SEWPCC Upgrading/Expansion
Conceptual Design Report

SECTION 14 - Solids Handling

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14.0 Solids Handling

The following sections provide recommendations for solids handling at the proposed SEWPCC expansion/upgrade project. The major solids stream includes primary sludge, waste activated sludge (WAS) and scum. Solids generated via screening and grit removals are discussed in Section 7 - Raw Sewage Pumping and Headworks.

The following discussions specifically address primary sludge fermentation, WAS thickening and sludge storage facilities at the SEWPCC. Scum handling procedures are discussed further in Section 8 - Primary Treatment and Section 10 - Secondary Clarifiers.

14.1 FERMENTATION

14.1.1 Purpose of Unit Process

The purpose of primary sludge fermentation is to generate short chain volatile fatty acids (SCVFA) to facilitate enhanced biological phosphorus removal (EBPR) as well as provide a source of soluble readily biodegradable COD (rbCOD) for denitrification. For the SEWPCC expansion/upgrade project, primary sludge fermentation is recommended to off-set the lack of sufficient SCVFA in the existing primary effluent relative to the level of phosphorus throughout the year. Other secondary benefits to the City includes a net reduction of primary sludge by 25 ~ 40% which consequently reduces the sludge hauling volume to NEWPCC and also loading to the anaerobic digesters (capital and O & M savings).

14.1.2 Type of Fermenter

As stated in the PDR, the type recommended for the SEWPCC project is a side-stream static fermenter.

14.1.3 Design Criteria

The fermenter is generally designed based on annual average day flows (AAF) for primary sludge. It was determined that approximately 50% of the primary sludge (PS) requires fermentation to meet the year-round VFA requirement for EBPR. The key design assumptions and criteria are summarized as follows:

- Design annual average day wastewater flow = 90.4 ML/d.
- Primary Sludge Loading to fermenter at AAF = 0.5 x 0.65 x 21,090 Kg/d = 6,854 Kg/d at 1.5% solids or 460 m^3/day (based on 50% PS fermentation, 65% solids capture in Primary Settling Tanks (PST) and TSS loading to PST at AAF of 21,090 kg/d).
- Number and size of fermenter = one (1) at 20 m ϕ.

- Design Solids Retention Time (SRT) (winter conditions) = 7 days.
- Estimated overall TSS reduction via fermentation = 30%.
- Average solids concentration in the sludge blanket = 4% (6% at the bottom) on a dry-weight basis.
- Total depth of fermenter = 5.5 m consisting of sludge blanket depth = 3 m, supernatant = 2 m and 0.5 meter of free board.
- Volume of sludge wasted at 6% solids = 80 m^3/day.
- Estimated elutriation flow = 300 m^3/day (source of elutriation water is from existing secondary effluent plant wash water).
- Estimated fermentate flow = 680 m^3/day (calculated as the sum of primary sludge and elutriation water flow less volume of fermented sludge wasted per day).

Following discussion with the City, it was decided to add a second 20 m ϕ fermenter such that all of the primary sludge generated can be fermented. The advantage of the second fermenter is as follows:

- Provides redundancy in fermenter operations.
- Increases operator flexibility and decreases the risk of process failure.
- The process thickens the entire primary sludge volume to approximately 6% which ultimately reduces the overall volume of sludge hauled to the NEWPCC.
- Fermentation reduces the primary sludge volume by 30% thereby reducing the loading to the anaerobic digesters at the NEWPCC.

The comparison of fermenting 50% versus 100% of the primary sludge in terms of sludge storage and hauling volumes is presented in Section 14.3.1.

The following section describes the various components associated with fermentation. Refer to Figure 14.1 for a process flow diagram for the fermentation system and Figure 14.2 for the proposed fermenter floor layout.

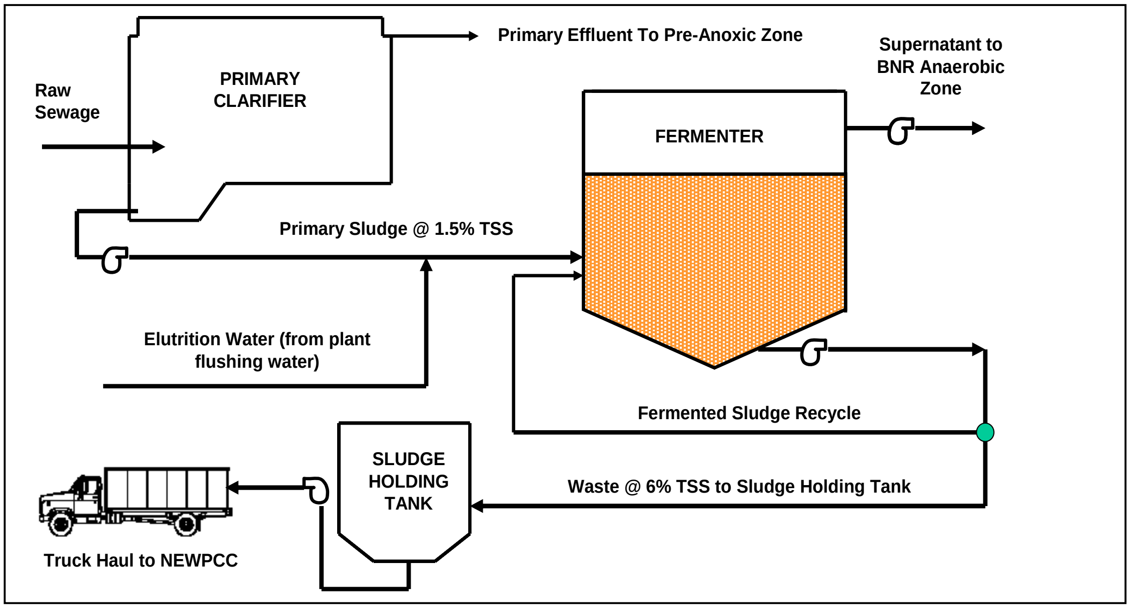


Figure 14.1: Fermentation Process Flow Diagram

14.1.4 Fermenter and Associated Process Components

Two, 20-meter diameter fermenters are proposed for the SEWPCC. The fermenters will be located adjacent to the proposed dissolved air floatation (DAF) room so that access to the fermenter sludge and supernatant pumps can be provided through the DAF room.

Primary sludge mixed with elutriation water will be pumped to the fermenter on a continuous basis. The fermenter will include a sloped base with a picket fence type sludge thickening / collection mechanism. The thickening / collection mechanism will be rotated by a drive unit external to the tank. The fermenter recycle pumps will operate continuously to either recycle sludge back to the fermenter or waste it to the sludge holding tank. The removal rate to the sludge holding tank will be based on maintaining the desired SRT in the fermenter. The fermenter supernatant pump will continually withdraw supernatant and transfer it to the anaerobic zone of the BNR.

14.1.4.1 Fermenter Covers

Two (2) options have been investigated with regards to the fermenter covers. Option No. 1 is to provide a flat aluminum cover over the tank similar to that for the fermenters to be constructed at the WEWPCC. Option No. 2 involves covering the tank with a low profile aluminum dome. The advantage of the flat roof is that it minimizes the headspace in the fermenter and therefore reduces the quantity of air that requires venting to the odor control facility. The advantage of the low profile dome is that it reduces the need for internal support beams and has a lower capital cost. Both options would include an eaves trough around the exterior of the dome to capture rainwater and snow melt.

Refer to Figures 14.3 and 14.4 for cross sections of each option. The low profile dome option is recommended due to lower capital costs.

14.1.4.2 Primary Sludge Pumping

The existing sludge pumps for PST No. 1 & 2 (P105-STP & P106-STP) are Morris vortex type pumps, while the primary sludge pumps for PST No. 3 (P111-STP & P116-STP) are Hayward Gordon vortex type pumps. The inlet piping for pumps P105 and P106 is interconnected. Therefore they can operate on in a duty-standby fashion for PST No. 1 and 2, while P111 and P116 operate in a duty-standby fashion for PST No. 3. All four sludge pumps are rated for 6.9 – 21 L/s at a maximum head of 9.8 m and are operated by variable frequency drives (VFD). The operators have reported that the existing drives are direct current (DC) drives and require replacement.

