Red Lake WPCP Chemical Metering and Storage Building

Preliminary Design Report

Final

Municipality of Red Lake

RVA 194666

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1.0 BACKGROUND

The Preliminary Design Report summarizes the required works at the Red Lake Water Pollution Control Plant (WPCP) to upgrade the disinfection system and provide a new Chemical Metering and Storage Building. The Red Lake WPCP consists of preliminary treatment (screening and grit removal), aeration, clarification and chlorination before discharging into Howey Bay. The Red Lake WPCP is owned by the Municipality of Red Lake and operated by Northern Waterworks Incorporated (NWI). On January 1, 2015, the Federal Government of Canada's Federal Wastewater Systems Effluent Regulation (WSER) came into effect and limited the discharge concentration of Total Residual Chlorine (TRC) to 0.02 mg/L. As per the WSER, all plants that have a capacity less than 5,000 m^3/day must comply with the TRC concentration by January 1, 2021. In addition, new pH and Total Phosphorus (TP) limits will be required for the Red Lake WPCP. It is the goal of the Municipality to complete upgrades to meet future TRC and effluent requirements.

2.0 EXISTING CONDITIONS

The Red Lake WPCP has a rated capacity of 2,460 m^3/day and currently operates under an existing Certificate of Approval (C of A) No. 3-1060-81-826, dated August 19,1993. The existing C of A has treated effluent requirements for BOD_5 (15 mg/L) and total suspended solids (30 mg/L) but lacks additional effluent requirements and effluent limits. Sampling at the WPCP is completed as per the Ministry Procedure F-10-1 and is designed to comply with the WSER. The average effluent parameters as provided in the NWI Red Lake WPCP annual reports (2017 and 2018) are summarized in Table 2.1 below.

Table 2.1: Effluent Quality Data and Characteristics

	2017	2018	Average	Peak
CBOD5 (mg/L)	2.44	2.73	2.59	4.90
TSS (mg/L)	5.33	6.56	5.95	8.40
Total P (mg/L)	1.27	1.49	1.38	2.16
TKN (mg/L)	1.73	1.90	1.81	3.29
TAN (mg/L)	0.16	0.50	0.33	3.10
Nitrate (mg/L)	15.8	15.6	15.7	22.0
Nitrite (mg/L)	0.05	0.03	0.04	0.11
E. Coli (MPN/100mL)	519	460	489	>2420

An amended C of A for the Red Lake WPCP will be required for the upgrades and would likely have additional compliance requirements for TP and pH. Based on similar WPCP, TP effluent requirements are expected to be below 1.00 mg/L and pH effluent requirements are expected to be between 6.5 to 9.5. Based on historical effluent quality data, the Red Lake WPCP would not achieve the required total chlorine residual limit and would have difficult meeting TP and pH limits consistently.

Daily average and peak inflows as provided in the WPCP annual reports and Red Lake WPCP Data from 2017, 2018 and 2019 are summarized in Table 2.2 below.

Table 2.2: WPCP Average and Peak Daily Sewage Inflows

Year	Average Daily Inflow (m^3/day)	Peak Daily Inflow (m^3/day)
2017	1,009	2,294
2018	1,009	2,251
2019	1,088	4,278
Average	1,035	2,941

As shown in Table 2.2, the 3-year average day flow at the WPCP is 1,035 m^3/day which indicates that the plant is operating at approximately 42% of its design capacity on average. The highest peak daily flow measured through the plant occurred in 2019 was 4,278 m^3/day, which represents a peak day flow (PDF) peaking factor of 4.1. The peak instantaneous design flow is 7,728 m^3/day which combines the maximum hydraulic capacity (5,649 m^3/day) and the by-pass flow (2,079 m^3/day) for the plant. The maximum pumping capacity of the lift stations, which provides all flows for treatment does not exceed the peak instantaneous design flow. As such, the chemical systems were sized based on the peak instantaneous design flow (7,728 m^3/day) for the WPCP.

3.0 BASIS OF DESIGN

The basis of design outlined below is based on requirements from the MECP Design Guidelines (2008), Chlorine Institute Guidelines, the Ontario Building Code (OBC), Ministry of Labour (MOL), and Health and Safety regulations. Based on historical plant flow data and the NWI yearly reports, no bypasses were recorded. As such, all chemical systems were sized based on the peak instantaneous design flow (7,728 m^3/day) and minimum day flow (699 m^3/day) of the plant.

3.1 Disinfection Requirements

Similar to ECA requirements for other WWTP, the effluent limit and effluent objective for E. coli are assumed to be 200 cfu/100 ml and 150 cfu/100 ml monthly geometric mean density, respectively.

3.1.1 Chlorination

The Municipality has chosen to continue to disinfect at the Red Lake WPCP using chlorine. Chlorine gas and sodium hypochlorite solution were reviewed as disinfection options, refer to Appendix A for details. Based on this review and discussions with NWI and the Municipality, RVA has proceeded with sodium hypochlorite as the preferred chemical for disinfection.

The disinfection system was sized using the peak instantaneous design flow (7,728 m^3/day) and minimum day flow (699 m^3/day) of the plant. A chlorine dosage of 6.5 mg/L and 3.0 mg/L was assumed at peak instantaneous and minimum day flows, respectively. Based on a 12% sodium hypochlorite solution, the operating range of the system of the system will be 15.1 to 360.5 L/day of sodium hypochlorite. At the rated capacity (2,460 m^3/day) of the plant and assuming a chlorine dosage of 6.5 mg/L, the chlorine feed rate would be 114.9 L/day for a 12% sodium hypochlorite solution.

The MECP recommends a minimum chlorine contact time of 30 minutes at the rated capacity (2,460 m^3/day) of the plant and 15 minutes at peak instantaneous design flows. The existing chlorine contact tank has a volume of 80.40 m^3, a rated capacity (2,460 m^3/day) contact tank time of 47 minutes and a peak instantaneous design flow capacity (7,728 m^3/day) contact time of 15 minutes. Based on the calculated contact times above, the chlorine contact tank is adequately sized to meet the rated and peak capacity flows for the Red Lake WPCP.

The chlorine contact tank, however, does not meet the MECP recommended length-to-width ratio of greater than 40:1. The existing tanks have approximate length-to-width ratios of 3:1 and 4:1, respectively. Additional evaluation of the chlorine contact tanks and chlorine dosage rates may be required in the future to meet the revised effluent requirements.

3.1.2 Dechlorination

The Fisheries Act and Wastewater Systems Effluent Regulation SOR/2012-139 for levels of inorganic chloramines in chlorinated wastewater effluents state that the maximum concentration of Total Residual Chlorine (TRC) in wastewaters must be lower than 0.02 mg/L by January 1, 2021. The Red Lake WPCP experienced typical TRC values in exceedance of 0.02 mg/L in 2017-2019, it is therefore required that dechlorination be included when chlorine is utilized for effluent disinfection. The Municipality has indicated that sodium bisulphite (SBS) solution is the preferred chemical for the dechlorination.

SBS is a common chemical used for dechlorination and available as a 40% solution. The MECP Design Guidelines recommends a mixing time of 30 seconds for dechlorination. Based on the peak instantaneous design flow (7,728 m^3/day), the contact time requires a volume of 2.7 m^3.

The dechlorination system was sized using the peak instantaneous design flow (7,728 m^3/day) and minimum day flow (699 m^3/day) of the plant. A chlorine residual of 2 mg/L and 0.5 mg/L was assumed at peak instantaneous and minimum day flows, respectively. Based on a 40% sodium bisulphite solution, and assuming that 1.5 mg/L of SBS is required to neutralize 1 mg/L of chlorine, the operating range of the system of the system will be 1.0 to 49.0 L/day of sodium bisulphite. At the rated capacity (2,460 m^3/day) of the plant and assuming a chlorine dosage of 1.5 mg/L, the sodium bisulphite feed rate would be 10.6 L/day for a 40% sodium bisulphite solution. Additional details regarding dechlorination calculations and assumptions are available in Appendix A.

3.2 pH Requirements

Historically (2017-2019) the Red Lake WPCP effluent pH ranged from 5.9 - 7.9. While this is not a compliance issue with the current C of A, it will result in frequent non-compliance should the effluent pH criteria be revised to 6.5 - 9.5. As such, an alkalinity dosing system is recommended to assist the treatment process and meet future pH requirements. The Municipality has indicated that Sodium Carbonate (Soda Ash) powder is the preferred chemical for the pH adjustment system.

The pH adjustment system was sized using the peak instantaneous design flow (7,728 m^3/day) and minimum day flow (699 m^3/day) of the plant. An alkalinity addition of 100 mg/L and 50 mg/L was assumed at peak instantaneous and minimum day flows, respectively. Assuming these values, the operating range of the system will be 35 to 772 kg/day. At the rated capacity (2,460 m^3/day) of the plant and assuming an alkalinity addition of 75 mg/L, the soda ash feed rate would be 184 kg/day.

Based on historical flow data (2017-2019), the pH at the plant was below 6.5 approximately 25% of the time. Therefore, the actual consumable of the system based on historical average day flows will approximately 19.5 kg/day, or 278 L/day at a 7% soda ash solution.

It should be noted that additional alkalinity may also increase the nitrifying effect of the treatment process and may help to control the ammonia concentrations of the plant as an additional benefit of this chemical. Additional details regarding pH adjustment calculations and assumptions are available in Appendix A.

3.3 Total Phosphorus (TP) Removal

Historically the effluent TP averaged 1.38 mg/L and ranged from 0.61 – 2.16 mg/L (2017-2018). While this is not a compliance issue with the current C of A, it will result in frequent non-compliance should the effluent TP criteria be revised to 1.0 mg/L. As such, a phosphorus reduction system is recommended to assist the treatment process and meet future TP requirements. The Municipality has indicated that an alum solution is the preferred chemical for TP removal.

The TP removal system was sized using the existing rated capacity of the plant (2,460 m^3/day) and an alum dosing rate of 27.9 L alum/kg P removed. This results in a required alum dosing rate of 142 L/day of 48% liquid alum solution. Based on historical flows, the operating range of the system will be 40 – 142.0 L/day of alum. Additional details regarding TP removal calculations and assumptions are available in Appendix A.

3.4 Pre-Engineered Building

To house the proposed chemical systems, a new Chemical Metering and Storage Building will be required. Due to space restrictions on the site, the only location to construct the new Chemical Metering and Storage Building is in the same location as the existing sludge truck garage. As such, removal of the garage will be required. The Municipality has indicated that the existing garage is 40 years old and does not meet the future needs of the Red Lake WPCP.

The new building will be a pre-engineered structure with four (4) areas for each chemical system, a common vestibule, a small mechanical room, electrical room and a storage bay to house various wastewater equipment required at the plant. The building will be approximately 19.5 m x 15.7 m x 7.85 m high and will feature areas for maintenance and complete with roll-up doors.

3.5 Structural

This section provides the approach and methodology for the structural design criteria and proposed works for the conceptual design of the Red Lake WCPCP Chemical Metering and Storage Building. In general, the structural components will be designed according to relevant codes, standards, and industry best-practices to help achieve a 60-year life span.

The structural scope of work for the Red Lake WPCP Chemical Metering and Storage Building Preliminary Design consists of the design of a 19.5 m x 15.7 m structure that will accommodate one (1) west facing and one (1) east facing 4.3 m x 3.7 m (14’ x 12’) storage bay roll-up doors. The total building height will be 7.85 m from grade to eaves. Foundations will extend 2.6 m below grade to protect the foundations from frost heave. The building will be constructed as a structural steel pre-engineered building. The bottom 1.2 m of the building walls will be concrete work and above that will be metal cladding. The base slab will comprise of a slab-on-grade, bearing on well-compacted gravel and be reinforced with either steel reinforcement or steel fibres. Foundations to steel columns and stanchions will be pad foundations and the exterior block walls will be founded using strip footings. The interior walls of the structure will be of suitable finishes for the purpose of washing down and maintaining durability of the structure. The structural design will be reviewed and completed upon final design of the Pre-Engineered Building. Applicable Codes and Standards for the structures design are listed below in Table 3.1.

Table 3.1: Applicable Codes and Standards for Structural Design

Code/Standard	Description of Use
National Building Code and Structural Commentary Part 4	Strict use required; guidance for developing minimum acceptable environmental loads; structural commentary provides a detailed background on NBC design criteria.
Ontario Building Code	Strict use required for all buildings. Guidance for developing minimum acceptable loads for all other structures.
CSA A23.1/2 – Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete	Structural design of concrete components; concrete durability requirements; acceptable standards of concrete practice and methods of construction; guidance on chemical test methods, standard practices, test equipment, and cementitious materials used in concrete/masonry/mortar; one copy each will be provided on site during construction.
CSA A23.3 – Design of Concrete Structures	Structural design of concrete components.
CSA S304.1 – Design of Masonry Structures **CSA A179 – Mortar and Grout for Unit Masonry** **CSA A370 – Connectors for Masonry** **CSA A371 – Masonry Construction for Buildings**	Structural design of masonry, mortar, grout, and connector components; guidance on acceptable material uses and construction practices.
CSA S16 – Limit States Design of Steel Structures **CSA G40.20/21 – General Requirements for Rolled or Welded Structural Quality Steel**	Structural design of steel components; includes plates, shapes, hollow sections, sheet, cold-formed channels, Z sections, and bars for general construction and engineering purposes.
CSA S157 – Strength Design in Aluminum	Structural design of aluminum components.
CS SBI 30M – Standard for Steel Building	Structural design, fabrication, and erection of pre-engineered steel building systems.
Canadian Foundation Engineering Manual	Design of foundations and earth retaining structures.

The proposed design will be designed as "Post-Disaster" according to NBC designation, as this is the intended use. See Table 3.2, Table 3.3 and Table 3.4 for Building Code and Climatic Data, Unit Self Weight, and Minimum Design Live Loads, respectively.

Table 3.2: Building Code and Climatic Data for Red Lake

Criteria	Abbreviation	Design Value
Ground Snow Load (1/50 years)	Ss	2.6
Associated Rain Load (1/50 years)	Sr	0.3
Snow Load Importance Factor	Is (SLS) Is (ULS)	0.9 1.25
Reference Hourly Wind Pressure (1/50 years)	Q	0.30
Wind Load Importance Factor	Iw (SLS) Iw (ULS)	0.75 1.25
Wind Internal Pressures	Cpi	Category 2
Seismic Data	PGA PGV	0.041 0.025
5% Damped Spectral Response Acceleration Values (2% Probability of exceedance in 50 years)	Sa(0.2) Sa(0.5) Sa(1.0) Sa(2.0) Sa(5.0) Sa(10.0)	0.068 0.038 0.019 0.0076 0.0016 0.0008
Seismic Site Response	Soil Class	Class E
Seismic Importance Factor	Ie (SLS) Ie (ULS)	As per OBC 1.5

Table 3.3: Unit Self Weight

Material or Assembly	Unit Self Weight
Reinforced and Precast Concrete	24 kN/m³
Structural Steel	77 kN/m³

Table 3.4: Minimum Design Live Loads

Use of Area	Live Load
Construction on Ground	15 kPa
Storage	4.8 kPa

Use of Area	Live Load
Garages for loaded buses and trucks and all other trucking spaces	12.0 kPa
Roof	1.0 kPa

3.5.1 Geotechnical and Foundation Considerations

The proposed location of the new Pre-Engineered Building is in the north-east side of the Red Lake Water Pollution Control Plant. A geotechnical investigation will be required to determine suitability of subgrade material for construction. A conservative conceptual design for the purposes of this report have been completed, but final recommendations from a geotechnical consultant will be required prior to completing the detailed design of the building foundation.

