TORONTO STAFF REPORT

November 4, 2004

To: Board of Health

From: Dr. David McKeown, Medical Officer of Health

Subject: Health and Ecological Risk Associated with Toronto Biosolids Pellets

Purpose:

To report on the human health and ecological risks associated with land application of Toronto biosolids pellets.

Financial Implications and Impact Statement:

There are no financial implications resulting from the adoption of this report. Any financial impacts for City departments stemming from implementation of the recommendations will be considered through future budget processes.

Recommendations:

It is recommended that the Board of Health request:

(1) that if the City proceeds with reconstructing the pelletizer plant and developing markets for biosolids pellet uses within the City and beyond, the Commissioner of Works and Emergency Services ensure the viability and safety of pellet utilization through adequate monitoring of the pelletizing process and testing of pellet quality, and through the adoption of precautionary measures regarding the use and storage of pellets, as detailed in Appendix A of this report;

(2) the Commissioner of Works and Emergency Services report to the Works Committee on amendments to the Toronto Sewer Use By-law to restrict the disposal of waste pharmaceuticals and untreated blood and blood products, including those from funeral homes and animal slaughter houses (abattoirs), into the sewage system;

(3) the Federal Minister of Health, Federal Minister of Agriculture and Agri-Food, and the Ontario Minister of Agriculture and Food ensure implementation of actions to prevent possible contamination of the sewer system from prions by:

(a) preventing animals showing symptoms of mad cow disease or similar illnesses transmitted through prions from being slaughtered in abattoirs, and to dispose of such animals in an appropriate manner; and

(b) requiring the placement of fine screens in abattoir drains so that prion-containing particles, if present, will not be able to pass into the sewer system;

(4) the Federal Minister of Agriculture and Agri-Food to:

(a) undertake studies, including laboratory-based research to address the potential bioavailability, phytotoxicity and/or ecotoxicity from chromium and copper with long-term use of biosolids pellets on urban parks and residential properties, so as to facilitate the development of appropriate new standards for chromium and copper in fertilizers; and

(b) establish standards for maximum permissible levels of chromium and copper in all fertilizers, for inclusion in the federal Fertilizers Act;

(5) the Ontario Minister of Health and Long Term Care to conduct, in consultation with the Ontario Minister of the Environment, a health study regarding the potential risks to human health from the use of biosolids cakes;

(6) the Medical Officer of Health report to the Board of Health on the findings of the Health Status Study for the South Riverdale and Beaches Community, as well as the Ashbridges Bay Treatment Plant Air Modelling Study, upon their completion;

(7) that this report be forwarded to the Works Committee for information and appropriate action; and

(8) the appropriate City Officials be authorized and directed to take the necessary action to give effect thereto.

Background:

In the early 1990s, the Works Department of former Metropolitan Toronto initiated an environmental assessment (EA) regarding planned modifications and improvement to the operation of the Ashbridges Bay Treatment Plant (ABTP). The environmental assessment is a requirement under the Ontario Environmental Protection Act. Many studies were conducted and options considered. A pilot project was initiated to apply 50% of dewatered sewage sludge (biosolids cake) on agricultural land in Ontario. By 1998, City Council made a decision to pursue

100% beneficial biosolids use (land application) and to construct a pelletization plant at ABTP to convert 50% of the dewatered cake into dry pellets.

At the March 1999 Council meeting, Council granted authority to WES to negotiate with USF Canada to design and build a biosolids pelletization facility, as well as to market and distribute the biosolids pellets. During the course of negotiating a marketing agreement, the Board of Health received a letter from Councillor Mihevc (dated November 29, 1999) requesting the Works Committee and the Board of Heath to direct staff to report on an on-going monitoring system with respect to the City's biosolids agreement to ensure against potential negative and environmental health consequences. This report was to be directed to both the Board of Health and Works Committee. At its meeting on February 21, 2000, the Board of Health requested the Medical Officer of Health to submit such a report to the Board, and to include comment on the health aspects of direct land application of biosolids.

During this time, WES participated in a mediation process (first initiated in 1998) with members of the local community as part of the original ABTP Environmental Assessment. As a result of the negotiation, the City agreed in June 2001 to fund the community's request for three studies related to the ABTP. The Medical Officer of Health was requested to commission and oversee these studies. The three studies commissioned by the Medical Officer of Health are: (1) Biosolids Pellet Review Study: Human Health and Ecological Risk Assessment; (2) Health Status Study for the South Riverdale and Beaches Communities; and (3) ABTP Air Modelling Study. The first study is completed and is the subject of this report. The remaining two studies are nearing completion and their findings will be reported to the Board in 2005.

Toronto Public Health initiated the Toronto biosolids review study after consulting with WES staff and the Implementation Compliance and Monitoring Committee (ICMC). The ICMC is a committee comprised of citizen volunteers, non-governmental organization representatives and signatories to the ABTP Environmental Assessment Mediation Agreement. The ICMC was established to advise the City regarding implementation of commitments made in the Mediation Agreement and to report annually on compliance with the Agreement. The scope of the biosolids review study was also informed by consultation with health units across Ontario, as well as with the Ontario Ministry of the Environment (MOE) regional and district offices with respect to concerns that the public has raised over land application of biosolids. The review examines the potential risks to people, plants and soil organisms, pets (cats and dogs), birds and other wildlife associated with three options for using pellets by the City.

