Needs Assessment for Sludge Processing Technologies in Ontario: Executive Summary

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Executive Summary

Sludge handling and biosolids disposition are important activities that are associated with wastewater treatment and represent a significant economic activity. This report addresses a study that was conducted to:

- establish current sludge handling and biosolids management practices in the province of Ontario,
- review current and innovative technologies for biosolids reduction and energy generation,
- assess the opportunities for innovative technology implementation.

In the first phase of this study, the sludge handling technologies currently employed and the quantity and quality of biosolids generated between 2014-2016 were characterized. Information was gathered from the Ontario Ministry of Environment and Climate Change (MOECC), the Ontario Clean Water Agency (OCWA) and through direct contacts with WWTPs. The current use of sludge handling technologies was categorized by functionality including thickening, stabilization and dewatering and the disposition practices of the produced biosolids were characterized.

The use of separate thickening processes was reported at 16% of WWTPs and these were employed at plants with design hydraulic capacities (DHCs) greater than 10,000 m^3/day. Stabilization was implemented at 77% of the surveyed WWTPs with 52.8 % of them using aerobic digestion and 36.7% employing anaerobic digestion. Anaerobic stabilization is most commonly employed in WWTPS with DHC values greater than 10,000 m^3/day while aerobic stabilization is predominantly employed at the remaining plants. Dewatering is primarily employed at large WWTPs (DHC > 10,000 m^3/day) representing 13% of all WWTPs. A majority of biosolids are employed for agricultural use and this is followed by landfilling and incineration for final disposition. There was no apparent relationship between the DHC of the WWTPs and disposition practices.

The distribution of WWTPs producing liquid and dewatered biosolids was characterized. It was found that WWTPs generating 1000-5000 m^3 of liquid biosolids/year and 1000-5000 tonnes of dewatered biosolids/year respectively were most common. Liquid

biosolids typically had solids concentrations in the range of 1~4% over the range of DHC from 100 to 100,000 m^3/day. The solids content of dewatered biosolids ranged between 20%-30%. There is evidence of a number of WWTPs that might benefit from enhanced dewatering to increase solids content and hence reduce the volume of biosolids produced.

The quality of biosolids was assessed with respect to parameters that may influence technology selection and disposition alternatives. The pathogen indicator content was found to be consistently within regulatory requirements for current disposition practices although improved quality would be needed if more diverse alternatives were to be desired. Three general patterns of metals concentrations were identified including those of low concern (arsenic, cadmium, cobalt, chromium and lead), medium concern (mercury, nickel and zinc) and highest concern (copper, selenium and molybdenum). The concentrations of highest concern metals met NASM requirements but may prevent the biosolids from being employed as composts. Dewatered biosolids typically had lower metals concentrations as compared to liquid biosolid and in general met Category B requirements for compost.

Phase 2 of the project involved gathering of information on innovative technologies for sludge processing. A keyword search of research publications yielded 262 reports that demonstrated the primary development of innovative technologies occurs in East Asia, Europe and North America. Most reports described bench and pilot scale testing and there were limited reports of full scale demonstration of selected stabilization, thermal reduction, heat drying, resource recovery and dewatering technologies. Globally, innovations in stabilization (34%), conditioning (27%) and dewatering (16%) technologies were most prominent. The most frequently reported developments in Canada were in the category of stabilization.

The largest number of reports within the stabilization category addressed innovation in biological processes. Anaerobic digestion processes had the dominant number of biological treatment reports with a focus of pre-treatment technologies for enhanced digester performance and process enhancements respectively. A limited number of reports on innovations on aerobic digestion were identified although these may be most feasible for many of the smaller WWTPs in Ontario.

Innovations in chemical conditioners were most frequently reported as there is a focus on reduced costs of dewatering and increased solids content of dewatered biosolids. The corresponding interest in dewatering was indicated by a substantial number of reports describing innovation in electro-dewatering, physical, and passive technologies. Collectively, innovations in conditioning and dewatering represent a significant opportunity due their potential to respond to a number of drivers that are expected to impact sludge handling in the future.

A total of 39 commercially available innovative sludge processing technologies were documented in this study. Innovations in sludge stabilization were found to represent 44% of the commercial reports and most of the companies are located in either North America or Europe with 77% of the technologies demonstrated at full scale. The market for development of anaerobic digestion technologies is highly developed and Canadian-based companies are active in this category. Most companies focusing on thermal reduction were identified to be located in the United States and Europe. Thermal reduction technologies tend to only be employed at large WWTPs. Phosphorous and fertilizers are the most common resources targeted for recovery by commercial technologies and Canadian companies are active in this area.