3.5.2 Material Selection

Material selection plays an important role in achieving the desired service life of a structure. Suitable materials will be selected in accordance with code requirements to mitigate deterioration from potentially damaging environmental conditions. Table 3.5 lists a summary of potential structural materials and properties.

Table 3.5: Structural Materials and Properties

Structure	Material
Concrete for Foundations, Floors, and Walls	Low shrinkage < 0.04%, 35 MPa strength, Class C1, 30% slag
Anchors and Bolts	Anchor Bolts - ASTM A307 or ASTM A1554 Bolts/Nuts/Washers - Stainless Steel Type 316
Steel	Galvanized Steel ASTM A123

3.6 Architectural

This section provides the preliminary design of the proposed Chemical Metering and Storage Building. The report establishes various key design parameters, including sizing and dimension of major equipment, layouts and arrangement and presents the preliminary construction cost, schedule and sequencing.

The scope of work includes the demolition of the existing sludge truck garage and the construction of the new Chemical Metering and Storage Building at The Red Lake WPCP. The building contains five (5) distinct program areas: workshop bay area for storage and maintenance and four (4) separate chemical rooms for individual components. The disinfection, dechlorination, alkalinity adjustment and total phosphorus adjustment systems will all be accessible via a common vestibule.

A detailed holistic architectural design approach has been incorporated for the Red Lake WPCP which includes necessary measures to provide a sustainable, low maintenance, aesthetically pleasing industrial building with high consideration towards efficiency and cost-effectiveness. Current site conditions and characteristics such as topography, vegetation, orientation, site access, and location of major services are key site components that will be taken into consideration for a holistic design approach.

The new Chemical Metering and Storage Building will be located in the north-east corner of the existing wastewater facility site and serviced by the existing WPCP driveway. Parking in front of the Chemical Metering and Storage Building is not required though access to storage bay will be necessary for storage of various wastewater equipment. As such extra room in front of the Chemical Metering and Storage Building will be provided to ensure ease of maneuvering in and out of the bay.

3.6.1 Building Classification and fire Protection

The new Chemical Building is classified under OBC 3.2.2.83, Group F, Division 3, one storey Non-Sprinkler Building. Note that the major occupancy classification of Group F, Division 3 is defined as a Low Hazard Industrial Occupancy.

Presently, the two National Codes which affect the fabric of building in Red Lake, Ontario are the latest versions of the Ontario Building Code (OBC) and the National Fire Code of Canada. Related regulations are the Industrial Health and Safety Act, the Technical Standards Safety Authority – Fuel Safety Regulations, the Technical Standards Safety Authority – Pressure Vessel Regulations, and the Explosives Regulatory Division of the Ministry of Natural Resources Canada. The National Electrical Code would also govern the electrical installation at the facility.

3.6.1.1 Ontario Building Code (OBC)

The objective is to provide the Red Lake WPCP Chemical Metering and Storage Building with an acceptable level of Life Safety with respect to regulatory Building, Fire Code, and operational process related matters; including building fire separation walls, egress requirements, and process related exterior and interior building environment spatial separation.

The building code and life safety provisions that would be considered include:

- Occupancy classification and separation – OBC designation
- Occupancy load
- Life safety, exit and egress requirements
- Fire resistance / separation requirements

- Alarm and detection systems
- Fire fighting service provisions, building access and remote annunciation
- Fire suppression / sprinklers (class D occupancy) and portable extinguishers F2 occupancy
- Emergency communication and alarms
- Smoke control / ventilation

3.6.1.2 National Fire Code (NFC)

The National Fire Code is a regulation under the Fire Marshals Act. For the most part, the NFC is a maintenance document addressing the mitigation of fire hazards in the ongoing use of a building or property.

3.6.1.3 Industrial Health/ Safety Act

The Industrial Health and Safety Act deals with safety issues within the workplace as they relate to the facility and its operation to the extent of related Building and Fire Code life safety requirements.

3.6.2 Building Exterior Materials and Finishes

The building façade would be designed to match the existing surrounding buildings as well as to provide a pleasing aesthetic appearance to the public.

The exterior of the building would incorporate the following features:

- Aesthetically pleasing exterior - The exterior of the building would be designed to blend with the existing Red Lake WPCP buildings, while also serving as a focal point for the surrounding area. Insulated metal panel with colours to match the surrounding buildings is the proposed exterior finish material to match existing building on site.
- Security will be provided through the installation hollow metal man doors and rolling up door.
- Energy efficient roofing will be provided, through the use of a ‘reflective colour’ sloped pre-finished insulated ‘roof panel’.

3.6.3 Building Envelope

The building envelope would incorporate the following features:

- Exterior Walls – Up to 1200mm above finished floor – architectural split face concrete block with Insulation Value RSI 3.52 (R12) and prefinished insulated metal wall panels to the roof.
- Roof - Insulation Value: RSI:5.28 (R30): pre-finished insulated metal roof panels.
- Floors: Main floor is slab in grade concrete with 50mm underslab rigid insulation and A/V barrier. Epoxy ceiler will be applied as protective finish.

3.6.4 Doors and Windows

Exterior doors will be designed with insulated hollow metal, 16 gauge (1.5mm) with thermally broken hollow metal frames. Door frames will be insulated with low density spray polyurethane foam or batt type mineral wool insulation. All doors will to be painted and hollow metal doors and frames will be installed with stainless-steel lever door hardware. All doors will be provided with panic and push bars for egressing.

3.6.5 Wall Louvres

Where indicated, proposed aluminum exterior wall louvres with bird/bug screen will incorporate high-performance gauge aluminum extrusions complete with a drainage system and aluminum insect screens. The specified louvre aluminum will be etched and given a chromate conversion pre-treatment before application of the finish coating. Louvres will be finished with a minimum 1.4 mil (0.035 mm) full strength 70% resin, 3 coat fluoropolymer system.

3.6.6 Miscellaneous Accessories

Building signage systems will be developed based on consultation the Municipality of Red Lake and Northern Waterworks Incorporated (NWI) to match existing facility standards.

3.7 Electrical

3.7.1 Existing Power Supply

Power to the plant is supplied by Hydro One from a bank of three (3) pole mounted transformers located inside the plant premises (Figure 3.1). Information about the rating and primary voltage of the transformer is not available from the as-built drawings, but the visual inspection of transformer and the main MCC breaker rating of 400A (as per as built drawings) suggests that the transformer to be 300 kVA.

Figure 3.1. Existing Pole Mounted Transformer

Underground secondary directly buried TECK cables are run from the transformer secondary to the existing MCC main breaker inside the administration building. Refer to Figure 3.2 for existing as-built site plan. The MCC is supplied by Allen Bradley (Bulletin 2100) and rated at 600V, 800A. Although the MCC appears to be in good condition with two (2) spare buckets available for future upgrades, it is approximately 40 years old and may need to be replaced with a new unit in the future.

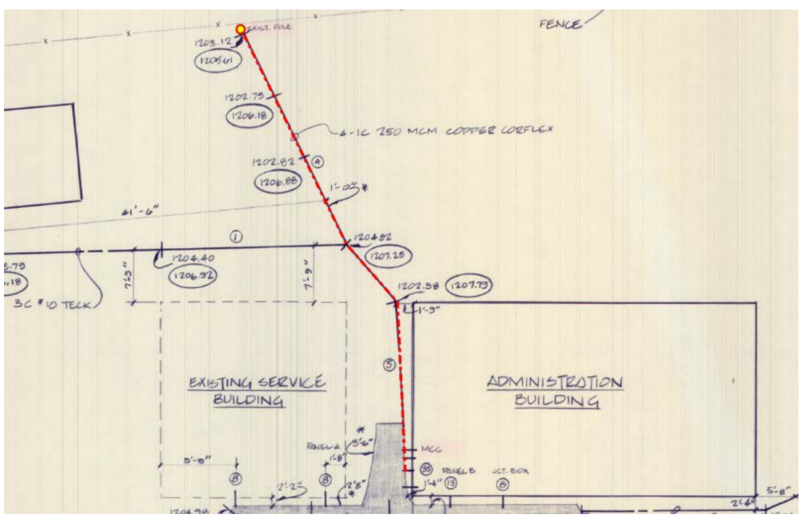

Figure 3.2. Existing Electrical Site Plan

3.7.2 Existing Average and Peak Demand Loads

The Average Demand Load from January 2019 to November 2019 (11 months) was 66 kVA and the Peak Demand Load was 86 kVA. Assuming that the existing transformer has a rating of 300 kVA and following the historical demand profile, there is sufficient spare capacity available to meet the estimated power demand of the proposed upgrade.

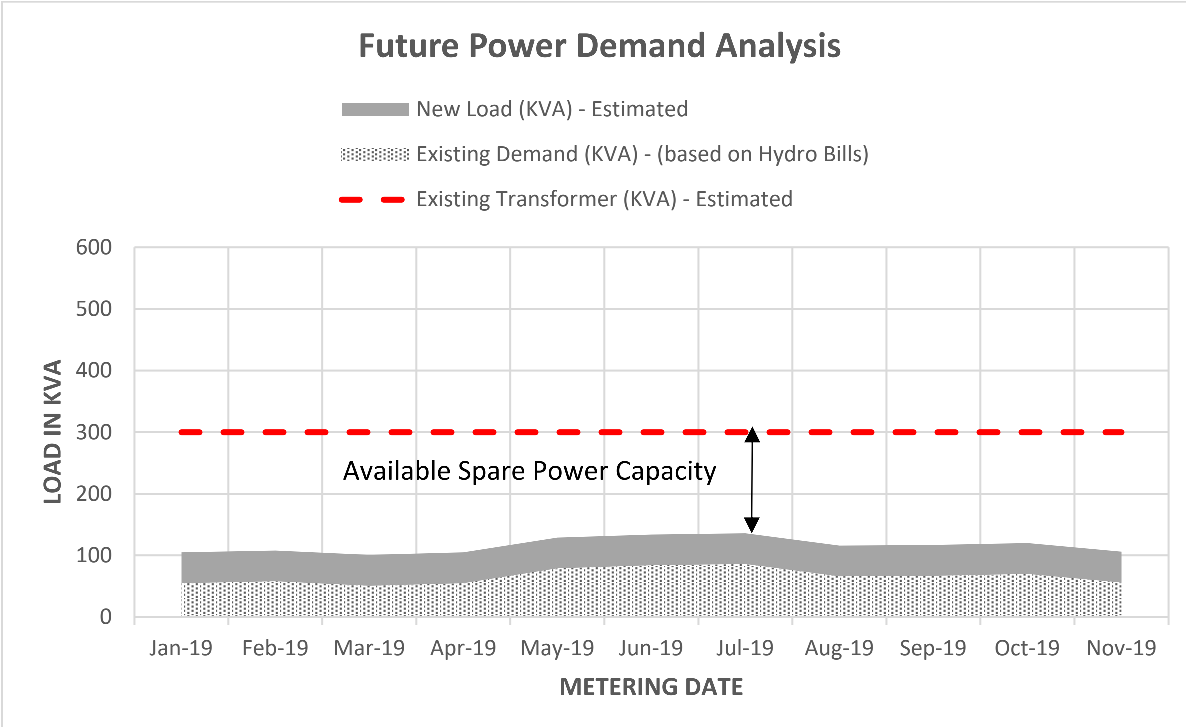

Figure 3.3. Graphical Load Analysis

3.7.3 Load Analysis and Generator Sizing

Based on discussions with the Municipality, the emergency generator is to be an exterior grade natural gas generator and should have sufficient power to power the following:

- Existing WPCP processes and equipment;
- New chemical metering and storage building;
- The municipalities public works yard located adjacent to the WPCP; and,
- Municipal Lift Station #3 located on the same street as the WPCP.

Based on the load analysis for the plant and the conceptual design, a 300 kW generator will be required to provide sufficient emergency power. Refer to Appendix B for the electrical load analysis.

3.8 Mechanical

3.8.1 Heating, Ventilation and Air Conditioning

Heating, ventilation, and air conditioning (HVAC) considerations for the Chemical Metering and Storage Building at the Red Lake WPCP included minimum general and chemical storage ventilation rates, increased rates for periods of high ventilation or occupancy, and supplemental building heating to maintain minimum setpoints at design heating days for the geographical region. The building is divided into the Chemical Rooms, Storage Bay, Electrical and Mechanical Rooms, and a Vestibule. Applicable codes included:

- ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality
- Ontario Building Code
- NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities

Preliminary outside air ventilation rates were completed for each space of the Chemical Metering and Storage Building. Ventilation rates for the Chemical Rooms, Vestibule and Utilities Rooms, and Storage Bay were determined for minimum breathing space ventilation (LOW). Additional high level exhaust (HIGH) rates for purging gas or odour build-up for periods of occupancy were determined for the Chemical Rooms (at chemical storage room minimum exhaust rates) and Storage Bay (at three (3) air changes per hour (ACH)). The Vestibule would be supplied excess supply air in addition to the ventilation rate to induce positive pressure in the space and prevent migrating gases and odours from the chemical/storage areas. Ventilation rates are defined as shown in Table 3.6.

Table 3.6: Ventilation Rates

Zone	Occupancy Category	Area (m^2)	Area Outdoor Are Rate ($L/s\cdot m^2$)	Total LOW (L/s)	Total HIGH (L/s)
Chemical Storage Room 1	Occupiable storage rooms for liquids or gels	17.9	0.6	10.7	136.0
Chemical Storage Room 2	Occupiable storage rooms for liquids or gels	17.9	0.6	10.7	136.0
Chemical Storage Room 3	Occupiable storage rooms for liquids or gels	17.9	0.6	10.7	136.0
Chemical Storage Room 4	Occupiable storage rooms for liquids or gels	17.9	0.6	10.7	136.0
Storage Bay	Warehouses	141.6	0.3	42.5	708.4
Vestibule & Utilities	Corridors	40.7	0.3	12.2	N/A
Total		**254**		**98**	**1,265**

Ventilation will be provided to the Chemical Metering and Storage Building using exhaust and supply fans and interlocked intake/exhaust motorized dampers.

Preliminary heating loads were determined for minimum outside air ventilation requirements (LOW setting) and for building envelope heating requirements for the entire Chemical Metering and Storage Building. Continuous heating at HIGH ventilation will not be provided, HIGH ventilation setting will be used explicitly for exhausting gases and odours from the chemical/storage areas and not for extended or continuous operation. Preliminary heating load calculations were completed using design day temperature data for the geographical region, heating requirements are summarized in Table 3.7.

Table 3.7: Heating Requirements

Heating Load	Assumptions	Load (kW)
Ventilation	- Maintain minimum temperature of 10 °C at minimum outside air ventilation rate - Annual Heating and Humidification Design Conditions – Red Lake Airport	5.5
Building Envelope	- Assumed 18.9 kW/100 m2 (6,000 BTUH/100 ft2)	48.1
	Total Heating	**53.6**

Ventilation and building envelope heating loads will be satisfied using in-slab hydronic heating loops. Ventilation heating will be provided for LOW ventilation. Additional heating demand in excess of the in-slab system capacity will be provided by electric unit heaters.

3.8.2 Plumbing

Plumbing requirements for the Chemical Metering and Storage Building includes domestic water service for the Chemical Storage Rooms and Storage Bay washdown (six (6) hose bibs total), chemical process make-up water, and service to four (4) eyewash stations. Hot and cold service water hydraulic fixture loading is summarized in Table 3.8.