This report to the Board of Health was prepared in consultation with staff from the Works and Emergency Services Department.

Comments:

Biosolids are products of the sewage treatment process, which consists of a combination of physical, chemical and biological processes. The solids remaining after anaerobic digestion of sewage sludge are dewatered to produce biosolids cake (30% solid, 70% water). The Ontario

Ministry of the Environment regulates the land application of biosolids cake in Ontario, including biosolids cake derived from Toronto's sewage treatment plants.

Biosolids pellets are products of the sewage treatment process and further heat-based processing in a pelletizer plant to create small solid granules with low moisture content. They have potential value as a fertilizer, and as a soil amendment that can improve the structure of soils. Biosolids pellets have greatly reduced pathogen content compared with biosolids cake. A comprehensive study was undertaken through Toronto Public Health to assess the health and ecological risk associated with long-term pellet use for 25 years on City-owned property (such as landfill cover seeded to establish a vegetative cover), on park land (such as City-owned parks and golf courses), and on residential property (such as lawns and urban food gardens). An explanation of the key findings of the study is provided in Appendix B. The Toronto Public Health study recommends that the Ministry of Health and Long-Term Care conduct a complementary study regarding the use of biosolids cakes.

The health component of the Toronto Public Health study examined the chemical and microbiological risk to young children (7 months to 5 years), adult residents and workers applying pellets on land. A quantitative risk assessment was completed for the 11 metals regulated in biosolids, as well as for PCBs, dioxins and furans. The assessment of microbiological risk was based on an evaluation of the extent to which the pelletizer technology provided the conditions necessary to destroy microorganisms that might be present in sewage sludge. Overall, the study found that there was negligible risk to human health from possible chemical pathways of exposure arising from pellet use in all scenarios assessed.

Regarding microbiological risk, there is less certainty than with the assessment of chemical risk; however, overall, microbiological risk is likely very low. Pelletization appears to provide the conditions for effective destruction of micro-organisms. However, to ensure safety, several recommendations are directed at providing confirmatory monitoring for process temperature, process duration, humidity levels and indicator biological agents to verify that microbiological risks are negligible. The study also suggests that the use of pellets on grass with extensive bare patches should be avoided until such time that microbiological monitoring results can demonstrate negligible risk from accidental ingestion of pellets visible and readily accessible to young children. Use of pellets on turf free of bare patches is not likely to be of concern.

The study notes the importance of the City's stringent Sewer Use By-law in reducing the levels of most metals in sewage sludge, and the need to continually strengthen the Sewer Use By-law. Additional measures are proposed to enhance the by-law such as preventing the disposal of waste pharmaceuticals and untreated blood and blood products, including those from funeral homes and animal slaughter houses (abattoirs). An important way to ensure the long-term viability of a biosolids program is to prevent substances not easily destroyed at the treatment plant from entering the sewage system in the first place. The adoption of precautionary measures can address new and emerging concerns regarding chemical and biological agents. The federal Minister of Health, federal Minister of Agriculture and Agri-Food, and the Ontario Minister of Agriculture and Food all have important roles in preventing the entry into the sewer system of potential hazards such as prions arising from animals showing symptoms of mad cow disease or similar illnesses. The potential risk for exposure to prions through Toronto's biosolids pellets is

very low, in large part because there is no known source of prions in the area, nonetheless, precautionary measures are warranted.

The ecological component of the biosolids pellets study suggests that overall risks to pets and wildlife from long-term (25 year) pellet use are negligible. There is some concern regarding the impact of chromium on robins, however the risk is small and would likely diminish with time as chromium levels continue to drop in sewage sludge. The impact of copper on plant health arising from pellet use merits investigation and may be useful in establishing appropriate pellet application rates. The federal Minister of Agriculture and Agri-Food is requested to develop standards for maximum permissible levels of chromium and copper in biosolids pellets and for all fertilizers, as regulated through the federal Fertilizers Act.

If the City proceeds with reconstructing the pelletizer, more attention needs to be directed at the range of potential markets for pellet uses. There is benefit in developing a phased-in approach to marketing Toronto pellets that addresses public concern with their use for food crops. It is recommended that the initial marketing of pellets focuses on demonstrating successful use of pellets for horticulture, forestry and land reclamation applications prior to making pellets available for the home retail market in Toronto.

Conclusion:

Based on the biosolids pellets review study, there is no evidence to date that microbiological or chemical concerns are sufficiently significant to preclude the beneficial use of pellets for agricultural or horticultural purposes. However, a number of important recommendations are provided in Appendix A of this report need to be addressed if the City proceeds with reconstructing the pelletizer and developing markets for pellets within the City and beyond. In addition, it is recommended that the initial marketing of pellets focuses on demonstrating successful use of pellets for horticulture, forestry or land reclamation applications prior to making pellets available to the home retail market.

