

The Edmonton Region Biosolids Strategy

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Abstract

A Biosolids Management Strategy (BMS) for the Edmonton Region presents a unique opportunity to bring together a number of interested stakeholders working towards the development and implementation of a long term, strategic plan. This will include the examination of land application processes, regulatory reform, emerging technologies, risk management, and financial modeling that will provide a roadmap to best manage and finance the management and beneficial uses of biosolids in the Edmonton Region over the next 20 years. The development and implementation of a biosolids management strategy in the Edmonton Region has been ongoing from the day the Clover Bar Lagoons opened between 1971 to 1972. Since that time there have been only two biosolids applications; biosolids application to agricultural farmland (the NutriGold Program) and the use of biosolids as feedstock for the production of compost products at the City of Edmonton's compost facility. The development of sustainable BMS began in 2007 with the formation of the Edmonton Region Biosolids Partnership. Since that time this partnership has identified opportunities for both land application and technologies for extracting value from biosolids. The Edmonton BMS through this paper also highlighted the development of the social contexts for biosolids such as; public perception, persuasion and developing sound environmental policies.

Keywords: *biosolids, biosolids management strategy, beneficial use, dewatering, emerging technologies, land application, public participation, regulatory reform.*

1 Introduction

The Biosolids Management Strategy (BMS) is a long term strategic plan undertaken by the Edmonton Region Biosolids Partnership, which involves the development and implementation of a more comprehensive Biosolids management program. Biosolids are defined as wastewater sludge destined for beneficial use. In order for the wastewater

sludge to be amenable for beneficial use, prior treatment such as stabilization and dewatering is required.

The BMS involves aspects such as regulatory reform, the analysis and evaluation of emerging technologies, management of the risks associated with the strategy, more in depth examination of the current application of Biosolids, among other aspects that could lead to a better Biosolids management.

The Biosolids for the Edmonton Region are produced from the City of Edmonton's Gold Bar Wastewater Treatment Plant and the Alberta Capital Region Wastewater Treatment Plant. The population being serviced by both wastewater treatment plants was estimated in 2010 as approximately of 1,150,000 People. The Biosolids produced by both plants are managed in the City's Clover Bar Waste Management Facility. The Location of the Clover Bar Waste Management Facility is South of 137 Avenue NE between Meridian Street NE and 17 Street NE as shown in Figure 1.



Figure 1: Location of the Clover Bar Waste Management Facility

The liquid biosolids received at the Clover Bar Waste Management Facility are either discharged to sludge lagoons or dewatered directly using centrifuges in part of the co-composting facility. The biosolids that are in the lagoons are either dredged out and dewatered for use in the co-composting facility or they are loaded into tanker trucks in a liquid form and hauled away as part of the Nutri Gold agricultural land application program. Biosolids that are dewatered directly may also end up in the municipal solid waste co-composting process or in a separate aerated windrow composting program with chipped woody debris.

The overall objective of the BMS can be defined as to ensure the sustainable management of the current Biosolids management programs and the development of new and beneficial uses for the biosolids. The parties involved in the BMS are: Drainage Services, City of Edmonton; Waste Management Centre, City of Edmonton; Alberta Capital Region Wastewater Commission and EPCOR Water Services.

2 Scope of work

The BMS will be a long term strategic plan that will guide the management of municipal biosolids produced at the Gold Bar Wastewater Treatment Plant (GBWWTP) and the Alberta Capital Region Wastewater Treatment Plant (ACRWWTP). The BMS will guide the established biosolids management programs and the development of new opportunities for the beneficial use of biosolids produced at the two wastewater treatment plants and stored at the Clover Bar Biosolids Lagoons. Overall, the BMS has an Early Action Plan (3-5 years) and a Long Term Plan (5-30 years)

2.1 Goals Of Strategy

The Biosolids Management Strategy will provide details on meeting the following goals:

- Develop sustainable biosolids processes with capacities that match the projected yearly production of biosolids from the two wastewater treatment plants and reduce the inventory of biosolids at Clover Bar Lagoons to an acceptable operational level.
- Optimize the use of all existing biosolids management assets.
- Enhance the effectiveness of operations and management of liquids at the Clover Bar Biosolids Lagoons.
- Identify and develop new markets for the beneficial use of biosolid products.
- Develop capital investment plan and sustainable funding process to meet the objectives of the various biosolids management initiatives.
- Develop risk management plans related to specific biosolids management assets, operations and programs.
- Ensure that biosolids processes, projects and management plans have public acceptance.

