Pender Harbour Landfill
Waste Management Options
FINAL REPORT

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- Landfill Engineering
- Solid Waste Planning
- Environmental Monitoring
- Landfill Fire Control

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1 INTRODUCTION

Sperling Hansen Associates (SHA) was retained by the Sunshine Coast Regional District (SCRD) on the 18th of September, 2008, to complete an assessment on Waste Management Options for the Pender Harbour Landfill. The Pender Harbour Landfill is due to reach capacity in 2010, and the SCRD wishes to assess the best option to handle the areas waste going forward.

The following report looks at two potential waste management scenarios for Pender Harbour; expanding the existing landfill to the west or north, and closing the landfill and developing a transfer station to haul waste to the Sechelt Landfill. An assessment of the environmental, social and economic impacts of each of these options is presented.

2 LANDFILL EXPANSION ASSESSMENT

For this scenario, it has been assumed that the Pender Harbour Landfill will stay open beyond 2010 and continue to receive waste from the local area. Two expansion options were assessed; one to the west of the site, the other to the north. This section looks at the following for each expansion option; the conceptual design, lifespan, environmental controls required, environmental impacts, social impacts and costing.

2.1 Final Contour Design

Two options for expanded final contours were prepared, one for an expansion to the west, the other for an expansion to the north, as shown in Figures 2.1 and 2.2 respectively. The western expansion will see the final contours reach a peak of 65 m, with a 4 m bench road established at 55 m elevation as recommended for slope stability. The western expansion will develop approximately 5,424 m^2 of virgin footprint area that is outside the current waste footprint to the west, burying the existing road and requiring a new road to be created. The northern expansion will begin by filling the valley to the north above the wetland, reaching a final elevation of 76 m, and will not impact the existing road or place waste above the existing eastern steep slopes. The northern expansion will develop a larger 14,744 m^2 of virgin footprint outside the current waste footprint.

A cut and fill analysis was completed to evaluate the volume available between existing contours and the proposed expansion options. This was completed using AutoDesk Civil 3D, a powerful terrain modelling program. The cut and fill results are shown graphically in Figure 2.3 and 2.4 for the western and northern expansion respectively. The analysis showed that 69,817 m^3 of volume was available for the western expansion option, and 125,247 m^3 of volume was available for the northern expansion option. Assuming that 16,533 m^3 of volume will be consumed by final cover for the western expansion, and 24,628 m^3 will be consumed by final cover for the northern expansion (assuming 1 m thick final cover system), this equates to 53,284 m^3 and 100,619 m^3 of airspace for waste and cover for the western and northern expansion areas respectively.

On a waste capacity to virgin area impacted ratio, the western expansion will gain 10 m^3 of airspace per 1 m^2 of virgin ground impacted, while the north expansion will gain a lower ratio of 7 m^3 of airspace per 1 m^2 of virgin ground impacted. This is because the western expansion builds mainly upon the existing

waste footprint, while the northern expansion is largely on virgin ground that has not previously received waste.

2.2 Lifespan Analysis

A lifespan analysis was completed for the two expansion options prepared. The following assumptions were made, based upon data provided by the SCRD and the previous lifespan analysis completed by SHA under PRJ02028 (SHA, 2003).

- Waste and cover soil placed in the landfill would settle 10% on a volume basis
- Waste density estimated at 0.75 tonnes/m^3 based on expected compaction achievable by onsite equipment.
- Total waste disposal rate of 0.907 tonnes/person/year based on a baseline waste disposal amount of 2,404 tonnes in 2007, with a population of 2,650 in that year.
- Total waste landfilled rate of 0.623 tonnes/person/year based on a baseline waste landfilled amount of 1,652 tonnes in 2007, with a population of 2,650 in that year.
- Waste to cover ratio of 2.09 vol/vol, based on 2007 values for 1,652 tonnes of waste landfilled with an estimated density of 0.75 tonnes/m^3, and 1,952 tonnes of cover soil used with an estimated density of 1.85 tonnes/m^3. This value is higher than 0.9 vol/vol value calculated under PRJ02028, but considered reasonable for what is achievable at this site and what is achieved at other landfills in BC of a similar size.
- Base population of 2,624 based on 2006 Census Data for Electoral Area A. Population growth rates taken from BC Stats for projections for the entire SCRD as no specific growth data was available for the area in question.

