludge Dewatering

Type	Belt Filter Press	
Number	1	
Size	2	m
Capacity	125	gpm
	1,000	lb/hr

Sludge Dewatering Feed Pumps

Number		2
Pump 1 Type	Progressive Cavity	
Capacity		150 gpm
Motor		10 HP
Drive	Variable-Frequency	
Pump 2 Type	Rotary Lobe	
Capacity		150 gpm
Motor		10 HP
Drive	Variable-Frequency	

Sludge Dewatering Polymer System

Number		2
Polymer Type	Liquid Emulsion in 55 gal drums	
Number of Injection Locations		3

Sludge Dewatering Filtrate Recycle Pumps

Number		2
Type	Dry-pit Centrifugal	
Capacity		560 gpm @ 36 ft TDH
Motor		10 HP
Discharge Location	Grit Basin Effluent	

Biosolids Treatment

Type	RDP	
Size	800	lb/hr in winter
Number	1	
Class A Technique	Pasteurization with Lime & Heat for 30 min.	

Biosolids Storage

Type	Covered Shed	
Size		
Width	80.5	ft
Length	139.5	ft
Length of Free Space	20.0	ft
Total Area for Biosolids	9,600	sq ft
Stacking Height (35-40% TS), when adding FeSO4	9.0	ft
Stacking Height (30-35% TS), no FeSO4	4.0 to 5.0	ft
Storage Volume	86,400	cf

- Chapter V -
FUTURE CONDITIONS

A. INTRODUCTION

To evaluate and size facilities for a Wastewater Management System, future population and wastewater flows and loadings must be estimated for the planning area. Wastewater flows and loadings are a function of the sewered population, per capita water use, commercial and industrial discharges, hauled-in wastes, and Infiltration/Inflow (I/I).

This Chapter defines the planning period, staging period, estimates future population, and estimates future flows and loadings anticipated within the planning area.

B. PLANNING PERIOD

The planning period is the time period over which the Wastewater Management System is evaluated for cost effectiveness. According to United States Environmental Protection Agency (USEPA) and Wisconsin Department Of Natural Resources (DNR) regulations, the planning period for a Facilities Plan shall be 20-years [NR 110.,09(1)]. For the purposes of this Facilities Plan, the planning period shall be to the year 2037.

C. POPULATION ESTIMATES

As previously noted in Chapter II, the Wisconsin Department Of Administration (DOA) population projections for the 10, 15 and 20-year staging period are as follows:

Year	Population Projection
2027	4,123*
2032	4,221*
2037	4,250 *

* Interpolated WI DOA Population projections

D. FUTURE FLOWS & LOADINGS

Projected future influent raw wastewater flows and loadings for the Kiel Wastewater Treatment Facility are provided in Table V-1.

Table V-1

REVISED PROJECTED FLOWS & LOADINGS
Projections Based On November 2016 No Hauled-In Waste Trial (2037) (1)

Parameter	Future
Influent Flow (mgd)	
▪ Average	1.43
▪ Maximum Month (PF = 1.6)	2.29
▪ Maximum Day (PF = 2.7)	3.86
▪ Peak (PF = 3.5)	5.00
BOD, lbs./day	
▪ Average	12,365
▪ Maximum Month (PF = 1.3)	16,075
▪ Maximum day (PF = 2.5)	30,912
TSS, lbs./day	
▪ Average	5,673
▪ Maximum Month (PF = 1.5)	8,510
▪ Maximum day (PF = 3.0)	17,019
Total P, lbs./day	
▪ Average	282
▪ Maximum Month (PF = 1.2)	338
▪ Maximum day (PF = 2.8)	790
TKN, lbs./day	
▪ Average	620
▪ Maximum Month (PF = 1.6)	993
▪ Maximum day (PF = 2.3)	1,427

(1) Revised Average Flows & Loadings Calculated Based On November 2016 Trial No Hauled-In Waste Data

The flows and loadings projections were developed on the following basis:

1. Historical Wastewater Treatment Facility influent flows and loadings [Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), Total Phosphorus (P)] from 2012 through 2016 were used, as well as monitoring data from the two (2) significant industrial contributors, Land O'Lakes, Inc. and Sargento.

2. In November 2016, the City of Kiel performed a 1-month trial to determine the impact of hauled-in wastes. Influent samples were analyzed for combined City and hauler waste, and for influent wastewater with only City waste. The November 2016 sample trial results are summarized in Table V-2. The flows and loadings are summarizes as follows:

    a. Hauled-In Waste + City Waste Flows & Loadings
    b. City Waste Flows & Loadings (No Hauled-In Waste)
    c. Hauled-In Waste Flows and Loadings (Calculated)

    The 1-month sample trial data was used to project the 'adjusted' base residential / commercial Wastewater Treatment Facility flows and loadings. The residential / commercial flows and loadings were determined on days when Sargento Foods and Land O'

Table V-2

INFLUENT OF HAULER WASTE ON INFLUENT LOADING
November 2016 Sample Trial
CITY OF KIEL, WISCONSIN
Wastewater Treatment Facility - Facilities Plan | 2017 Update

	Plant Influent HAULED-IN WASTE + CITY WASTE							Plant Influent CITY WASTE							Plant Influent HAULED-IN WASTE (Calculated)						
	Flow	BOD		TSS		Phosphorus		Flow	BOD		TSS		Phosphorus		Flow	BOD		TSS		Phosphorus	
Date	mgd	mg/L	lbs./day	mg/L	lbs./day	mg/L	lbs./day	mgd	mg/L	lbs./day	mg/L	lbs./day	mg/L	lbs./day	mgd	mg/L	lbs./day	mg/L	lbs./day	mg/L	lbs./day
11/1/2016	1.18	735.00	7,254	480.00	4,737	23.00	227	1.120							0.063						
11/2/2016	1.25							1.176							0.076						
11/3/2016	1.20							1.142							0.062						
11/4/2016	1.18							1.136							0.043						
11/5/2016	1.10							1.086							0.016						
11/6/2016	1.04	787.50	6,804	450.00	3,888	20.96	181	1.020							0.016						
11/7/2016	1.10							1.052							0.050						
11/8/2016	0.98	1620	13,191	1370	11,155	16.65	136	0.904							0.072						
11/9/2016	1.10	1710	15,693	1240	11,380	25.26	232	1.047	720	6,287	360	3,144	16.59	145	0.053	21,121	9,406	18,494	8,236	195	87
11/10/2016	1.18	1170	11,491	900	8,839	24.92	245	1.129	1065	10,028	390	3,672	22.59	213	0.049	3,608	1,463	12,742	5,167	79	32
11/11/2016	1.09	1410	12,779	700	6,344	28.60	259	1.051	645	5,654	330	2,893	15.42	135	0.036	23,931	7,125	11,593	3,452	417	124
11/12/2016	0.99	893	7,344	630	5,181	21.30	175	0.974	735	5,971	300	2,437	12.42	101	0.012	13,559	1,374	27,084	2,744	733	74
11/13/2016	1.00	1290	10,764	460	3,838	25.67	214	0.977							0.024						
11/14/2016	1.03							0.992							0.035						
11/15/2016	1.06							0.995							0.061						
11/16/2016	1.12	1440	13,489	840	7,869	26.21	246	1.036	848	7,327	330	2,851	18.84	163	0.087	8,473	6,162	6,899	5,017	114	83
11/17/2016	1.09	1380	12,571	830	7,561	19.11	174	1.043	585	5,089	320	2,784	15.90	138	0.049	18,216	7,482	11,631	4,777	87	36
11/18/2016	1.06	1290	11,450	1060	9,409	23.96	213	1.015	990	8,380	690	5,841	19.79	168	0.049	7,466	3,070	8,678	3,568	110	45
11/19/2016	0.84	1380	9,658	800	5,599	24.92	174	0.814	1080	7,332	480	3,259	20.68	140	0.025	11,090	2,326	11,157	2,340	162	34
11/20/2016	0.92	848	6,469	300	2,290	21.43	164	0.897	585	4,376	290	2,169	19.52	146	0.018	13,728	2,093	791	121	115	18
11/21/2016	1.07	1170	10,405	910	8,092	23.48	209	0.985	525	4,313	340	2,793	17.88	147	0.081	8,986	6,092	7,818	5,299	91	62
11/22/2016	1.04	1230	10,663	910	7,889	31.61	274	0.988	585	4,820	290	2,390	17.27	142	0.052	13,604	5,843	12,804	5,500	307	132
11/23/2016	1.10	1005	9,230	530	4,867	22.53	207	1.041	405	3,516	230	1,997	13.79	120	0.060	11,387	5,713	5,721	2,871	174	87
11/24/2016	0.91	930	7,068	560	4,256	17.81	135	0.906	735	5,554	220	1,662	14.33	108	0.005	34,264	1,515	58,681	2,594	613	27
11/25/2016	0.97							0.925							0.047						
11/26/2016	0.87							0.867							0.002						
11/27/2016	0.95	585	4,654	310	2,466	19.04	152	0.954							0.000						
11/28/2016	1.24	1260	13,004	660	6,812	21.91	226	1.151	450	4,320	340	3,264	15.01	144	0.087	12,038	8,684	4,918	3,548	114	82
11/29/2016	1.17	1140	11,120	860	8,389	28.33	276	1.125	360	3,378	210	1,970	14.61	137	0.045	20,815	7,742	17,256	6,419	374	139
11/30/2016	1.21	1110	11,241	710	7,190	21.98	223	1.149	540	5,175	330	3,162	15.29	147	0.065	11,140	6,067	7,396	4,028	140	76
Average	**1.068**	**1,161**	**10,302**	**739**	**6,574**	**23.27**	**207**	**1.023**	**678**	**5,720**	**341**	**2,893**	**16.87**	**143**	**0.045**	**14,589**	**5,135**	**13,979**	**4,105**	**239**	**71**
Maximum	**1.252**	**1,710**	**15,693**	**1,370**	**11,380**	**31.61**	**276**	**1.176**	**1,080**	**10,028**	**690**	**5,841**	**22.59**	**213**	**0.087**	**34,264**	**9,406**	**58,681**	**8,236**	**733**	**139**

NOTE: Hauled-in high strength waste is pumped from the high strength tank to the Headworks. The influent flow meter does not include hauled-in waste flows. During the November samping trial, the Treatment Facility sampled only the City waste stream, and sampled the combined waste stream with hauled-in waste and City Waste.

Red Indicates Calculated Values

Table V-3

ADJUSTED LOADINGS BASED ON NO-HAULER INFLUENT WASTE
November 2016 Sample Trial
CITY OF KIEL, WISCONSIN
Wastewater Treatment Facility - Facilities Plan | 2017 Update

		Plant Influent - City Waste NO HAULED-IN WASTE						SARGENTO LOADING							LAND O'LAKES, INC. LOADINGS							Adjusted Plant Loading			
	Influent	**BOD**		**TSS**		**Phosphorus**		**FLOW**	**BOD**		**TSS**		**Phosphorus**		**FLOW**	**BOD**		**TSS**		**Phosphorus**		**FLOW**	**BOD**	**TSS**	**Phosphorus**
Date	mgd	mg/L	lbs./day	mg/L	lbs./day	mg/L	lbs./day	gpd	mg/L	lbs./day	mg/L	lbs./day	mg/L	lbs./day	gpd	mg/L	lbs./day	mg/L	lbs./day	mg/L	lbs./day	mgd	lbs./day	lbs/day	lbs./day
11/1/2016	1.120														307,490	1,477	3,788	485	1243.8	92.986	238.5				
11/2/2016	1.176														297,410	1,167	2,895	765	1897.5	36.584	90.7				
11/3/2016	1.142														307,530	932	2,389	325	833.6	33.989	87.2				
11/4/2016	1.136														293,900	1,148	2,813	380	931.4	35.491	87				
11/5/2016	1.086														301,920	1,101	2,772	355	893.9	33.17	83.5				
11/6/2016	1.020														329,550	1,576	4,331	665	1827.7	45.87	126.1				
11/7/2016	1.052							61,800	750	387	490	252.6	10.773	5.6	282,520	1,230	2,898	385	907.1	35.218	83	0.70768			
11/8/2016	0.904							73,100	1,548	943	1,240	756	14.87	9.1	197,900	794	1,310	345	569.4	26.888	44.4	0.633			
11/9/2016	1.047	720	6,287	360	3,144	16.59	145	74,400	1,055	655	910	564.7	13.504	8.4	288,000	1,145	2,749	340	816.7	35.628	85.6	0.6846	2883	1762.11	50.86
11/10/2016	1.129	1,065	10,028	390	3,672	22.59	213	96,800							352,400	785	2,306	350	1028.7	29.073	85.4	0.6798			
11/11/2016	1.051	645	5,654	330	2,893	15.42	135	74,600	5,330	3,316	2,210	1375	19.24	12	318,260	1,499	3,977	410	1088.3	39.315	104.4	0.65814		429.26	18.76
11/12/2016	0.974	735	5,971	300	2,437	12.42	101	35,500	2,645	783	1,300	384.9	24.976	7.4	262,290	1,752	3,832	525	1148.4	42.047	92	0.67621	1356	903.65	1.49
11/13/2016	0.977							36,200	933	282	350	105.7	11.592	3.5	319,650	1,769	4,716	380	1013	47.646	127	0.62115			
11/14/2016	0.992														263,660	2,154	4,736	345	758.6	45.597	100.3				
11/15/2016	0.995														316,650	998	2,634	370	977.1	38.632	102				
11/16/2016	1.036	848	7,327	330	2,851	18.84	163								312,580	1,423	3,710	345	899.4	41.91	109.3				
11/17/2016	1.043	585	5,089	320	2,784	15.90	138								336,210	1,068	2,995	415	1163.7	36.72	103				
11/18/2016	1.015	990	8,380	690	5,841	19.79	168								292,800	1,365	3,333	390	952.4	38.906	95				
11/19/2016	0.814	1,080	7,332	480	3,259	20.68	140								281,100	2,382	5,584	710	1664.5	52.972	124.2				
11/20/2016	0.897	585	4,376	290	2,169	19.52	146								287,370	1,250	2,996	540	1294.2	49.558	118.8				
11/21/2016	0.985	525	4,313	340	2,793	17.88	147								319,120	1,197	3,186	625	1663.4	47.236	125.7				
11/22/2016	0.988	585	4,820	290	2,390	17.27	142								313,160	1,367	3,569	555	1449.5	35.491	92.7				
11/23/2016	1.041	405	3,516	230	1,997	13.79	120								318,120	930	2,467	300	795.9	35.491	94.2				
11/24/2016	0.906	735	5,554	220	1,662	14.33	108								311,050	822	2,132	265	687.5	29.619	76.8				
11/25/2016	0.925														279,700	1,007	2,348	245	571.5	38.906	90.8				
11/26/2016	0.867														278,140	1,254	2,909	305	707.5	35.628	82.6				
11/27/2016	0.954														291,690	1,030	2,506	325	790.6	54.474	132.5				
11/28/2016	1.151	450	4,320	340	3,264	15.01	144								270,850	1,109	2,504	530	1197.2	33.716	76.2				
11/29/2016	1.125	360	3,378	210	1,970	14.61	137								288,900	1,228	2,959	330	795.1	46.963	113.2				
11/30/2016	1.149	540	5,175	330	3,162	15.29	147								254,570	1,110	2,357	375	796.2	40.954	87				
Average	**1.023**	**678**	**5,720**	**341**	**2,893**	**16.87**	**143**	**64,629**	**2,044**	**1,061**	**1,083**	**573**	**15.83**	**8**	**295,816**	**1,269**	**3,123**	**423**	**1,045**	**41.22**	**102**	**0.6658**	**2,120**	**1,032**	**24**
Maximum	**1.176**	**1,080**	**10,028**	**690**	**5,841**	**22.59**	**213**	**96,800**	**5,330**	**3,316**	**2,210**	**1,375**	**24.98**	**12**	**352,400**	**2,382**	**5,584**	**765**	**1,898**	**92.99**	**239**	**0.7077**	**2,883**	**1,762**	**51**

Negative Number

Lakes, Inc. waste data was available, and the hauled-in waste was received. Refer to Table V-3 for a summary of the base residential / commercial flows and loadings.

3. The average base residential / commercial flows and loadings were used to estimate the future design flows and loadings. The projected average increase in average residential / commercial flows and loadings were determined using an estimated population increase of 396 from 2017 to the Design Year 2037, and textbook per capita flows and loading factors as follows:

   a. Average Flow = 100-gallons/capita/day
   b. Average BOD5 = 0.18 lbs./capita/day
   c. Average TSS = 0.2 lbs./capita/day
   d. Average Total P = 0.007 lbs./capita/day
   Source: WEF MOP 8

4. As stated previously, hauled-in waste contributions were excluded from the projected future loadings based on the November 2016 sampling trial results.

5. Future average flows and loadings projections for the Land O'Lakes, Inc. facility were provided by Land O' Lakes, Inc. and are included in Table V-4.

Table V-4

LAND O'LAKES, INC. FUTURE FLOWS & LOADINGS

	Flow	BOD	TSS	P
	mgd	lbs./day	lbs./day	lbs./day
Average	0.600	6,828	2,418	223
Maximum Month *	0.600	6,828	2,418	223
Maximum Day **	0.645	8,330	3,023	282

* Maximum Month Same as Averages

** Maximum Day Peaking Factors for Flow, BOD, TSS and P are 8%, 22%, 25% and 26%, respectively.

6. Future flow and loading projections for Sargento were provided by the City of Kiel, based on current plant expansion plans. Refer to Table V-5.

Table V-5

SARGENTO FUTURE FLOWS & LOADINGS

	Flow	BOD	TSS	P
	mgd	lbs./day	lbs./day	lbs./day
Average	0.122	3,346	2,144	32
Maximum Month *	0.128	3,513	2,251	33
Maximum Day *	0.134	3,681	2,358	35

* Maximum Month and Maximum Day Represent a 5% and 10% Increase of Averages

7. Total projected future average flows and loadings were determined to be the sum of the adjusted Wastewater Treatment Facility flows and loadings without hauled-in wastes, projected increases in average residential / commercial based on textbook value, future average projections for Land O'Lakes, Inc. and Sargento. It should be noted that the City of Kiel has been contacted by industries outside of the service area that would be interested in utilizing treatment capacity should Land O'Lakes, Inc. or Sargento not meet their projected flows and loadings.

8. The future average Total Kjeldahl Nitrogen (TKN) loadings were projected based on future average flow and an average TKN concentration of 60 mg/L, which was determined based on influent TKN monitoring data from July 27 through August 6, 2015.

9. Future maximum month and maximum day flows and loadings were projected using peaking factors determined based on the current total Wastewater Treatment Facility influent data (years 2012 to 2016). Peaking factors for TKN were based on those used in Kiel's Master Plan. It should be noted that the calculated peaking factor for maximum day TSS was 4.13; however, a more reasonable peaking factor of 3.0 was used for projecting future maximum day TSS, discounting the maximum day TSS value in 2013, which was considered an outlier and skewed the data.

10. Table V-1 summarizes the revised projected flows and loadings. It should be noted that the projected average influent flow was calculated based on the November 2016 data without hauled-in waste or the 2037 population projections.

11. Table V-6 summarizes the derivation of the average source loadings based on the information provided in this section.

E. DESIGN PERIOD

The design period is the time period in which the Wastewater Management System is expected to reach design capacity. For Wastewater Treatment Facilities, NR 110.09(2)(j)4.b. recommends three (3) alternative staging periods of 10, 15 and 20-years be evaluated for cost effectiveness, based upon the following:

Table V-7

STAGING PERIODS

	Flow Growth Factor	Maximum Initial Staging Period
1.	Avg. Design Flow < 1.3-Times Initial Flow	20-years
2.	Avg. Design Flow 1.3 to 1.8 Times Initial Flow	15-years
3.	Avg. Design Flow > 1.8 Times Initial Flow	10-years

Utilizing a 20-year planning period results in a flow growth factor of 1.43/0.862 = 1.66.

Table V-6

AVERAGE INFLUENT LOADINGS
Source Summary Table

CITY OF KIEL, WISCONSIN

Wastewater Treatment Facility - Facilities Plan | 2017 Update

Parameter	Average	Source Derivation / Comments
Flow (mgd)		
Residential/Commercial	0.71	Table V-3 Adjusted Plant Loading Flow + Population Increase Contribution (100 gallons per capita per day)
Hauled-in Waste	0.00	Facility will not continue accepting Hauled-in Waste
Subtotal, Flow (mgd)	0.71	
Land O' Lakes	0.60	Provided from Land O'Lakes, Inc.
Sargento	0.12	Provided by City Of Kiel.
Total, Flow (mgd)	**1.43**	
BOD_5, (lbs./day)		
Residential/Commercial	2,191	Table V-3 Adjusted Plant Loading BOD + Population Increase Contribution (0.18 lbs. per capita per day)
Hauled-in Waste	0	Facility will not continue accepting Hauled-in Waste
Subtotal, lbs./day	2,191	
Land O' Lakes	6,828	Provided from Land O'Lakes, Inc.
Sargento	3,346	Provided by City Of Kiel.
Total, BOD_5 (lb./day)	**12,365**	
TSS, (lbs./day)		
Residential/Commercial	1,111	Table V-3 Adjusted Plant Loading TSS + Population Increase Contribution (0.2 lbs. per capita per day)
Hauled-in Waste	0	Facility will not continue accepting Hauled-in Waste
Subtotal, lbs./day	1,111	
Land O' Lakes	2,418	Provided from Land O'Lakes, Inc.
Sargento	2,144	Provided by City Of Kiel.
Total, TSS (lbs./day)	**5,673**	
TP, (lbs./day)		
Residential/Commercial	27	Table V-3 Adjusted Plant Loading TP + Population Increase Contribution (0.007 lbs. per capita per day)
Hauled-in Waste	0	Facility will not continue accepting Hauled-in Waste
Subtotal, lbs./day	27	
Land O' Lakes	223	Provided from Land O'Lakes, Inc.
Sargento	32	Provided by City Of Kiel
Total, TP (lbs./day)	**282**	

NOTE: The population increase was based on the population increase from 2017 (3,854) to 2037 (4,250) resulting in a population increase of 396; The 2037 population was interpolated between 2035 and 2040.

When considering a 15-year staging period, the only flow related change is due to the reduction in population of 29 people, when compared to the 20-year period. The corresponding reduction in flow is equal to only 2,900 gpd, and results in the same flow growth factor of 1.427/0.862 = 1.66.

Therefore, it can be concluded that the Wastewater Treatment Facility sizing is the same for both the 15-year and 20-year design periods, with only a 2,900 gpd (0.2%) difference in flow.

NR 110.09(2)j(4)a states '*The Owner shall analyze at least 3 alternative staging periods (10-years, 15-years and 20-years) and the least costly (i.e., total present worth or average annual cost) staging period shall be selected*.' When considering the size of unit treatment processes for the 15-year and 20-year design periods, they may be considered to be equal. When comparing the average annual cost of a project, a 20-year project has a lower annual cost, compared to a 15-year project.

Therefore, the 20-year staging period will be utilized for design purposes.

F. DESIGN CAPACITY

The current and proposed future Wastewater Treatment Facility design criteria are summarized in Table V-8.

Table V-8

PROPOSED WASTEWATER TREATMENT FACILITY DESIGN CRITERIA
Projections Based On November 2016 Trial (2037) (1)

Design Year	Current Design	2037
Population	N/A	4,250
Flow (mgd)		
▪ Average	0.862	1.43
▪ Maximum Month	1.214	2.29
▪ Maximum Day	3.095	3.86
▪ Peak Hour	4.26	5.00
Biochemical Oxygen Demand (BOD) (lbs./day)		
▪ Average	6,000	12,365
▪ Maximum Month	6,280	16,075
▪ Maximum Day	9,250	30,912
Total Suspended Solids (TSS)		
▪ Average	2,842	5,673
▪ Maximum Month	4,480	8,510
▪ Maximum Day	7,420	17,019
Total Kjehldahl Nitrogen (TKN)		
▪ Average	N/A	620
▪ Maximum Month	N/A	993
▪ Maximum Day	N/A	1,427
Phosphorus (P)		
▪ Average	145	282
▪ Maximum Month	184	338
▪ Maximum Day	247	790

(1) Revised Average Flows & Loadings Calculated Based On November 2016 Trial with No Hauled-In Waste Data

Capacity limitations of existing unit processes are summarized in Table V-9.

