3

Synthesis of Panel's Findings

The Capital Regional District (CRD) is responsible for the programs that manage liquid wastes in the Victoria area. To meet these responsibilities, the CRD developed the Core Area Liquid Waste Management Plan (LWMP), which was approved by the British Columbia Ministry of the Environment in March 2003 and is still in effect. The plan makes a number of specific commitments to protect human health and the environment against adverse effects associated with liquid wastes, including the following:

- Control contaminant inputs at their source, for example, photographic shops and dentist offices.
- Develop and conduct a wastewater and marine monitoring program to assess the environmental consequences of wastewater discharged into the Strait of Juan de Fuca.
- Manage and control inflow and infiltration of groundwater and/or surface water into the region's sewer system.
- Develop a stormwater quality management program to minimize stormwater-related detrimental effects to human health and the environment.[1]
- Develop an environmental action program to remediate and protect Victoria and Esquimalt Harbours.
- Ensure that trucked liquid wastes (non-domestic and septage liquid wastes) are handled and disposed of in an appropriate and responsible manner to protect human health and the environment.
- Eliminate overflows of wastewater to the environment.
- Treat and dispose of wastewater for areas served by the municipal collection systems.
- Treat and dispose of wastewater for areas not served by the municipal collection systems.

CRD faces similar issues to those being addressed in other urban coastal communities in Canada that are responsible for the development, administration, operation, and management of multiple liquid waste programs. CRD differs from most other coastal communities in North America in the level of wastewater treatment; virtually all other communities provide a minimum of primary treatment, while the CRD only "screens" its wastewater before it is discharged to the environment. Also, in a review of other coastal jurisdictions, only the CRD and the Greater Vancouver Regional District (GVRD) were identified as relying on an environmental trigger process as the basis for wastewater treatment decisions.

[1] Stormwaters are the flows that collect on surfaces (for example, roads, parking lots, and agricultural areas) and then go into ditches and drains leading to streams and marine waters

Liquid Waste Management Plan

The Core Area LWMP provides a comprehensive management program for addressing all aspects of liquid waste management in the CRD, and the Panel commends the CRD for the scope and magnitude of the plan. Results of the recent independent audit[2] indicate that the LWMP, for the most part, is being implemented successfully. The Panel encourages the CRD to implement the recommendations in that audit and to ensure that any future commitments are "SMART" (**S**pecific, **M**easurable, **A**chievable, **R**ealistic, and **T**ime-bound).

As part of the Panel's scope of work, we reviewed the effectiveness of the LWMP. One key finding is that, although adequate liquid waste management policies are formulated and described in the LWMP, the CRD lacks the authority to properly implement and/or enforce some of these policies. Any effective management plan not only must describe a program of action but also must award the necessary authority for its implementation.

The Panel offers these additional, specific comments regarding the LWMP:

- The Source Control Program is well developed and represents the current "state of the science". The CRD should continue to support and expand the program. However, the CRD should consider that such programs are effective only for targeted contaminants and will only reduce the amount of selected contaminants discharged to the environment, not totally eliminate them.
- Some areas of the CRD have high inflow and infiltration flows into the sewer system. Reducing these flows is an important component of total sewerage management.
- Like other jurisdictions, the CRD faces the common dilemma of how to assess, prioritize, and manage stormwaters because of their variability and potential for adverse environmental effects. Because stormwater discharges occur intermittently, the public health and environmental risks often are perceived as minimal. In fact, stormwater quality can be very poor; therefore, the risks to the public and to the environment may be much greater than expected. While the CRD is responsible for stormwater quality management, it lacks the authority to enforce stormwater bylaws.
- The decision-making process in the Core Area LWMP related to the need for wastewater treatment is highly dependent on the trigger process, which the Panel has reviewed in detail (see below). Fundamentally, the Panel is not of the view that the seafloor trigger process will function as designed.
- The CRD coordinates harbour environmental protection and improvement efforts with its partners, but it lacks the authority to enforce related LWMP commitments. Given the extent and magnitude of contamination in the harbours, and given their potential contribution to contaminant issues in the region, the CRD should focus additional attention on coordination efforts, ensuring that the stressors are managed in relative priority to the waterways they affect.
- Although the CRD operates a program to inventory and manage trucked liquid waste, it apparently lacks the authority to ensure proper disposal of that waste.
- With significant potential to contaminate land and near-shore environments and to expose humans to wastewater, sanitary and combined sewer overflows deserve particular attention from the CRD.

