A regional approach to biosolids management: The Sechelt experience

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Abstract: The lack of sufficient overburden and nutrient deficient soils provide reclamation challenges and opportunities at Construction Aggregates Limited's Sechelt Mine located near Sechelt, BC. Reclamation activities are augmented through the application of biosolids from the local communities of Sechelt, Gibsons and Powell River and pulp and paper mill sludge from Howe Sound Pulp and Paper for irrigation and fertilization. Ongoing stakeholder consultation and partnerships between local government, First Nations and industry have led to the success of this award winning biosolids program. Program highlights include the establishment of an artificial wetland and two hybrid poplar plantations. For over a decade environmental monitoring has failed to identify an adverse environmental impact. Biosolids use in reclamation activities supports vegetation establishment, promotes environmental stewardship, demonstrates regional sustainability and provides training and employment opportunities.

Keywords: Gravel mine, poplar, reclamation, stakeholder, wetland

INTRODUCTION

Construction Aggregates Limited’s Sechelt Mine (CAL) is the largest operating sand and gravel mine in Canada, producing between 5 to 7 million tonnes of product annually which is shipped by barge to regional markets and by ocean freighters to markets as far away as Hawaii and California. Since the commencement of mining activities over a decade ago, the mine has identified reclamation as both a significant opportunity and a challenge. A specific challenge in the reclamation of the mine site is the condition of the existing soil. The overburden redistributed across the mine site is often poorly developed, lacking the nutrients and organic matter to support and sustain vegetation. The mine is located immediately adjacent to the community of Sechelt and on portions of Sechelt Indian Band (SIB) lands. Visual quality, wind erosion, and sound abatement are additional challenges. The use of biosolids in reclamation activities to provide the nutrient and physical capital to facilitate vegetation establishment was viewed as an opportunity to promote environmental stewardship, recycling and regional sustainability.

BACKGROUND

Location

The District of Sechelt (DoS) is located along the Sunshine Coast of British Columbia (BC) roughly 60 km north west of Vancouver, approximately 1.5 hours by vehicle and ferry. The District is bordered by the Strait of Georgia along the south coast and Sechelt Inlet along the north coast. The DoS has a population of 7,775 on a land area of 39 km² (Statistics Canada, 2002). Access to the Sunshine Coast is limited to ferry service. Other communities within the region include the Town of Gibsons and the City of Powell River.

Service sectors, health and education, tourism and natural resources are major industries within the DoS. The SIB has land both within the community and the mine footprint. The intersection of resource extraction and tourism within the community presents a challenge when meeting competing industry objectives. This challenge is amplified by the location of the sand and gravel mine. CAL is located on the East Porpoise Bay Plateau immediately adjacent to the community of Sechelt (Figure 1). The mine occupies in excess of 250 hectares of land from four different landowners, including two private companies, the Crown and the SIB. It is visible from the community, Alaska bound cruise ships and Vancouver Island. A shopping mall and hospital are located within 200 m of the mine site.
Reclamation Objectives

Ongoing reclamation and vegetation establishment in cleared areas of the mine site are of paramount importance for a number of reasons. Revegetation of cleared areas not only improves aesthetics but also reduces windblown particulates and soil erosion. Creating vegetated berms around the exterior of the mine reduces noise as well as impedes access to the site which can be a safety concern for both the public and workers. Establishing vegetation and improving soil allows for interception and storage of rainfall, in effect moderating significant precipitation events and assisting with water management. Establishing a self-sustaining cover of vegetation is the first step in creating habitat for wildlife, and may lead to different options for future land use after mine closure.

Traditional methods of reclamation, however, have limited success on this and similar sites. When overburden is redistributed in a reclamation area, it is often sandy and poorly developed, lacking the organic matter, nutrients and water holding capacity required to sustain vegetation. While providing an initial boost of nutrients, chemical fertilizer does not contribute to the long term establishment of self sustaining vegetation as it does not improve soil structure. The organic matter content and cation exchange capacity of these soils is very low, resulting in limited nutrient and moisture storage. Significant winter rain and summer drought affect the establishment, survival, and growth of vegetation. While the region receives approximately 1370 mm of precipitation per year, only approximately 220 mm are received from the beginning of June to the end of September (Environment Canada, 2004). Wind erosion of exposed areas can impact air quality and germinating plants are susceptible to being covered in sand. Hydroseding had been attempted in the past but was unsuccessful on sandy slopes on and surrounding the mine.

Application of organic amendments was selected as a method of addressing the reclamation requirements of the site as well as the limitations of more traditional techniques. When applied to overburden, biosolids and pulp mill sludge increase organic matter in the soil, improving water holding capacity and providing a long term source of soil nutrients (Cogger, 2005; Van Ham and Teshima, 2005). Applications began on a research trial basis in 1997. Based upon the results of this trial, a permit was granted by the Ministry of Environment for ongoing applications of biosolids, pulp mill sludge and lime mud.