Table 2.1 below shows the volume of airspace available for each expansion option as calculated above, and the correlating lifespan based on the lifespan analysis. Details on the lifespan analysis can be seen in Table 2.2.

Table 2.1: Lifespan Analysis Summary

Expansion Option	Airspace Available accounting for Final Cover (m^3)	Lifespan (years)	Expected Year of Closure
Western Expansion	53,284	16	2025
Northern Expansion	100,619	29	2038

As can be seen, there is the potential for up to an additional 16 years of capacity remaining for the western expansion, and up to 29 years remaining for the northern expansion. If desired, the northern expansion could be further increased if waste were to be placed to the west, providing a potential lifespan of approximately 60 years. This option was not evaluated as part of this report as it was deemed too long range.

2.3 Environmental Impacts and Controls

2.3.1 Expansion

The Pender Harbour Landfill has been developed as a natural control site, meaning that leachate is attenuated using the natural soils underlying the waste fill. Piteau Associates (Piteau, 1994) conducted some test pitting at the site, and determined that the foundation soils to the north of the site consisted of a very compact to very dense sand and gravel, to gravelly sand with a trace of silt, that was 2 to 3 m thick. The permeability of this material was not tested. The elevation of the water table beneath the landfill is also unclear. Under PRJ02028 (SHA, 2003) it was estimated that the water table could be at or near ground level.

Test pitting was carried out by Levelton Engineering Ltd surround the wetland area at the toe of the landfill (Levelton, 1997a). The test pits had groundwater seepage from 0.3 to 4.7 m below surface. Two in-situ falling head permeability tests were also conducted by Levelton (Levelton, 1997b). Results for the native silt / clay layer between 2.20 and 2.85 m showed a hydraulic conductivity of 8×10^{-5} cm/s, while results for the native silty / fine sand layer between 2.10 to 2.40 m showed a hydraulic conductivity of either 5×10^{-6} or 5×10^{-4} cm/s (faxed copy of report was illegible).

The B.C. Ministry of Environment (MoE), under the *Landfill Criteria for Municipal Solid Waste* (MoE, 1993), requires the bottom-most waste cell to be 1.2 m above the seasonal high groundwater table, and that there should be at least a 2 m thick layer of low permeability soil (1×10^{-6} cm/s or less) below the bottom-most waste cell. As it is unclear at this stage whether the conditions at Pender Harbour meet these requirements, if an expansion were to be conducted an exemption should be sought and / or further field investigation should be conducted.

If an exemption is not received or the field investigation reveals unfavorable conditions for a natural attenuation site, then additional capital works may be required to line the expansion areas with a clay or geomembrane base liner system. For the purpose of this analysis, it has been assumed that the expansion areas will continue to operate as natural attenuation based on previous site history and the limited environmental impact the site is currently having.

In general, if the western or northern expansions were to be pursued, the virgin expansion areas would need to be prepared, by stripping away vegetation and conducting earthworks to grade the areas. In the case of the western expansion, the existing road would need to be re-aligned as shown in Figure 2.3. Further engineering work would need to be conducted to assure the stability of the proposed designs presented in Figure 2.1 and 2.2, which is outside the scope of this project.

Both expansion options will expand the landfill footprint onto virgin ground, impacting the environment over current conditions. The northern expansion has a greater footprint on virgin soil than the western expansion (14,744 m^2 vs 5,424 m^2).

2.3.2 Surface Water & Groundwater

Upslope surface water ditching would need to be installed to intercept surface water run-on and direct it around the waste footprint for both expansion options. Additional monitoring locations, including

surface water sites and groundwater monitoring wells would be required to monitor the impact of the expansion areas on surface water and groundwater conditions. In general, surface water and groundwater quality will be reduced the longer the landfill stays operational, and hence the western expansion will have less impacts than the northern expansion over existing conditions. Both options will impact surface water and groundwater quality in comparison to closing the site in 2010.