The Panel challenges the CRD to move forward and manage the LWMP within an overall design that respects the watershed and considers water to be an integrated resource within our ecosystems. The Panel recommends that the management of liquid wastes should em-

[2] The Panel's Terms of Reference required SETAC North America to identify and contract a third party to conduct a compliance review of the LWMP. The audit is Appendix C of the Panel's report.

phasize the relationships between the various components of the LWMP, particularly when it comes to coastal zone management.

CRD Environmental Monitoring Program

Since the late 1980s, the CRD has been monitoring the wastewater discharges, the surface waters, and the communities of seafloor-dwelling organisms in the vicinity of the Clover and Macaulay Point discharges. The marine monitoring program is comprehensive and is designed to evaluate the effects of sewage in the marine environment in and around the discharge points. The breadth and scope of the program is impressive, and the Panel commends the CRD for their intent to incorporate the best available science in the monitoring program. The existence of a voluntary, independent panel of experts, the Marine Monitoring Advisory Group (MMAG), as advisers to the CRD is an important strength of the program; the Panel encourages their continued involvement as well as adequate resourcing for the MMAG's function.

Fate and distribution

Approximately 130 megalitres of screened sewage are discharged daily from the combined outputs of Clover and Macaulay Points into the marine environment of the Strait of Juan de Fuca. The effluents contain a wide variety of chemical and microbiological constituents, are rich in nutrients, and have, at times, been shown to be toxic. Upon release at the outfalls, the constituents of the discharges disperse according to their physical and chemical properties and the prevailing environmental conditions of the Strait. There is no doubt that the effluents are rapidly diluted and transported away from the discharge location; however, we do not have a complete understanding of the fate and distribution of the effluents. There is conclusive chemical, microbiological, and observational evidence that, under certain environmental conditions, the diluted sewage plumes or their constituents reach the ocean's surface.

Human health concerns

A great deal of uncertainty surrounds the human health effects of sewage discharged by the CRD into the Strait, with respect to both bacterial contamination in water and chemical contamination in seafood. Anecdotal information suggests that few persons frequent the areas in and around the discharge points, and therefore, human exposure and its related risks are limited. Despite the uncertainty and the perceived infrequency of exposure, data indicate that when the diluted plume (and therefore bacteria) does come to the water's surface, persons exposed to the water are at increased risk for adverse health effects. This uncertainty about human health risk is due, in part, to the sampling regime and the choice of bacterial indicators. The Panel therefore recommends reducing the uncertainly by increasing the frequency of monitoring and by including *Enterococci* as a monitoring parameter. In addition, fish tissue monitoring and risk assessment is also recommended, particularly for chemicals with the potential to accumulate in animals and move up the food chain.

Environmental concerns

Overall, the CRD's program to evaluate the effects of sewage in marine environments is one of the more comprehensive programs being implemented anywhere in the world. Like many monitoring programs, it focuses on the seafloor. Documented impacts on seafloor organisms and communities are restricted to those areas immediately around the outfalls. Sediments and mussel tissues close to the outfalls reflect the burden of discharged chemicals, specifically:

1) At Macaulay Point, community diversity is reduced and pollution-tolerant invertebrates dominate the sediment-dwelling organisms.
2) At Clover Point, mussel tissue monitoring for chemical bioaccumulation shows that levels of a number of substances (for example, copper and lead) are elevated in

mussels at the outfall (and in some cases, at both the near-field and far-field stations), compared to the reference stations. In terms of chemicals with the potential to move up the food chain (for example, persistent chemicals that are not broken down in the environment and can get concentrated in animals), polychlorinated biphenyl (PCB) concentrations show a small increase near the outfall, where concentrations in mussel tissues were low, but they are nearly double the concentrations at the far-field stations. Polybrominated diphenyl ether (PBDE) concentrations have the widest footprint in mussels tissues around the outfall; levels at the outfall and at both near-field and far-field monitoring sites (out to 800 m) were elevated, compared to the reference station. Available ecological thresholds or screening-level risk assessments for these chemicals indicate that observed tissue concentrations are well below those shown to cause adverse effects. Although Victoria's contribution of persistent organic contaminants is undoubtedly minor, the concern about these contaminants is heightened in the local area because Orca whales in the Georgia Basin have been identified as among the most contaminated cetaceans in the world.

