Fresh Water, Sewage, and Waste Water Management Plan
Canadian Forces Station Alert, Nunavut

In support of the
Nunavut Water Board Licence
No. 8AC-ALT1929

Originally prepared: January 2020
Revised:

Prepared by:
8 Wing Environment Office
CFB Trenton

Revision Control Page

Revision No.	Revised By	Date	Issue/Revision Description
1.0			
2.0			

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1 Acronyms

BOD	Biological Oxygen Demand
CAWT	Center for Alternative Wastewater Treatment
CFS	Canadian Forces Station
DND	Department of National Defence
LWPH	Lake Water Pumphouse
NWB	Nunavut Water Board
SOP	Standard Operating Procedure
SWTP	Station Water Treatment Plant
TSS	Total Suspended Solids
AWWA	American Water Works Association
IBC	International Building Codes
NSF	National Sanitation Foundation
GCWQ	Guidelines for Canadian Drinking Water Quality

NWT Regulation 108-2009
Northwest Territories Water Supply System Regulations
Ontario Regulation 170/03
Safe Drinking Water Act, 2002
Nunavut Waters and Nunavut Surface Rights Tribunal Act, SC 2002, c 10
Northwest Territories Water Act
Northwest Territories Water Regulations (SOR/93-303)
Ontario Drinking Water Quality Standards
Canadian Fisheries Act
Canadian Environmental Protection Act (1999)
CCME Water Quality Guidelines for the Protection of Aquatic Life
Ontario Guidelines for Sewage Works 2008
CCME Guidelines for Compost Quality
NSF/ANSI Standard 61 Drinking Water System Components
AWWA Standard B100 Filtering Material
AWWA Standard B604 Granular Activated Carbon
OSHA Occupational Safety and Health Administration

2 Introduction

This document describes the fresh water supply and wastewater management plan for Canadian Forces Station (CFS) Alert. Specifically, this document focuses on freshwater supply and wastewater treatment and disposal at CFS Alert Station .In accordance with Part D, Item 10 and Part E, Item 6, of CFS Alert's Type A Water Licence No. 8AC-ALT1929 for, the licensee shall submit to the Board for approval in writing, by March 31, 2020. This plan has been developed to take into account commitments made with respect to submission received during the preliminary and technical review of Application documents, as well as final submissions and issues raised during Public Hearing Process.

This plan will be updated to include plans and upgrades to the water treatment system as required/planned. It will also include in appendixes any operations manuals, SOP's and other documentation required to provide additional relevant information for this document.

2.1 LICENCEE INFORMATION

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74 Polaris Avenue, Room 305
PD Box 1000 Stn Forces
Astra, ON K0K 3W0

2.2 CONTACT- 24 HOUR

Alert Commanding Officer

1-613-945-3145

2.3 DECRIPTION OF LOCATION

CFS Alert is situated on the north-eastern tip of Ellesmere Island, approximately 817 kilometres from the geographic North Pole at coordinates (lat/long) 82˚28' N, 62˚30' W. (UTM) Easting 552375.7996584666, Northing 6874583.726844844 (Map sheet number 120E05).

The station has been in continuous operations as part of the Canadian Military since September 1958. Staffing on site typically ranges from 50 to 100 military and civilian individuals although for short durations the population can rise to 400 during military exercises.

The area is bound in two directions by the Arctic Ocean and is characterized by rocky hills and valleys largely made up of shale and slate. It has pack ice year round and average temperature during January is -33^{o}c and in July average temperature is 3^{o}c.

Figure 1. CFS Alert Location Map

CFS Alert has 13 buildings connected to the water distribution system (See Table 1 for details). The location includes 11 established monitoring stations (See Appendix A, Figure 2) for current systems and under the new water licence two new monitoring stations (ALT-12, ALT-13). ALT-13 will be established at the outfall of the future packaged plant project.

