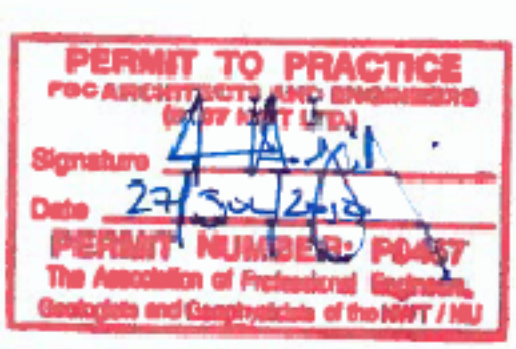
Sewage Sludge Management Alternatives
For the
Hope Bay Project

Created June 2010

Version 1.0

Effective till January 2015

Project # 2010-0100



Prepared for:

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LISTEN. DESIGN. MANAGE.

1 Executive Summary

Sewage sludge is a by-product of sewage treatment. People often think of it as a toxic waste and this is because of uncontrolled dumping of toxic wastes into sewage. But, if the materials entering a sewage treatment facility are managed at the source, and toxic wastes not dumped, then sewage sludge can have beneficial uses such as fertilizer or to stabilize soil. This makes it useful in reclamation projects.

This report shows Hope Bay Mining Ltd commitment to creating beneficial sewage sludge from each of its camps in the Hope Bay Project. Hope Bay Mining Ltd will manage the incoming sewage, and keep it free of contaminants such as toxic cleaners and petroleum products, so that a beneficial sludge that meets CCME guidelines can be produced.

In addition to the Hope Bay Mining Ltd commitment, this report discusses:

- The sources and plans to reduce contaminants;
- Plans to prevent toxic dumping;
- Alternatives for sludge treatment;
- Alternatives for sludge storage; and
- Beneficial uses and typical reclamation projects.

Also included is disposal by incineration, if that is necessary, and Hope Bay Mining Ltds further commitment to work with Environment Canada to reduce dioxins and furans in stack gases.

This report will be part of Hope Bay Mining Ltds planning process for all the camps associated with the Hope Bay Project.

ANAGUKVIKMIN KIKHOKNIGANIK MONAGIYAGANI ATOLAKTUN - KAPIHILIKTUMI

HAVAAK

JUNE-MI 2010-MI

1. Atanguyan Okaohen Naetomik

Anagukvikmin kikhokniga avalekpaktok imagiknitiknikmin. Inoen ihomagilikpagaan aneaknaktotun ikagutun una taemaetok monagiyaoteagitkagamik aneanaktun ataguvaloen anagukvikmun. Kiheani, hunalika kuviyaokpata anagunik imagikhitikvikmun monagiyaoteakatalo honaonigin, aneaknaktolo ikaguginikata, anagukveom kikhomaniga ikayutaolaktok naoteavaloen naonagigeagani nunaenaklunen nakuhiyagani. Una atoktaolaktok utiktineaknikata ilitkohenun nunan.

Una onipkak naonaepkotaokman Hope Bay-kon Oyagakheoktin akhogotigiyaenik ikayutaolaktonik anagukvikmin kikhumaniganik atoktaoyagani atuni iglukpakakvikmiknin Kapihiliktumi Havaami. Hope Bay-kon Oyagakheoktin monagineakaan anaguvaloen, pikagitaganilo halomaelguvaloknik aneagotaolaktonik halomaktigutinik okhokyoavalokniklo, taemaenika ikayutaolaktok kikhomayok namageagani CCME-koni maligoagakhani kigoagulo pikaligeagani.

Ilataok Hope Bay-kon Oyagakheoktin okageyaktaeni, una unipkaak okaohikakmiyok:

* Ihoakotin opalogaeyaotilo mikhivaaligeagani halomaegutilaktun;

* Polalogaeyaotin aneaknaktonik atagugitagani;

* Aheagun atoknikhaenik kikhumanigin imagikhitikvikmin;

* Aheagun atoknikhaenik kikhumanigin tutkoktiktaoyagani; unalo

* Ikayutaolaktun atokata utiktitiyutaovaktolo nunanik ilitkohenun havaan.

Ilagikmiyalo akaguvaloknik ikulatiyagani, piyageakaknikan, Hope Bay-kon Oyagakheoktin okageyaktaenihavakatigenageagani Avatilikiyin Kanatami Kavamanin mikhivaaligeagani halomaetun poyuvaloen poyukviknin. Una unipkak ilagineaka Hope Bay-kon Oyagakheoktin oplaogaeyaknikun havaagiyakhaenik tamaeni iglukpakakvikni ilagiyaenilo

kapihiliktumi Havaaguyun.