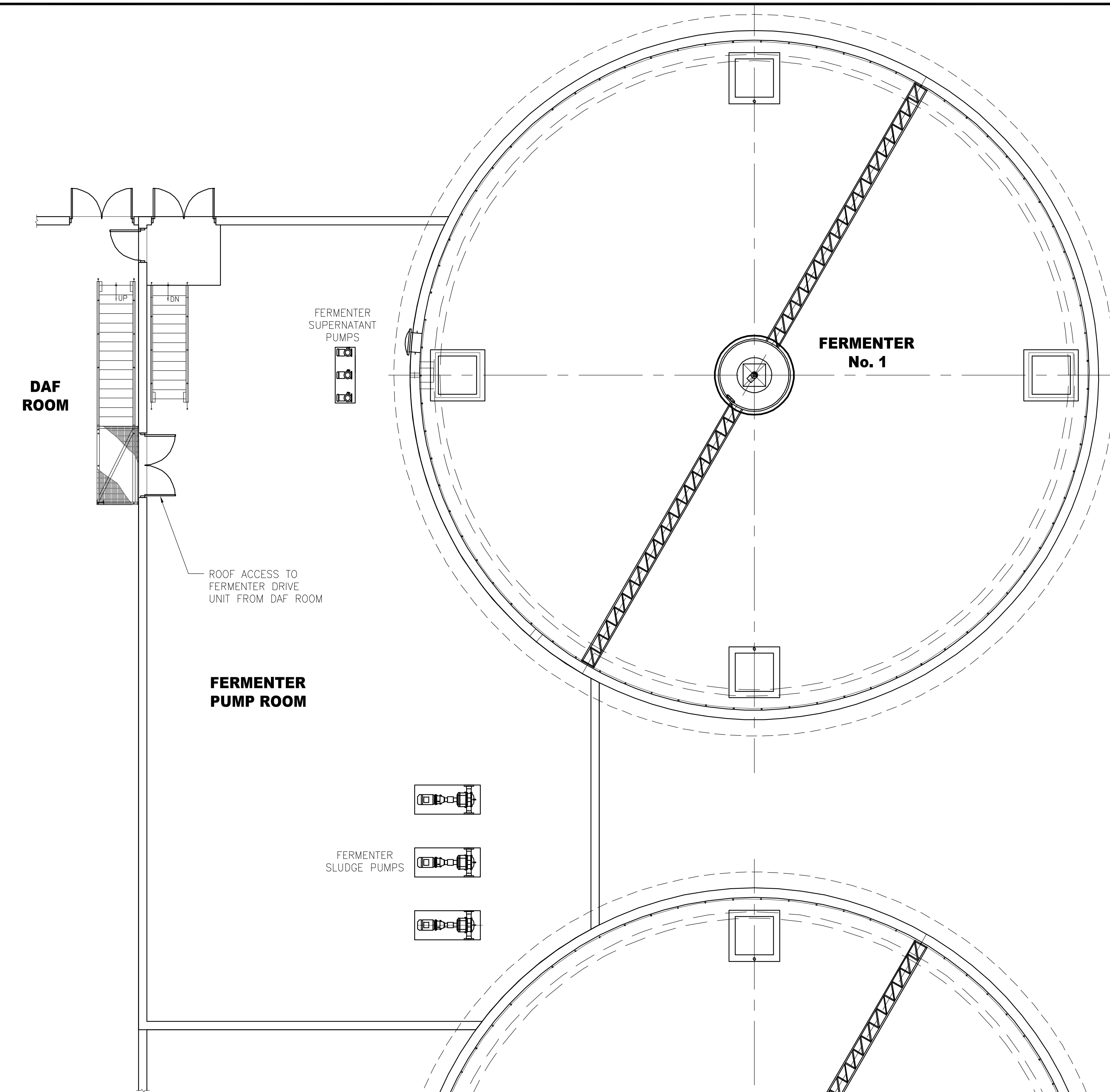
Currently primary sludge is wasted based on the sludge blanket level in the PSTs and the pumps operate periodically based on level. The proposed operation strategy is to operate the PST with very little or zero sludge blanket. The estimated pumping rate to the fermenter will range from 6 to 16 L/s and is within the capacity of the existing primary sludge pumps.

The primary sludge piping from PST No. 1 and 2 currently combines with the primary sludge piping from PST No. 3 in the pipe gallery at the east end of PST No. 3 and then travels west down the pipe gallery between PSTs No. 2 and No. 3 to the sludge holding tank. The existing configuration will remain the same except that instead of traveling west towards the existing Sludge Holding Tanks the primary sludge line will travel east down the gallery, turn south and travel through the existing Boiler Room to a proposed pipe gallery connecting the existing facility with the DAF Room and Fermenter Pumping Room. Refer to Figure 14.5 for a plan view of the proposed pipe runs and an overall facility layout.

14.1.4.3 Elutrition Water System

The elutriation water system is an important operating component that maintains the desired oxidation reduction potential (ORP) of the fermenter. If the ORP strays below about -150mv, the EW flow is increased to ensure that true anaerobic conditions are not established. Similarly, if the value goes above -80mv, the EW flow is decreased so that good fermentative conditions prevail in the fermenter. However, to cover the variability inherent in both the natural oxidative state of the PS and the solids content of that PS, the elutriation water flow to the fermenter would be maintained in the range of 120 ~ 600 m^3/day (1.4 ~ 7 L/s). The existing plant flushing water line is secondary effluent and will be used as elutriation water.

The existing flushing water pumping system consists of four (4) constant speed pumps (S550-FWP, S551-FWP, S552-FWP, S553-FWP) that draw secondary effluent from secondary clarifier no. 1 and 2 drop shafts. S553-FWP satisfies the low demand situation (0-19 L/s), S550-FWP satisfies the intermediate demand situation (19-39 L/s), while pumps S551-FWP and S552-FWP act in a duty-standby fashion to satisfy a high demand situation (39-76 L/s). Operation of the



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THE CITY OF WINNIPEG
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SOUTH END WATER POLLUTION CONTROL CENTRE

FERMENTER FLOOR PLAN

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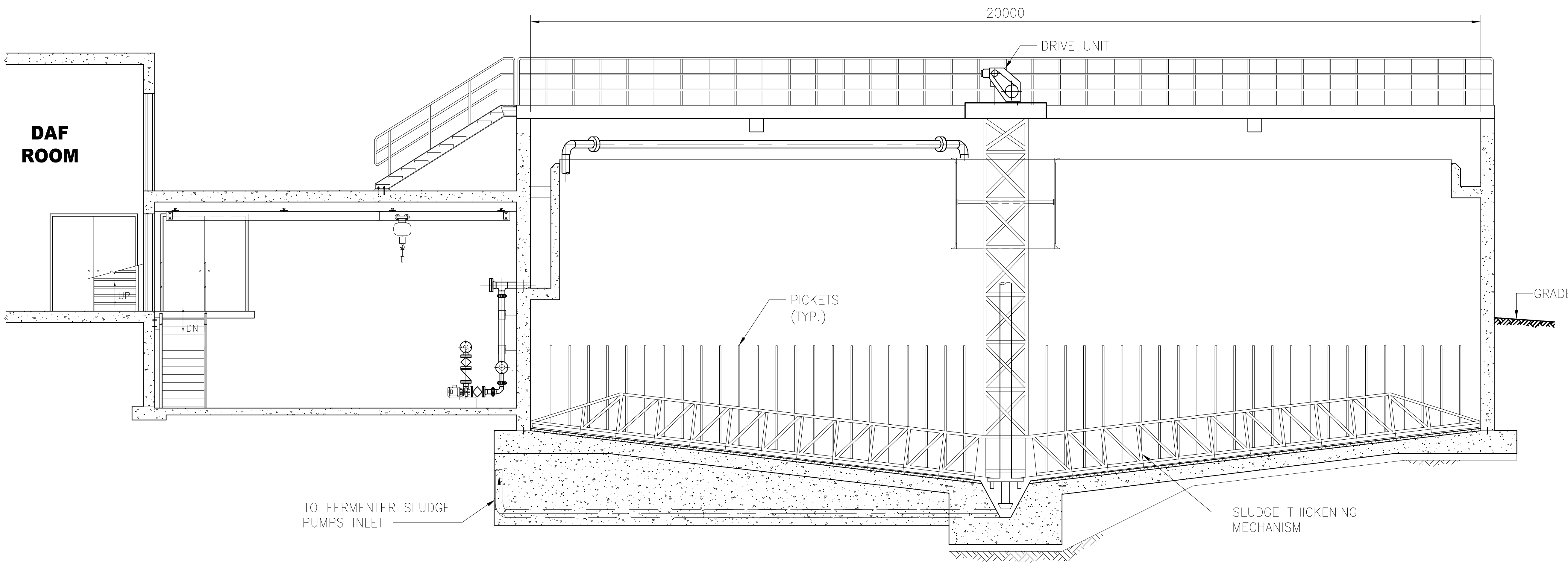