2.2 Elements Of Biosolids Management Strategy

The BMS will contain the following 12 elements:

- Regulatory Reform
- Compost Production
- Nutri-Gold Program
- Non-Agricultural Land Application
- Technology and Energy Options

- Carbon Credits, Offsets and Sequestration
- Capital Investment Plan
- Financial Modeling
- Funding Process
- Risk Analysis and Mitigation
- Communications Plan Development
- BMS Review Process

3 Structure of Biosolids Management Strategy

3.1 Membership

The BMS is represented by the following stakeholders:

- Drainage Services Branch, City of Edmonton
- Waste Management Branch, City of Edmonton
- Alberta Capital Region Wastewater Commission
- Gold Bar Wastewater Treatment Plant, EPCOR Water Services

3.2 Committees

There are two committees for the BMS:

- Edmonton Regional Biosolids Partnership (ERBP) Working Committee
- Edmonton Regional Biosolids Partnership (ERBP) Steering Committee

3.3 Roles and Responsibilities

3.3.1 ERBP Working Committee The chair is (Drainage Services):

- Organize and facilitate Working Group meetings
- Produce and distribute meeting notes capturing decisions and action items.
- Distribute meeting agendas to the Working Committee, approximately one week in advance of the meeting
- Manage the development of the Biosolids Management Strategy in accordance with the project charter and project plan
- Facilitate issue resolution for identified conflicts.
- Represent the ERBP Working Committee (or delegate responsibility)
- Coordinate external messaging of the Biosolids Management Strategy (or delegate responsibility)
- Report issues to the Steering Committee in order to obtain decision/direction

- Members:
- Provide adequate resources and representation to the Working Group, and task groups (as appropriate)
- Work towards to the objectives of the ERBP
- Identify new objectives or issues for the Working Committee, in a timely manner.
- Identify issues within the member's business unit which may affect the development or implementation of the Biosolids Management Strategy

3.3.2 ERBP Steering Committee The chair is (Drainage Services) and ACRWC is a member:

- Development of the project charter
- Resolves Issues
- Approves changes
- Reviews work products
- Approves Deliverables
- Organize and facilitate committee meetings

4 Biosolids Use Regulations In Alberta

In Alberta the application to Agricultural land of biosolids generated through municipal wastewater treatment is governed by the “Guidelines for the Application of Municipal Wastewater Sludges to Agricultural Land” (Alberta Environment March 2001; hereafter referred to as the Guidelines). The Guidelines were prepared by Alberta Environment in 1982, revised in 1996 through a process of peer review and updated in 2009. Land treatment of biosolids is an authorized activity under the Alberta Environment Protection and Enhancement Act.

Based on a principal of beneficial reuse, the Guidelines recognize the value of biosolids as a soil conditioner and fertilizer providing that the biosolids application in controlled and directed towards maintaining and enhancing agricultural soil-plant systems. It is the expectation of Alberta Environment that land application will be conducted in a beneficial manner with minimal risk to health and the environment. To facilitate this, the Guidelines provide criteria for development of a biosolids spreading program as shown in Tables 1, 2 and 3, sampling and analytical methodology, Equipment calibration and application of biosolids.

In general, spreading biosolids to land is permitted during spring, summer, and fall and is not permitted in ground which is ice-covered, snow-covered, or frozen. Exceptions might be made to when there is a summer or fall snowfall or unseasonal cold weather freezes the surface layer or soil.

The acceptable crops that biosolids can be applied to include; Forages, Oil seed crops, Small grains, Dried peas and beans, Commercial sod and trees. While the unacceptable crops that biosolids cannot be applied to include; Root crops, Fresh vegetables and fruits, Tobacco and Dairy pasture land.

In addition to the criteria listed in this section, three conditions must be met before re-application of biosolids to a particular site permitted:

- A minimum period of three years must have elapsed after the previous biosolids application event;
- Plant available nitrogen (NH₄-N, NO₃-N) in the surface 150 cm of soil shall be no greater than 250 kg/ha; and
- The maximum cumulative additions of biosolids-borne elements shall not exceed the limits specified in Table 4.

