CSPW.19.021
Attachment #6

FINAL REPORT
EVALUATION OF LONG-TERM LEACHATE MANAGEMENT ALTERNATIVES

KINCARDINE WASTE MANAGEMENT CENTRE
KINCARDINE, ONTARIO

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1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) has prepared this report to evaluate long-term leachate management alternatives for the Kincardine Waste Management Centre (KWMC) formerly known as the Ward 2 Landfill, located in Kincardine, Ontario (Site). The evaluation is designed to provide both a technical and economic review of applicable long-term leachate management alternatives for the KWMC that will assist the Municipality of Kincardine (Municipality) in selecting the preferred long-term alternative. The evaluation also includes a review of forecasted leachate quality and leachate generation rates for the KWMC.

The three long-term leachate management alternatives evaluated include:

1. Trucking of leachate to the existing Kincardine waste water treatment plant (WWTP)
2. Construction of leachate forcemain to sanitary sewer (disposal at WWTP)
3. On-Site Treatment (disposal to on-Site stormwater pond)

A conceptual design was prepared for each management alternative. The conceptual designs were then evaluated based on technical, regulatory, environmental and economic considerations herein referred to as evaluation criteria.

2.0 BACKGROUND

The Municipality obtained the necessary approvals in 2011 for the updated design of the landfill at the KWMC. The updated design provides for seven landfill stages providing an approximate 40-year Site life at a forecasted fill rate of approximately 15,000 tonnes per year. The updated design is provided in the Design and Operation Report and Plans (2009 D&O Plan), (CRA, 2009).

The KWMC landfill also includes existing unlined trenches that previously comprised the original Ward 2 Landfill. The leachate generated in the original trenches is currently managed within the Site groundwater by natural attenuation. Based on the groundwater quality monitoring results to date, no collection or active management of the leachate is currently required for the original Ward 2 trenches.

The newly approved design includes six deep trenches (landfill cells) with a re-compacted clay layer on the base, clay lined side walls and leachate collection system. The leachate collection system includes clear stone french drains and perforated collector pipes on the base of the landfill, a collection sump and a leachate storage tank located adjacent to the Stage 1 cell. The Stage 1 cell is the lowest in elevation and all six landfill cells will drain to the sump located in Stage 1. Construction of the Stage 1 cell was completed in the first half of 2012 and began receiving waste on June 26, 2012.

In the interim, any leachate generated in the newly constructed Stage 1 cell will be conveyed to an on-Site leachate storage tank via a dedicated submersible leachate pump. The leachate will then be loaded and trucked by a licensed liquid waste hauler to the Kincardine WWTP for treatment. The WWTP discharges treated effluent directly to Lake Huron via two facultative lagoons in accordance with its Certificate of Approval issued under the Ontario Water Resources Act. CRA understands that the disposal of the KWMC leachate at the Kincardine WWTP has been approved by the Ministry of the Environment (MOE). The Amended Certificate of Approval, dated April 8, 2011, allows for a maximum of 33 cubic metres per day of leachate from the KWMC to be discharged to the WWTP.

There are currently no Bylaw criteria for discharging to the Kincardine WWTP or to the Municipality's sanitary sewer system. As a good practice the Ontario Model Sewer Use By-Law should be referenced as an indication of suitable levels of key parameters should the raw leachate be discharge to the sanitary sewer upstream of the WWTP.

For the purpose of this evaluation, CRA has assumed that leachate will be trucked to the Kincardine WWTP as an interim measure for a period of 5 years commencing from

September 2012 to allow for a preferred long-term leachate management alternative to be identified and implemented by the Municipality.

3.0 CURRENT CONDITIONS

A review of leachate generation and collection rates and forecasted leachate quality was completed for the KWMC in order to develop concept designs for the selected long-term leachate management alternatives. Leachate generation rates are provided in the 2009 D&O Plan.

3.1 LEACHATE QUALITY

Leachate quality at the KWMC is anticipated to be similar to that encountered at the Ward 1 landfill because the facilities serve similar waste generation and collection areas. Thus leachate quality from the leachate collection system at the Ward 1 landfill is expected to be representative of the near future leachate quality at the KWMC.

Analytical results from samples collected from the Ward 1 leachate collection system between 2005 and 2011 were used to calculate the average parameter concentrations in the leachate. The results are provided in Table 3. These results were used as a design basis when developing conceptual designs for the three long-term leachate management alternatives.

3.2 TREATMENT OBJECTIVES

The leachate treatment objective depends on the long-term treatment alternative being considered. Alternatives 1 and 2, trucking and forcemain, include ultimate treatment of the leachate at the WWTP. The effluent criteria established for the WWTP is stipulated in the Certificate of Approval for the operation of the WWTP with discharge to Lake Huron.

Alternative 3 includes full on-Site leachate treatment and therefore must meet Provincial Water Quality Objective (PWQO) criteria to discharge directly to the on-Site stormwater pond that provides controlled discharge to the on-Site wetland with eventual discharge to the Penetangore River.

3.3 LEACHATE GENERATION

As described in Section 2.0, leachate is currently generated in both the original Ward 2 trenches and the newly constructed Stage 1 cell. Environmental monitoring results for

the groundwater quality to date indicate that no collection or active management of the leachate is required for the Ward 2 trenches.

As part of the 2009 D&O Plan developed for the KWMC, CRA calculated forecasted leachate generation rates for the 40-year life of the landfill. The generation of leachate is dependent on a number of factors including the amount of precipitation, the active disposal area, the cover soil characteristics, side and top slopes, and the various stages and durations of landfill development (areas of new cells, areas of exposed refuse, areas completed with final cover, etc.). Such factors were considered when evaluating the leachate generation rates for each landfill stage to be constructed at the Site.

The leachate generation rate for the Site was estimated based on infiltration rates projected by the Hydrologic Evaluation of Landfill Performance (HELP) model. The HELP model is a basic landfill design tool commonly used to estimate the amount of water entering a landfill through a cover.

Though leachate is generated in the original Ward 2 trenches no collection system is in place. Therefore two rates were calculated in the D&O Report, a generation rate and a collection rate. The generation rate includes leachate generated in both the original Ward 2 trenches and the Stage 1 to Stage 6 landfill cells. The collection rate assumes that none of the leachate generated in original Ward 2 trenches is collected and that all leachate generated in Stage 1 to Stage 6 cells is collected. The forecasted leachate generation and collection rates for the KWMC are provided in Table 2.

3.4 REQUIRED TREATMENT CAPACITY

Based on the results of the forecasted leachate collection, an average collection rate of 18 m^3/day was calculated for over the 40-year life of the landfill with a peak collection rate of 33 m^3/day. For the purpose of this evaluation, a 20 m^3/treatment capacity is proposed because this capacity allows all collected leachate to be managed throughout the active and post-closure Site life. The 20 m^3/day provides a reasonable design rate for assessing the leachate management alternatives and will not result in over designing and inflated costs of the long term management of the KWMC leachate. During years in which leachate generation exceeds treatment capacity (Stage 6), leachate will be temporarily stored within the base of the landfill and then be treated once treatment capacity of the preferred management alternative exceeds generation in post-closure phase of the landfill. The temporary storage of leachate in the base of the landfill is acceptable due to the thickness of the silt and clay beneath the landfill and the travel for any leachate to break through to the underlying aquifer (100 years). The forecasted

daily leachate collection rates, treatment capacity and cumulative storage volume for the life of the landfill are shown in Figure 1.

From Figure 1, approximately 25,000 m^3 would be stored within the landfill during Stage 6. This volume can be easily stored within the landfill on a temporary basis, because the storage capacity within the landfill in Stage 6 is estimated to be greater than 100,000 m^3. The leachate storage capacity of the landfill also allows leachate to be stored on a seasonal basis as may be required by winter road conditions or summer-time WWTP discharge restrictions.

The leachate storage capacity within the landfill is discussed further in the following Section.

3.5 LEACHATE STORAGE CAPACITY IN LANDFILL

The waste mass in the landfill can be used to temporarily store leachate when leachate generation exceeds treatment capacity. This temporary storage capacity increases as the landfill is developed. In early development stages, storage capacity is limited because the leachate level must be maintained below the native clay and silt elevation of the interim unlined north wall to prevent the migration of leachate outside of the landfill cell. The native clay and silt layer does not extend the length of the north sidewall at a uniform elevation and several troughs/low points in the top of the silt and clay were encountered during the Stage 1 cell construction.

The lowest trough was observed in the northeast corner of the Stage 1 cell at an elevation of 249.97 metres above mean sea level (m AMSL) however additional silt and clay material was compacted in this trough during construction to prevent groundwater from seeping into the cell. The next lowest trough present in the silt and clay layer is located in the western half of the north sidewall at an elevation of 250.97 m AMSL. Based on the cell floor elevation of 248 m AMSL, the Stage 1 landfill cell is currently capable of storing 2.97 m of leachate.

During Cell 6 construction, the unlined north wall of the Stage 5 cell will be removed and a final north side wall will be constructed complete with a compacted clay liner. This will significantly increase the leachate storage capacity of the landfill by allowing leachate to be stored to an elevation of approximately 260 m AMSL.

Using the approved design and the inferred clay and silt till elevations provided in the D&O Report, the estimated leachate storage capacity was calculated for each landfill cell.