2.4 Sustainable Development Strategy

DND assigns a high priority to its environmental programs and is committed to conducting its operations in ways that protect human health and the environment. The Department continues to evolve as an environmentally responsible and sustainable organization by addressing past environmental problems and continuing to seek opportunities to maintain the health of the environment into the future.

In support of the Government of Canada's commitment to environmental sustainability, the Department of National Defence and the Canadian Armed Forces have developed an integrated strategy for energy and environmental management, the Defence Energy and Environment Strategy (DEES). The DEES builds on Canada's defence policy, Strong, Secure, Engaged and reaffirms the strategy's commitment of greening DND's operations. It also aligns with the Federal Sustainable Development Strategy (FSDS) 2016-2019, and guides DND's efforts to meet or exceed the federal target to reduce greenhouse gas emissions by 40 percent below 2005 levels by 2030 (excluding military fleets).

The DEES provides a clear vision and identifies concrete targets to improve energy efficiency and reduce environmental impacts across Defence activities. The Department, with the Canadian Armed Forces, will strive to fulfill four key objectives:
•less energy waste;
•cleaner energy;
•a reduced Defence environmental footprint; and
•better-managed energy and environmental performance.

More information can be found by flowing the below link.

https://www.canada.ca/en/department-national-defence/services/greening-defence.html

3 Fresh Water

3.1 Water Intakes

3.1.1 Screens on Intake Pumps

All intakes will be screened in accordance with the Department of Fisheries and Oceans (DFO) Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO Guideline) to ensure no entrapment of fish. This guideline requires a 2.54 mm mesh size on the water intake pipeline to prevent entrainment of fish greater than 25 mm in length. It also requires a water withdrawal rate such that fish do not become impinged on the screen.

3.1.2 Selection of Short-Term Water Take Locations

Short-term water intake are required at a low frequency. Withdrawal of water is taken from Upper Dumbbell Lake for specific needs. This includes, dust suppression and possible fire suppression. The DFO guideline used for water take from water bodies is to restrict removal of water to a maximum of 5% of the total volume. During winter under ice conditions water must be drawn from below two (2) m of non-frozen water (as the top two (2) m of water contain the majority of oxygen for fish). During the open water season water taking guideline states that no significant drawdown can be caused. There must be no impact to fish or fish habitat.

3.2 Water Metering and Water Conservation Measures

Water meters are installed at strategic locations to monitor water consumption and enable the development of management strategies to reduce water usage/consumption. These strategies include the installation of low flow water taps, etc.

3.3 Fresh Water Source

Water is drawn from a single source as per the water licence; Upper Dumbell Lake. Upper Dumbell Lake covers approx. 264 hectares or 900 acres and the average depth is about 7.6 m. It remains ice covered for 9 months out of the year and break-up typically happen in mid-July with re-freeze in September. Ice usually reaches a thickness of between 1.8m to 2.75m.

3.4 Annual Production

The Station on average has a daily consumption of 86,400 litres per day plus a fire storage capacity (75% of the total storage capacity) of 341,000 litres is also maintained. The maximum amount to be drawn under the water licence is 875 m^3 per day (or 875,000L) so the Station is well under allotted amounts.

Water is currently provided to 13 building at CFS Alert.

Table 1. CFS Alert building and water/sewer status.

Building	**Water**	**Bleeder**	**Sewer**	**Status**
Water Treatment Plant	Yes	No	Yes	Operational
Standby Power Plant	Yes	Yes-1	Yes	Operational
Main Power Plant	Yes	No	Yes	Operational
Main Supply & Warehouse	Yes	Yes-1	Yes	Operational
Main Workshop & Firehall	Yes	No	Yes	Operational
Maintenance Transport	Yes	No	Yes	Operational
Transport Storage Building	No	No	No	Operational
Main Ops	Yes	Yes-1	Yes	Operational
Chimo Quarters	Yes	Yes-2	Yes	Operational
Ladner Quarters	Yes	Yes-2	Yes	Operational
Whitehourse Quarters	Yes	Yes-1	Yes	Operational
Churchill Hall	Yes	No	Yes	Operational
Cold Storage Building	No	No	No	Operational
Incinerator Building	Yes	Yes-1	Yes	Operational
Gymnasium Building	Yes	Yes-1	Yes	Operational
Curling Rink Building	No	No	No	