Table 3.8: Hydraulic Fixture Loading

Item	Quantity	Cold Fixture Units per Item	Hot Fixture Units per Item	Total Fixture Units per item	Total Fixture Units	Min. Fixture Service Size (mm)
Eye wash stations	4	2.0	2.0	3.0	12.0	13
Hose bibbs	6	2.5	-	2.5	15.0	13
Soda ash make-up water connection	1	3.0	-	3.0	3.0	13
Total Fixture Units and Building Service					**30.0**	**40**

Sanitary service piping will be PVC-DWV in accordance with CSA B181.2 PVC Drain, Waste, and Vent Pipe and Pipe Fittings. Table 3.9 dictates the sanitary fixture units schedule and corresponding minimum sanitary service size for the building.

Table 3.9: Sanitary Fixture Loading

Item	Quantity	Fixture Units per Item	Total Fixture Units
Floor drain (75 mm trap)	7	3.0	21.0
Eyewash stations (50 mm trap)	4	3.0	12.0
Total Fixture Units			**33.0**
Minimum Service Size (2% Slope)			**100 mm**

3.9 Site Civil

3.9.1 Building Services

Service requirements for the new Chemical Metering and Storage Building will include potable water for plumbing and a new sump and forcemain for wastewater. As such, the following minimum services are required:

- 40 mm diameter PVC connected to existing 40 mm (assumed) diameter potable water lines located in the Service and Administration Buildings. The service requires a minimum depth of 2.6 m or equivalent insulation will be provided. Based on discussions with operations, they wish to increase the water service to site. As such, a new 100 mm diameter service connected to the existing watermain located on Young St. will be required.

- New sump in the Chemical Metering and Storage Building with a 100 mm PVC/ HDPE forcemain that drains to the headworks building. The forcemain will be buried at a minimum depth of 2.6 m and will be heat traced to prevent freezing.

3.9.2 Chemical Feed Lines

Chemical feed lines are required for injecting the various chemicals at the correct location of the treatment process. As such, the following is required:

- Disinfection: A 100 mm diameter insulated and heat traced PVC pipe to the existing chlorine contact tank.
- Dechlorination (SBS): A 100 mm diameter insulated and heat traced PVC carrier pipe and 10 mm diameter PTFE chemical tubing. The tubing will be from the new Chemical Metering and Storage Building to the chlorine contact tank effluent v-notch weir.
- Alkalinity Adjustment (Soda Ash): 100 mm diameter insulated and heat traced PVC carrier pipe and 10 mm diameter PTFE chemical tubing. The tubing will be from the new Chemical Metering and Storage Building to the Grit Channel.
- Total Phosphorus Removal (Alum): Three (3) 100 mm diameter insulated and heat traced PVC carrier pipe and 10 mm diameter PTFE chemical tubing. The tubing will be from the new Chemical Metering and Storage Building to the headworks and to the end of the aeration tanks in Treatment Unit #1 and Treatment Unit #2, respectively.

3.9.3 Site Works

Proposed site works for the Red Lake WPCP include the following:

- Relocation/removal of a shed, seacan and demolition of the existing sludge truck garage at the north east corner of the property to allow for construction of the new Chemical Metering and Storage Building;
- Removal of the existing catch basin located south of the existing sludge truck garage;
- New natural gas service line form Young street to service new 300 kW emergency generator. Confirmation on service size from local gas utility is required;
- Site grading to provide proper drainage around the new Chemical Metering and Storage Building;
- New Chemical Metering and Storage Building foundation;

- New generator pad; and,
- Installation of a concrete or metal weir in the 2nd effluent maintenance hole (MH) to provide dechlorination contact time in the existing outfall MH and piping.

3.10 Additional Works

In addition to the new Chemical Metering and Storage Building, the Municipality has indicated that additional related infrastructure requires replacement should capital funding become available. For this project, these include:

- Replacement of the main lift station (Lift Station #1) forcemain which pumps to the WPCP and recently has experienced extensive breaks;
- Extension of lift station #4 forcemain to the WPCP; and,
- Replacement of the existing headworks building which is in a state of disrepair.

These additional items have not been included in this preliminary design report but will be included in any capital funding request to be completed in conjunction with the Chemical Metering and Storage Building upgrades at the plant.

4.0 PROPOSED WORKS

4.1 Process Upgrades

Process works for the proposed Chemical Metering and Storage Building will include a new disinfection system, dechlorination system, alkalinity adjustment system and TP removal system. The systems will require new yard piping for injections at various locations into the plant.

4.1.1 Disinfection System

Disinfection at the Red Lake WPCP will be switched from a chlorine gas system to a liquid sodium hypochlorite feed system. The process works for the dosing system will generally be comprised of the following components:

- Two (2) solenoid-driven diaphragm metering pumps (one duty, one standby);
- Pressure gauges, pressure relief valves, back pressure valves, isolation valves, calibration column, lot of fittings & tubing, terminal box, HDPE board and float switch; and,
- Two (2) 1800L chemical tanks.

The new sodium hypochlorite system will be placed in the new Chemical Metering and Storage Building. The solution will be mixed with water and reconnected to the existing chlorine distribution line located at the chlorine contact tank. Pump control will be available manually at the pump or through the SCADA system at the plant.

4.1.2 Dechlorination System

The dechlorination system for the Red Lake WPCP will utilize a liquid Sodium Bisulphite solution. The process works for the dosing system will generally be comprised of the following components:

- Two (2) solenoid-driven diaphragm metering pumps (one duty, one standby);
- One (1) Oxidation Reduction Potential (ORP) analyzer (to be placed in the effluent MH);
- Pressure gauges, pressure relief valves, back pressure valves, isolation valves, calibration column, lot of fittings & tubing, terminal box, HDPE board and float switch; and,
- One (1) 1000L chemical tank.

The new SBS system will be placed in the new Chemical Metering and Storage Building. To allow for the appropriate contact time volume of 2.7 m^3, the SBS solution will be injected at the effluent v-notch weir to allow for turbulent flow/mixing. A concrete or metal weir (approximately 1 m in height) will be placed in the 2nd effluent MH and will flood the upstream piping and MH to provide the required contact time for the SBS.

The amount of SBS required will depend on the measured flow of the plant effluent, and the measured chlorine residual, in the form of oxidation reduction potential (ORP), of the effluent flow. A signal from the plants ORP transmitter will be sent to the SBS flow controller, which can adjust the SBS dosage in relation to both flow and ORP. The ORP will be installed in the 2nd effluent MH to monitor total residual chlorine in the effluent leaving the plant. If the ORP sensor indicates a chlorine residual reading in excess of the allowable discharge concentration of 0.02 mg/L, a signal will be transmitted to the SBS system which will adjust the SBS dosage accordingly.

4.1.3 Alkalinity Adjustment System

The alkalinity adjustment for the Red Lake WPCP will be completed using Sodium Carbonate (Soda Ash) powder and mixing the powder into a 7% soda ash solution. The process works for the dosing system will generally be comprised of the following components:

- Two (2) solenoid-driven metering pumps (one duty, one standby);

- Pressure relief valves, back pressure valves, isolation valves, calibration column, lot of fittings & tubing, pressure gauge, and Control Box;
- Two (2) tank mixers; and,
- Two (2) 1400L chemical tanks.

The soda ash system will be placed in the new Chemical Metering and Storage Building. The solution will be injected into the existing grit channel in the headworks building. The pH will be monitored manually and the operators will adjust the soda ash dosages as required. Pump control will be available manually at the pump or through the SCADA system at the plant.

4.1.4 Total Phosphorus (TP) Removal System

Phosphorus removal will be completed using a liquid alum solution. The process works for the dosing system will generally be comprised of the following components:

- Three (3) solenoid-driven metering pumps (two duty, one standby);
- Pressure relief valves, back pressure valves, isolation valves, calibration column, lot of fittings & tubing, pressure gauge, and Control Panel with Automatic Switch-Over; and,
- Two (2) chemical tanks with a minimum combined 5000 L of storage.

The alum solution will be injected in both Sewage Treatment Units at the end of the aeration process, as well as into the raw water in the headworks building. The amount of alum required will depend on the measured flow of the plant effluent. Pump control will be available manually at the pump or through the SCADA system at the plant.

4.2 Structural

4.2.1 Structures Above Grade

The building superstructure will be designed for the following loads:

- building self-weight;
- roof live loads;
- snow;
- wind; and,
- earthquake.

Table 4.1: Building Systems and Chosen Designs

Building System	Chosen Design
Primary Structural Support	Steel portal frame made from tapered wide-flanges
Secondary Structural Support	Steel z-girts for the roof, steel channels for the walls Internal steel bracing along the perimeter and roof
Floor	Concrete slab-on-grade reinforced with either conventional rebar, steel fibers, synthetic fibers, or a combination of rebar and fibers for a minimum loading of 12.0 kPa to accommodate trucks and vehicles parked in the facility
Foundations	Portal frames supported on concrete pedestals and spread footings Exterior walls founded on concrete strip footings Internal walls founded on slab on grade Floor founded on structural fill Spread/strip footings founded on competent undisturbed native soil, structural fill, or bedrock
Structural Fill	Granular A for top 300 mm and Granular “B” Type I or Granular “B” Type II (OPSS 1010) material,

For seismic analysis, the building is deemed a post-disaster structure.

4.2.2 Durability

The facility will be located at the Red Lake WPCP and will be near the vicinity of other structures used for conveying and storing treated/untreated sewage that are exposed to harsh environmental conditions such as submergence, spray, wetting/drying, chemicals, debris, and ice. The structure will be designed with consideration given level of exposure to these environmental conditions in accordance with the applicable codes and standards.

4.2.3 Material Selection

Material selection plays an important role in achieving the desired service life of the structure. Suitable materials will be selected in accordance with code requirements to mitigate deterioration from potentially damaging environmental conditions. The structural materials for this scope of work will be reinforced concrete, masonry blockwork, and structural steel.

4.2.3.1 Reinforced Concrete

The foundation and base slab will be made with cast-in-place reinforced concrete using an A1 concrete mix, with adequate cover and concrete requirements per Table 4.2. An extended foundation at the perimeter walls will be included to a height of 1200 mm to protect the insulated panel shell from damage where heavy equipment will be manoeuvred and stored.

Table 4.2: Concrete Requirements

Durability Requirement	Concrete Requirement
Minimize Cracking	Low-shrink concrete (<0.04%) Supplementary Cementing Materials (>30% Slag) Limit Water to Cement Ratio (<0.4)
Low Permeability	Supplementary Cementing Materials (>30% Slag) Limit Water to Cement Ratio (<0.4)
Chemical Resistance	Supplementary Cementing Materials (>30% Slag) Limit Water to Cement Ratio (<0.4)
Protection of Reinforcing Steel	Concrete Cover (60-75 mm)

4.2.3.2 Structural Steel

Structural steel will be used for the portal frame and superstructure of the facility. A suitable steel corrosion protection and coating application will be specified accordingly.

4.2.3.3 Miscellaneous Metals

Miscellaneous metals components will be used for many secondary structural elements. Stainless and galvanized steel, and aluminum will be primarily used for miscellaneous metals fabrications due to their high resistance to chemical attack and corrosion.

4.3 Electrical

As part of the upgrades the existing underground supply will be directed to a new 600V, 3 phase MCC installed in a dedicated electrical room in the Chemical Metering and Storage Building. The MCC will have an integral ATS section to switch power from normal to emergency in case of utility failure. The new MCC will feed the existing MCC in the administration building. Provision will be provided in the new MCC to power adjacent public yard building in future and Lift Station #3.

4.3.1 Standby Power Supply

There is no backup power available on site. As part of the new upgrades a 300 kW outdoor natural gas generator with tight fit sound proof enclosure will be provided. The generator will be sized based on the existing and new critical load of the plant plus the load of the adjacent public works yard building. An outdoor load bank connection box will be provided as part of the design to facilitate testing of the generator.

4.3.2 Lighting Design

Lighting for the new building would be via high efficiency LED fixtures, controlled by occupancy sensors with manual override option. Emergency lighting and exit signage would be provided as per Building Code.

4.4 Control and Instrumentation

This section provides the approach and methodology for control and instrumentation design criteria and proposed work for the conceptual design of the Red Lake WPCP.

The work includes providing four individual ultrasonic level transmitters on each day tank for storage of Soda Ash, Alum, Sodium Hypochlorite and Sodium Bisulphite chemicals. There will be four different skids, with two pumps per skid, to control the dosing of each chemical. As per requirement, four (4) new eye wash stations have been considered along with flow switches.

Following equipments' signals will be connected to the PLC:

1. Ultrasonic level transmitters
2. Skid pumps' signals
3. Flow switches for new eye wash stations
4. ORP Signals
5. New standby generator and ATS signals

All signals that are to be connected to the PLC also require configuration in the SCADA HMI.

The existing PLC make, and model is a Schneider M340 which does not support Ethernet Remote I/O options. Based on this fact, there are three different options available for connecting the new building I/Os to the existing SCADA system. These options include:

1. Rebuild the existing control panel with a bigger panel size so the new I/O module rack can be added, along with required terminals in the same panel, as there is no space to accommodate the new rack and terminals. However, this will require a shutdown of this panel as well as the plant.
2. Consider a new panel with a new PLC controller in the new building Electrical Room. With this approach, the existing controller and operation will not be affected, and the new

I/Os will be connected to the existing SCADA system seamlessly. With this option, field instrument cable run will be less from new building to existing control panel location.

3. Consider a new panel just beside the existing panel for connecting all new I/Os. The only limitation with this option is the extension cable from the existing rack to the new rack (in new panel) cannot go beyond 12 meters in length. With this option, the controller will remain the same (in the existing panel) for all new I/Os, with an additional rack in a different panel.

It is recommended to move forward with option #2, a new PLC controller in the new building, though these options can be further evaluated during detailed design.

4.5 Mechanical

4.5.1 Heating, Ventilation and Air Conditioning

The Chemical Metering and Storage Building areas will have independent ventilation systems for operation at LOW and HIGH ventilation settings. The Chemical Storage Rooms will each be ventilated by a sidewall 2-speed exhaust fan (EFs 3 through 6) with an interlocked modulating motorized damper (MDs 2 through 5) to provide fresh air intake. All Chemical Storage Rooms will exhaust to atmosphere through the north wall and intake air through louvers on the east or west walls, with ducted supply air for interior rooms with no east or west perimeter wall. Hydronic heating will be provided by in-slab hot water loops fed from the combination boiler (BO-1) located in the Mechanical Room. Heating will be supplied to offset LOW ventilation rates and building envelope losses.

The Vestibule and Utilities Rooms will be provided 14 L/s of outside air by a wall mounted supply fan (SF-1) located at the west wall. SF-1 will be interlocked with a motorized damper (MD-6) situated at a louver opening in the east wall. The Vestibule will be provided 10% excess supply air to maintain positive pressure throughout the space and prevent migrating chemical or sludge gases. The Vestibule ventilation and building loss heating demand will be satisfied by the in-slab hydronic heating system, with supplementary heating provided by an electric unit heater (EUH).

The Storage Bay will contain wall mounted exhaust fans at rated capacities of 43 L/s (EF-1) and 708 L/s (EF-2) for LOW and HIGH ventilation respectively. EF-1 and EF-2 will be interlocked with motorized intake dampers MD-7 and MD-1 respectively. Heating will be provided by the in-slab hydronic loop and EUHs.

Control of the Chemical Storage Rooms ventilation will be by individual OFF/LOW/HIGH manual switches located in the Vestibule. Control of the Vestibule SF will be by H/O/A switch located at the SF inside the Vestibule entrance. The Storage Bay ventilation system will be controlled by OFF/LOW/HIGH manual switch located in the Storage Bay. The in-slab heating system will be provided with temperature sensors in the Vestibule, the Sludge Truck Bay, and a perimeter Chemical Storage Room for independent hot water loop temperature control in the three separate areas (Vestibule/Utilities, Storage Bay, Chemical Storage Rooms). Temperature setpoints and loop control will be by a system controller in the Mechanical Room.