As Stage 7 of landfilling involves landfilling over the original Ward 2 trenches to final contours and does not include the construction of a new cell, there is no increase in the leachate storage capacity associated with Stage 7. The table below summarizes the estimated storage capacity of the landfill at each stage of construction.

Cells Constructed	1	2	3	4	5	6
Leachate Storage Capacity (m^3)	3,000	8,000	11,500	15,500	18,500	100,000

Note: Waste porosity was assumed to be 0.3

Figure 1 provides a comparison of annual forecasted leachate collection volumes and available landfill storage capacities. As demonstrated by Figure 1, the storage capacity within the landfill is adequate for leachate storage should seasonal operation be required.

3.6 KINCARDINE WWTP CAPACITY

The capacity of the Kincardine WWTP must be considered when developing alternatives that include discharge of the leachate to the Kincardine WWTP (Alt 1 – Trucking & Alt 2 - Forcemain).

The Kincardine WWTP is located at the intersection of Bruce Avenue and Mahood-Johnston Drive and discharges to Lake Huron. The Kincardine WWTP consists of an aerated lagoon with alum addition, two stabilization ponds, and a newly installed ultraviolet disinfection system and has both treatment volume and effluent quality permit criteria. With respect to treatment volume, CRA understands that discharge of KWMC will not be a concern because seasonal peak flows only reach 80 percent of the 5,910 m^3/day permitted capacity during precipitation events.

Although treatment volume is not a concern, CRA understands the treatment capacity of the WWTP is a concern because the WWTP struggles to maintain target dissolved oxygen (DO) concentrations in summer months even when operating the aeration system at maximum capacity. Because the WWTP is operating near capacity rather than over capacity, the WWTP produces an effluent that consistently meets discharge criteria. Average WWTP influent and effluent quality data collected in 2011 is presented on Table 3.

In order to maintain adequate DO concentrations and consistently meet discharge criteria, the operators occasionally suspend the discharge and treatment of Ward 1 leachate during the summer. This helps to maintain adequate DO concentrations and meet discharge criteria because leachate contains metals, biodegradable organics and ammonia that consume DO during treatment. It is likely the discharge of leachate from the KWMC will also be suspended from time to time.

In the fall, winter and spring the WWTP is able to maintain adequate DO concentrations and meet discharge criteria without running the aeration system at full capacity even when treating Ward 1 leachate. Considering this, the WWTP has capacity to treat additional leachate during the fall, winter and spring while maintaining adequate DO concentrations and meeting discharge criteria. Additional leachate from the KWMC cannot be treated during the summer because the WWTP is currently operating near its treatment capacity. The WWTP effluent quality and sludge quality should be closely monitored through regular sampling for discharge criteria parameters and leachate parameters of potential concern.

Further to the above, it is understood that the direct discharge of leachate into the aerated lagoon will be of potential concern due to shocking of the biological process in and DO levels in the aerated lagoon. On this basis, for the purposes of evaluating the leachate management alternatives, it is proposed to construct a leachate holding tank adjacent to the Ward 1 Landfill leachate Pump Station No. 2 and allow both the Ward 1 and the KWMC leachate to be introduced into the WWTP on a controlled basis.

CRA understands that the WWTP does not currently impose a discharge fee for the Ward 1 landfill or the KWMC for disposing leachate at the WWTP. Although there is no direct charge, there is a real cost related to treatment of leachate at the WWTP because leachate consumes DO during treatment which requires the WWTP to increase aeration. The increased treatment consumes additional power, generates additional sludge and increases the metals concentration in the sludge. As such, CRA has included a cost to dispose of the KWMC leachate at the WWTP based on experience with other Ontario Municipalities in the Cost Assessment presented in Section 5.

4.0 DESCRIPTION OF LEACHATE MANAGEMENT ALTERNATIVES

The following three long-term leachate treatment alternatives were considered for the KWMC. Each alternative has been developed based on the treatment objectives and required treatment capacity described in Sections 3.2 and 3.4, respectively.

Alternative No.	*Description*
1	Trucking to the Kincardine WWTP
2	Construction of a pump station and forcemain to the existing municipal sanitary sewer
3	On-Site treatment

A detailed description of each treatment alternative is provided below.

4.1 ALTERNATIVE 1 – TRUCKING LEACHATE TO THE KINCARDINE WWTP

This alternative includes direct hauling of leachate from the KWMC to the Kincardine WWTP and is the long-term extension of the current interim leachate management measure. Existing Site infrastructure currently available for leachate haulage trucks includes the landfill access road, gravel loading pad, and a 27,000 litre (L) concrete leachate storage tank installed below grade, adjacent to the Stage 1 cell. Leachate haulage trucks pump leachate from the storage tank via an aluminum quick-connect pipe fitting on the storage tank's concrete riser. The leachate storage tank is filled by an automated leachate pumping system that draws from a sump constructed on the landfill base at the southwest corner of the Stage 1 cell.

As described in Section 3.5, the landfill can be temporarily used to store leachate if trucking cannot be completed due to unsafe road conditions during the winter months or during summer months when the WWTP is at its treatment capacity. Based on the estimated leachate storage capacity and collection rates, the landfill can store leachate for a period 5 to 6 months each year.

The round trip haulage distance to the Kincardine WWTP is approximately 26 km. It is assumed that for a 12 m^3 (3000 gallons) truck, three trips will be required per day for 6 months each year on average (Fall and Spring). As leachate cannot be directly discharged to the WWTP to minimize the potential for shocking the biological treatment process in the aeration lagoon, a leachate unloading system and storage tank will need to be established to allow for the controlled introduction of leachate into the WWTP

process. The WWTP Certificate of Approval allows for a maximum discharge rate of 33 cubic metres per day of leachate from the KWMC.

4.2 ALTERNATIVE 2 - CONSTRUCTION OF A PUMP STATION AND LEACHATE FORCEMAIN TO THE KINCARDINE WWTP

This alternative includes construction of a wastewater pump station at the KWMC, implementation of odour control, and installation of a pipeline to convey leachate to the Municipality's sanitary sewer system and subsequently to the Kincardine WWTP.

Potential pipeline routes are provided below:

Number	*Route*	*Distance (km)*
1	West on Concession 5, south on Highway 21	9.1
2	South on Sideroad 15, west on North Line, South on Highway 21	9.1
3	South on Sideroad 15, west on Highway 9	9.6
4	South on Sideroad 15, west on North Line, South on Sideroad 10, West on Highway 9	9.6

Route numbers 1 and 2 would connect to the sanitary sewer on Sutton Street and route numbers 3 and 4 would connect to the sanitary sewer on Durham Street.

Based on a review of the proposed routes with respect to ease of construction, route number 4 was selected as the most technically feasible. Route 4 bypasses deep ravines associated with the Penetangore River crossings on Concession 5 and North Line (west of Sideroad 10), which would present significant increased costs due environmental protection measures and regulatory approvals required for river crossings. The selected route is 9.6 km long and will involve crossing a two-lane road four times and crossing one creek west of Millarton. The proposed pipeline route is provided on Figure 2.

Pumping directly to the sanitary sewer may require the addition of odour control measures and may eventually cause deterioration to the sewer system entry point over time due to the undiluted leachate quality. Sewer system maintenance and/or leachate

pre-treatment may be required in the future to bring the leachate parameter concentrations in line with those provided in the MOE's model sewer use by-law. As leachate can only be discharged to the WWTP in the Fall, Winter and Spring when there is excess capacity available to treat the leachate, the forcemain would only be required to be operated for a 6-month period each year and can discharge during low flow periods (i.e., midnight to 6:00 am) not to exceed the 33 m^3/day Certificate of Approval limit.

4.3 ALTERNATIVE 3 - ON-SITE TREATMENT

This alternative includes the construction of a full-scale treatment facility at the KWMC that would discharge directly to the on-Site stormwater management pond which drains to the on-Site wetland and then to the Penetangore River. The treatment facility effluent would be required to meet the PWQOs prior to discharge to the stormwater management pond. The following on-Site treatment facility concept design was developed based on the forecasted leachate quality, treatment objectives and collection rates provided in Section 3.1 to 3.3, respectively. The on-Site treatment facility would be constructed immediately west of the on-Site stormwater management pond and would utilize the existing power line and leachate pumps for providing influent into facility.

The proposed technology for the on-Site treatment facility is biological nutrient removal (BNR) to provide ammonia/nitrogen and phosphorous removal. BNR is a proven biological treatment process that uses an unaerated (anoxic) treatment tank and an aerated treatment tank (oxic) to convert ammonia to nitrate and then nitrogen gas which is released into the atmosphere.

In addition to nutrient removal, a BNR system will reduce trace metals by uptake in the biomass and reduce volatile organics concentrations through metabolism and volatilization. Based on a review of the Ward 1 Landfill leachate data presented in Table 1, a BNR based system is expected to be able to meet PWQOs for ammonia and volatile organics; however, additional treatment in the form of filtration may be required to reduce metals concentrations below the PWQO. Bench scale testing or pilot testing should be completed with Site specific leachate to confirm the treatment efficiency of a BNR system and to determine if additional treatment is required to meet PWQOs. It is noted however that the on-Site treatment system would discharge to the on-Site stormwater pond which in turn discharges to the on-Site wetland prior to reaching the Penetangore River. As such, the potential need for additional treatment or polishing is minimized as this would be provided by the existing wetland throughout the spring, summer and fall. Utilizing the on-Site wetland for polishing may result in the seasonal operation of the treatment plant (April – November).

