The Walkerton Inquiry

Notes from the Expert Meeting on:

Potential Contamination of Drinking Water
&
Drinking Water Standards

Ryerson University
International Conference Centre

April 23-24, 2001

Chair: Steve E. Hrudey

Topics of Discussion:

Sources of Microbial Pathogens: Human Waste
Sources of Microbial Pathogens: Agricultural Waste and Wildlife
Sources of Chemical Contaminants: Point Sources
Sources of Chemical Contaminants: Non-point Sources
Drinking Water Criteria: Objectives, Guidelines, Standards and Regulations
Setting Drinking Water Criteria: Processes and Participation
Other Critical Issues Regarding Our Knowledge Foundations on Drinking Water Health Risks

The notes for this expert meeting have been prepared to brief the Commissioner and to facilitate participation in Part II of the Inquiry by those who were not at the meeting. The notes are intended to represent the major items of discussion and positions put forward by participants. They are based on notes taken by Rapporteurs and are not intended to be an official report or transcript of the meeting. They do not represent the views of the Commissioner.

Meeting Summary
Potential Contamination of Drinking Water & Drinking Water Standards

The agenda, prepared for the meeting by the Chair, provided the framework for the report. The scope of the meeting was outlined to focus on the identification of contaminants and risks they potentially pose to drinking water, not specifically how to manage or protect against them. The report summarizes the main points of contention and agreement between the parties under the six themes and related questions on the agenda.

1. **Sources of Microbial Pathogens – Human Waste:** Discussion identified paths and venues of waterborne pathogens in human wastes and considered identification of contamination risk, in particular the strengths and weaknesses of fecal coliform testing which has been the standard for detection of fecal contamination of drinking water supplies. Land application of both septic tank waste and sewage sludge are both possible sources of water contamination, especially when extreme events (heavy rainfall or spring flow) occur. Capacity of wastewater treatment plants may also be a problem in these cases when storm events can cause combined sewage (sanitary and storm sewage in one combined sewer) to overflow untreated sewage. The importance of considering local geography and site specific variables in assessing the relative significance of contaminant sources and pathways and tailoring site specific management approaches was also noted related to human, agricultural and wildlife waste.

2. **Sources of Microbial Pathogens -- Agricultural Waste and Wildlife:** There was limited discussion focused on identification of specific agriculture and wildlife pathogens. Wildlife and agricultural animals contribute to pathogen contamination but there was no statement regarding agricultural animal waste on a proportionate basis to human wastes. Comments related to concerns about land application and plant treatment also applies to agricultural wastes especially when extreme events (heavy rainfall or spring flow) occur. Consensus was reached that there is nothing unique about agricultural waste with respect to the pathogens they contribute as risk to drinking water contamination.

3. **Sources of Chemical Contaminants (Point Sources):** there was consensus on some prevalent point sources of chemical contaminants as well as on some high profile chemical contaminants important to human health. The scale and scope of health risk is generally assessed using risk assessment models and available contaminant monitoring data, which is not of consistently good quality. There was consensus that there is a need to improve our state of knowledge related to the sources and risks of different chemical contaminants. There was little discussion regarding prospects for the immediate improvement of knowledge in these areas beyond improving comprehensiveness of water quality monitoring data.

4. **Sources of Chemical Contaminants (Non-Point Sources):** Discussion regarding non-point chemical contaminants focused largely on pesticides. Some contention exists regarding the degree of risk to humans from pesticides as they are currently occurring in

water sources. There was general agreement that the current frequency of testing/monitoring is not adequate and the methodology for testing is unsatisfactory to some. It was hoped that new legislation and its regulations for standards in Ontario, as well as the on-going work of the Drinking Water Surveillance Program, will assist in refining knowledge in this area.

5. **Drinking Water Criteria: Objectives, Guidelines, Standards and Regulations:** the current actors involved in determining criteria were discussed. There was some agreement that sensitive sub-populations such as children should be taken directly into account when setting criteria but there was strong disagreement about the extent to which children are considered in current practice. Recognizing the uncertainty in the process, there was also consensus that there is value in transparency in the criteria setting process and clarity about what numbers convey. There is consensus on the need to improve data upon which decisions are made.

6. **Setting Drinking Water Criteria –Processes and Participation:** The discussion focused on the challenges of risk assessment and risk management processes and the appropriate role of stakeholders and the public. The public should be engaged in the process of criteria-setting but there is no agreement on the extent of involvement or exact role.

Meeting Participants and Affiliations

Chairperson	Steve Hrudey
Co-Chair	James Van Loon
Issue Paper Author, University of Ottawa	Ken Roberts (for Dan. Krewski)
Issue Paper Author, University of Guelph	Michael Goss Ken McEwan
Issue Paper Author, University of Guelph	Len Ritter Paul Sibley
Issue Paper Author, Reilly	Maureen Reilly (for April 23 only)
Chief Coroner of Ontario	David Gruber
Ontario Pork (OP)	Sam Bradshaw (for April 23 only)
Christian Farmers Federation (CFF)	Robert Bedggood
Ontario Farmers Environment Coalition (OFEC) Ontario Federation of Agriculture (OFA)	Paul Verkley Tina Schankula (April 23 only) Dave Armitage (April 24 only)
Great Lakes United/SLDF (GLU/SLDF)	Rich Whate
Conservation Ontario (CO)	Doug Hocking Sonya Meek
Dairy Farmers of Ontario	Debbie Brander
Ontario Cattlemen's Association	Stan Eby
OWWA/OMWA	Joe Castrilli Les Gammie
Sierra Alert	Jennifer McLellan Jackie Harman
Concerned Walkerton Citizens/ Canadian Environmental Law Association (CELA)	Theresa McClenaghan Grace Patterson Kathleen Cooper (April 24 only)

Meeting Participants Cont'd:

Provincial Medical Officer- Ministry of Health and Long Term Care	Colin D'Cunha
Health Canada	Adel Shalaby Will Robertson
Government of Ontario, Ministry of the Environment (MOE)	Jim MacLean Eileen Smith
Ontario Ministry of Agriculture, Food and Rural Affairs	Jim Wheeler Brent Kennedy
Province of Ontario (Smith Lyons)	John Callaghan Jim Ayres
Research Advisory Panel Members	Alison McGeer Michelle Prévost Dr. George Connell
Walkerton Inquiry Staff:	James Van Loon Karen Minden
Rapporteur Team Leader	Carolyn Johns
Rapporteurs	Judith Muncaster Sarah Wolfe

Discussion of Substantive Issues

1. SOURCES OF MICROBIAL PATHOGENS – Human Waste

1.1 What waterborne pathogens arise in human wastes and are relevant to Ontario drinking water?

1.1.2 *Is pathogen contamination of water sources from human wastes a problem in Ontario (Hrudey)?*

- The sources would be septage and wastewater treatment plant sludges. With a focus on rural areas, the venues for contamination include runoff sources, groundwater and well contamination and surface supplies that are accessible for drinking water. A considerable problem exists for people who live adjacent to (direct) application areas for sewage sludge or septage. These locations frequently have poor quality well tests although question of test timing (before or after spreading) may influence the findings. Another problem is the lack of tracking of land application of bio-solids.(Goss, Reilly)
- It is largely recognized that discharges from wastewater treatment systems in Ontario are a source of microbial contamination of surface waters, particularly related to overflows. By no means do all communities provide tertiary treatment, there is a wide range of treatment efficiency and uneven use of disinfection methods for discharge water. (additional comment from ALERT/Sierra)

1.1.3 *Do we have an appropriate indicator for E.coli O157, even at low levels, with existing testing methodologies (Goss)?*

- The current goal of microbial indicators (e.g *E. coli*) is to identify water sources at risk of contamination from wastes containing human pathogens. This is currently done by fecal coliform testing to recognize human or animal fecal contamination, rather than conducting a specific pathogen search. Using these microbial indicators *E.coli* should be covered in terms of potential for contamination, but will not be specifically recognized in the sense of knowing if the enteropathogenic strains (such as O157:H7) are present. Bacterial pathogens will be destroyed through treatment as long as the chlorination is continuous, the dose is adequate to provide a residual and the turbidity is low enough to prevent protection of bacteria within particulate clumps (OWWA/OMWA).