4.5.2 Plumbing

The Chemical Metering and Storage Building plumbing will consist of an incoming 40 mm service water line to serve eyewash stations, hose bibbs, and chemical process make-up water requirements. A gas fired combination hot water and heating boiler will provide hot water for the domestic hot water lines and hydronic heating loop. Domestic water piping will be hard drawn copper tube, type L, conforming to ASTM B88M – Standard Specification for Seamless Copper Water Tube. The building sanitary will drain to a sump pump located in the Storage Bay and subsequently pumped to the headworks building. The sump pump will discharge to the WPCP sanitary system at a minimum flowrate to satisfy the theoretical sanitary fixture load of the building adjusted for intermittent use (33.0 FU, 1.7 L/s).

4.6 Conceptual Design Drawings

Conceptual Design Drawings for the Chemical Metering and Storage Building, site plan and chemical system have been developed and are located in Appendix C.

5.0 COST ESTIMATE

5.1 Disinfection and Building Upgrades

The following estimate is provided for the construction of the new Chemical Metering and Storage Building and associated upgrades. Based on the proposed upgrades outlined in this preliminary design report, the order of magnitude cost estimate (+/- 25%) is as follows:

Table 5.1 – Chemical Systems and Building Cost Estimate

	Cost
Section I – Direct Costs	
General Requirements	$180,000
Removals	$30,000
Site Works	$305,000
Process	$360,000
Building Architectural/Structural	$869,500
Control & Instrumentation	$136,000
Mechanical	$136,000

Electrical	$400,000
Contingency	$250,000
Total Section I =	**$2,666,500**
Section II – Indirect Costs	
Design and Construction Services	$162,000
Geotechnical Engineering	$10,000
Material Testing and Quality Control Allowance	$5,000
Permits/Approvals allowance	$3,000
Total Section II =	**$180,000**
Total Section I & II =	**$2,846,500**

Notes: 1) Amounts do not include taxes.
2) Estimate developed prior to completion of geotechnical investigation.
3) Estimate does not include repair/replacement of local sanitary or storm sewers.

5.2 Additional Works

Based on discussions with the Municipality, high level cost estimates (+/- 50%) were completed for the forcemain and headworks building, they are outlined as follows:

Table 5.2 – Forcemain and Headworks Building Cost Estimate (+/- 50%)

	Cost
New Forcemain Lift Station #1	$1,250,000
Headworks Upgrades	$250,000
Contingency (20%)	$300,000
Engineering	$145,000
Total Section I =	**$1,945,000**

Notes: 1) Amounts do not include taxes.
2) Estimate developed prior to completion of geotechnical investigation.
3) Forcemain estimate includes trench restoration to match existing (not full road reconstruction).
4) Estimate does not include repair/replacement of local sanitary or storm sewers.
5) Engineering estimate includes detailed design, contract administration (part-time), inspection (3 months full time), and geotechnical.

6.0 CLOSURE

We trust this report meets your current needs. Should you require any additional information, please do not hesitate to contact the undersigned.

Yours very truly,

R.V. ANDERSON ASSOCIATES LIMITED

LICENSED PROFESSIONAL ENGINEER
J. D. RANGER
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Jan. 22, 2020
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PROVINCE OF ONTARIO

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APPENDIX A

Chemical System Sizing and Selection Technical Memorandum

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TECHNICAL MEMORANDUM

TO:	Todd Olson, Municipality of Red Lake	**RVA:**	194666
FROM:	Joshua Ranger, P.Eng., Stephanie Pascal, EIT		
DATE:	January 22, 2019		
SUBJECT:	Red Lake WPCP Chemical System Sizing and Selection- Final		

1.0 BACKGROUND

The Red Lake Water Pollution Control Plant (WPCP) consists of preliminary treatment (screening and grit removal), aeration, clarification and chlorination before discharging into Howey Bay. The Red Lake WPCP is owned by the Municipality of Red Lake and operated by Northern Waterworks Incorporated (NWI). On January 1, 2015, the Federal Government of Canada's Federal Wastewater Systems Effluent Regulation (WSER) came into effect and limited the discharge concentration of Total Residual Chlorine (TRC) to 0.02 mg/L. As per WSER SOR/2012-139, all plants that have a capacity less than 5,000 m^3/day must comply with the TRC concentration by January 1, 2021.In addition, new pH and Total Phosphorus (TP) limits will be required for the WPCP. It is the goal of the Municipality to complete upgrades to meet future TRC and effluent requirements. This technical memorandum outlines required upgrades to meet new disinfection, pH and TP requirements n a new Environmental Compliance Approval (ECA).

2.0 EXISTING CONDITIONS

The Red Lake WPCP has a rated capacity of 2,460 m^3/day and currently operates under an existing Certificate of Approval (C of A) No. 3-1060-81-826, dated August 19,1993. The existing C of A has treated effluent requirements for BOD_5(15 mg/L) and total suspended solids (30 mg/L) but lacks additional effluent requirements and effluent limits. Sampling at the WPCP is completed as per the Ministry Procedure F-10-1 and is designed to comply with the WSER. The following parameters are sampled in the process effluent:

- Carbonaceous BOD;

- Total Suspended Solids;
- Total Ammonia Nitrogen;
- Total Phosphorus;
- Total Kjeldahl Nitrogen;
- Nitrate;
- Nitrite; and,
- E.Coli

The average effluent parameters as provided in the NWI Red Lake WPCP annual reports (2017 and 2018) are summarized in Table 2.1 below.

Table 2.1: Effluent Quality Data and Characteristics

	2017	2018	Average	Peak
CBOD5 (mg/L)	2.44	2.73	2.59	4.90
TSS (mg/L)	5.33	6.56	5.95	8.40
Total P (mg/L)	1.27	1.49	1.38	2.16
TKN (mg/L)	1.73	1.90	1.81	3.29
TAN (mg/L)	0.16	0.50	0.33	3.10
Nitrate (mg/L)	15.8	15.6	15.7	22.0
Nitrite (mg/L)	0.05	0.03	0.04	0.11
E. Coli (MPN/100mL)	519	460	489	>2420

An amended C of A for the Red Lake WPCP will be required for the upgrades and would likely have additional compliance requirements for TP and pH. Based on similar WPCP, TP effluent requirements are expected to be below 1.00 mg/L and pH effluent requirements are expected to be between 6.5 to 9.5. Based on historical effluent quality data, the Red Lake WPCP would not achieve the required total chlorine residual limit and would have difficulty meeting TP and pH limits consistently.

Daily average and peak inflows as provided in the WPCP annual reports and Red Lake WPCP Data from 2017, 2018 and 2019 are summarized in Table 2.2 below.

Table 2.2: WPCP Average and Peak Daily Sewage Inflows

Year	Average Daily Inflow (m^3/day)	Peak Daily Inflow (m^3/day)
2017	1,009	2,294
2018	1,009	2,251
2019	1,088	4,278
Average =	1,035	2,941

As shown in Table 2.2, the 3-year average day flow at the WPCP is 1,035 m^3/day which indicates that the plant is operating at approximately 42% of its design capacity on average. The highest peak daily flow measured through the plant occurred in 2019 was 4,278 m^3/day, which represents a peak day flow (PDF) peaking factor of 4.1. The peak instantaneous design flow is 7,728 m^3/day which combines the maximum hydraulic capacity (5,649 m^3/day) and the by-pass flow (2,079 m^3/day) for the plant. The maximum pumping capacity of the lift stations entering the plant does not exceed the peak instantaneous design flow. As such, the chemical systems were sized based on the peak instantaneous design flow for the WPCP.

3.0 CHEMICAL CALCULATIONS

3.1 Disinfection and Dechlorination Requirements

Similar to ECA requirements for other WWTP, the effluent limit and effluent objective for E. coli are assumed to be 200 cfu/100 ml and 150 cfu/100 ml monthly geometric mean density, respectively. The Municipality has chosen to continue to disinfect at the Red Lake WPCP using chlorine. Common chemicals used for chlorine disinfection include chlorine gas and sodium hypochlorite solution.

3.1.1 Chlorination

3.1.1.1 Chlorine Gas

The Ministry of Environment, Conservation and Parks (MECP) Design Guidelines for Sewage Works states that for an activated sludge WPCP, the typical chlorine dosage is between 2 mg/L and 9 mg/L for the process effluent. A value of 6.5 mg/L was assumed for calculating the Max Feed Rate for the facility. Under this assumption and a maximum plant flow rate of 89.4 L/s (7,728 m^3/day), the chlorine design maximum feed rate would be:

Max. Feed Rate = (6.5 mg/L) x (89.4 L/s)

= (581.1 mg/s) x 60 s/min x 60 min/hr x 24 hr/d x (1 kg/1,000,000 mg)

= 50.2 kg/d

The daily rated capacity flow rate at the Red Lake WPCP is 2,460 m^3/day, therefore, assuming an average flow rate of 28.5 L/s and a chlorine dosage of 6.5 mg/L, the design average feed rate would be:

Avg. Feed Rate = (6.5 mg/L) x (28.5 L/s)

(Rated Capacity) = (185.3 mg/s) x 60 s/min x 60 min/hr x 24 hr/d x (1 kg/1,000,000 mg)

= 16.0 kg/d

The current average flow rate at the Red Lake WPCP is 1,035 m^3/day (2017-2019), therefore, assuming an average flow rate of 12 L/s and a chlorine dosage of 6.5 mg/L, the current average feed rate would be:

Avg. Feed Rate = (6.5 mg/L) x (12 L/s)

(Current Flows) = (78 mg/s) x 60 s/min x 60 min/hr x 24 hr/d x (1 kg/1,000,000 mg)

= 6.7 kg/d

The current minimum day flow at the WPCP is 8.1 L/s (699 m^3/day), therefore, assuming a minimum chlorine dosage of 3 mg/L, the current minimum feed rate would be:

Min. Feed Rate = (3.0 mg/L) x (8.1 L/s)

= (24.3 mg/s) x 60 s/min x 60 min/hr x 24 hr/d x (1 kg/1,000,000 mg)

= 2.1 kg/d

The dosage rates for the varying plant flow rates are summarized in Table 3.1.

Table 3.1: Chlorine Dosing Ranges

Flow	Daily Feed Rate (kg/day)
Design Maximum (7,728 m^3/day)	50.2
Design Average (2,460 m^3/day)	16.0
Current Average (1,035 m^3/day)	6.7 (Expected Usage)
Current Minimum (699 m^3/day)	2.1

The rotameters should be sized for 2.1 to 50.2 kg/d or to the nearest available rotameter size. Chlorine gas is typically available in a variety of tank sizes. Based on the rated capacity of the WPCP (2,460 m^3/day), a 68 kg cylinder of chlorine gas would last an average of 4.3 days. In order to supply the Red Lake WPCP for thirty (30) days, seven (7) 68 kg cylinders would be required.

3.1.1.2 Sodium Hypochlorite

Sodium hypochlorite is typically used in wastewater treatment at concentrations of 12-15%. Assuming a concentration of 12%, a specific gravity of 1.16 for the solution, a chlorine feed rate of 6.5 mg/L and a maximum plant flow rate of 89.4 L/s (7,728 m^3/day), the sodium hypochlorite design maximum feed rate would be:

Max. Feed Rate = (8.33*) (6.5 mg/L) x (89.4 L/s)

= (8.33*) (50.2 kg/d) / (1.16) (1,000kg/m^3)

= (8.33*) (0.0433 m^3/day) (1,000 L/m^3)

= 360.5 L/day or 4.17 mL/s

* A factor of 8.33 was included to account for the fact that NaOCl is typically available as a 12% solution.

The daily rated capacity flow rate at the Red Lake WPCP is 2,460 m^3/day, therefore, assuming an average flow rate of 28.5 L/s and a chlorine dosage of 6.5 mg/L, the sodium hypochlorite design average feed rate would be:

Avg. Feed Rate = (8.33*) (6.5 mg/L) x (28.5 L/s)

(Rated Capacity) = (8.33*) (16.0 kg/d) / (1.16) (1,000kg/m^3)

= (8.33*) (0.0138 m^3/day) (1,000 L/m^3)

= 114.9 L/day or 1.33 mL/s

The current average flow rate at the Red Lake WPCP is 1,035 m^3/day (2017-2019), therefore, assuming an average flow rate of 12 L/s and a chlorine dosage of 6.5 mg/L, the sodium hypochlorite current average feed rate would be:

Avg. Feed Rate = (8.33*) (6.5 mg/L) x (12 L/s)

(Current Flows) = (8.33*) (6.7 kg/d) / (1.16) (1,000kg/m^3)

= (8.33*) (0.0058 m^3/day) (1,000 L/m^3)

= 48.1 L/day or 0.56 mL/s

The current minimum day flow at the WPCP is 8.1 L/s (699 m^3/day), therefore, assuming a minimum chlorine dosage of 3 mg/L, the sodium hypochlorite current minimum feed rate would be:

Min. Feed Rate = (8.33*) (3.0 mg/L) x (8.1 L/s)

= (8.33*) 2.1 kg/d / (1.16) (1,000kg/m^3)

= (8.33*) 0.00181 m^3/day (1,000 L/m^3)

= 15.1 L/day or 0.17 mL/s

The dosage rates for the varying plant flow rates are summarized in Table 3.2. Based on the average daily rated capacity (2,460 m^3/day), the Red Lake WPCP would use 3,447 L of sodium hypochlorite in thirty (30) days.

Table 3.2: Sodium Hypochlorite Dosing Ranges

Flow	Daily Feed Rate (L/day)
Design Maximum (7,728 m^3/day)	360.5
Design Average (2,460 m^3/day)	114.9
Current Average (1,035 m^3/day)	48.1 (Expected Usage)
Current Minimum (699 m^3/day)	15.1

3.1.1.3 Chlorine Contact Time

A review of the chlorine contact tank was completed to ensure the minimum contact time of 30 minutes at the rated capacity of the plant and 15 minutes at peak day flows meets MECP requirements.

As per the Red Lake WPCP Operation Manual, the existing chlorine contact tank has a total volume of 80.40 m^3. As such, the estimated chlorine contact times for the capacities above is as follows:

Contact Time = (80.4 m^3)/ (7,728 m^3/day)
(Peak Cap.) = (80.4 m^3)/ (5.37 m^3/min)
= 15 minutes

Contact Time = (80.4 m^3)/ (2,460 m^3/day)
(Rated Cap.) = (80.4 m^3)/ (1.71 m^3/min)
= 47 minutes

Based on the contact times above, the chlorine contact tank is adequately sized to meet rated capacity (2,460 m^3/day) and peak capacity (7,728 m^3/day) for the Red Lake WPCP plant. The MECP has additional guidelines for the chlorine contact tank design in regard to the following:

- Mechanical mixing of chlorine solution and wastewater to achieve a complete-mix condition within 3 seconds;
- A length-to-width ratio of greater than 40:1; and,
- A height-to-width ratio of the channel should not exceed 2:1.

The existing chlorine contact tank is separated into two units located in Treatment Unit #2. Based on the as-builts, chlorine contact tank 1 has a length-to-width ratio of approximately 3:1 and a height-to-width ratio of approximately 2:1. Chlorine contact tank 2 has a length-to-width ratio of 4:1 and a height-to-width ratio of approximately 2:1. The tank does not meet the recommended length-to-width ratios as per the MECP guidelines. Additional evaluation of the chlorine contact tanks, and chlorine dosage rates may be required in the future to meet the revised effluent requirements.