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List of Attachments:

Appendix A: Detailed Recommendations for the Commissioner of Works and Emergency Services Regarding Biosolids Pellets

Appendix B: Overview of the Toronto Biosolids Pellet Study

Appendix A
Detailed Recommendations for the Commissioner
of Works and Emergency Services Regarding Biosolids Pellets

It is recommended that if the City proceeds with reconstructing the pelletizer plant and developing markets for pellets within the City and beyond, the Commissioner of Works and Emergency Services:

(a) conduct follow-up monitoring of the pelletizer, or a pelletizer of similar design in operation, to confirm the effectiveness of the pelletizing process, including aspects such as process time, temperature and humidity;

(b) monitor the levels of metals, polychlorinated biphenyls, dioxins and furans in pellets and conduct trend analysis periodically to ensure that the quality of the pellets is maintained or continues to be improved through effective enforcement of the Toronto Sewer Use By-law;

(c) in consultation with the Medical Officer of Health, assess the feasibility of extending the routine monitoring program to include additional organic compounds and other unregulated metals, in particular those identified in this report; and once adequate data are available, consider the need to evaluate the significance of their impacts on human health and the environment;

(d) conduct testing for more suitable indicator bacteria and phages, by measuring reductions as a result of the pelletization process, until a sufficient history confirms the suitability of monitoring representative parameters and moisture content to ensure pellet quality. The testing should also be done at the time of pellet distribution to provide additional assurance for minimal risk from microbial agents;

(e) develop a contingency plan for unforeseeable events that may result in the production of pellets that are unsafe for planned uses, such as pelletizer malfunctioning or pellets not meeting specification. The contingency plan should include an alert system which serves as a trigger for specific actions in a timely manner to halt product distribution;

(f) conduct a field test on the potential for pathogen regrowth in the soil at the time of pellet use;

(g) conduct a review of storage issues for pellets, including the potential for pathogen and microbial regrowth and smouldering, and put into place the necessary precautionary measures prior to restarting pelletization of biosolids in Toronto;

(h) market pellets as a product only after the pelletization facility can achieve pellets of intended quality, approximately 3 mm in size and a solid content of 97% (3% water content);

(i) include precautions instructions on the label on how to properly store the pellets, including advice on preventing access to pellets by young children;

(j) avoid the use of pellets on lawns and park turf with extensive patches of bare soil where pellets might become accessible to young children, until such time as suitable indicator bacteria and phages confirms the absence of microbiological risk from accidental ingestion of pellets;

(k) conduct, in consultation with the Commissioner of Economic Development, Culture and Tourism, controlled field tests to provide added assurance that the pellets break down in a timely fashion to be useful as a soil amendment and fertilizer;

(l) conduct, in consultation with the Commissioner of Economic Development, Culture and Tourism, controlled field tests to monitor concentrations of the 'entities of concern' (identified in the Technical Summary) in pellet-amended soils over time in the park to confirm the results of the modelling exercise;

(m) consult with the Ontario Ministry of the Environment to explore non-agricultural uses for the pellets in Ontario;

(n) submit a proposal to the Minister of the Environment and the Minister of Agriculture and Food requesting that Section 97.(0.1) of Regulation 267/03 be amended to permit land application of further processed biosolids pellets to golf courses in Toronto; and

(o) focus initial marketing of pellets on demonstrating their successful use in horticultural, forestry or land reclamation applications prior to making pellets available to the home retail market.

Appendix B
Overview of the Toronto Biosolids Pellet Study

The purpose of the biosolids study was to provide a quantitative assessment of the health risks associated with different options for using biosolids pellets within Toronto. The study examined risks associated with pellet application: (1) on City-owned property (such as part of a landfill topdressing material applied as the final landfill cover seeded to establish a vegetative cover); (2) on parkland (such as on City-owned parks and golf courses); and (3) on residential properties (e.g. on lawns, gardens, vegetable growing beds).

The technical report "The Biosolids Pellet Review Study: Human Health and Ecological Risk Assessment" was prepared for Toronto Public Health by Jacques Whitford Environment Limited under the direction of a project team made up of staff from Toronto Public Health and experts from the academic sector. The study has benefited from advice from a Project Advisory Committee that included representatives from the Ontario Ministry of the Environment, Ontario Ministry of Health and Long Term Care, Ontario Ministry of Agriculture and Food, Toronto Public Health, Toronto Works and Emergency Services, Toronto Parks and Recreation, Ontario Federation of Agriculture, Rural Ontario Municipal Association, Canadian Infectious Diseases Society, Sierra Club, and the Implementation Compliance and Monitoring Committee. The Project Advisory Committee had input on the terms of reference for the study, selection of consultants through the request for proposals (RFP) process, assessment scenarios and interpretation of results. To ensure that the methodologies, analysis and interpretation of results meet the necessary scientific rigor, the technical report has been peer reviewed by four international experts from Canada and the United States.

