BIONEST
KODIAK

DESIGN AND CALCULATION

CAM-D Simpson Lake Site (30 workers)
80 km west of Kugaaruk, Nunavut

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July 20th, 2009

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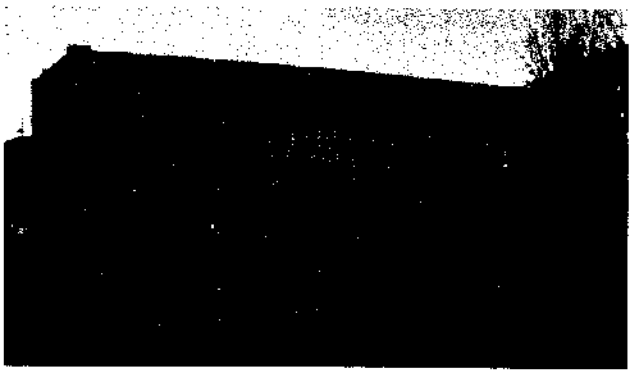
1.0 Project description

This design booklet sizes a Kodiak System for the wastewater treatment of the CAM-D Simpson Lake site, where 30 workers will stay for a period of 3 months for three consecutive years.

The type of sewage to treat is considered of domestic strength. The treated water will be discharged into an outfall sewer designed by the consultant.

The design flow rate has been evaluated to 6,000 liters by day. A 20 feet Kodiak WWTP will be installed on the decontamination site, located 80 km west of Kugaaruk, Nunavut.

2.0 Design Criteria



The BIONEST™ system is an advanced generation of onsite wastewater treatment systems. It combines all the advantages of a natural, simple yet robust process and brings that peace of mind that a permanent system can offer. The BIONEST™ system consists of two reactors installed in series.

The first tank's primary role is a digestion/settling reservoir equipped with an effluent filter. The second tank, the bioreactor, is split in two compartments (2/3 – 1/3). The biological process, in the first compartment, consists of an aerated submerged fixed film reactor combined with BIONEST™ media. The biomass is mostly fixed to a ribbon type media (polymer). The second compartment of the bioreactor is not aerated, but the oxygen level is still adequate, thus ensuring treatment completion.

The BIONEST™ Wastewater Treatment System has successfully obtained NSF Standard 40, Class 1 and BNQ certifications.

3.0 Design Flow rate

Wastewater design flow and organic load:

- Design flow rate: 6 000 L/d
    - 30 workers x 200 L/person.day[1] = 6 000 L/d
- Organic load: the BIONEST™ system initially treats wastewater in a two-compartement septic tank equipped with a conventional effluent filter. The septic tank is followed by a two-compartment BIONEST™ reactor. System is intended to treat domestic-like wastewater. Table below represents typical concentration of domestic sewage as presented in the USEPA Onsite Wastewater Treatment Systems Manual (tables 3-7 from pages 3-11; 2002; http://www.epa.gov/owm/septic/pubs/septic_2002_osdm_all.pdf).

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Table 1: Constituent mass loadings and concentrations in typical residential wastewater

Constituent	Concentration (mg/L)
Total solids (TS)	500-880
Volatile solids	280-375
Total suspended solids (TSS)	155-330
Volatile suspended solids	110-265
5-day biochemical oxygen demand (BOD_5)	155-286
Chemical oxygen demand (COD)	500-660
Total nitrogen (TN)	26-75
Ammonia (NH_4)	4-13
Nitrites and nitrates (NO_2-N; NO_3-N)	< 1
Total phosphorous (TP)	6-12
Fats, oils and grease	70-105
Volatile organic compounds (VOC)	0.1-0.3
Surfactants	9-18
Total coliforms (TC)[d]	10^8 - 10^{10} MPN/100 mL
Fecal coliforms (FC)[d]	10^6 - 10^8 MPN/100 mL

- Temperature: < 12°C

1 As provided by Mr. François Bourassa, P. Eng. and based on «Sewerage system standard practice manual » issued by the Ministry of Health Services of British Columbia and published at http://www.bcossa.com/images/Sewage_System_Standard_Practice.pdf for "construction camps with flush toilets (189 l/worker/d).