Table 1 - Minimum Acceptable Ratios of Nitrogen and Phosphorus to Metals

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Nitrogen (Organic+ Nitrate + Ammonium)	1,500	20	15	3,000	100	20	10
Or ¹							
Phosphorus (Total)	600	8.0	6.0	1,100	40	8.0	4.0

¹ Biosolids is unacceptable if either the nitrogen or phosphorus criterion is not met. Spiking biosolids with nitrogen or phosphorus to achieve these ratios is not permitted.

Table 2 - Classification of Sites on the Basis of Site and Soil Characteristics

	Acceptable ¹			Not Acceptable
	Class 1 Sites	Class 2 Sites	Class 3 Sites	Class 4 Sites
pH	≥ 6.5	≥ 6.5	≥ 6.5	<6.5 ²
“Texture” ³	CL, SiCL, SiL, Si, SiC, L, SCL, SC	C, HC	LS, SL	Sand and gravel ⁴
Slope (%) ⁵	0-2	2-5	5-9	9
Depth to Potable Aquifer (m)	>5	3-5	2-3	<2

¹ A site falls into the lowest class represented by any characteristic.

² A site with a pH less than 6.5, which would otherwise be classed 1, 2, or 3, may be upgraded by liming to pH 6.5 or higher.

³ As determined on samples from representative soil horizons to a depth of at least 30 cm.

⁴ Other class 4 sites include stream valleys, intermittent drainage areas and organic soils.

⁵ Restriction of biosolids application rates based on slope considerations apply only when surface application methods are employed. Slope criteria can be relaxed if biosolid waste is applied by subsurface injection.

Table 3 - Maximum Addition of Solids and Nitrogen for Each Site Class and Biosolids Type – Single Application

Biosolids Type	Solids Application Rate ¹			Total Nitrogen Application Rate			Available Nitrogen [(NH ₄ + NO ₃) - N] Application Rate for Surface Spreading ²		
	t/ha dry weight basis			kg/ha			kg/ha		
	Class 1 Sites	Class 2 Sites	Class 3 Sites	Class 1 Sites	Class 2 Sites	Class 3 Sites	Class 1 Sites	Class 2 Sites	Class 3 Sites
Digested	25	20	10	900	700	400	450	350	200
Wastewater Lagoon	10	8	5	800	600	300	400	300	150
Undigested ³	5	4	2.5	600	500	200	300	250	100

¹For surface application a maximum hydraulic loading rate of 100 m³/ha/day is imposed for biosolids containing less than 5% solids. Allowable solids and nitrogen rates for such biosolids may be achieved by making several incremental additions with the soil cultivated between each addition. There is no hydraulic loading rate restriction on sub-surface injection.

²For sub-surface injection the maximum available nitrogen application rate is 200 kg/ha on Class 1 and 2 Sites and 150 kg/ha on Class 3 Sites.

³Additional restrictions may apply to undigested sludge based on site specific conditions.

Table 4 - Maximum Cumulative Additions (kg/ha) of Biosolids – Borne Elements to Soil¹

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Class 1 Sites	1.5	100	200	0.5	25	100	300
Class 2 Sites	1.1	75	150	0.4	19	75	200
Class 3 Sites	0.8	50	100	0.2	12	50	150

¹ Not more than one-third of the cumulative loading may be applied in a single application.

5 Current Practices of Biosolids in Edmonton - Alberta

Drainage Services, with the City of Edmonton manages biosolids generate by the GBWWTP and ACRWC. The annually biosolids managed between the years of 2006 till the end of 2010 was about 24,000 – 27,000 dry tonnes. Table 5 shows the biosolids transfers in/out at the Clover Bar Lagoons and Figure 2 shows the Edmonton’s Biosolids Management. Annual disposal rate has not kept pace with biosolids production and has resulted in an accumulation of biosolids at the Clover bar lagoons. The accumulated biosolids at the end of 2010 was at a range of 180,000 to 200,000 dry tonnes.