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FERMENTER WITH FLAT ALUMINUM ROOF

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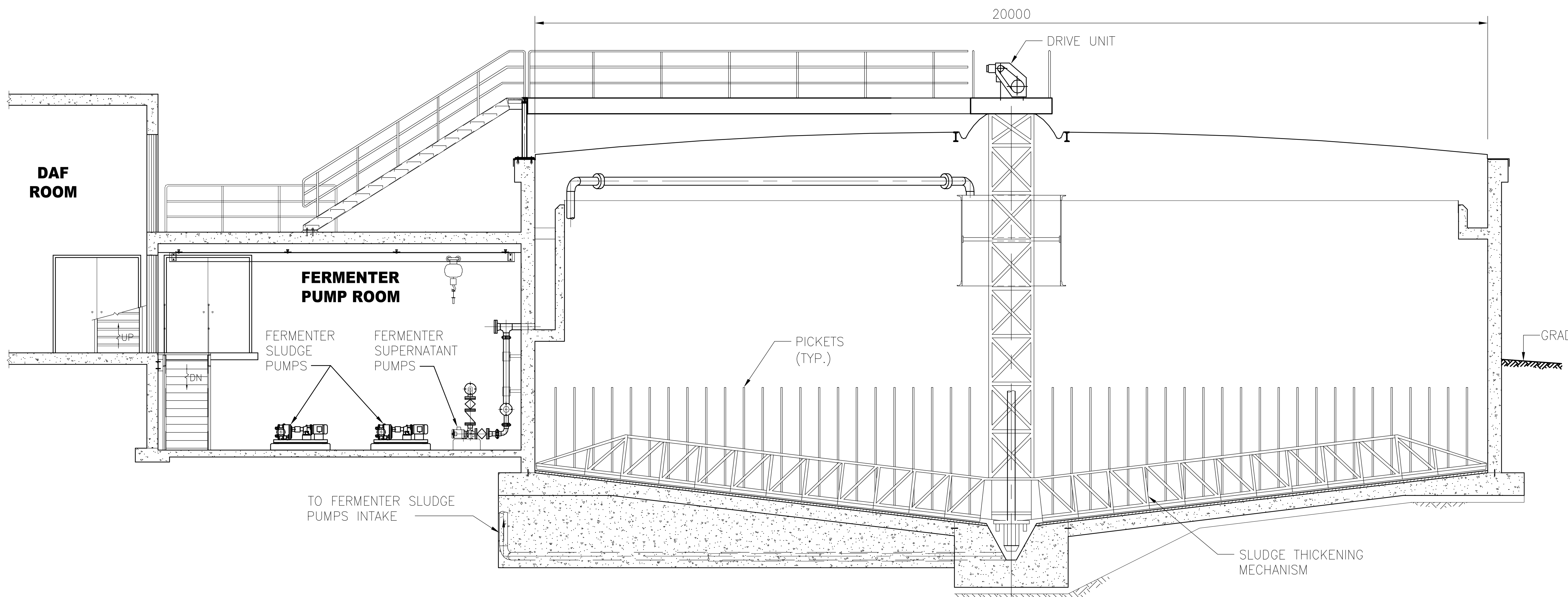

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FERMENTER WITH LOW PROFILE ALUMINUM DOME ROOF

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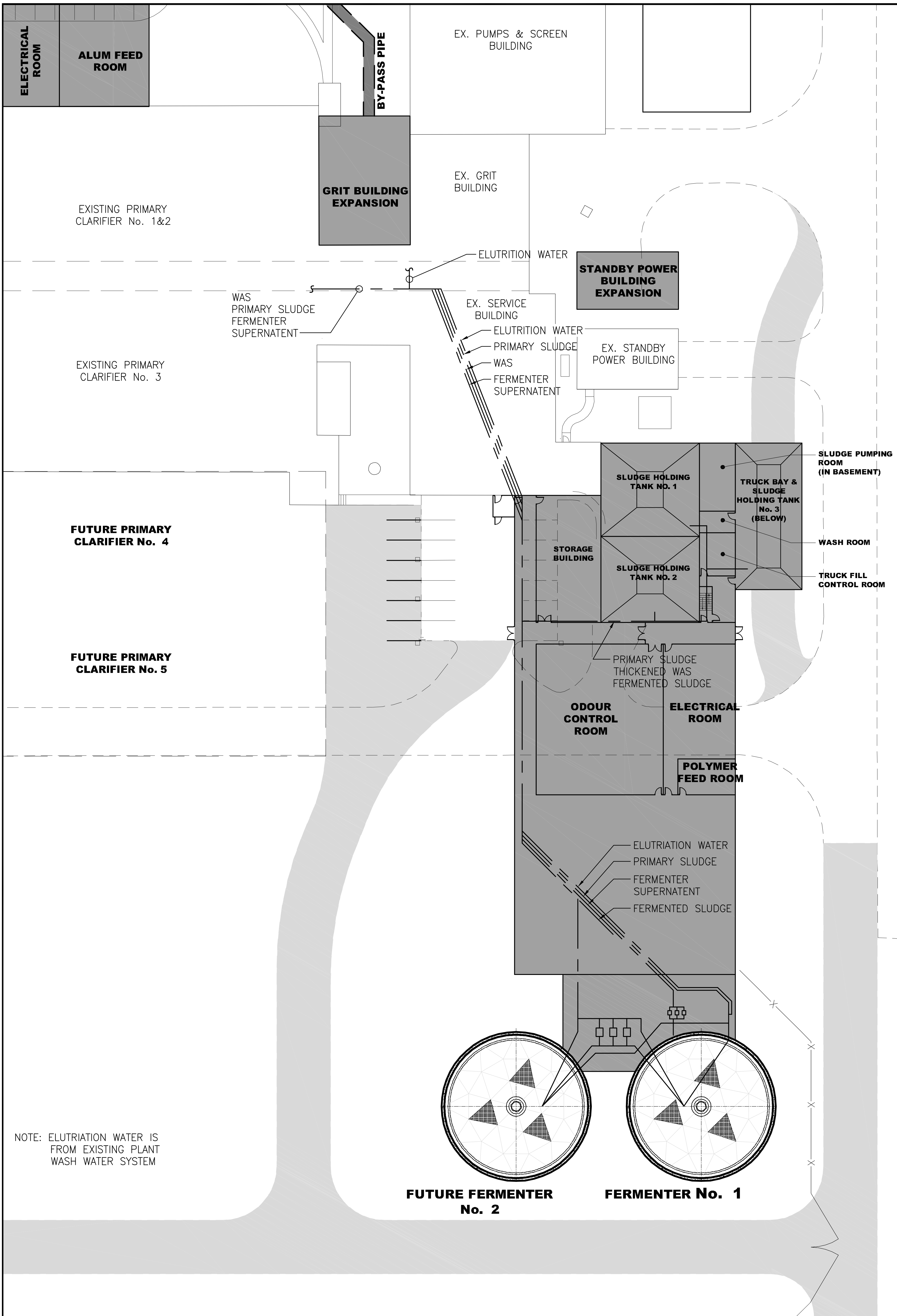

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SITE PLAN

CITY DRAWING NUMBER: FIGURE 14.5
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pumps is controlled by pressure in the flushing water header. The existing flushing water availability is more than adequate to meet the elutriation water demand of 1.4 ~ 7 L/s flow rate.

14.1.4.4 Fermented Sludge Pumping

The recycle sludge pumps will also serve the function of wasting fermented sludge to the sludge holding tanks. The recycle pumps were sized such that the upflow solids loading rate does not exceed 200 $Kg/m^2/day$.