2.3.3 Landfill Closure

No final cover systems have been implemented at Pender Harbour Landfill to date. The Landfill has been developed with very steep side slopes that range in grade from 2.3H:1V to 1.7H:1V, with some slopes as steep as 1.4H:1V. Existing landfill slopes have been covered by a continuous layer of intermediate cover soil, and are currently heavily vegetated. Dayton and Knight (Dayton and Knight, 1994) recommended that the steep eastern slopes be left as is and that no final cover system be placed in that area. It is believed that the MoE supports this concept, although SHA has no written evidence of this at the time of writing this report. It has been assumed that the steep eastern slopes, with an approximate area of 8,112 m^2, will not require any further work to achieve closure.

All expanded portions of the landfill are designed at slopes of 3H:1V in accordance with the Landfill Criteria. SHA recommends that a conventional geomembrane closure system be adopted for closure of the expansion areas and the existing slopes (excluding the steep eastern slopes), instead of a 1.0 m thick soil barrier layer. A geomembrane system is recommended as there appears to be no local source of clay available (Dayton and Knight, 1994), and it will also conserve airspace as it is thinner than a clay system.

SHA recommends phased closure of landfills in order to reduce the environmental impacts of completed landfill slopes by reducing LFG and leachate generation. For the western expansion, it will be difficult to complete phased closure as waste is planned to be placed over the existing waste footprint in a narrow lift. For the northern expansion, the existing landfill slopes at the south of the site could be closed in 2010, and phased closure could be incorporated into the northern expansion area as filling proceeds.

2.3.4 Leachate Treatment

A review of the existing leachate treatment system, comprised of surface water diversion ditching, leachate collection piping and a leachate treatment wetland, by Microbial Technologies (Microbial, 2001) concluded that the system was functioning well.

If the western expansion option were to be pursued, the impact of the additional leachate generation from the increased waste footprint on the leachate treatment system would need to be evaluated. It is likely that some small upgrades to the wetland might be required, but overall the system should be able to cope with the western expansion and continue treating leachate at the present standard. The western expansion will increase leachate generation over the current rate proportional to the increase in landfill footprint.

If the northern expansion were to be pursued, more drastic upgrades would be required to the leachate collection system and wetland to maintain the current treatment standards. The northern expansion will increase the capacity of the landfill dramatically, with a much larger footprint, and will also fill over the existing collection system. Further investigation into the impacts of this expansion on the leachate

collection and treatment system would be required. It is anticipated that the wetland capacity would need to be increased, and that an upgrade to increase the capacity of the collection system would likely be required. Leachate generation will be increased beyond current conditions and those anticipated from the western expansion, proportional with the increase in landfill footprint.

2.3.5 Landfill Gas

SHA did not complete a detailed Landfill Gas (LFG) generation estimation as part of this project. If either expansion option were to be pursued, an assessment of LFG in line with the newly released *Landfill Gas Management Regulation* (MoE, 2008) would need to be conducted. Based on SHA's experience, an active LFG collection system will not be required at the site. Expansion of the site will increase LFG and hence GHG emissions, with the northern expansion producing more than the western expansion over time due to the increased capacity of the northern expansion.

However, as the SCRD wishes to minimize the Greenhouse Gas (GHG) impact of the site, SHA recommends that a passive LFG collection system be installed beneath the final cover system as part of closure, and that collected LFG be passed through a biofilter to convert methane to carbon dioxide, significantly reducing GHG emissions as carbon dioxide has a much lower Global Warming Potential than methane. Biofilters are simple, inexpensive devices that work under atmospheric pressure, where collected LFG is passed through a bed of compost containing methanotrophic bacteria, which consume the methane within the LFG and release carbon dioxide as a by product.

For the steep eastern slopes that will receive no further final cover, SHA recommends investigating the LFG emissions from these areas under a field program. If LFG emissions (particularly methane) are high, then biocover can be utilized to significantly reduce GHG emissions. Biocover is similar to a biofilter, expect it can be placed directly on slopes. Biocover is comprised of a compost material, mixed with a carbon source and sand to provide habitat for methanotrophic bacteria. SHA has implemented biocover at Nanaimo Landfill as part of an interim closure system.