Table V-9

CAPACITY LIMITATIONS

Item	Current Capacity	Current NR 110 Requirement	Future Capacity Requirement
River Road Pump Station	2.42 mgd	4.26 mgd	5.00 mgd
Screening	4.3 mgd	4.26 mgd	5.00 mgd
Primary Clarifiers	1.23 mgd Avg. 1.85 mgd Peak	0.862 mgd, Avg. 4.26 mgd, Peak	1.43 mgd Avg. 5.00 mgd Peak
16-inch PE Piping	2.0 mgd	---	5.00 mgd
Aeration Capacity	4,970 lbs./day	4,970 lbs./day	12,365 lbs./day
16-inch MLSS Piping	2.0 mgd	---	5.00 mgd
Final Clarifiers	2.513 mgd Peak	4.26 mgd Peak	5.00 mgd Peak
RAS Pumping	2.016 mgd	1.72 mgd	2.50 mgd
Tertiary Filters	2.0 mgd	4.26 mgd	5.00 mgd
Disinfection	2.53 mgd, Peak	4.26 mgd Peak	5.00 mgd Peak

- 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. <u>General</u>

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 5.00 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 2, Classified Hazardous Area. The electrical systems, including controls, meet safety requirements by having adequate ventilation provided, which drops the area from Division 1 to Division 2.

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, unless specific process equipment options mandate an increased level of screening. 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 4,847 gpd/LF, which is well below the NR 110 maximum value of 10,000 gpd/LF.

The projected surface settling rate at average conditions is 1,161 gpd/sq.ft., which is close to the NR 110 maximum value of 1,000 gpd/sq.ft.; the peak hour projected value is 4,060 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 the south (1965 vintage) aeration tankage will require structural repairs to concrete, as necessary to extend their service life.

As the existing aeration system is significantly overloaded and the organic loading from the two (2) principle industries is scheduled to increase in 2018, constructability aspects must be considered. Treating the projected 2018 organic loading, while taking one (1) of the three (3) trains off-line for construction, is likely to result in inadequate treatment and increased operational costs; should there be any mechanical failure during this type of work, plant upsets and incomplete treatment are anticipated. Therefore, a new third train, matching the two (2) newest north trains, will be provided and the 1965 vintage south train will be decommissioned.

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 larger, more energy efficient units.

Retrofitting the aeration system with an Integrated Film Activated Sludge (IFAS) system should be considered as an alternative to increasing the existing conventional activated sludge system. 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.

Consideration will 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, and with an IFAS 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. Consideration will be given to replacing the Fiberglass-Reinforced Plastic (FRP) domes with launderer covers. 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 5.00 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 60.6-minutes at the 1.43 mgd average design flow, while it is only 17.3-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

Until recently, the City of Kiel pumped hauled-in waste to the Headworks and high strength waste to the digesters. The Facility is not accepting hauled-in and high strength wastes, as the plant is organically overloaded. It is not recommended to expand or upgrade the high strength waste system at the Facility, as there are no plans to receive them in the future.

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 December 5, 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.

A new, third aeration train will be provided to match the two (2) north trains, and the 1965 vintage south train will be decommissioned. 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. Retrofitting the existing north trains and the new third train with IFAS and adding two (2) final clarifiers is Option #2. Option #3 utilizes MBR technology and a new third train, along with modifications to the existing north trains; no clarifiers are required for Option #3. 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 and Option #2. 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.

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 Settling Rate, gpd/sq.ft.	
▪ Average Flow, 1.43 mgd	2@1,161
▪ Peak Hour Flow, 5.00 mgd	2@4,060
▪ Weir Overflow Rate, gpd/ft.	
▪ Average Flow, 1.43 mgd	2@4,847
▪ Detention Time, hours	
▪ Average Flow, 1.43 mgd	2@1.9
▪ Maximum Day Flow, 3.86 mgd	2@0.7
▪ Removal Efficiencies	
▪ BOD, %	21
▪ SS, %	50
▪ TKN	10
▪ Primary Sludge, lbs./day	
▪ Average Day	2,837
▪ Maximum 30-Day	4,255
▪ Volatile Sludge, lbs./day	
▪ Average Day (78% VSS)	2,213
▪ Maximum 30-Day (78% VSS)	3,319
▪ Primary Sludge, gpd @ x% solids	3
▪ Average Day	11,339
▪ Maximum 30-Day	17,006

Table VI-1

PROPOSED WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
SECONDARY TREATMENT SYSTEM	
▪ Design Loadings To Secondary, lbs./day (including recycle streams)	
▪ Biochemical Oxygen Demand (BOD)	
▫ Average Day	10,908
▫ Maximum Day	25,670
▫ Maximum 30-Day	13,010
▪ Total Kjeldahl Nitrogen (TKN), lbs./day	
▫ Average Day	649
▫ Maximum Day	1,456
▫ Maximum 30-Day	1,022
▪ Phosphorus (P), lbs./day	
▫ Average Day	302
▫ Maximum Day	810
▫ Maximum 30-Day	358
▪ Number Of Parallel Trains	3
▪ Aeration Tanks, size, ft./train	4@65x32
▪ SWD, ft.	14
▪ Total Tank Volume, cu.ft.	349,440
▪ Anaerobic Selector, ft.	3@30x32
▪ Anaerobic Volume, cu.ft.	40,320
▪ Anaerobic / Aerobic Ratio	0.12
▪ Aerobic Volume, cu.ft.	309,120
▪ BOD Loading, lbs./1,000 cu.ft.	
▪ Average Day	35.3
▪ Maximum 30-Day	42.1
▪ Design MLSS, mg/L	
▪ Average	2,514
▪ Maximum Month	2,999
▪ Design F:M	
▪ Average	0.30
▪ 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	7,308
▪ Maximum 30-Day	8,717
▪ WAS To Dewatering, gpd @ 1%	
▪ Average	87,626
▪ Maximum Month	104,520
▪ Oxygen Requirements, lbs./day @ 1.5 lb. O2/lb. BOD Applied & 4.6 lb. O2/lb. TKN Applied	
▪ Average Day	19,347
▪ Maximum Day	45,203
▪ Maximum Month	24,216

Table VI-1

PROPOSED WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	**Proposed Design 2037**
SECONDARY TREATMENT SYSTEM (continued)	
▪ Air Requirements, scfm	
▪ Average Day	6,349
▪ Maximum Day	14,674
▪ Maximum Month	8,112
▪ Blowers	
▪ Number Of New PD Blowers (4-Duty + 1 Standby)	5
▪ Capacity, each new unit, scfm	3,669
▪ Discharge Pressure, psig	8.5
▪ Firm Capacity, scfm	14,676
SECONDARY CLARIFIERS	
▪ Number Of Units	4
▪ Diameter, ft.	4@40
▪ SWD, ft.	14.25
▪ Surface Settling Rate, gpd/sq.ft.	
▪ Average Flow, 1.43 mgd	284
▪ Peak Hour Flow, 5.00 mgd	995
▪ Weir Loading, gpd/ft.	
▪ Average Flow, 1.43 mgd	2,416
▪ Peak Hour Flow, 5.00 mgd	6,838
▪ Detention Time, hours	
▪ Average Flow, 1.43 mgd	6.0
▪ Peak Hour Flow, 5.00 mgd	2.1
▪ Solids Loading, lbs./hour/sq.ft.	
▪ Average Flow, 1.43 mgd	0.36
▪ Peak Hour Flow, 5.00 mgd	1.23
FILTERS	
▪ Filtration Rate, gpm/sq.ft.	
▪ Average Flow, 1.43 mgd (firm)	1.06
▪ Peak Hour Flow, 5.00 mgd (firm)	3.69
DISINFECTION	
Number Of Tanks	2
Total Volume, gallons	60,250
Detention Time, minutes	
▪ Average Flow, 1.43 mgd	60.7
▪ Peak Hour Flow, 5.00 mgd	17.3
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	21
▪ South Digester	21
▪ Maximum Volume, gallons	
▪ North Digester	269,639
▪ South Digesters	267,657
Total	537,296
▪ Mixing System	Linear Motion
▪ Cover Type	
▪ North Digester	Gas Holder
▪ South Digester	Gas Holder
▪ Maximum Month HRT, days	
▪ North Digester	15.8
▪ South Digester	15.7
Total	31.5
▪ Maximum Month VSS Loading, lbs. VSS/KCF	46.2
▪ VSS Destruction, %	50
▪ Heat Exchanger Capacity, gpd	41,000
▪ Sludge To Dewatering, lbs./day	
▪ Average	1,731
▪ Maximum Month	2,595
▪ Anaerobic Sludge To Dewatering, gpd @ 1.8%	
▪ Average	11,339
▪ Maximum Month	17,006
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, avg. gallons/day	1,796
▪ Sludge To Dewatering, lbs./day	
▪ Average	9,338
▪ Maximum Month	11,611
▪ Sludge To Dewatering, gpd @ 2%	
▪ Average	55,983
▪ Maximum Month	69,610
SLUDGE DEWATERING (1)	
▪ Number Of Units	1
▪ Capacity, each	
▪ lbs./hour	726
▪ lbs./day	17,424
▪ Hours Of Operation/Day	24
▪ Average Days Of Operation/Week	4
▪ Cake Solids, %, minimum	17 - 20

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
▪ Avg. 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
4/9/2013	22:33:00	2015
4/9/2013	22:48:00	2110
4/9/2013	23:03:00	2125
4/9/2013	23:18:00	2115
4/9/2013	23:33:00	2000
4/9/2013	23:48:00	2130

4/10/2013	0:03:01	2095	
4/10/2013	0:18:00	2065	
4/10/2013	0:33:00	0	
4/10/2013	0:48:00	2135	
4/10/2013	1:03:00	2125	
4/10/2013	1:18:00	2125	
4/10/2013	1:33:00	2040	
4/10/2013	1:48:01	2120	
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	
4/10/2013	7:33:00	2260	
4/10/2013	7:48:00	2180	
4/10/2013	8:03:00	2210	
4/10/2013	8:18:00	2205	

4/10/2013	8:33:00	2230
4/10/2013	8:48:01	2115
4/10/2013	9:03:00	2220
4/10/2013	9:18:00	2200
4/10/2013	9:33:00	2200
4/10/2013	9:48:00	2185
4/10/2013	10:03:00	2180
4/10/2013	10:18:00	2185
4/10/2013	10:33:01	2195
4/10/2013	10:48:00	2165
4/10/2013	11:03:00	2170
4/10/2013	11:18:00	2175
4/10/2013	11:33:00	2190
4/10/2013	11:48:00	2190
4/10/2013	12:03:00	2180
4/10/2013	12:18:01	2180
4/10/2013	12:33:00	2165
4/10/2013	12:48:00	2160
4/10/2013	13:03:00	2155
4/10/2013	13:18:00	2160
4/10/2013	13:33:00	2165
4/10/2013	13:48:00	2175
4/10/2013	14:03:01	2170
4/10/2013	14:18:00	2155
4/10/2013	14:33:00	2065
4/10/2013	14:48:00	2175
4/10/2013	15:03:00	2175
4/10/2013	15:18:00	2185
4/10/2013	15:33:00	2190
4/10/2013	15:48:01	2190
4/10/2013	16:03:00	2185
4/10/2013	16:18:00	2195
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
4/10/2013	19:03:00	2200
4/10/2013	19:18:01	2205

4/10/2013	19:33:00	2200
4/10/2013	19:48:00	2190
4/10/2013	20:03:00	2195
4/10/2013	20:18:00	2075
4/10/2013	20:33:00	2180
4/10/2013	20:48:00	2155
4/10/2013	21:03:01	2195
4/10/2013	21:18:00	2195
4/10/2013	21:33:00	2185
4/10/2013	21:48:00	2175
4/10/2013	22:03:00	2080
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
4/11/2013	0:33:01	2170
4/11/2013	0:48:00	2170
4/11/2013	1:03:00	2145
4/11/2013	1:18:00	2150
4/11/2013	1:33:00	2145
4/11/2013	1:48:00	2145
4/11/2013	2:03:00	2145
4/11/2013	2:18:01	2155
4/11/2013	2:33:00	2150
4/11/2013	2:48:00	2150
4/11/2013	3:03:00	2145
4/11/2013	3:18:00	2145
4/11/2013	3:33:00	2155
4/11/2013	3:48:00	2150
4/11/2013	4:03:01	2150
4/11/2013	4:18:00	2150
4/11/2013	4:33:00	2045
4/11/2013	4:48:00	2145
4/11/2013	5:03:00	2150
4/11/2013	5:18:00	2155
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
4/11/2013	6:33:00	2155
4/11/2013	6:48:00	2150
4/11/2013	7:03:00	2150
4/11/2013	7:18:00	2155
4/11/2013	7:33:01	2155
4/11/2013	7:48:00	2165
4/11/2013	8:03:00	2160
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4/11/2013	8:48:00	2150
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4/11/2013	10:48:00	2175
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4/11/2013	11:18:00	2175
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4/11/2013	12:18:00	2175
4/11/2013	12:33:00	2190
4/11/2013	12:48:01	2190
4/11/2013	13:03:00	2190
4/11/2013	13:18:00	2185
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4/11/2013	14:03:00	2210
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4/11/2013	15:18:00	2175
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
4/11/2013	16:33:00	2160
4/11/2013	16:48:00	2040
4/11/2013	17:03:00	2165

4/11/2013	17:18:00	2160
4/11/2013	17:33:00	0
4/11/2013	17:48:00	2195
4/11/2013	18:03:01	2160
4/11/2013	18:18:00	2150
4/11/2013	18:33:00	2180
4/11/2013	18:48:00	2150
4/11/2013	19:03:00	2150
4/11/2013	19:18:00	2155
4/11/2013	19:33:00	2155
4/11/2013	19:48:00	2155
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4/11/2013	20:48:00	2150
4/11/2013	21:03:00	2150
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4/11/2013	21:33:00	2155
4/11/2013	21:48:00	2040
4/11/2013	22:03:01	2155
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4/11/2013	22:33:00	2145
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 | December 5, 2017

Biosolids Handling
Dewatering and Drying Evaluation Report
City of Kiel WWTP

Date:	December 5, 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 experiencing major equipment failures which have expedited the implementation of solids handling improvements.

Design Basis

Donohue's future design criteria is based on the projected 2037 design year loadings, inclusive of near term industrial growth. Below is the design criteria outlined in McMahon's 2017 Update report:

Sludge to Dewatering, lbs./day	Proposed Design
▪ Average	8,995
▪ Maximum Month	14,500

This design criteria used a combination of influent loading changes, operational changes, and process changes and accounted for their impact on sludge production. Currently sludge processing has a peaking factor of 1.33, which is anticipated to increase to 1.6. The dewatering and drying capacity was selected to process these sludge loads. Table 1 highlights the design criteria used in this determination.

Table 1 – 20-year Design Criteria for Kiel WWTP

Description	Units	2037 Average Average (18.5% TS)	2037 Max Month Average (22% TS*)
Sludge Production	lb TS/d	8,995	14,500
Dewatering Operation	hrs/d	24	24
	d/wk	4	7
	hr/wk	96	168
	gpm	85.3	80.5
Avg %TS	%	1.5 – 1.8	
*Solids concentration increases during peak conditions due to increased inert chemical sludge loading of maximum month conditions.			

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 Target Particle Temp	90% TS 70 deg C		
Cake Dryness (%TS)	14.5-16.5	17-20	20-24
Min. Evaporation Capacity (lb water/hour)	3,166	2,583	2,083
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.

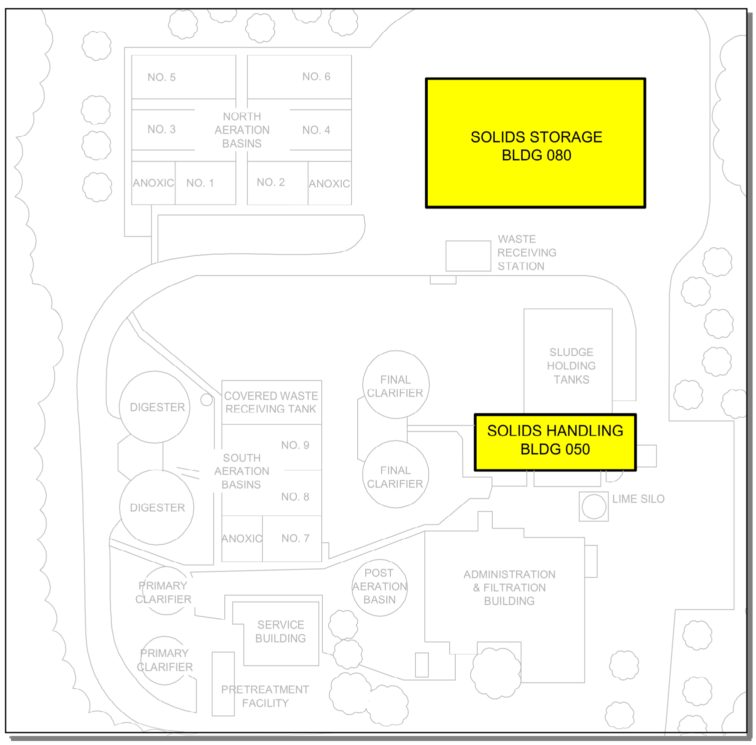


Figure 1 – On-site Solids Handling Building and Solids Storage Building Locations

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 peak solids loading capacity of 726 lb/hr. This loading capacity is based on a 24 hour/7 day operating schedule during maximum conditions. A slightly lower loading (640 lb/hr) and fewer hours of runtime is expected 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

Figure 2 – Alfa Laval BFP

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 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

Each of the listed technologies utilize the EPA acknowledged process to further reduce pathogens using heat drying to achieve Class A biosolids via a 90%TS (10% residual moisture) and 70 deg C internal particle temperature.

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. The manufacturer currently has other municipal projects in the procurement stage.

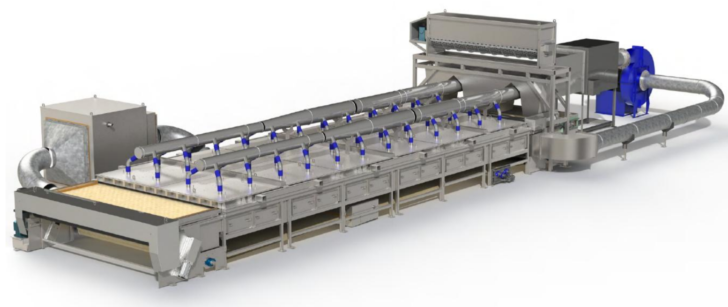


Figure 5 – Gryphon Belt Dryer with Vacuum

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.

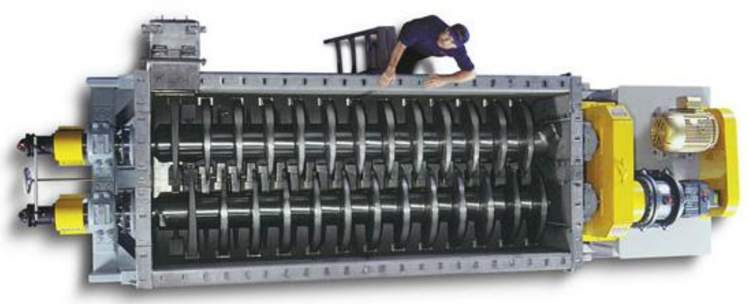


Figure 6 – Komline Paddle Dryer

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.

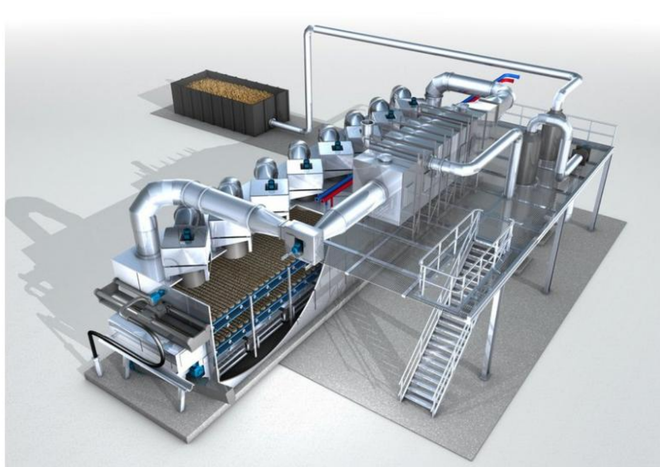


Figure 7 – Huber Belt Dryer

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.

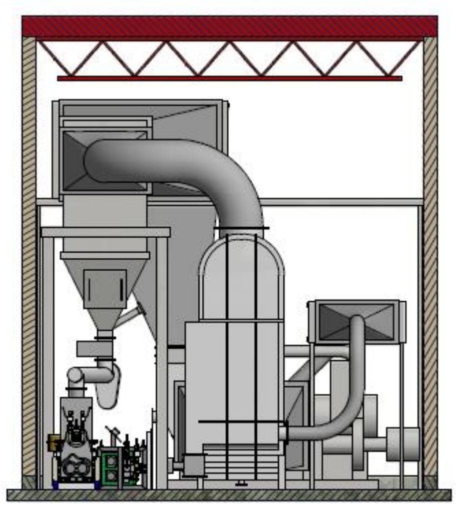


Figure 8 – Schwing Fluid Bed Dryer

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.

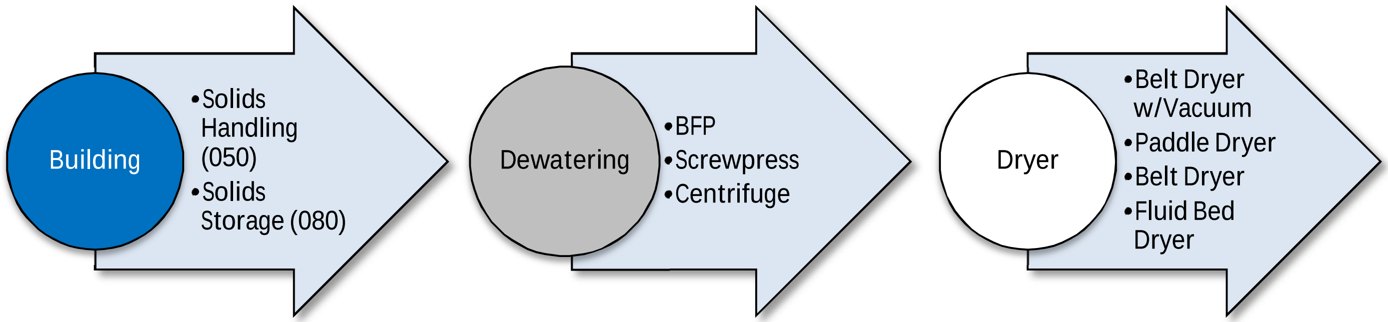


Figure 9 – Dryer Package Matrix

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 3.875%. 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~~	~~5,200,000~~	~~208,000~~	~~8,000,000~~
~~2A~~	~~BLDG 050: BFP + Paddle Dryer~~	~~7,500,000~~	~~223,000~~	~~10,500,000~~
~~3A~~	~~BLDG 050: BFP + Belt Dryer~~	~~9,300,000~~	~~209,000~~	~~12,100,000~~
~~4A~~	~~BLDG 050: BFP + Fluid Bed Dryer~~	~~5,900,000~~	~~224,000~~	~~8,900,000~~
~~5A~~	~~BLDG 050: Screwpress + Belt Dryer with Vacuum~~	~~5,100,000~~	~~236,000~~	~~8,300,000~~
6A	BLDG 050: Screwpress + Paddle Dryer	6,900,000	247,000	10,200,000
~~7A~~	~~BLDG 050: Screwpress + Belt Dryer~~	~~8,800,000~~	~~236,000~~	~~12,000,000~~
8A	BLDG 050: Screwpress + Fluid Bed Dryer	5,700,000	248,000	9,000,000
9A	BLDG 050: Centrifuge + Belt Dryer with Vacuum	4,300,000	230,000	7,400,000
10A	BLDG 050: Centrifuge + Paddle Dryer	6,000,000	239,000	9,200,000
11A	BLDG 050: Centrifuge + Belt Dryer	8,300,000	230,000	11,400,000
12A	BLDG 050: Centrifuge + Fluid Bed Dryer	5,100,000	240,000	8,300,000
1B	BLDG 080: BFP + Belt Dryer with Vacuum	6,100,000	208,000	8,900,000
2B	BLDG 080: BFP + Paddle Dryer	8,600,000	223,000	11,600,000
3B	BLDG 080: BFP + Belt Dryer	10,400,000	209,000	13,200,000
4B	BLDG 080: BFP + Fluid Bed Dryer	7,000,000	224,000	10,000,000
5B	BLDG 080: Screwpress + Belt Dryer with Vacuum	5,400,000	236,000	8,600,000
6B	BLDG 080: Screwpress + Paddle Dryer	7,400,000	247,000	10,700,000
7B	BLDG 080: Screwpress + Belt Dryer	9,300,000	236,000	12,500,000
8B	BLDG 080: Screwpress + Fluid Bed Dryer	6,200,000	248,000	9,500,000
9B	BLDG 080: Centrifuge + Belt Dryer with Vacuum	4,900,000	230,000	8,000,000
10B	BLDG 080: Centrifuge + Paddle Dryer	6,600,000	239,000	9,800,000
11B	BLDG 080: Centrifuge + Belt Dryer	8,900,000	230,000	12,000,000
12B	BLDG 080: Centrifuge + Fluid Bed Dryer	5,600,000	240,000	8,800,000

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 through 5A, and 7A did not have adequate space to fit in the building and were eliminated from any other further consideration. The Solids Storage Building provides improved access to all dewatering and drying systems, 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. Additionally, if the existing biosolids equipment was left in place, it could be maintained and used as a redundant solids handling system.