3.5 Current Water Treatment Facilities

3.5.1 Facility Description

The CFS Alert water treatment system consists of five basic components:

1. Lake intake and Lake Water Pumphouse (LWPH)
2. Raw water supply line and heated water return line between the LWPH and Station Water Treatment Plant (SWTP);
3. SWTP;
4. Station water distribution system; and
5. Station sewage collection system.

Water is taken in from Dumbell Lake by the Lake Water Pumphouse and pumped via centrifugal pumps to the SWTP. Supply water run through insulated piping approx. 2,438 m to the SWTP.

Upon entry to the SWTP temperature and flow are monitored then water is chlorinated and run through an Anthracite filter (one of two), treated by UV and into a storage tank. The SWTP has (2) 227,000L water storage tanks for this purpose. Water from these tanks serve multiple purposes, it can be heated and returned to the LWPH where it is used to prevent freeze up of the water intake or it can be distributed to the station by the water distribution system.

The water distribution system is a re-circulating loop that runs continuously. Temperature and flow are monitored both leaving and returning the SWTP. Returning flow is sent to the top of the storage tanks while flow leaving the tanks goes out the bottom.

4 Sewage Treatment

4.1 Sewage Discharge Criteria

All Sewage generated from CFS Alert will be directed to the Sewage Treatment Terrace or as otherwise approved by the Nunavut Water Board. The Licensee shall construct and operate all infrastructure and Facilities designed to contain, withhold, divert or retain Water and/or Waste in accordance with all applicable legislation and industry standards. Unless otherwise approved by the Board in writing, effluent will be discharged at a distance of least thirty-one (31) metres above the Ordinary High Water Mark of any Water body, where direct flow into the Water body is not possible, such that surface erosion is minimized and no additional impacts are created. The quality of the sewage treatment terrace effluent discharging to Freshwater or directly into ocean shall be in accordance with the applicable site discharge limits and the approved Type A Water Licence (8AC-ALT1929) as listed in the following table.

Table 2. Effluent discharge quality limits for sewage terrace to Ocean*

Parameter	Max Concentration of any grab sample
BOD5	80 mg/L
pH	Between 6 and 9
Total Suspended Solids (TSS)	70mg/L
Oil and Grease	5mg/L and no visible sheen

*Source: Type A Water Licence (8AC-ALT1929)

4.2 Land Farm Discharge/ Outfall Locations

All discharge from Bulk Fuel Storage Facilities and Land Farm will not exceed the following Effluent Quality Limits provided in the table below.

Table 3. Effluent Discharge Quality Limits for Bulk Fuel Storage Facilities and Land Farm

Parameter	Max Concentration of any grab sample
Benzene	370
Toluene	2
Ethylbenzene	90
Lead	1
Oil and Grease	15 and no visible sheen
Phenols	20

4.3 Sewage Sludge Treatment Process Description

An engineered Sewage Terrace System is the type of facility used to dispose of sewage at the station. This system is located to the east of the station (refer to Figure 1) and is comprised of the outfall from the sewage pipe, hill side terracing, and once vegetation has established, a wetland at the base of the terrace.

The terrace wetland was established in the summer of 2010 and has operated since. The daily volume of wastewater can range from approximately 70 cubic metres per day during winter months to a high of approximately 120 cubic metres per day in the summer time; reflective of the fluctuation in the number of personnel stationed at the base. Water is constantly allowed to bleed through the collection and distribution systems to prevent freezing. Therefore wastewater is constantly flowing to the terraced wetland. This wastewater is a combination of bleed water, garburated food wastes along with grey water and sanitary sewer waste. This means that the consistency of the wastewater can be quite variable and range in strength from very dilute to moderately strong depending on the time of day.