Table 5 - Biosolids Transfer In/Out at Clover Bar Lagoons

Year	Stabilized Sludge Transferred To Clover Bar lagoons (DT)			Biosolids Transferred Out from Clover Bar lagoons (DT)			Annual Storage (DT)	Accumulated Storage (DT)
	Gold bar	ACRWC	Total	NutriGold	Composter	Total		
2006	21,128	5,245	26,373	4,517	3,675	8,192	18,181	78,899
2007	21,092	4,613	25,705	10,720	8,598	19,318	6,387	85,286
2008	21,177	4,056	25,233	12,239	7,194	19,433	5,800	91,086
2009	19,587	3,907	23,494	10,691	14,244	25,569	-2,075	89,011
2010	19,843	4,325	24,168	12,694	5,607	20,528	3,640	92,651

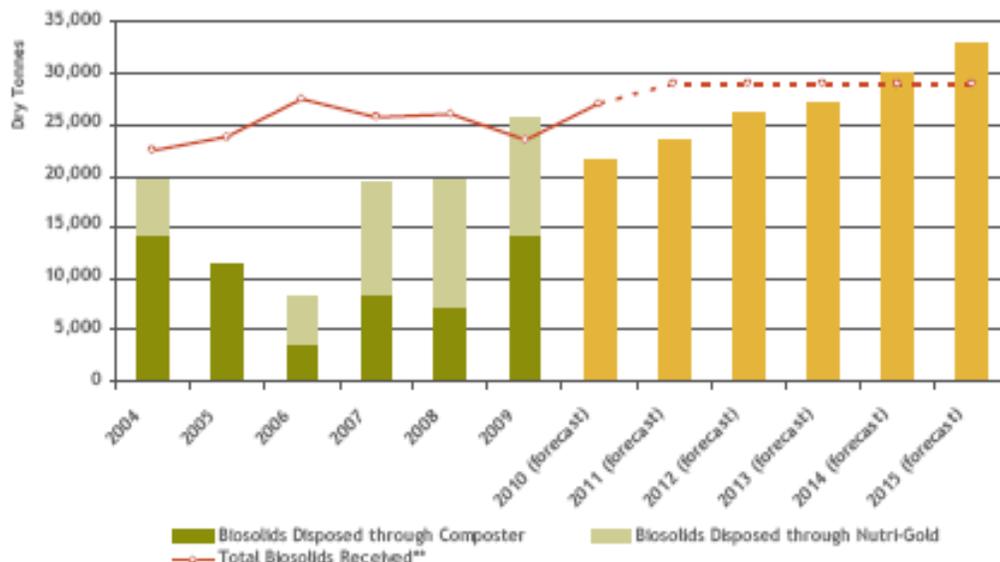


Figure 2: Edmonton Biosolids Management

5.1 Composting

The majority of biosolids is currently being managed through the composter facility. Composting of biosolids includes de-watering, co-composting, and curing. The composter can manage up to 20,000 dry tonnes annually when operating at full capacity.

5.1.1 Changing Household Waste to Compost The average Edmonton household produces about 800 kilograms of non-recyclable waste every year. Before the City introduced recycling programs in 1988, all residential waste was buried in landfills. By 1998, the City was diverting about 14 per cent through recycling.

In the year 2000, Edmonton ushered in a new era of waste management. The City now recycles 15 per cent of its waste, and all remaining household solid waste is taken to a huge composting facility, the largest of its type in North America.

A large portion of all household waste is organic matter (food, garden trimmings, paper), see Figure 3 for residential waste composition. The Edmonton Composting facility processes that organic material along with biosolids (sewage sludge) to create compost, a rich soil supplement. With recycling and composting, only about 40 per cent of Edmonton's household waste goes to landfill.

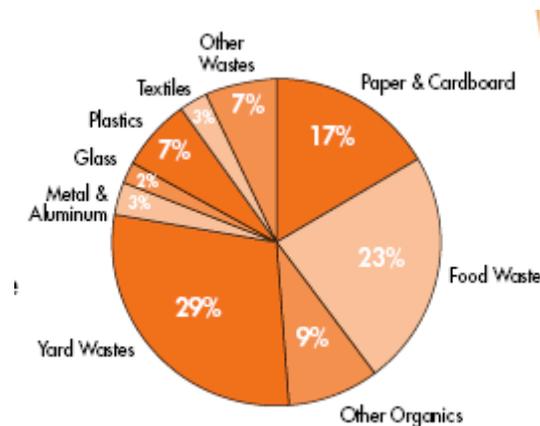


Figure 3: Composition of Residential Waste

5.1.2 Why Composting Because it's good for the environment and it's more economical than landfilling over the long term. Landfills are unpopular, increasingly expensive, and carry environmental risks. They also take up valuable land space. While composting initially costs more, it will reduce Edmonton's waste disposal costs in the future. It also provides us with a valuable soil supplement that will improve the quality of top soil in the Edmonton region.