Each fermenter will be provided with a duty pump and standby pump capable of backing up either duty pump for a total of three pumps. These pumps will be lobe style positive displacement pumps equipped with VFD to handle a range of flow from 4.5 ~ 9.0 L/s. The pumps will also be designed to act as dewatering pumps when the fermenters need to be drained for inspection and maintenance.

14.1.4.5 Fermenter Scum Pumping

The fermenters will be equipped with a scum collection and collection trough. The collected scum will be pumped to the sludge holding tanks.

14.1.4.6 Fermenter Supernatant Pumping

A duty supernatant pump for each fermenter will be provided with a standby pump capable of backing up either duty pump. These pumps will be end-suction centrifugal type sized to continually pump 4 ~ 8 L/s of supernatant to the anaerobic zone of the BNR. The flow rate will be paced based on a level sensor located in the fermentate collection chamber.

14.1.4.7 Instrumentation

The fermenters will require as a minimum the following instrumentation:

- Sludge blanket level indicator.
- ORP probe.
- Temperature and pH probe.
- Magnetic flow meter.

14.1.4.8 Constructability

The fermentation system is a new process and will have minimal impacts from an operations or constructability perspective. Tie-ins to the primary sludge pumping piping system and flushing water piping system will have minor impacts to the operation of the existing facility.

14.2 WASTE ACTIVATED SLUDGE THICKENING

14.2.1 Purpose of Sludge Thickening Unit Process

The purpose of WAS thickening at the SEWPCC is to reduce the volume of liquid sludge in order to optimize the size of the sludge storage facility and reduce the transportation and operational costs associated with hauling sludge to the NEWPCC for further processing. Thickening also reduces the volumetric loading to the downstream solids processing and increases the efficiency at the same time. For the City, this results in a higher efficiency of sludge digestion and a net lower disposal cost for the digested sludge.

Sludge storage is provided at SEWPCC to allow periodic hauling of sludge from the plant. Following start-up and commissioning of the BNR plant at the SEWPCC, the current practice of co-thickening WAS with PS in the PST is not recommended. In BNR plants, co-thickening of WAS with PS results in re-release of phosphorus into the liquid stream. As discussed in the previous section, all PS will undergo fermentation and thickening to approximately 6% solids in the fermenters. As 100% of the PS generated will be subject to fermentation, additional thickening options for PS were not evaluated further.

The handling of the thickened sludge by the truck haulers requires that the percent solids not be greater than 6%. If it is, pumpability may be compromised during unloading at the NEWPCC. A maximum 6% solids content is assumed for the conceptual design.

It was noted in Section 8 that there is an option to combine WAS thickening with scum. While it has not been included as part of this section, it is recommended to evaluate this option further in the detailed design.

14.2.2 WAS Thickening Options

Some of the common methods utilized for WAS thickening includes the following:

- Gravity Thickener (GT).
- Centrifuge.
- Gravity Belt Thickener (GBT).
- Rotary Drum Thickener (RDT).
- Dissolved Air Flotation (DAF).

GT are simple to operate and require low operator attention. However, their performance for WAS is erratic and their thickening potential limited for WAS. Also, GT require a larger space and have the potential to re-release phosphorus in the liquid stream.

Centrifuge has been successfully used in thickening WAS to higher solids concentrations especially with polymer addition. As the units are enclosed, this minimizes odour and spill considerations. Centrifuges are associated with sophisticated maintenance requirements, have higher capital and power costs (relative to other options).

GBT provides a low capital and power cost option for thickening. However, the process is heavily dependent on the use of appropriate polymers to function and also requires a lot of wash water for maintaining a clean belt. Additionally, GBT has potential for odour but comes with optional covers.

RDT is comparable to a GBT for its application to WAS thickening as it provides a low capital and power cost option for thickening. The process relies heavily on type and amount of polymer. Compared to GBT, there is less potential for odour.

Dissolved Air Flotation (DAF) is a very effective means for WAS thickening as it takes advantage of the inherent characteristics of WAS which tends to float easily rather than settle. DAF is used extensively for thickening WAS from BNR plants as it prevents any re-release of phosphorus by maintaining the sludge under aerobic conditions. Additionally, the process involves simple equipment components, is relatively cheaper than centrifuge and can thicken up to 5% solids without polymer use. Similar to GBT, DAF has some potential for odour.

Based on the above discussions and our experience in the industry, the DAF technology is recommended for the SEWPCC. Our recommendation is based on the following rationale:

- DAF provides a better opportunity to prevent re-release of phosphorus back into the liquid stream as it maintains an aerobic environment for the WAS which is wasted directly from the last aerobic zone of the BNR bioreactor. It is reported by the U.S. Environmental Protection Agency (USEPA) that DAF effluent often has 8 to 10 mg/L of dissolved oxygen which greatly reduces phosphorus release and odor potential.

- The DAF process can be operated to produce thickened WAS (TWAS) up to 5% solids (dry-weight basis) without polymer use. This presents the City with some operational cost savings as well as ease of plant operation.

- Compared to a centrifuge (second choice), DAF units have a lower capital cost and lower operational cost. Controls are relatively simple and maintenance procedures are less complicated.

- The City has selected DAF for its WEWPCC which will offer some continuity in sharing plant operation and troubleshooting knowledge among its staff.

14.2.3 Design Criteria

Several factors affect DAF process performance including the following:

- Type and characteristics of sludge.
- Hydraulic loading rate.
- Solids loading rate.
- Air-to-solids ratio.
- Chemical conditioning.
- Operating policy.
- Float-solids concentration.
- Effluent quality (DAF effluent).

From a sizing perspective, the two most important parameters are the hydraulic loading rate (HLR) and the solids loading rate (SLR). The hydraulic loading rate (HLR) refers to the sum of the feed and recycles flow rates divided by the net available flotation area. For activated sludge flotation thickening, a range of 150 - 200% recycle rates has been applied to DAF units. The design of DAF thickening units are generally based on a hydraulic loading rate of 30 to120 $m^3/m^2/d$ (1.25 $m^3/m^2/hr$ to 5 $m^3/m^2/hr$) assuming no conditioning chemicals.

The solids loading rate (SLR) is defined as the total sludge loading to the DAF thickener per hour per unit effective area. Without any chemical conditioning, the range of solids loading rate for WAS thickening ranges from approximately 2 to 5 kg/ m^2/hr to produce a thickened float of 3 to 5% total solids (depending on the biomass quality). With the addition of polymer, the solids loading rate to a DAF thickener typically can be increased 50 to 100%, with up to a 0.5 to 1% increase in the thickening solids concentration.

The air/solids ratio (ASR) refers to the weight ratio of air available for flotation to the solids to be floated in the free stream. The ASR is most important in determining effluent TSS. Recycle flow and pressure can be varied to maintain an optimal ASR. The range of air/solids ratios are typically from 0.01:1 to 0.4:1. Adequate flotation is achieved in most municipal wastewater thickening applications at ratios of 0.02:1 to 0.06:1.

For the SEWPCC project, the design of the DAF system is based on maximum month WAS flow and solids loading. This occurs at the design spring maximum month flow (MMF) conditions and is 18,634 kg/d or 6211 m^3/day @ 0.3% solids.

14.2.4 DAF Design Summary

Based on a maximum month WAS flow-rate of 6211 m^3/day, a recycle rate of 150% and a maximum hydraulic loading rate of 5 m^3/m^2/hr, the required DAF area = 130 m^2. Similarly, based on a maximum month WAS solids loading of 18,634 kg/d, an allowable solids loading rate of 5 Kg/m^2/hr, the required DAF area = 155 m^2. Hence, the solids loading governs the required DAF area.

A summary of the DAF design is summarized in Table 14.1.

Table 14.1 – DAF Design Summary

Description	Value	Unit
Spring Maximum Month Flow WAS Production	18,634	kg/d
Maximum Solids Loading Rate	5	kg/m^2/hr
Gross Effective Area	155	m^2
Number of DAF thickeners	4	
Effective area per thickener	38.8	m^2
Length	10.8	m
Width of thickener	3.6	M

14.2.5 Dissolved Air Flotation Unit

WAS from the MLSS recycle zone immediately following the IFAS aerobic zone of the BNR reactor will be conveyed to the proposed DAF units. To ensure that the DAF systems do not encounter sudden changes in the flow regime, the WAS pumps will be equipped with variable frequency driven pumps with magnetic flow meters mounted in the pump discharge lines to maintain flow balancing or regulation to ensure a consistent flow rate.