The results of the full technical study have been incorporated into a technical summary report by public health staff. The summary report "Human Health and Ecological Assessment of Toronto Biosolids Pellets - Technical Summary" is available on the public health website (www.toronto.ca/health/hphe/waste/biosolids.htm). The full technical report prepared by Jacques Whitford Environment Limited is also available on the public health website, given the strong interest by municipalities across Canada for this type of research. While some municipalities have conducted a review of the international literature as it relates to land application of biosolids, the value of the current study is that it goes well beyond a literature review and provides a quantitative and qualitative assessment of risk based on the actual quality of Toronto's biosolids products.

(1) Agricultural and Horticultural Value of Biosolids

The nutrient value and organic matter content of biosolids make them potentially useful as a fertilizer and soil amendment. Biosolids are products of the sewage treatment process, which consists of a combination of physical, chemical and biological processes. The solids remaining after anaerobic digestion of sewage sludge are dewatered to produce biosolids cake (30% solid, 70% water). Pathogen content is reduced during the treatment processes. Biosolids cake can be further processed through heat drying to produce biosolids pellets. Biosolids cake and pellets are then available for landfilling, incineration or land application.

The pelletizer plant that was installed at the ABTP produced pellets through an indirect heating process that coats a nucleus of dry biosolids with wet biosolids. The pellets are exposed to high heat and controlled dryer times. The dryer can produce pellets approximately 3 mm in diameter and 97% solid, with 3% water content. Currently the Toronto pelletizer is out of service following a fire at the facility in August 2003.

Organic matter, such as that arising from sewage treatment plants, can potentially have agricultural or horticultural value in two ways: (1) as a fertilizer if it contains sufficient essential elements for plant growth; and (2) as a soil amendment that improves the physical structure of soil. Biosolids cake is used widely in North America as a fertilizer and soil amendment on agricultural lands. Compared with biosolids cake, biosolids pellets have greatly reduced pathogen content, assuming the pelletizer is functioning optimally and is meeting all expected provincial standards.

Toronto's biosolids contain appreciable concentrations of many of the fifteen elements essential for plant growth, but not much potassium. The pellets could potentially be used as soil amendments, as well as general-purpose lawn and garden fertilizers if they are blended with potassium and water-soluble nitrogen to boost the content of plant nutrients. However, before this option becomes viable, further work is required by WES to establish the release rates of the organic matter and nutrients to determine the actual usefulness and suitability of the pellets for different applications.

Biosolids are a potentially valuable resource that merit further study by WES as to marketing opportunities. The focus of the biosolids study by Toronto Public Health is confined to assessment of the chemical and biological risk associated with pellet use in Toronto.

(2) Health Risk from Pellet Use

The risks to human health were assessed through a quantitative risk assessment for metals and key organic chemicals present or potentially present in Toronto biosolids. To assess biological risk, the study examined the effectiveness of the pelletization process in destroying biological agents of potential concern, such as indicator bacteria, enteric viruses and parasitic pathogens.

(a) Chemical Risk

The assessment of health risk was made possible by the large volume of data collected by WES since 1978 on the levels of chemicals in Toronto's biosolids. There have been improvements over the years in sewage treatment efficiency, changes in the type of industrial operations in Toronto and greater control over discharges to the sewer system. The levels of metals in Toronto biosolids show an overall downward trend since 1978. This downward trend was further enhanced with the enactment of a revised Sewer Use By-law in July 2000 which introduced more stringent discharge limits for contaminants into sewers, and which required industries to submit pollution prevention plans since July 2001. The levels of arsenic, chromium, nickel, lead, zinc and mercury in Toronto biosolids have dropped since the revised Sewer Use By-law was implemented.

The land application of Toronto's biosolids first began in 1995. The risk assessment was based on sludge cake data from 1996 to 2003 because it was most representative of current biosolids quality. Using these and auxiliary data, the health risks associated with exposure to eleven regulated metals (arsenic, cadmium, cobalt, chromium, copper, mercury, molybdenum, nickel, lead, selenium and zinc) polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (dioxins) and polychlorinated dibenzofurans (furans) were evaluated for the various options for using biosolids pellets within Toronto.

Cake data were used in the risk assessment because the cake data set was more complete than the pellet data set. Data on pellets was collected for only a relatively short time period after September 2002 and prior to the fire at the pellet plant. Use of cake data tends to overestimate rather than underestimate chemical concentrations in pellets, especially for the more volatile chemicals. This is because the chemical contents in biosolids are measured from liquid samples and reported on a dry weight basis as required by the MOE. As a result, it is reasonable to assume that the actual health risk from chemical exposures through pellet use is even less than reported in the risk assessment.

Health risks were estimated for landfill and park workers applying pellets, residents (adult and young children) who come into contact with recreational spaces (e.g. parks, golf courses, gardens) on which pellets are applied, and residents (adults and young children) exposed to pellet use on home lawns and backyard gardens. Among the residents, young children between the ages of 7 months and 5 years represent those likely to experience the highest exposure due to their low body weight, higher metabolic rate and hand-to-mouth activity. Cancer risk is evaluated for exposure over a lifetime.

