12.0 SUMMARY AND RECOMMENDATIONS

12.1 Introduction

This chapter provides a summary of the Independent External Review,a and presents recommendations for improving the Crane Mountain Landfill.

12.2 Summary of Review

The findings of the Independent External Review of Crane Mountain Landfill are summarized in the following table. Summary comments are provided for each specification of the review. The Request For Proposals called for highlighting real or potential areas of concern, if any, and proposals for remedial measures. These are included in the summary. Some comments indicate that a particular item "appears adequate". Such an assessment is based on the information available for the study, which may not have been complete.

Summary of Review

Specifications		Comments
Review of Approvals to Operate	*Assessment of the Fundy Region Solid Waste Commission's compliance with Approvals to Operate*	In general the FRSWC operates the landfill in compliance with the Approval, including design, monitoring and reporting. Amendments should be considered relative to leachate treatment and disposal. An air quality sampling station should be considered during construction activities. Improved analysis of monitoring data is recommended.
	Assessment of adequacy of the Approvals to Operate in providing protection for domestic wells and streams in "host community" down gradient of landfill.	The design of the landfill meets current Approval requirements. Improvements that lower the operating level of the leachate level within the landfill cells should be implemented to better protect the groundwater. A double liner system should be considered for future cells.
Review of Monitoring Wells Surrounding the Landfill	*Adequacy of location, design, and number of onsite monitoring wells, given the hydrogeological characteristics of the site.*	Adequate. Consideration to installing deeper bedrock wells should be given to assist in further addressing characterization of the flow system and fracture network. Improve management of the monitoring program in the context of down gradient domestic well users.

Specifications		Comments
	Analytical database of monitoring well data.	Adequate.
	Adequacy of background data with respect to scope and variability.	Adequate.
	Identification of analytical anomalies with particular attention to leachate indicator parameters.	Further work required. Trigger parameters and levels referenced in EMP should be defined. Site warrants more detailed level of interpretation and reporting in the context of location in upstream end of drainage basin with large number of domestic supply wells located downgradient of site.
	Adequacy of sampling and testing: quality control, frequency, and scope.	Adequate.
	Adequacy of analysis of data from testing.	Further work required. Trigger parameters and levels referenced in EMP should be defined. Site warrants more detailed level of interpretation and reporting in the context of location in upstream end of drainage basin with large number of domestic supply wells located downgradient of site.
	Adequacy of emergency response plans relative to findings in onsite monitoring wells.	General framework is adequate. More work should be completed in terms of practical implementation (e.g. trigger parameters and levels referenced in EMP require definition).
Review of Handling and Control of Leachate	*Effect of uncapped cells on leachate quantity and quality.*	The uncapped cells mean increased leachate generation rates. It is suggested that additional portions of Cells #1 and #2, and portions of Cell #3 receive final closure. A strategy of progressive closure should be implemented.
	Effect of raising height of cells on integrity of clay and synthetic liners.	Raising the height of the landfill does not appear to adversely affect the liner systems beyond their design capacity, particularly since there are no pipe penetrations through the liner.

Specifications		Comments
	Adequacy of material used for cell-capping.	The landfill cover system used to cap the sideslopes of Cells #1 and #2 appears to adhere to the Approval.
	Permeability/ advective breakthrough time of clay liner, under field conditions, relative to recorded heights of leachate in cells (based on studies of three sources of materials tested).	Appears adequate if typical municipal design head of 0.3 m is maintained. *Relative to recorded heights of leachate in cells, further clarification of documentation provided on breakthrough time is warranted.* Breakthrough time should be revisited in context of proposed ponding of leachate in cell, and the fact that existing data suggests during operation there have been prolonged periods wherein leachate head is higher than the 0.3 m typically used in landfill design.
	Effect on clay and synthetic liners of using cells as holding ponds.	It is recommended that the leachate levels be maintained at a lower level. It is suggested that leachate be automatically pumped to the Surge Pond and that a double liner system be used.
	Pre-treatment of leachate before disposal.	Since the Zenon treatment plant closed there is not pre-treatment of leachate prior to trucking it to the Lancaster treatment facility. The FRSWC is in negotiations with the City of Saint John to establish an agreement for the long-term discharge of leachate to the Lancaster Facility. An option that could be considered in conjunction with using the Surge Pond to lower leachate levels in the cells, would be to add aeration to the Surge Pond for pre-treatment.
	Assessment of interaction between groundwater and surface water.	The removal of water as leachate, out of the groundwater system is expected to have a nominal impact on the hydrology of the landfill watershed.
	Surge pond: Integrity of clay liner and synthetic liner, using projected depth of stored leachate.	The present operation of the Surge Pond involves only temporary use of the facility. Therefore the increased depth of leachate on the liner is not expected to cause a problem.
	Identification of chemical composition of leachate.	The leachate composition is regularly monitored and documented. Over time, the BOD concentration has dropped to very low levels for a landfill. In 2004 the average was 140 mg/L. This is partly due to the diversion of organics waste to the composting facility.