3.1.2 Dechlorination

The Fisheries Act and WSER for levels of inorganic chloramines in chlorinated wastewater effluents state that the maximum concentration of total residual chlorine in wastewaters must be lower than 0.02 mg/L by January 1, 2021. It is therefore required that dechlorination be included when chlorine is utilized for effluent disinfection

3.1.2.1 Sodium Bisulphite (SBS)

Sodium Bisulphite (SBS) at a concentration of 40% is a common dechlorination chemical used at WPCP. SBS must be injected after chlorination, mixing and contact time is complete. SBS requires a mixing time of 30 seconds during peak flows as per the MECP Design Guidelines. Equipment and chemicals for the SBS system must be housed separately from the chlorine system to avoid potentially hazardous conditions. Assuming the current treatment capacity of the chlorine contact tank (7,728 m^3/day), the contact volume for the SBS would be 2.7 m^3. The contact volume will be provided in the effluent pipe and maintenance holes.

It is recommended that the system be designed to accommodate an estimated chlorine residual of 0.5 mg/L to 2 mg/L during minimum day and peak flow scenarios, respectively. Assuming 1.5 mg/L of SBS is required to neutralize 1 mg/L of chlorine at the maximum plant flow rate of 89.4 L/s (7,728 m^3/day), the SBS design maximum feed rate would be:

Max. Feed Rate = (2.5*) (2.0 mg/L Chlorine) (1.5 SBS / Chlorine) (89.4 L/s) (1.1**)

= (2.5*) (3.0 mg/L SBS) (89.4 L/s) (86,400 s/day) (1 kg/1,000,000 mg)

= (2.5*) 25.49 kg/d (1L/1.3 kg)

=49.0 L/day

* A factor of 2.5 was included since the SBS is available as a 40% solution.

** included a 10% excess under the assumption that inconsistent chemical solutions may be acquired from a supplier.

The daily rated capacity flow rate at the Red Lake WPCP is 2,460 m^3/day, therefore, assuming an average flow rate of 28.5 L/s and a chlorine residual of 1.5 mg/L, the SBS design average feed rate would be:

Avg. Feed Rate = (2.5*) (1.5 mg/L Chlorine) (1.5 SBS / Chlorine) (28.5 L/s)

(Rated Capacity) = (2.5*) (2.25 mg/L SBS) (28.5 L/s) (86,400 s/day) (1 kg/1,000,000 mg)

= (2.5*) 5.54 kg/d (1L/1.3 kg)

=10.6 L/day

The current average flow rate at the Red Lake WPCP is 1,035 m^3/day (2017-2019), therefore, assuming an average flow rate of 12 L/s and a chlorine residual of 1.5 mg/L, the SBS current average feed rate would be:

Avg. Feed Rate = (2.5*) (1.5 mg/L Chlorine) (1.5 SBS / Chlorine) (12 L/s)

(Current Flows) = (2.5*) (2.25 mg/L SBS) (12 L/s) (86,400 s/day) (1 kg/1,000,000 mg)

= (2.5*) 2.33 kg/d (1L/1.3 kg)

=4.5 L/day

The current minimum day flow at the WPCP is 8.1 L/s (699 m^3/day), therefore, assuming a minimum chlorine residual of 0.5 mg/L, the SBS current minimum feed rate would be:

Min. Feed Rate = (0.5 mg/L Chlorine) (1.5 SBS / Chlorine) (8.1 L/s)

= (0.75 mg/L SBS) (8.1 L/s) x 86,400 s/day x (1 kg/1,000,000 mg)

= (2.5*) 0.52 kg/d (1L/1.3 kg)

=1.0 L/day

The dosage rates for the varying plant flow rates are summarized in Table 3.3. Based on a 40% SBS solution and on the average daily rated capacity (2,460 m^3/day), the Red Lake WPCP would use 318 L of SBS in thirty (30) days.

Table 3.3: Sodium Bisulphite Dosing Ranges

Flow	Daily Feed Rate (L/day)
Design Maximum (7,728 m^3/day)	49.0
Design Average (2,460 m^3/day)	10.6
Current Average (1,035 m^3/day)	4.5 (Expected Usage)
Current Minimum (699 m^3/day)	1.0

3.2 pH Requirements

The current system's effluent pH ranges from 5.9 -7.9. While this is not a compliance issue with the current C of A, it will result in frequent non-compliance should the effluent pH criteria be revised to 6.5 to 9.5. As such, an alkalinity dosing system is recommended to assist the treatment process and meet future pH requirements. The Municipality has indicated that sodium carbonate (soda ash) is the preferred chemical for the pH adjustment system. The Sodium Carbonate (Soda Ash) will also increase the nitrifying effect of the process and may help to control the ammonia concentrations of the plant.

3.2.1 Sodium Carbonate (Soda Ash)

As mentioned above, an alkalinity dosing system is required to meet the anticipated future effluent requirements. We have assumed the existing rated capacity of the plant (2,460 m^3/day) and an alkalinity range of 50 mg/L to 100 mg/L when sizing the alkalinity adjustment system.

Soda Ash is available in a powder form and must be mixed with water then injected after mixing is complete. Assuming an alkalinity addition of 100 mg/L and a maximum plant flow rate of 89.4 L/s (7,728 m^3/day), the soda ash design maximum feed rate would be:

Max. Feed Rate = (89.4 L/s) (100 mg/L) (1kg/1,000,000 mg) (86,400 s/day)

= 772 kg/day

The daily rated capacity flow rate at the Red Lake WPCP is 2,460 m^3/day, therefore, assuming an average flow rate of 28.5 L/s and an alkalinity addition of 75 mg/L, the soda ash design average feed rate would be:

Avg. Feed Rate = (28.5 L/s) (75 mg/L) (1kg/1,000,000 mg) (86,400 s/day)

(Rated Capacity) = 184 kg/day

The current average flow rate at the Red Lake WPCP is 1,035 m^3/day (2017-2019), therefore, assuming an average flow of 12 L/s and an alkalinity addition of 75 mg/L, the soda ash current average feed rate would be:

Avg. Feed Rate = (12 L/s) (75 mg/L) (1kg/1,000,000 mg) (86,400 s/day)

(Current Flows) = 77.8 kg/day

The current minimum day flow is 8.1 L/s (699 m^3/day), therefore, assuming a minimum alkalinity addition of 50 mg/L, the soda ash current minimum feed rate would be:

Min. Feed Rate = (8.1 L/s) (50 mg/L) (1kg/1,000,000 mg) (86,400 s/day)

= 35 kg/day

The dosage rates for the varying plant flow rates are summarized in Table 3.4. Based on the historical pH values for 2017-2019, the system would operate periodically when needed, approximately 25% of the time. Based on the average feed rate (2,460 m^3/day) and a 7% soda ash solution, the Red Lake WPCP would use 657 L of 7% sodium carbonate solution per day when operated 25% of the time.

Table 3.4: Sodium Carbonate Dosing Ranges

Flow	Daily Feed Rate (kg/day)	(L/day)	Expected Usage (25%) (L/day)
Design Maximum (7,728 m^3/day)	772	11,028	2,757
Design Average (2,460 m^3/day)	184	2,628	657
Current Average (1,035 m^3/day)	78	1,114	278 (Expected Usage)
Current Minimum (699 m^3/day)	35	500	125

3.3 Total Phosphorus (TP) Removal

Based on historical effluent quality (2017-2018), the effluent TP averaged 1.38 mg/L and ranged from 0.61 – 2.16 mg/L (2017-2018). While this is not a compliance issue with the current C of A, it will result in frequent non-compliance should the effluent TP criteria be revised to 1.0 mg/L. As such, a phosphorus reduction system is recommended to assist the treatment process and meet future TP requirements. The Municipality has selected Alum as the preferred chemical for TP removal.

3.3.1 Alum

Using an Alum to Phosphorus molar ratio of 1.5:1 and a mass ratio of 1.3 kg of Al per kg of Phosphorus. Liquid alum is available as a 48% liquid solution and has a density of 1.2 kg/L and a molecular weight of 666.5 g/mol. The calculations for the alum dose are as follows:

Alum Dose = (1.3 kgAl/kgP) / [(0.48) (1.2 kg/L) (2 x 26.98/666.5)]

= (1.3 kgAl/kgP) / 0.0466 kg/L

= 27.9 L alum /kg P

The maximum feed rate of alum is based on the rated capacity (2,460 m^3/day) and peak TP concentration since at higher flows, the TP concentration will decrease. As per 2017-2018, the peak TP concentration is 2.16 mg/L. However, approximately 0.15 mg/L will not be removed chemically and the Al:P molar ratio achieves approximately 75% removal. As such, the TP value was assumed to be 1.5 mg/L. Based on these assumptions and the rated capacity flow rate of 28.5 L/s (2,460 m^3/day), the Alum design maximum feed rate would be:

Max. Feed Rate = (1.5*) (28.5 L/s) (1.5 mgP/L) (27.9 L alum/kgP) (1kgP/1000000mgP)

= (1.5) (0.0072 L alum/s) (86,400 s/day)

= 154 L alum/day

* A factor of 1.5 was included to account for the Al:P molar ratio of 1.5:1.

The daily rated capacity flow rate at the Red Lake WPCP is 2,460 m^3/day, therefore, assuming an average TP value of 1.38 mgP/L, the Alum design average feed rate would be:

Avg. Feed Rate = (1.5*) (28.5 L/s) (1.38 mgP/L) (27.9 L alum/kgP) (1kgP/1000000mgP)

(Rated Capacity) = (1.5) (0.0011 L alum/s) (86,400 s/day)

= 142 L alum/day

The current average flow rate at the Red Lake WPCP is 1,035 m^3/day, therefore, assuming an average flow of 12 L/s and a TP value of 1.38 mgP/L, the Alum current average feed rate would be:

Avg. Feed Rate = (1.5*) (12 L/s) (1.38 mgP/L) (27.9 L alum/kgP) (1kgP/1000000mgP)

(Current Flows) = (1.5) (0.0004 L alum/s) (86,400 s/day)

= 60 L alum/day

The current minimum day flow is 8.1 L/s (699 m^3/day), therefore, assuming an average TP value of 1.38 mgP/L, the Alum current minimum feed rate would be:

Min. Feed Rate = (1.5*) (8.1 L/s) (1.38 mgP/L) (27.9 L alum/kgP) (1kgP/1000000mgP)

= (1.5) (0.0003 L alum/s) (86,400 s/day)

= 40 L alum/day

The dosage rates for the varying plant flow rates are summarized in Table 3.5. Based on the average feed rate (2,460 m^3/day), the Red Lake WPCP would use 4,260 L of Alum in thirty (30) days.

Table 3.5: Alum Dosing Ranges

Flow	Daily Feed Rate (L/day)
Design Maximum (7,728 m^3/day)	154
Design Average (2,460 m^3/day)	142
Current Average (1,035 m^3/day)	60 (Expected Usage)
Current Minimum (699 m^3/day)	40

4.0 DISINFECTION SELECTION REVIEW

There are several possible options available for disinfection, but given the existing conditions, basis of design and evaluation of the existing disinfection system, RVA reviewed two options for providing permanent final disinfection.

- Option #1 - Chlorine Gas
- Option #2 - Sodium Hypochlorite

4.1 Option #1 – Chlorine Gas

High concentrations of chlorine gas and contact time is used to inactivate E. Coli. It requires a source of chlorine gas, associated vacuum gas chlorination equipment along with a contact chamber. The new chlorine gas system would be installed in the existing chlorine room located in the service building.

An inventory and site assessment of the existing chlorine system was completed. The chlorine system is generally adequate to meet the current rated average daily flow capacity (2,460 m^3/day) and peak daily capacity (7,728 m^3/day), but requires upgrades to meet MECP Guidelines, Chlorine Institute and Ministry of Labour (MOL) regulations. These upgrades are summarized in Table 4.1.

Table 4.1 – Recommended Chlorine System Upgrades

System/Component	Recommended Upgrades	Rational
Chlorine System		
Chlorinator system	Replacement	Current system is too small for peak flow rates. New system to be sized for a feed rate of 2.1 to 50.2 kg/day
Chlorine lines	Replacement	
Chlorine solution line/ hose	Replacement	
Chlorine Room and Vestibule		
Potable Water Supply	New backflow preventor to be installed on potable water service line prior to mixing with chlorine gas line	No backflow preventor currently on potable water line.
Breathing Apparatus	Complete maintenance and Inspection of apparatus per suppliers' recommendations	Breathing apparatus is past inspection and maintenance requirements
Eyewash Station and Piping	Provide new eyewash station with tempered water is required	Eyewash station is corroded and does not have tempered water
Miscellaneous Pipe Hangers and Supports	Replacement	Piping is corroded
Vestibule HVAC System	Provide new system	Existing system was not tested, and capacity is unknown. New fan to positively pressurize the vestibule will be required
Building Structure	Repair of existing building deficiencies	Repair of existing building deficiencies Visible cracks in concrete block wall. Inspection of existing building recommended
Chlorine Detection System	Install additional sensor in the vestibule. Equipment to comply with MOL requirements	Chlorine gas detection system is past lifespan and requires upgrades

The capacity of the HVAC system is unknown. Upgrades may be required if current system doesn't provide the minimum 3 Air Exchanges (ACH) and 30 ACH in the case of emergency. In addition, the vestibule must remain positively pressurized at all times.

Providing the Red Lake WPCP with proper chlorination via chlorine gas will involve the installation of a new chlorination system and upgrades to the existing building. The following replacements/ upgrades are required to the existing chlorine system:

- Replacement of chlorinator, valves, piping, switch over valves and educator;
- Replacement of HVAC system to ensure normal and emergency ACH requirements;
- Replacement of eyewash station complete with tempered water;
- Installation of backflow preventer on the service water line to the chemical system; and,
- Miscellaneous upgrades to existing building structure as required.

Temporary chlorinators will be required during the replacement of the existing chlorine system. Approval from the MECP will be required for this temporary shutdown and replacement.

4.2 Option #2 – Sodium Hypochlorite

Sodium hypochlorite solution is used to inactivate E. Coli. It requires a source of sodium hypochlorite, associated solution pumps and piping, and a chlorine contact tank. The sodium hypochlorite system would be placed in its own room in the new chemical metering and storage building and the existing chlorine gas system would be decommissioned. The following components would be required for the sodium hypochlorite system:

- Two (2) 1800L tanks (for 30 days of storage);
- One (1) sodium hypochlorite dosing panel complete with two (2) solenoid-driven pumps, pressure gauges, pressure relief valves, back pressure valves, lot of fittings & tubing, calibration column, terminal box, HDPE board and float switch; and,
- One (1) new eyewash station with tempered water located in the new chemical metering and storage building.

Upon commissioning of the sodium hypochlorite system, the existing chlorine gas system would be decommissioned. Approval from the MECP will be required for this new chlorination system.

4.3 Cost Estimate

Chlorine gas and sodium hypochlorite systems would both require the removal of the existing chlorination equipment and similar electrical upgrades. Additionally, the construction of the new chemical metering and storage building is required regardless and was not included in the Sodium Hypochlorite cost estimate. The cost estimates are based on the equipment, material and maintenance cost required for the system.

4.3.1 Capital Cost

The following is an order of magnitude cost estimate (± 25 - 50%) of the disinfection options previously presented. The total capital costs include costs associated with equipment, applicable upgrades, general requirements and engineering costs.

It is expected that both options will have a minimum 10 – year operating period. Consideration regarding varying prices in consumables such as energy and chemical costs were considered as part of the calculations. The daily usage for the chemicals was estimated based on the yearly plant flow average of 1,035 m^3/day. Refer to Appendix A for the detailed cost estimate tables. The O&M costs for both options are included in Table 4.2.