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 5B and 9B have the lowest 20-year present worth among the available 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 completed. The City 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
- Lease or Construction of a new storage
- Identify a contracted year-round product outlet
- Commit to landfill disposal when storage is full

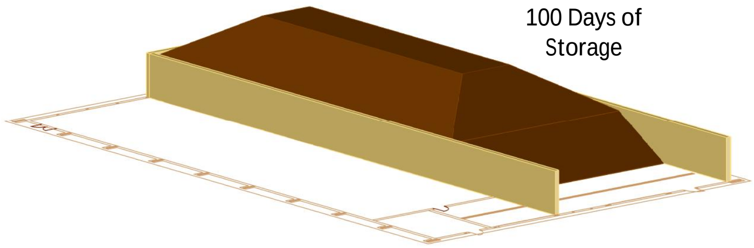


Figure 10 – Maximum Dried Product Storage in Building 080

Lastly, by utilizing the Sludge Storage Building, 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 3,166 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 1030 or Equivalent	Each	2	813,000	1,626,000
Installation	Each	2	162,600	325,200
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				2,544,200
Contingency			20%	508,840
Subtotal				3,053,040
Contractor Overhead & Profit			25%	763,260
Total Construction Cost				**3,816,300**
Engineering			15%	572,445
Spare Parts				813,000
Total Initial Cost				**5,200,000**

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
14% Loading Increase Adjustment				25,538
Total Annual Cost				**208,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742

Present Worth of Total Annual Cost 2,860,000

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 3,166 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
Paddle Dryer	Each	1	2,880,000	2,880,000
Installation	Each	1	864,000	864,000
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				4,321,000
Contingency			20%	864,200
Subtotal				5,185,200
Contractor Overhead & Profit			25%	1,296,300
Total Construction Cost				**6,481,500**
Engineering			15%	972,225
Total Initial Cost				**7,500,000**

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
14% Loading Increase Adjustment				27,404
Total Annual Cost				**223,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,060,000**

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 3,166 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
Belt Dryer	Each	1	3,680,000	3,680,000
Installation	Each	1	1,104,000	1,104,000
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				5,372,000
Contingency			20%	1,074,400
Subtotal				6,446,400
Contractor Overhead & Profit			25%	1,611,600
Total Construction Cost				**8,058,000**
Engineering			15%	1,208,700
Total Initial Cost				**9,300,000**

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
14% Loading Increase Adjustment				25,653
Total Annual Cost				**209,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742

Present Worth of Total Annual Cost **2,870,000**

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 3,166 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
Fluid Bed Dryer	Each	**1**	**2,185,000**	2,185,000
Installation	Each	**1**	655,500	655,500
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				3,394,500
Contingency			**20%**	678,900
Subtotal				4,073,400
Contractor Overhead & Profit			**25%**	1,018,350
Total Construction Cost				**5,091,750**
Engineering			**15%**	763,763
Total Initial Cost				**5,900,000**

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
14% Loading Increase Adjustment				27,500
Total Annual Cost				**224,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,080,000**

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 2,583 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			120,000
Demoltion	See Worksheet for Detailed Cost Breakdown			0
Model 1050 or Equivalent	Each	1	1,307,000	1,307,000
Installation	Each	1	261,400	261,400
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 726 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				2,559,850
Contingency			20%	511,970
Subtotal				3,071,820
Contractor Overhead & Profit			25%	767,955
Total Construction Cost				**3,839,775**
Engineering			15%	575,966
Spare Parts				653,500
Total Initial Cost				**5,100,000**

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: STR 050 Addition	sq ft	400	300	120,000
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				**120,000**
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 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
14% Loading Increase Adjustment				28,960
Total Annual Cost				**236,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,240,000**

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 2,583 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
Paddle 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
Screwpress Dewatering 726 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				4,003,450
Contingency			**20%**	800,690
Subtotal				4,804,140
Contractor Overhead & Profit			**25%**	1,201,035
Total Construction Cost				**6,005,175**
Engineering			**15%**	900,776
Total Initial Cost				**6,900,000**

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
14% Loading Increase Adjustment				30,390
Total Annual Cost				**247,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742
Present Worth of Total Annual Cost	**3,390,000**

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 2,583 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
Belt Dryer	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
Screwpress Dewatering 726 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				5,096,450
Contingency			20%	1,019,290
Subtotal				6,115,740
Contractor Overhead & Profit			25%	1,528,935
Total Construction Cost				**7,644,675**
Engineering			15%	1,146,701
Total Initial Cost				**8,800,000**

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
14% Loading Increase Adjustment				28,958
Total Annual Cost				**236,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,240,000**

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 2,583 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
Fluid Bed Dryer	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
Screwpress Dewatering 726 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				3,302,450
Contingency			20%	660,490
Subtotal				3,962,940
Contractor Overhead & Profit			25%	990,735
Total Construction Cost				**4,953,675**
Engineering			15%	743,051
Total Initial Cost				**5,700,000**

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
14% Loading Increase Adjustment				30,468
Total Annual Cost				**248,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,410,000**

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 2,083 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 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
Centrifuge Dewatering 726 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				2,161,450
Contingency			20%	432,290
Subtotal				2,593,740
Contractor Overhead & Profit			25%	648,435
Total Construction Cost				**3,242,175**
Engineering			15%	486,326
Spare Parts				530,000
Total Initial Cost				**4,300,000**

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
14% Loading Increase Adjustment				28,205
Total Annual Cost				**230,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,160,000**

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 2,083 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
Paddle Dryer	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 726 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
14% Loading Increase Adjustment				29,365
Total Annual Cost				**239,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,280,000**

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 2,083 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
Belt Dryer	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 726 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
14% Loading Increase Adjustment				28,203
Total Annual Cost				**230,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,160,000**

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 2,083 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
Fluid Bed Dryer	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 726 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
14% Loading Increase Adjustment				29,429
Total Annual Cost				**240,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742
Present Worth of Total Annual Cost	**3,300,000**

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 3,166 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	2	813,000	1,626,000
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
BFP Dewatering 726 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				3,066,080
Contingency			20%	613,216
Subtotal				3,679,296
Contractor Overhead & Profit			25%	919,824
Total Construction Cost				**4,599,120**
Engineering			15%	689,868
Spare Parts				813,000
Total Initial Cost				**6,100,000**

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
14% Loading Increase Adjustment				25,538
Total Annual Cost				**208,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **2,860,000**

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 3,166 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
Paddle Dryer	Each	1	2,880,000	2,880,000
Installation	Each	1	864,000	864,000
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 726 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				4,993,480
Contingency			20%	998,696
Subtotal				5,992,176
Contractor Overhead & Profit			25%	1,498,044
Total Construction Cost				**7,490,220**
Engineering			15%	1,123,533
Total Initial Cost				**8,600,000**

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
14% Loading Increase Adjustment				27,404
Total Annual Cost				**223,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742
Present Worth of Total Annual Cost	**3,060,000**

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 3,166 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
Belt Dryer	Each	1	3,680,000	3,680,000
Installation	Each	1	1,104,000	1,104,000
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 726 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				6,056,480
Contingency			20%	1,211,296
Subtotal				7,267,776
Contractor Overhead & Profit			25%	1,816,944
Total Construction Cost				**9,084,720**
Engineering			15%	1,362,708
Total Initial Cost				**10,400,000**

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
14% Loading Increase Adjustment				25,653
Total Annual Cost				**209,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742
Present Worth of Total Annual Cost	**2,870,000**

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 3,166 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
Fluid Bed Dryer	Each	1	2,185,000	2,185,000
Installation	Each	1	655,500	655,500
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 726 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				4,078,980
Contingency			20%	815,796
Subtotal				4,894,776
Contractor Overhead & Profit			25%	1,223,694
Total Construction Cost				**6,118,470**
Engineering			15%	917,771
Total Initial Cost				**7,000,000**

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
14% Loading Increase Adjustment				27,500
Total Annual Cost				**224,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,080,000**

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 2,583 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 1050 or Equivalent	Each	1	1,307,000	1,307,000
Installation	Each	1	261,400	261,400
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 726 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				2,758,880
Contingency			20%	551,776
Subtotal				3,310,656
Contractor Overhead & Profit			25%	827,664
Total Construction Cost				**4,138,320**
Engineering			15%	620,748
Spare Parts				653,500
Total Initial Cost				**5,400,000**

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
14% Loading Increase Adjustment				28,960
Total Annual Cost				**236,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742
Present Worth of Total Annual Cost	**3,240,000**

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 2,583 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
Paddle 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
Screwpress Dewatering 726 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				4,288,480
Contingency			20%	857,696
Subtotal				5,146,176
Contractor Overhead & Profit			25%	1,286,544
Total Construction Cost				**6,432,720**
Engineering			15%	964,908
Total Initial Cost				**7,400,000**

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
14% Loading Increase Adjustment				30,390
Total Annual Cost				**247,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,390,000**

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 2,583 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
Belt Dryer	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
Screwpress Dewatering 726 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				5,411,480
Contingency			20%	1,082,296
Subtotal				6,493,776
Contractor Overhead & Profit			25%	1,623,444
Total Construction Cost				**8,117,220**
Engineering			15%	1,217,583
Total Initial Cost				**9,300,000**

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
14% Loading Increase Adjustment				28,958
Total Annual Cost				**236,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,240,000**

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 2,583 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
Fluid Bed Dryer	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
Screwpress Dewatering 726 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				3,590,480
Contingency			20%	718,096
Subtotal				4,308,576
Contractor Overhead & Profit			25%	1,077,144
Total Construction Cost				**5,385,720**
Engineering			15%	807,858
Total Initial Cost				**6,200,000**

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
14% Loading Increase Adjustment				30,468
Total Annual Cost				**248,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,410,000**

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 2,083 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
Centrifuge Dewatering 726 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				2,539,480
Contingency			20%	507,896
Subtotal				3,047,376
Contractor Overhead & Profit			25%	761,844
Total Construction Cost				**3,809,220**
Engineering			15%	571,383
Spare Parts				530,000
Total Initial Cost				**4,900,000**

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
14% Loading Increase Adjustment				28,205
Total Annual Cost				**230,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,160,000**

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 2,083 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
Paddle Dryer	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 726 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
14% Loading Increase Adjustment				29,365
Total Annual Cost				**239,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,280,000**

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 2,083 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
Belt Dryer	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 726 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
14% Loading Increase Adjustment				28,203
Total Annual Cost				**230,000**

Present Worth Analysis

Interest Rate Per Year	**3.88%**
Number of Years	**20**
Present Worth Factor	13.742

Present Worth of Total Annual Cost **3,160,000**

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 2,083 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
Fluid Bed Dryer	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 726 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

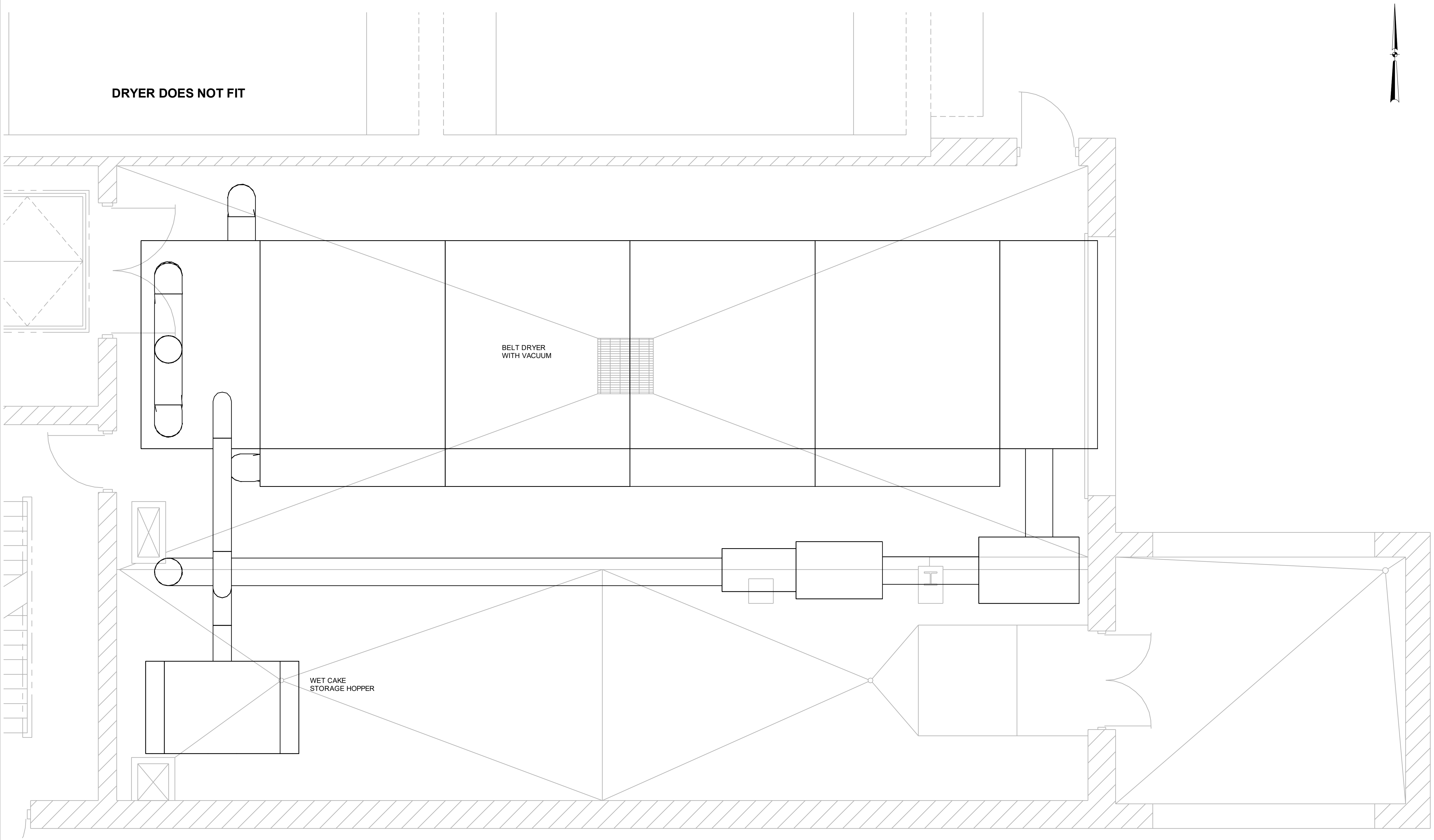
	Belt Dryer	Centrifuge	Backwash
Number of Pumps Operating	1	1	1
Brake Horsepower of Each Operating Pump	64	21	22
Total Bhp	64		
Motor Efficiency	92%		
Adjustable Frequency Drive Efficiency	90%		
Wire Horsepower	77	21	22
Wire Kilowatts	54	15.6	16.4
Operating Hours Per Day	24	24	1
Operating Days Per Week	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
14% Loading Increase Adjustment				29,429
Total Annual Cost				**240,000**

Present Worth Analysis

Interest Rate Per Year	3.88%
Number of Years	20
Present Worth Factor	13.742
Present Worth of Total Annual Cost	**3,300,000**

Attachment B



GRADE PLAN

0 3' 8'

Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	EJL
Drawn By	EJL
Checked By	MWG
Approved By	EJL
Filename	050MP1_10X40.DWG
Project No.	12193.11
Project Date	

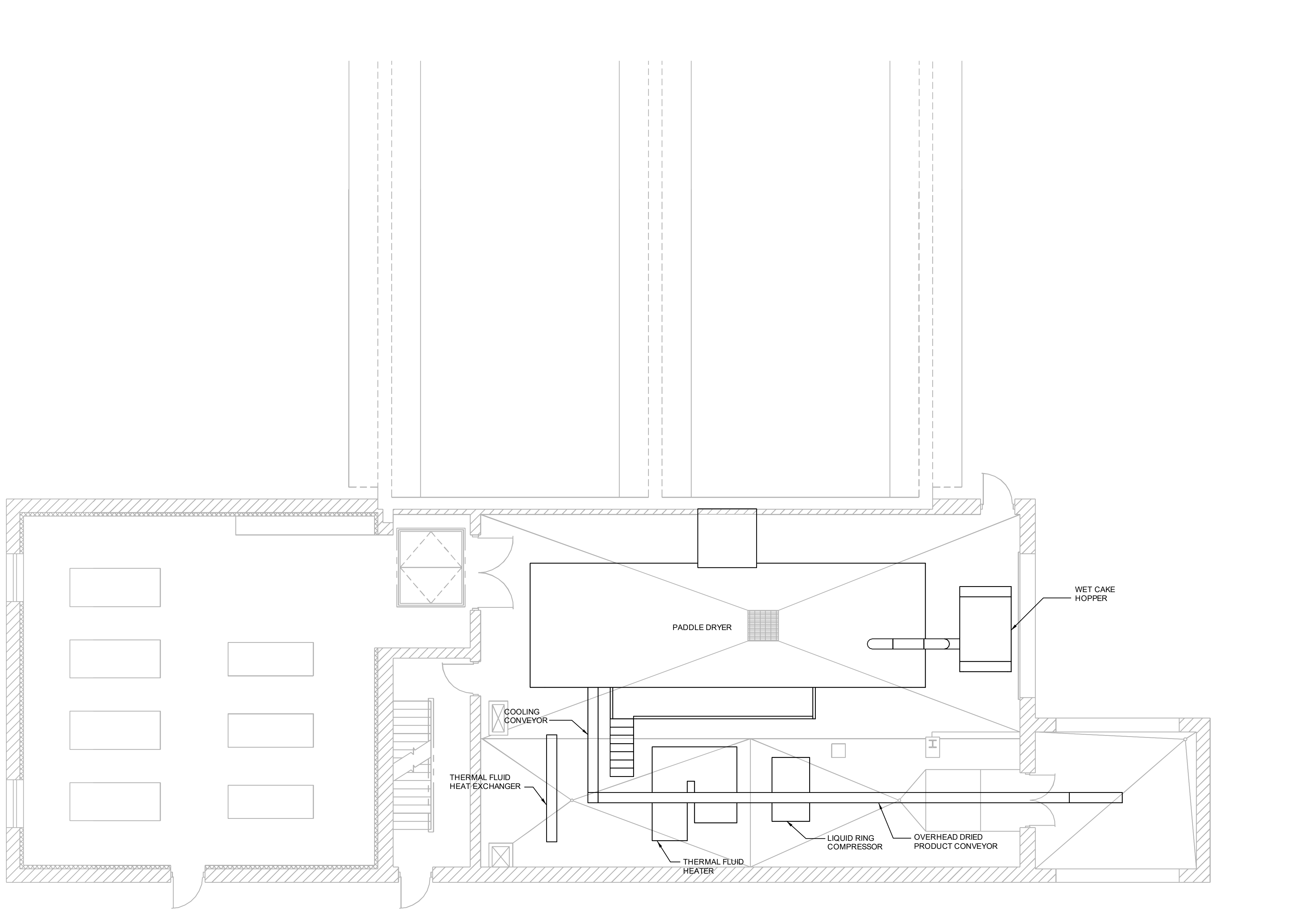
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-G-BFP

DONOHUE

Sheet No. 1

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
Project Date	Date

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

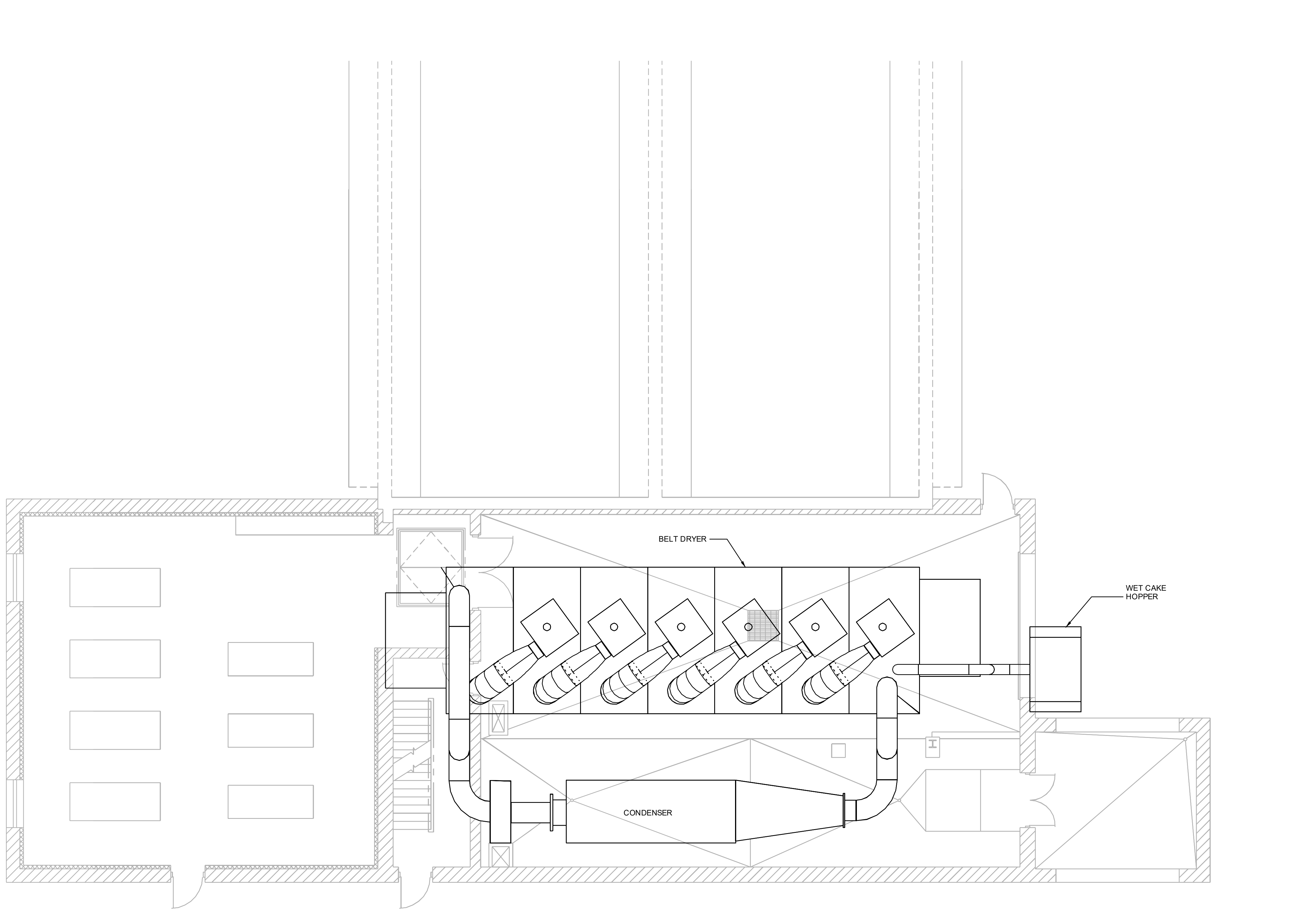
SOLIDS HANDLING BUILDING
50-K-BFP

DONOHUE

Sheet No. 2

Drawing No.