If however any additional treatment is required to meet PWQO, an ultra-filtration or reverse osmosis system would provide a very reliable way to meet discharge criteria. A reverse osmosis system is a permeable membrane that only allows clean water to pass through it. This permeable membrane allows the clean water to be separated from the contaminated water. The clean water is discharged to the receiving body and the contaminated water is recirculated to the landfill.

In either case, with or without ultra-filtration/reverse osmosis polishing, on-Site treatment will provide a very high level of treatment and is capable of treating peaks in leachate generation and collection rates. In addition, on-Site treatment has been proven to be an effective leachate management measure at a number of landfills in Ontario.

5.0 COST EVALUATION

A summary of the cost evaluation is presented in Table 4. The cost summary shows a cost range for the three alternatives of $5.9 M to $8.4 M. The cost evaluation shows construction and maintenance of a forcemain has a higher cost than both trucking and on-Site treatment due to the upfront capital cost.

The source data used to develop the cost evaluation presented in Table 4 are presented in Appendix A. The source data includes:

- Summary of cost evaluation inputs (inflation rate, discount rate per Stats Canada 2012, etc.)
- Capital cost estimates based on CRA experience with current projects
- Operating cost estimates based on industry standards and data from other Ontario landfills
- Leachate haulage costs for the interim haulage of leachate based on recent quotes
- NPV calculations

It should be noted that there is uncertainty in the cost estimates for off-Site disposal, especially for the long term trucking alternatives. The uncertainty in the off-Site disposal cost estimate arises from uncertainty in the disposal cost of leachate at the WWTP and the long term cost of fuel. The cost to the municipality to dispose leachate could be very low, if excess treatment capacity is available for leachate disposal at the WWTP. However, the cost could be much higher if treatment of the leachate triggers operational changes or capital upgrades to the WWTP. For the purposes of this cost evaluation, the leachate disposal cost from other Ontario municipalities of five dollars per cubic meter was used. The trucking alternative includes the uncertainty for disposal costs in addition to uncertainty related to volatility in fuel prices.

Considering the 40-year Site life commenced in 2012, a 35-year net present value calculation commencing in 2018 was used to evaluate the cost of each alternative. A 35-year period was used because it is assumed that a 5-year period will be required to fund, design, obtain approvals, construct and commission a leachate forcemain or on-Site treatment system. During the 2012 to 2018 period, the interim trucking of leachate to the Kincardine WWTP will be common for all alternatives and thus was not included in the comparison of alternatives.

Operation and maintenance costs including, labour, equipment, power consumption etc. were considered for each cost assessment. Inflation and discount rates were applied appropriately to assess the costs of each alternative in terms of 2012 dollars.

It is noted that leachate will be required to be managed for a minimum period of approximately 25 years post-closure, but was not included in this assessment.

6.0 REGULATORY APPROVALS

The evaluation of the leachate management alternatives considers the feasibility and cost of obtaining regulatory approvals for each alternative.

For Alternative 1, trucking to the WWTP, an amendment to the existing Ward 1 Landfill Section 53 OWRA Certificate of Approval would be required to construct and operate a truck unloading facility and holding tank adjacent to the Ward 1 Leachate Pump Station No. 2. No other approvals would be required for Alternative 1. As such, only review by the Ontario Ministry of the Environment (MOE) would be required. Considering this, the regulatory approvals for Alternative 1 are considered easily obtained and low cost.

For Alternative 2, pump station and forcemain, a Class Environmental Assessment (Class EA) with public consultation would be required as well as an amendment to both the EPA and OWRA Certificates of Approval for the KWMC. The Class EA would review the alternative routes in detail and would also potentially involve a comparison of the forcemain to the other alternatives. An approval from the Ministry of Transport would be required for routing the forcemain along one of the provincial highway right of ways (Highway 9 and/or Highway 21). The approvals for Alternative 2 would be considered more onerous to obtain and be at a higher cost than those for Alternatives 1 and 3. Commenting/approval agencies include the Ministry of Transport, the Saugeen Valley Conservation Authority (SVCA) and the MOE.

For Alternative 3, construction and operation of an on-Site leachate treatment facility would require approval under Section 53 of the Ontario Water Resources Act and the Conservation Authority Regulation 169/06. The Ontario MOE has approved numerous on-site leachate treatment facilities in the past including the design utilized here-in for evaluation of the alternatives. Although this approval is feasible to obtain, it would be at a higher cost than that for Alternative 1 due to the technical complexity. Approval agencies include the SVCA and the MOE.

7.0 COMPARISON OF ALTERNATIVES

Four primary criteria are used to describe the study of specific engineering, environmental, and social concerns. Within each of the primary criteria there are a number of sub criteria that are used to quantify merits or detractions of the alternatives. The four primary criteria with sub-criteria contained in brackets used in this evaluation of alternatives are as follows:

- *Environmental Impacts* (terrestrial vegetation and wildlife habitat, surface water resources, air quality, visual aesthetics, noise, and vibration and energy conservation.)
- *Technology Reliability* (proven technology, level of treatment, ability to meet changes in waste stream quantity and quality characteristics and trucking accidents and disruptions)
- *Logistics* (access to infrastructure, regulatory requirements, land acquisition or new land use and implementation time)
- *Economics* (construction, operation, maintenance, repair on both an initial up front capital cost and a long term present value basis)

The selection of the sub criteria is important to the decision-making process since these sub criteria describe the potential differences between the alternatives. The sub-criteria are further described in Table 5.

Table 6 provides a comparison of the three alternatives with respect to the sub criteria described in Table 5. Table 6 establishes a score for each alternative on a comparative basis only. The score for each alternative assists with the overall evaluation by indicating in general which alternative is "superior" relative to the sub-criteria. It is noted however the criteria are not weighted and therefore further evaluation considering the importance of each sub-criteria (weighting) can be carried out to complete a more detailed evaluation.

8.0 EVALUATION OF ALTERNATIVES

Based on the cost evaluation presented in Section 5 and the comparison of alternatives presented in Section 7, CRA provides the following evaluation and recommends on-Site treatment as the preferred long-term leachate management alternative based on the results of this evaluation.

Alternative 1 – Trucking to the WWTP

Alternative 1 is simply an extension of the current interim leachate management measure. As shown on Table 6, the trucking alternative has the lowest rating with respect to Environmental Impacts on a relative basis due to the continual operation of a liquid waste haulage vehicle through the rural country side. The evaluation notes the impacts resulting from on terrestrial vegetation, air quality and noise and vibration to the properties located along the haul route. In addition, it is noted that Alternative 1, removes on average 18 cubic metres of water per day from the watershed that would normally eventually discharge to the Penetangore River.

Alternative 1 also has the lowest rating for technology reliability due to a lower level of treatment provided by the WWTP as compared to an on-Site leachate treatment facility Alternative 1 also has a lower flexibility with changes in leachate volumes and leachate strengths. It is noted that although the WWTP will provide treatment, it was not designed with the treatment of leachate in mind. Finally, Alternative 1 consumes significantly more energy due to operation of the haulage vehicle as compared to the other technologies.

Alternative 1 is however the highest rating alternative with respect to logistics. The implementation time for Alternative 1 is the shortest of all alternatives with minimal infrastructure modifications.

Alternative 1 also is preferred with respect to initial capital costs to complete the implementation and as a result has the highest rating for economics. It is noted, however, that a significant cost uncertainty is inherent to Alternative 1 due to the long-term cost of fuel which has not been accounted for in neither the cost analysis nor the ratings.

Alternative 2 – Pipeline to Sewer

Alternative 2, involving the construction of a pump station and pipeline has a higher rating than Alternative 1 for Environmental Impacts but less than Alternative 3 due to the significant construction required along the rural right of ways and Provincial

Highway(s). Alternative 2 also removes surface water from the watershed and has the potential to create a nuisance odour at the point of discharge to the sewer.

Alternative 2 is technically reliable with a higher rating the Alternative 1 as it does not rely on trucking and eliminates the risk of trucking accidents and disruptions but Alternative 2 still utilizes the WWTP for ultimate treatment of the leachate resulting in a lower rating than Alternative 3 under technology reliability.

Alternative 2 has the lowest rating for logistics due to the regulatory approval requirements and implementation time involving a Class EA and Ministry of Transport approvals.

Alternative 2 also has the lowest rating under economics due to the large up front capital costs. It is noted, however, that once constructed Alternative 2 has a significantly lower annual operation and maintenance cost.

Alternative 3 – On-Site Treatment

Alternative 3 has the highest overall comparative rating. Alternative 3 leaves the surface water in the water shed and has minimal effects on the vegetation and wildlife due to its location within the landfill buffer zone. Alternative 3 also has much lower energy consumption relative to Alternative 1 and is similar to Alternative 2.

Alternative 3 will provide the highest level of treatment for the leachate and will have a superior ability to accommodate changes in leachate quantities and quality. Alternative 3 also eliminates the risk of trucking accidents and weather disruptions.

Alternative 3 is implementable and approvable but will take a longer period of time than Alternative 1 due to its technical complexity. Alternative 3 will require operation by a licensed treatment plant operator. Alternative 3 does not however require access or modification to any of the existing municipal infrastructure.

Alternative 3 has a higher up-front implementation cost than Alternative 1 but much lower than Alternative 2.