However, because the present monitoring program is highly focused on seafloor sediments, it overlooks some other key components of the marine ecological community. While the CRD's marine monitoring program is a comprehensive one, given the effluent is untreated and a higher degree of caution is merited, there are numerous gaps:

- direct toxicity of the effluent,
- effect of the effluent on water-column–dwelling organisms,
- effect on the surface micro-layer,
- monitoring of far-field effects,
- predictive capability for estimating fate and distribution of the plumes,
- sufficient reference sites to use for comparison (additional sites are needed with increased replication), and
- potential effects and risks of persistent organic contaminants through food chain transfer.

The CRD's analytical monitoring program includes a wide range of contaminants, but given the lack of significant sewage treatment, the Panel felt it prudent that the CRD's monitoring program be more inclusive than similar programs for other jurisdictions. The CRD has recently added high-resolution analyses of persistent organics such as PCBs and PBDEs; the Panel commends this approach and believes it should continue. The Panel noted that some of the "traditional" contaminants are missing from the monitoring program (for example, chlorinated pesticides), and their addition should be considered. Additionally, the Panel appreciates the CRD's initiative to monitor new "compounds of concern", such as pharmaceuticals and endocrine-disrupting compounds,[3] and urges them to include new compounds in the program as appropriate.

Seafloor Trigger process

A "triggering process" incorporated in the CRD monitoring program and the Core Area LWMP is intended to signal when unacceptable biological consequences occur in the sediments adjacent to the sewage outfalls and to indicate when wastewater treatment is necessary. Conceptually, the trigger process is based on sound marine sediment and environmental monitoring principles, and the data collected to date and their analyses have been consistent with these same sound scientific principles. However, the difficulties associated with designing and implementing a trigger process create considerable uncertainty about the program's potential effectiveness to protect the ecosystems near the CRD outfalls. As designed, the magnitude of environmental effects necessary to indicate the need for treatment and the time necessary to observe and confirm

[3] Substances that cause adverse biological effects by interfering with the endocrine system and disrupting the physiologic function of hormones

these environmental impacts seems lengthy. Further, the time specified to implement remedial actions as a result of observed adverse environmental effects is underestimated. Additional specific concerns the Panel identified in the triggering process are these:

- The Panel was concerned with the validity of the mussel length and weight-at-age endpoint as a sensitive and/or predictive (that is, time-responsive) tool.
- The Panel felt that the use of mussel reproductive development as an early indicator, as is currently done, is inappropriate because the results cannot be interpreted.
- The selection and location of the sites within the compliance zone do not appropriately account for the area influenced by the effluent plume. If the plume is not uniformly distributed, requiring 4 of 8 sites (100 m) in the compliance zone to exceed triggers may underestimate effects to the receiving environment.
- Reference sites must be added and replication must be increased in order to establish reliable reference conditions and to improve the interpretation of the monitoring results.

Future Concerns

What will happen in the future, with respect to population growth and emerging issues? Because of its desirability as a city, Victoria's population will no doubt increase substantially in the future. This increase will result in a concomitant increase in sewage load to the wastewater systems. Prudent planning that incorporates the most current and accurate population forecasts allows communities to prepare for future needs. For public utilities, conservative planning is considered the best approach. Due to the length of time required to plan, design, and implement essential public utilities, the future literally begins tomorrow.

The Panel does not view reducing selected contaminants through source control as a means to significantly lower the annual discharge of such chemicals in the long term. While some sources can be eliminated and the chemical concentrations can be reduced, the increase in flows containing reduced concentrations generated by new residents will likely carry nearly the same annual mass of these chemicals to the discharge sites. The Panel concludes that the environmental "footprint" of the wastewater discharges will increase proportionately with an increase in volume of discharged wastes. The location of the release and the overall quality of the wastewater will also affect the footprint. Source control efforts will help reduce inputs of certain contaminants, and these programs should continue to be supported and expanded. However, adequate control of all potentially toxic wastewater constituents via source control efforts is unlikely, and alternative approaches must be considered. Wastewater disposal inherently creates public health and environmental risks, and those risks increase with the generation and disposal of more wastewater resulting from urban growth, particularly when the wastewater is not treated.