- Testing specifically for *E.coli* O157:H7 will lengthen the turn around time in obtaining monitoring results and make system response less effective. We need tests which have shorter turnaround reporting period, are biased to identify potential problems and which support a public health surveillance system (Hrudey, McGeer).

- It is critical that we have a clear understanding about our existing system strengths and weaknesses and we build towards what we anticipate for the future. For example, emerging science and technology is increasing the analytical potential of water quality indicators. In the future, it will be increasingly possible to use new molecular biology indicators to identify the source of the biological contamination (human, animal, specific

animal). This technology and analysis is currently specialized but may become more readily available as the needs arise (Reilly, McGeer).

- There was some empirical evidence that testing will not always detect enteropathogenic *E. coli* (such as O157:H7). There was also mention that there can be resuscitation in the human intestine of the pathogen that are non-viable according to current monitoring methods. Such low levels of the pathogen may not be recognized by standard sampling method. (CELA) Subsequent reference provided by CELA. References from Inquiry Evidence Part 1A indicate (i) the potential for chlorine-injured pathogenic bacteria to not be detected on sampling, but to resuscitate in the human intestine. Evidence presented by Gary Palmateer, October 19, 2001 (Vol.4, pages 40-42); (ii) standard testing for *E. coli* not picking up (and not being designed to pick up) *E.coli* O157:H7. Evidence presented by Gary Palmateer, October 19, 2001 (Vol.4 pages 64-69 and following).

1.2 What is currently known about pathogen loading and survival in current or potential drinking water sources?

1.2.1 *What do we know about pathogen survival capacities?*

- The most hostile environment for pathogens in manure is one of sunlight and dryness. Therefore, the most cost effective means of treatment for inactivation of pathogens is land spreading (in dry, sunny weather). Relatively speaking, there are limited numbers of contamination events considering extent of use (OFEC).

- ALERT/Sierra disagrees and cited Dr. Payment's testimony at the Inquiry indicating that few contamination events are actually measured. There is no form of commercial "drying" method for the inactivation of microbial pathogens in manure. This method of disposal provides no assurance of inactivation. Best Management Practices in Ontario call for working the manure into the soil by disking or light cultivation in order to preserve the nitrogen content, that is, the opposite of spreading on a hot sunny day and leaving it there. Manure is almost exclusively applied in the spring and fall, Ontario's wettest seasons. (addition by ALERT/Sierra).

- A follow up study to Goss's water well survey demonstrated that a huge percentage of farm families experience elevated gastro-intestinal episodes as a result of drinking contaminated well water.*(reference?)* Also, the most frequent source of spills in the MOE spills database come from breached manure storage or handling systems (addition by ALERT/Sierra).

- OWWA/OMWA added subsequently that it is important to differentiate between usual treatment of animal and human wastes. The most cost effective means of treatment of animal wastes is land spreading. Human wastes should normally go through a sewage treatment plant (and sewage sludges may then be land applied). Note however, that sewage plant effluents can be a major source of Giardia and Cryptosporidium (See North

Battleford and current work in the North Saskatchewan River Basin upstream of Edmonton). (OWWA/OMWA)

Points of Contention:

- Reilly stated that microbial digestion process in treatment plants is a battle within a chemical elixir, which may contain antibiotics etc. This environment can facilitate mutations in reproducing organisms that build "super bugs" which are then directly applied to the land. If organisms show resistance to human or animal antibiotics, this will serve as an indicator of contamination (Reilly) Subsequent references provided by Reilly.[1]

- There is no doubt that the risk of antibiotic resistance occurs primarily inside humans and to a lesser extent, inside animals, however don't focus on outside interactions. (McGeer)

- There is some research (*Goss to submit*) that it is possible for *E. Coli* to reproduce outside of a host (i.e. in water), but there is considerable evidence to the contrary because conditions like natural waters are so different than conditions in the mammalian gut (Hrudey). This would have tremendous implications on water management systems and health surveillance. (Goss, OFEC). Reilly added that a suitable environment including heat and nutrient availability, for example in a paper mill sludge pile, coliform like fecal streptococcus can multiply. (Reilly) There appears to be some difference of opinion on the reproduction of *E. Coli* outside the body. Most researchers maintain it is an excellent indicator of fecal contamination, yet some research suggests it can reproduce outside the body. *E. Coli* have been reported growing at over 40C in pulp paper wastewater in a study from Finland (Reilly).[2]

1.2.2 *To what extent does Ontario use direct application (spreading) methodology of human waste products as means to disposal?*

- Ontario directly applies ('spreads') two times as much sewage sludge compared to other provinces, rather than incineration or land filling. The capacity of sewage treatment plants in Ontario to handle sludge was also identified as an issue constraining the ability of septic haulers to follow good practice. (Reilly) Ontario land applies twice as much sewage sludge as all other provinces in Canada put together.[3] OCA wondered about the data for sewage sludge application in Ontario and said this is a big stress on land application in the province (OCA). OFEC agreed that there is a need for better research and tracking regarding land applied bio-solids.

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[1] Transgenic Transgression of Species Integrity and Species Boundaries [http://www.anth.org/ifgener/ho.htm] and Fecal Contamination Source Identification Methods in Surface Water [http://ecy.wa.gov/pubs/99345.pdf]

[2] Nieme et.al. 1987, Canadian Journal of Microbiology, 33: 541-545

[3] In 1997, Ontario land applied 112,500 dry tonnes of sludge and all of Canada applied 164,000 dry tonnes. See CCME report "Fate of Mercury in Sewage Sludge" by Conestoga Rovers 1999. (additional details and reference provided by Reilly).

- ALERT/Sierra added that "human" wastewater sludge represents the combined solid and precipitated matter from three waste streams: residential, commercial and industrial. It is well documented that wastewater treatment plant sludge contains metals and complex organic chemicals which are not present in animal manure.(ALERT/Sierra)

1.2.3 ***Are there any examples of contamination directly linked to direct application of human sludge (Connell)?***

- Reilly was unable to access data from the Ministry of the Environment but urged participants to distinguish between drainage of septic tank tile fields, leakage and direct application of sewage. It is important that we not ignore septic systems as a direct source of water contamination. (Goss, OFEC).

- Substantial concern was expressed regarding septic systems and the amount of risk they pose. It was pointed out that sewage sludge has various levels of treatment across the province (Reilly). OFEC argued that Ontario has a bad track record of managing septic tanks and sewage treatment plants do not have the capacity to manage within a reasonable haulage rate. OFEC proposed that we are using a system (land spreading of untreated septic) that is recognized as bad practice and it should be stopped. Reilly agreed and argued that the potential pathogen content in human septage is several times higher than digested sewage sludge.

Point of Contention:

- No consensus was achieved on whether a clear statement can be made that human wastewater sludges are more dangerous than animal manures. While many direct application risks were identified, the opinion that land application of bio-solids from municipal treatments supported and contributed to a cycle of nutrients was also tabled. Many opportunities exist for research and tracking under a proper nutrient management plan (OWWA/OMWA, Hrudey, OFEC).