FSC-KON TITIGAOYAKTIN NAONAEYAEYILO HANAOGAKHANIK

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ᔪᓂ 2010
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ᕼᐅᑉ ᐸᐃᒥ ᐅᔭᕋᓐᓂᐊᖅᑎᑦ ᓕᒥᑕᑦ ᐱᓕᕆᔨᖏᑕ ᐊᓯᖏᓐᓂᑦ ᐅᓂᒃᑲᖅᑲᕐᒥᔪᑦ ᒪᑯᓂᖓ:

- ᐱᕕᐅᒐᔭᖅᑐᓂᑦ ᐊᒻᒪ ᐸᕐᓇᐅᑎᓕᐅᕐᓗᑎᒃ ᓱᕈᓐᓇᖅᑐᑦ ᖃᓄᖅ ᓄᖑᑎᑕᐅᒐᔭᕐᒪᖓᑕ;
- ᐸᕐᓇᐅᑎᓕᐅᕐᓗᑎᒃ ᖃᓄᖅ ᐃᒋᑦᓯᑦᑕᐃᓕᒪᐅᑎᑦᓴᓂᑦ ᓱᕈᓐᓇᖅᑐᓂᑦ;
- ᐊᓯᖏᓐᓂᑦ ᐊᑐᖅᑕᐅᖓᕈᓐᓇᖅᑐᓂᑦ ᑭᓇᓗᐃᑦ ᑲᓐᖓᒥᓂᖏᓐᓂᑦ ᓴᓗᒻᒪᕐᓴᐃᔾᔪᑎᑦᓴᓂᑦ;
- ᐊᓯᖏᓐᓂᑦ ᐊᑐᖅᑕᐅᖓᕈᓐᓇᖅᑐᓂᑦ ᑭᓇᓗᐃᑦ ᑲᓐᖓᒥᓂᖏᓐᓂᑦ ᓴᓂᕐᕙᐃᓯᒪᕕᑦᓴᓂᑦ; ᐊᒻᒪ
- ᐱᕙᓪᓕᐅᑎᔪᓂᑦ ᐊᑐᖅᑕᐅᔪᓐᓇᖅᑐᓂᑦ ᐊᒻᒪ ᓄᓇᒥᑦ ᓴᓗᒻᒪᕐᓴᐃᓂᕐᒥᑦ ᐱᓕᕆᔾᔪᑕᐅᒐᔪᑦᑐᓂ.

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Table of Contents

2 Introduction

2.1 PURPOSE

This manual has been produced to outline the processes and options that may be used at the Hope Bay Project to manage sewage sludge with the ultimate goal of its beneficial use to the project.

2.2 GOAL

HBML's goal is to produce Class B compost as per CCME Guidelines with the exception of the microoganism requirements. The CCME Guidelines were developed so that the compost could be used in populated areas, or where agricultural crops were grown. The Hope Bay Project is not in such an area. All of the camps are located in unpopulated, remote areas. None of the camps are located in areas with extensive wildlife. Therefore, the potential risks associated with microorganism exposure are minute.

That said, HBML is committed to the safety and well-being of its employees, staff and workers. Every effort will be made to ensure their safety.

2.3 INFORMATION OF THE LICENSEE

Hope Bay Mining Ltd
#300 – 889 Harbourside Drive
North Vancouver, BC V7P 3S1

2.4 INFORMATION OF 24 HOUR CONTACT

HBML Site Manager
604-985-5701

2.5 WHAT IS IN THIS PLAN

This Plan consists of sewage sludge management alternatives for:

- Treatment;
- Storage;
- Dewatering;
- Beneficial use; and
- Disposal.

2.6 GENERAL DESCRIPTION OF THE APPROACH

Sewage sludge is often defined as one of the toxic wastes from our cities. This is because municipal sewers receive all manner of waste and this was tends to accumulate toxins in the sludge, the residual of sewage treatment.

In contrast, the Hope Bay Project and its associated camps strictly manage their incoming sewage. Only faeces, food particles and grey water[1] enter our domestic sewers. The quality of the wastewater is managed by:

- Not connecting shop and floor drains to the domestic sewer;
- Orientation and education of staff and workers;
- Using only non-biodegradable cleaners and products (see 1.6 below); and
- Monitoring and enforcement by EMS staff.

The purpose of this effort is to ensure that treated sewage sludge can be used beneficially in HBML reclamation projects; thus, turning a potential waste into valuable resource.