DRYER DOES NOT FIT



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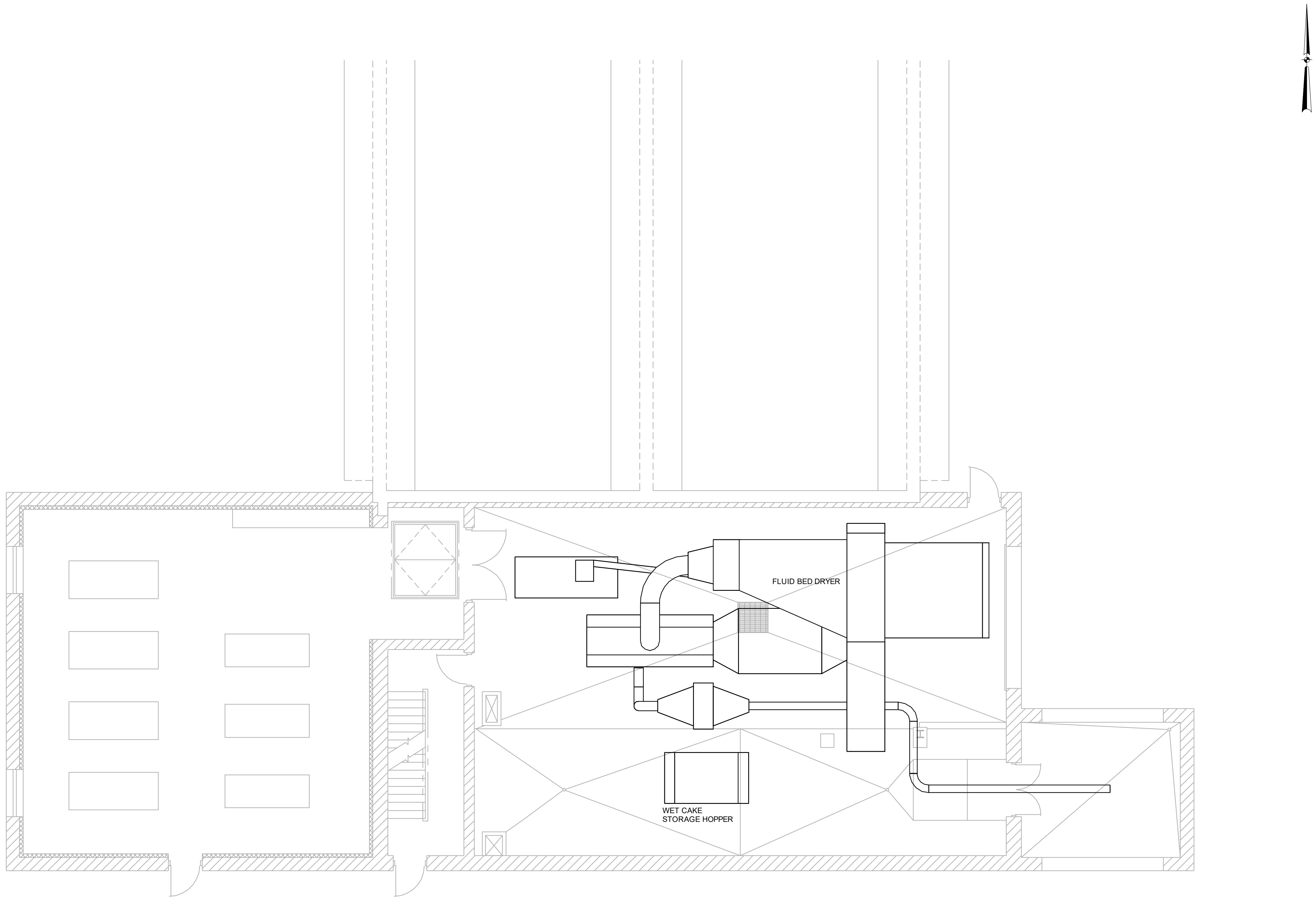
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-H-BFP

DONOHUE

Sheet No. 3

Drawing No.



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Designed By	SAM
Drawn By	SAM
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Approved By	EJL
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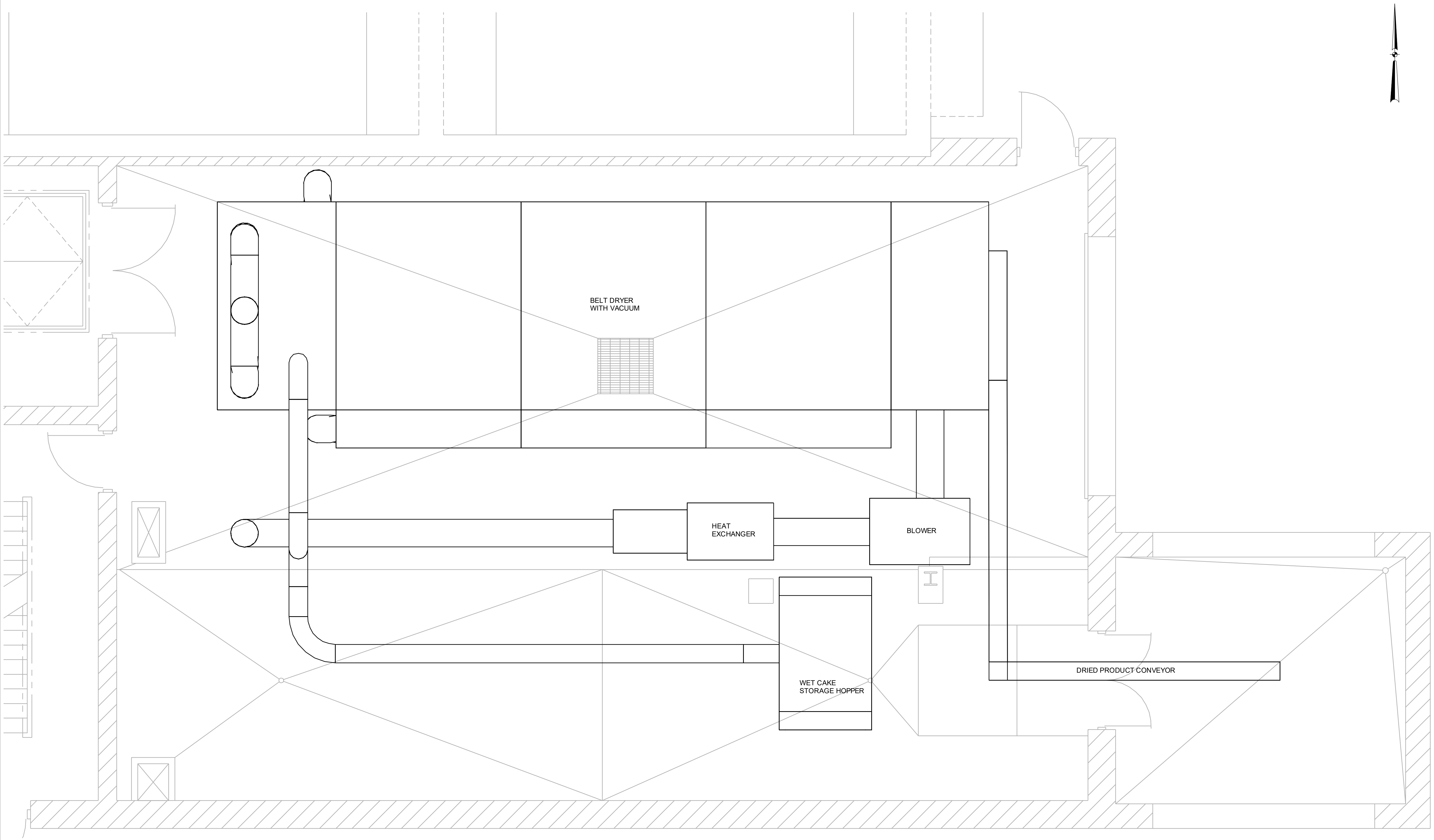
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-S-BFP

DONOHUE

Sheet No. 4

Drawing No.



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Drawn By	SAM
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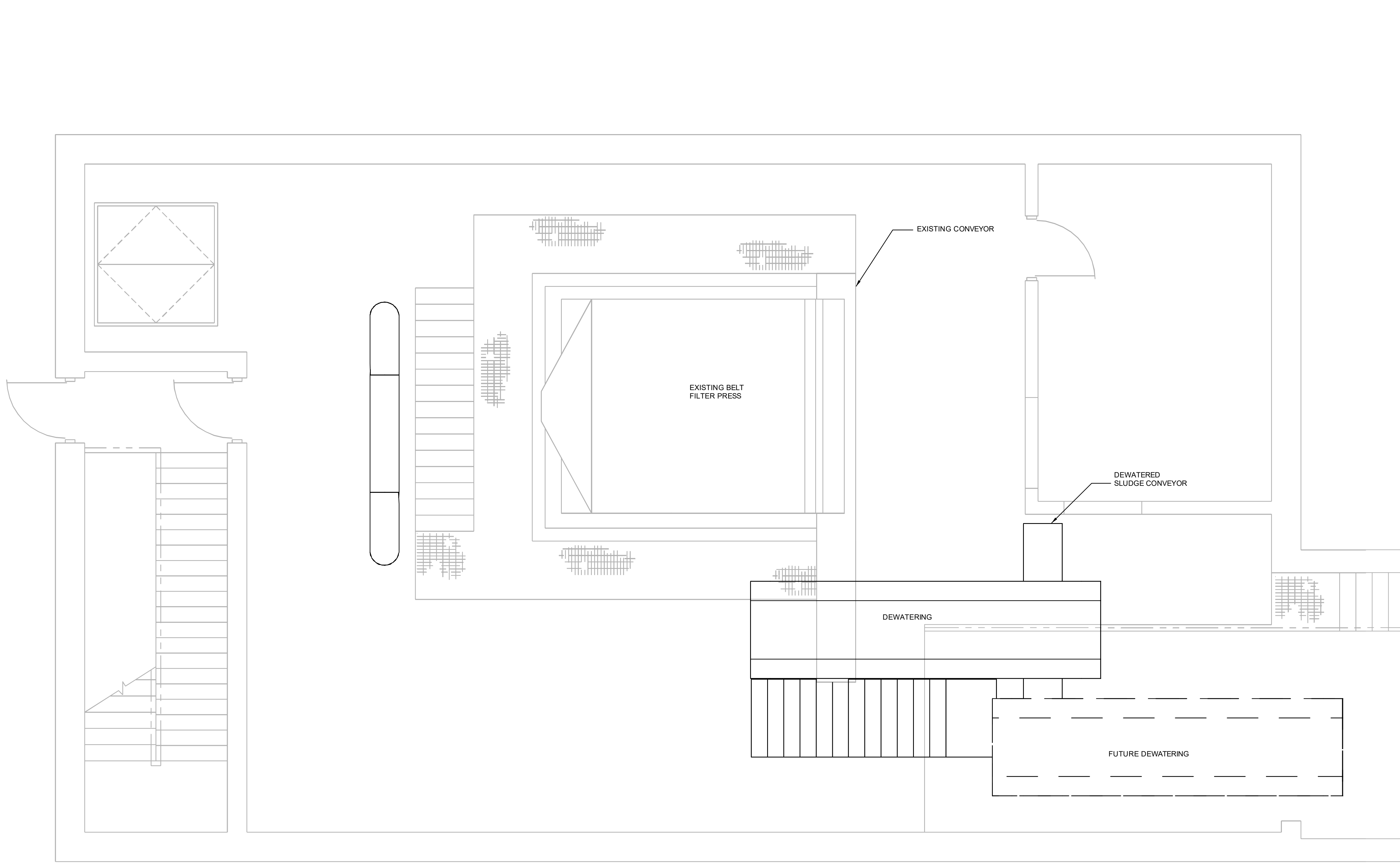
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-G-SP

DONOHUE

Sheet No. 5

Drawing No.



UPPER PLAN

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Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	SAM
Drawn By	SAM
Checked By	EJL
Approved By	EJL
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Project No.	12193.11
Project Date	

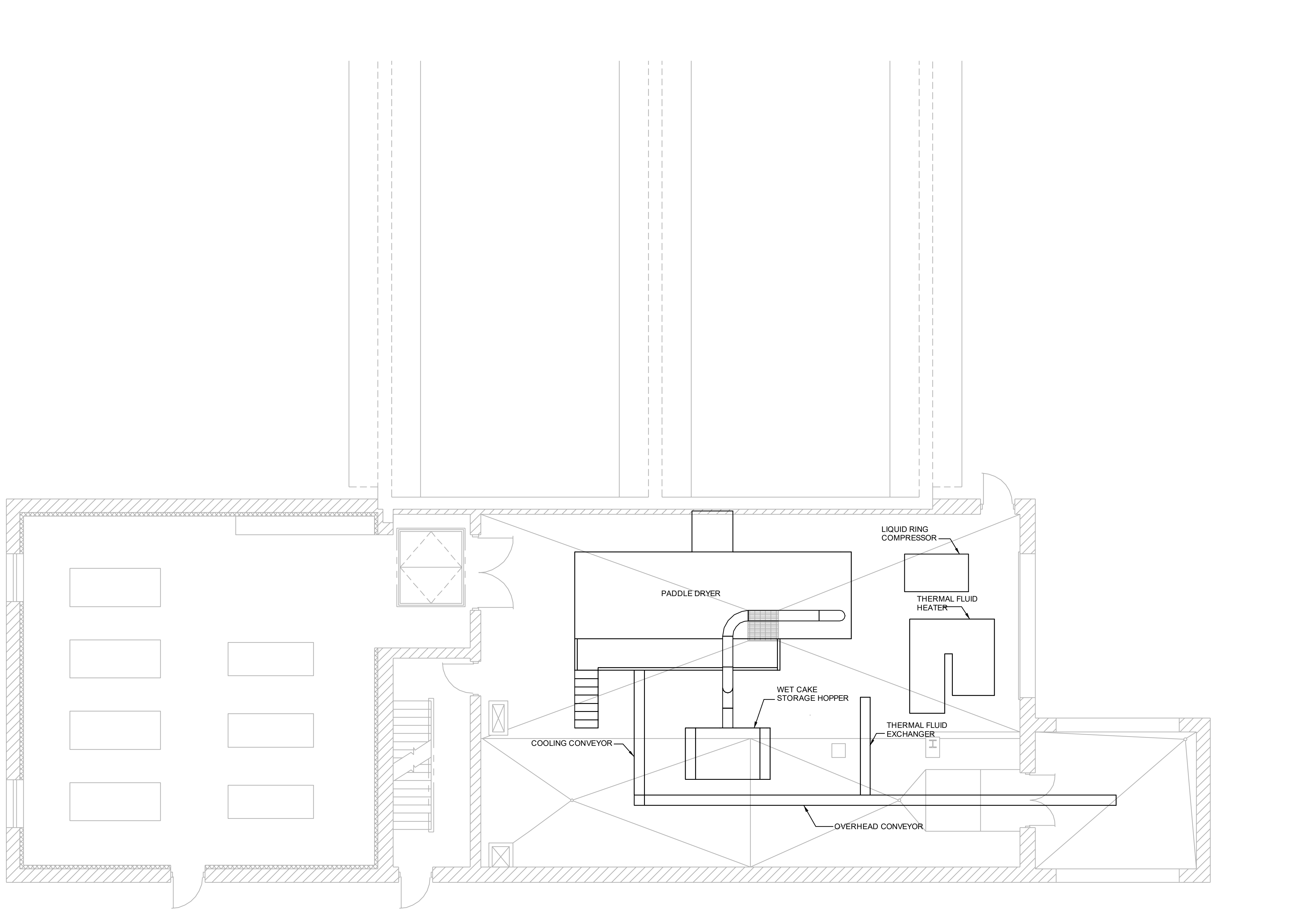
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-G-SP

DONOHUE

Sheet No. 6

Drawing No.



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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	050MP2.DWG
Project No.	12193
Project Date	Date

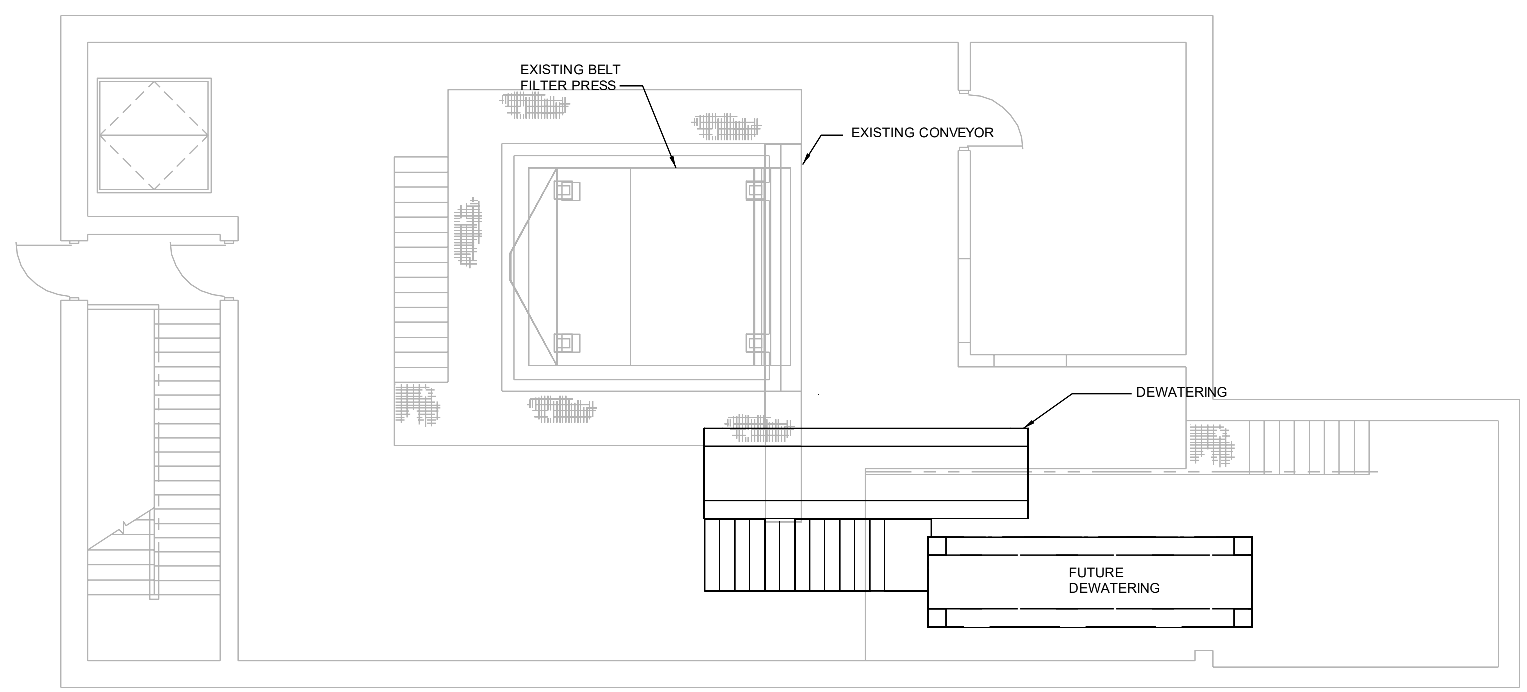
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-K-SP

DONOHUE

Sheet No. 7

Drawing No.



UPPER PLAN

0 3' 16'

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Designed By	EJL
Drawn By	EJL
Checked By	MWG
Approved By	EJL
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Project No.	12193
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CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-K-SP

DONOHUE

Sheet No. 8

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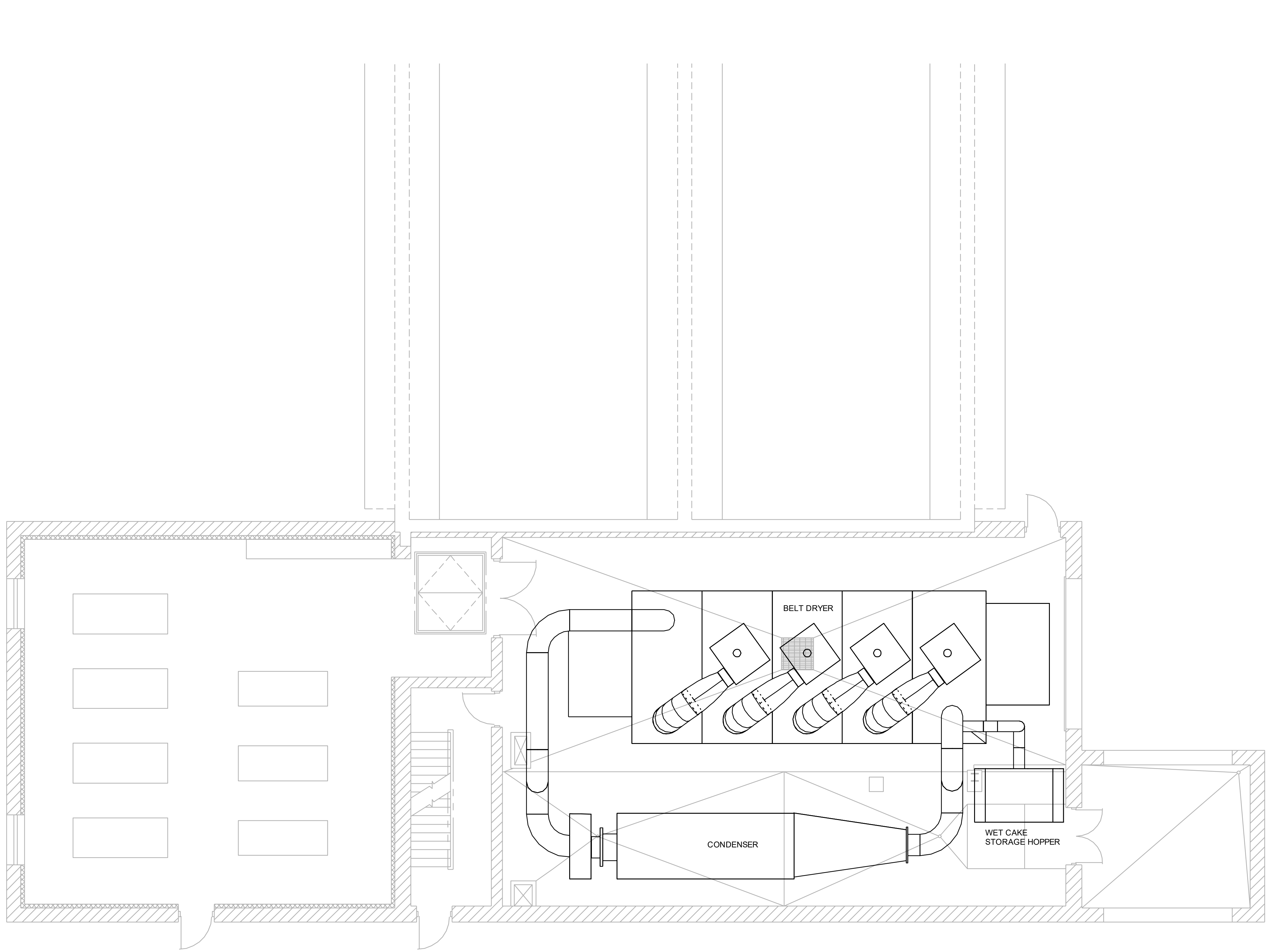

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Checked By	EJL
Approved By	EJL
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CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-H-SP