Ingestion of pellets, pellet-amended soils, inhalation of dust and vapour, and dermal contact were considered for exposure estimation for pellet use on park turf and lawns. Ingestion of vegetables and fruits grown on pellet-amended soil was an additional exposure pathway considered in the home garden scenario. Although pellets would not be readily available for children present on healthy lawns with thick turf, they are more accessible if spread on lawns with extensive patches of bare soil. Therefore, the exposure calculation took into consideration the scenario that children under 5 years old might ingest pellets that they pick up from bare soil surfaces.

The risk assessment was based on the assumption that pellets would be applied for 25 years, which is the lifetime of the pelletizer. To take into consideration that some people might overapply pellets, twice the maximum recommended application rate (5.4 tonnes per hectare per year) was used to calculate the levels of pollutants in pellet-amended soil, garden produce, dust and vapour in the air after 25 years of pellet use. The risk assessment was based on the upper-end contaminant levels expected after ongoing pellet use over a 25-year period.

The method used to assess the health risks to residents and workers is based on comparing the calculated predicted exposures to a given chemical from all the likely exposure pathways, and comparing these to scientifically-based health benchmarks below which there would be no or negligible health risks. In the case of substances that are not carcinogenic, the health benchmark is the level below which no health risk is anticipated. In the case of carcinogens, the benchmark

of negligible risk used by various jurisdictions typically varies from a one-in-ten thousand to a one-in-one million increased risk of cancer over a lifetime. Toronto Public Health typically adopts the more health protective one-in-a-million cancer risk level. Health benchmarks used in the biosolids study were adopted from published values by reputable regulatory agencies such as Health Canada, USEPA and MOE after a review of their scientific basis. The results from the risk assessment based on 25 years of pellet use in Toronto indicate that potential exposure to arsenic, cadmium, cobalt, chromium, copper, mercury, molybdenum, nickel, lead, selenium, zinc, PCBs, dioxins and furans are below the health benchmarks for non-cancer effects, and thus are not expected to result in adverse non-cancer effects.

Of the substances evaluated, arsenic, cadmium, PCBs, dioxins and furans are known or probable human carcinogens, in addition to having the potential to have non-cancer adverse effects at levels higher than those associated with pellet use. The results from the risk assessment show that exposure to cadmium, PCBs, dioxins and furans for a lifetime as a result of pellet use would increase cancer risk by less than one-in-a-million new cases, and hence are considered to be of negligible health risk.

In the case of arsenic, the cancer risk for lifetime exposure resulting from ingestion/dermal exposure after 25 years of pellet use in the home environment was estimated to be five-in-a-million. This risk is below the Health Canada benchmark of negligible risk of one in-a-hundred thousand. Ingestion of home-grown fruits and vegetables contributes about 80% of the total lifetime incremental cancer risk while risk from exposure due to pellet use only on lawns makes up about 20%. The risk from lawn use alone is about one-in-a-million and hence of negligible health risk.

The predicted cancer risk for arsenic exposure is likely overstated in the risk assessment because the many assumptions used in the calculations tend to overestimate the risk, including the use of cake data for the assessment. The arsenic concentration is much lower in pellets than in cakes and is actually similar to the background soil concentration in Toronto. Furthermore, the arsenic levels in Toronto biosolids are decreasing overtime, particularly since the enactment of the improved Toronto Sewer Use By-law in July 2000. If the trend continues, the actual arsenic concentration in the pellet-amended soil after 25 years of application would likely be lower than the value calculated in the risk assessment study. Finally, many fertilizers in existing use contain traces of arsenic. It is noteworthy that the levels of arsenic in the biosolids pellets are below allowable limits for arsenic in fertilizers sold in Canada. Given these observations, it is reasonable to assume that the cancer risk from arsenic associated with prolonged pellet use is very low and would be of minimal health consequence.

Since health risk was calculated using the estimated soil concentrations after 25 years of pellet use, if operation and sale of pellets were to continue beyond the 25-year period, further review would be required at that time. A field study to monitor annually the change in soil concentration (e.g. in a park) is recommended to confirm the results of the modelling exercise.

(b) Biological Risk

The assessment of biological risks is more difficult than assessing chemical risks for which there are well-developed guidelines on how to conduct the assessment and health benchmarks against which to assess risk. There are no established guidelines for conducting assessments of biological risks from environmental exposure to biological agents and no clear definition for acceptability as to what level of exposure constitutes a health risk and what level is of negligible or no risk. The science of assessing biological risks is still under development by the scientific community. Consequently the risk from exposure to pathogens as a result of pellet use has not been calculated. Rather this study evaluated the effectiveness of the pelletization process in destroying biological agents of potential concern.

In the United States, biosolids are classified based on certain quality characteristics. To qualify for Class A designation, biosolids must meet specific process, pathogen content and monitoring requirements. The objective is to reduce pathogen content to below detection limits for Salmonella sp., enteric viruses and viable helminth ova (a parasite pathogen). The microbial agents must be measured at the time the biosolids are used or disposed and prepared for distribution. Processes that involve heat treatment must also meet specific time-temperature requirements. The pelletizer manufacturer asserts that the pelletization process at ABTP meets the United States Environmental Protection Agency (USEPA) requirement for Class A biosolids. If the Toronto pelletizer is reconstructed and meets the operating conditions required for Class A biosolids, the pellets can be distributed in the United States without restriction since they also meet the USEPA chemical pollutant concentration limits.