ORGANIC AMMENDMENTS

The mine is committed to the principles of recycling, reclamation and regional sustainability, which is reflected by its continued support of biosolids recycling. In developing the reclamation program, the mine sought to establish long term partnerships with local governments, First Nations, regulatory agencies and industries to recycle and reuse organic residuals. Since its inception in 1997, the reclamation program has incorporated the following organic residuals: dewatered and liquid biosolids, pulp and paper sludge, lime mud and wood waste. In addition, back flush water from a drinking water treatment plant is also utilized on site instead of being discharged.
Regulatory Criteria
During the research trial phase initiated in 1997, biosolids were applied under a 15 month authorization from the BC Ministry of Environment (MoE). Based on the success of these initial applications, a permit was sought and obtained from the MoE in 1998. The permit enables the application of biosolids, pulp sludge and lime mud within the mine boundaries. Biosolids continue to be applied under permit today.

Permit requirements include maximum annual discharge rates, amendment quality and soil quality after application of the amendment. Monitoring of the amendments and the receiving environment, soil surface and groundwater, is required and must be reported annually to the MoE and proximal stakeholders.

Regional Partnerships
Biosolids represent the largest volume of organic amendments used in the reclamation program. Liquid biosolids (approximately 4% total solids) are obtained from the DoS which operates a secondary wastewater treatment plant adjacent to the mine site. Additional biosolids are provided by the Town of Gibsons and the City of Powell River; these biosolids are approximately 15% total solids. Dewatered biosolids, approximately 27% solids, from the Greater Vancouver Regional District (GVRD) have also been used at the mine site for special projects.

In addition to the biosolids, pulp mill sludge and lime mud from the Howe Sound Pulp and Paper (HSPP) mill in Port Mellon have also been used for reclamation activities. As well, limited volumes of wood waste from local generators and back flush water from the DoS water treatment plant have been used.

In conjunction with planned wastewater treatment plant upgrades and reclamation opportunities, the DoS is working with CAL to site a new facility that would see effluent irrigation and continued biosolids fertilization over the mine site.

Having access to a long term recycling option for their materials is of utmost importance to these community partners as it provides them with the opportunity to plan for long term infrastructure needs and eliminates less desirable disposal options for the duration of the program. These relationships with local biosolids producers also facilitate a long term partnership with the SIB, who continues to be an important stakeholder in all facets of the mine operations including reclamation. Through maintenance and development of ongoing reclamation activities, CAL is able to provide ongoing opportunities for continued education and training in silviculture and land stewardship.

RECLAMATION PROGRAM
Research Study
Building on experience managing biosolids and pulp mill sludge at other locations within the province, CAL and SYLVIS Environmental initiated a research study to explore reclamation options at the mine. The initial pilot was designed to assess the long term feasibility of using such materials on-site and determine effective application rates. DoS liquid biosolids were used in combination with pulp sludge from HSPP in four demonstration plots (Figure 2). Stakeholder consultation was conducted through tours of the application site, open houses and newspaper bulletins. In addition, these plots were established on a berm highly visible from the community. The public was engaged and provided feedback on the applications and reclamation work. The research and demonstration trial proved that organic residuals can be used to successfully reach community oriented reclamation objectives both quickly and in a manner that is protective of the environment.
Ongoing Operations

Since obtaining its permit from the MoE in 1998, CAL has conducted progressive reclamation throughout its operation. Biosolids have been used on-site in three different ways: irrigation of existing vegetation through liquid biosolids applications, soil amendment and fertilization through direct dewatered applications, and biosolids use in combination with sand, wood chips or other materials as a mixed product.

Liquid biosolids are applied to vegetated slopes to provide needed nutrients and moisture to these difficult to reach areas. With a skidder mounted self loading application vehicle, applications can reach up to approximately 20-30 metres. Direct applications to growing poplar trees are also conducted to supply much needed water to these crops throughout the very dry summer months in the region (Figure 3). In these applications a tractor-pulled liquid tanker is used to direct the liquid biosolids along the tree rows.

Dewatered biosolids are applied to level ground where incorporation is possible. Following application, biosolids are incorporated into the subsoil to minimize odours and nutrient losses (Figure 4). Discing also decreases water and nutrient competition from grasses. Biosolids may be applied to amend sandy overburden prior to planting or as an ongoing fertilization treatment. Agronomic application rates are determined based on amendment quality, soil nutrient concentrations and vegetation requirements.
Dewatered biosolids are directly land applied to a poplar plantation periodically, conditions necessitate the production of a “soil-like” mixture of multiple materials to achieve reclamation objectives (Figure 5). This is the case where aesthetics are important, where odours must be mitigated, or where access is difficult and a one-time application is more practical than ongoing fertilization. Mixtures of biosolids and sand have been used on perimeter berms surrounding the mine operations. The Organic Matter Recycling Regulation (OMRR) (British Columbia Ministry of Water, Land and Air Protection, 2002) governs biosolids use in BC. The OMRR enables the use of the highest quality (Class A) biosolids in the production of a biosolids growing medium (BGM). BGM meeting quality-based criteria stipulated in the OMRR can be used without restriction. In 2004, a BGM was fabricated from biosolids, compost and sand and was used in the establishment of an anthropogenic wetland.