2.3.6 Operational Issues

One of the largest operational issues facing the site is a lack of cover soil, which is currently imported to the site. In 2007, approximately 1,000 m^3 of cover soil was imported, at a cost of approximately $15,000. For the western expansion option, approximately 20,000 m^3 of cover soil will be required to 2025, and for the northern expansion approximately 37,000 m^3 of cover soil will be required to 2038. If the current source of this material is exhausted, or if soil prices increase, then this will drive up the costs of operating the landfill. The SCRD has implemented an alternate daily cover system at site made from used conveyor belting bolted together, reducing cover soil placement to 1 day per week, which reduces cover soil requirements and also increase the lifespan and capacity of the landfill. The SCRD is looking to potentially increase the time between cover soil placement to 1 day every two weeks pending MoE approval, which will further decrease cover soil usage.

The site has had issues in the past with litter control. Should an expansion be pursued, the perimeter of the site will be increased, increasing the potential for litter control issues. Portable litter control fencing should be utilized to control litter issues, and a litter pickup patrol should be initiated to clean up litter outside the property boundary as required.

2.4 Social Impacts

If an expansion of the landfill were to be pursued, there would be numerous social impacts. Foremost would be the issue related to the local community dealing with its own waste disposal. Based on information provided by the SCRD, local residents prefer to have a local landfill site to deal with their waste, rather than export it to be dealt with by another community such as Sechelt. By pursuing the western expansion, the local community would be able to deal with their own waste at the landfill until 2025, at which time they would have to look towards another expansion, another landfill site or exportation of their waste. By pursuing the northern expansion, the local community would be able to deal with their own waste at the landfill until 2038, at which time they would have to look towards another expansion, another landfill site or exportation of their waste. The best means to deal with this issue is by the reduction of solid waste production, through increased recycling, extended producer responsibility programs to reduce packaging wastes, and providing programs to deal with organic wastes locally.

There may also be local residents who do not like living near the landfill, and desire it to be closed. The SCRD has not received any such complaints in recent years following improved operational and environmental controls being implemented at the site. If an expansion were pursued, the landfill could continue to operate in its current location for up to 29 more years. Consultation with nearby residents will be required to identify and address concerns they have with any proposed expansion.

If the western expansion is pursued, access to properties north of the landfill along the existing road may be disrupted during development of the expansion area. Expansion of the landfill will not increase the current traffic to and from the landfill over what currently exists.

The local community is sensitive to the environmental and GHG impacts of the waste disposal option selected. If the landfill were to be expanded, a more detailed assessment of GHG impacts and environmental impacts should be undertaken.

2.5 Landfill Expansion Conceptual Cost Estimate

2.5.1 Expansion Cost Estimate

A conceptual cost estimate was prepared for the capital works required to complete the western and northern landfill expansions based on SHA's experience at landfills throughout BC. For this assessment it was assumed that the MoE would approve the expansion to operate as a natural control site and that no additional base lining system would be required. If this is not the case and a base lining system is required, this would increase expansion costs to approximately \$60 per m^2. SHA also assumed that the leachate treatment and collection system would be upgraded as required as discussed above. Capital costs included roads, clearing and grubbing, base layer grading, surface water cutoff ditches and monitoring upgrades.

For the western expansion, SHA estimates that capital costs, including engineering, will be in the range of \$155,000, or approximately \$29 per m^2. This includes 300 m for the relocation of the perimeter road, at \$100 per meter. For the northern expansion, SHA estimates that capital costs, including engineering, will be in the range of \$267,000, or approximately \$18 per m^2.

2.5.2 Closure Cost Estimate

For the purpose of this study, SHA has assumed that the landfill will be closed utilizing a geomembrane closure system. Geomembrane closure systems cost in the range of $50 to $60 per m^2, incorporating site preparation works, LFG passive collection system, biofilter, drainage layers, geomembrane barrier layers, topsoil layers, surface water management, road establishment and engineering. Clay closure systems are typically cheaper than geomembrane closure systems, but as there is no local source of clay this will not likely be the case at the site. SHA has assumed that 8,112 m^2 of the eastern steep slopes will not require closure for the western expansion, and 4,594 m^2 of the eastern steep slopes will not require closure for the northern expansion.

For a conservative geomembrane closure cost rate of $60 per m^2, the final closure of the western expansion will cost $991,980, while the final closure of the northern expansion will cost $1,477,680.

2.5.3 Post Closure Cost Estimate

Following closure of the landfill, SHA typically allows $1 per m^2 of the waste footprint for post closure monitoring for a period of 25 years. This includes cover system maintenance, monitoring, reporting, administrative staff and power.