The DAF unit functions under the effect of micro air bubbles flowing upwards, the sludge solids are trapped by the bubbles and carried to the surface to form a sludge blanket also known as float. The float forms on the liquid surface of the DAF tank and is removed by a skimmer. The thickened sludge is pumped to the sludge storage tanks.

The production of saturated water from which the micro air bubbles are generated, is normally achieved by injecting high pressure air into a recycle stream of the DAF subnatant. An air compressor produces compressed air that is conveyed to a pressure vessel known as an air saturation tank that also contains recycled liquid pumped by a centrifugal pump from the DAF effluent. The pressurized air saturates the pressurized recirculated liquid. The percentage of saturation which can be achieved depends on the design of the system. Saturation efficiencies of up to 80-95% can be expected.

The air saturated liquid then flows to the DAF influent pipe and into the DAF unit. Since the DAF is a vessel open to atmospheric conditions, the pressurized saturated air is released from the liquid and forms micro air bubbles that rises to the liquid surface carry along solids. The solids that accumulate on the liquid surface is known as the float. The thickened float layer will have a solids concentration in the range of approximately 3% to 5% without the use of chemical conditioning.

The float is removed from the liquid surface by a continuously operating skimmer that moves the float along the surface to the float collection trough. The skimmer motors will be 1.5 HP equipped with a VFD so the removal of float can be adjusted according to the rate of float production. A pump conveys the thickened WAS to the sludge storage tank.

Solids that settle to the bottom of the DAF unit are collected in a hopper bottom. Either an auger or gravity is used to remove the solids. The solids would be pumped to the sludge holding tank. The removal of solids from the bottom of the DAF unit would be infrequent because the processes ahead of the DAF have removed most of the heavy solids.

The subnatant liquid (clarified liquid) would be conveyed to the influent of the PST. The plan and section of the proposed DAF building is shown in Figures 14.6 and 14.7.

14.2.5.1 DAF Construction Material

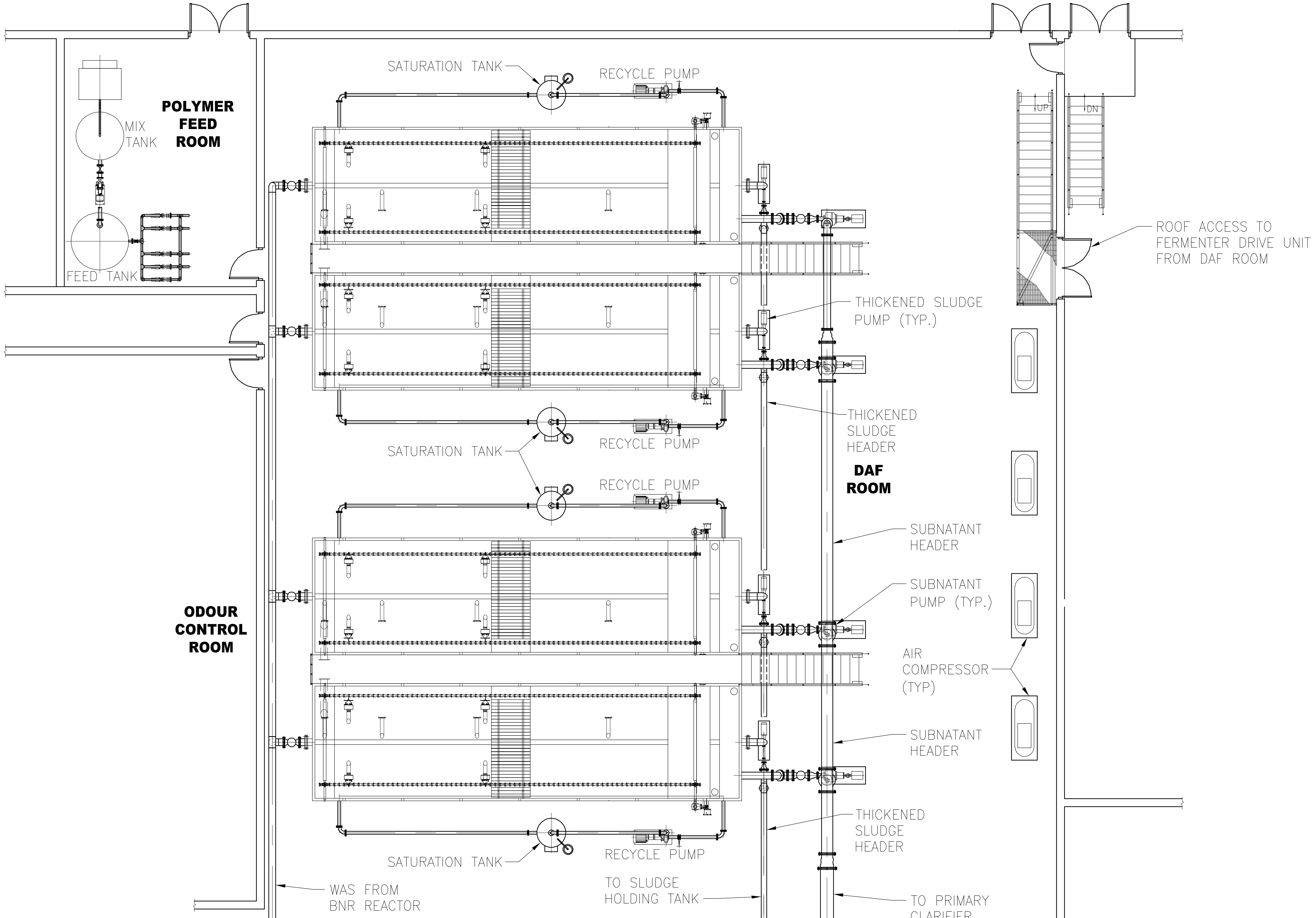
Wetted materials of construction of the flotation tank will be of type 304L Stainless Steel (SS) with external supports of 304L SS. The floated sludge skimmers will be supported on 304L SS structural angles. The support structure will be stainless steel. An optional aluminum or fibreglass cover could be used to control odours from the DAF.

An aluminum, or fiberglass reinforced plastic (FRP) platform will be positioned along the side of each DAF unit to be used by an operator at the top of the DAF unit for housekeeping and maintenance purposes.

14.2.5.2 DAF Air Saturation and Recycle System

Three air compressors of approx. 7.5 HP each with Totally Enclosed Fan Cooled (TEFC) motor, 300 litre horizontal air receiver built to American Society of Mechanical Engineers (ASME) standards, non-cycling refrigerant air dryer and one (1) micron coalescing air filter would provide process air to the air dissolving vessel. The coalescing filter separates large water and oil droplets from the compressed air stream. The non-cycling refrigerant air dryer air removes moisture from the process air. The non-cycling refrigerant air dryer air would use R-134a refrigerant because of its ozone depletion factor of 0.0.