The scientific literature suggests that a minimum process time of 60 to 90 minutes at a temperature of 80°C is needed to effectively destroy most pathogens and qualify the biosolids as Class A. The process information and limited analytical data available suggest that the biosolids pellets from ABTP were likely of similar quality to Class A biosolids. However, no confirmatory testing is known to have been undertaken to validate the pellet temperature, drying time and humidity achieved by the ABTP pelletizer. Follow-up monitoring of the pelletizer or a pelletizer of similar design in operation should be used to verify these operating conditions, and confirm the effectiveness of the process. The pelletizer process should be maintained without attempting to hasten production of pellets. A mechanism has to be in place that provides assurance that the necessary processing is taking place at all times when the pelletizer is in operation. A contingency plan and emergency procedures to address pelletizer malfunction and related issues should be part of the overall operating program for producing biosolids pellets.

Although pelletization appears to provide the conditions for effective destruction of microorganisms, additional monitoring is needed to confirm this because the testing of biological agents is limited to date. This could be done by routine monitoring for selected bacteria and phages. Faecal coliform (the most common indicator organism monitored) is a suitable indicator organism for treatment efficiency, but may not be ideal as an indicator for public health hazard. Some pathogens are hardier than faecal coliform. Phages are considered suitable indicators for the presence of human enteric viruses and as process indicators for bacteria. The pellets should be routinely monitored for selected bacteria and phages by measuring reductions during treatment until a sufficient history of the process confirms the suitability of monitoring only

certain process parameters (e.g. temperature and time) and a smaller number of indicator microorganisms at the time of pellet distribution.

One potential risk from biosolids aerosols (airborne particles) arises from endotoxins on the outer cell wall of some bacteria, whether they are pathogens or not. Airborne endotoxins can exacerbate existing allergy and asthma symptoms, thus increases the risk to infection. The pelletization process is unlikely to provide the needed conditions to destabilize the endotoxin. However, the dust fall from the pellets is expected to be low as long as the pellets remain dry and would likely not be a concern for the general public. For workers routinely handling large quantities of pellets, a similar degree of care generally used for handling fertilizers would be reasonable to minimize potential exposures during handling.

If pellets are exposed to moisture or water, there may be a potential for the pellets to break down more readily into dust upon handling. A relative moisture content around 9% was reported to be sufficient to initiate microbial activity. Such activity can occur if drying is incomplete. Therefore it is important that the pelletizer is operated properly and that commercial distribution of pellets takes place only after the pelletizer can consistently achieve pellets of the intended quality (3% water content at most). Routine monitoring of moisture content is advisable. Rewetting biosolids pellets prior to land spreading could also permit some pathogen regrowth. The biological activity initiated can then contribute to the self-heating phenomenon that is sometimes observed. Dry storage conditions would prevent this type of problem. Issues regarding storage and handling need to be addressed by WES to reduce the chance of microbial regrowth and smouldering prior to restarting pelletization of biosolids at ABTP. Pathogen regrowth has also been observed following land application following rainfall.

It is possible that the pelletization process may not have deactivated some biological agents. While pellets spread on lawns with well-established turf are not readily available to children less than 5 years old, those left on patches of bare soil can be accessible. The available methods and information are not adequate to quantify risks to these children in contracting infectious diseases from ingestion of pellets while playing in the park and on lawns at home.

(3) Ecological Risk from Pellet Use

The assessment of ecological risk was undertaken to evaluate the likelihood of adverse effects for a set of indicator ecological (non-human) receptors that are important to humans. These receptors are considered representative of species in the Toronto area. The assessment considered the three environments for pellet use: landfill topdressing; recreational green spaces (parks and golf courses); and residential properties.

(a) Plants and Soil Organisms

A screening level assessment was conducted with respect to plants and soil organisms. The levels that may accumulate in the soil after 25 years of pellet application were compared to the Canadian Council of Ministers of the Environment (CCME) and MOE ecotoxicity criteria for plants and soil organisms. As a result of this assessment, no risk to plants or soil organisms from pellet use are expected from arsenic, cadmium, cobalt, chromium, mercury, molybdenum, nickel,

lead, selenium, zinc, PCBs, dioxins and furans. Levels of copper were higher than both the MOE toxicity value and CCME criteria.

The screening assessment is not adequate to conclude whether or not adverse effects may actually occur. It is useful only for identifying areas that need further analysis and areas that do not. Therefore, to confirm whether plants or soil organisms would be at risk from copper due to pellet application on lawns, gardens or City lands, more detailed evaluation is needed. To facilitate this evaluation, more comprehensive studies, including laboratory-based research and field studies, are needed to address the potential bioavailability, phytotoxicity and/or ecotoxicity resulting from long-term use of pellets in urban parks and residential properties.