DONOHUE

Sheet No. 9

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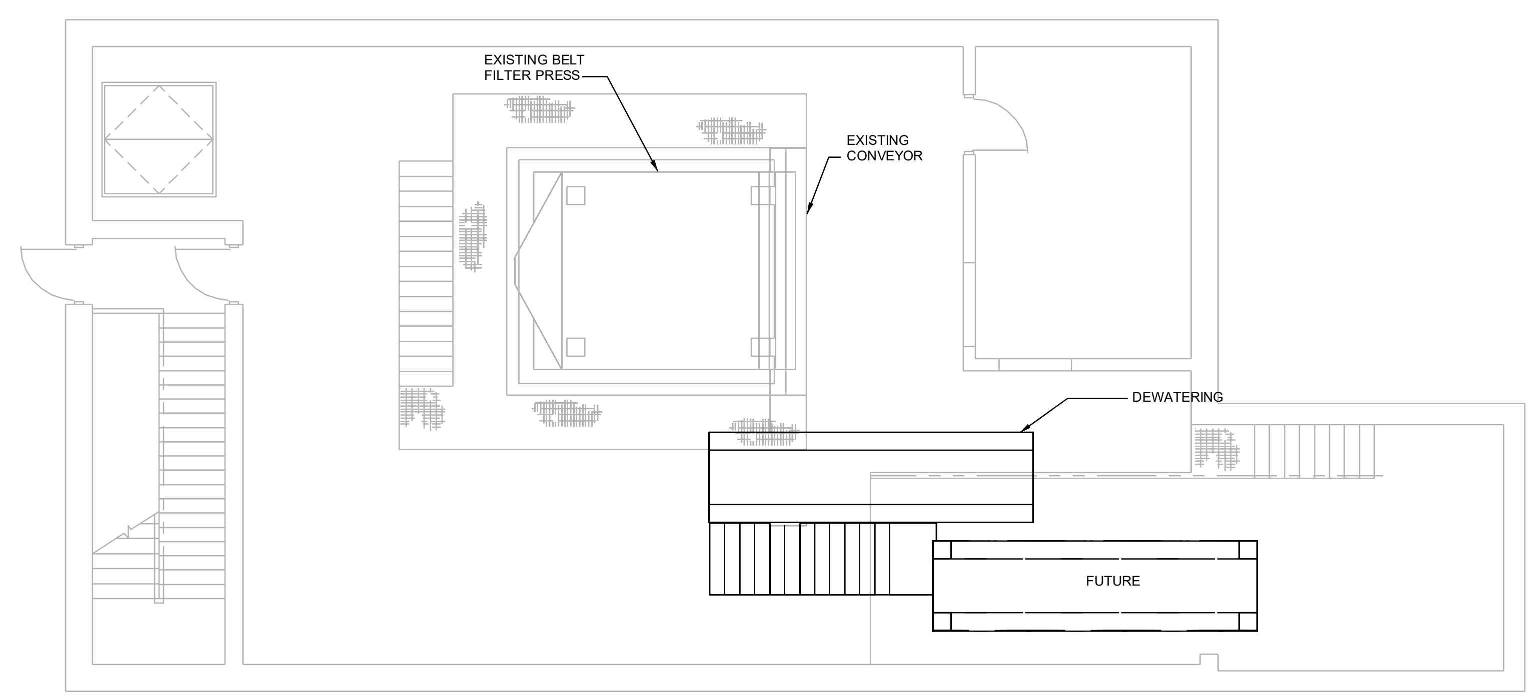

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Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	EJL
Drawn By	EJL
Checked By	MWG
Approved By	EJL
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Project No.	12193
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CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-H-SP

DONOHUE

Sheet No. 10

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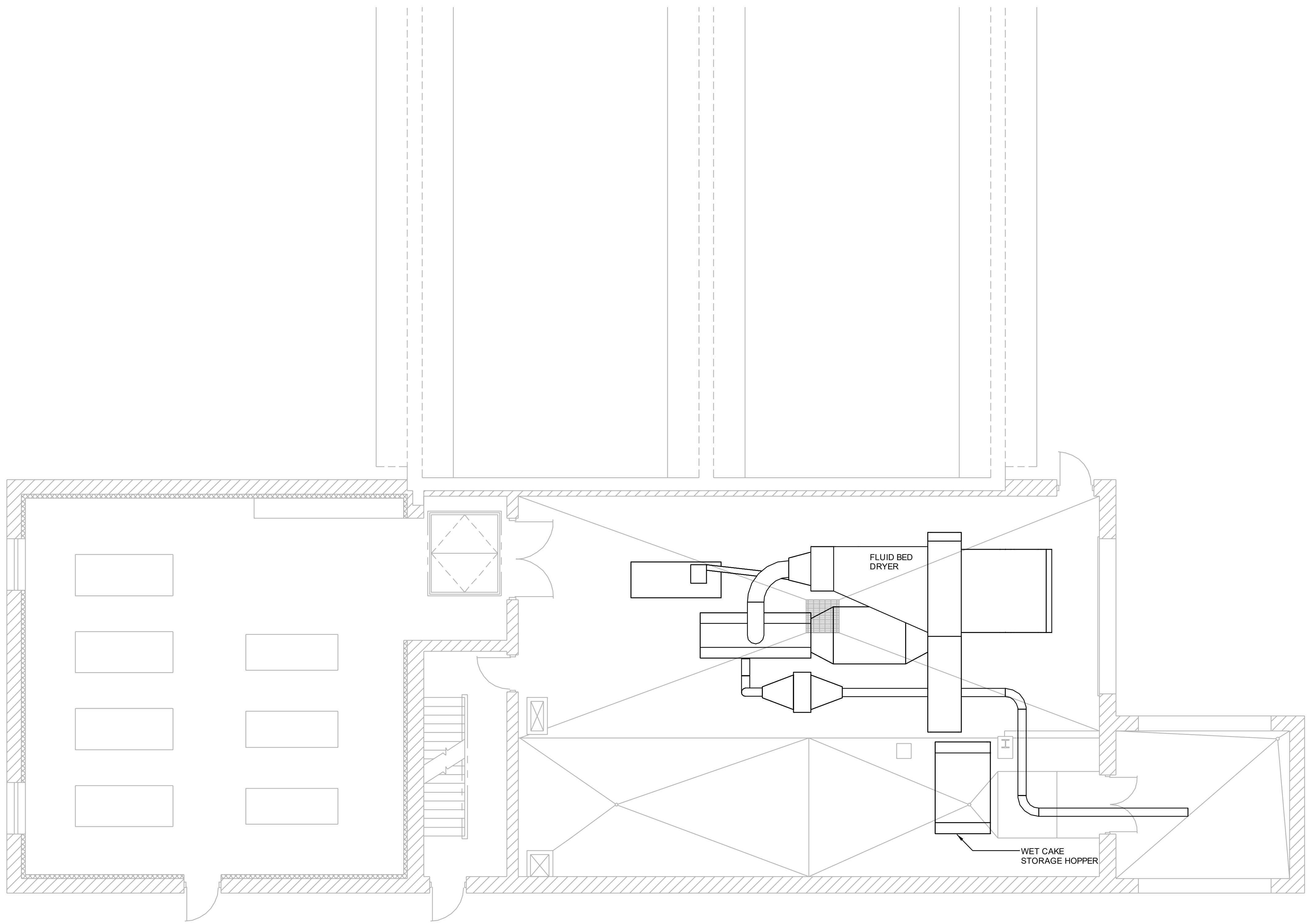

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Drawn By	SAM
Checked By	EJL
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CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-S-SP

DONOHUE

Sheet No. 11

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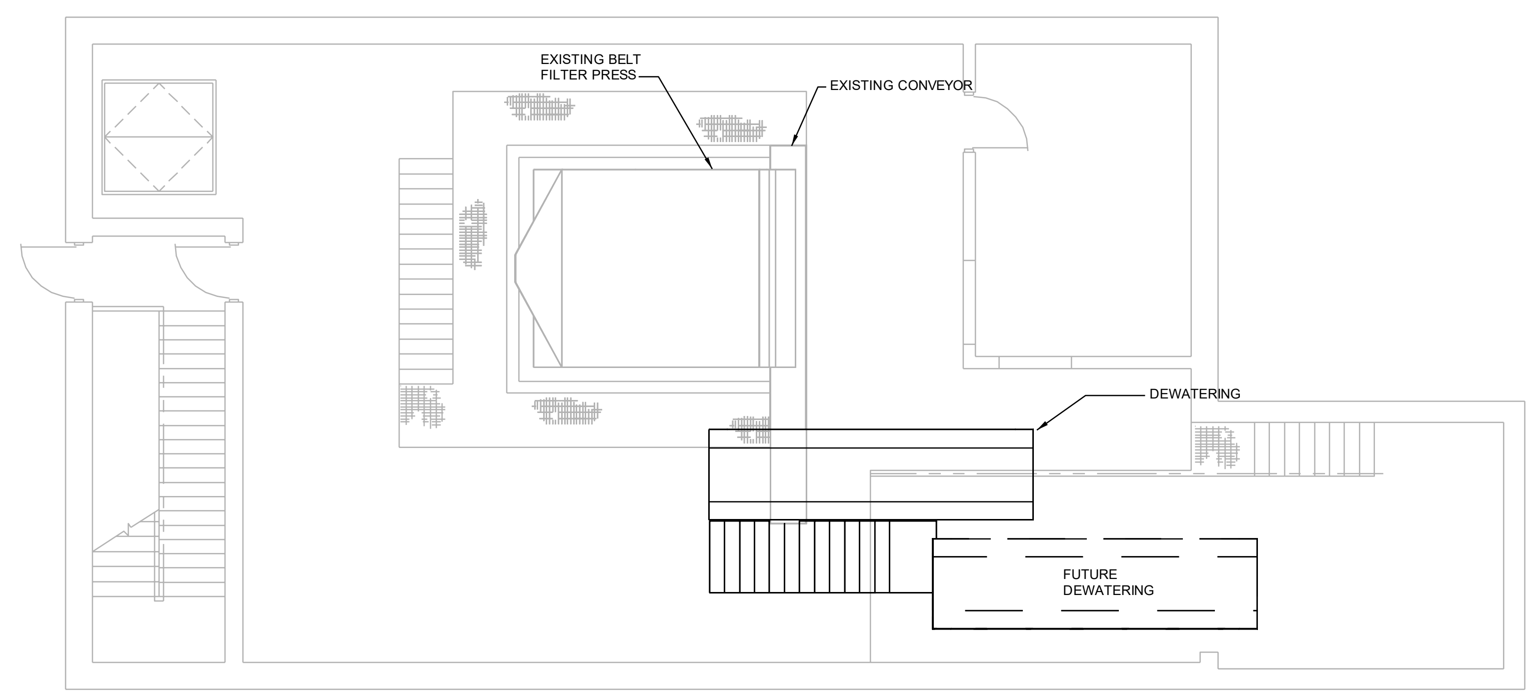

UPPER PLAN

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Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	EJL
Drawn By	EJL
Checked By	MWG
Approved By	EJL
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Project No.	12193
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CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
50-S-SP

DONOHUE

Sheet No. 12

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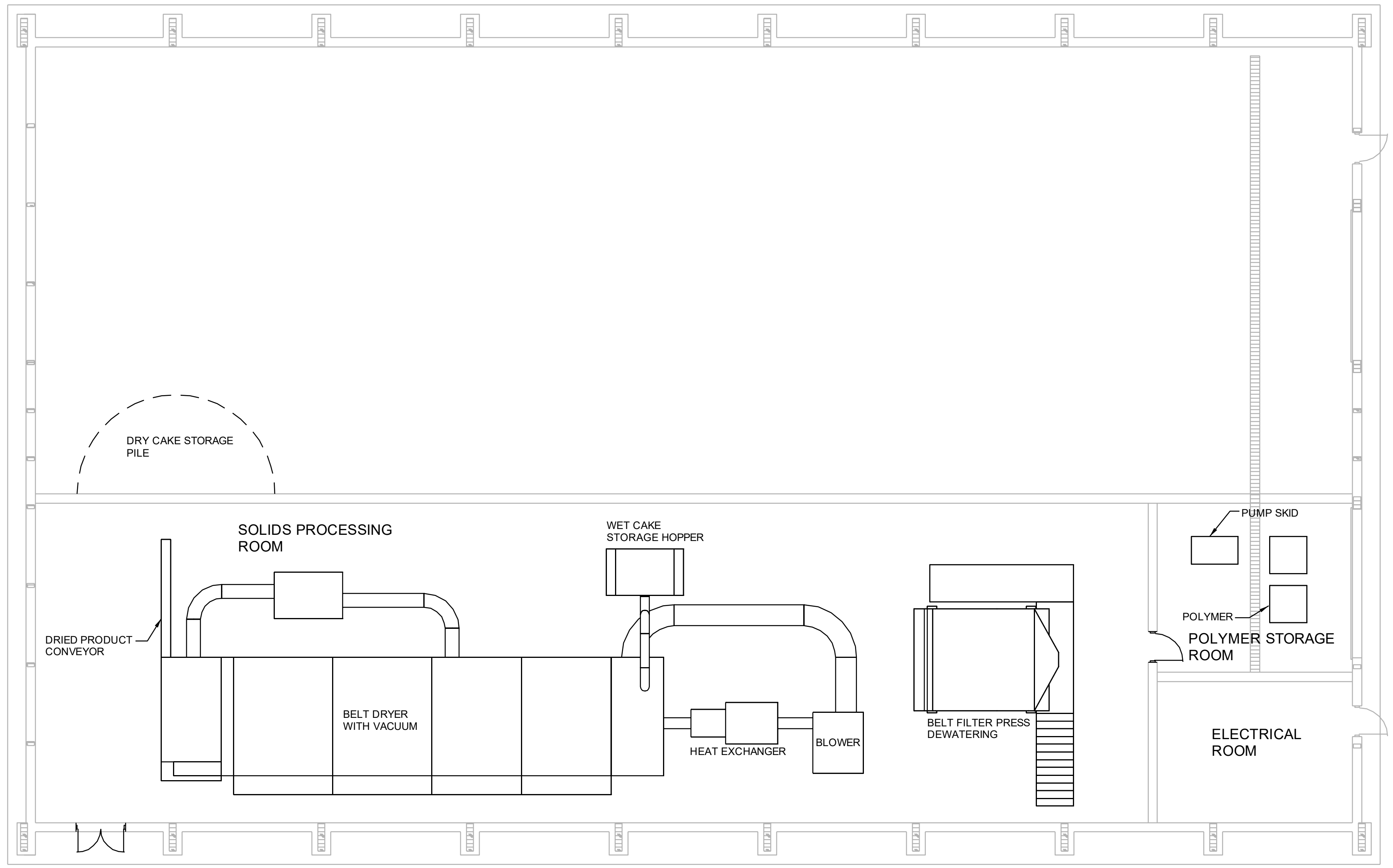


GRADE PLAN

0 1' 8'

Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	SAM
Drawn By	SAM
Checked By	EJL
Approved By	EJL
Filename	080MP2_10X40.DWG
Project No.	12193.11
Project Date	

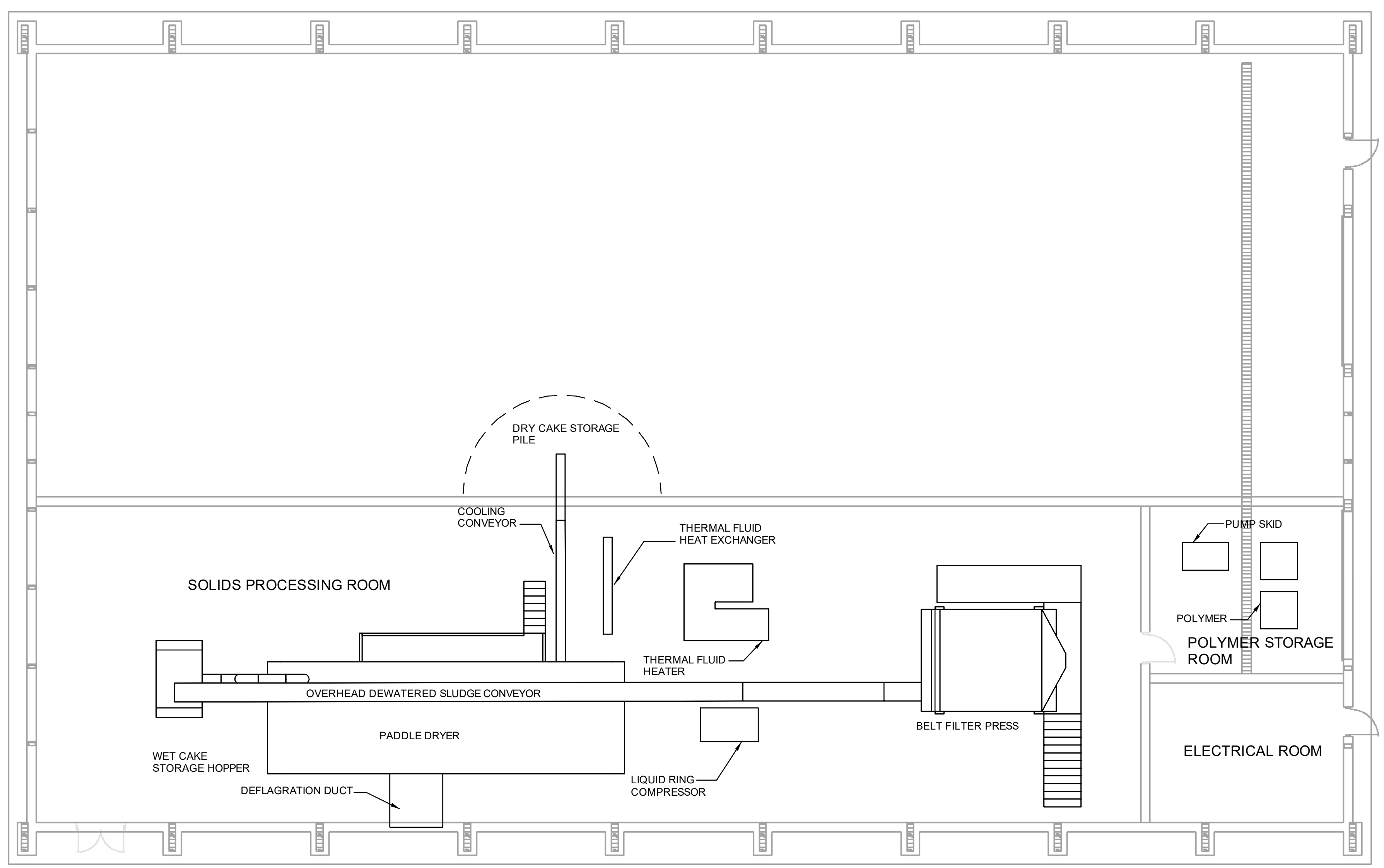
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS STORAGE BUILDING
80-G-BFP

DONOHUE

Sheet No. 13

Drawing No.



GRADE PLAN

0 1' 8'

Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	SAM
Drawn By	SAM
Checked By	EJL
Approved By	EJL
Filename	080MP1.DWG
Project No.	12193
Project Date	Date

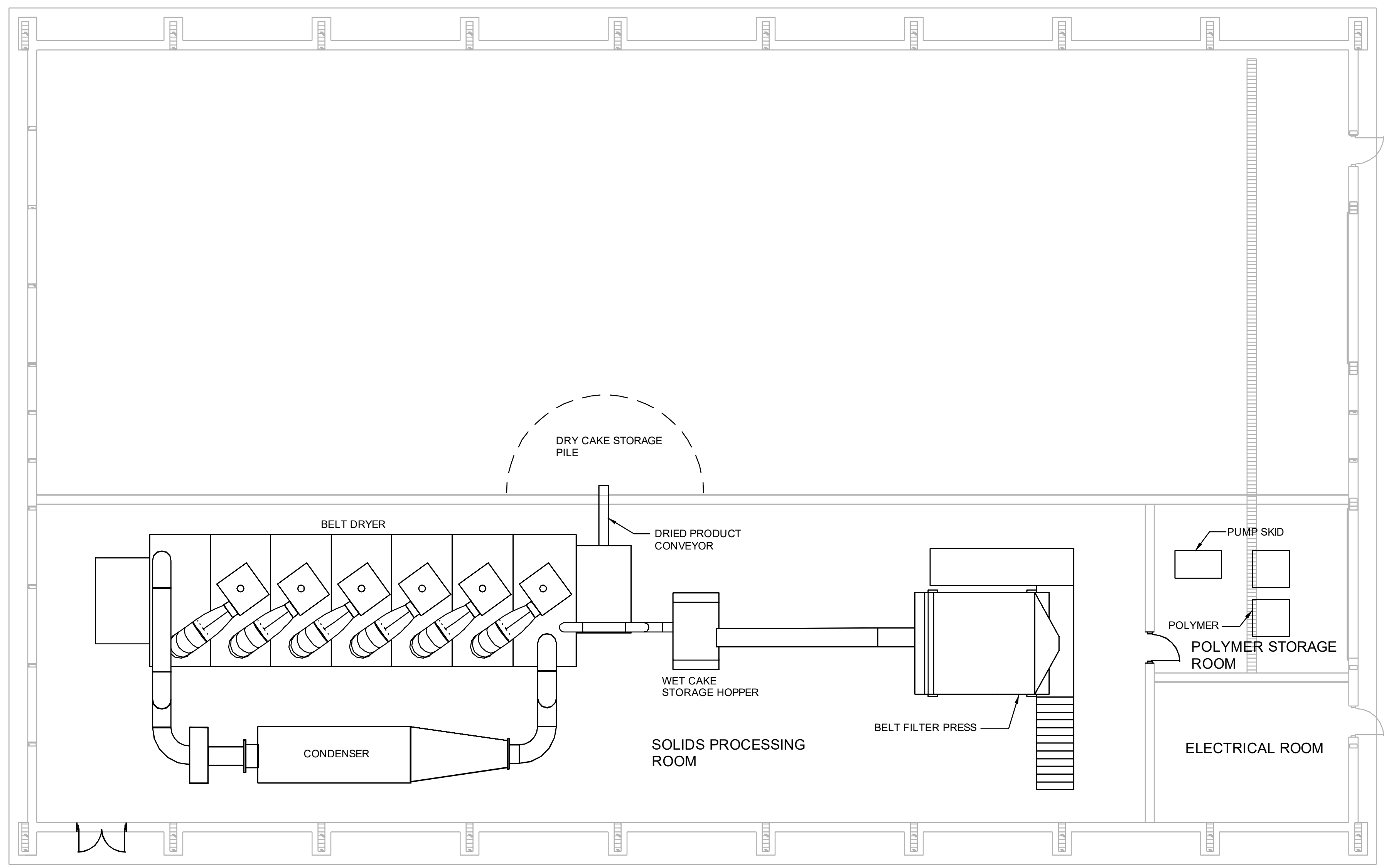
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
80-K-BFP

DONOHUE

Sheet No. 14

Drawing No.