Table 4.2 – Disinfection Systems Cost Estimate

Options	Capital Cost ($)	Operating Cost ($/year)	Total Cost Over 10-Year Period ($)
Option 1- Chlorine Gas	$196,000	$8,375	$279,750
Option 2- Sodium Hypochlorite	$90,000	$12,986	$219,860

The above summary indicated that the combined operating and maintenance costs over a 10-year period are lowest for Option #2, the sodium hypochlorite system.

4.4 Recommendation

Based on the evaluation between the two (2) proposed options for the disinfection systems, we recommend that the Municipality proceed with a sodium hypochlorite system at the Red Lake WPCP.

APPENDIX A

COST ESTIMATE TABLES

OPTION #1- Chlorine Gas
Capital Costs

Project Costs		Unit of Measure	$/Unit of Construction	Installation Factor	Installed Cost			Power Table				
					Qty.	Cost$	Comments	kW	Operating Time	Hours	Efficiency	Sub-Total
Construction Costs												
1	Chlorine Room Upgrades	lump sum	$ 25,000.00	1	1	$25,000	- Labour cost is built into $/unit of construction					
2	Chlorine Gas Feed System	lump sum	$ 90,000.00	1.5	1	$135,000	- Labour cost is built into installation factor	0.1	1	8760	1	0.9
3	Chlorine Gas Detector	lump sum	$ 2,500.00	2	1	$5,000	- Labour cost is built into installation factor	0.1	1	8760	1	0.9
General Requirements (10% of Construction Costs)						$16,000						
Contingency Fees (25% of Construction Costs)						$40,000						
Total Construction Cost						**$196,000**						
Geotechnical Investigation (N/A)						$0						
											Total (MWh)	2

TOTAL COST **$196,000**

Annual O&M Costs		**Measure**	**Value**	**Quantity**		**Cost$**	**Comment**	**Area (m2)**		**(W/m2)**	**Hours**	**Energy(kW.h)**
1	Electricity	$/kWhr	$144.00	2		$252	$0.14/kWhr					
2	Chemical Usage (Chlorine Gas)	$/kg	$2.34	2446		$5,722	Estimate based on average flows (1,035 m3/day)					
2	Equipment Maintenance (5% of equipment cost)	Estimate	$2,400	1		$2,400	Estimate					

TOTAL O&M COST **$8,375**

Operating Period	10 years
Total Annual O&M Costs	$8,375
Total Capital Cost	**$196,000**
Annualized Cost This Option (Capital + O & M)	**$27,975**
Total Cost Over Operating Period	**$279,750**

OPTION #2 - Sodium Hypochlorite
Capital Costs

	Project Costs	Unit of Measure	$/Unit of Construction	Installation Factor	Installed Cost			Power Table				
					Qty.	Cost$	Comments	kW	Operating Time	Hours	Efficiency	Sub-Total
Construction Costs												
1	Chemical Feed System & Piping	lump sum	$30,000	1.5	1	$45,000	- Labour cost is built into installation factor	0.1	1	8760	1	0.9
2	Two (2) 1800L Tank	lump sum	$6,000	1.5	2	$18,000	- Labour cost is built into installation factor					
3	Containment Wall	lump sum	$5,000	1	1	$5,000	- Labour cost is built into $/unit of construction					
General Requirements (10% of Construction Costs)						$6,000						
Contingency Fees (25% of Construction Costs)						$16,000						
Total Construction Cost						**$90,000**						
Geotechnical Investigation (N/A)						$0						
											Total (MWh)	1

TOTAL COST **$90,000**

	Annual O&M Costs	Measure	Value	Quantity		Cost$	Comment	Area (m2)		(W/m2)	Hours	Energy(kW.h)
1	Electricity	$/kWhr	$144.00	1		$126	$0.14/kWhr					
2	Chemical Usage (12%Sodium Hypochlorite)	$/L	$0.63	17556		$11,060	Estimate based on average day flows (1,035 m3/day)					
2	Equipment Maintenance (5% of equipment cost)	Estimate	$1,800	1		$1,800	Estimate					

TOTAL O&M COST **$12,986**

Operating Period	10 years
Total Annual O&M Costs	$12,986
Total Capital Cost	**$90,000**
Annualized Cost This Option (Capital + O & M)	**$21,986**
Total Cost Over Operating Period	**$219,860**

`

APPENDIX B

Load Analysis

R.V.Anderson Associates Ltd

Load Analysis

Projec	194666_Red Lake	Date:	Jan 17, 2020
Sheet	1 / 1		
Utility Pole No:		Calc. by	SFH
Transformer/SS No		Checked by	
MCC		Revised	jan-202 SFH

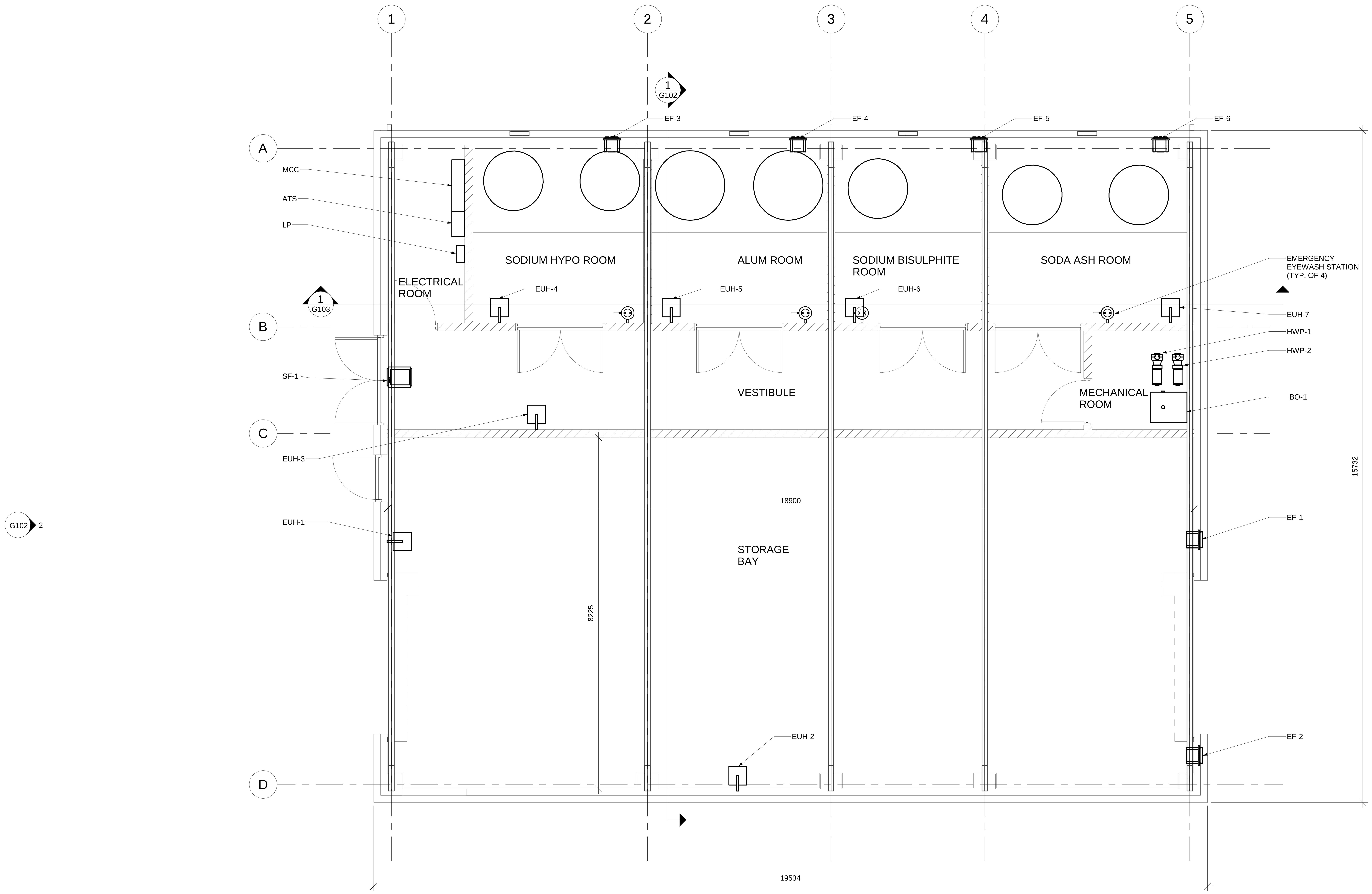
S. No.	Load Description	Connected Load				Demand Factor	Demand Load		Critical load		Startin g
		HP	kWe	p.f.	kVA	-	kWe	kVA	kWe	kVA	
	PROCSSS EQUIPMENT										
1	Blower BL-1	40.0	32.5	0.80	40.8	1	32.5	40.8	32.5	40.8	DOL
2	Blower BL-2	40.0	32.5	0.80	40.8	1	32.5	40.8	32.5	40.8	DOL
3	Blower BL-3	40.0	32.5	0.80	40.8	0	0.0	0.0	0.0	0.0	DOL
4	Communitor	1.0	1.0	0.58	1.7	1	1.0	1.7	1.0	1.7	DOL
5	Clarifier - Plant 2	0.5	0.5	0.55	0.9	1	0.5	0.9	0.5	0.9	DOL
6	Spray Pump - Plant 1	1.0	1.0	0.58	1.7	1	1.0	1.7	0.0	0.0	DOL
7	Clarifier - Plant 1	0.8	0.7	0.57	1.3	1	0.7	1.3	0.7	1.3	DOL
8	Sludge Pumpout	2.0	1.8	0.66	2.7	1	1.8	2.7	1.8	2.7	DOL
9	Decant Pump	2.0	1.8	0.66	2.7	1	1.8	2.7	0.0	0.0	DOL
10	Sludge Pump - 1	2.0	1.8	0.66	2.7	1	1.8	2.7	1.8	2.7	DOL
11	Sludge Pump - 2	2.0	1.8	0.66	2.7	1	1.8	2.7	0.0	0.0	DOL
12	Sludge Pump - 3	2.0	1.8	0.66	2.7	1	1.8	2.7	0.0	0.0	DOL
13	Return Sludge Pump	2.0	1.8	0.66	2.7	1	1.8	2.7	1.8	2.7	DOL
	HVAC EQUIPMENT										
14	Lumped HVAC Heating		25.0	1.00	25.0	1	25.0	25.0	25.0	25.0	DOL
	Small Electrical Loads										
15	Existing Lighting Panel A		9.0	0.90	10.0	0.5	4.5	5.0	4.5	5.0	DOL
16	Existing Lighting Panel B		22.5	0.90	25.0	0.5	11.3	12.5	11.3	12.5	DOL
	HVAC EQUIPMENT										
17	Lumped HVAC Heating - New		35.0	1.00	35.0	1	35.0	35.0	35.0	35.0	DOL
18	Garage Sewage Pump	2.0	1.8	0.66	2.7	1	1.8	2.7	1.8	2.7	DOL
	Small Electrical Loads										
19	Lighting Panel LP-100		40.5	0.90	45.0	0.75	30.4	33.8	30.4	33.8	DOL
	Additional loads for Gen only										
20	Public Works Yard		21.0	1.00	21.0	0.75	15.8	15.8	15.8	15.8	DOL
21	LS#3 Pump	10.0	8.3	0.76	11.0	1	8.3	11.0	8.3	11.0	DOL
22	LS#3 Pump	10.0	8.3	0.76	11.0	1	8.3	11.0	8.3	11.0	DOL
	TOTAL		283		330		219	255	213	245	
Results:			kWe		kVA		kWe	kVA	kWe	kVA	

Considering divesity factor of = 1.2

Actual Demand 212 kVA

APPENDIX C

Concept Drawings



1 FLOOR PLAN - LVL 1

1 : 50

NOTES

CONCEPT DRAWINGS

No.	Description	By	YYYY.MM.DD

CONCEPTUAL DESIGN

MUNICIPALITY OF RED LAKE

CONTRACT No. #######

R.V. Anderson Associates Limited
engineering • environment • infrastructure

RED LAKE WPCP

GENERAL

CHEMICAL METERING AND STORAGE BUILDING

PRELIMINARY FLOOR PLAN

Project No:	194666	Designed:	Designer
Date:	JAN.2020	Checked:	Checker
Scale:	AS SHOWN	Drawn:	Author

DWG NO. G101

REV.