Emerging contaminants

A wide variety of emerging contaminants (for example, endocrine-disrupting compounds) have been identified in municipal wastewaters; however, the importance of many of the newer substances from an environmental risk perspective remains unclear. These chemicals have varying physical, chemical, and toxicological properties, making it extremely difficult to characterize and/or generalize their fate, distribution, and effects in the environment, especially as complex mixtures. Many of the emerging chemicals will be difficult or impossible to control in the current CRD collection system if deemed necessary. The weight of evidence suggests that untreated effluents will result in estrogenic responses in exposed organisms.[4] Chemicals that bind to sediments will

[4] A biological response controlled through the estrogen receptor, for example, when male fish develop female characteristics such as egg development in male sex organs.

be bioavailable[5] to local species and also to marine ecosystems (through the food chain). The majority of emerging chemicals can be greatly reduced or removed from effluents with a combination of sewage treatment processes and oxidation techniques. Treatment of wastewater effluents reduces the risk of environmental impacts. However, treatment will produce sludges that must also be treated and managed.

To Treat or Not to Treat: A Risk Management Decision

How to handle the disposal of wastewater in the CRD now and in the future is a "risk management" decision that should involve inputs from a variety of disciplines. The Panel provides the CRD with scientific, technological, and engineering perspectives, but other important inputs include social and political considerations, economic concerns, and regulatory drivers (see Figure 3-1). The CRD Scientific and Technical Review Panel emphasizes that the Panel's advice must be viewed in the context of these other inputs.

The Panel expended considerable effort in addressing the "to treat or not to treat" question, as documented in this report. Scientific risk concerns, public values, and the prevailing regulatory climate argue for the CRD to improve the overall quality of its discharged wastewater. Relying on the dilution and natural dispersion processes of the Strait of Juan de Fuca is not a long-term answer to wastewater disposal, especially considering the growth predicted for the CRD and adjacent communities that also contribute contaminant loads to the Strait and to Puget Sound.

Improvements to wastewater effluents could be made using a variety of approaches that should include not only a continuation of existing programs (for example, source control) but also consideration of approaches not currently in effect, such as wastewater treatment. Our review of waste management and treatment technologies found a wide range of plausible options with a range of post-treatment wastewater qualities. Human and environmental health concerns should establish the minimum criteria for wastewater quality that would be considered acceptable. The Panel suggests that any decisions about liquid waste management should take into account the local watershed and its ecosystems. Specific efforts should be made to address the "responsibility" versus "authority" issues highlighted previously.

Information made available to the panel underlies the notion that the populace of the CRD, the province of British Columbia, and Canada support the concept of wastewater quality improvement in the CRD. In recent years, the CRD has taken significant steps toward controlling risks to human health and the environment in the Victoria area, and many of the programs implemented to date represent the state of the science. Future improvements in wastewater handling in the CRD no doubt will reflect this "cutting-edge" approach and will result in significant reductions in risk to human health and the biologically rich marine environment in the Strait of Juan de Fuca.

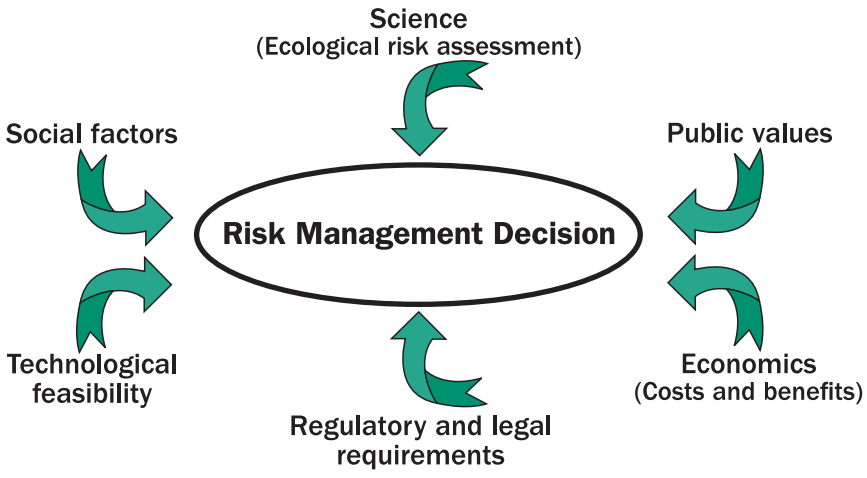

Figure 3-1: Inputs to risk management decisions (adapted with permission from Stahl et al. 2001, Risk Management: Ecological Risk-Based Management, ©SETAC)

[5] The degree to which a substance is absorbed or becomes available at the site of physiological activity after exposure; chemicals bind to environmental media in varying degrees or are present in different forms, thus altering their availability to organisms.