Based on this rate, the western expansion will have an annual post closure cost of $24,645, and the northern expansion will have an annual post closure cost of $29,222.

2.5.4 Operating Cost Estimate

Based on information provided by the SCRD based on their 2007 actual spending and some estimates by SHA, a cost per tonne operating cost for landfilling of waste at the Pender Harbour Landfill was calculated. The following costs were included:

- Operating Contract $85,410
- Cover Soil $15,000
- Surveys $4,000
- Staffing $86,950
- Benefits $22,739
- Administration $32,739
- Others $10,000

Based on a waste landfilled rate of 1,652 tonnes in 2007, this equates to an operating cost of $155.47 per tonne. On top of this, in 2007 $40,000 was set aside for the closure fund, which equates to $24.21 per tonne, bringing the total operating costs to $179.68 per tonne.

2.6 Issues for Siting a New Landfill

Siting a new landfill is a difficult process that many Regional Districts throughout BC have struggled with over recent years. It is a challenging process as a new site requires adequate buffer distances from environmental sensitive areas, such as creeks and streams, must be geologically sound, and must not impact local groundwater or local communities. It is SHA's belief that an existing landfill site is better to be expanded, if there are no major environmental or social issues that can't be solved via engineering

solutions, rather than develop a new landfill site, which will impact an even greater area. Alternatively, as smaller landfills are closed, waste can be managed in a regional manner, reducing operating costs and pooling capital expenditures for environmental controls.

3 TRANSFER STATION ASSESSMENT

For this scenario, it has been assumed that the Pender Harbour Landfill will be closed in 2010, and waste will be transferred via hauling from an onsite transfer station to the Sechelt Landfill. This section details the following for the transfer station option; conceptual design including layout and haul frequency, standard transfer bins versus stationary compactors, environmental controls required, environmental impacts, social impacts and costing.

3.1 Transfer Station Conceptual Design

If the landfill is not expanded further, it will reach capacity in 2010, from which time waste would need to be transferred to another disposal facility, namely the Sechelt Landfill, a distance of approximately 40 kilometers. There is currently four 40 yd transfer bins located at the site; two handling material that gets dropped off by residents and hauled to the active face of the landfill, and two handling recyclable material that is hauled offsite for processing. The layout of the existing transfer facilities is shown in Figure 1.1. No analysis on recyclable materials has been conducted as part of this study, as they will continue to be processed in the same manner irrespective of the decision to expand the landfill or develop a transfer station.

Currently residents with small loads dump them in the two 40 yd bins, which are hauled to the active face for landfilling. Discussions with site staff reveal that in winter months 1 bin is hauled to the active face each day, and in summer months both bins can be hauled to the active face in a day. Large loads and commercial haulers dump waste directly at the active face.

At the request of the SCRD, SHA has investigated the use of standard waste transfer bins and has also investigated using stationary compactors in order to increase waste density to reduce the frequency of waste haul. The comparison of these two options is presented in this section, however a design for the transfer station layout has only been prepared for standard waste transfer bins.

In order to calculate the required capacity of the transfer station, SHA made the following assumptions:

- Uncompacted waste within transfer bins has density of 0.2 tonnes/m^3 (Tchobanoglous, 1993)
- Compacted waste within transfer bins has density of 0.4 tonnes/m^3 (The Metro Group, 2009)
- All waste currently landfilled will require transfer to Sechelt Landfill.
- 1 yd = 0.765 m^3.
- 3 bins can be transferred at one time.

3.1.1 Haul Frequency

Standard Transfer Bins

Assuming standard transfer bins with a waste density of 0.2 tonnes/m^3, and based on the waste generation projections shown in Table 2.2 and the assumptions above, SHA calculates that 4 new 50 yd transfer bins, along with the 2 existing 40 yd bins, would be required to meet the required waste

quantities. Based on the volume of bins, 1 load of 3 bins would be hauled to Sechelt every 4 to 5 days in 2010, i.e. all 6 bins would be full every 9 days. Table 3.1 gives a summary of the haul frequency based on future waste projections. As can be seen, by 2020 all 6 bins would be full within 8.4 days, and by 2030 all 6 bins would be full within 7.8 days. Based on the design presented in Figure 3.1, it would be possible to add more bays in the future as required to meet increasing demand.