1.2.4 ***To what extent are miscellaneous sources, for example portable toilets etc, regulated (directed to Reilly)? Are all operators licensed (Connell)? How are we tracking the land applied sludge and pathogenic content (CELA)?***

- Miscellaneous sources of human sewage are supposed to be regulated and managed under a Certificate of Approval (CofA). Reilly stated that some certificates may be 20-30 years old and the context within which they were established has changed. The output of human sewage may be directly applied and/or pumped into treatment plants. Problems arise when treatment plants won't accept the product and septic haulers are forced to pump it out onto land. Septic haulers may often be distraught about pumping it directly and unsure of alternatives (Reilly).

- There must be a distinction between septic tank drainage (tile fields), leakage and other sources of human pathogen contamination. Household pathogens can be "familial" which may provide greater resistance to family members exposed through contamination of the

family well with family wastes. Reilly proposed that the risk of "exotic" viruses also has implications for human health. She proposed that we be conscious of the capability of sewage treatment plant sludges to distribute exotic and resistant pathogens from hospitals into the environment but could not state that these pose a greater risk than ordinary pathogens.

- McGeer disagreed and stated that "ordinary" pathogens (enteropathogenic E coli, Cryptosporidium and Giardia) are just as dangerous as exotic pathogens (exotic actually less of a threat).

1.2.5 *What are the proposed strategies to decrease water contamination risks from direct application of human wastes?*

- From the standpoint of impacts on the ability of water treatment plants to operate effectively, summer spreading of manure is appropriate. Winter spreading of manure is not and must be controlled. In addition, there is also a need to address problems of manure contamination to source waters during rain events. (OWWA/OMWA).

- CELA questioned the viability of an example from New York, described by a presenter at the Inquiry's Waterloo Town Hall meeting where they had adopted year round spreading. CELA wanted to know what the advantages and disadvantages of this approach were. OFEC said this type of system has potential as it prevents a pollution overload of the system: "Dilution is part of the solution". A point of clarification was added that the New York case concern was for potential contamination of surface water rather than groundwater (Goss).

- Bradshaw proposed that it is critical to not only have timed spreading events but also distribute the sludge properly the first time so not to pollute i.e. amount, method, unique geographic and temporal characteristics to avoid impacting groundwater.

- Concern was expressed over the regulatory framework and intensified cropping practices which caused a narrower window of available application times. This was perceived as playing "Russian roulette" with environment and leading to potential disaster (OFEC). There should be the same type of regulations for land application of sewage and septage (Goss).

Consensus:

- Septic tank pump-out (septage) and tile field drainage has the potential to cause serious drinking water problems. The disposal of septic on land through direct application is not as carefully controlled as it should be. This is a situation that requires greater research attention.

- A database on extent and potential contamination from land application as well as data on the characteristics of sewage treatment plant discharge is needed. (OWWA/OMWA, GLU/SLDF)

- A contributing factor in improving this waste disposal situation would be to increase the capacity of wastewater treatment plants to allow them to accept septic tank truck discharges.

- A comprehensive regulatory system must incorporate information on where and how frequently the material is being directly applied. Information technologies such as Geographic Information Systems (GIS) would be an effective tool to manage this information. The need for a common database for the province was also mentioned.

- We need to understand and look at needs of management for land application. A total ban of land application can't be achieved today (MOE) and is not necessarily desirable from a perspective of making the most environmentally beneficial overall use of waste residuals containing organic matter and nutrients that can be recycled (Hrudey). Hrudey later added that we do not just dispose of these residuals to get rid of them, they do have a beneficial role in soil structure and replenishing soil nutrients, i.e. recycling.

- Much septic tank land application is not for "beneficial use". There is no 'crop'. It is disposal, not 'nutrient recycling'. This is often not an agricultural enterprise and OMAFRA has no jurisdiction or consultation role. (Reilly)

1.3 Can pathogens be grouped in terms of occurrence and survival to allow effective surrogates to be identified?

No discussion on this specific question.

1.4 How effective is pathogen control at source (waste treatment)?

1.4.1 *How effective is the current level of capacity in municipal wastewater treatment plants? What implications do extreme events (i.e. heavy rainfall or spring flow) have for current treatment/disinfection capacities? (OWWA/OMWA, CELA, Reilly)*

- Depending on system design, overflow from weather variations leads to peaks of pathogen presence in water. Heavy rains prevented wastewater treatment plants from using direct land spreading of their wastewater sludges this past summer (2000). Plants also had inadequate peak flow capacities to prevent overflow (direct dumping into a water source of untreated combined sewerage wastewater).

- Most municipalities do not have adequate storage facilities for storing sewage sludge in years when constant summer rains make the land unsuitable for spreading sludge. Municipalities need to have back-up facilities or treatment for sludge and septage under these conditions (storage, land-fill, incineration). Farmers also need adequate manure storage when inclement weather makes land application of manure inadvisable.

Municipalities need to address the problem of sewage overflows into surface waters. Sewage treatment plants are the number one source of nutrient pollution into surface waters in Canada. (Reilly referencing NPRI).

- OWWA/OMWA stated that multiple barrier approaches to reduce the loadings of pathogens is a good idea from the treatment perspective. We need to focus on the "sudden events" rather than just regular testing for general conditions. Extreme events and pathogen peaks may be orders of magnitude higher. Sudden rain events are when water treatment systems may break down. (OWWA/OMWA).

- The design perception among some overconfident engineers in the 1980s-1990s for multiple barrier protections was that technology can "deal with anything" (i.e. extreme events, source quality). Although very high levels of water quality can be achieved from very poor raw water quality, this is not a desirable option. The "we can treat anything" perception is changing and examining the management and protection at source is more widely accepted as the first line of defense (Roberts). With the premise of multiple barriers, we must also include multiple levels of management from source protection, through treatment to monitoring and quality control. Source control within a multiple use environment cannot and will not eliminate the need for water treatment (Hrudey)

- CELA added that viruses are less effectively treated than bacteria. CELA subsequently added that evidence at Part 1A of the Inquiry presented by Dr. Pierre Payment on February 28, 2001 (Vol.49, Page 31) that "the other detail we have learned is that viruses are more resistant to these infection [sic] so that even if you put in the chlorine, you do kill the bacteria, but viruses can still go through so that is why we've seen a large number of outbreaks of hepatitis A in groundwater, which is a virus which survives better, which resists better chlorine treatment and which has as low - low -an effective dose so that it doesn't take as much to infect a human".

- Viruses and parasites last longer than bacteria in soils receiving land applied manures and sewage sludges. Wastewater treatment plants are not very effective at pathogen removal. (addition and references provided by Reilly)[4]

- CO commented on the loading question and multiple barrier system. In determining significance of types of waste, we must identify specific variables for a local area including local characteristics - soils, watershed conditions. Loading risks must consider local assessments and this should be built into the system (planning process, certificates of approval) and cumulative implications.

[4] See P.Payment et.al. "Removal of Indicator Bacteria, Human Enteric Viruses, Giardia Cysts, and Cryptosporidium oocysts at a Large Wastewater Primary Treatment Facility", *Canadian Journal of Microbiology*, 47 (3), 2001: 188-193. See also C. Charet et.al. "Fate of Cryptosporidium oocyst, Giardia cysts and Microbial Indicators During Wastewater Treatment and Anaerobic Sludge Disgestion", *Canadian Journal of Microbiology*, 45(3), 1999: 257-262.

- The Certificates of Approval (CofA) for the wastewater treatment plants manages provisions for overflow events. Monitoring for pathogens is set out through the CofAs if there are indicators of source contamination (MOE).

For more information on the topic of drinking water monitoring in Ontario, refer to Krewski et. al. (2001:95). Managing Health Risks from Drinking Water: A Background Paper for the Walkerton Inquiry.