One air-dissolving vessel of 304L SS construction would be designed and built to ASME Section VIII with a design working pressure of 700 kPag. The vessel is complete with internal spray



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SOUTH END WATER POLLUTION CONTROL CENTRE

DISSOLVED AIR FLOATATION PLAN VIEW

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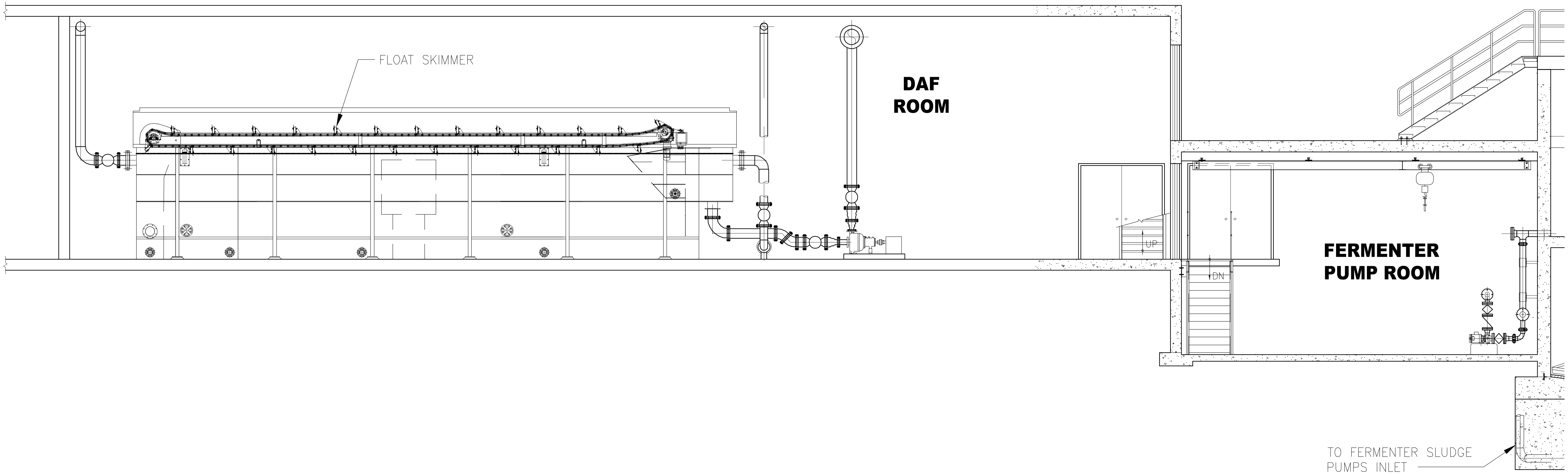

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DESIGNED BY		CHECKED BY	
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HOR. SCALE: VERTICAL:	N.T.S.	RELEASED FOR CONSTRUCTION:	
DATE	2008.06.03	DATE	

ENGINEER'S SEAL

TENDER NO.

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

SOUTH END WATER POLLUTION CONTROL CENTRE

DISSOLVED AIR FLOATATION SECTION VIEW

CITY DRAWING NUMBER: FIGURE 14.7

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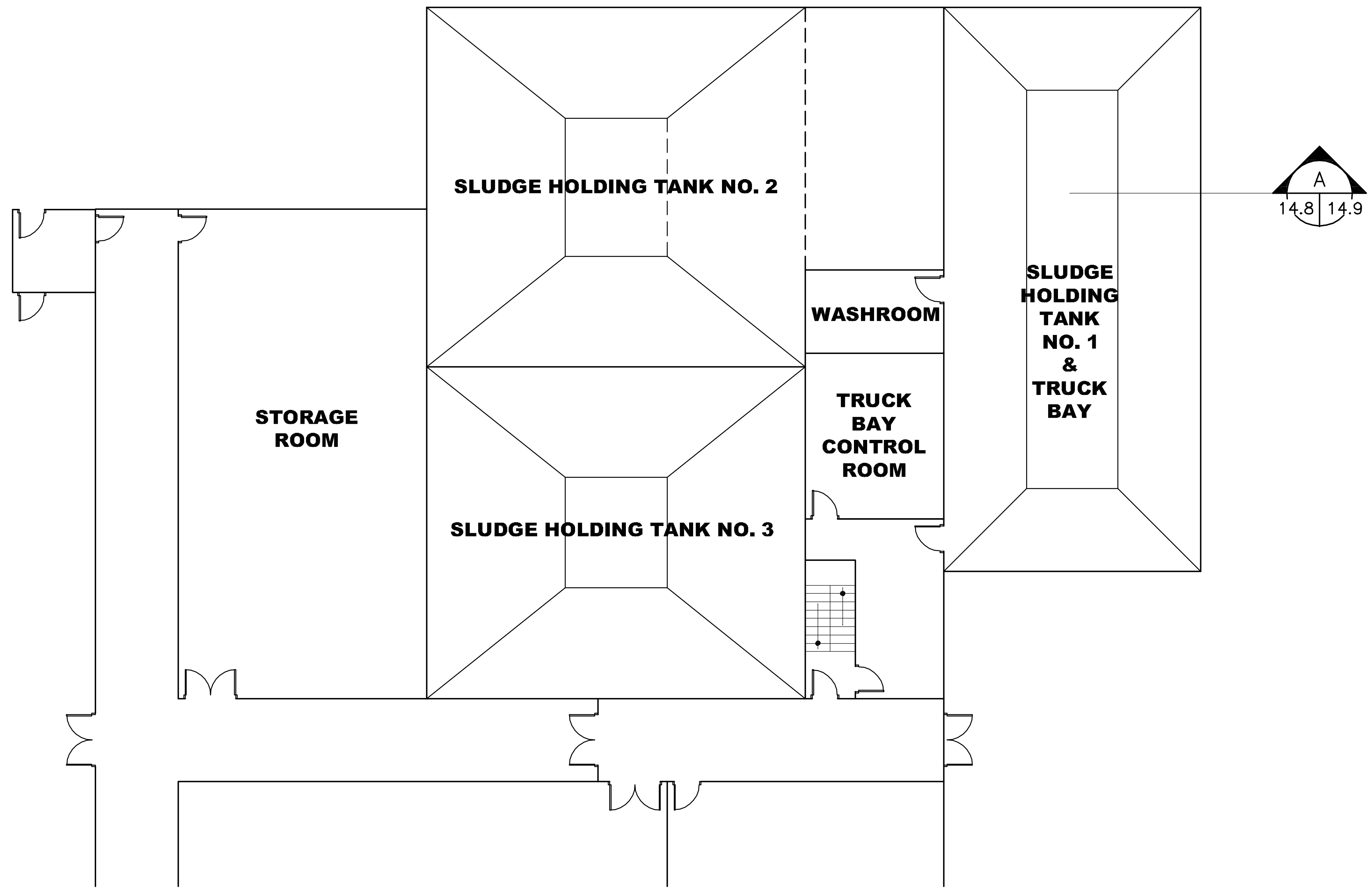

APEGM Certificate of Authorization
Stantec Consulting Ltd.
No. 1301 Expiry: April 30, 2009

LOCATION APPROVED UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE   DATE

NOTE:
LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

B.M.
ELEV.

NO.	REVISIONS	DATE	BY

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TENDER NO.

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

SOUTH END WATER POLLUTION CONTROL CENTRE
SLUDGE STORAGE FACILITY
FLOOR PLAN

CITY DRAWING NUMBER
FIGURE 14.8

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2008-11-07 08:51AM By: kmmonroe