GRADE PLAN

0 1' 8'

Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	SAM
Drawn By	SAM
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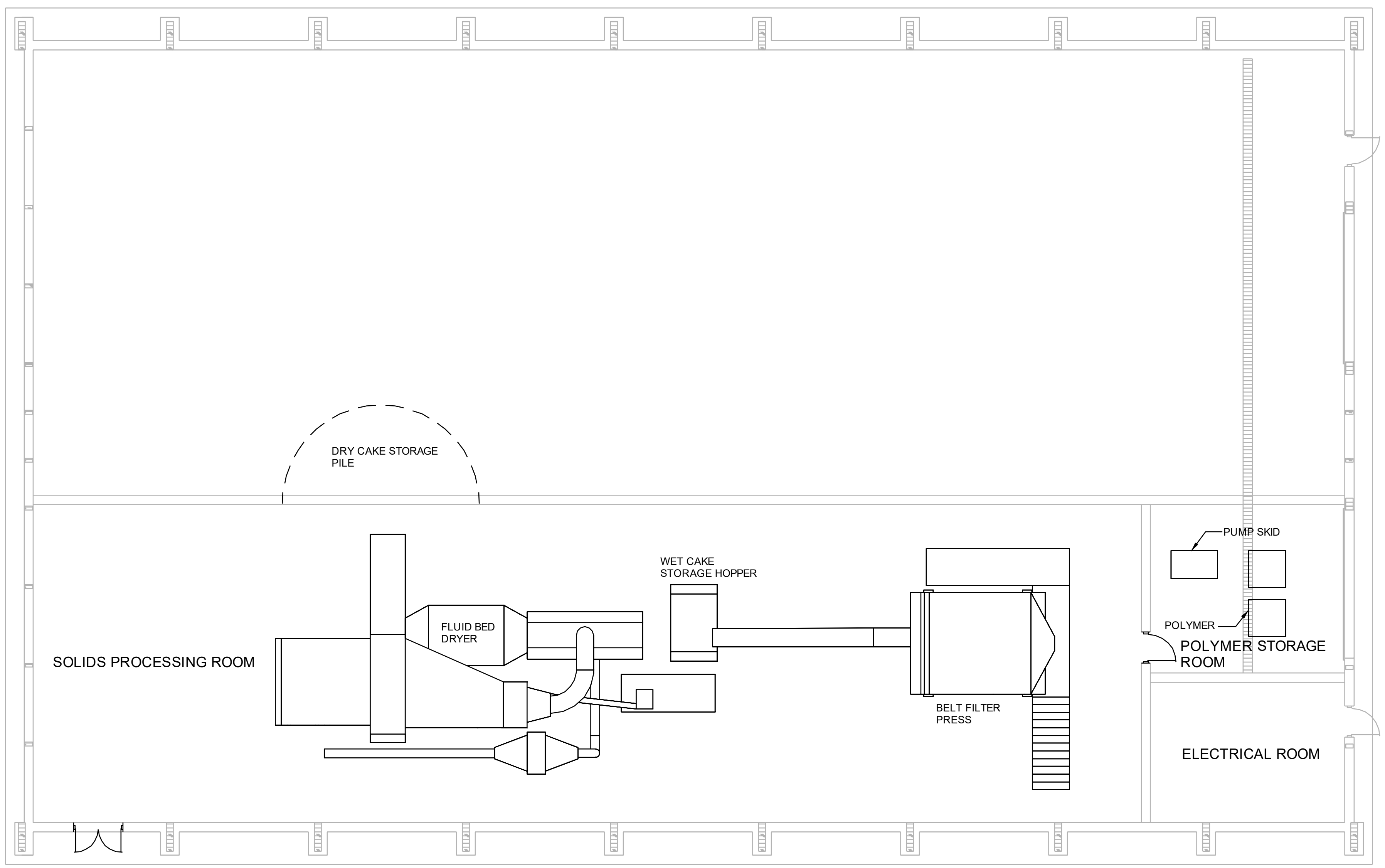
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
80-H-BFP

DONOHUE

Sheet No. 15

Drawing No.



GRADE PLAN

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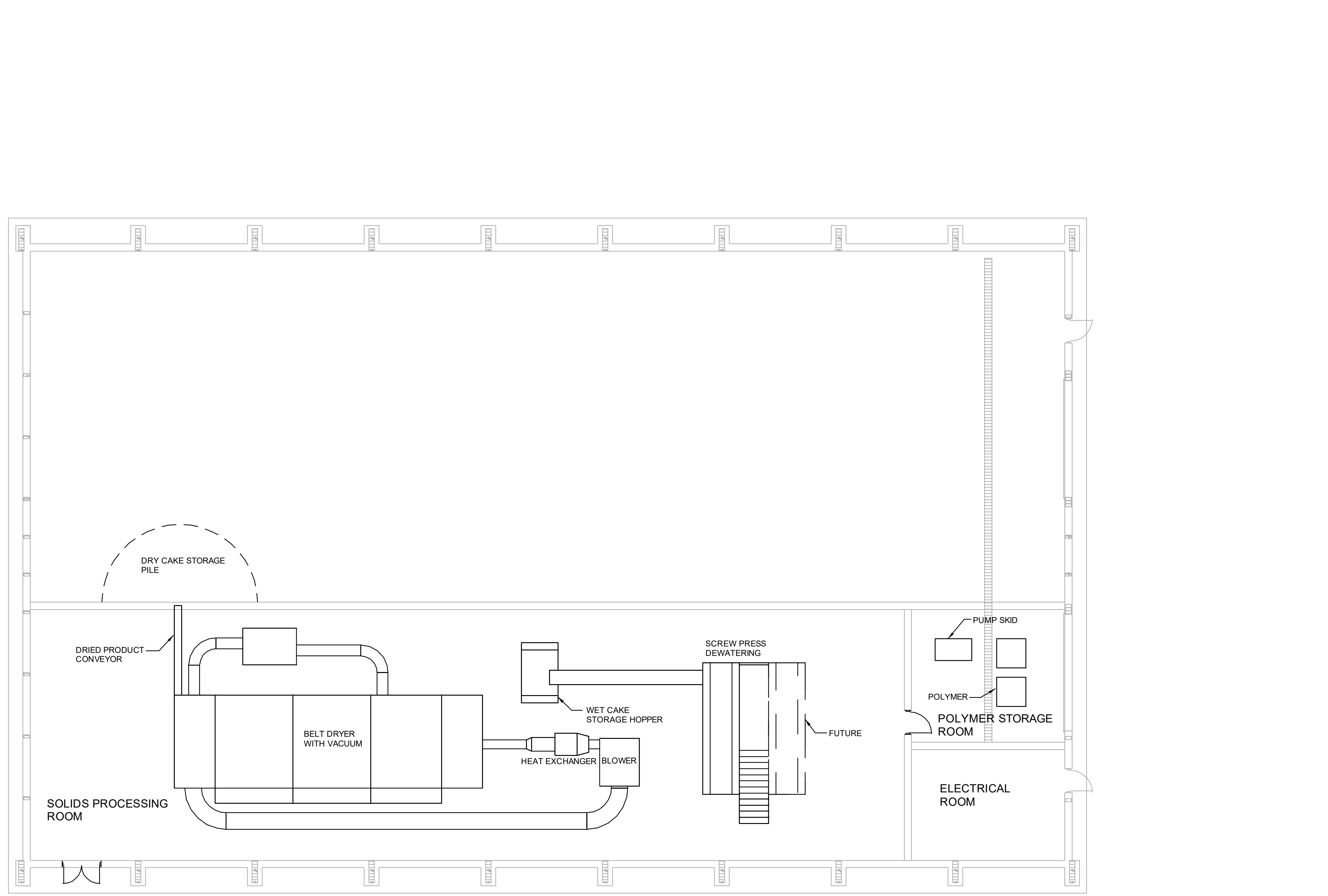
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
80-S-BFP

DONOHUE

Sheet No. 16

Drawing No.



GRADE PLAN

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Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	SAM
Drawn By	SAM
Checked By	EJL
Approved By	EJL
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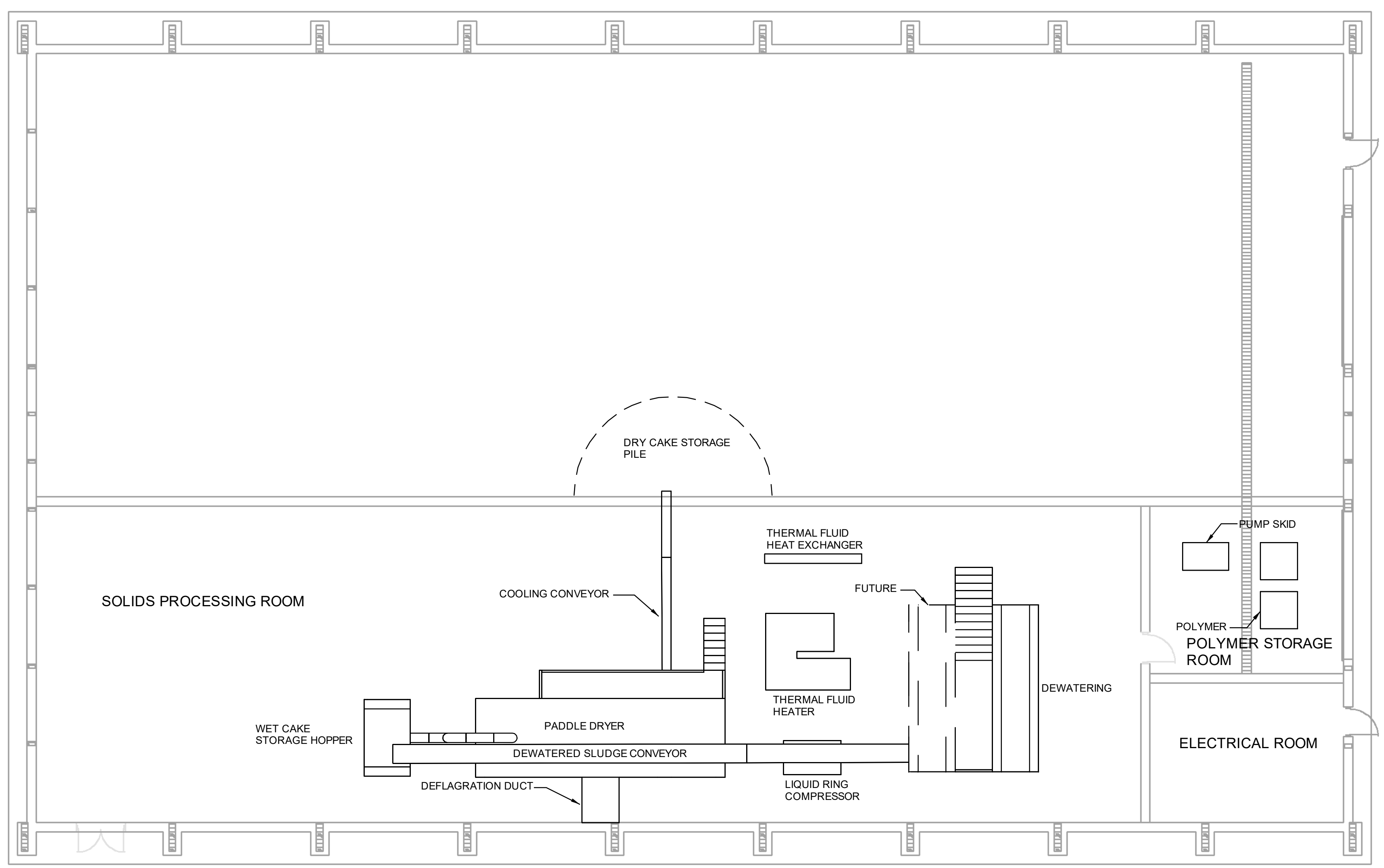
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS STORAGE BUILDING
80-G-SP

DONOHUE

Sheet No. 17

Drawing No.



GRADE PLAN

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Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	SAM
Drawn By	SAM
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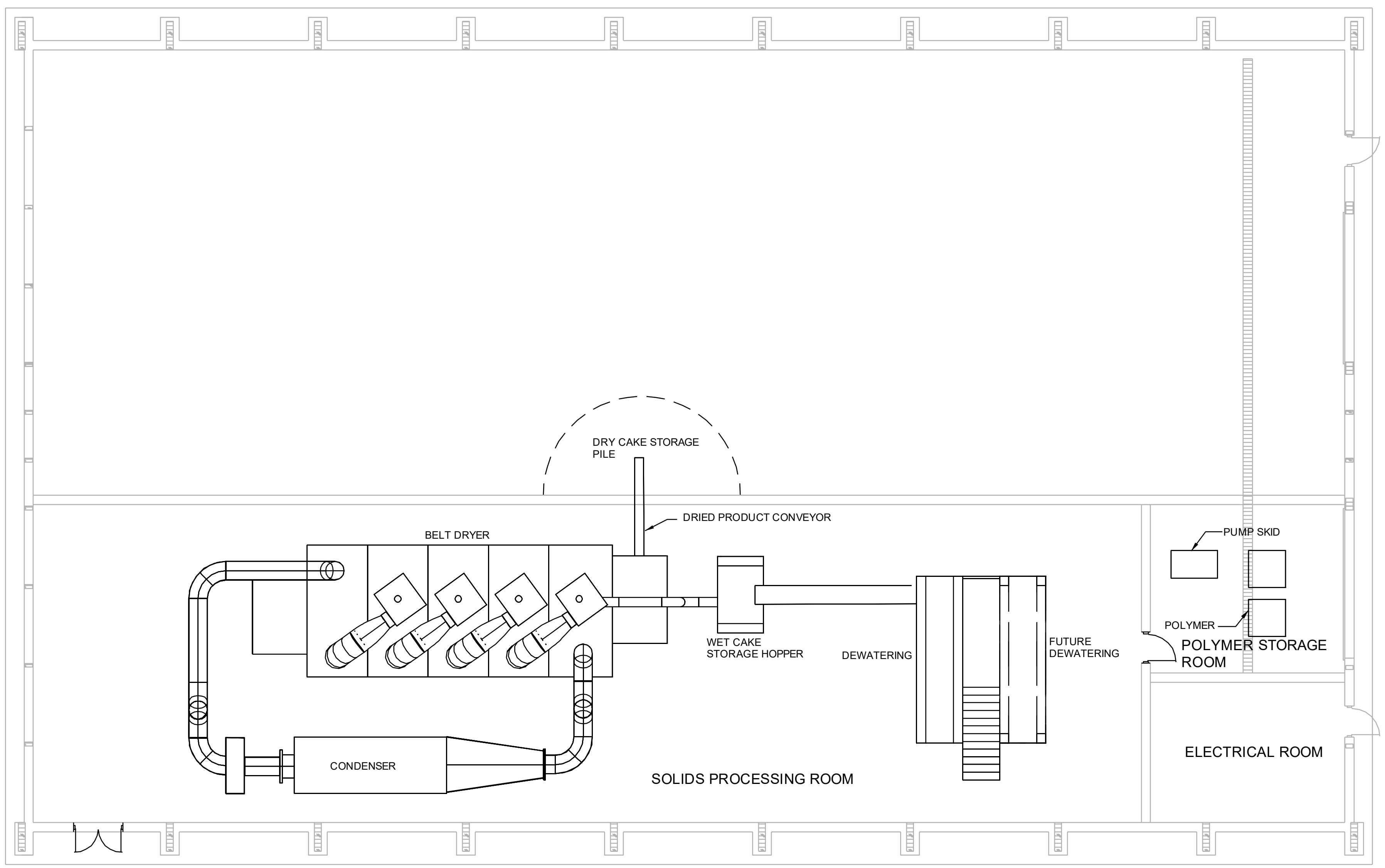
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
80-K-SP

DONOHUE

Sheet No. 18

Drawing No.



GRADE PLAN

0 1' 8'

Revision Number	Revision Description	Drawn By	Checked By	Date

Designed By	SAM
Drawn By	SAM
Checked By	EJL
Approved By	EJL
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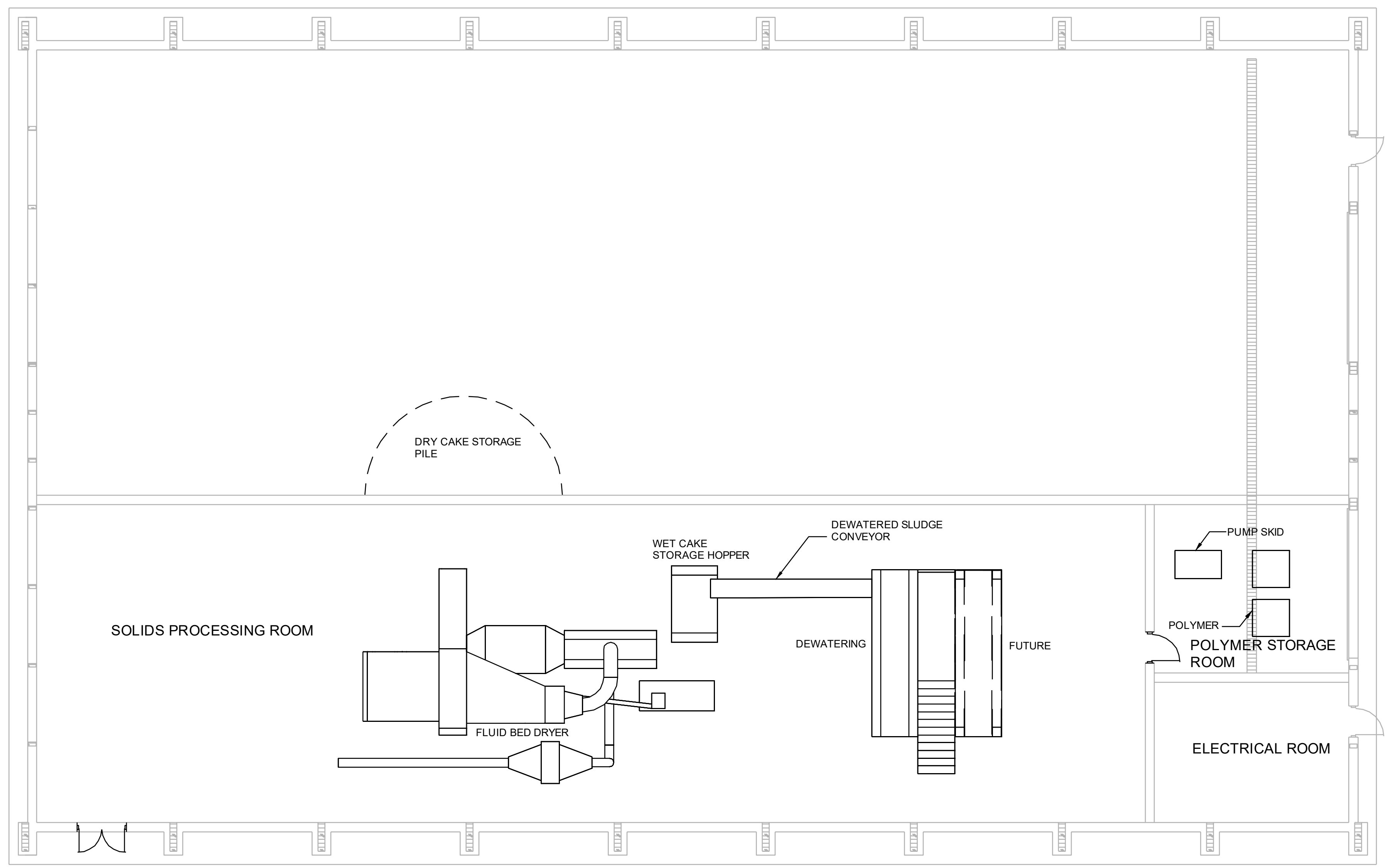
CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
80-H-SP

DONOHUE

Sheet No. 19

Drawing No.



GRADE PLAN

0 1' 8'

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Designed By	SAM
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CITY OF KIEL
WASTEWATER TREATMENT FACILITY
SLUDGE DRYER IMPROVEMENTS
KIEL, WI

SOLIDS HANDLING BUILDING
80-S-SP

DONOHUE

Sheet No. 20

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 third quarter of 2017, 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: .... $55.00/Hour (includes fringe benefits)
- 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 3-7/8%.

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 & Class A Process (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) Integrated Film Activated Sludge (IFAS)
3) Membrane Bio-Reactor (MBR)

A diagram of each activated sludge alternative is shown on Figure VII-1, Figure VII-2 and Figure VII-3. The detailed description of each alternative was previously noted in Chapter VI.

b. Analysis:

Table VII-1, Table VII-2 and Table VII-3 contain the Present Worth Analysis of each of the alternatives. The potential capital construction costs are summarized as follows:

Option #1 - Expand Existing System $17,470,960
Option #2 - IFAS $19,463,568
Option #3 - MBR $15,895,653

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

Option #1 - Expand Existing System $17,773,184
Option #2 - IFAS $19,786,887
Option #3 - MBR $16,036,521

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 $878,701
Option #2 - IFAS $957,567
Option #3 - MBR $911,153

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

Option #1 - Expand Existing Facilities $12,075,110
Option #2 - IFAS $13,158,886
Option #3 - MBR $12,521,065

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

<u>Total Present Worth</u>
Option #1 - Expand Existing Facilities $29,848,294
Option #2 - IFAS $32,945,774
Option #3 - MBR $28,557,586

The Capital Cost of Options #1 and #2 are 10% and 22% higher than the Capital Cost of Option #3.

The Total Present Worth of Options #1 and #2 are 5% and 15% higher than the Total Present Worth of Option #3.

c. **Conclusions:**

1) From a Capital Cost basis and a Total Present Worth basis, the MBR system (Option #3) is the most cost effective option.

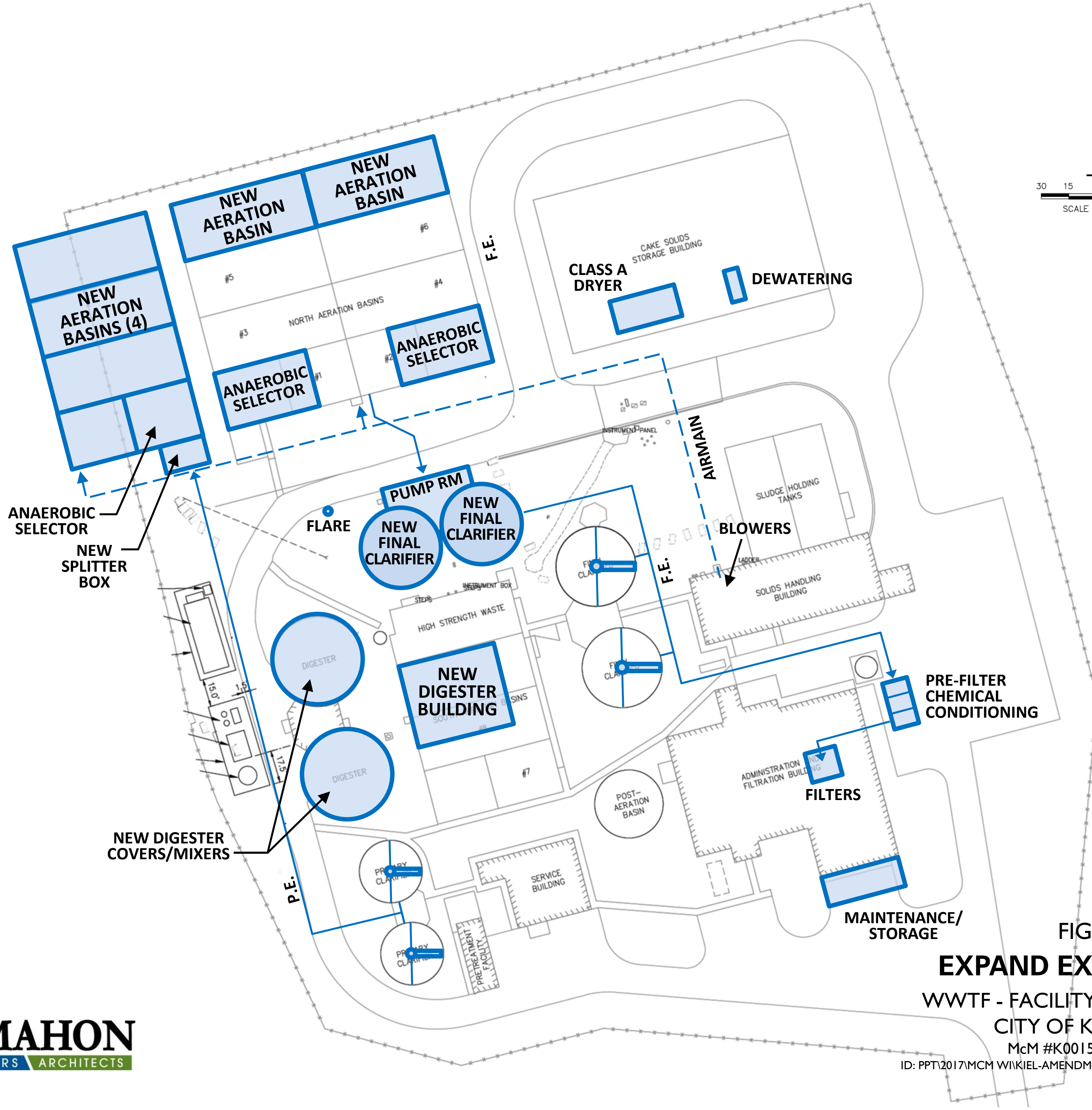

FIGURE VII-1

EXPAND EXISTING SYSTEM

WWTF - FACILITY PLAN AMENDMENT #2

CITY OF KIEL, WISCONSIN

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McMAHON ENGINEERS ARCHITECTS