5.1.3 How does Composting Work Biosolids is dewatered at the Cloverbar Waste Management Facility prior to composting. The process including Tipping, Mixing, Screening, Composting, Compost Refining and Odour treatment as shown in Figure 4.

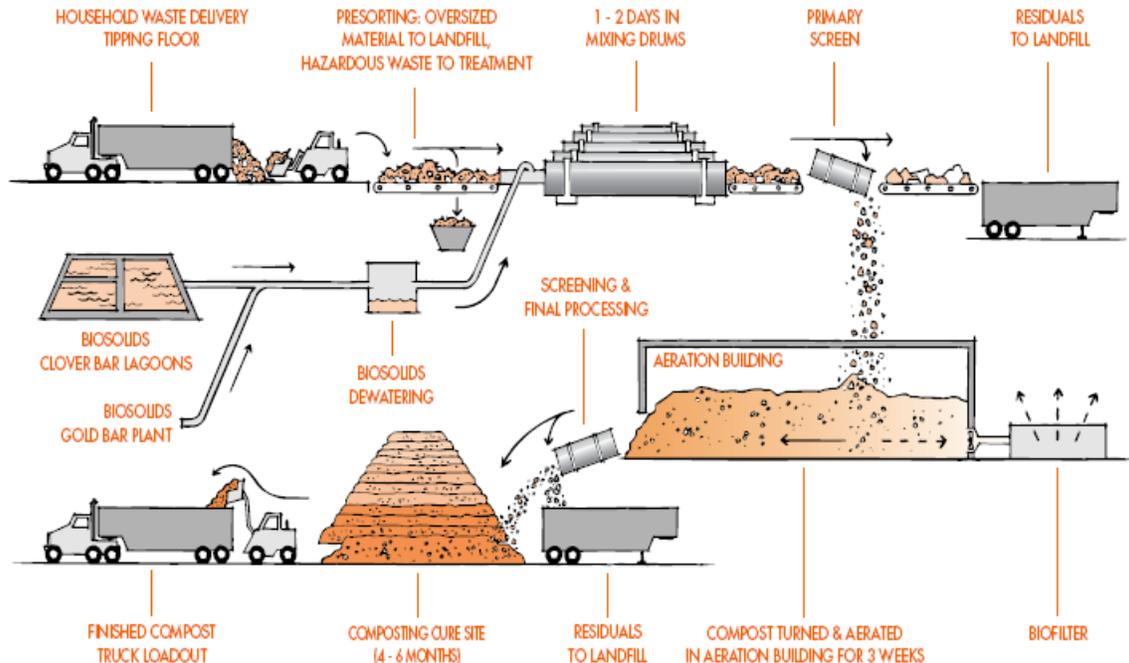


Figure 4: Composting Process at the Edmonton Waste Management Facility

5.1.4 Benefits of the Composting Facility

- It provides an affordable long-term solution for two of Edmonton’s waste streams-municipal solid waste and biosolids;
- With its combined recycling and composting programs, Edmonton diverts about 60 per cent of its residential waste from landfill; and
- The Facility receives thousands of visitors from around the world, creating economic spin-offs for local business.

5.1.5 Where is the Compost used? Compost products at the Edmonton Composting facility has many uses, these include:

- Home use in soil blends (Gardens and flowerbeds, lawns and Mulch);
- Agriculture (General field soil supplement and reduced chemical fertilizer);
- Landscaping and Nutrients (Planting bed preparation and Mulching);
- Roadsides (Erosion control); and
- Forest Recovery (New seeding establishment and mulch for tree planting).

5.2 Agricultural land Applications (Nutri-Gold Program)

The City of Edmonton’s Nutri-Gold agricultural application program was established nearly thirty two years ago. Biosolids from the storage lagoons (gravimetrically thickened to approximately between 8% - 10% total solids) at the Cloverbar Waste Management Facility are applied to selected agricultural operations within the Edmonton area to

improve soil fertility and physical properties. Transportation of the biosolids and land application are completed by end off-load tanker trucks. The Nutri-Gold program is weather dependent, but on average, is expected to manage 5,000 dry tonnes of biosolids annually.