Recommendation

Alternative 3, on-Site treatment is recommended because it has lower long-term cost to trucking but offers clear advantages to trucking with respect to:

- Certainty in long-term costs

- Higher level of treatment
- Reduced carbon footprint
- Reduced chance of leachate spills
- Improved safety by eliminating the requirement for trucking (especially during winter operations)
- Reduced load to municipal WWTP which is already at capacity during the summer season

Trucking is however more implementable with significantly lower upfront implementation costs but comes with the long term inherent risk of escalating fuel costs and trucking accidents /disruptions. A forcemain is not recommended due to the high capital costs and potential concerns with obtaining the required regulatory approvals.

9.0 REFERENCES

Conestoga-Rovers & Associates, December 2009, Design and Operations Report.

All of Which is Respectfully Submitted,

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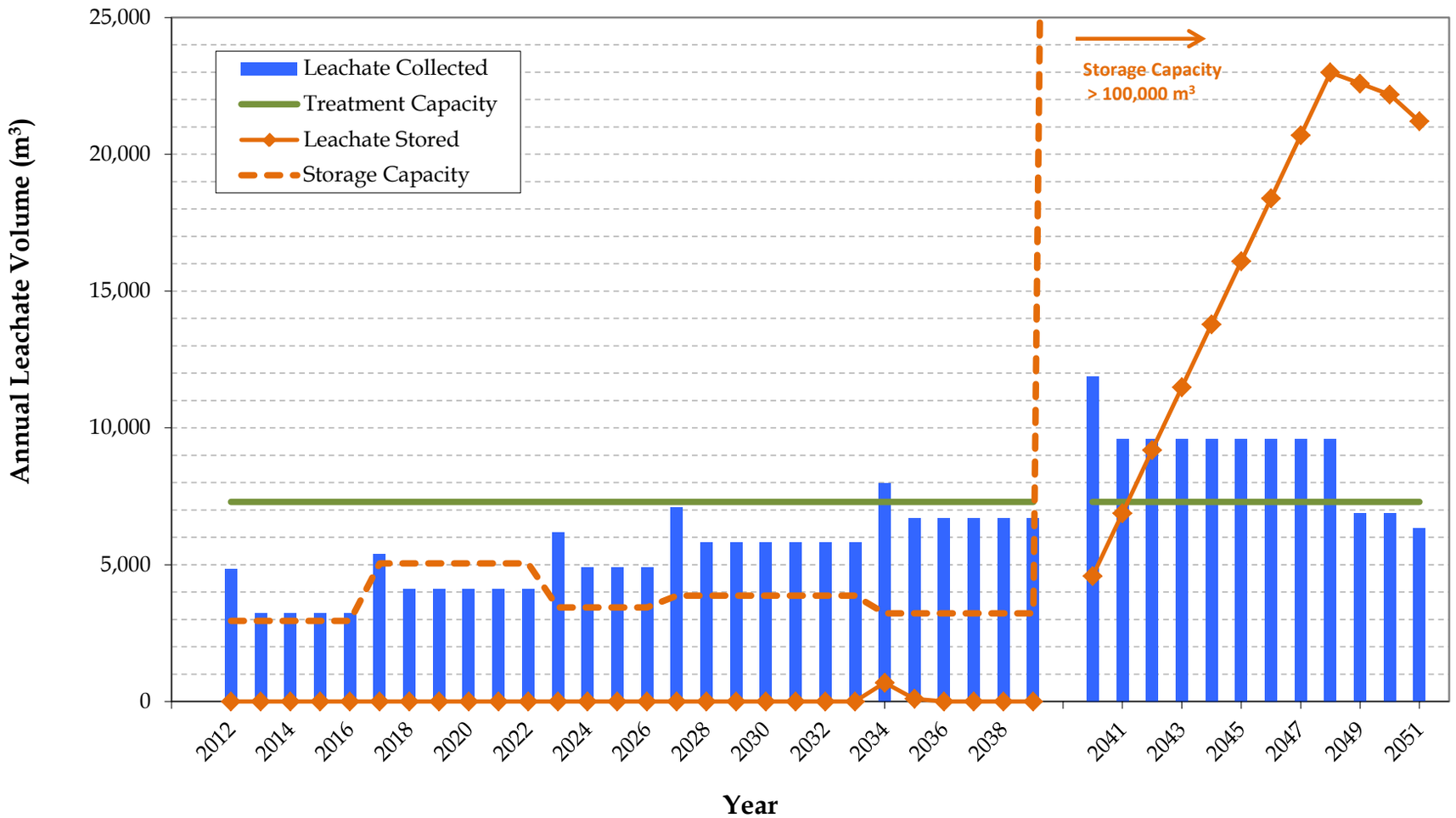
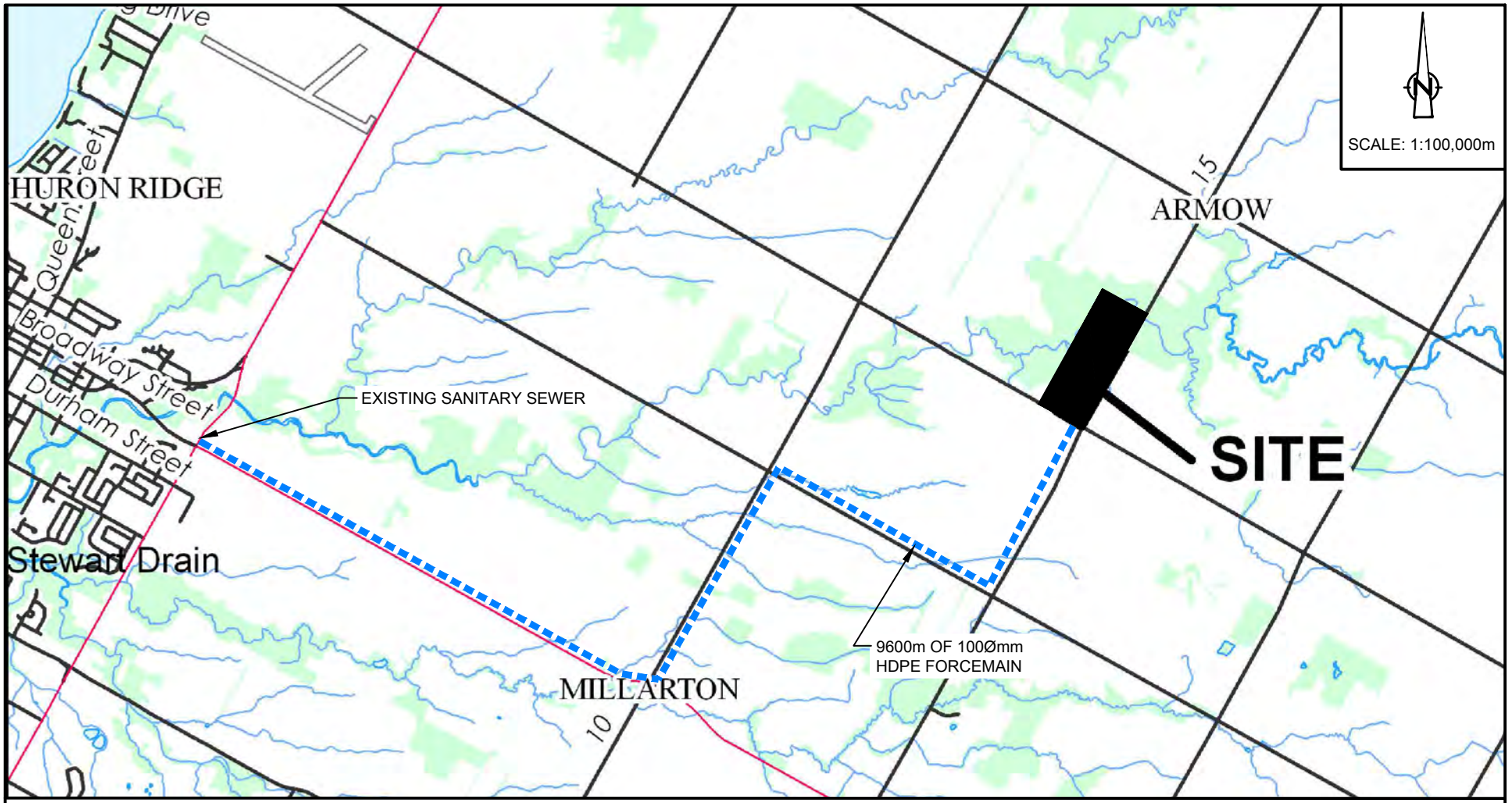


figure 1
LEACHATE COLLECTION, TREATMENT AND STORAGE VOLUMES
LEACHATE MANAGEMENT PLAN
Kincardine Waste Management Centre