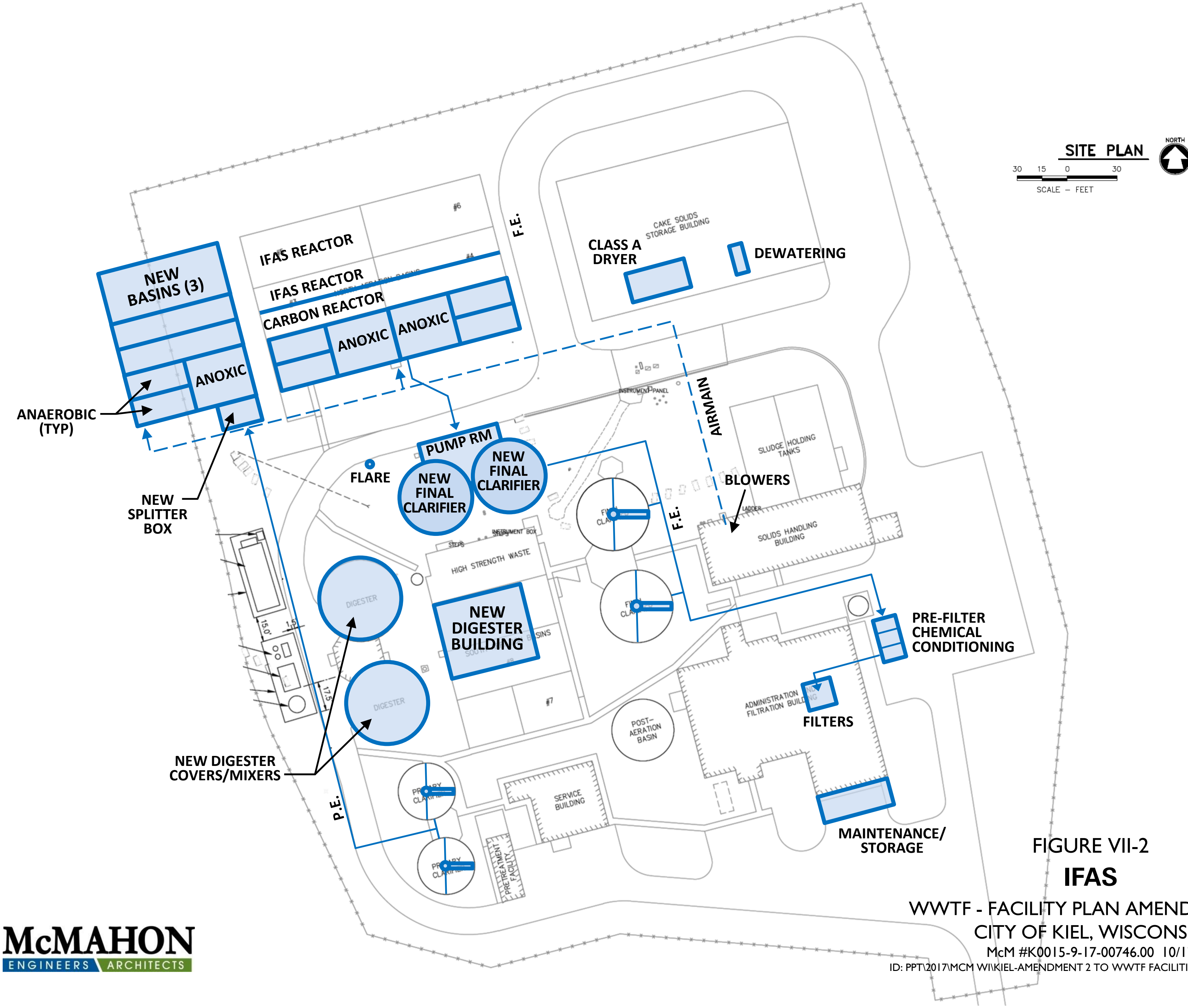

FIGURE VII-2

IFAS

WWTF - FACILITY PLAN AMENDMENT #2

CITY OF KIEL, WISCONSIN

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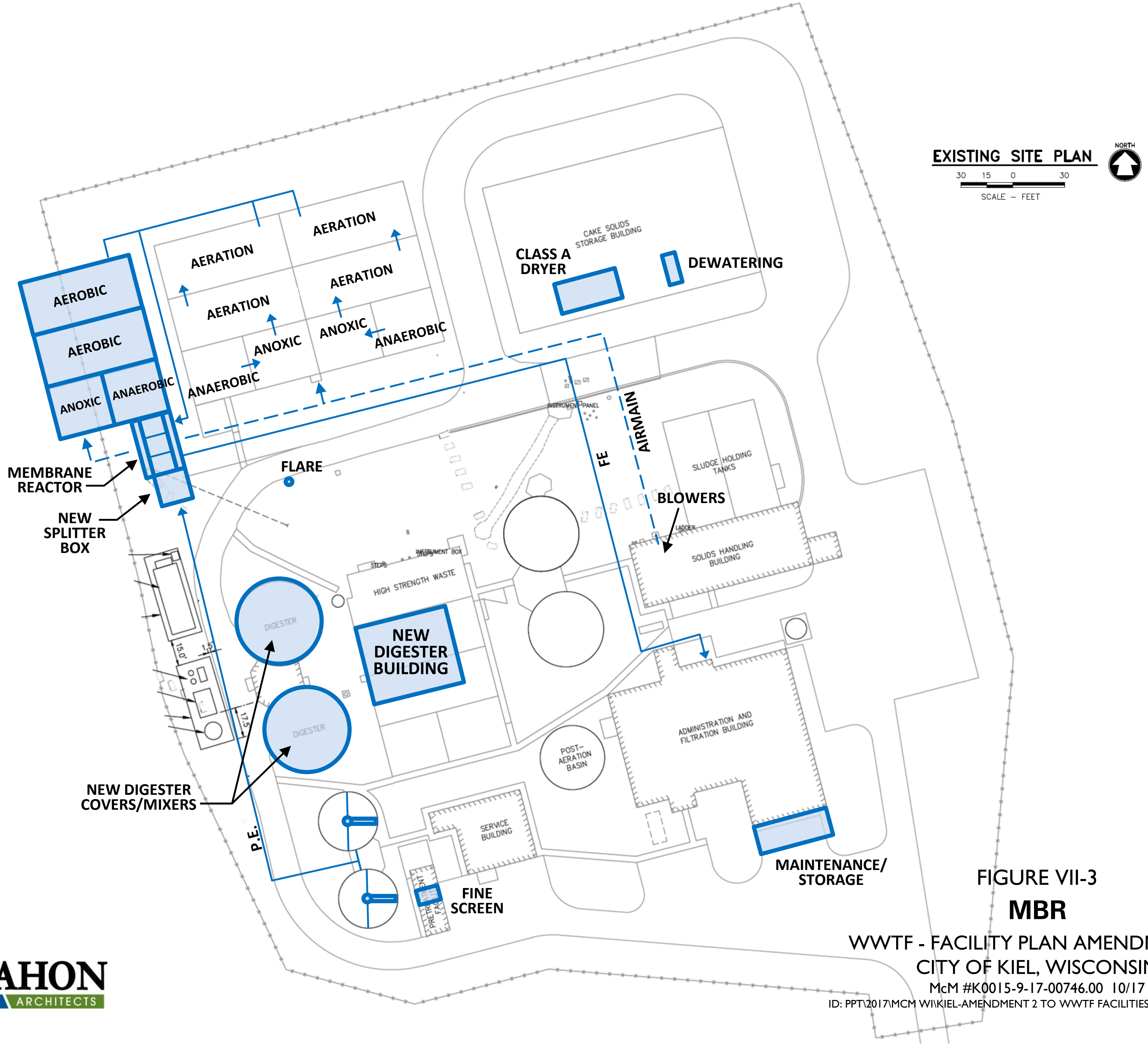

FIGURE VII-3

MBR

WWTF - FACILITY PLAN AMENDMENT #2

CITY OF KIEL, WISCONSIN

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Table VII-1
OPTION #1 - Expand
CITY OF KIEL
Wastewater Treatment System - Facilities Plan

Capital Construction Costs Item		Service Life	Replacement Cost	Salvage Value
Miscellaneous				
▪ Mechanical and Structural Demolition	$52,000	--	--	--
▪ Dewatering	$10,000	--	--	--
▪ Tank Cleaning (Primary/Secondary Clarifiers, Aeration Basins, Digesters)	$120,000	--	--	--
▪ Miscellaneous Metals/Grating/Railing/Hatches	$100,000	40	$0	$0
▪ Painting (Digesters, Digester Bldg., Filter Building)	$230,000	20	$0	$0
Miscellaneous Subtotal	**$512,000**			
Site Work				
▪ Underground Piping (20" PE/FE/MLSS, 14" AB, 8" RAS, 6" WAS)	$338,000	40	$0	$169,000
▪ Airmain (28"/24"/18")	$208,000	40	$0	$104,000
▪ Relocate Flare	$10,000	--	--	--
▪ Grading and Landscaping	$50,000	--	--	--
▪ Fencing	$17,000	40	$0	$8,500
▪ Paving	$182,000	20	$0	$0
Site Work Subtotal	**$805,000**			
Structures				
▪ Primary Clarifier Crack Injection	$30,000	20	$0	$0
▪ Aeration Basins (65' x 32' x 14' SWD x 6)	$1,195,000	40	$0	$597,500
▪ Pump Room/ Secondary Clarifiers (2 x 40' Dia)	$380,000	40	$0	$190,000
▪ Aeration Splitter Box	$28,000	40	$0	$14,000
▪ Final Clarifier Splitter Box	$28,000	40	$0	$14,000
▪ Filter Floc/Coagulation Tank	$211,000	40	$0	$105,500
▪ Chlor/Dechlor Gas Room Modifications	$10,000	40	$0	$5,000
▪ Digester Building	$420,000	40	$0	$210,000
▪ Admin. Bldg. Maintenance Addition	$175,000	40	$0	$87,500
Structures Subtotal	**$2,477,000**			
Equipment				
▪ Pri. Clarifier Drives, Mechanisms, Weirs, Baffles (2)	$201,000	20	$0	$0
▪ Primary Sludge Pumps (3)	$75,000	10	$75,000	$0
▪ Aeration Basin Gates	$50,000	40	$0	$25,000
▪ Aeration Splitter Box Gates	$31,000	40	$0	$15,500
▪ Aeration System (3 Trains)	$248,000	20	$0	$0
▪ Blowers	$633,000	20	$0	$0
▪ Sec. Clarifier Drives, Mechanisms, Weirs, Baffles (Typ 4)	$540,000	20	$0	$0
▪ Sec. Clarifier Launder Covers (4)	$80,000	20	$0	$0
▪ Sec. Clarifier Splitter Box Gates	$23,000	40	$0	$11,500
▪ RAS Pumps (6)	$150,000	10	$150,000	$0
▪ WAS Pumps (2)	$50,000	10	$50,000	$0
▪ Scum Pump (2)	$26,000	10	$26,000	$0
▪ Disc Filters & Chem Feed	$1,050,000	20	$0	$0
▪ Digester Mixers and Covers (2)	$684,000	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)	$341,000	20	$0	$0
Equipment Subtotal	**$4,282,000**			
Equiment Installation (20% of Equipment)	$856,400	--	$80,200	$0
Mechanical (Process Piping, Plumbing, HVAC) (30% Equip.)	$1,284,600	40	$0	$642,300
Electrical Infrastructure Improvements	$533,000	40	$0	$266,500
Process Electrical	$1,061,000	20	$0	$0
Controls and SCADA	$749,000	10	$749,000	$0
Subtotal	$12,560,000	--	$1,230,200	$2,465,800
General Conditions, Bonds, Insurance (7% Subtotal)	$879,200	--	--	--
Total	$13,439,200	--	$1,230,200	$2,465,800
Contingencies (15% of Total)	$2,015,880	--	--	--
Engineering (15% of Total)	$2,015,880	--	--	--
Grand Total	$17,470,960	--	$1,230,200	$2,465,800
Present Worth of Total	$17,773,184	--	$841,134	$538,910

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

i = 3.875 %
n = 10 (Replacement)
n = 40 (Salvage)

$(1 + i)^{-n}$ = 0.683737866 (Replacement)
$(1 + i)^{-n}$ = 0.218553884 (Salvage)

Operation and Maintenance Costs	
Labor/Maintenance	$56,900
Power	$351,536
Chemical	$110,577
Replacement (5% Equipment + Installation)	$256,920
Parts & Supplies (2% Equipment + Installation)	$102,768
Total Annual O&M	$878,701
O&M Present Worth	$12,075,110
Capital Present Worth	$17,773,184
Total Present Worth	**$29,848,294**

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

i= 3.875%
n= 20

$$\frac{(1+i)^n-1}{ix(1+i)^n}$$ **13.74200079**

Table VII-2
OPTION #2 - IFAS
CITY OF KIEL
Wastewater Treatment System - Facilities Plan

Capital Construction Costs Item		Service Life	Replacement Cost	Salvage Value
Miscellaneous				
▪ Mechanical and Structural Demolition	$52,000	--	--	--
▪ Tank Cleaning (Primary/Secondary Clarifiers, Aeration Basins, Digesters)	$120,000	--	--	--
▪ Miscellaneous Metals/Grating/Railing/Hatches	$68,000	40		
▪ Painting (Digesters, Digester Bldg., Filter Building)	$230,000	20	$0	$0
▪ Dewatering	$10,000	--	$0	$0
Miscellaneous Subtotal	**$480,000**			
Site Work				
▪ Underground Piping (20" PE/FE/MLSS, 14" AB, 8" RAS, 6" WAS)	$290,000	40	$0	$145,000
▪ Airmain (24"/20"/14")	$170,000	40	$0	$85,000
▪ Relocate Flare	$10,000	--	--	--
▪ Grading and Landscaping	$40,000	--	--	--
▪ Fencing	$8,000	40	$0	$4,000
▪ Paving	$179,000	20	$0	$0
Site Work Subtotal	**$697,000**			
Structures				
▪ Primary Clarifier Crack Injection	$30,000	20	$0	$0
▪ Aeration Basins (65' x 32' x 14' SWD x 3)	$588,000	40	$0	$294,000
▪ Pump Room/ Secondary Clarifiers (2 x 40' Dia)	$380,000	40	$0	$190,000
▪ Aeration Splitter Box	$28,000	40	$0	$14,000
▪ Final Clarifier Splitter Box	$28,000	40	$0	$14,000
▪ Filter Floc/Coagulation Tank	$211,000	40	$0	$105,500
▪ Chlor/Dechlor Gas Room Modifications	$10,000	40	$0	$5,000
▪ Digester Building	$420,000	40	$0	$210,000
▪ Admin. Bldg. Maintenance Addition	$175,000	40	$0	$87,500
Structures Subtotal	**$1,870,000**			
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	$31,000	40	$0	$15,500
▪ Aeration Basin Gates	$22,000	40	$0	$11,000
▪ IFAS System	$1,996,000	20	$0	$0
▪ Blowers	$390,000	20	$0	$0
▪ Sec. Clarifier Drives, Mechanisms, Weirs, Baffles (Typ 4)	$540,000	20	$0	$0
▪ Sec. Clarifier Launder Covers (4)	$80,000	20	$0	$0
▪ Sec. Clarifier Splitter Box Gates	$23,000	40	$0	$11,500
▪ RAS Pumps (6)	$150,000	10	$150,000	$0
▪ WAS Pumps (2)	$50,000	10	$50,000	$0
▪ Scum Pump (2)	$26,000	10	$26,000	$0
▪ Disc Filters & Chem Feed	$1,050,000	20	$0	$0
▪ Digester Mixers and Covers (2)	$684,000	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)	$341,000	20	$0	$0
Equipment Subtotal	**$5,759,000**			
Equipment Installation (20% of Equipment)	$1,151,800	--	$80,200	$0
Mechanical (Process Piping, Plumbing, HVAC) (30% Equip.)	$1,727,700	40	$0	$863,850
Electrical Infrastructure Improvements	$533,000	40	$0	$266,500
Process Electrical	$1,040,000	20	$0	$0
Controls and SCADA	$734,000	10	$734,000	$0
Subtotal	$13,992,500	--	$1,215,200	$2,322,350
General Conditions, Bonds, Insurance (7% Subtotal)	$979,475	--	--	--
Total	$14,971,975	--	$1,215,200	$2,322,350
Contingencies (15% of Total)	$2,245,796	--	--	--
Engineering (15% of Total)	$2,245,796	--	--	--
Grand Total	$19,463,568		$1,215,200	$2,322,350
Present Worth of Total	**$19,786,887**		$830,878.25	$507,558.61

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

i = 3.875 %
n = 10 (Replacement)
n = 40 (Salvage)

$(1 + i)^{-n}$ = 0.683737866 (Replacement)
$(1 + i)^{-n}$ = 0.218553884 (Salvage)

Operation and Maintenance Costs	
Labor/Maintenance	$56,900
Power	$306,334
Chemical	$110,577
Replacement (5% Equipment + Installation)	$345,540
Parts & Supplies (2% Equipment + Installation)	$138,216
Total Annual O&M	$957,567
O&M Present Worth	$13,158,886
Capital Present Worth	$19,786,887
Total Present Worth	**$32,945,774**

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

i= 3.875%
n= 20

$$\frac{(1+i)^n-1}{ix(1+i)^n} = 13.74200079$$

Table VII-3

OPTION #3 - MBR

CITY OF KIEL

Wastewater Treatment System - Facilities Plan

Capital Construction Costs **Item**		**Service Life**	**Replacement Cost**	**Salvage Value**
Miscellaneous				
▪ Mechanical and Structural Demolition	$52,000	--	--	--
▪ Dewatering	$10,000	--	$0	$0
▪ Tank Cleaning (Primary Clarifiers, Aeration Basins, Digesters)	$100,000	--	--	--
▪ Miscellaneous Metals/Grating/Railing/Hatches	$36,000	40		
▪ Painting (Digesters, Digester Bldg., MBR Bldg.)	$220,000	20	$0	$0
Miscellaneous Subtotal	**$418,000**			
Site Work				
▪ Underground Piping (20" PE/FE, 18"/24"/30"MLSS, 14" AB)	$221,000	40	$0	$110,500
▪ Airmain (24"/20"/14")	$170,000	40	$0	$85,000
▪ Relocate Flare	$10,000	--	--	--
▪ Grading and Landscaping	$40,000	--	--	--
▪ Fencing	$8,000	40	$0	$4,000
▪ Paving	$203,000	20	$0	$0
Site Work Subtotal	**$652,000**			
Structures				
▪ Primary Clarifier Crack Injection	$30,000	20	$0	$0
▪ Aeration Basins (65' x 32' x 14' SWD x 3)	$588,000	40	$0	$294,000
▪ MBR Basins/Pump Room/Building	$315,000	40	$0	$157,500
▪ Aeration Splitter Box	$28,000	40	$0	$14,000
▪ Chlor/Dechlor Gas Room Modifications	$10,000	40	$0	$5,000
▪ Digester Building	$420,000	40	$0	$210,000
▪ Admin. Bldg. Maintenance Addition	$175,000	40	$0	$87,500
Structures Subtotal	**$1,566,000**			
Equipment				
▪ 2mm Fine Screens/6mm Fine Screens (5MGD)	$516,000	20	$0	$0
▪ 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	$35,000	40	$0	$17,500
▪ Aeration Basin/MBR Gates	$41,000	40	$0	$20,500
▪ MBR System	$2,000,000	20	$0	$0
▪ RAS Pumps (5)	$75,000	20	$0	$0
▪ WAS Pumps (2)	$20,000	20	$0	$0
▪ Blowers	$390,000	20	$0	$0
▪ Digester Mixers and Covers (2)	$684,000	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)	$341,000	20	$0	$0
▪ Bridge Crane	$35,000	40	$0	$0
Equipment Subtotal	**$4,513,000**			
Equipment Installation (20% of Equipment)	$902,600	--	$35,000	$0
Mechanical (Process Piping, Plumbing, HVAC) (30% Equip.)	$1,353,900	40	$0	$676,950
Electrical Infrastructure Improvements	$533,000	40	$0	$266,500
Process Electrical	$870,000	20	$0	$0
Controls and SCADA	$619,000	10	$619,000	$0
Subtotal	$11,427,500	--	$829,000	$1,948,950
General Conditions, Bonds, Insurance (7% Subtotal)	$799,925	--	--	--
Total	$12,227,425	--	$829,000	$1,948,950
Contingencies (15% of Total)	$1,834,114	--	--	--
Engineering (15% of Total)	$1,834,114	--	--	--
Grand Total	$15,895,653		$829,000	$1,948,950
Present Worth of Total	**$16,036,521**		$566,818.69	$425,950.59

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

i = 3.875 %

n = 10 (Replacement)

n = 40 (Salvage)

$(1 + i)^{-n}$ = 0.683737866 (Replacement)

$(1 + i)^{-n}$ = 0.218553884 (Salvage)

Operation and Maintenance Costs	
Labor/Maintenance	$56,900
Power	$310,188
Chemical	$99,453
Replacement (5% Equipment + Installation)	$270,780
Membrane Replacement	$65,520
Parts & Supplies (2% Equipment + Installation)	$108,312
Total Annual O&M	$911,153
O&M Present Worth	$12,521,065
Capital Present Worth	$16,036,521
Total Present Worth	**$28,557,586**

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

i= 3.875%

n= 20

$\frac{(1+i)^n-1}{\quad}$ 13.74200079

- Chapter IX -
RECOMMENDED PLAN

A. INTRODUCTION

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

- Upgrading and expanding the existing activated sludge process with Membrane Bioreactor (MBR) technology;
- 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);
- 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