In 2006, 5,377 dry tonnes of biosolids were applied to five agricultural sites. Table 6 summarizes 2006 Nutri-Gold biosolids applications.

Table 6 - 2006 Edmonton's Nutri-Gold Applications

Site	Biosolids Applied (DT)	Area (ha)	Application Rate (DT/ha)
1	749	33	23
2	1,297	58	22
3	832	37	22
4	1,288	72	18
5	1,211	54	22

Agricultural application continues to be a primary biosolids management option for many jurisdictions. Data on biosolids recycling collected from several jurisdictions similarly sized to the City of Edmonton indicated that agricultural applications incorporated 15-100% of biosolids recycled.

6 Alternatives for Piloting Land Application Options (Non – Agricultural)

The City of Edmonton started in identifying alternative land applications (Non-Agricultural Lands) for the biosolids since the 2008. The major factors prompting the need for this assessment include:

- Uncertainty in the long-term sustainability of the Nutri-Gold agricultural application program;
- Uncertainty in the ability to increase biosolids use in the composting program;
- Likely increase in biosolids production resulting from infrastructure expansion at the Gold Bar Wastewater Treatment Plant; and
- Concerns regarding the environmental impact of the existing storage lagoons.

Sylvis is the consultant retained by the City of Edmonton to investigate multiple options for the non-agricultural purposes.

A phased approach has been taken for the Non-Agricultural Land applications. In Phase 1 the project land application options were evaluated to augment the current Edmonton Region Biosolids Management Program. Phase 2 involved the securing of land application projects to demonstrate the prioritized land application options which include mine reclamation, biomass production and marginal land improvement. Phase 3 is currently in progress. The objectives of Phase 3 are to install operational biosolids land application demonstration projects and evaluate them from the perspectives of logistical feasibility, environmental protection, and stakeholder support.

Currently, the Alberta Environment biosolids guidelines are limited to biosolids applications to productive agricultural lands. The demonstration and evaluation of the projects as biosolids management options will facilitate the development of best management guidelines or revision of current guidelines to enable ongoing biosolids application in the City of Edmonton.

To date, four demonstration projects have been established:

- Agronomic crop and poplar establishment at the marginal land site owned by the Alberta capital Region Wastewater Commission;
- Poplar establishment on marginal agricultural land in partnership with Alberta Pacific Forest Industries;
- Agronomic crop establishment on marginal agricultural land in Lamont County; and
- Amending topsoil placed as part of operational mine reclamation at Capital Power Corporation's Genesee Mine.

Environmental monitoring and operational assessments were completed for these projects during the summer and fall of 2010.

In 2011 operational biosolids applications will be conducted in another mine reclamation demonstration at Lehigh Hanson's Villeneuve Pit.

6.1 Alberta Environment Consultation and Regulatory Reform

Following are the tasks required to be completed and submitted to Alberta Environment by Sylvis for the projects identified in the Section 5 above:

- Develop a draft biosolids stockpiling guideline document and submit to Alberta Environment as the recommended guideline for use at the project sites;
- Prepare a research overview document that addresses the research components of each of the four project sites as requested by Alberta Environment;
- Develop and present a report to Alberta Environment providing recommendations for the implementation of best management practices based on the findings; and
- Develop and present a report to Alberta Environment which provides detailed statistical analysis and results of the research and monitoring for the projects.

6.2 Evaluation of Non – Agricultural Land Application Options

Evaluation of the non-agricultural land application options are divided into five groups. Each of these five groups for evaluating the land application options has several sub-criteria, as shown below:

Environmental:

- Ease of regulatory compliance;
- Protection of human health;
- Carbon sequestration potential; and
- Greenhouse gas offset potential.

Social:

- Likely stakeholder acceptance; and
- Social benefit.

Economic:

- Capital costs;
- Operating and maintenance costs;
- Potential funding opportunities;
- Potential to generate revenues; and
- Potential for cost-sharing.

Technical:

- Proven technology;
- Innovative technology;
- Green technology;
- Compatibility with current and future biosolids quality; and
- Integration with City of Edmonton programs.