Sewage is untreated and continuously flows from the outfall pipe and travels down grade approximately 200 to 250 m to the east through the terrace system prior to entering the receiving body Parr Inlet; refer to Figure 3 for as-built engineering drawing of terrace system. The terracing system length of approximately 500 m allows for sufficient dispersal of the sewage (or sludge) over the entire length of the system. The sediments settle and biodegrade during the summer through increased surface area exposure to aeration and natural ultraviolet-light exposure).

Physical filtration and or entrapment of organic matter appears to be the major treatment process occurring within this wetland. This means that the organic portion of the wastewater is being retained in the upper portions of the wetland with the result that the wastewater exiting the wetland is lower in BOD5, volatile suspended solids (the organic fraction of TSS), and organic nitrogen. This is also supported by a higher organic content within the soil sediments from the upper portions of the wetland. The molecular characterization of the microbial population also suggests that the greatest metabolic activity of the microorganisms is also occurring in this region. wastewater, likely through the process of adsorption onto particle and rock surfaces within the wetland.

Many of the processes (biochemical, chemical, physical) operating in the treatment of municipal sewage / effluents are common to both wastewater treatment plants and to treatment wetlands. In brief, the treatment of municipal sewage and effluents can be summarized as: i) oxidizing organic and chemical constituents to harmless products, ii) the removal of viable pathogens, and iii) removal of suspended solids along with inorganic and or organic contaminants associated with the solids. The intent of the strategy is to ensure there are no deleterious effects to the water bodies receiving the treated effluent, particularly with regard to fish health and or fish habitat.

Wetlands can be effective in the removal of suspended solids contained within municipal effluents. The removal process is usually one of entrapment within the matrices of the wetlands substrate or attachment to biofilms and the force of gravitational pull causing solids to fall out of solution. Some of the prime factors affecting a wetland's effectiveness in reducing the concentration of total suspended solids (TSS) are water velocity, HRT, and the size and volume of the interstitial spaces through which the effluent flows. The release of high concentrations of suspended solids to the receiving environment can have deleterious effects on natural habitats or biota through the burial of vital habitat components or through the co-transport of other harmful contaminants or pathogens. The potential for wetlands to reduce TSS provides a surrogate measure for the removal of other potentially more harmful contaminants attached to suspended solids such as trace elements, pathogens, nutrients like phosphorus and other chemicals. Thus removal of the suspended solids often correlates to a reduction in the concentration of these contaminants within the treated effluent.

4.3.1 Operation and Maintenance Protocols

The purpose of Operation and Maintenance Plan for this system is to maintain continuous operation, prolong system life, prevent freezing of the sewer lines and ensure the treatment area performs as intended. The following table outlines the frequency and tasks to be completed to operate and maintain the sewage disposal facility.

Frequency	Tasks
Daily	▪ Check sewer lines, monitor temperatures throughout the station. ▪ Remove accumulated ice at the sewage outfall by hand/backhoe to prevent freezing of effluent and any damage related to ice jamming or ice lifting of the outfall pipeline (2-3 times/week during subzero temperatures).
As required	▪ Repair terraces, prevent channelling (summer). ▪ Repair/replace snow fencing to prevent snow accumulation at the Sewage Terrace System.
Monthly	▪ Sampling of effluent (during times of flow). ▪ Report sewage volumes.
Annually	▪ Report sampling results and sewage volumes.

The Sewage Terrace System was constructed during the summer of 2010 and therefore maintenance records have not yet been developed. Maintenance records shall include the details of any maintenance undertaken on the terrace system.

Weed and insect control is not required at the site. Birds and mammals such as wolves have been frequently observed in the area of the sewage outfall and terrace system. For over 25 years the Canadian Wildlife Service has been conducting an annual avian study on the birds attracted to the waste water particles in the upper portion of the treatment area to gain a better understanding of high Arctic avian populations and the continuing effects of climate change.