2. SOURCES OF MICROBIAL PATHOGENS: Agricultural Waste and Wildlife

2.1 Are there any pathogens unique to non-human sources (Hrudey)?

- Treatment sewage sludge also contains animal pathogens (slaughterhouse wastes, rendering plants, pets etc.) (Reilly)

There was limited discussion focused on identifying specific agricultural and wildlife pathogens during the Expert Meeting. For more information on the biophysical aspects of manure management, including pathogens, refer to Goss et al (2001: Chapter Two) and Ritter et al (2001: 60).

2.2 What is known about the comparative scale of pathogen contamination from these sources compared to human wastes (elsewhere and in Ontario)?

- Wild deer, geese, beaver, raccoon, possum etc. are a relatively lower source of contributions, however, population numbers have increased so we can assume that wildlife continue to contribute water contamination (CFF). A University of Guelph research study located *Cryptosporidium parvum*[5] in groundwater drainage tile and this was attributed to wildlife sources (Bradshaw). We shouldn't assume that "pristine" water supplies are safe; we are not well endowed with information about wildlife sources but it seems implausible that wildlife are a huge contribution of pathogens relative to livestock and human wastes (Hrudey).

- In the past, an algorithm tool was developed as part of the Clean Up Rural Beaches (CURB) program, for estimating the relative loadings of bacteria from various sources (wildlife vs. agriculture vs. septic drainage etc.) within a watershed. The CURB program was administered by the MOE in partnership with Conservation Authorities. (CO, *related references provided to the Chair and the Inquiry*).

- Nitrate in groundwater is also an important parameter which has taken more municipal supply wells out of service in Ontario than any other single parameter and agriculture accounts for upwards of 70% of this non-point source in the province. (Alert/Sierra, citing IJC report 1980).

[5] For a definition of Cryptosporidium parvum and other related terms from this topic, refer to the Glossary of Terms in Krewski et al (2001: 200 - 203). Managing Health Risks from Drinking Water: A Background Paper for the Walkerton Inquiry.

- OEFC outlined that it is important to understand that the agricultural community views "waste" as "nutrients". The concentrated time of application was also tabled as an issue. Reilly outlined that the concentrated time of application applies to land applied manure, sewage sludge and septage.

- The issue of the size of the agricultural operation was also highlighted as an issue. OWWA/OMWA noted that in Alberta there is better regulatory control for large feedlot operations and, as a result, these operations often control wastes better than small operations. However, the number of small operators is much larger so the cumulative effect of these smaller facilities can be significant. (OWWA/OMWA).

- How do we (depending on contaminant and loading information) make informed decisions when the information database is insufficient? The numbers reported are not based on common units and ranges, which makes comparison difficult. Issues related to individual pathogens and better information on indicators (rather than individual pathogens) was also discussed (Goss)**.**

2.3 What means can be effective at source?

2.3.1 What impact do different types of on-farm manure management practices have on pollution of source water?

- A problem is that we've moved from a storage/solids to composting model of manure management (manure and straw) to liquid manure management (holding tanks, lagoons and spraying). Although this may reduce volumes, this may result in more nitrogen and increase susceptibility to runoff and water pollution (Reilly). Traditional systems did incorporate greater flexibility for composting (Goss) and nutrient management plans need to be long-term and sustainable (OP). From the standpoint of impacts on the ability of water treatment plants to operate effectively, summer spreading of manure is appropriate. Winter spreading of manure is not and must be controlled. In addition, there is also a need to address problems of manure contamination to source waters during rain events. (OWWA/OMWA).

- The on-farm reality is that liquid manure is the only way to reduce volume and for application efficiency: compost required mechanization for aeration (OFEC). Solid manure management and composting are two separate practices and should have differentiation in their cost-benefit analysis (Goss). It was also noted that in Ontario, cattle housed inside resulted in greater control over manure distribution (OCA).

  For more information on manure handling and storage, refer to Goss (2001:57 - 59).

2.3.2 *Should we change the feed lot regimes in Ontario to potentially create a less hospitable environment for pathogens (Reilly)?*

- OFEC disagrees with the premise that feeding regimes contribute to pathogen risk. OWWA/OMWA argued that the spreading of manure in winter should be regulated where there is potential for runoff to reach water supplies.
- Source protection is important but, given that the current regulatory framework for source water control is weak, it is a long-term goal. Most utilities do not have control over their watersheds (OWWA/OMWA).
- Goss and OCA agreed that more research is needed on this topic as alterations in feeding regimes hasn't completely shown that one or the other results in less shedding of pathogens.

Consensus

- There is nothing unique about agriculture and wildlife waste and the pathogens they contribute.
- It was generally agreed that wildlife is a relatively lower source of pathogen contamination compared to agricultural wastes and human wastes. There was no definitive statement on the comparative scale of pathogen contamination from agricultural sources and human sources. Both were thought to be important.
- Contamination from agricultural was generally thought to vary depending on time of application, size of the operation, type of operation and type of manure management.
- Research has indicated higher levels of pathogens are contributed by liquid manure spraying, when cattle are stored outside and there is no major control of droppings.
- Data limitations prevent generalizations about different sources and impacts of different management practices.

3. SOURCES OF CHEMICAL CONTAMINANTS: POINT SOURCES

3.1 Are there point sources of chemical contaminants that are likely to be relevant in Ontario?

3.1.1 *What consensus exists on point sources of chemical contaminants?*

- leaching from underground or underwater storage sites
- land fill leachates
- buried waste (including ash heaps from coal fire generators)
- industrial sites and abandoned contaminated sites
- high natural fluoride sites
- spills
- sewage sludge

For further information regarding point sources for chemical contaminants, refer to Ritter et. al. (2001). Sources, Pathways and Relative Risks of Contaminants in Water. Walkerton Inquiry issue paper.

3.2 What chemical contaminants are important to human health? Which appear to be clear health priorities?

3.2.2 *What consensus exists on high profile chemical contaminants that need attention?*

- Lead
- Water treatment disinfection by-products
- Nitrate/nitrite
- Fluorides
- Water treatment chemicals (fluoride, alum, polymers)
- Endocrine disruptors and pharmaceuticals may pose future problems (OWWA/OMWA)

For further information regarding chemical contaminants, refer to Ritter et al (2001). Sources, Pathways and Relative Risks of Contaminants in Water. Walkerton Inquiry issue paper.

Notwithstanding that many of the chemical contaminants are discussed in the referenced report, there was considerable additional discussion regarding chemical contaminants of which the following are salient points:

- There are a number of contaminants known to be present in, or potentially present in, water which are also harmful to human health. There were concerns expressed about the effect and amount of other less known substances in water supplies.

- While there is uncertainty regarding effects of exposure to many contaminants etc., there is also much that is known. We must make the best possible use of what we do know to avoid preventable problems or to respond wisely to problems that cannot be avoided. Over time, study will show what substances constitute major problems vis-a-vis minor problems (Hrudey).

- Lead (leached from old distribution pipes, plumbing systems, municipal waterworks systems, brass fixtures) has been proven to be harmful to human health, especially to children (OFA, Hrudey). There are lead replacement programs in place in many municipalities; lead is generally acknowledged as risky (Roberts). Lead was identified in Hazard Quotient/Risk Assessment analysis as outlined in commissioned paper referenced above (Ritter).

- Nitrates were identified in the Hazard Quotient analysis as greater than one in many rural areas (Ritter)

- Water treatment chemicals (fluoride, alum) are considered a potential contamination source; their quality needs to be monitored carefully to insure that contaminants in water treatment chemicals do not contribute excessive contaminant loadings to treated water. These should be picked up in engineering reports for the treatment plants (Roberts). Likewise there have been poisoning incidents where water treatment chemical dosing

was inadequately controlled (Roberts, Hrudey).