Figure 5 Dewatered biosolids and sand are combined in a reclamation mix that is used to establish vegetation on steep slopes

Program Highlights

While the overall program has been nationally recognized as exemplary, a few project highlights are cornerstones of the reclamation program. Firstly, community involvement has been integral to the success of biosolids use on site. CAL hosts an annual community-wide open house which attracts 750 to 900 residents each year. These open houses include opportunities for community members to learn about biosolids recycling and site reclamation and to ask questions directly to mine staff and reclamation consultants. Community members are given the opportunity to tour the site to observe how applications are conducted and gauge the success of reclamation efforts. Local high school and scouting groups have participated in tree planting efforts on site, providing both learning and fundraising opportunities. The SIB forestry crew has participated in planting and plantation maintenance. Reclamation updates are published in the local paper to keep community members informed year round.

A second project highlight is the anthropogenic wetland created in 2004. The mine identified a previously cleared area that remained saturated throughout the dry summer season and opted to transform it into a wetland (Figure 6). The area was contoured and BGM produced with Class A biosolids, compost and sand was
applied in the upland area. Coarse woody debris and boulders were placed to provide varied habitat and the site was planted with native trees and shrubs and seeded. The wetland plays a central role in a wildlife corridor which will ultimately run the length of the operations. Geese, ducks, songbirds, and amphibians all use this habitat extensively.

Figure 6 Area of wetland prior to construction (left) and following completion (right)

A third highlight of the program is the establishment in 2004 of an 11 ha poplar plantation on a section of the mine owned by the SIB. As an alternative to seeding the area with grasses, poplar trees were planted to provide education and employment opportunities for the SIB in the short term as well as economic return with harvestable crop in the long term. The plantation is fertilized and irrigated with biosolids, enabling harvesting of a commercially valuable tree crop in as little as twelve years. These fast growing trees assist in carbon sequestration and pedogenesis. Figure 7 shows the plantation one year after planting. A second plantation was established in 2005.

Figure 7 Poplar plantation one year following planting

Environmental Monitoring and Reporting

A comprehensive monitoring program was initiated in 1998 and continues today. Soil, water, and amendment data collected from this program is used to assess the short and long term effects of biosolids use on the site. Prior to biosolids application a soil sample is collected from all areas to establish a background sample and analyzed for a number of parameters including nutrients, organic matter content and trace element concentrations. The organic amendments are in turn analyzed for similar parameters to ensure only high quality material is applied and to establish an appropriate application rate on a site specific basis. Additionally, a soil sample is collected annually where biosolids have been applied to confirm application goals have been attained and that no adverse conditions are observed. Since monitoring began in 1998, no application areas have exceeded soil limits for trace elements as outlined in the application permit. Beneficial results such as increased organic matter and nutrient availability have been observed. Results of this monitoring are reported to MoE annually.
Often public perception is that biosolids applications have a deleterious effect on local water resources. Research has been conducted on the impact of such applications in agricultural and mining environments on surface water (Tian et al., 2006) while groundwater studies are currently more limited. At the Sechelt Mine two surface water (one upstream and one downstream of reclamation activities) and two groundwater samples are collected quarterly and analyzed for nutrient, trace element and biological parameters. Results are reported quarterly to MoE. Since monitoring began in 1998, no negative impacts on surface or groundwater resources has been indicated by biosolids applications to the site.

CONCLUSIONS

As one of the premier organic matter recycling initiatives in Canada, CAL’s reclamation program has expanded over the past ten years to include biosolids from all generators within the region. Today, liquid and dewatered biosolids from the surrounding communities of the DoS, Town of Gibsons, City of Powell River and Greater Vancouver Regional District are recycled on-site. These materials are incorporated into a beneficial use program for reclaiming disturbed portions of the mine site. Activities are undertaken in a manner that is protective of the environment and ongoing monitoring of soil, water and amendments is conducted and provided to the Ministry of Environment.

The reclamation program is successful in large part due to the open dialogue that exists between the mine and community stakeholders. The mine, the organic residuals generators, the local communities and the environment enjoy a win-win-win partnership in the recycling of organic residuals in mine reclamation. The mine provides an environmentally responsible utilization option for the region’s organic residuals and the generators are able to participate in regionally sustainable management practices. The program provides education and training opportunities in silviculture and land management practices to the SIB.

REFERENCES