Stationary Compactors

Assuming the use of stationary compactors which provide a waste density of 0.4 tonnes/m^3, and based on the waste generation projections shown in Table 2.2 and the assumptions above, SHA calculates that 3 new 50 yd transfer bins with stationary compactors would be required to meet the required waste quantities (for this scenario existing 40yd bins would not be used). Based on the volume of bins, 1 load of 3 bins would be hauled to Sechelt every 10 days in 2010. Table 3.2 gives a summary of the haul frequency based on future waste projections. As can be seen, by 2020 all 3 bins would be full within 9 days, and by 2030 all 3 bins would be full within 8 days.

3.1.2 Waste Compaction in Transfer Bins

Standard Transfer Bins

Based on discussions with site staff, a 40 yd bin is emptied per day during the winter, while up to 2 of the 40 yd bins are emptied in summer per day. Assuming that 100% of residential waste gets disposed of in these bins, they receive approximately 1.7 tonnes per day (based on 630 tonnes/year of residential waste received at the site). Assuming SHA's uncompacted waste density of 0.2 tonnes/m^3, which is a relatively standard value, this results in 8.6 m^3/d of uncompacted waste entering the bins. At this rate, it would take 3.5 days to fill a 40 yd bin, which is less frequent than what is reported to occur at the site.

In order for a 40 yd bin to be filled every day based on the incoming residential tonnages, an uncompacted waste density of less than 0.1 tonnes/m^3 needs to be assumed. This is a low density value, and indicates that more supervision of waste placement in the transfer bins is required. Also, to improve this density, onsite equipment may need to be used to compact waste within the bin. Prior to the detailed design of the transfer station, the bins should be weighed on the weigh scales while empty and then when full in order to determine the waste density achieved. If it is found that the density is below the 0.2 tonnes/m^3 assumed by SHA, this will increase the frequency of haul of transfer bins to Sechelt and hence increase the operational costs.

Stationary Compactors

Based on discussions with manufacturers of stationary compactors the use of this equipment can increase waste density in transfer bins up to 0.4 tonnes/m^3.

3.1.3 Transfer Station Layout

A conceptual design for the transfer station, shown in Figure 3.1, was developed based on the use of standard transfer bins, including 4 new 50 yd bins. 2 new bays were added to the existing bays, whilst a separate 2 bays were developed to the south east of the site in order to accommodate commercial haulers and large loads. Room has been made to allow for stockpiling of wood waste, green waste, tires, appliances and asphalt to the north east corner of the transfer station. Best estimates of turning radius required for large vehicles and transfer bin haul trailers have been made based on past experience, but

discussions should be held with local haulers to determine if the assumptions accommodate their requirements. The design presented is one of numerous potential layouts, which would need to be further refined as part of a detailed design for the transfer station facility and is provided at this stage for conceptual costing and to determine feasibility.

To accommodate the use of stationary compactors, these could be fitted to the two new bays to the south of the site for commercial haulers and large loads, and one of the existing bays could be retrofitted. The two new bays for residential loads shown in Figure 3.1 would not be required. Electrical upgrades would be required in order to run the 3 Phase stationary compactors on the 1 Phase power that is currently available on site.

3.2 Environmental Impacts and Controls

3.2.1 Landfill Closure

As discussed in Section 2.3.3, no final cover systems have been implemented at Pender Harbour Landfill to date. If the landfill were to be closed in 2010, approximately 11,109 m^2 of the landfill would require closure, assuming that the steep eastern slopes, with an approximate area of 8,112 m^2, will not require any further work to achieve closure. As per Section 2.3.3, SHA recommends a geomembrane closure system.

By closing the site in 2010 and hauling waste to Sechelt in transfer bins, the environmental impact on the local environment will be reduced. The landfill closure system will reduce leachate production, and hence reduce impacts to surface water and groundwater quality over time. LFG will be collected via passive venting and run through a biofilter to reduce GHG emissions.