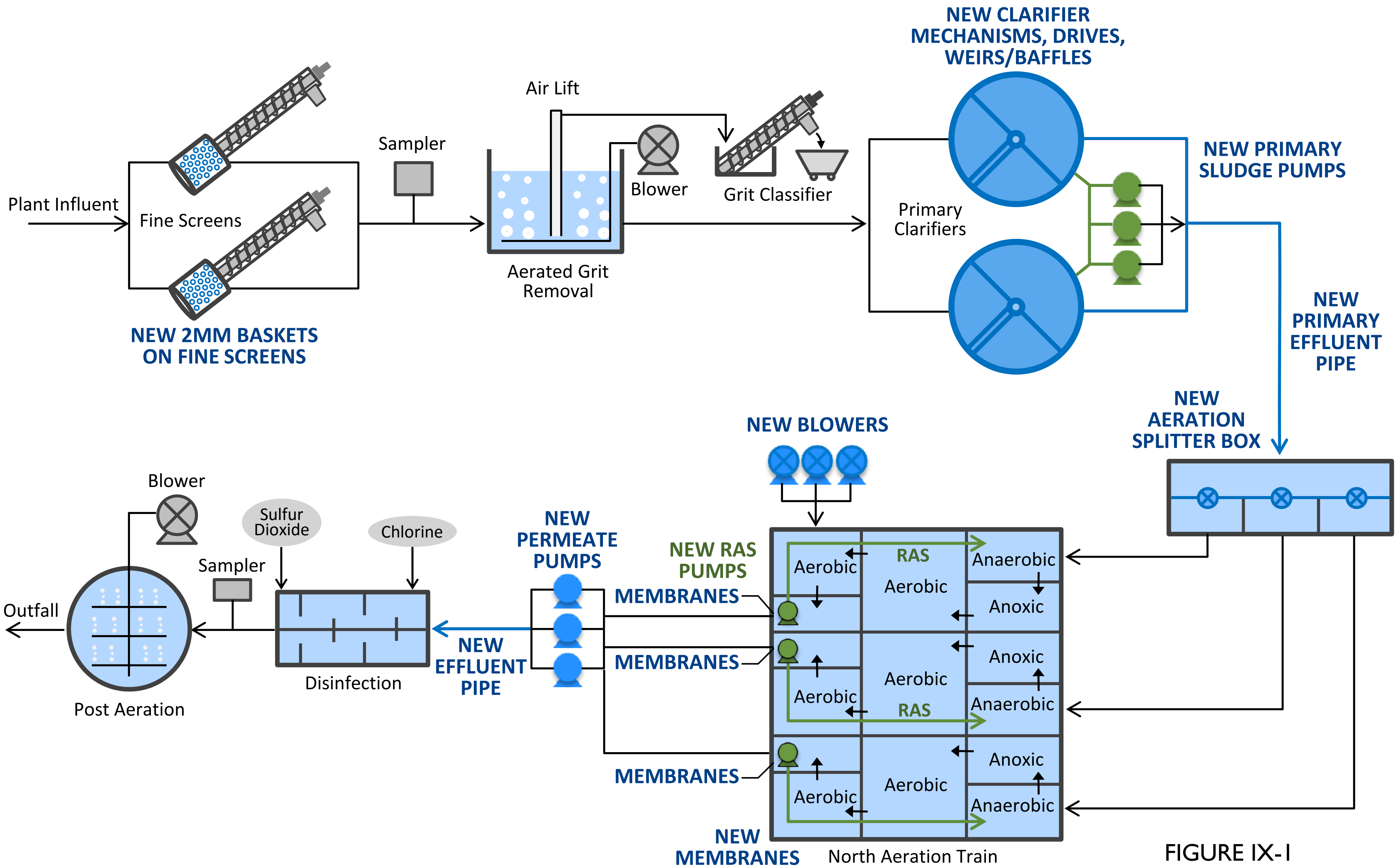

FIGURE IX-1

LIQUID TRAIN

WWTF - FACILITY PLAN AMENDMENT #2

CITY OF KIEL, WISCONSIN

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ENGINEERS ARCHITECTS

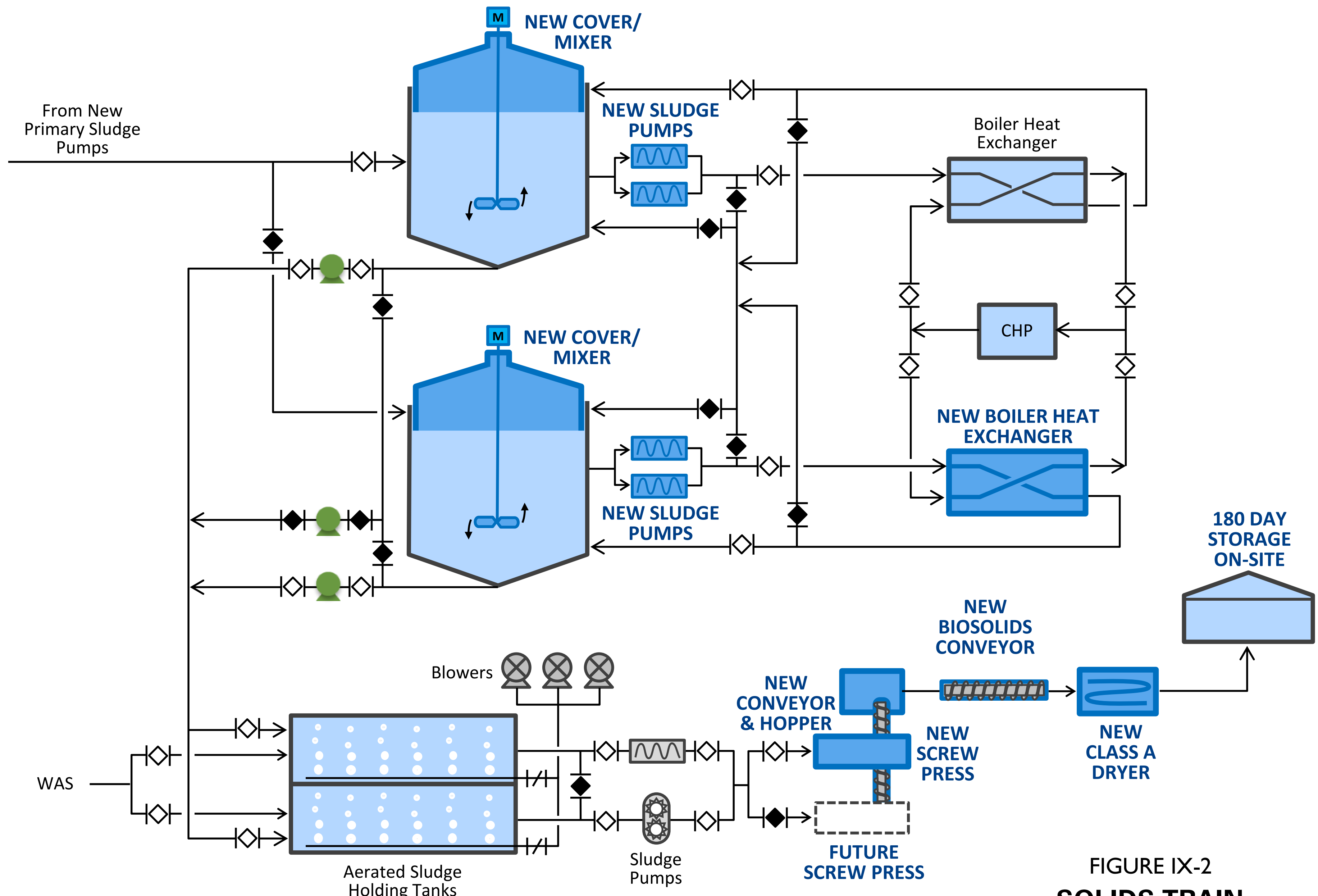

FIGURE IX-2

SOLIDS TRAIN

WWTF - FACILITY PLAN AMENDMENT #2

CITY OF KIEL, WISCONSIN

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ENGINEERS ARCHITECTS

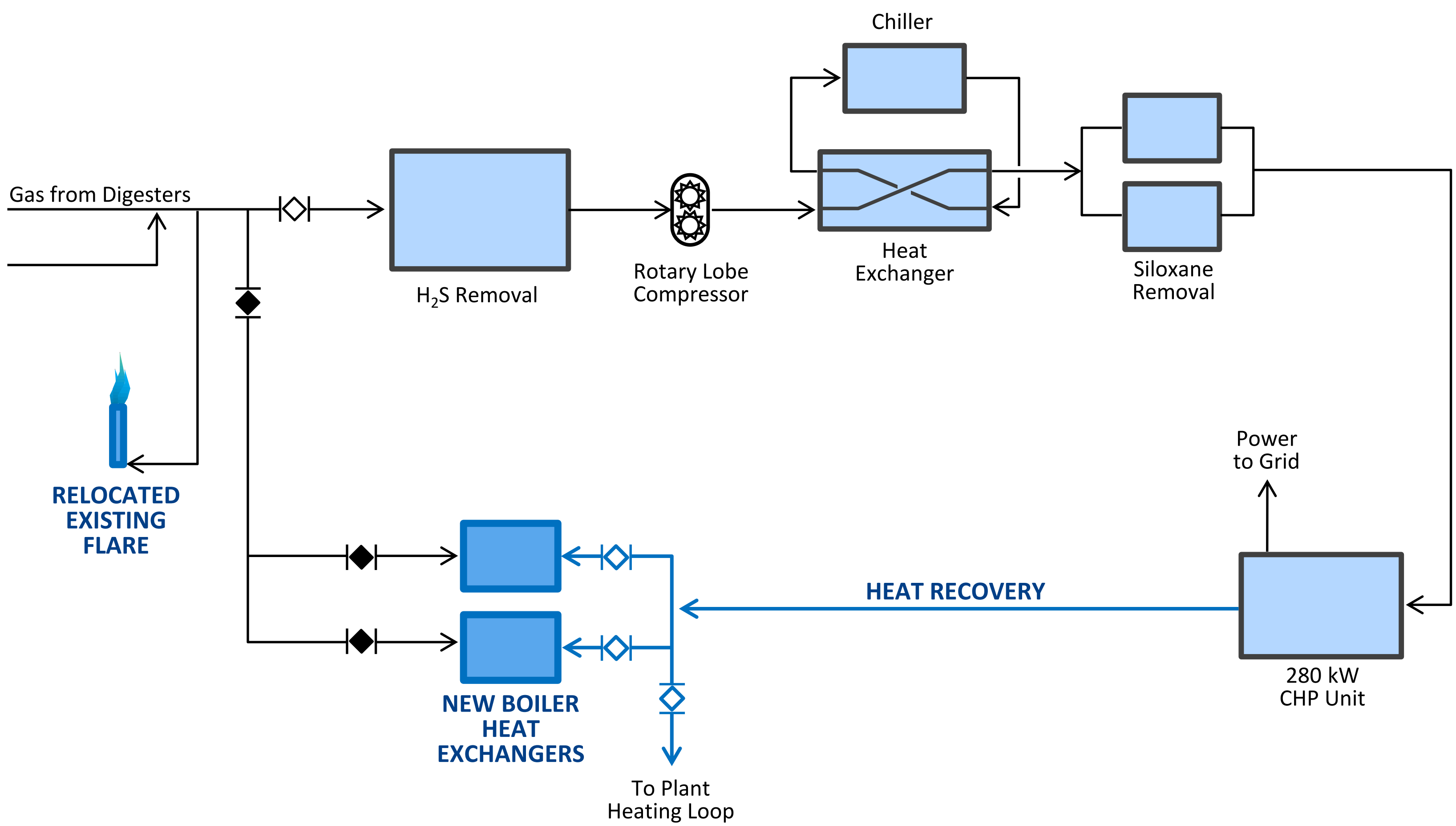

FIGURE IX-3

BIOGAS SCHEMATIC

WWTF - FACILITY PLAN AMENDMENT #2

CITY OF KIEL, WISCONSIN

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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	5.0
▪ Clear Opening, mm	2
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 Settling Rate, gpd/sq.ft.	
▪ Average Flow, 1.43 mgd	2@1,161
▪ Peak Hour Flow, 5.00 mgd	2@4,060
▪ Weir Overflow Rate, gpd/ft.	
▪ Average Flow, 1.43 mgd	2@4,847
▪ Detention Time, hours	
▪ Average Flow, 1.43 mgd	2@1.9
▪ Maximum Day Flow, 3.86 mgd	2@0.7
▪ Removal Efficiencies	
▪ BOD, %	21
▪ SS, %	50
▪ TKN	10
▪ Primary Sludge, lbs./day	
▪ Average Day	2,837
▪ Maximum 30-Day	4,255

<u>**Table IX-1**</u>

RECOMMENDED PLAN
WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
PRIMARY CLARIFIERS (continued)	
▪ Volatile Sludge, lbs./day	
▪ Average Day (78% VSS)	2,213
▪ Maximum 30-Day (78% VSS)	3,319
▪ Primary Sludge, gpd @ x% solids	3
▪ Average Day	11,339
▪ Maximum 30-Day	17,006
SECONDARY TREATMENT SYSTEM	
▪ Design Loadings To Secondary, lbs./day (including recycle streams)	
▪ Biochemical Oxygen Demand (BOD)	
▫ Average Day	10,908
▫ Maximum Day	25,670
▫ Maximum 30-Day	13,010
▪ Total Kjeldahl Nitrogen (TKN), lbs./day	
▫ Average Day	649
▫ Maximum Day	1,456
▫ Maximum 30-Day	1,022
▪ Phosphorus (P), lbs./day	
▫ Average Day	302
▫ Maximum Day	810
▫ Maximum 30-Day	358
▪ Number Of Parallel Trains	3
▪ Number Of Tanks, size, ft./train	3@65x32
▪ SWD, ft.	14
▪ Total Tank Volume, cu.ft.	349,440
▪ Anaerobic Reactor, ft.	3@30x32
▪ Anaerobic Volume, cu.ft.	40,320
▪ Anoxic Reactor, ft.	3@34x32
▪ Anoxic Volume, cf	45,696
▪ Aerobic Reactors, ft.	6@65x32
▪ Aerobic Volume, cu.ft.	174,720
▪ BOD Loading, lbs./1,000 cu.ft.	
▪ Average Day	62.4
▪ Maximum 30-Day	74.5
▪ Design MLSS, mg/L	
▪ Average @ 10°C x 2-trains	9,900
▪ Maximum Month @ 10°C x 2-trains	11,000
▪ Design Sludge Retention Time (SRT), Days	
▪ Average	18
▪ Volatile Solids, %	75%
▪ Total Sludge Production, lbs. SS/lb. BOD	0.67
▪ Secondary Sludge, lbs./day	
▪ Average	5,715
▪ Maximum 30-Day	7,350
▪ WAS To Dewatering, gpd @ 1.25%	
▪ Average	55,700
▪ Maximum Month	64,800

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	19,347
▪ Maximum Day	45,203
▪ Maximum Month	24,216
▪ Air Requirements, scfm	
▪ Average Day	4,390
▪ Maximum Day	8,983
▪ Maximum Month	5,813
▪ Blowers	
▪ Number Of New PD Blowers (2-Duty + 1 Standby)	3
▪ Capacity, each new unit, scfm	4,492
▪ Discharge Pressure, psig	8.25
▪ Firm Capacity, scfm	8,984
DISINFECTION	
Number Of Tanks	2
Total Volume, gallons	60,250
Detention Time, minutes	
▪ Average Flow, 1.43 mgd	60.7
▪ Peak Hour Flow, 5.00 mgd	17.3
ANAEROBIC DIGESTION	
▪ Number Of Digesters	
▪ Primary	2
▪ Secondary	0
▪ Diameter, feet	2@45
▪ Maximum SWD, feet	
▪ North Digester	21
▪ South Digester	21
▪ Maximum Volume, gallons	
▪ North Digester	269,639
▪ South Digesters	267,657
Total	537,296
▪ Mixing System	Linear Motion
▪ Cover Type	
▪ North Digester	Gas Holder
▪ South Digester	Gas Holder
▪ Maximum Month HRT, days	
▪ North Digester	15.8
▪ South Digester	15.7
Total	31.5
▪ Maximum Month VSS Loading, lbs. VSS/KCF	46.2
▪ VSS Destruction, %	50
▪ Heat Exchanger Capacity, gpd	41,000

Table IX-1

RECOMMENDED PLAN
WASTEWATER TREATMENT FACILITY DESIGN CRITERIA

Design Year	Proposed Design 2037
ANAEROBIC DIGESTION (continued)	
▪ Sludge To Dewatering, lbs./day	
▪ Average	1,731
▪ Maximum Month	2,595
▪ Anaerobic Sludge To Dewatering, gpd @ 1.8%	
▪ Average	11,339
▪ Maximum Month	17,006
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, avg. gallons/day	1,796
▪ Sludge To Dewatering, lbs./day	
▪ Average	7,746
▪ Maximum Month	10,245
▪ Sludge To Dewatering, gpd @ 2%	
▪ Average	46,439
▪ Maximum Month	61,421
SLUDGE DEWATERING (1)	
▪ Number Of Units	1
▪ Capacity, each	
▪ lbs./hour	726
▪ lbs./day	17,424
▪ Hours Of Operation/Day	24
▪ Average Days Of Operation/Week	4
▪ Cake Solids, %, minimum	17 - 20
CLASS A DRYING PROCESS (Belt Dryer w/Vacuum) (1)	
▪ Number Of Units	1
▪ Minimum % Solids	90
▪ Hours Of Operation/Day	24
▪ Avg. Days Of Operation/Week	4

(1) Data By Donohue & Associates

C. IMPLEMENTATION

Due to the timing of the increased flows and loadings, the Recommended Plan includes a single phase construction.

D. CAPITAL COST

The Opinion Of Probable Construction Costs [2] for the Recommended Plan, including engineering and contingencies, is summarized below. A detailed breakdown of these costs is provided for each train in Table IX-2 and Table IX-3.

1. Liquid Train

Capital Cost	$12,227,425
Engineering @ 15%	1,834,114
Contingencies @ 15%	1,834,114
TOTAL	$15,895,653

2. Solids Train [1]

Capital Cost	$4,227,476
Engineering	620,748
Contingencies	551,776
TOTAL	$5,400,000
GRAND TOTAL	**$21,295,653**

[1] Data Provided by Donohue & Associates

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Table IX-2

RECOMMENDED PLAN - LIQUID TRAIN
Opinion Of Probable Construction Cost (1) (2)

Miscellaneous	
▪ Mechanical and Structural Demolition	$52,000
▪ Dewatering	$10,000
▪ Tank Cleaning (Primary Clarifiers, Aeration Basins, Digesters)	$100,000
▪ Miscellaneous Metals/Grating/Railing/Hatches	$36,000
▪ Painting (Digesters, Digester Bldg., MBR Bldg.)	$220,000
Miscellaneous Subtotal	**$418,000**
Site Work	
▪ Underground Piping (20" PE/FE, 18"/24"/30"MLSS, 14" AB)	$221,000
▪ Air Main (24"/20"/14")	$170,000
▪ Relocate Flare	$10,000
▪ Grading and Landscaping	$40,000
▪ Fencing	$8,000
▪ Paving	$203,000
Site Work Subtotal	**$652,000**
Structures	
▪ Primary Clarifier Crack Injection	$30,000
▪ Aeration Basins (65' x 32' x 14' SWD x 3)	$588,000
▪ MBR Basins/Pump Room/Building	$315,000
▪ Aeration Splitter Box	$28,000
▪ Chlor/Dechlor Gas Room Modifications	$10,000
▪ Digester Building	$420,000
▪ Admin. Bldg. Maintenance Addition	$175,000
Structures Subtotal	**$1,566,000**
Equipment	
▪ 2mm Fine Screens/6mm Fine Screens (5MGD)	$516,000
▪ Pri. Clarifier Drives, Mechanisms, Weirs, Baffles (2)	$201,000
▪ Primary Sludge Pumps (3)	$75,000
▪ Aeration Splitter Box Gates	$35,000
▪ Aeration Basin/MBR Gates	$41,000
▪ MBR System	$2,000,000
▪ RAS Pumps (5)	$75,000
▪ WAS Pumps (2)	$20,000
▪ Blowers	$390,000
▪ Digester Mixers and Covers (2)	$684,000
▪ Digester Recirc Pumps (2)	$50,000
▪ Sludge Transfer Pumps (2)	$50,000
▪ Boiler/Heat Exchanger (2)	$341,000
▪ Bridge Crane	$35,000
Equipment Subtotal	**$4,513,000**
Equipment Installation (20% of Equipment)	$902,600
Mechanical (Process Piping, Plumbing, HVAC) (30% Equip.)	$1,353,900
Electrical Infrastructure Improvements	$533,000
Process Electrical	$870,000
Controls & SCADA	$619,000
Subtotal	**$11,427,500**
General Conditions, Bonds, Insurance (7% Subtotal)	$799,925
TOTAL	**$12,227,425**
Contingencies (15% of Total)	$1,834,114
Engineering (15% of Total)	$1,834,114
GRAND TOTAL	**$15,895,653**

(1) Data Provided by Donohue & Associates

Table IX-3

RECOMMENDED PLAN - SOLIDS TRAIN
Opinion Of Probable Construction Cost (1) (2)

Item	Units	Quantity	Unit Cost	Initial Cost
Architectural / Structural				
Earth Work	Refer to Worksheet For Detailed Cost Breakdown			$9,330
Concrete	Refer to Worksheet For Detailed Cost Breakdown			49,700
Metals	Refer to Worksheet For Detailed Cost Breakdown			6,450
Buildings	Refer to Worksheet For Detailed Cost Breakdown			64,000
Demolition	Refer to Worksheet For Detailed Cost Breakdown			0
Model 2050 or Equivalent	Each	1	$1,307,000	$1,307,000
Installation	Each	1	261,400	261,400
Dried Product Conveyors & Truck Loading	Each	1	100,000	100,000
Dried Product Storage (by Others)	Each	1	0	0
Odor Control System	Each	1	100,000	100,000
Air Compressor	Each	1	40,000	40,000
Structural & Lifting Mod.	Each	1	50,000	50,000
Heat Exchanger	Each	1	45,000	45,000
Screw Press Dewatering 726 lbs./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 & 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				**$2,758,880**
Contingency			20%	551,776
Subtotal				**$3,310,656**
Contractor Overhead & Profit			25%	827,664
TOTAL Construction Cost				**$4,138,320**
Engineering			15%	620,748
Spare Parts				653,500
TOTAL Initial Cost				**$5,400,000**

(2) Data Provided by Donohue & Associates

E. POTENTIAL COST IMPACT

The City Of Kiel has prepared a sewer user rate study. The results are summarized in Appendix IX-1.

F. SCHEDULE

A proposed Implementation Schedule is shown below:

- Submit Facility Plan To Wisconsin DNR .... December 2017
- Public Hearing .... January 2018
- Wisconsin DNR Facility Plan Approval .... January 2018
- Begin Equipment Procurement Process .... January 2018
- Equipment Procurement Bidding .... March 2018
- Award Equipment Contracts .... March 2018
- Submit Drawings & Specifications To DNR .... December 2018
- Bid Phase I - Liquid Train .... January 2019
- Phase I - Construction Start .... May 2019
- Phase I - Completion .... May 2020
- Bid Phase II - Solids Train .... January 2020
- Phase II - Construction Start .... May 2020
- Phase II Completion .... May 2021

(2) 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 2018 to 2027
CITY OF KIEL
Wastewater Treatment Facility - Facility Plan
2019 Sewer Revenue Loan

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Capital Upgrades		$22,500,000								
O&M Expenses	$1,662,652	$2,087,628	$2,073,149	$2,149,152	$2,151,201	$2,230,288	$2,229,949	$2,317,305	$2,345,144	$2,419,119
Revenue Requirement	$2,187,740	$3,984,745	$3,984,745	$4,064,440	$4,064,440	$4,145,729	$4,145,729	$4,228,643	$4,228,643	$4,313,216
Annual Dept Payments	$395,088	$1,560,816	$1,575,295	$1,578,987	$1,576,938	$1,579,140	$1,579,479	$1,575,038	$1,547,199	$1,557,797
Replacement Fund	$130,000	$336,300	$336,300	$336,300	$336,300	$336,300	$336,300	$336,300	$336,300	$336,300
User Rate										
Fixed										
5/8	$15.91	$25.46	$25.46	$25.97	$25.97	$26.48	$26.48	$27.01	$27.01	$27.55
3/4	$15.91	$25.46	$25.46	$25.97	$25.97	$26.48	$26.48	$27.01	$27.01	$27.55
1	$20.45	$32.72	$32.72	$33.37	$33.37	$34.04	$34.04	$34.72	$34.72	$35.42
11/2	$23.37	$37.39	$37.39	$38.14	$38.14	$38.90	$38.90	$39.68	$39.68	$40.47
2	$26.29	$42.06	$42.06	$42.91	$42.91	$43.76	$43.76	$44.64	$44.64	$45.53
3	$35.50	$56.80	$56.80	$57.94	$57.94	$59.09	$59.09	$60.28	$60.28	$61.48
4	$48.20	$77.12	$77.12	$78.66	$78.66	$80.24	$80.24	$81.84	$81.84	$83.48
6	$78.87	$126.19	$126.19	$128.72	$128.72	$131.29	$131.29	$133.92	$133.92	$136.59
Volumetric Rate	$2.45	$3.34	$3.34	$3.41	$3.41	$3.47	$3.47	$3.54	$3.54	$3.61
BOD Rate/lb	$0.33	$0.47	$0.47	$0.47	$0.47	$0.48	$0.48	$0.49	$0.49	$0.50
TSS Rate/lb	$0.55	$0.59	$0.59	$0.60	$0.60	$0.61	$0.61	$0.62	$0.62	$0.63
Phos Rate/lb	$4.74	$8.17	$8.17	$8.33	$8.33	$8.50	$8.50	$8.67	$8.67	$8.84
Single Family Monthly Average with 600 cubic feet usage	$30.64	$45.49	$45.49	$46.40	$46.40	$47.33	$47.33	$48.28	$48.28	$49.24
Percentage Increase for Average Single Family Home		48%	0%	2%	0%	2%	0%	2%	0%	2%