- Chloride is showing up in private rural wells (Conservation Ontario). There has also been some indication of an increase in chloride (OFA). Increases in chloride may be as a result of heavy rains in 2000 and/or runoff from road salting (Hrudey). OWWA/OMWA subsequently added that there is some confusion between chlorine and chloride. Chlorine is a very minor source of chloride and most chloride would come from road salts.

- There has been debate about the risks of using chlorine as a disinfectant. A question was asked about whether chlorine itself posed a health risk? (OFA). The risk from the levels of chlorine used in drinking water are not a health concern (OWWA/OMWA). The risks are not h associated with chlorine itself but with the by-products that are formed when chlorine reacts with natural organic matter normally present in surface waters (Hrudey). The risk from microbial pathogens is evident by the consequences of water borne disease outbreaks that arise in the absence of effective disinfection (Ritter). By comparison, health risks from disinfection by-products are hypothesized, but the causal link between disinfection by-products and various adverse health effects is not established. Reference was made to regulatory negotiations in the United States where consideration was being given to further tightening of regulatory standards for disinfection by-products which would have made achieving adequate disinfection increasingly challenging. A multi-stakeholder group evaluating the choices opted for leaving the regulatory levels for disinfection by-products where they were rather than place additional challenges on disinfection which is clearly essential to prevent waterborne disease (Hrudey).

- Considerable research has investigated alternatives to chlorine disinfection but there is no risk-free alternative. Ozonation has been studied extensively and although it has some important advantages over chlorine, it also has some serious problems, such as the formation of bromate, a toxic disinfection by-product (Hrudey).

- Ultra violet (UV) has also emerged as a potential option for disinfection. It appears to be much more effective than chlorine for Cryptosporidium, but UV, like ozone, does not maintain any residual disinfectant in treated water to control microbial regrowth or subsequent re-contamination in the distribution system. Overall, the prospect is developing that combinations of disinfection processes will be used. (Hrudey)

- Polyacrylamide polymers are used in drinking water and sludge dewatering as a flocculant agent. The concern is that there is a toxic fraction of the polymers, especially those used for sludge dewatering which can be as much as 5% toxic acrylamide monomer. These sludges may be discharging the acrylamide into groundwater where the sludges are used at high rates (rehabilitation of pits and quarries with papermill sludge and papermill sludge stockpiles). (Reilly)[6]. Polyacrylamide polymers have been in use

[6] See also SFC, 10/24/97, p/A11 regarding contaminant containing acrylamide known to cause nerve damage. [http://www.ceps.unh.edu/news/releases98/kinner498.html] and Sec.2 Neurotic Properties of Acrylamide [http://birc.technopol.be/tbb08.htm] and [http://www.newstimes.com/archive97/oct1897/inf.htm]. Also L.Chang et.al. "Aerobic and Anaerobic Biodegradability of Flocculant Polymer", *Water Science and Technology*, in press.

in water utilities for many years. Acceptable doses of each type of polymer are set by the US National Sanitation Foundation. Monomer content has to be demonstrated to be within acceptable limits for each product. (OWWA/OMWA).

- Disposal of increasing amounts tetrachlorethylene (commonly used in cleaning as a degreaser) is of concern

- Calcium, magnesium, sulphates may have effects (diarrhea) on population sub-sets (CELA), however, evidence on hard water (containing those elements) suggest that it may be beneficial (Hrudey)

- Buried asphalt, the amount of which is unknown presents a concern. There is one case in which a herd of cattle had to be moved due to the effects of buried asphalt on the herd (OFA). CELA provided subsequent reference that this is a case (Berendsen v.Ministry of the Environment) an appeal from which is pending from the Supreme Court of Canada on a procedural issue. *(relevance for drinking water?)*

- Some participants (GLU, CELA) expressed concerns about the effects of radio-nuclides like tritiated water released by Ontario Hydro, especially around the Bruce Peninsula and in Durham Region (the areas around the Darlington and Pickering outflows) which are upstream of major community drinking water intakes. Tritium as a source of radioactivity raises concerns with cancer causation.[7] The concerns expressed in this discussion were mostly directed to the process of how the tritium standard was set in Ontario, not that the standard that was set is being exceeded.

3.3 What is known about the scale and scope of health risk that chemical contaminants may pose in Ontario's drinking water?

A comprehensive discussion of risk assessment and management is contained in Ritter et. al. .(2001). Sources, Pathways and Relative Risks of Contaminants in Water.

The salient points of discussion on scale and scope of chemical contaminants include:

- There will always be a need to consider new contaminants that are not currently recognized as a problem (OWWA/OMWA).

- There is growing interest in the presence of trace levels of pharmaceuticals in drinking water (particularly in Europe) wherever drinking water sources are strongly influences by human wastewater discharges. The latter are being found to contain pharmaceutical residuals which are then able to enter drinking water treatment plants (Hrudey).

3.4 What are the prospects for improving or refining our stock of knowledge on these areas?

Also D. Raymond and R.W. Pero "Contaminants in Polyelectrolytes Used in Water Treatment", *Journal of the American Water Works Association*, November 1990: 87-97.

[7] CELA has provided references related to childhood leukemia and tritium in drinking water to the Inquiry.

- There was little direct discussion on this area, but later discussions on pesticides and risk assessments were relevant to this topic. It was noted that Health Canada maintains an on-going subcommittee (Federal Provincial Sub-committee on Drinking Water Standards) that investigates and reviews substances identified as potential risks to safe drinking water.

Discussions regarding prospects for refining knowledge on these issues are contained in the following papers commissioned for Part II of the Walkerton Inquiry:

Ritter et al. Sources, Pathways and Relative Risks of Contaminants in Water

Krewski et al (2001) Managing Health Risks from Drinking Water: A Background Paper for the Walkerton Inquiry, Chapter 2.

4. SOURCES OF CHEMICAL CONTAMINANTS: NON-POINT SOURCES

4.1 Are there non-point sources of chemical contaminants that are likely to be relevant in Ontario?

4.1.1 *What consensus exists for non-point sources of chemical contaminants?*

The non-point sources were broadly identified as both urban and agricultural. The following list includes some items that present very localized concerns, so not all items on this list should be considered major contaminant sources across the province. Specific sources mentioned included:

- Agricultural wastes
- Urban stormwater drainage
- Groundwater infiltration of surface contaminants
- Pesticides
- Spills
- Roadcover from old spent coke/pulp and spent pulping liquor as dust suppressant

For further information regarding sources of chemical contaminants see Ritter et al. (2001). Sources, Pathways and Relative Risks of Contaminants in Water (pg. 61).

4.2 What non-point source chemical contaminants are important to human health? Which appear to be clear health problems?

Discussion centred almost exclusively on pesticides. There was significant discussion and debate about the importance of pesticides as a contaminant with documented human health impacts via drinking water exposures.

- Pesticides should be considered a serious risk (OFA, CELA). There is a need to determine what is meant by the term 'pesticide': There are several different definitions and there is a need to be clear about the terms being used (Ritter). CELA subsequently clarified that they use the definitions in federal legislation, which are mirrored in provincial legislation, and which encompass herbicides, fungicides and insecticides. This definition does not exclude biological or organic pesticides. CELA also points out that the concerns being discussed were primarily regarding chemical pesticides.

- OEFC outlined that pesticides can be viewed as a point source as most are covered under licensing and storage regulations. CFF argued the risk of pesticides has to be put in perspective and that availability for residential use should be more of a concern. CFF also articulated that there would be significant impacts if pesticides were taken away from agriculture.