SOURCE: MNR NRVIS, 2008. Produced by CRA under license from Ontario Ministry of Natural© Resources, Queens Printer 2008 Datum: NAD 83 Projection: UTM Zone 17

figure 2

PROPOSED LEACHATE FORCEMAIN ROUTE
LEACHATE MANAGEMENT PLAN
KINCARDINE WASTE MANAGEMENT CENTRE
Kincardine, Ontario

04074-77(072)GN-WA001 AUG 7/2012

TABLE 1

HISTORICAL LEACHATE QUALITY
WARD 1 LANDFILL
KINCARDINE, ONTARIO

Parameter	*Units*	*PWQO*	*Historical Min*	*Historical Max*	*Historical Average*	*Number of Samples*	*Number of Detections*	*Number of Exceedances*
General Chemistry								
Alkalinity, total (as CaCO3)	mg/L	-	2	3150	1726	18	18	-
Ammonia-N	mg/L	1.67 (1)	**28.7**	**162**	**89.7**	15	15	15
Biochemical oxygen demand (BOD)	mg/L	-	12	2990	612	19	18	-
Chemical oxygen demand (COD)	mg/L	-	67	7800	1250	19	19	-
Chloride	mg/L	-	44	650	352	19	19	-
Dissolved organic carbon (DOC)	mg/L	-	18.9	3110	578	13	13	-
Hardness	mg/L	-	540	3020	1340	19	19	-
Nitrate (as N)	mg/L	-	1	3	1.84	15	4	-
Nitrite (as N)	mg/L	-	0.03	0.03	0.03	15	1	-
pH	s.u.	6.5-8.5	7.2	7.6	7.37	3	3	0
Phenolics (total)	mg/L	0.001	0.001	**1.6**	**0.21**	13	13	12
Phosphorus	mg/L	0.01	**0.42**	**5.30**	**1.92**	13	13	13
Total kjeldahl nitrogen (TKN)	mg/L	-	26	180	98.0	15	15	-
Total suspended solids (TSS)	mg/L	-	32	258	97.6	10	10	-
Metals								
Aluminum	mg/L	0.075	**0.17**	**11.6**	**1.67**	20	20	20
Barium	mg/L	-	0.09	0.328	0.19	20	20	-
Beryllium	mg/L	0.011	**1.77**	**1.97**	**1.87**	19	2	2
Bismuth	mg/L	-	ND	ND	ND	13	0	-
Boron	mg/L	0.2	**0.46**	**1.19**	**0.99**	6	4	4
Cadmium	mg/L	0.0002	0.0001	**0.005**	**0.0016**	20	10	6
Calcium	mg/L	-	160	877	345	18	18	-
Chromium	mg/L	-	0.0078	0.17	0.034	20	18	-
Cobalt	mg/L	0.0009	**0.0028**	**0.02**	**0.0071**	20	14	14
Copper	mg/L	0.005	**0.001**	**0.095**	**0.029**	20	16	14
Iron	mg/L	0.3	**2.87**	**53.4**	**14.4**	20	20	20
Lead	mg/L	0.005	0.0009	**0.022**	**0.011**	21	14	12
Magnesium	mg/L	-	52	201	137	20	20	-
Manganese	mg/L	-	0.21	6.22	1.62	20	20	-
Molybdenum	mg/L	0.04	0.0012	0.003	0.002	19	5	0
Nickel	mg/L	0.025	0.012	**0.16**	**0.043**	20	17	12
Potassium	mg/L	-	**17**	**334**	**166**	11	11	-
Silver	mg/L	0.0001	0.00006	0.00006	0.00006	17	1	0
Sodium	mg/L	-	39	594	340	12	12	-
Strontium	mg/L	-	0.99	3.08	2.22	19	19	-
Titanium	mg/L	-	0.008	0.1	0.044	19	19	-
Tungsten	mg/L	0.03	0.001	0.03	0.012	11	5	0
Vanadium	mg/L	0.006	0.002	**0.029**	**0.010**	20	16	14
Zinc	mg/L	0.03	**0.039**	**4.04**	**0.91**	20	20	20

Notes:

(1)	PWQO for un-ionized ammonia is 0.02 mg/L. Criteria shown for total ammonia was calculated using temperature of 20 C and pH of 7.5
PWQO	Provincial Water Quality Objectives, Ontario Ministry of Environment and Energy, July 1994
ND	Parameter not detected above the laboratory method detection limit
-	No criteria
1820	Parameter concentration exceeds associated PWQO

TABLE 1

HISTORICAL LEACHATE QUALITY
WARD 1 LANDFILL
KINCARDINE, ONTARIO

Parameter	*Units*	*PWQO*	*Historical Min*	*Historical Max*	*Historical Average*	*Number of Samples*	*Number of Detections*	*Number of Exceedances*
Volatile Organic Compounds								
1,1,1,2-Tetrachloroethane	ug/L	20	ND	ND	ND	4	0	0
1,1,1-Trichloroethane	ug/L	10	5	5	5	21	1	0
1,1,2,2-Tetrachloroethane	ug/L	70	ND	ND	ND	20	0	0
1,1,2-Trichloroethane	ug/L	800	ND	ND	ND	20	0	0
1,1-Dichloroethane	ug/L	200	0.1	1	0.47	21	3	0
1,1-Dichloroethene	ug/L	40	ND	ND	ND	21	0	0
1,2-Dibromoethane (Ethylene dibromide)	ug/L	5	ND	ND	ND	6	0	0
1,2-Dichlorobenzene	ug/L	2.5	ND	ND	ND	21	0	0
1,2-Dichloroethane	ug/L	100	1.2	1.2	1.2	21	1	0
1,2-Dichloropropane	ug/L	0.7	ND	ND	ND	19	0	0
1,3-Dichlorobenzene	ug/L	2.5	ND	ND	ND	21	0	0
1,4-Dichlorobenzene	ug/L	4	0.3	0.6	0.47	21	3	0
2-Butanone (Methyl ethyl ketone) (MEK)	ug/L	400	65	**1820**	**943**	6	2	1
2-Chloroethyl vinyl ether	ug/L	-	ND	ND	ND	8	0	-
2-Hexanone	ug/L	-	ND	ND	ND	6	0	-
4-Methyl-2-pentanone (MIBK)	ug/L	-	ND	ND	ND	6	0	-
Acetone	ug/L	-	78	910	494	6	2	-
Benzene	ug/L	100	0.2	0.69	0.45	21	2	0
Bromodichloromethane	ug/L	200	ND	ND	ND	21	0	0
Bromoform	ug/L	60	ND	ND	ND	21	0	0
Bromomethane (Methyl bromide)	ug/L	0.9	ND	ND	ND	21	0	0
Carbon disulfide	ug/L	-	21.9	21.9	21.9	6	1	-
Carbon tetrachloride	ug/L	-	ND	ND	ND	21	0	-
Chlorobenzene	ug/L	15	ND	ND	ND	20	0	0
Chloroethane	ug/L	-	ND	ND	ND	15	0	-
Chloroform (Trichloromethane)	ug/L	-	0.8	1	0.9	21	2	-
Chloromethane (Methyl chloride)	ug/L	700	ND	ND	ND	15	0	0
cis-1,2-Dichloroethene	ug/L	200	0.81	0.81	0.81	15	1	0
cis-1,3-Dichloropropene	ug/L	-	ND	ND	ND	21	0	-
Dibromochloromethane	ug/L	40	ND	ND	ND	21	0	0
Dichlorodifluoromethane (CFC-12)	ug/L	-	ND	ND	ND	4	0	-
Ethylbenzene	ug/L	8	0.2	3	1.09	21	9	0
m&p-Xylenes	ug/L	-	0.2	12	2.72	21	12	-
Methyl tert butyl ether (MTBE)	ug/L	200	ND	ND	ND	4	0	0
Methylene chloride	ug/L	100	3.91	3.91	3.91	20	1	0
o-Xylene	ug/L	40	0.1	1.68	0.66	21	10	0
Styrene	ug/L	4	ND	ND	ND	6	0	0
Tetrachloroethene	ug/L	50	0.4	0.4	0.4	16	1	0
Toluene	ug/L	0.8	0.2	**31**	**6.73**	21	10	7
trans-1,2-Dichloroethene	ug/L	200	ND	ND	ND	15	0	0
trans-1,3-Dichloropropene	ug/L	7	ND	ND	ND	21	0	0
Trichloroethene	ug/L	20	ND	ND	ND	21	0	0
Trichlorofluoromethane (CFC-11)	ug/L	-	ND	ND	ND	13	0	-
Trihalomethanes	ug/L	-	ND	ND	ND	6	0	-
Vinyl chloride	ug/L	600	ND	ND	ND	21	0	0
Xylenes (total)	ug/L	-	6.8	6.8	6.8	6	1	-

Notes:

PWQO	Provincial Water Quality Objectives, Ontario Ministry of Environment and Energy, July 1994
ND	Parameter not detected above the laboratory method detection limit
-	No criteria
1820	Parameter concentration exceeds associated PWQO

TABLE 2

LEACHATE GENERATION SUMMARY
LEACHATE MANAGEMENT PLAN
KINCARDINE WASTE MANAGEMENT CENTRE

	Leachate Generated		*Leachate Collected*	
	m^3/year	*m^3/day*	*m^3/year*	*m^3/day*
Stage 1 (Year 2012) Initial	8,886	24	4,864	13
Stage 1 (Year 2013 to 2016) Active	7,265	20	3,243	9
Stage 2 (Year 2017) Initial	9,404	26	5,381	15
Stage 2 (Year 2018 to 2022) Active	8,124	22	4,101	11
Stage 3 (Year 2023) Initial	10,216	28	6,194	17
Stage 3 (Year 2024 to 2026) Active	8,937	24	4,914	13
Stage 4 (Year 2027) Initial	11,114	30	7,092	19
Stage 4 (Year 2028 to 2033) Active	9,834	27	5,812	16
Stage 5 (Year 2034) Initial	12,012	33	7,989	22
Stage 5 (Year 2035 to 2039) Active	10,732	29	6,709	18
Stage 6 (Year 2040) Initial	15,901	44	11,879	33
Stage 6 (Year 2041 to 2048) Active	13,624	37	9,602	26
Stage 7 (Year 2049) Initial	13,690	38	6,893	19
Stage 7 (Year 2050) Active	13,154	36	6,893	19
Post-Closure (Year 2051 +)	9,577	26	6,325	17
Min	**7,265**	**20**	**3,243**	**9**
MAX	**15,901**	**44**	**11,879**	**33**