Market Potential:

- Regionally available markets or sites;
- Promotes biosolids management diversification; and
- Long-term stability/reliability

Based on the above criteria, following are the ranks for the options for the non-agricultural land:

- Biomass/biofuel production (Rank 1)
- Marginal land conversion (Rank 2)
- Mine reclamation (Rank 3)

7 Alternatives for Piloting Non – Land Application Options (Technologies)

Phase 1 of the BMS development project investigated and identified preferred opportunities for beneficial utilization of current and emerging technologies within the entire biosolids production and beneficial utilization chain. A few of the technology options identified during Phase 1 were related to the use of biosolids products for the production of energy. This project will continue on the work done in Phase 1 with the identification and evaluation of candidate technologies and make recommendations for the integration of technology throughout the biosolids production and beneficial utilization chain apart from their usage on agricultural and/or non-agricultural land applications. Recommendations will focus on the optimization of all existing facility assets, reduction of biosolids production and inventory, biosolids dewatering and drying, biosolids thickening, struvite removal and enhanced utilization of biosolids and biogas

Following are some of the proposed technologies to treat/dry the Edmonton biosolids:

- Ultrasonic waste activated sludge cell wall destruction;
- The microsludge process;
- Vacuum plate and frame combined dewatering and drying;
- Mechtronix valoris dewatering and drying;
- Fluidized bed combustion;
- Indirect drying;
- Use of dried solids as a cement kiln fuel; and
- Dried biosolids as a gasification feedstock;

Among the above options for the non-land applications, only Mechtronix Valoris has been piloted in early of 2011.

7.1 Evaluation of Non – Land Application Options (Technologies)

The Non-land application options are evaluated on the basis of four screening criteria and eleven more general value criteria, as shown below:

- Screening Criteria includes (maturity, technical capability, impacts on City of Edmonton programs and safety)
- Value Criteria Includes:
 - Meet or exceed Regulatory Compliance Requirements;
 - Helps to minimize environmental impacts;
 - Sustainability (long term, technical, and regulatory);
 - Flexibility (flexibility/versatility in operation);
 - Helps to build markets for biosolids and biogas;
 - Helps to reduce the consumption of resources;

- Ease of integration with existing system;
- Example of innovative technology;
- Example of green technology;
- Likelihood of public acceptance; and
- Cost.

Based on the above criteria, the Non-Land application options ranked as below:

- Ultrasonic disintegrators (Rank 1)
- Microsludge (Rank 2)
- Vacuum Plate (Rank 3)
- Disposal and reuse at cement kiln (Rank 4)
- Fluidized Bed Combustion (Rank 5)
- Dried biosolids to gasification (Rank 6)
- Mechtronix Valoris (Rank 7)
- Indirect drying (Rank 8)

8 Greenhouse Gas Mitigation and Carbon Sequestration

Most beneficial uses of biosolids, whether used on land or as energy source, have the potential to generate carbon credits and/or offsets. The beneficial use of biosolids has been promoted as a strategy to reduce greenhouse gas (GHG) emissions. The proposed biosolids management options discussed in previous sections will be assessed qualitatively through the development of the BMS based on their potential to generate or reduce GHG emissions through the following:

- Transportation and handling by fossil fuel-consuming machinery;
- Potential to offset chemical fertilizers requirements;
- Potential to generate alternative, non-fossil fuel energy sources; and
- The ability to use biosolids in the development of other GHG mitigation technologies, including fugitive methane (CH₄) mitigation at landfills.

Carbon sequestration in relate to biosolids also will be assessed by considering three processes:

- Soil development and increase in soil organic carbon (SOC);
- Conservation of existing SOC; and
- Increases in biomass carbon resulting in enhanced vegetation growth response following biosolids application.

9 Conclusions

A Biosolids Management Strategy is currently being jointly developed with EPCOR Water Services, Waste Management Branch and Alberta Capital Region Wastewater Commission. This strategy will identify new technology and regional opportunities to increase the capacity for disposal of biosolids in a cost-effective, socially and environmentally acceptable manner. The Strategy will also explore the potential for revenue generation to partially offset costs. The strategy will also cover the social context of biosolids such as; public acceptance, policies, persuasion and payoffs.

The immediate goal of the Strategy is to maximize existing capacity to match the expected increase in production rate in the next 5 years. The longer term goal is to reduce the existing inventory at Clover Bar Lagoons without placing undue pressure on the utility rate. Concurrently, studies on new technologies aimed at increasing the capacity for disposal are underway.

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