3.2.2 Impact at Sechelt

By transferring waste for disposal to Sechelt Landfill, the environmental impacts related to leachate and LFG will also be transferred to that site. However, SHA believes that the overall environmental impacts to the region will be reduced by doing this. By disposing of the waste at one site instead of two, capital funding can be focused to improve environmental protection at the Sechelt Landfill, and saving made through economies of scale of landfill operation can be invested into environmental infrastructure, such as phased landfill closure at Sechelt, biocover to reduce GHG emissions and litter control programs.

3.2.3 Waste Transfer

Hauling transfer bins approximately 40 km each way between Pender Harbour and Sechelt will result in GHG emissions above current waste haul operations. It is unclear at this time if these emissions will be offset by reduced emissions from both the Pender Harbour Landfill due to closure, and from the Sechelt Landfill due to potential increased funding for GHG control as mentioned above. Further investigation into this is required, and is outside the scope of this project. By utilizing stationary compactors over standard transfer bins, the frequency of waste haul will be halved, reducing the waste haul GHG emissions.

3.2.4 Power Consumption

By utilizing stationary compactors, power consumption at the site will increase over using standard transfer bins. The environmental impacts from the additional power consumption should be easily offset from the reduced environmental impact by reduced haul frequency.

3.3 Social Impacts

If the Pender Harbour Landfill were to be closed in 2010, and a transfer station constructed to transfer waste to the Sechelt Landfill, there would be numerous social impacts. Firstly, local residents feel strongly about dealing with their own waste in the local area. By transferring the waste to Sechelt, they may feel that they are not being responsible. While it's not expected to be an issue, in Sechelt there may be some resentment towards handling Pender Harbour's waste.

Development of a transfer station at the site will increase traffic to the site, as haulers will need to collect bins and haul to Sechelt every 5 to 10 days, on top of current residential and commercial traffic. This increase in traffic has previously been identified as an issue, so consultation with local community members, particularly along Garden Bay Rd, should be undertaken. By utilizing stationary compactors, the frequency of waste haul can be decreased from 5 to 10 days, meaning that the transfer station would result in only an additional 2 truck movements along Garden Bay Rd every 10 days.

3.4 Transfer Station Conceptual Cost Estimate

3.4.1 Capital Costs

Standard Transfer Bins

Assuming the use of standard transfer bins, and based on the conceptual transfer station design presented in this report, SHA estimated the capital costs for construction of the transfer station based on previous experience within BC. SHA assumed that each Lok Block transfer bay would have a concrete pad at the base, and have a drainage system to protect the structure and that safety railings would be installed on all transfer bays (including existing), with signage included. Capital costs also included grading, gravel for roads and engineering costs.

For this analysis it has been assumed that transfer bins would be leased from the haul company at a rate of $75 per month and costs are included under operational costs. If the SCRD wished to purchase the transfer bins, they cost approximately $8,000 to $9,000 each, and hence would be paid off comparative to leasing them in approximately 10 years. However, in that scenario the SCRD would be responsible for maintenance of the bins. This option should be further analyzed during detailed design of the transfer station.

In total SHA estimates that for 6 new transfer bays and the above noted work, capital costs would be approximately $146,000.

Stationary Compactors

Assuming the use of 3 stationary compactors, and based on the conceptual transfer station design presented in this report, SHA estimated the capital costs for construction of the transfer station based on previous experience within BC. SHA assumed that the two new Lok Block stationary compactor transfer

bays would have a concrete pad at the base, and each have a drainage system to protect the structure, 1 existing transfer bay would be retrofitted to incorporate a stationary compactor with a concrete pad, and that safety railings would be installed on all transfer bays (including existing), with signage included. Capital costs also included grading, gravel for roads and engineering costs, and upgrading the power connection for the 3 stationary compactors.

Transfer bins would be leased from the haul company and costs are included under operational costs as per above. The benefit of leasing over purchasing outright should be assessed at the detailed design stage for the transfer station.

In total SHA estimates that for 2 new stationary compactor transfer bays, retrofitting a stationary compactor to an existing bay and the above noted work, capital costs would be approximately $300,000.

3.4.2 Closure Costs

As part of this option, the landfill would need to be closed in 2010. Based on costs outlined in Section 2.5.2, geomembrane closure for this option would cost approximately $666,500. It has been assumed that for 8,112 m^2 of the steep eastern slopes, no closure work is required.