TABLE 3

KINCARDINE WWTP ANALYTICAL DATA - 2011
LEACHATE MANAGEMENT PLAN
KINCARDINE WASTE MANAGEMENT CENTRE

Parameter [1]		*C of A*	*January*	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Average*	*Raw Leachate*
BOD[2]	*Influent*	-	95	111	79	64	139	116	131	116	67	82	157	89	104	612
	Effluent	30	8	9	9	20	6	3	5	19	15	14	18	11	11	
SS	*Influent*	-	105	103	74	65	159	123	166	183	99	109	214	80	123	98
	Effluent	40	5	8	9	35	9	6	11	**44**	**45**	27	18	15	19	
TKN	*Influent*	-	25	34	22	15	25	32	34	26	33	20	32	21	26	98
	Effluent	-	16	19	14	11	12	15	14	10	5	8	12	13	12	
Total P	*Influent*	-	2.6	3.9	2.1	1.7	3.2	2.6	3.6	2.3	1.3	2.0	4.0	2.3	2.6	1.9
	Effluent	1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.2	0.3	0.2	
Alkalinity	*Influent*	-	276	309	256	248	241	255	228	212	222	225	275	483	269	1726
	Effluent	-	207	207	212	183	175	193	167	114	81	99	155	186	165	
Nitrite	*Effluent*	-	0.2	0.2	0.2	0.1	0.1	0.1	0.3	0.3	1.3	1.0	0.2	0.1	0.3	
Nitrate	*Effluent*	-	0.6	0.3	0.6	0.8	0.7	0.5	0.9	0.7	1.1	1.4	0.7	0.6	0.7	
Ammonia	*Effluent*	-	15	18	14	11	12	14	15	8	4	7	10	12	12	
E Coli	*Effluent*	200[3]	128	333	1143	164	4	2	3	64	12	46	76	1692	10	
DO	*Effluent*	-	10	6	6	12	6	6	3	5	5	3	9	10	7	
pH	*Effluent*	6-9.5	7.4	7.2	7.2	7.9	7.4	7.6	7.8	7.8	7.5	7.8	6.9	7.9	7.5	
Un-ionized ammonia	*Effluent*	-	0.05	0.04	0.03	0.23	0.10	0.18	0.79	0.27	0.05	0.15	0.02	0.12	0.2	

Notes

1. All units in mg/L expect pH and E Coli
2. Effluent BOD from May to December is actually CBOD
3. Geometric Mean Density - Criteria only applies from May to October

TABLE 4

COST SUMMARY OF LEACHATE TREATMENT ALTERNATIVES
LEACHATE MANAGEMENT PLANKINCARDINE WASTE MANAGEMENT CENTRE

Alternative No.	*Alternative*	*Capital Costs (NPV)*	*O&M Cost (NPV)*	*Haulage Cost (NPV)*	*Disposal Cost (NPV)*	**35-Yr Present Worth**
1	Trucking to the Kincardine WWTP	$290,000	$1,060,000	$4,830,000	$1,190,000	**$7,380,000**
2	Construction of a pump station and forcemain to the Kincardine WWTP	$5,320,000	$1,870,000	$0	$1,190,000	**$8,380,000**
3	On-site treatment	$1,700,000	$4,230,000	$0	$0	**$5,930,000**

DESCRIPTION OF EVALUATION CRITERIA
LEACHATE MANAGEMENT PLAN
KINCARDINE WASTE MANAGEMENT CENTRE

Environmental	
Terrestrial Vegetation and Wildlife	• Mortality/stress of vegetation due to sediment deposition, construction activities or changes in soil moisture • Conditions resulting in reduction and/or deterioration of wildlife habitat • Changes in vegetative composition as a result of environmental changes • Effects of timing of construction activities on spawning and breeding periods • Change or removal of existing habitat including food and shelter • Removal or disturbance of significant trees and/or ground flora • Effects on neighbouring properties due to possible migration of wildlife if habitat is reduced • New or increased use of land and wildlife from lack of trees and/or ground flora • Effect of contaminants on vegetation and wildlife
Groundwater Resources	• Changes in quality and quantity of groundwater • The interference with flows or levels of groundwater
Surface Water Resources	• Change in quality • Increases surface water runoff • Decreased surface water infiltration • Sedimentation and turbidity of adjacent water bodies due to construction activities • Contamination of surface watercourses
Air Quality	• Change in air quality • Effects of air contaminants
Visual Aesthetics	• Removal of vegetation or landscape features • Change of compatibility with landscape • Residents, non-residents, recreationalists and tourists exposed to a new appearance
Noise and Vibration	• Changes in environmental noise and vibration on and off Site
Nuisance Odour	• Potential to emit nuisance odour

DESCRIPTION OF EVALUATION CRITERIA
LEACHATE MANAGEMENT PLAN
KINCARDINE WASTE MANAGEMENT CENTRE

Technology Reliability	
Proven Technology	• Track record for means of treatment • Track record for means of conveyance
Level of Treatment	• Level of treatment of waste streams • Efficiency of treatment of wastewaters
Ability to Meet Changes in Waste stream Quantity and Quality	• Adaptability to changing waste stream quantity • Adaptability to changing waste stream quality
Energy Conservation	• The amount of energy required to convey leachate to off-Site treatment facility
Logistics	
Access to Infrastructure	• Access of infrastructure required to implement alternative
Regulatory Requirements	• Feasibility of obtaining regulatory approval • Requirements for obtaining approval
Residential, Commercial, Industrial, and Institutional Land Use	• Temporary disruption during construction • Accessibility changes • Effects on layout or operations • Safety and movement patterns of pedestrian traffic
Trucking Accidents	• Effects on public safety due to the potential for trucking accidents
Implementation Time	• Time required to construct and begin operations
Economics	
Capital cost	• Capital costs
Total - 44 years NPV	• Operational/ maintenance/ repair costs • Discharge fee to a treatment facility/sewer

TABLE 6

SUMMARY OF COMPARATIVE EVALUATION
LEACHATE MANAGEMENT PLAN
KINCARDINE WASTE MANAGEMENT CENTRE

	Alternative 1- Trucking to Kincardine WWTP	Alternative 2: Forcemain to Kincardine WWTP	Alternative 3: On-Site Treatment
ENVIRONMENTAL IMPACTS	**3.5**	**5**	**6**
Terrestrial Vegetation and Wildlife	E	S	S
Surface Water Resources	E	E	S
Air Quality	E	S	S
Visual Aesthetics, Noise and Vibration	E	S	S
Nuisance Odour	S	E	S
Energy Conservation	E	S	S
TECHNOLOGY RELIABILITY	**2**	**2.5**	**3.5**
Proven Technology	E	E	E
Level of Treatment	E	E	S
Ability to Meet Changes in Waste stream Quantity and Quality	E	E	S
Trucking Accidents / Disruptions	E	S	S
LOGISTICS	**3**	**2**	**2.5**
Access to Infrastructure	E	E	S
Regulatory Requirements	S	E	E
Residential, Commercial, Industrial, and Institutional Land Use	E	E	E
Implementation Time	S	E	E
ECONOMICS	**1.5**	**1**	**1.5**
Capital cost	S	E	E
Total- 35 Year NPV	E	E	S
TOTAL	**10**	**10.5**	**13.5**

Notes:

E Equivalent rating weighted as 0.5
S Superior rating weighted as 1

APPENDIX A

COST ESTIMATE FOR LONG TERM LEACHATE MANAGEMENT ALTERNATIVES

TABLE A-0

COST ASSESSMENT INPUTS

General Notes:

1. The annual inflation and interest rates used in the following calculations have been assumed to be:

Annual Inflation Rate: **4.28%** [1]

Annual Interest Rate: **4.66%** [2]

The annual system maintenance and replacement O&M costs in the following calculations have been assumed to be:

Annual Maintenance and Replacement O&M Rate: **2.0%** of Capital Costs

1.0% of Capital Costs for buildings & pipelines

Assumptions:

2. The following assumptions have been incorporated into the following calculations:

2.1 Sewer Discharge Fee: **$ 5.00** /m^3
Cost based on experience with other Ontario Municipalities

2.2 Leachate Production Rate: **20** m^3/ day

2.3 Trucking Cost to KWWTP: **$ 20.00** /m^3

(1) Annual Inflation Rate - 10 year avergae of the Non-Residential Building Construction Index, Ottawa-Gatineau, Ontario part, Statistics Canada 2012

(2) Annual Interest Rate - 10 year average of the Government of Canada Benchmark Bond Yields, Bank of Canada 2012

TABLE A-1

CAPITAL COST
TRUCKING TO KINCARDINE WWTP

Item	*Description*	*Unit*	*Quantity*	*Unit Cost*		*Cost*
1.0	**Truck unloading facility and holding tank at WWTP (Ward 1 Landfill) Pump Station No. 2**	**LS**	1	250,000	**$**	**250,000**
2.0	**Engineering and Administration Costs (15% of Item 1.0)**	**LS**	1	37,500	**$**	**37,500**
3.0	**Owner's Fee (5%)**	**LS**	1	12,500	**$**	**12,500**
				TOTAL CAPITAL COST		**$300,000**