- Goss made reference to an Ontario farm water quality survey in 1991/92 indicating low detection levels of pesticides.

- McKewan distributed some data on Pesticide Use in Ontario from OMAFRA's survey of pesticide use in Ontario. Reference was also made to an OMAFRA program in the 1980s designed to reduce pesticides by the year 2002. (*Documentation to be provided to the Inquiry by OMAFRA).*

- Pesticides comprise a wide range of chemicals with a wide range of health risks, particularly in children (CELA)

- Of pesticides, atrazine (and diethylatrazine) have been identified as the most ubiquitous in water samples and they have been found to remain a long time in the environment; could have long term effects (Ritter, CELA)
- There was also discussion about monitoring and reporting on these chemicals (OEFC, GLU/SLDF). It was noted that pesticides can be removed by water treatment plants using particle removal (if the pesticide adsorbs on particles), or by using activated carbon where the pesticide is water soluble (e.g. atrazine). (OWWA/OMWA).

- Ontario should be looking at substances that are regulated or proposed for regulation under the drinking water laws of other countries (e.g. US Safe Drinking Water Act) and then determine if any of these substances are a problem in Ontario. (OWWA/OMWA).

- The discussion foreshadowed a later elaboration of the need to distinguish between detecting pesticides in monitoring programs versus the existence of evidence of human health effects arising from documented exposure to pesticides via drinking water.

Reference was also made to a 1998 water quality study in Ontario see Ritter et. al. (2001). Sources, Pathways and Relative Risks of Contaminants in Water (pg. 70).

Consensus:

- There was consensus that there are deficiencies in drinking water monitoring data for pesticides.

4.3 What is known about the scale and scope of health risk that they may pose in Ontario?

There was significant discussion regarding current knowledge of the scale and scope of health risk that may be posed in Ontario by these non-point source chemicals. Again, the salient points of concern centred largely on pesticides.

There was some considerable discussion and some disagreement regarding the inclusion of pesticides as a health risk because of the scale of exposures and the degrees of uncertainty involved:

- It is essential to distinguish between detection of presence of pesticide and risk (Hrudey). Detections at less than regulated amounts do not equate to human health risk unless the standards have been set too loosely. Pesticide levels that are detected in drinking water are typically so low that they do not warrant action by any government body (Ritter). Studies indicate that pesticides are not occurring above accepted use [Siron, Ripley, 1978; Goss to provide reference].

- Atrazine has been widely used in different forms (including on railroad tracks and in urban centres) and it gets leached and ends up in water samples (Goss).

- There was agreement that it is difficult to get a handle on all the chemicals that are used in pesticides. Some suggested using the EPA regulation list. Others maintained that the list is essentially the same as that in Canada, while others suggested that it contains some chemicals that are not available in Canada. In the United States, the chemicals are designated as active substances, not under marketed name. The latter does vary from country to country. There are some pesticides being deposited aerially in Canada that have long been banned in Canada (mainly organochlorine pesticides). These may be coming from other jurisdictions which still approve them (e.g. DDT) and some transport is continuing in the form of long range transport from past contamination (Hrudey).

- In studying exposure, it is important to understand the proportion of exposure to pesticides through water as opposed to other sources (CELA). For most pesticides exposure through water is very low because many pesticides have very low water solubility and consumption of a few litres a day of drinking water with trace levels of pesticide yields very small mass doses of pesticides (Hrudey). However, even food exposure is not very high despite the lack of a water solubility limitation because the vast majority of foods are free of pesticide residues (Ritter).

- The harmful effects of pesticide in farm use have been reduced through education / training and use of more bio-degradable pesticides (OFA). Moreover, pesticide use on farms is regulated at the federal level: every farmer in the province has certification for

the use of pesticides (CFF). Farmers are confident that when applied properly, chemicals won't get into groundwater. Studies [Ritter] show that certification process has resulted in a drastic reduction in individual contaminated wells, with major improvements in groundwater management and quality of groundwater (Goss).

- CELA asked if there are corresponding standards at the provincial level for each chemical? CELA expressed concern that the federal regulatory process is 30 years old and needs to be reformed in light of international scientific information especially regarding effects on children's health.

- Pesticide use is different in urban/rural settings (GLU) and the impacts of use and effects of removing pesticides are different for each setting (aesthetics versus economic impacts).

4.3.1 *What additional issues are related to the monitoring of non-point source chemical contaminants?*

- It is difficult to determine the amount of testing/monitoring that would be effective, but there is general agreement that current frequency of testing is inadequate (Ritter), and also that testing should be done when pesticides are applied in order to better measure impact on drinking water supplies (OWWA/OMWA). Testing should be done at water treatment facilities to determine if they are able to handle pesticides (CELA). Testing in Ontario is now being done quarterly according to the new guidelines and these results are now being analyzed. Testing may need to be done more often at some locations, depending on results showing that problems may exist (MOE).

- CELA argued that sometimes the effect of a very small detection can be very large. There was a long and vigorous discussion on the current state of knowledge about health effects from pesticide exposure. Epidemiological research is inadequate (and under funded) to provide good findings regarding substance presence and exposure (CELA). However, there needs to be an understanding of the inherent limitations of epidemiological research to answer questions of causation for environmental exposures at the level levels under consideration. It is not possible (ethically or practically) to conduct experiments to find out what adverse health outcomes occur in humans from low level pesticide exposures. Consequently, the epidemiological studies are limited to being observational in nature with enormous uncertainty in the level of individual human exposure to pesticides with substantial confounding and bias in interpreting low levels of adverse health outcomes in the population. (Hrudey).

- There is a fundamental difference between knowing with confidence that some pesticide exposure exceeds a level that we would clearly expect adverse health effects (accidental acute poisonings define such levels) versus the analytical detection of the presence of a pesticide. The ability to detect any given pesticide in water is entirely a function of the analytical detection limit of the monitoring program which in turn is an arbitrary function of the analytical technology that has been used. The failure to detect a pesticide by even extremely sensitive analytical techniques does not mean that the pesticide is absent, only

that the analytical method was not sensitive enough for the level of pesticide that may have been present. In a typical case, a sensitive analytical detection limit for benzene (0.1 microgram per liter), below which some might assume there is no benzene is present, would still allow for more than 1,000,000,000,000,000 molecules of benzene per litre to be present and not be detected. Analytical detection limits are arbitrary and they do not tell us anything about health risk (Hrudey).

- There was contention regarding the setting of standards. Some argued that health standards should be set first based on scientific evidence and then the cost of those standards should be calculated (CELA). Others believe that standards must be set with consideration for reasonable cost (Ritter). A precautionary approach is advocated by CELA which would prevent exposure from occurring - requiring a "proof of no harm" approach rather than "wait and see" approach.

- The critical question is how precautionary is precautionary and how much cost is acceptable. This discussion did highlight an important issue for how risk assessment and risk management are practiced. Risk assessment is supposed to be limited to consideration of the scientific issues about health risk and risk management is supposed to be the stage at which cost and practicality are considered. The common practice of defining health risk numbers in the risk assessment stage and treating the risk management stage as being a consideration of how the standard can be met creates some difficulties (Hrudey). The decisions made in the standard setting stage often involve choices about how precautionary the standards will be (e.g. how large the uncertainty factors that are selected will be). It is difficult to divorce this choice of how precautionary the standard will be from the costs and practicality of achieving a standard. CELA argues that this separation must be maintained, yet current practice often if not normally allows the degree of precaution to be adopted to be a part of the risk assessment process. This issue was discussed further in Section 5.

Further information regarding the scale and scope of health risk that non-point chemical contaminants pose in Ontario, please see Ritter et al. as referred to earlier.