4.4 Safety Procedures

Safety procedures have not yet been formalized for the sewage facility. Access to the sewage disposal area is not restricted; however, the following safety measures were put into operation for the sewage pipeline:

- A permanent rope lifeline has been constructed to aide operators walking along the sewage pipeline (between the Water Treatment Plan and the sewage outfall).
- The sewage outfall area is well lit.

Table 1: Assumed Sewage Loads

Source	Flow (L/day)	BOD_5 (g/d/person)	BOD_5 (g/day)	BOD_5 (mg/L)	TSS (g/d/person)	TSS (g/day)
Blackwater	50	20	2000	400	60	6000
Greywater	150	25	2500	167	18	1800

Combined	200	45	4500	225	78	7800

BOD_5: biochemical oxygen demand is a chemical procedure, performed over 5 days @ 20^0 C, to determine how fast biological organisms use up oxygen in a body of water (unit, mg/l)
TSS: total suspended solids is a water quality measurement determined by pouring a measured volume of water through a pre-weighed filter of a specified pore size, then weighing the filter again, drying and determining the gain in weight (unit, mg/l)

5 Sampling, Monitoring, and Reporting

Generally, sampling and monitoring of the potable and wastewater treatment systems will include the following:

- Regular sampling of sewage and wastewater discharge in accordance with water licence requirements.

- More frequent internal process sampling (minimum once per week) and monitoring (daily)to identify potential upset conditions early that could lead to non-compliance.

- Record of volumes of sewage and wastewater effluent discharged and sludge generated in accordance with water licence requirements.

- Completion of daily checklists related to the O & M requirements for the facilities and the reporting of any upset conditions that require action.

- Aquatic effects monitoring program to confirm/validate environmental predictions.

The monitoring program will identify upset conditions related to the sewage treatment plants which will be immediately reported to the CFS Alert Site Manager for corrective action.

5.1 Potable Water System Monitoring

Untreated Fresh water will be sampled at Water Treatment Plant. Treated potable water will be sampled from the potable treatment plant effluent. Samples shall be collected at every active water take location for select analyses at frequencies specified in applicable regulations/guidelines. A typical list of parameters to be tested includes the following:

Calcium, Magnesium, Sodium, Potassium, Aluminum, Arsenic, Boron, Barium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Selenium, Silver, Strontium, Thallium, Vanadium, Zinc, Tin, pH, Conductivity, Alkalinity as CaCO3,TDS (COND-CALC), TSS (total suspended solids), Turbidity, Phenols, N-NH3, SO4, Cl,Br,N-NO2, N-NO3, NO2 + NO3 as N, Mercury, Hardness as CaCO3, COD (chemical oxygen demand), Oil and Grease

A comparison of the sampling results to the Guidelines for Canadian Drinking Water Quality
(GCDWQ) will be completed.

5.2 Sewage Treatment System Monitoring

Treated sewage effluent will be monitored and sampled at proposed locations specified in the Type A Water Licence (8AC-ALT1929). The proposed effluent discharge criteria was summarized in Table 2.