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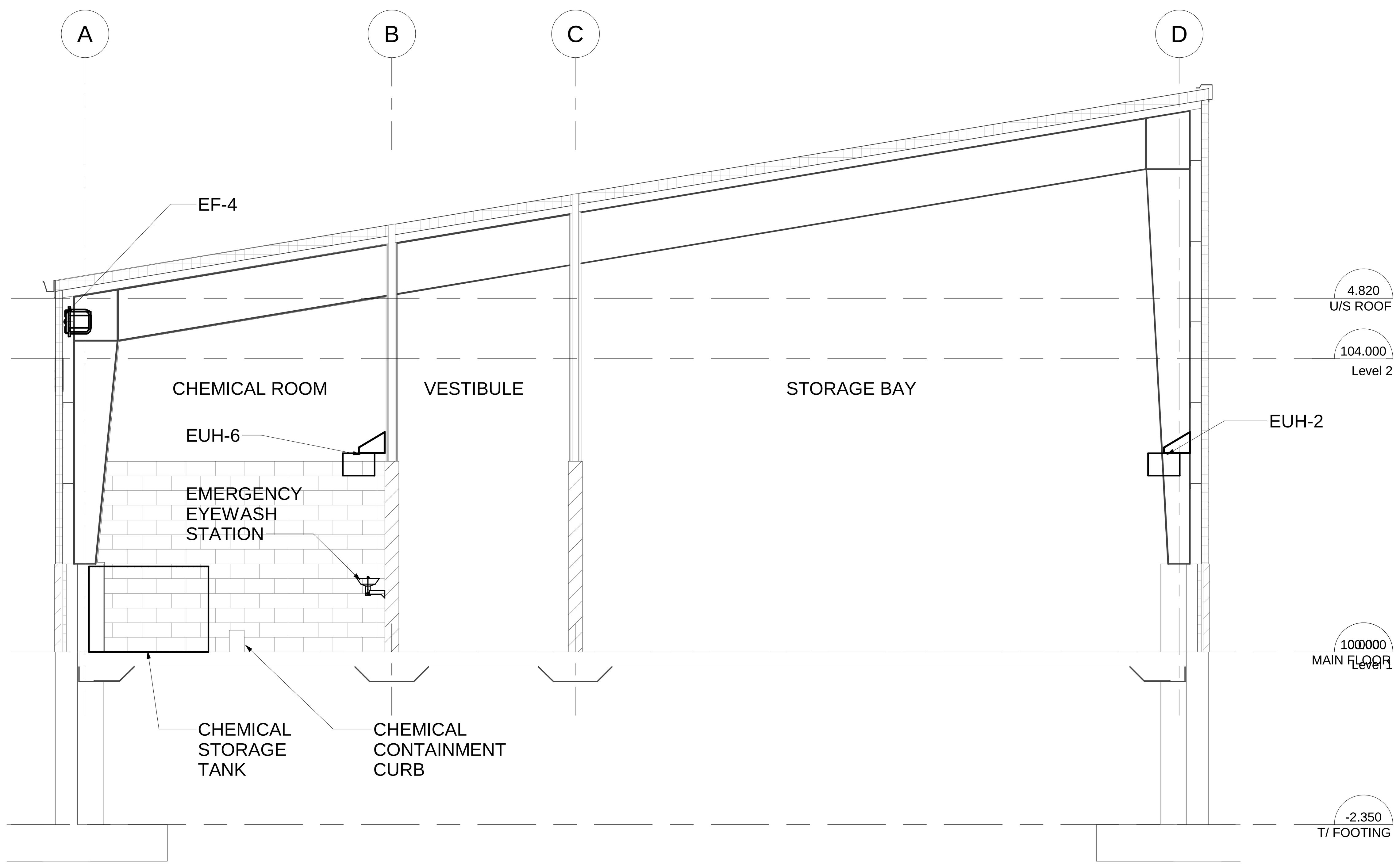
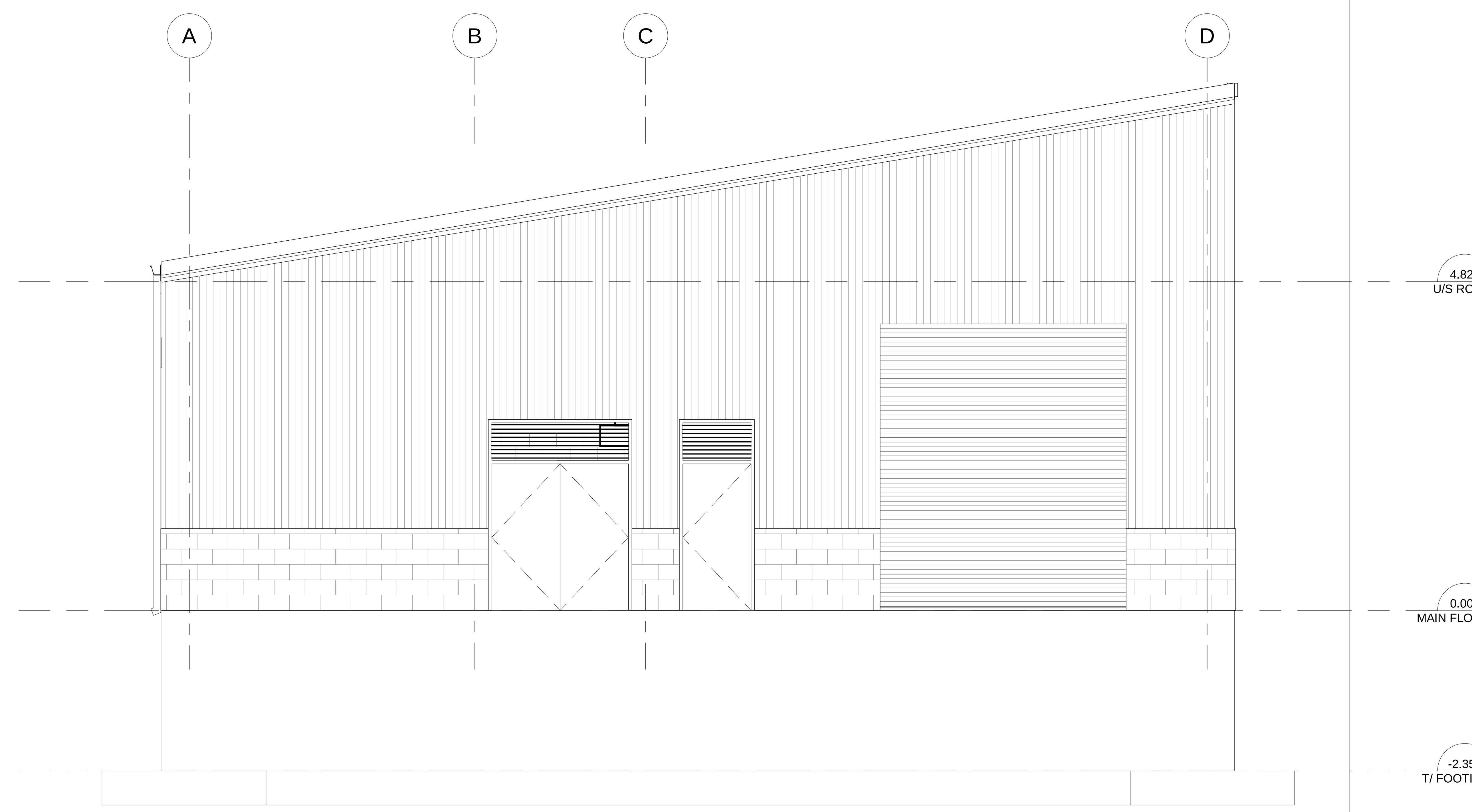


1 SECTION 1
1 : 50



2 WEST EL.
1 : 50

NOTES
CONCEPT DRAWINGS

No.	Description	By	YYYY.MM.DD

CONCEPTUAL DESIGN

MUNICIPALITY OF RED LAKE
CONTRACT No. #######

R.V. Anderson Associates Limited

RED LAKE WPCP
GENERAL
CHEMICAL METERING AND STORAGE BUILDING
SECTION AND ELEVATION

Project No:	194666	Designed:	Designer
Date:	JAN.2020	Checked:	Checker
Scale:	AS SHOWN	Drawn:	Author

DWG NO. G102
REV.

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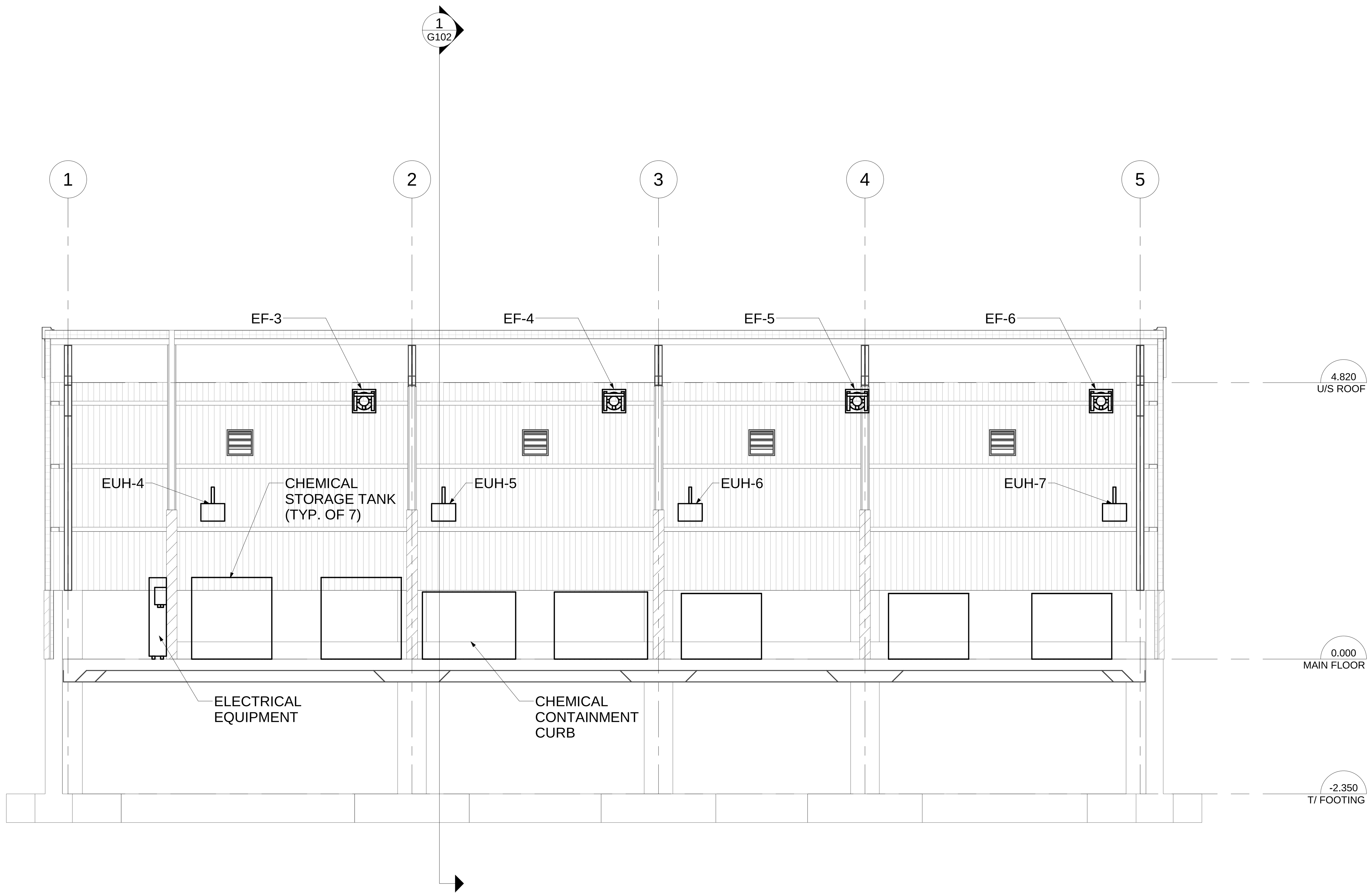

1 SECTION 2
1 : 50

NOTES
CONCEPT DRAWINGS

No.	Description	By	YYYY.MM.DD

CONCEPTUAL DESIGN

MUNICIPALITY OF RED LAKE
CONTRACT No. #######

R.V. Anderson Associates Limited
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RED LAKE WPCP

Project No:	194666	Designed:	Designer
Date:	JAN.2020	Checked:	Checker
Scale:	AS SHOWN	Drawn:	Author

GENERAL
CHEMICAL METERING AND STORAGE BUILDING
SECTION VIEW

DWG NO.
G103
REV.

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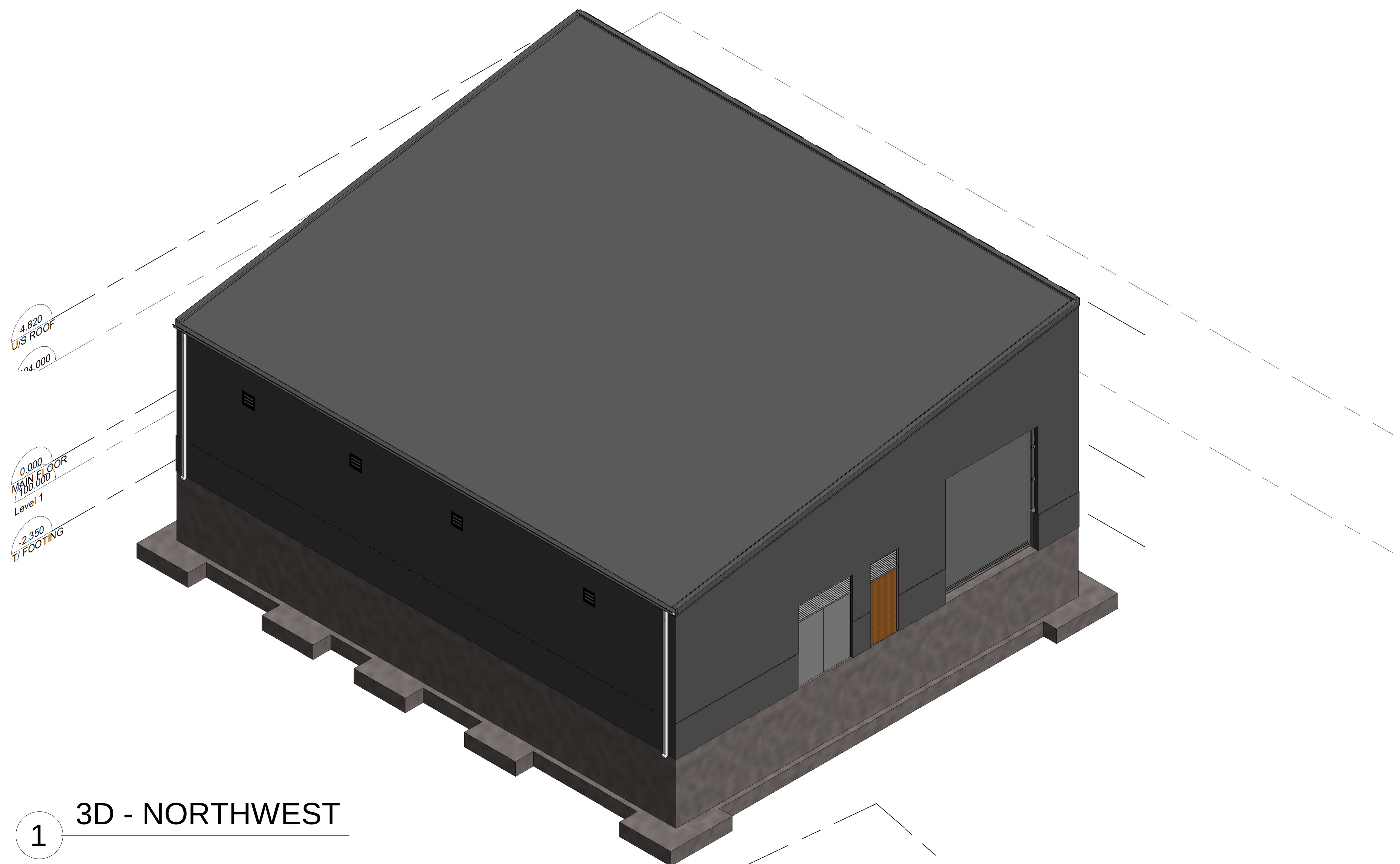
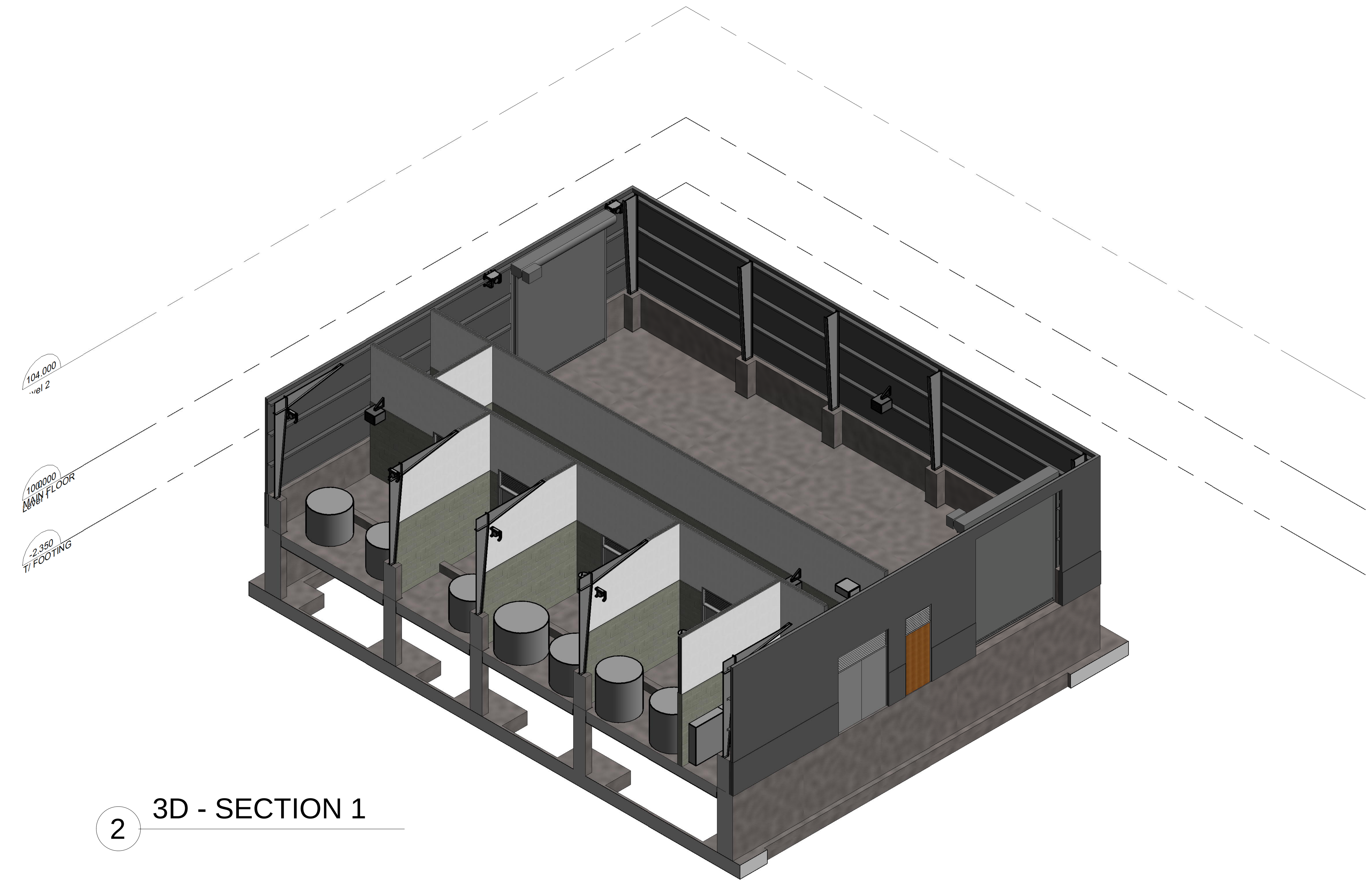
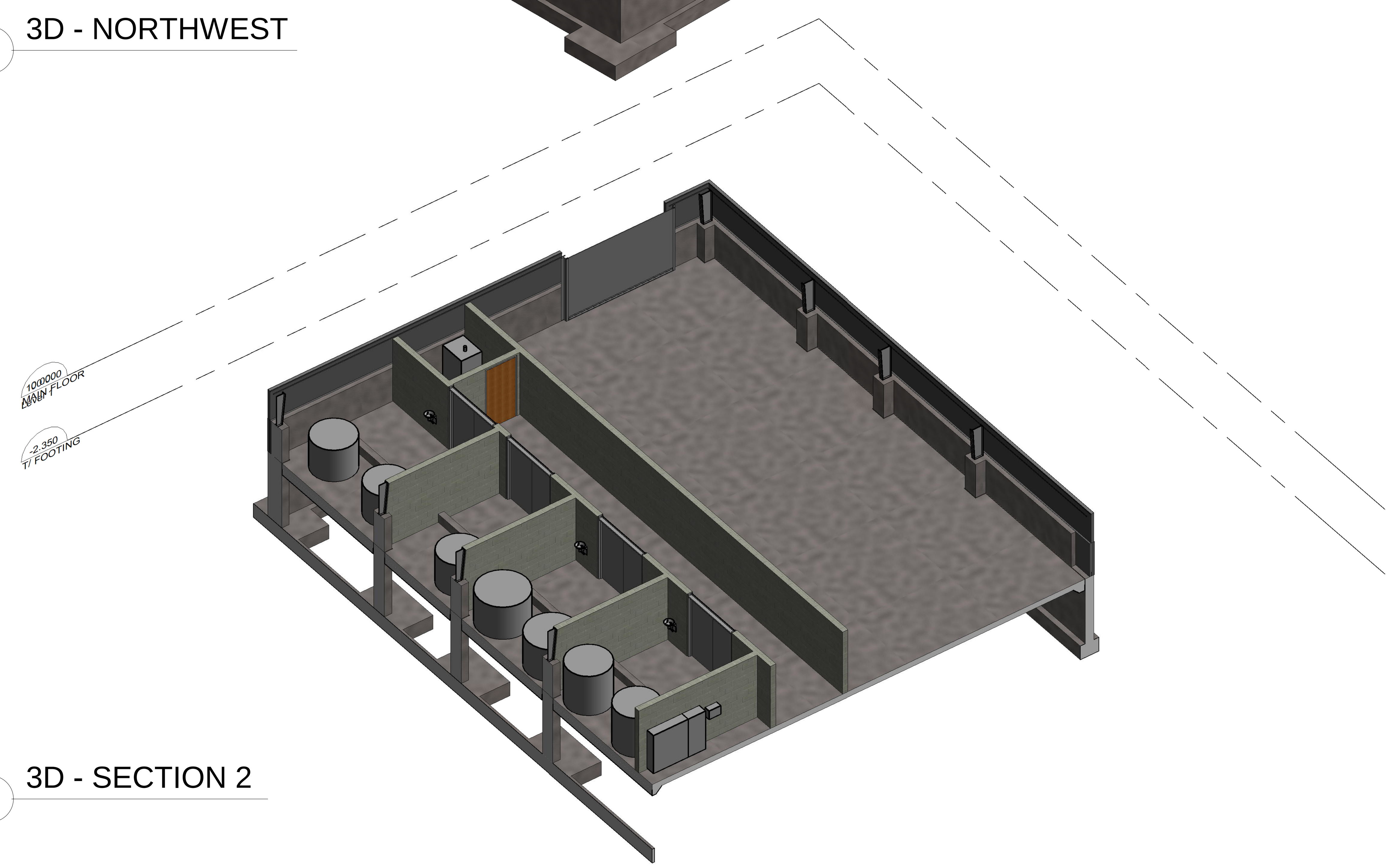