The potential for implementation of innovative technologies was assessed on the basis of a number of drivers that are anticipated to influence decision making on sludge processing technologies and biosolids disposition practices. For each driver, innovations that would assist WWTPs to respond to the driver are suggested.

Energy/Greenhouse Gases

- Development of anaerobic digestion technologies that are viable in smaller WWTPs. There are a number of commercially available technologies that can provide enhanced anaerobic digestion but they have primarily focused on medium and large scale WWTPs. A number of sludge pretreatment technologies have been developed but there has been limited implementation.
- Advanced thermal reduction technologies that are capable of energy recovery/and or fuels production while allowing recovery of nutrients. Current thermal technologies that are employed in the province may provide some energy

recovery but solids destruction appears to be the primary objective for these systems. Innovations in sludge drying could further increase the viability of thermal reduction technologies.

- High efficiency aerobic digestion technologies with reduced energy consumption. There are a large number of aerobic digesters employed at small and medium sized WWTPs that tend to be energy intensive. Relatively few reports on innovation in aerobic digestion and few innovative commercial aerobic digestion technologies were identified.

Changing populations

In large (and growing) WWTPs:

- Enhancements in sludge conditioning/thickening and dewatering that are typically employed at large WWTPS and which increase process efficiency and produce dewatered biosolids of higher solids content. There has been considerable activity in this regard in the research literature (i.e. electro-dewatering) but the number of implementations in Ontario are modest.
- The implementation of advanced thermal reduction technologies increases in viability at large scale. As the number and scale of large WWTPs increases with growth in populations the number of opportunities for implementation of these technologies will increase.
- The implementation of digestion enhancements that increase capacity (i.e. sludge pretreatment technologies) will be of interest to larger WWTPs with increasing sludge production. Thermal hydrolysis technologies have been implemented internationally but there has been little uptake in Canada.
- The implementation of technologies that provide higher quality products (i.e. disinfection) will diversify the disposition opportunities and may increase local usage.

In small WWTPs:

- Passive technologies that require minimal operator attention.
- Low cost thickening and dewatering technologies that reduce haulage and disposition costs.

Reductions in Agricultural Land Availability

- Enhanced conditioning, thickening and dewatering technologies. For larger WWTPs there would be a benefit in obtaining higher solids content products to reduce haulage costs. The development of technologies that support smaller WWTPs would increase implementation in these facilities. There is currently little use of these technologies in small WWTPs.
- The implementation of advanced thermal reduction technologies in large WWTPs will reduce the demand for agricultural land for biosolids disposition.
- The implementation of digestion enhancements that increase solids destruction (i.e. sludge pretreatment technologies) will reduce the demand for agricultural land for biosolids disposition.
- Implementation of technologies capable of producing biosolids of higher quality (i.e. reduced pathogen content) to support alternative disposition practices.

Changes in Septage Disposition

- Development of thickening and dewatering technologies that address septage solids in small WWTPs.

Changes in Landfill Regulations

- Development of thickening and dewatering technologies in small and medium size WWTPs that support increased winter storage to reduce the need for landfilling.

Increased Emphasis on Resource Recovery

- Further innovation and implementation of technologies capable of recovering phosphorous and nitrogen. Commercial technologies exist in this regard but their implementation to date has been modest.
- Advanced thermal reduction technologies that are capable of energy recovery/and or fuels production while allowing recovery of nutrients. The growth of larger cities may provide the conditions that are supportive of use of these technologies. Enhancements in supporting technologies such as drying would increase the viability of thermal reduction technologies.
- Integration of resource recovery with technologies that achieve increased solids destruction. For example, recovery of nutrients from dewatering return streams downstream of advanced anaerobic digestion processes.

Increasingly stringent regulations on wastewater discharges

- Passive technologies that require minimal operator attention in small WWTPs that are most impacted by recent regulatory initiatives.
- Low cost thickening and dewatering technologies that reduce haulage and disposition costs.
- High efficiency aerobic digestion technologies with reduced energy consumption. Aerobic digesters employed at small and medium sized WWTPs tend to be energy intensive.