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APPENDIX A: FIGURES

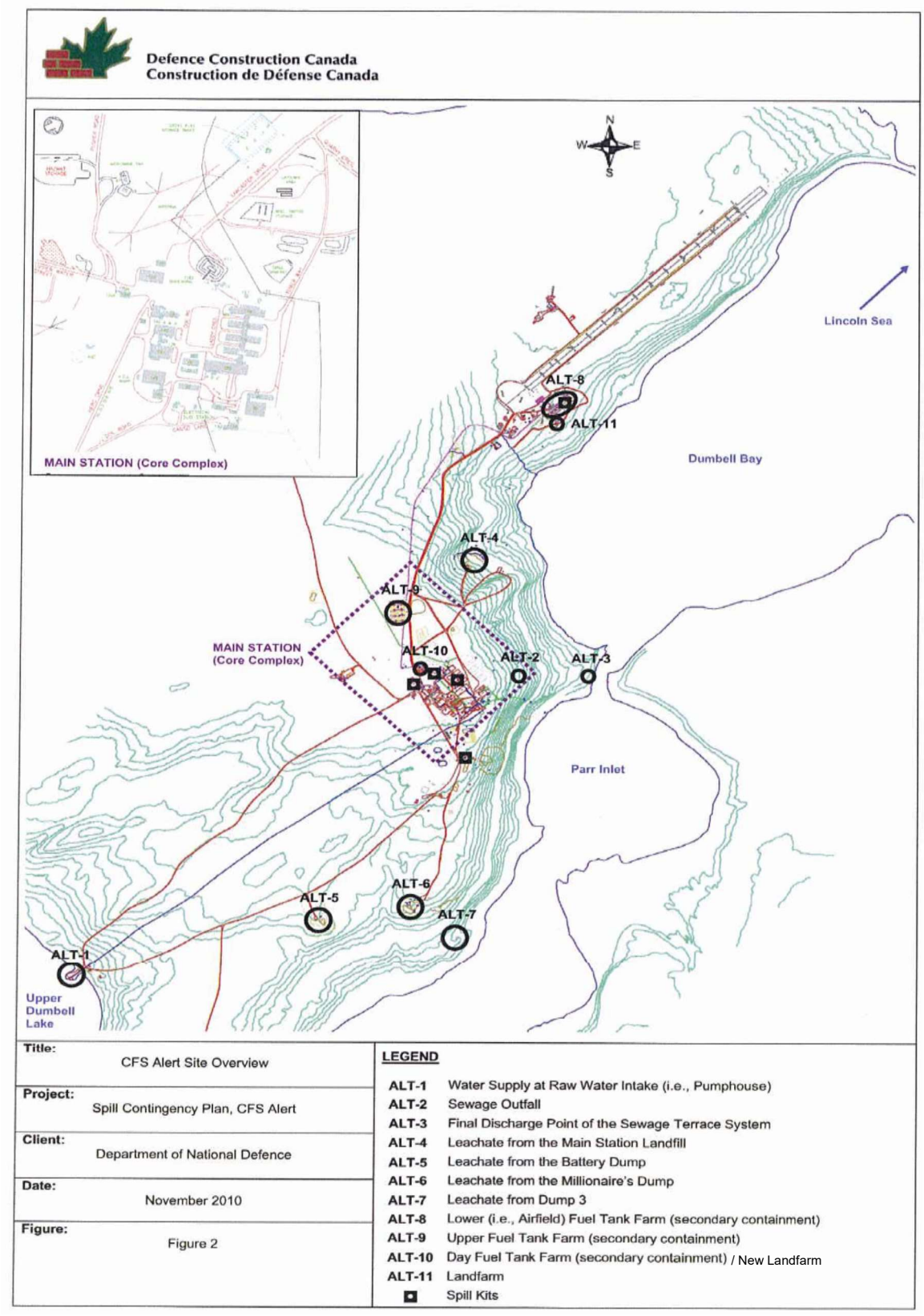

Figure 2. Water Licence Monitoring Stations, revised January 2014.