(b) Wildlife and Pets

A limited quantitative ecological assessment was conducted for wildlife and pets, using an assessment framework similar to that used for human health. Representative species from different levels in the food chain were selected for assessment. Receptors include: animals that feed on vegetation only (vole); animals that feed on other smaller animals (masked shrew); animals that feed on both smaller animals and vegetation (red fox); birds that eat worms only (American robins); and birds of prey (red-tailed hawk). The most important exposure pathway for wildlife and pets is ingestion, including ingestion of plants and prey species that have accumulated chemicals from the soil, as well as soil ingestion as a result of feeding and grooming.

The risk assessment indicates that for cats and dogs potentially exposed to pellets, the calculated associated exposure to arsenic, cadmium, chromium, cobalt, copper, mercury, molybdenum, nickel, lead, selenium, zinc, PCBs, dioxins and furans would all be below health benchmarks. It is therefore unlikely that the use of biosolids pellets around the home or parks would pose a danger to pets.

For the wildlife indicator species – vole, masked shrew, red fox and red-tailed hawk - the risk assessment indicates that exposure to pellets and associated chemicals would be below levels associated with adverse effects in relation to survival or reproduction. In the case of the American robin, only one chemical pollutant, chromium, was associated with some risk, given that robins eat mainly worms, which in turn could be exposed to pellets. The American robin is considered to be more sensitive than other bird species in Toronto, so that an elevated risk for the American robin is not expected to indicate a potential risk to other bird species.

The chromium levels in Toronto biosolids are decreasing over time, particularly since the enactment of the more stringent Sewer Use By-law in July 2000. If this trend continues, the actual chromium concentrations in pellet-amended soil after 25 years of application would likely be considerably lower than the value used in the current risk assessment. Furthermore, it is likely that the current risk assessment overestimates the actual risk to robins since the bioavailability of chromium in soil is likely less than the 100% assumed in the assessment. Taken together, these observations suggest that the risk to robins is not significant, and would likely diminish with time.

(4) Emerging Issues

Some new concerns have arisen in recent years related to the land application of biosolids. Some concerns are due to newly detected chemicals in sewage or biosolids worldwide. Other concerns come about because of new evidence indicating potential adverse effects for certain substances that could be present in the sewage. For example, the effect of low level exposure to endocrine disruptors is an emerging issue that continues to be monitored by the scientific community.

Other chemicals of scientific and public interest are flame retardants (e.g. polybrominated diphenyl ethers (PBDEs)), linear alkylbenzene sulphonates, pharmaceuticals, radioactive materials, other unregulated metals, and endocrine disruptors such as phthalates, alkylphenol ethoxylates and their metabolites alkylphenols. A preliminary review of the issues suggests that the risk to humans may not be substantial, however, the characterization of these substances for their potential presence in biosolids or pellets is not well developed. For this reason, these chemicals are not included in routine biosolids monitoring programs. Toronto can reduce the possible risk from exposure to these substances via land application by improving the quality of the biosolids through continual update and enforcement of the Sewer Use By-law.

The detection of antibiotics in wastewater arising from sewage treatment plants worldwide raises concern about the possibility of proliferation of drug-resistant strains of bacteria in biosolids and the environment. The National Research Council reviewed this issue in 2002 and concluded that land application of biosolids would not have any substantial potential to alter the prevalence of antibiotic resistance among pathogenic microbial agents. Health Canada, which is responsible for regulating pharmaceuticals, is considering the development of a ‘cradle to grave’ approach to dealing with pharmaceuticals, thereby greatly limiting their entry into the environment.

Prions are infectious biological agents that are not living organisms. Examples of illnesses that have arisen from prions are Creutzfeldt-Jakob disease in humans or bovine spongiform encephalopathy (mad cow disease) in animals. There is no evidence from other jurisdictions or the scientific literature for the transmission of prions from diseased animals through their feces or urine, however, blood components have been found to carry infectivity. For example, blood transfusion has been demonstrated to transmit prion disease in experimental animals, and was suspected but not proven in two human cases. The potential risk for exposure to prions through Toronto’s biosolids pellets is very low, in large part because there is no known source of prions. Nonetheless, precautionary measures should be taken to prevent biosolids from potentially acting as a vehicle for transmission of prion diseases. Consequently, it is recommended that the discharge of untreated blood and blood products into sewers be restricted. Policies regarding abattoir (slaughterhouse) operations similar to those in the United Kingdom could be adopted in Ontario. These include the placement of fine screens in abattoir drains to prevent prion-containing tissues from entering the sewer system.

The possible public perception that pellets are associated with an odour may affect public acceptance of pellet use. Odour detection is very subjective and varies considerably across the population. Although biosolids pellets would be at the low end of a subjective measurement scale of odour unpleasantness, individual tolerance and sensitivity to odours will influence public acceptance.

(5) Regulations and Monitoring

Biosolids sold as fertilizers or soil supplements for non-agricultural uses in Ontario are regulated by the federal Fertilizers Act, which specifies standards for labelling, registration and product quality, including the level of metals in the product. Since the Fertilizers Act has no monitoring requirement regarding product use, it is at the users' discretion to adhere to the instructions on the label.