Specifications		Comments
	Adequacy of sampling and analysis of sampling of under-drain layer.	The underdrain sampling frequency seems adequate, but the analysis of the data is inadequate.
	Adequacy of emergency response plans relative to leachate control.	The leachate control emergency response plans appear adequate.
Review of Handling and Control of Onsite Surface Water	*Effectiveness of sedimentation ponds in treating and containing surface runoff during normal conditions.*	The available monitoring data indicates that under normal rainfall and operating conditions, the sedimentation ponds can effectively treat the surface runoff.
	Effectiveness of sedimentation ponds in treating and containing surface water during conditions of heavy or extended precipitation.	Under adverse conditions, the system may not be able to adequately treat the surface water. This occurred in Nov. 2004 during heavy rains, lack of flocculent and during construction projects. Improvements have been made to reduce the risk. It is recommended that a specific stormwater management plan be established for construction projects.
	Effectiveness of monitoring of surface water runoff.	The available data indicated a data gap in 2002. Monitoring should be completed in accordance with the schedule in the Approval, and the monitoring data should be analysed for trends in key leachate indicator parameters.
Review of Handling/Disposal of Hazardous Wastes	*Methods of identification and control of industrial and household hazardous wastes.*	Adequate monitoring of waste materials appears to be conducted on-site at the landfill active face and at the C&D site. It is recommended that a HHW drop-off facility be provided at the landfill to assist the public in separating hazardous wastes from municipal waste. It should be located beside the residential drop-off bin/ transfer station.
Review of Waste Diversion	*Methods used.*	Waste is diverted out of the engineered landfill cells through composting, recycling and the separate C&D debris disposal site. Additional waste is diverted privately through commercial paper recycling.

Specifications		Comments
	Rate of diversion.	The rate of diversion can be calculated several different ways. Using only the 2004 data from the landfill scale, the diversion including ICI material was about 25% and the residential diversion rate was about 36%. An on-site blue bin recycling depot is recommended.
Review of Daily Operations	*Daily cover.*	Appears adequate.
	Quality control of acceptable and unacceptable waste.	Monitoring of waste at the C&D site appears to be very good. It is more difficult at the landfill active face, so better opportunities for the public to sort their HHW would help to reduce unacceptable waste going to the landfill.
	Pest and bird control.	Appears adequate.
General Review of Monitoring/Control of Landfill Gas	*Effect of uncapped cells on landfill gas production.*	The uncapped cells allow more water into the landfill and therefore more gas production.
	Monitoring/control of concentration and migration of methane, carbon dioxide, non-methane organic compounds (NMOCs).	There is no landfill gas monitoring station. Without a cap the gases cannot be controlled.
	Monitoring/control of lateral migration of landfill gas.	Lateral gas migration is not a serious issue given the HDPE lined cells and that the cells are largely above grade.
	Monitoring/control of airborne particulate and odour.	Capping, gas collection and flaring or gas utilization is recommended to control odours and reduce greenhouse gas emissions.
Review of Issues Related to Domestic Wells	*Location of wells tested.*	Appears adequate, based on a 1997 plan. Should update and reevaluate.
	Number of wells tested.	Marginal. Well owners should be encouraged to continue to participate in monitoring program to provide as large a sample population as practical.
	Frequency of testing.	Increase to document seasonal conditions.
	Parameters tested.	Considered generally adequate, but should be reviewed in context of developing detailed EMP trigger parameters.

Specifications		Comments
	Adequacy of emergency response plans relative to domestic well contamination.	General framework is adequate. More work required in terms of practical implementation (e.g. trigger parameters and levels referenced in EMP require definition).
	Devise a system whereby results of domestic well tests can be managed.	Further work required.

Discussion of Landfill Issues

The design and operation of the landfill requires a coordinated approach consistent with the original design concept, such that the liner design is compatible with the operation of the leachate controls and the landfill closure philosophy.

The leachate system operation needs to consider the landfill liner design concept relative to the depth of leachate over the liner and the collection sump. The original objective was to keep the leachate levels as low as possible and therefore this approach should be maintained, which means the landfill cells should not be used for leachate storage.

The landfill should be capped according to the design assumptions of each cell. For example Cell #1 and #2 designs assumed that these cells would be capped shortly after reaching capacity. This has only been done on the sideslopes. Capping these two cells would reduce leachate production.

If the landfill cells are not going to be progressively closed as each cell is completed, then the design of the liner system for those cells should reflect that design approach. If the cells are going to left open for an extended period of time, resulting in higher leachate production levels and higher leachate levels over the liner, then consideration should be given to a double liner system.