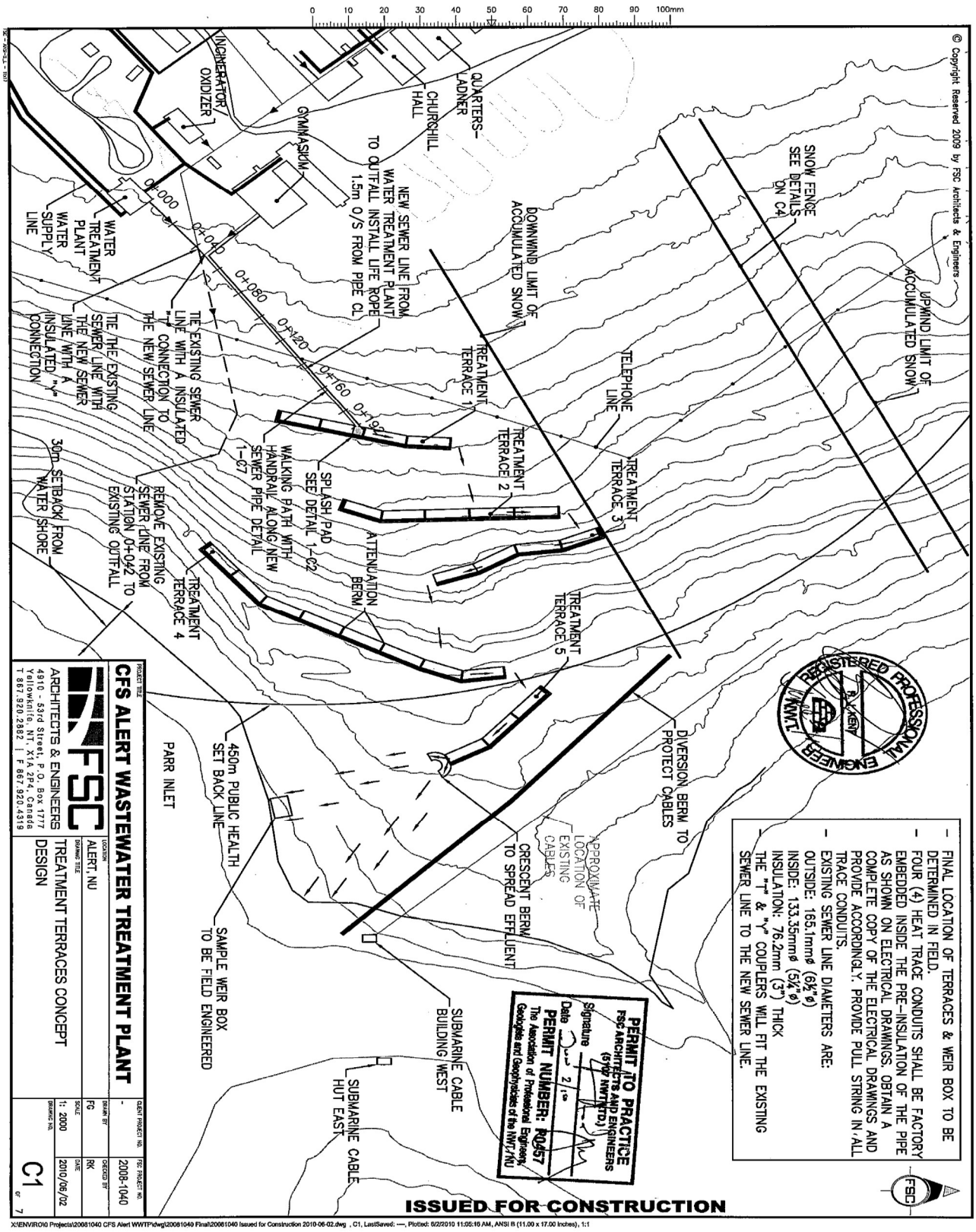

Figure 3. Wetland Terrace Wastewater Treatment Design

APPENDIX B: TABLES

Frequency	Tasks
Daily	▪ Check sewer lines, monitor temperatures throughout the station. ▪ Remove accumulated ice at the sewage outfall by hand/backhoe to prevent freezing of effluent and any damage related to ice jamming or ice lifting of the outfall pipeline (2-3 times/week during subzero temperatures).
As required	▪ Repair terraces, prevent channelling (summer). ▪ Repair/replace snow fencing to prevent snow accumulation at the Sewage Terrace System.
Monthly	▪ Sampling of effluent (during times of flow). ▪ Report sewage volumes.
Annually	▪ Report sampling results and sewage volumes.

Table 1. Excerpt from the CFS Alert Water Licence O& M regarding wastewater system checks.