4.0 Equipment sizing

4.1 Grease interceptor

A properly sized in-ground grease interceptor offering a minimum effective volume of 4 500 L is required in order to reduce the fats, oils and greases (FOG) concentrations to domestic levels. Table 3-7 from the USEPA Onsite Wastewater Treatment Systems Manual (table 3-7 from pages 3-11; 2002; http://www.epa.gov/owm/septic/pubs/septic_2002_osdm_all.pdf) presents typical concentrations of different constituents found in domestic sewage. FOG normally ranges between 70-105 mg/L leaving a house and its concentration falls around 20-25 mg/L in the septic tank's effluent (USEPA Onsite Wastewater Treatment and Disposal Systems, 1980, page 99; http://www.epa.gov/owm/septic/pubs/septic_1980_osdm_all.pdf). Therefore, the grease interceptor shall be designed by the consultant and operated by the owner to find a concentration of 20-25 mg/L at the inlet of the BIONEST™ bioreactor. The grease interceptor is an inexpensive, but yet a very important equipment to assure proper functioning of the treatment chain.

It shall be equipped with at least one Polylok PL-625 effluent filter (0.8 mm [1/32"] openings). Only kitchen sewage can be sent to the grease interceptor. The grease interceptor shall be designed in accordance with the following study on restaurant pre-treatment from the TOWTRC or equivalent:http://www.towtrc.state.tx.us/common/FOG%20report%20reduced%20with%20reduced%20appx.pdf (page 5). Its main function is to offer enough detention time to allow the effluent to cool off and cause dissolved oils and greases to float.

4.2 Kodiak Unit

4.2.1 Septic tank

The septic tank will have an effective volume of 9 000 L. The working volume of the septic tank is separated at its 2/3 – 1/3 interface and offers a retention time of 1.5 days.

The tank will be equipped with a Polylok PL-525 effluent filter (1.6 mm [1/16"] openings)

Effluent leaving the septic tank is considered having a BOD of around 200 mg/L.

4.2.2 BIONEST™ Bioreactor

The Bioreactor shall offer a detention time of 1.5 days at design flow. Therefore, a tank with a working capacity of 9 000L is provided.

The density of the BIONEST™ media in the bioreactor shall be 92,5 m^2/m^3 (effective liquid volume). The media will be evenly distributed in the tank for a total of 1 620 m^2 of media for the entire system.

Permanent aeration of the first compartment of the bioreactor is assured by linear diffusers. Therefore, 10 diffusers connected to 5 small diaphragm air pumps (model HP-80 from Hiblow or equivalent) will be installed. Each air diffuser will provide 35 L/min, for a total of 350 L/min.

The effluent from the bioreactor is recirculated back into the aerated section of the bioreactor at a rate of 2.5 times the daily flow. One recirculation pump will recirculate the effluent at a flow rate of 10.4 L/min.

To maintain wastewater temperature above 12°C, two (2) pipe insert heaters (5 kW) are installed in the 1/3 section of the septic tank.

4.2.3 UV disinfection

An ultraviolet disinfection unit is required to disinfect the effluent prior to surface discharge. The following table is used to select the model and number of units required.

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Table 2: TrojanUVmax's maximum instantaneous flow rate per model.

Model UVMAX	Max flow
« D »	6,8 L/min
« E »	16 L/min
« F »	27 L/min

A maximum hourly peak factor (HPF) of 6 at the end of the bioreactor is assumed. (http://www.mddep.gouv.qc.ca/eau/eaux-usees/domestique/chapitre2.htm#2-1). Therefore, the maximum instantaneous flow rate will be:

$$Q_{daily} = \frac{Q_{daily}}{24hrs * 60\min} = \frac{6000L}{24hrs * 60\min} = 4.16L/\min$$

$$Q_{inst} = Q_{daily} * HPF = 4.16L/\min * 6 = 25.0L/\min$$

One (1) UVmax model F unit disinfecting at a rate of 27 L/min will be required. The unit shall be installed inside the mechanical room to facilitate access and maintenance.

5.0 Effluent criteria

The proposed design will meet the following values.

Parameters	Concentrations
$CBOD_{5,C}$[1]	<15 mg/L
TSS[2]	<15 mg/L
Faecal coliforms	<200 CFU[3]/100 ml

[1] Carbonaceous biochemical oxygen demand (5 days)
[2] Total suspended solids
[3] Colony forming unit

4 Maintenance of the Kodiak unit

Bionest provides an operation manual of the Kodiak unit to the owner and a copy for the Nunavut water. The operation manual details the requirements related to the Kodiak unit and the Bionest™ treatment system.