1 3D - NORTHWEST



2 3D - SECTION 1



3 3D - SECTION 2

NOTES

CONCEPT DRAWINGS

No.	Description	By	YYYY.MM.DD

CONCEPTUAL DESIGN

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GENERAL

CHEMICAL METERING AND STORAGE BUILDING

3D RENDERINGS

DWG NO. G104

REV.

File: C:\Users\csmith\Documents\194666-MEP-CENTRAL-Red Lake Disinfection_candersonJZDZ4.rvt
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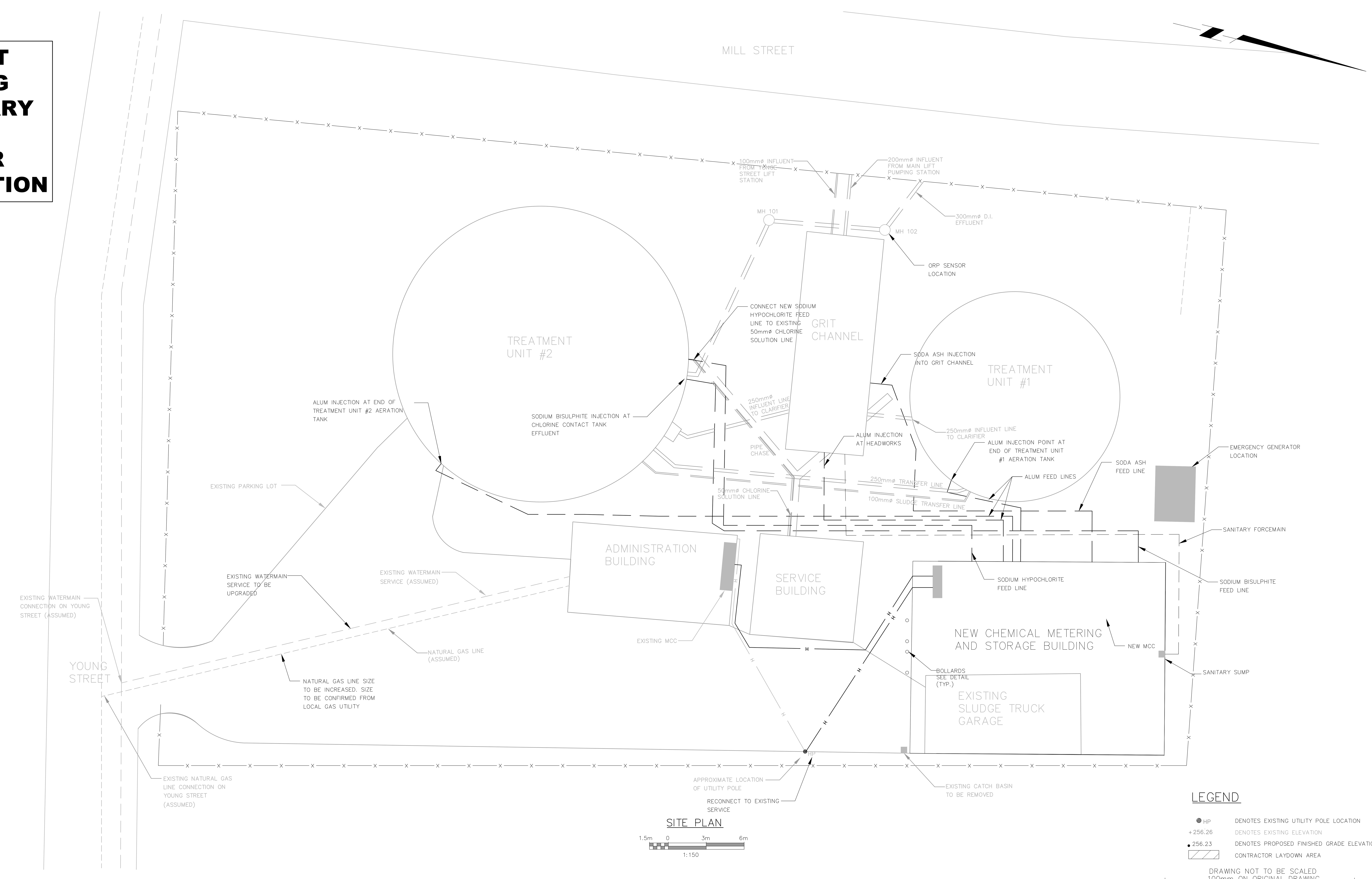
CONCEPT DRAWING PRELIMINARY ONLY NOT FOR CONSTRUCTION



NOTES

CONCEPT DRAWING

CONCEPTUAL DRAWING

MUNICIPALITY OF RED LAKE

CONTRACT NO. ######

RED LAKE WPCP

GENERAL

CHEMICAL METERING AND STORAGE BUILDING

SITE PLAN - CONCEPT

Project No:	194666	Designed:	Designer
Date:	JAN. 2020	Checked:	Checker
Scale:	AS SHOWN	Drawn:	Author

DWG NO. G105

REV.

File: :\2019\194666 - WWTS Effluent Disinfection\R CADD - Vertical\A.000.2 Site\Sheets

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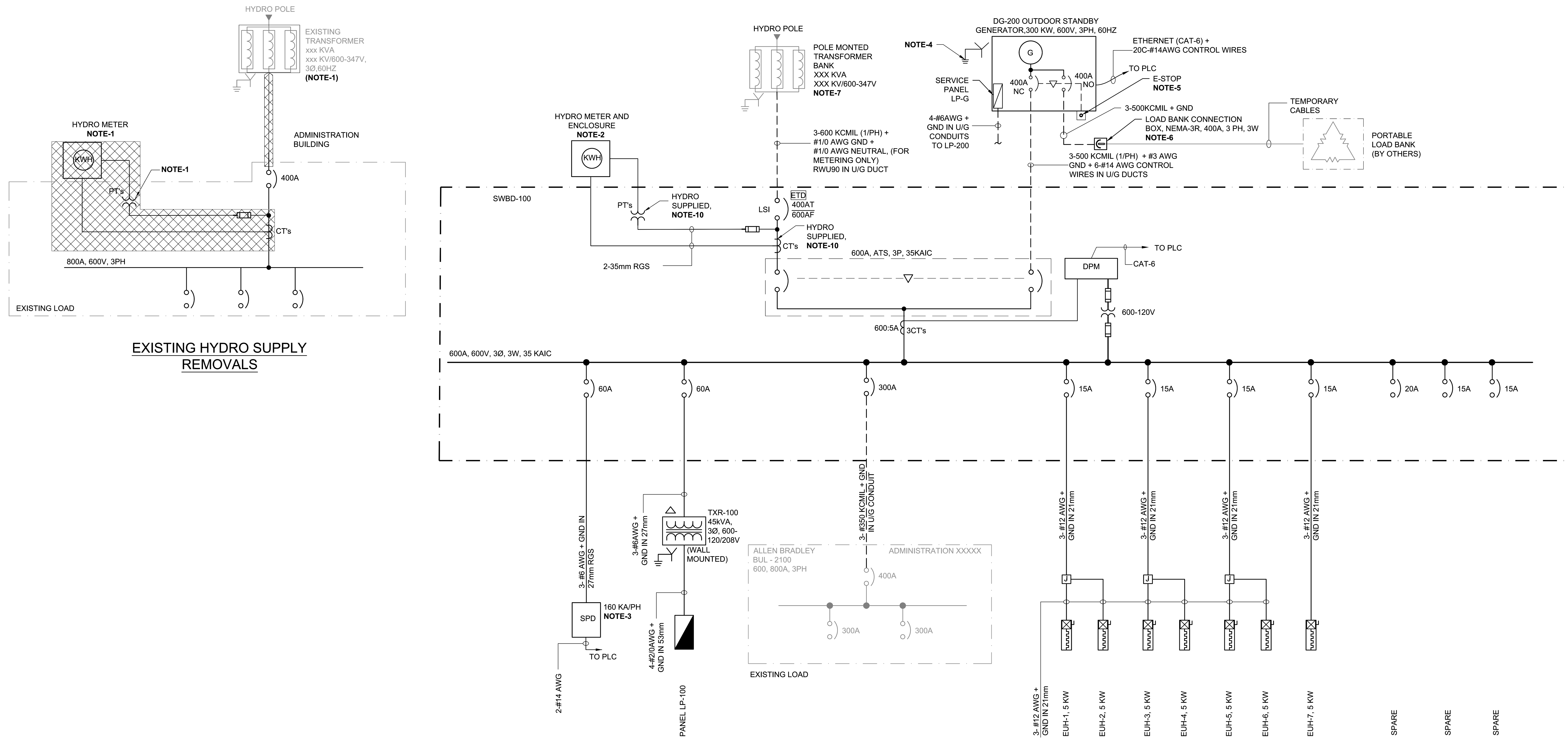

LEGEND:

- EXISTING INSTALLATION
- NEW INSTALLATION
- INSTALLATION/EQUIPMENT TO BE REMOVED

NOTES:

1. COORDINATE WITH HYDRO ONE TO REMOVE EXISTING UNDERGROUND FEED FROM THE POLE MOUNTED TRANSFORMER TO MCC IN ADMINISTRATION BUILDING. REMOVE EXISTING CTs, PTs COMPLETE WITH HYDRO METER. COORDINATE WITH PLANT STAFF FOR A SHUT DOWN BEFORE THE WORK. CLEAN THE MCC SECTION AND LABEL IT AS SPARE FOR FUTURE USE.
2. INSTALL NEW HYDRO METER AS PER HYDRO REQUIREMENTS.
3. PROVIDE SPD WITH SURGE COUNTER AND DRY CONTACTS FOR ALARM. SPD TO BE EQUIVALENT TO 'SERVICE TRACK' SERIES FROM TOTAL PROTECTION.
4. SOLIDLY GROUND THE GENERATOR NEUTRAL AS PER ESA BULLETIN 10-10-8, FIG. B3.
5. INTERLOCK E-STOP SWITCH TO TRIP THE LOAD BANK BREAKER WHEN PRESSED.
6. PROVIDE CONNECTION BOX TO CONNECT PORTABLE LOAD BANK TO FACILITATE PERIODIC TESTING OF GENERATOR. CONNECTION BOX TO BE 'TEMP TAP' BY ESL POWER SYSTEM OR APPROVED EQUAL.
7. COORDINATE WITH HYDRO ONE TO TERMINATE NEW SECONDARY CABLE..

No.	Description	By	YYYY.MM.DD
A	PRELIMINARY DESIGN REPORT	RM	2020.01.17

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Project No:	194666	Designed	FSH
Date:	Jan-2020	Checked	SQR
Scale:	AS SHOWN	Drawn	MSH

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RED LAKE WPCP

ELECTRICAL

CHEMICAL METERING AND STORAGE BUILDING

SINGLE LINE DIAGRAM

DWG NO. E101

REV. A

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