2.7 DIOXANS AND FURANS

It is the goal of HBML to create Class B compost as defined by the CCME Guidelines for Compost Quality from all our sewage sludge. It is a further goal to eliminate incineration of sewage sludge to reduce the potential for the formation of dioxins and furans in stack gases. Our efforts to manage the quality of the incoming wastewater plus our commitment to work with Environment Canada to develop a suitable and sustainable elimination strategy should ensure our goals are met.

2.8 CONTAMINANTS OF EMERGING CONCERN

Neither in the current water licence nor in the National Performance Standard, but rising in importance as discussions with Health Canada continue, are contaminants of emerging concern. A partial list relevant to the Hope Bay Project includes:

- Pharmaceutical and personal care products;
- Surfactants – surface active agents;
- Organic solvents; and
- Anti-bacteria agents.

These contaminants are not removed by conventional sewage treatment. In the especially fragile high north environment Newmont will show leadership by addressing these concerns through staff education and orientation programs for:

[1] Grey water is defined as water drained from sinks, showers, kitchens and laundry. Unlike black water, grey water contains no human wastes. After filtering it is typically used as non-drinkable water, for example for washing and irrigation.

2.8.1 Pharmaceutical and personal care products

Educating staff that all waste drugs and personal care products are not disposed into the sewer, rather, that they are disposed by incineration prior to landfilling or shipped south for disposal. Pharmaceuticals can lead to anti-biotic resistant organisms and endocrine disrupting agents in the environment. Less is known about personal care products, however, it is known that they are present in the environment in small but measurable quantities.

2.8.2 Surfactants – surface active agents

Notwithstanding the need for personal hygiene and camp cleanliness, camp cleaners will be selected that are biologically compatible.

2.8.3 Organic Solvents

Organic solvents or any such material will not be disposed in the sewer; and

2.8.4 Anti-bacteria Agents

Anti-bacteria agents --- such agents are found in so-called anti-bacteria or anti-viral soaps and the like. They are weak bactericides that do not kill all the bacteria or viruses. Those surviving can mutate and are stronger for the experience. In contrast, plain soap is also anti-bacteria but those surviving organisms whose cell wall was simply disrupted causing death are unlikely to mutate to a stronger form. Soaps and other products with so-called anti-bacteria agents will no longer be provided at a Newmont Camp. This is important as there are birds in the area and it is known that there are organisms that will cross between birds and people. Therefore, it will be prudent to reduce the numbers of mutated anti-biotic resistant organisms in the area.

3 Sludge Treatment

3.1 SOURCES

Each Newmont Camp has state-of-the-art sewage treatment. Such sewage treatment may consist of:

- Activated sludge systems; or
- RBC systems.

3.1.1 Activated Sludge Systems

The typical activated sludge system used at a Hope Bay Project camp is an MBR (membrane reactor), although others may be used. This process uses a membrane as a final filtering stage in the treatment process. As a result, high concentrations of bacteria can be kept on the "dirty" side of the filter. This leads to high sludge ages and a treated sludge that is similar in quality to one treated in an aerobic digester.

3.1.2 RBC Systems

The typical RBC system has two components of sludge. Raw sludge, that is, settled faecal and food matter; and biomass sludge, that is, biomass that is sloughed from the biodisks. Both are acceptable for treatment in an aerobic digester.

3.2 AEROBIC DIGESTION

3.2.1 Purpose

The purpose of aerobic digestion is to reduce the volatile suspended solids concentration (VSS) to about 50% of the TSS in the remaining sludge. This eliminates nuisance conditions by reducing putrescibility and reduces threats to human health by reducing levels of microorganisms.

3.2.2 Adopted Use by HBML

Aerobic digestion is acceptable for use with both raw (primary) sludge and with biomass (secondary) sludge. HBML will use aerobic digestion at all its camps.

3.2.3 Types of Aerobic Digesters

HBML will use two types of aerobic digesters:

- A stand alone digester; and/or
- The biomass sludge from an MBR system that will be considered to be aerobically digested.

Either or both processes will be used at any camp.

4 Storage

4.1 SLUDGE PONDS

Treated, or partially treated sludge, ultimately destined for a beneficial use but still in a relatively liquid state is to be stored in a sludge pond. A sludge pond is an unlined depressed area that collects but does not discharge water. Water is removed by evaporation or by pumping to a transportation vehicle for further treatment if necessary. If water meets licensed discharge values, water will be discharged overland from the pond. Any sludge pond is located away from the camp proper to reduce bear/human interaction.