4.4 What are the prospects for improving or refining our state of knowledge on these issues for Ontario?

During the overall discussion of the foregoing issues, vehicles that will assist in the improvement/refinement of knowledge on these issues included:

- Continued use of the Federal/Provincial Sub-Committee on Drinking Water and MOE's Drinking Water Surveillance Program should assist in refining our knowledge about many of these contaminant issues (Roberts).

- Ontario’s new legislation requiring quarterly reporting which is now being analyzed should improve quality and quantity of information regarding drinking water (MOE)

4.4.1 What are the major concerns with chemical contamination of drinking water for the group?

There was some consensus about the contaminants with some degree of recognized potential to cause harm based on some evidence of high exposures in some Ontario water supplies.

Contaminants included:

- Lead
- Nitrate/nitrite
- Fluoride (naturally occurring)
- Disinfection by-products
- Water treatment chemicals (noting the alum poisoning incident in the UK)

Sources:

- Leaking underground storage tanks
- Contaminated sites/Buried waste (abandoned)
- Landfills/ash heaps
- High natural fluoride sites

5. DRINKING WATER CRITERIA: OBJECTIVES, GUIDELINES, STANDARDS AND REGULATIONS

Ritter cautioned the meeting that they were not in a position to debate standard setting procedure because the individual experts who set the standards where not present to defend or explain their processes and rationale.

5.1 What risk assessment procedures and protocols are in Ontario, Canada and elsewhere to set drinking water quality criteria?

- Roberts reviewed the process for the Canadian Drinking Water Guidelines as outlined in the Krewski report.
- Len Ritter also discussed the risk assessment protocols for pesticides - see Section 4.

For more information on risk assessment procedures and protocols in Canada and elsewhere, refer to:

Ritter, Len et al (2001). *Assessing Relative Risk and Risk Characterization* in Sources, Pathways and Relative Risks of Contaminants in Water. Walkerton Inquiry (Part II) Issue Paper.

5.2 What are the conceptual strengths and weaknesses of various risk assessment approaches?

5.2.1 *How are the needs of susceptible sub-populations included in standard setting procedure?*

- CELA took a very critical perspective to risk assessment practice arguing that there is no evidence which indicates that most sensitive populations have been historically or currently included in the risk assessment procedure, why or why not and how appropriate the resulting numbers are for those populations. They argue that there should be an explicit or mandatory requirement within the Canadian risk assessment procedure to take special consideration of special subsets of the population (CELA).

- In response to CELA, Ritter outlined the Health Canada's role and approach in standard setting based on the paradigm used to set water standards is an international system endorsed by the World Health Organization (WHO). It is a paradigm that has served the public health interests very well and responds to emerging science as required. (Health Canada).

- The established standards, using ranking criteria and information from different agencies, have been very effective risk prevention and over-emphasizes safety. The overemphasis on safety is based on exposure using field data (rather than models) and in almost every case, there has been an overestimate of exposure in the past 4-5 years (Ritter).

- Regarding the specific issue of children's' health: children are special sub-set requiring special consideration. For example, U.S. Environmental Protection Agency (EPA) stated that established standards were not adequate and in 1996, the Government applied additional safety procedures (CELA). The World Health Organization (WHO) argued that there were no reasons to add these new procedures as (1) the risk paradigm had already recognized that special interests had already been incorporated in risk and standards and (2) toxicological studies had been specifically designed to incorporate aspects of the developing body. Therefore, subset of children has already been addressed. Health Canada's review (1999) supported WHO findings based on above. Discussing children is just an articulation of a principle of special sensitivity of sub-populations which has been incorporated in the risk assessment paradigm (Ritter).

- Ritter advised that the World Health Organization concluded that the 10-fold precautionary additions (U.S. example above) aren't necessary. But CELA disputed the notion that the risk assessment paradigm has considered the effects of pesticides on children in setting standards which may end up so diluted as to not be protective of them. (CELA).[8]

- There was no consensus on how well risk assessment as it has been applied to date has dealt with sensitive sub-populations (i.e. children). There was however consensus that children are a sensitive sub-population and that risk assessment must take their specific needs and risks into account.

[8] CELA has provided references about childhood leukemia and tritium in drinking water to the Inquiry. See also M.J. Gardner et.al. "Results of a Case-controlled Study of Leukemia and Lymphoma Among Young People Near Sallafield Nuclear Power Plant in West Cumbria", *British Medical Journal*, 1990: 429-434.

- There was consensus that the requirement for inclusion of sensitive sub-populations in risk assessment should be explicitly stated and include more transparency on how the process is completed.

5.2.2 *What risk assessment issues are related to the setting of standard numbers?*

- CELA argued that the implemented standards after risk assessment and management phases are highly diluted. Even if they have taken special consideration of sub-populations, the regulation is inadequate in strength. For example, accurate lead risk numbers and management regulations were not implemented until high numbers of children were ill (so this is a failure of risk assessment). We are making the same mistake again with pesticides by not taking regulatory action until "proof of no harm" evidence is in. The current risk assessment and exposure requirements are leading us to failures; we need to be disputing the paradigm and its assumptions. (CELA)

- CELA argued that by default we are conducting hundreds of thousands of uncontrolled experiments on children; we need to modify the risk assessment paradigm (regardless of duration and international acceptance).

- Ritter countered that the current paradigm with the evolving enhancements will continue to serve well. We should be, and are, invoking the precautionary principle through the pre-market testing and registration.

5.2.3 *What issues are related to the public's perception of standards and levels of risk?*

- CELA expressed concern that when the assessment is completed through the federal/provincial consensus process, a set of numbers are established with a number of considerations taken under advisement such as cost and industry concerns. CELA prefers that a more explicit and transparent process be established which would explain the set of numbers as standards established as a threshold action level, because once the numbers are established, the public equates the term "standard" with "safety". Since the process through which the numbers are arrived at is not currently well understood by the public, there is a tendency for the numbers to become entrenched. If the process were more transparent (process and orders of magnitude explained), this entrenchment would be less likely to happen. (CELA, OWWA/OMWA).

- The number generated for cancer risk assessment needs to be better understood by paying attention to the qualifiers that were put on these estimates in the original U.S. Federal Register description of the cancer risk assessment guideline. Basically these state (but rarely is this qualifier quoted), that cancer risk estimates are based on one model for risk assessment and the procedure is intended to represents a plausible upper bound but the real risk could potentially be zero. (Hrudey) The exact quote from the Federal Register from the EPA cancer risk assessment guidelines which were based on the linearized multistage model as the default assumption (provided by Hrudey). "It should be emphasized that the linearized multistage procedure leads to a plausible upper limit to the

risk that is consistent with some proposed mechanisms of carcinogenesis. Such an estimate, however, does not necessarily give a realistic prediction of the risk. The true value of the risk is unknown, and may be as low as zero. The range of risks, defined by the upper limit given by the chosen model and the lower limit which may be as low as zero, should be explicitly stated".[9]

- CELA argued that the methodology of assessing chemicals in isolation is inaccurate and does not take into account realistic combinations of exposure. Chemicals are assessed one by one and even where there is multi-media pathways assessment, there is no multi-compounds assessment.[10]

Consensus:

- There is indisputable value in greater clarity for what information standard risk estimates convey.

5.2.4 *When and how should a standard number be set?*

- Hrudey expressed a strong preference that the final guideline or standards numbers be set within the risk management phase rather than in the assessment process. This would ensure that the number set is tied to what is realistically achievable (Hrudey).

- Question was raised by CELA whether the number is set at a level because it is achievable (economically or otherwise) or because it adequately protects human health. CELA called for an explicit explanation as to how and why the number was established. The need for transparency and comprehension of risk assessment is extremely important.