The Cell #1 clay liner under the sump is 900 mm compared to 1300 mm under the Cell #3 sump. The rest of Cell #1 and Cell #2, which flows through Cell #1, have a 600 mm clay layer under the whole liner. The design of the cell's composite clay/geomembrane liner takes advantage of the high quality marine clay locally available. This is a key factor in the selection of the liner design.

The design of Cell #3 includes a thicker 1300 mm clay layer under the leachate collector sump, and a thickening of the liner's clay layer from 600 mm to 1000 mm at the lower east end of the landfill. This design improvement provides a higher quality barrier system. This would seem to reflect the operational concept of some leachate storage in the sump and lower portion of the landfill.

Given the difference in clay thicknesses, the leachate level within Cell #1 should be maintained as low as possible at all times. Given that the system is manually operated to pump into tanker trucks as they are available, there are potentially times when the leachate level periodically gets elevated and ponds in the lower portion of Cells #1 and #3. As a initial improvement, consideration could be given to automating the system so that the excess leachate is pumped directly to the Surge Pond for storage. In this case leachate levels will be at a higher level and therefore a double liner system for the pond should be considered. Also, an aeration system could be utilized to pre-treat the leachate if the BOD levels increase.

The long term solution, which the FRSWC is evaluating, is to construct a pump station and forcemain that would discharge at the Lancaster treatment plant. This would allow direct pumping of leachate without having to wait for tanker trucks, and therefore minimize leachate ponding over the liners.

The FRSWC plans to increase the finished landfill height from 90 m to 105 m. This concept should be coordinated and integrated with the design concepts and assumptions of each cell. It is noted that the final closure concept needs to be updated to reflect the Surge Pond being maintained as a permanent component of the landfill. The Surge Pond creates a significant cutout in the landfill footprint, which tends to isolate Cells #1 and #2 as well as Cell #3. Therefore those areas cannot be effectively raised to the 105 m level. Hence, these areas should be brought to final grade of 90 m for closure.

Overall, a clearly defined Design and Operations Plan should be developed that would provide clear direction for the design on each new cell, when to close completed cells, and how the leachate system would be operated for each cell.

12.3 Recommendations

Based on the findings of this review, recommendations have been developed. These relate to RFP Item 4.2, proposals for remedial measures, and Item 4.3, proposals for regular, ongoing monitoring/ review of the landfill. The recommendations are as follows:

Approval to Operate

1. That the FRSWC comply with all aspects of the Approval to Operate.

2. Apply for an amendment to the Approval to reflect the current leachate treatment and disposal strategy.

3. Establish an air quality sampling station during construction activities.

Groundwater Monitoring Wells

4. Install deeper bedrock monitoring wells and update hydrogeological characterization.

5. Define "trigger" parameters for groundwater monitoring samples.

6. Complete a detailed interpretation of the groundwater monitoring data.

7. Establish a monitoring database that includes analysis for data trends.

Leachate Management

8. Implement a strategy of progressive landfill closure.

9. Reduce the leachate level in the cells or consider double liner in future cells.

10. Consider automatically pumping leachate to the Surge Pond, upgrade the liner to a double liner and possibly pre-treat the leachate before discharge.

11. Complete a detailed analysis of the underdrain monitoring data.

Stormwater

12. Develop specific stormwater management plans for each phase of construction.

13. Complete a detailed analysis of the stormwater monitoring data.

Hazardous Waste

14. Establish a Household Hazardous Waste drop-off facility at the landfill.

Waste Diversion

15. Establish an on-site recycling facility at the landfill.

Landfill Gas

16. Install a landfill gas collection and flaring or utilization system to reduce odours and greenhouse gases.

Domestic Wells

17. Update the well location plan based on current participants, and reevaluate the number and location of wells.

18. Encourage homeowners to participate in the domestic well monitoring program.

19. Increase frequency of domestic well monitoring to document seasonal conditions.

20. Define "trigger" parameters for domestic well monitoring samples.

21. Complete a detailed interpretation of the domestic well data.

22. Establish a domestic well monitoring database that includes analysis for data trends.

Operations

23. Install an on-site rainfall monitoring gauge.

24. Prepare a Design and Operations Plan that defines the landfill development, closure and leachate management strategies.

Crane Mountain Enhancement, Inc.

25. The Crane Mountain Enhancement, Inc. continue to provide ongoing review of the landfill's monitoring programs to help ensure that adequate analysis is conducted of the monitoring data.
26. That Crane Mountain Enhancement, Inc. continue to work with the Fundy Region Solid Waste Commission to help improve the operation of the Crane Mountain Landfill.

These recommendations provide measures to improve the operation of the Crane Mountain Landfill, improve analysis of the monitoring data, and to suggest improvements to the planning and implementation of landfill development. The implementation of these recommendations should help to improve the protection of groundwater and surface water quality.