4.2 BEAR SAFETY

Bears are known to frequent the area, and precautions should be taken. Bear safety information can be found on the GNWT's Environment and Natural Resources website:

http://www.enr.gov.nt.ca/_live/documents/documentManagerUpload/Bear_Safety.pdf

4.3 BARRELS

Treated, or partially treated sludge, ultimately destined for a beneficial use but still in a relatively liquid state may be stored in barrels or similar containers either for additional storage or in advance of further conditioning.

The barrels will be stored in such a manner to prevent spillage. Barrels free of petroleum products will be used to store sludge.

Barrels may be used to fly sludge from one camp to another to facilitate treatment, dewatering, conditioning, beneficial use, or disposal.

4.4 DRY STORAGE

Sludge that has been dewatered and now awaits beneficial use will be stored in containers such as wooden totes, former ammonium nitrate bags or some other container that resists water. The containers will be marshalled in a designated storage are and identified.

5 Dewatering

5.1 GENERAL CONSIDERATIONS

Sludge dewatering is a process whereby sludge solids are treated by dewatering processes to remove excess water to facilitate further cost-effective storage or handling.

5.2 SLUDGE PRESS

For HBML, “Sludge Press” is a generic term used to define any mechanical process of dewatering.

The purpose of a sludge press is to remove sufficient water from the sludge to produce a product with a cake-like consistency that may be stored for future beneficial use or, if necessary, disposed by incineration cost-effectively.

While some of the MBR plants used at the Hope Bay Project do have an on-site sludge press, it is proposed that a mobile sludge press may be used to dewater sludge at other camps.

5.3 CONDITIONING

The process of sludge digestion is dependant on many factors including the type of sludge processed, temperature, and length of process time. As a result, sludge may be produced that requires additional conditioning prior to dewatering to improve that process. Conditioning is usually accomplished with the use of polymers including:

- Anionic (negative charge) -- serve as coagulants aids to inorganic Aluminum and Iron coagulants by increasing the rate of flocculation, size, and toughness of particles.
- Cationic (positive charge) -- serve as primary coagulants alone or in combination with inorganic coagulants such as aluminum sulfate.
- Nonionic (equal amounts of positively and negatively charged groups in monomers) -- serve as coagulant aids in a manner similar to that of both anionic and cationic polymers.

Lime treatment may also be used to pre-condition the sludge for dewatering and/or to produce sludge with a basic pH for use in a reclamation program.

5.4 SLUDGE DRYING BED

A sludge drying bed is a horizontal sand filter used to expose sludge to the atmosphere to facilitate evaporation and drying. Sludge dried in a sludge drying bed has several advantages including:

- Aerobic treatment continues as long as the sludge remains moist to further reduce putrescibility and levels of microorganisms;
- Once through a freeze thaw cycle, the sludge dewaters more readily and tends to stay dewatered rather than re-absorb water; and
- Sludge can be layered to more than a metre without adversely affecting the effectiveness of the process.

Water from the sludge drying bed is generally collected and analyzed prior to discharge. If it meets discharge requirements, it will be discharged directly to the adjacent land using such erosion control techniques as are necessary.

5.5 THERMAL CONDITIONING

Sludges that are difficult to dewater, dewater insufficiently, need to be drier to be used in a beneficial procedure, or need to be drier prior to incineration - may be thermally treated in a kiln.

A sludge kiln is a rotary drier consisting of a heating unit and some internal venting that carries away the produced water vapour. The heat transfer can be conducted directly or indirectly. In the most common case for a direct heat transfer, a gas stream, e.g. air, applies the heat by convection and carries away the vapour as humidity. A temperature below the flash point is chosen to avoid auto-ignition.

5.6 BIODIESEL

Biodiesel development continues to advance and sewage sludge has been a candidate for a feedstock for many years. Issues surrounding biodiesel from sludge include: cost-effectiveness, the viability of the process; safety; and disposal of process residuals.

It is not planned to use biodiesel without first completing a detailed feasibility study.

6 Beneficial uses

6.1 GENERAL

Sewage sludge has been used in various forms for centuries as fertilizer, soil stabilizer and a soil conditioner.

6.2 IDENTIFIED USES

Sewage sludge will be blended with other materials to be identified to produce a top-dress medium for use in reclamation programs.

Areas identified for reclamation include:

- Roads
- Airstrips
- Laydown pads
- Camp pads
- Ore piles
- Spoil piles
- Tailings
- Former sludge ponds

7 Disposal

7.1 GENERAL

Sludge that is to be disposed will be incinerated.

Sludge may be conditioned prior to incineration.