Notes

1. Existing KWMC truck filling station can be used for trucking alternative. No capital upgrades are required
2. Capital cost of $250,000 used to construct unloading facility and Pump Station No. 2 at the Ward 1 Landfill and for calculating maintenance and replacement costs

All values in 2012 dollars

TABLE A-2

CAPITAL COST
PIPELINE TO MUNICIPAL COLLECTION SYSTEM

Item	*Description*	*Unit*	*Quantity*	*Unit Cost*		*Cost*
1.0	**Administration Costs Requirements**					
	Insurance and Contractor Bonds (2%)	LS	--	--	$	70,000
	Mobilization/Demobilization (5%)	LS	--	--	$	170,000
					$	**240,000**
2.0	**Leachate Pipeline**					
	Allowance for moving/supporting utilities	LS	--	--	$	100,000
	Dewatering	LS	--	--	$	20,000
	Pipe install - open cut [4]	LM	9,550	$200	$	1,910,000
	Pipe install - directional drilling	EA	1	$20,000	$	20,000
	Reinstatement	LM	9,550	$60	$	570,000
	Valve chambers [3]	EA	10	$50,000	$	500,000
					$	**3,120,000**
3.0	**Pump Station [3]**					
	Civil/Mechanical/Elec/Control	LS	--	--	$	100,000
	2 x 5 HP Pumps	EA	2	$10,000	$	20,000
	Power Supply	LS	--	--	$	15,000
					$	**135,000**
4.0	**Special Construction [3]**					
	Pipeline Instrumentation and Controls	LS	--	--	$	70,000
	SCADA system	LS	--	--	$	35,000
					$	**105,000**
				Construction Subtotal	**$**	**3,600,000**
5.0	**Construction Contingency (20%)**	%	--	--	**$**	**720,000**
				Construction Total	**$**	**4,320,000**
6.0	**Engineering and Administration Costs (20%)**	%	--	--	**$**	**860,000**
				Construction, Engineering and Administration Subtotal	**$**	**5,180,000**
7.0	**Owners Fee (5%)**				**$**	**260,000**
				TOTAL CAPITAL COST	**$**	**5,440,000**

Notes

1. Based on pipeline route including four, 2-lane road crossings and one creek crossing
2. All values in 2012 dollars
3. Capital cost of $740,000 for equipment subject to O&M requirements (valve chambers, pump station, and special construction items) at rate of 2%
4. Capital cost of $1,910,000 for pipeline subject to O&M requirements at 1% rate

TABLE A-3

CAPITAL COST
ON-SITE LEACHATE TREATMENT (W/ RO)

Item	*Process Description*	*Unit*	*Unit Cost*	*Quantity*	*Cost*
1.0	**Administration Requirements**				
	Insurance and Contractor Bonds (5%)	LS	--	--	$ 40,000
	Mobilization/Demobilization (5%)	LS	--	--	$ 40,000
					$ 80,000
2.0	**Treatment Building [3]**				
	Site Preparation	LS	--	--	$ 50,000
	Fencing	LS			$ 15,000
	Utilities to Site	LS	--	--	$ 60,000
	Building Structure	LS	--	--	$ 250,000
					$ 375,000
3.0	**Primary Treatment [2]**				
	Flash mix, Floc, Chem add.	LS	--	--	$ 45,000
	Settling	LS	--	--	$ 25,000
					$ 70,000
4.0	**Secondary Treatment [2]**				
	Anoxic Tank	LS	--	--	$ 55,000
	Aerobic Tank	LS	--	--	$ 55,000
	Aeration	LS	--	--	$ 80,000
	A/O Clarifier & Filter	LS	--	--	$ 85,000
					$ 275,000
6.0	**Residuals Management [2]**				
	Sludge Holding Tank	LS	--	--	$ 25,000
	Concentrate Holding Tank	LS	--	--	$ 25,000
	Concentrate Recirculation	LS	--	--	$ 40,000
					$ 90,000
	Instrumentation and Controls [2]				
7.0	Instrumentation and Controls	LS			$ 100,000
					$ 100,000
8.0	**Start-up and Commissioning**				
	Start-up and Commissioning	LS	--	--	$ 60,000
					$ 60,000
				Construction Subtotal	**$ 1,050,000**
9.0	**Construction Contingency**				
	20% of Construction Subtotal	%	--	--	$ 210,000
				Construction Total	**$ 1,260,000**
10.0	**Engineering and Administration Costs**				
	Pilot Study	LS	--	--	$ 75,000
	Engineering and Administration Costs (25%)	%	--	--	$ 320,000
					$ 395,000
				Construction, Engineering and Administration Total	**$ 1,655,000**
11.0	**Owners Fee (5%)**	LS	--	--	$ 83,000
				TOTAL CAPITAL COST	**$ 1,738,000**

Notes:
1 - All values in 2012 dollars
2 - Capital costs of $535,000 for equipment subject to O&M requirements at 2% rate.
3 - Capital cost of $375,000 for building subject to O&M requirements at 1% rate.

TABLE A-4

OPERATING AND MAINTENANCE COST SUMMARY

ALTERNATIVE	APPLICABLE CAPITAL COSTS	ANNUAL OPERATING COSTS								ANNUAL HAULAGE COST	ANNUAL DISPOSAL COST	TOTAL ANNUAL COST
		No. Staff	*Labour ($/hr) Rate*	*Labour Costs*	*Maintenance and Replacement* [1]	*Chemicals*	*Site Maintenance*	*Electrical Power* [3]	*Lab Analytical*			
1. Trucking to the Kincardine WWTP	$ 250,000	0.1	32	$ 7,000	$ 5,000	$ -	$ 10,000	$ 1,000	$ 10,000	$ 150,000	$ 37,000	$ 220,000
2. Pump station and forcemain to sewer	$ 2,650,000	-	-	$ -	$ 33,900	$ -	$ 10,000	$ 4,000	$ 10,000	$ -	$ 37,000	$ 94,900
3. On-Site Treatment	$ 910,000	0.5	32	$ 33,000	$ 14,450	$ 15,000	$ 30,000	$ 14,000	$ 25,000	$ -	$ -	$ 131,450

Notes:

1) Annual System Maintenance and Replacement O&M cost considered to be 2% of the Capital Cost for equipment and 1% of capital cost for building and pipelines
2) Trucking assumes cost of $20.00/$m^3$. See inputs table
3) Electrical Power cost estimate based on $0.11/kw-h. Assume 1 HP (0.75 kW) for trucking, 5 HP (3.7 kW) for forcemain and 20 HP (15 kW) required for WTP

TABLE A-5

PRESENT WORTH
TRUCKING TO KINCARDINE WWTP

		2012 Dollars					Inflated Dollars	Present Value
Year	*Year*	*Capital Cost*	*Operating Cost (Less Trucking & Disposal)*	*Trucking Cost to Kincardine WWTP*	*Disposal Cost at Kincardine WWTP*	*Total Annual Cost*	*Total Annual Cost*	*Total Annual Cost*
2012	0	$0	$0	$0	$0	$0	$0	$0
2013	1	$0	$0	$0	$0	$0	$0	$0
2014	2	$0	$0	$0	$0	$0	$0	$0
2015	3	$0	$0	$0	$0	$0	$0	$0
2016	4	$0	$0	$0	$0	$0	$0	$0
2017	5	$0	$0	$0	$0	$0	$0	$0
2018	6	$300,000	$33,000	$150,000	$37,000	$520,000	$668,666	$508,774
2019	7	$0	$33,000	$150,000	$37,000	$220,000	$295,005	$214,469
2020	8	$0	$33,000	$150,000	$37,000	$220,000	$307,632	$213,690
2021	9	$0	$33,000	$150,000	$37,000	$220,000	$320,798	$212,915
2022	10	$0	$33,000	$150,000	$37,000	$220,000	$334,528	$212,141
2023	11	$0	$33,000	$150,000	$37,000	$220,000	$348,846	$211,371
2024	12	$0	$33,000	$150,000	$37,000	$220,000	$363,777	$210,604
2025	13	$0	$33,000	$150,000	$37,000	$220,000	$379,346	$209,839
2026	14	$0	$33,000	$150,000	$37,000	$220,000	$395,582	$209,077
2027	15	$0	$33,000	$150,000	$37,000	$220,000	$412,513	$208,318
2028	16	$0	$33,000	$150,000	$37,000	$220,000	$430,169	$207,562
2029	17	$0	$33,000	$150,000	$37,000	$220,000	$448,580	$206,808
2030	18	$0	$33,000	$150,000	$37,000	$220,000	$467,779	$206,057
2031	19	$0	$33,000	$150,000	$37,000	$220,000	$487,800	$205,309
2032	20	$0	$33,000	$150,000	$37,000	$220,000	$508,678	$204,564
2033	21	$0	$33,000	$150,000	$37,000	$220,000	$530,450	$203,821
2034	22	$0	$33,000	$150,000	$37,000	$220,000	$553,153	$203,081
2035	23	$0	$33,000	$150,000	$37,000	$220,000	$576,828	$202,344
2036	24	$0	$33,000	$150,000	$37,000	$220,000	$601,516	$201,609
2037	25	$0	$33,000	$150,000	$37,000	$220,000	$627,261	$200,877
2038	26	$0	$33,000	$150,000	$37,000	$220,000	$654,108	$200,148
2039	27	$0	$33,000	$150,000	$37,000	$220,000	$682,104	$199,421
2040	28	$0	$33,000	$150,000	$37,000	$220,000	$711,298	$198,697
2041	29	$0	$33,000	$150,000	$37,000	$220,000	$741,741	$197,975
2042	30	$0	$33,000	$150,000	$37,000	$220,000	$773,488	$197,257
2043	31	$0	$33,000	$150,000	$37,000	$220,000	$806,593	$196,540
2044	32	$0	$33,000	$150,000	$37,000	$220,000	$841,115	$195,827
2045	33	$0	$33,000	$150,000	$37,000	$220,000	$877,115	$195,116
2046	34	$0	$33,000	$150,000	$37,000	$220,000	$914,655	$194,407
2047	35	$0	$33,000	$150,000	$37,000	$220,000	$953,803	$193,701
2048	36	$0	$33,000	$150,000	$37,000	$220,000	$994,625	$192,998
2049	37	$0	$33,000	$150,000	$37,000	$220,000	$1,037,195	$192,297
2050	38	$0	$33,000	$150,000	$37,000	$220,000	$1,081,587	$191,599
2051	39	$0	$33,000	$150,000	$37,000	$220,000	$1,127,879	$190,904
2052	40	$0	$33,000	$150,000	$37,000	$220,000	$1,176,152	$190,210
							NPV	**$7,380,328**