The pellets produced by the City of Toronto contain 10% or less total nitrogen, available phosphorus and soluble potash. Because of this, the pellets will be considered "non-agricultural source material" under the Ontario Nutrient Management Act (NMA), even if they are sold. The Nutrient Management Regulation 267/03 prohibits the application of a non-agricultural source material to golf courses. Furthermore, like pellets that are not sold but given away, Toronto pellets are regulated by the same Ontario regulations as the biosolids cakes (see next section) when applied on agricultural land. The Ontario regulatory framework provides for non-agricultural uses of biosolids, although the regulatory processes governing some of these uses, such as reclamation of mine tailing, have not been worked out.

(6) Toronto Biosolids Cake

The application of biosolids cake on agricultural land is regulated in Ontario through the Environmental Protection Act and Regulation 367/03 of the Nutrient Management Act. Municipal biosolids cakes are considered "non-agricultural source material" under the Act and are subject to the MOE "Guidelines for the Utilization of Biosolids and Other Wastes on Agricultural Land". The Guidelines specify general rules for application of biosolids regarding application rates and quality standards for the eleven inorganic elements. The maximum soil criteria for the eleven inorganic elements are background based. Since soil testing is often required when applying for a Certificate of Approval for each application site, it is unlikely that these soil criteria would be exceeded. Therefore, the risks to humans, farm animals and wildlife from exposure to the eleven regulated metals as a result of land application of Toronto biosolids cakes on agricultural land are expected to be minimal.

Although biosolids cakes are treated sewage sludge with reduced pathogen content, they contain much higher levels of pathogens than pellets. To reduce the risk of infection from biosolids cake through land application, the MOE biosolids Guidelines require site restrictions for land application. The Guidelines specify separation distances from surface water, wells and residences. The Guidelines also specify waiting periods. Site-specific terms and conditions are contained in the Certificate of Approval that must be obtained for each application site. While there are anecdotal claims of illness associated with land application of biosolids cake in North America, the review of epidemiological evidence for health effects has yielded mixed results. Most studies were either unable to demonstrate increased human health effects, or found certain health effects to be somewhat increased but not significantly so. Some studies did find a significantly higher prevalence of gastrointestinal symptoms or headaches among sewage treatment plant workers and slightly higher rates of viral infection among farm and resident populations.

The MOE is responsible for ensuring that the land application of biosolids cakes is done in a safe manner. The MOE is sponsoring two major multi-year studies to deal with concerns about pathogens in biosolids. One study examines the movement of pathogens in soil following the application of biosolids. The other study examines the fate and level of pathogens resulting from the application of cake and liquid biosolids on farm fields with tile drains. These studies are scheduled for completion in 2006. The MOE is monitoring research initiatives elsewhere regarding the measurement of airborne pathogen levels around land application sites and will consider doing the same to address public concerns regarding bioaerosols (biological agents that become airborne). The MOE is also conducting an odour study, seeking to establish a benchmark for "normal farming practices," and examining the standardized odour testing procedures developed in Quebec. In addition, the MOE has been actively promoting and developing best management practices for the province.

It would be beneficial for the MOE to conduct a review study regarding the use of biosolids cakes, including a quantitative assessment of human health and ecological risks, similar to Toronto Public Health's study on pellets. Furthermore, it is recommended that the Ministry of Health and Long Term Care conduct a health study regarding the use of biosolids cakes, in consultation with the MOE.

(7) Potential Uses of Toronto Biosolids

Toronto Public Health's biosolids review study examined the health and ecological risk associated with three different use scenarios. These scenarios were selected for scientific purposes to identify the higher risk exposure scenarios, such as assessing risks to young children (given their high hand-to-mouth activity) and those of workers applying pellets (given the opportunity for frequent contact with pellets). Many other scenarios for using biosolids are possible, including: as inputs to facilities producing fertilizers; for horticultural applications such as in plant nurseries; for forestry applications; to enhance turf and other plants in greenspaces; to reclaim damaged or derelict urban lands; to reclaim damaged soil such as with disposal of mine tailings; and as landfill cover.

If the City proceeds with reconstructing the pelletizer, more attention needs to be directed at the range of potential markets for pellet uses. There is benefit in developing a phased-in approach to marketing Toronto pellets that addresses public concern with their use for food crops. It is recommended that the initial marketing of pellets focuses on demonstrating successful use of pellets for horticulture, forestry and land reclamation applications prior to making pellets available for the home retail market in Toronto.

Conclusion:

Based on the biosolids review study, there is no evidence to date that microbiological or chemical concerns are sufficiently significant to preclude the beneficial use of pellets for agricultural or horticultural purposes. However, a number of important recommendations are provided in this report that need to be addressed if the City proceeds with reconstructing the

pelletizer and developing markets for pellet uses within the City and beyond. In addition, it is recommended that the initial marketing of pellets focuses on demonstrating successful use of pellets for horticulture, forestry or land reclamation applications prior to making pellets available to the home retail market.