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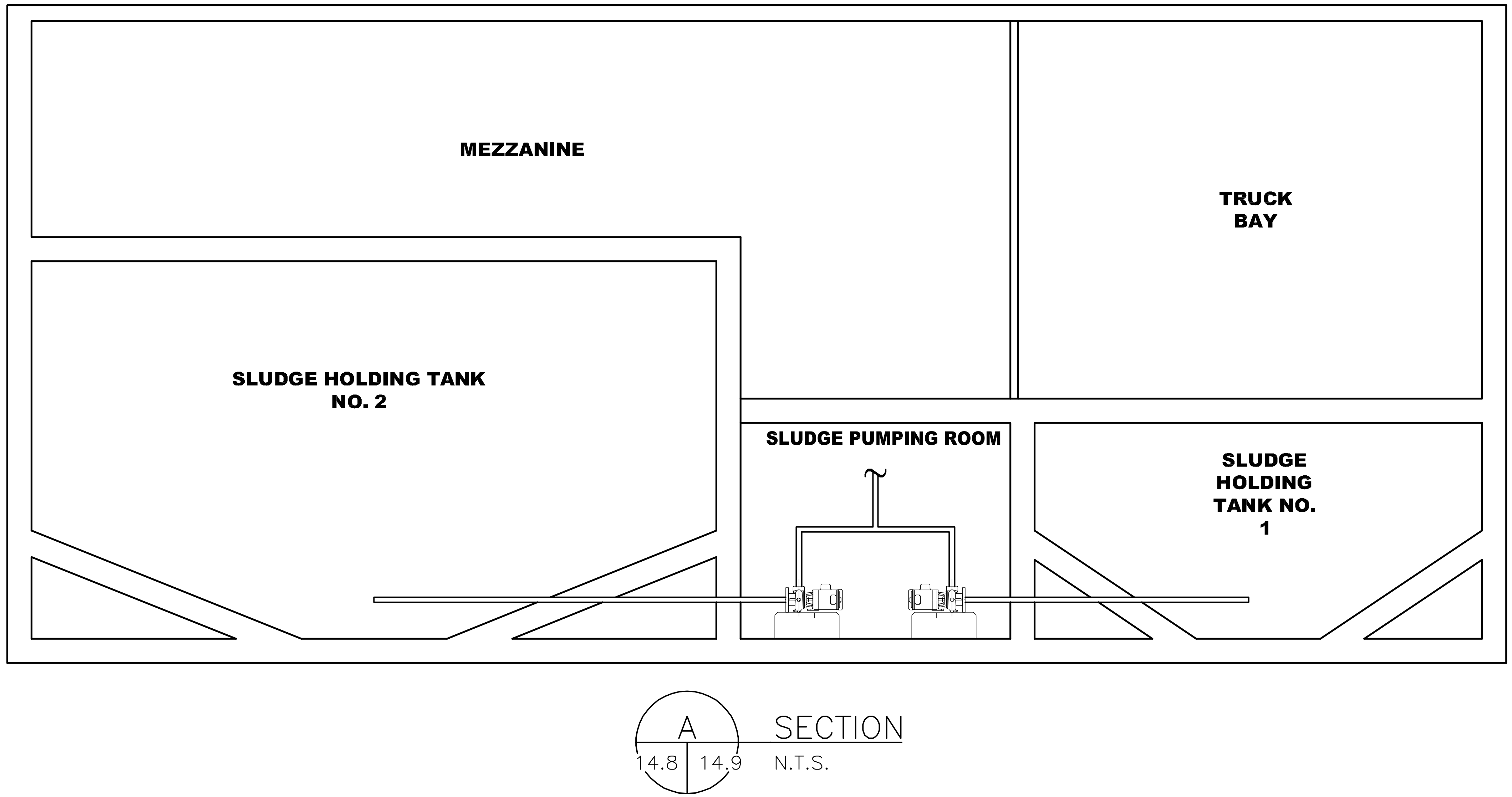

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DATE 08.06.30	DATE

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TENDER NO.

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

SOUTH END WATER POLLUTION CONTROL CENTRE
SLUDGE STORAGE FACILITY
CROSS SECTION

CITY DRAWING NUMBER: FIGURE 14.9

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2008-11-07 08:51AM By: kromoroce
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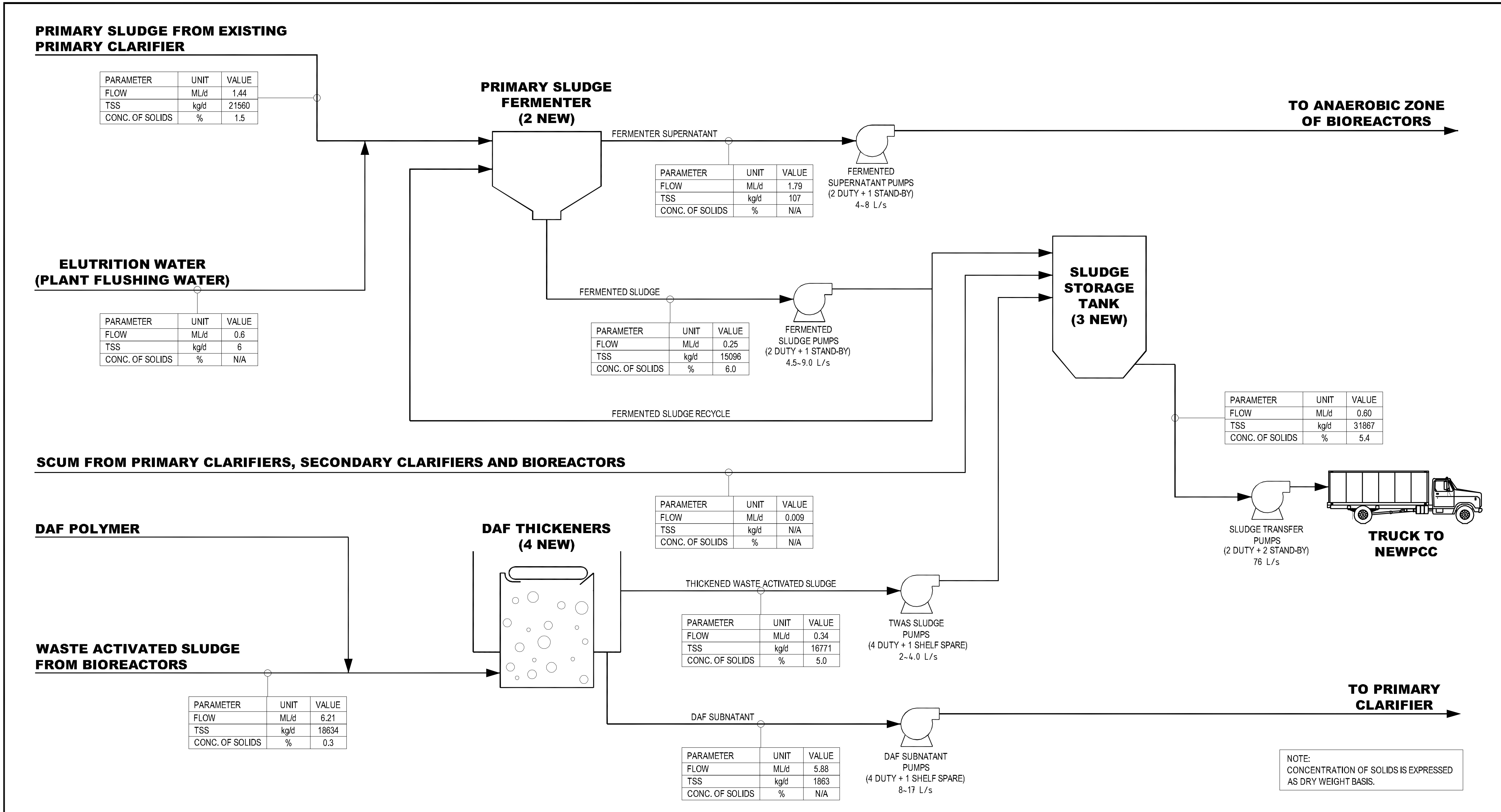

Primary sludge from existing primary clarifier:

PARAMETER	UNIT	VALUE
FLOW	ML/d	1.44
TSS	kg/d	21560
CONC. OF SOLIDS	%	1.5

Elutrition water (plant flushing water):

PARAMETER	UNIT	VALUE
FLOW	ML/d	0.6
TSS	kg/d	6
CONC. OF SOLIDS	%	N/A

Fermenter supernatant:

PARAMETER	UNIT	VALUE
FLOW	ML/d	1.79
TSS	kg/d	107
CONC. OF SOLIDS	%	N/A

Fermented sludge:

PARAMETER	UNIT	VALUE
FLOW	ML/d	0.25
TSS	kg/d	15096
CONC. OF SOLIDS	%	6.0

Sludge storage tank outlet:

PARAMETER	UNIT	VALUE
FLOW	ML/d	0.60
TSS	kg/d	31867
CONC. OF SOLIDS	%	5.4

Scum:

PARAMETER	UNIT	VALUE
FLOW	ML/d	0.009
TSS	kg/d	N/A
CONC. OF SOLIDS	%	N/A

Thickened waste activated sludge:

PARAMETER	UNIT	VALUE
FLOW	ML/d	0.34
TSS	kg/d	16771
CONC. OF SOLIDS	%	5.0

Waste activated sludge from bioreactors:

PARAMETER	UNIT	VALUE
FLOW	ML/d	6.21
TSS	kg/d	18634
CONC. OF SOLIDS	%	0.3

DAF subnatant:

PARAMETER	UNIT	VALUE
FLOW	ML/d	5.88
TSS	kg/d	1863
CONC. OF SOLIDS	%	N/A

NOTE:
CONCENTRATION OF SOLIDS IS EXPRESSED AS DRY WEIGHT BASIS.

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No. 1301 Expiry: April 30, 2009

LOCATION APPROVED
UNDERGROUND STRUCTURES
SUPV. U/G STRUCTURES COMMITTEE DATE
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B.M. ELEV.