- The Government of Ontario responded that they may set numbers ahead of technology based on expectations of best available technology and anticipation of scientific advances. This has implications for levels and viability. One option in standard setting is to use interim levels in order to get to target rate. CELA stated that the interim public consultation component of the process used for risk assessment of air quality standards was the most encouraging aspect of any recent risk assessment/risk management process in Ontario.

- Part of what would direct the decision to make the investment in achieving specified standards is the level of confidence that there is a significant health risk. Decision makers need to be confident that health risk would justify the expenditure and reallocation of funding away from other areas (Hrudey).

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[9] (U.S. Environmental Protection Agency 1986. Guidelines for Carcinogenic Risk Assessment, Federal Register 51(185): 33, 992-34, 003).

[10] See Canadian Environmental Law Association and the Ontario College of Family Physicians' Environmental Health Committee, "Environmental Standard Setting and Children's Health", 2000, Chapter 4, pages 121-122Also available at www.cela.ca/chp/toc.htm - click on Chapter 4, "Risk Assessment and the Precautionary Principle".

- A distinction must be made between criticizing risk assessment as a conceptual process committed to informing risk management and how risk assessment has actually been practiced. Do we have any other approach available? As an overall approach, what alternatives do we have? Risk assessment should be dedicated to understanding, as well a possible, how great the harm is (Hrudey). Risk assessment should be able to withstand a critical examination of the validity of its inherent assumptions but the decision making process should take risk assessment as inputs to informing a decision, not as the final decision (Hrudey, CELA).

5.2.5 *What are the issues of information availability for risk assessment procedures?*

- Information provided for risk assessment is not perfect; most information is highly limited and judgements need to be made. Including the uncertainty of various groups is the best way to understand the tradeoffs of risk at the lower levels (Prévost).

- Health Canada now puts draft guidelines plus supporting documentation on its website for public comment.(OWWA/OMWA)

- The US safety threshold for a product (e.g. a pesticide), and how that product would affect the creation of a drinking water standard, must show "reasonable certainty" that there will be no adverse harm (Ritter).

5.2.6 *What are the cost considerations in risk assessment? Should these be included?*

- CELA would not support a cost based analysis as part of a risk assessment procedure.

- Ritter inquired if the control of risk should be undertaken regardless of cost. CELA argued that a health based analysis should be done apart from cost considerations. Far too often the two are considered together so the health values get mixed with cost issues. The cost issue should not be mixed in at the higher conceptual level. OWWA/OMWA stated that Health Canada does take into account the cost of implementing guidelines when it sets its limits.

- Uncertainty is a substantial element of the challenges we face in risk assessment and standard setting. It is very helpful to draw a clear distinction between variability and true uncertainty (Hrudey). Variability is the true differences that exist in relevant parameters and ultimately in risk estimates that rely on those parameters. The true value of body mass for each individual in a group is an example of a variable quantity that could be measured. In contrast, true uncertainty is the ignorance of what the causal relationships between things are or what the true values of variables are. This is an important distinction because variability cannot be altered, while true uncertainty can be changed and reduced through research. Therefore, the risk management alternatives are a function of the proportion of variability and true uncertainty in the problem (Hrudey).

6. SETTING DRINKING WATER CRITERIA: PROCESSES AND PARTICIPATION

The discussions on public involvement will be focused on the explicit outcomes that are desirable from public involvement because the entire subject of public involvement in drinking water safety will be addressed in the June 5/6 meeting.

6.1 What processes should be followed for setting drinking water criteria?

6.1.1 *What are the types of errors in risk assessment and management?*

- In risk management, the challenge of making sensible judgements to ensure appropriate actions, when required and avoiding unnecessarily actions when not required. As a result of this challenge, there are two types of error:

  (1) False positive error: take action but not required which inevitably leads to inability to get action when required and because of systemic complacency;
  (2) False negative error: fail to take action when required due to an inaccurate interpretation of the problem.

The dilemma is that both errors have consequences and it is impossible to simultaneously eliminate both types of errors. A policy management challenge is to steer an appropriate middle course and there are limits to how precautionary we can be. The question that emerges from this analysis of errors is at what level were the poor judgements made and how do those influence the nature of errors? (Hrudey).

- Each case is specific so there is no implicit generality which can be attributed to the level of decision-making responsible for each circumstance. Decisions must make sense and be defensible, as errors could cost millions of dollars across Ontario, or through Health Canada regulations across the country, representing a waste (as in the sense of mis-direction) of available public health dollars (OWWA/OMWA).

- The decision making process should be transparent so that the public is able to understand the results and their costs as well as where the focus of regulatory and policy decisions resides (CELA). People should have faith in the numbers which guide decision making: explanations should be available and order of magnitude risks need to be explained (OWWA/OMWA).

6.2 What are the needs and role for: research to improve evidentiary foundations, explicit public and other stakeholder involvement in criteria-setting, academic participation and peer review and ongoing review and updating?

There was no consensus regarding any of the points of discussion which covered a range of issues:

- There is some difficulty in explaining risk due to interpretation of measurements and the huge number of variables. One of the problems is that chemicals are being assessed in

isolation; the real world risk is from a combination of exposures. There is a need for greater understanding and clarity about what is behind the numbers (CELA). Most estimates of levels of risk are based on limited evidence. There is a need to have technologies in place to measure risks and to provide data. (Prévost)

- There is concern regarding the role of different stakeholders in the process. Is the public being listened to? Does the government give more weight to industry opinion? Is one health benefit more important than another or is one industry concern more important than another? (CELA)

- In Ontario, the expert advisory committee process for environmental standards was disbanded. The MISA Advisory Committee is not still in operation (it was disbanded by the provincial government in 1996 at the same time as the Environmental Assessment Advisory Committee and the Advisory Committee on Environmental Standards). Perhaps it should be re-introduced (CELA). True engagement in the process (as opposed to simply attending meetings) as well as having the resources to be engaged are important considerations to public participation (Prévost).

- The Canadian Drinking Water Committee has members from the federal and provincial governments and provincial members are free to take information back to share with whomever they choose. (Hrudey) In Australia, there is a National Health and Medical Research Council working group which is chaired by a state employee and comprises a membership of water industry, health regulators, public interest groups and academics who are involved throughout the process, not just for just for consultation at the end of the process (Hrudey).

- MOE is currently in mid year of its work plan for Air Standards, for which the process includes assessments, a consultation schedule, posting of numbers and consultation on final numbers, management of times, risk when the standards can be achieved. It is reverting to a systematic process of taking smaller increments, to indicate that the standard is not open to interpretation. The numbers may be set ahead of technology in Ontario because the Ministry is aware of reasonable expectations through American technological expertise. Interim numbers are sometimes used to get to what is achievable. The original target does not disappear in this process (MOE). CELA supported this process for air quality standards management as a model for drinking water management.

- Confidence in the determination of a health risk is part of what drives the decision to invest in it, but there are other variables as well. Examples: Peru's reduction of chlorine to reduce cancer risk resulted in a cholera outbreak; Peel's decision to have tertiary treatment is based on aesthetics. Invariably, uncertainty is a big problem to challenges over the past few years.

7. OTHER CRITICAL ISSUES REGARDING OUR KNOWLEDGE FOUNDATIONS ON DRINKING WATER HEALTH RISK

There was no discussion on this agenda item. One related item of discussion was the need for research on a number of fronts.

The areas of research which need to be addressed:

- How *E coli* O157 gets from animal to animal and cross contamination from humans to animals (water is vector); potential role of cattle vaccination.
- The positive/negative aspects of liquid manure and opportunities to reduce impact (Goss)
- How extreme events contribute to water contamination; human decision failure risks and implications (Reilly, Hrudey)