TABLE A-6

PRESENT WORTH
PIPELINE TO MUNICIPAL COLLECTION SYSTEM

		2012 Dollars					Inflated Dollars	Present Value
Year	*Year*	*Capital Cost*	*Operating Cost (Less Trucking & Disposal)*	*Trucking Cost to Kincardine WWTP*	*Disposal Cost at Kincardine WWTP*	*Total Annual Cost*	*Total Annual Cost*	*Total Annual Cost*
2012	0	$0	$0	$0	$0	$0	$0	$0
2013	1	$0	$0	$0	$0	$0	$0	$0
2014	2	$0	$0	$0	$0	$0	$0	$0
2015	3	$0	$0	$0	$0	$0	$0	$0
2016	4	$0	$0	$0	$0	$0	$0	$0
2017	5	$0	$0	$0	$0	$0	$0	$0
2018	6	$5,440,000	$57,900	$0	$37,000	$5,534,900	$7,117,311	$5,415,412
2019	7	$0	$57,900	$0	$37,000	$94,900	$127,255	$92,514
2020	8	$0	$57,900	$0	$37,000	$94,900	$132,701	$92,178
2021	9	$0	$57,900	$0	$37,000	$94,900	$138,381	$91,844
2022	10	$0	$57,900	$0	$37,000	$94,900	$144,303	$91,510
2023	11	$0	$57,900	$0	$37,000	$94,900	$150,480	$91,178
2024	12	$0	$57,900	$0	$37,000	$94,900	$156,920	$90,847
2025	13	$0	$57,900	$0	$37,000	$94,900	$163,636	$90,517
2026	14	$0	$57,900	$0	$37,000	$94,900	$170,640	$90,188
2027	15	$0	$57,900	$0	$37,000	$94,900	$177,943	$89,861
2028	16	$0	$57,900	$0	$37,000	$94,900	$185,559	$89,535
2029	17	$0	$57,900	$0	$37,000	$94,900	$193,501	$89,210
2030	18	$0	$57,900	$0	$37,000	$94,900	$201,783	$88,886
2031	19	$0	$57,900	$0	$37,000	$94,900	$210,419	$88,563
2032	20	$0	$57,900	$0	$37,000	$94,900	$219,425	$88,241
2033	21	$0	$57,900	$0	$37,000	$94,900	$228,817	$87,921
2034	22	$0	$57,900	$0	$37,000	$94,900	$238,610	$87,602
2035	23	$0	$57,900	$0	$37,000	$94,900	$248,823	$87,284
2036	24	$0	$57,900	$0	$37,000	$94,900	$259,472	$86,967
2037	25	$0	$57,900	$0	$37,000	$94,900	$270,578	$86,651
2038	26	$0	$57,900	$0	$37,000	$94,900	$282,158	$86,336
2039	27	$0	$57,900	$0	$37,000	$94,900	$294,235	$86,023
2040	28	$0	$57,900	$0	$37,000	$94,900	$306,828	$85,711
2041	29	$0	$57,900	$0	$37,000	$94,900	$319,960	$85,399
2042	30	$0	$57,900	$0	$37,000	$94,900	$333,654	$85,089
2043	31	$0	$57,900	$0	$37,000	$94,900	$347,935	$84,780
2044	32	$0	$57,900	$0	$37,000	$94,900	$362,826	$84,473
2045	33	$0	$57,900	$0	$37,000	$94,900	$378,355	$84,166
2046	34	$0	$57,900	$0	$37,000	$94,900	$394,549	$83,860
2047	35	$0	$57,900	$0	$37,000	$94,900	$411,436	$83,556
2048	36	$0	$57,900	$0	$37,000	$94,900	$429,045	$83,252
2049	37	$0	$57,900	$0	$37,000	$94,900	$447,408	$82,950
2050	38	$0	$57,900	$0	$37,000	$94,900	$466,557	$82,649
2051	39	$0	$57,900	$0	$37,000	$94,900	$486,526	$82,349
2052	40	$0	$57,900	$0	$37,000	$94,900	$507,349	$82,050

NPV	**$8,379,551**

TABLE A-7

PRESENT WORTH
ON-SITE LEACHATE TREATMENT (W/ RO)

		2012 Dollars					Inflated Dollars	Present Value
Year	*Year*	*Capital Cost*	*Operating Cost (Less Trucking & Disposal)*	*Trucking Cost to Kincardine WWTP*	*Disposal Cost at Kincardine WWTP*	*Total Annual Cost*	*Total Annual Cost*	*Total Annual Cost*
2012	0	$0	$0	$0	$0	$0	$0	$0
2013	1	$0	$0	$0	$0	$0	$0	$0
2014	2	$0	$0	$0	$0	$0	$0	$0
2015	3	$0	$0	$0	$0	$0	$0	$0
2016	4	$0	$0	$0	$0	$0	$0	$0
2017	5	$0	$0	$0	$0	$0	$0	$0
2018	6	$1,738,000	$131,450	$0	$0	$1,869,450	$2,403,920	$1,829,092
2019	7	$0	$131,450	$0	$0	$131,450	$176,266	$128,145
2020	8	$0	$131,450	$0	$0	$131,450	$183,810	$127,680
2021	9	$0	$131,450	$0	$0	$131,450	$191,677	$127,216
2022	10	$0	$131,450	$0	$0	$131,450	$199,881	$126,755
2023	11	$0	$131,450	$0	$0	$131,450	$208,436	$126,294
2024	12	$0	$131,450	$0	$0	$131,450	$217,357	$125,836
2025	13	$0	$131,450	$0	$0	$131,450	$226,659	$125,379
2026	14	$0	$131,450	$0	$0	$131,450	$236,361	$124,924
2027	15	$0	$131,450	$0	$0	$131,450	$246,477	$124,470
2028	16	$0	$131,450	$0	$0	$131,450	$257,026	$124,018
2029	17	$0	$131,450	$0	$0	$131,450	$268,027	$123,568
2030	18	$0	$131,450	$0	$0	$131,450	$279,498	$123,119
2031	19	$0	$131,450	$0	$0	$131,450	$291,461	$122,672
2032	20	$0	$131,450	$0	$0	$131,450	$303,935	$122,227
2033	21	$0	$131,450	$0	$0	$131,450	$316,944	$121,783
2034	22	$0	$131,450	$0	$0	$131,450	$330,509	$121,341
2035	23	$0	$131,450	$0	$0	$131,450	$344,655	$120,900
2036	24	$0	$131,450	$0	$0	$131,450	$359,406	$120,461
2037	25	$0	$131,450	$0	$0	$131,450	$374,788	$120,024
2038	26	$0	$131,450	$0	$0	$131,450	$390,829	$119,588
2039	27	$0	$131,450	$0	$0	$131,450	$407,557	$119,154
2040	28	$0	$131,450	$0	$0	$131,450	$425,000	$118,721
2041	29	$0	$131,450	$0	$0	$131,450	$443,190	$118,290
2042	30	$0	$131,450	$0	$0	$131,450	$462,159	$117,861
2043	31	$0	$131,450	$0	$0	$131,450	$481,939	$117,433
2044	32	$0	$131,450	$0	$0	$131,450	$502,566	$117,006
2045	33	$0	$131,450	$0	$0	$131,450	$524,076	$116,582
2046	34	$0	$131,450	$0	$0	$131,450	$546,507	$116,158
2047	35	$0	$131,450	$0	$0	$131,450	$569,897	$115,737
2048	36	$0	$131,450	$0	$0	$131,450	$594,289	$115,316
2049	37	$0	$131,450	$0	$0	$131,450	$619,724	$114,898
2050	38	$0	$131,450	$0	$0	$131,450	$646,248	$114,481
2051	39	$0	$131,450	$0	$0	$131,450	$673,908	$114,065
2052	40	$0	$131,450	$0	$0	$131,450	$702,751	$113,651

NPV	**$5,934,846**