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HOR. SCALE: N.T.S. VERTICAL: | RELEASED FOR CONSTRUCTION:
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THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
SOUTH END WATER POLLUTION CONTROL CENTRE
SOLIDS FLOW SCHEMATIC AND MASS DIAGRAM
CITY DRAWING NUMBER FIGURE 14.10
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2008-11-07 08:31AM By: kromanace
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nozzle of cast iron construction, liquid level gauge, air inlet solenoid valve, liquid level switch, pressure gauge and relief valve.

Three (3) 316SS centrifugal recycle pumps each with a 50 HP 3500 rpm TEFC motor and discharge check valve would be used to pump the air saturated recycled liquid to the influent end of the DAF unit. Recycled flow rates would be in the order of 388 m^3/hr ~ 520 m^3/hr.

14.2.5.3 DAF Polymer Systems

Although the addition of chemical to the waste activated sludge stream is not proposed, it is recommended that a polymer system be installed in the event that addition of the thickened solids need to be increased or the DAF performance requires improvement when one DAF unit is taken out of service for maintenance or in the event that the operators wish to achieve a higher float solids concentration than is possible such addition.

DAF thickeners use polymer to improve their efficiency and maximize operation. With polymer addition, the solids loading rate to the DAF thickener typically can be increased 50 to 100% with a corresponding increase in the thickened solids content of 0.5 to 1%. Typically a medium strength cationic polymer is used in DAF thickening. The polymer consumption would be in the range of 1 - 3 ppm cationic polymer (medium strength) depending on the quality of the biomass.

Based on discussions with the City, a dry polymer system is proposed. A dry polymer make down unit will be employed to make liquid polymer. The unit equipment will consist of a dry polymer storage hopper, a polymer wetted head, a mixing / age tank and a storage tank.

14.2.5.4 Thickened WAS (TWAS) Sludge Pumps and Piping

The TWAS maximum TSS concentration would occur during the spring MMF. The anticipated TWAS flow and maximum TSS based on the mass balance model of the proposed facility are shown in Table 14.2 below.

Table 14.2 - Anticipated TWAS Flow and Maximum TSS

		Location	
		WAS	TWAS
MMF (spring)	Flow (ML/d)	6.211	0.335
	TSS (kg/d)	18,634	16,771

	Location	
	WAS	TWAS
Flow (m^3/h)	258.8	14.0
TSS (mg/L)	3,000	50,063

Progressive cavity pumps will be used to pump TWAS from the DAF unit to the sludge storage tanks. A progressive cavity pump close-coupled design will be dedicated to each DAF unit and one will serve as a spare unit.

The estimated capacity of the TWAS pump is 335,000 litres per day / 4 pumps/24 hrs* 3600 = 3.9 L/s. The TWAS pump will operate as follows: An ultrasonic level sensor will monitor the

TWAS level in the DAF solids collection hopper. The sensor will send a signal to a liquid controller and in turn the liquid controller will send a signal to the pump VFD. The VFD will stop, speed up or slow down the pump according to the level in the DAF hopper.

The thickened sludge line between the DAF units and the sludge storage tanks will be sized to accommodate a future DAF unit with the same solids discharge as the currently proposed.

14.2.5.5 Clarified DAF Effluent Pumps

Clarified DAF effluent (subnatant) will be pumped back to the influent of the PSTs using centrifugal pumps. One pump will be dedicated to each DAF unit with no standby. The flow is shown in Table 14.3. Each DAF pump would have a capacity of 61.2 m^3/hr (244.8 m^3/hr / 4) or 17 L/s.

Table 14.3 - Subnatant Flow

	Location			Location
	Subnatant			**Subnatant**
Flow (ML/d)	5.876		**Flow (m^3/h)**	244.8

The clarified DAF effluent pumps will operate as follows: An ultrasonic level sensor will monitor the liquid level in the DAF effluent discharge trough. The sensor will send a signal to a liquid controller and in turn the liquid controller will send a signal to the pump variable frequency drive (VFD). The VFD will stop, speed up or slow down the pump according to the level in the DAF trough.

The clarified effluent pipeline between the DAF units and the influent to the PSTs will be sized to accommodate one additional DAF unit at the current DAF flow rate.

In the event of a failure, it is proposed that one spare pump assembly be available to replace a malfunctioning unit. One TWAS pump and one subnatant pump will be provided as a shelf spare. Spare flights, shaft bearings and speed reducer gear box will be provided for the DAF units.

14.2.5.6 Constructability

WAS thickening is a new process and will have minimal impacts from an operations or constructability perspective. Tie-ins to the existing WAS piping system will have minor impacts to the operation of the existing facility. A plan and cross section of the proposed DAF Facility can be seen in Figures 14.6 and 14.7.

14.3 SLUDGE STORAGE AND HAULING

14.3.1 Purpose of Unit Process

The purpose of the sludge holding tanks are to provide storage for the thickened fermented sludge, thickened WAS and scum prior to truck hauling to the NEWPCC. As discussed in Section 27.1.3, fermentation of only 50% of the primary sludge was originally proposed to provide enough VFA for the BNR process. However in subsequent discussions with the City, a decision was made to ferment all of the primary sludge generated at the SEWPCC. Since the PSTs will be operated with low sludge blanket, the concentration of the primary sludge is expected to be dilute at a total solids concentration of 1.5%. This dramatically increases the sludge volumes that require hauling to the NEWPCC. Table 14.4 presents a volumetric comparison of fermenting 50% versus 100% of the primary sludge. The scum volume is based on the current volume of scum. The current volume of scum was determined by subtracting the average day volume of sludge pumped over the first six months of 2008 from the average day volume of sludge hauled over the same time period. As noted in Section 8 - Primary Treatment, potential exists to send scum to the DAF to reduce the overall volume. This option will be further evaluated in the detailed design.

Table 14.4 - Volumetric Comparison of Thickening 50% vs. 100% of the Primary Sludge

Scenario	Thickened WAS	Primary Sludge	Fermented Sludge	Scum	Total Sludge	Trucks / Day
Ferment 50% of P.S.	335 m^3/d	719 m^3/d	125 m^3/d	46 m^3/d	1225 m^3/d	41 m^3
Ferment 100% of P.S.	335 m^3/d	n/a	250 m^3/d	46 m^3/d	631m^3/d	21 m^3

The City indicated that the hauling costs have recently increased to $4.50/$m^3$ and therefore the additional annual hauling cost for only fermenting 50% of the primary sludge is $975,645. The cost of constructing an additional fermenter is estimated at $4.2 million dollars (including contingencies, engineering, estimating allowance and inflation allowance) and therefore the payback would approximately 4.3 years. As stated previously in Section 14.1.3, the second fermenter provides additional benefits from both a process and financial standpoint to the City.

14.3.2 Design Criteria

The design criteria for the sludge holding tanks are as follows:

- Thickened WAS = 335 m^3/d.
- Fermented Sludge = 250 m^3/d.

- Scum = 46 m^3/d.
- Three (3) days storage.
- Total Storage Requirement = 1893 m^3/d.

14.3.3 Proposed Sludge Storage and Hauling Facility

The proposed sludge holding tanks will be designed to store sludge for three (3) days. The design includes three (3) sludge holding tanks, a basement sludge pumping room, a truck bay equipped with a control room and washroom, and a mezzanine for air handling equipment. Refer to Figure 14.8 for a floor plan and to Figure 14.9 for sections of the proposed sludge storage and hauling facility.

Reusing the existing sludge storage tanks was investigated and was determined that it was not feasible. In considering this location it was assumed to make it feasible the DAF building and fermenters would need to be relocated near the ex-sludge storage tanks. It was determined that locating the fermenters and DAF building south of the existing sludge storage tanks while still maintaining access to the truck bay for sludge hauling was not possible. Locating the fermenters and sludge storage tanks north of the PSA room was considered, but was ruled out because the main electrical services enters the electrical room at this location. The existing sludge storage tanks are also one third of the size of what is proposed (they currently provide approximately one day storage) and they would need to be expanded. Expansion would only be possible south of the truck bay which would mean that temporary setup would be required to continue the sludge hauling process during construction.

A schematic for the proposed solids handling processes indicating solids loading under MMF (Spring) is presented in Figure 14.10.

14.3.4 Constructability

The sludge storage and hauling facility is a new process and will have no impact on the operation of the existing facility.