3.4.3 Post Closure Cost Estimate

Following closure of the landfill, SHA typically allows $1 per m^2 of the waste footprint for post closure monitoring for a period of 25 years. This includes cover system maintenance, monitoring, reporting, administrative staff and power.

Based on this rate, for closure in 2010 the annual post closure cost will be $19,221.

3.4.4 Operating Costs

In order to estimate the operating costs for the transfer station, SHA utilized numbers supplied by the SCRD, and also cost estimates obtained from Norm Bonin of Direct Disposal, a local waste haul contractor. The following assumptions were made to calculate the transfer station operating costs:

- Bin haul from Pender Harbour Landfill to Sechelt Landfill costs $500 per 3 bins round trip.
- Operating cost to SCRD at Sechelt Landfill for waste hauled from Pender Harbour Landfill is $30 per tonne, approximately half of actual operating costs at Sechelt. This value is based on a best estimate of actual operating costs at Sechelt as specific values were not available.
- Bin rental costs $75 per bin per month.
- Stationary compactor operating costs of $500 per year, including power and maintenance.
- Current site staffing costs of $86,950 will apply at Pender Harbour for supervision of transfer station.

Standard Transfer Bins

Assuming the use of standard transfer bins, and based on the haul frequency required under Section 3.1.1, SHA calculated the operational costs for the transfer station for each year of operation, including haul costs to Sechelt and cost of disposal of waste at Sechelt. In 2010, the estimated operational costs were $206,000, or $121 per tonne, in 2020 the costs were $216,500, or $117 per tonne, whilst in 2060

costs total $230,000, or $112 per tonne. As can be seen, operating costs decrease per tonne as waste tonnages increase over time.

Stationary Compactors

Assuming the use of stationary compactors, and based on the haul frequency required under Section 3.1.1, SHA calculated the operational costs for the transfer station for each year of operation, including haul costs to Sechelt and cost of disposal of waste at Sechelt. In 2010, the estimated operational costs were $184,000, or $108 per tonne, in 2020 the costs were $192,000, or $104 per tonne, whilst in 2060 costs total $201,000, or $100 per tonne. As can be seen, operating costs decrease per tonne as waste tonnages increase over time, and the operating costs for stationary compactors are much less than that for standard transfer bins, due to the decrease in waste haul frequency.

3.5 Issues for Siting a New Transfer Station

If a new transfer station were to be located at a more convenient site other than the Pender Harbour Landfill, a study would need to be undertaken to identify a potential site. The study would need to look at the users of the transfer station, and establish where the most convenient location would be to minimize haul times, both for users of the transfer station, and for transfer from Pender Harbour to Sechelt Landfill. Once a list of potential sites have been identified based on location and applicable zoning requirements, further screening should be conducted to assess the impact on potential neighbouring properties, based on aesthetics, odour issues, traffic impacts etc. Consultation with neighbouring properties and the community at large should be undertaken as the location of a transfer station is a sensitive social issue. In other Regional Districts within BC, transfer station location assessments have taken numerous years to complete in a worse case scenario. Generally, transfer stations should be located in industrial areas.

4 Lifecycle Cost Assessment

In order to assess the overall cost to the SCRD of the various scenarios, a Lifecycle Cost Assessment was completed for both of the expansion options, as well as the two transfer station options. The detailed lifecycle assessments for the two landfill expansion options can be found in Tables 4.1 and 4.2 for the western and northern expansions respectively, and for the two transfer station options in Tables 4.3 and 4.4 for the standard transfer bins and stationary compactors respectively. A summary of the Lifecycle Costs is presented in Table 4.5.

The Lifecycle Cost Assessment tables provide a summary of all cost estimations shown in the year that each occurs. The lifespan chosen for all scenarios was one that runs until 2063, 25 years after closure of the option with the longest lifespan, the northern expansion, so that an apples to apples comparison can be made. The year of landfill closure is highlighted and the associated closure costs are shown in the year in which they occur. Capital costs, such as landfill expansion or transfer station construction are shown as well. Revenue from tipping fees is shown, along with annual operating costs for each year of landfill or transfer station operation, and annual post closure costs are shown for a period of 25 years following landfill closure as per MoE requirements. The funds put aside for the landfill closure reserve are also shown whilst the landfill is operational. Totals for each cost category over the life of the assessment are shown at the bottom of the table. The total cost for each scenario has been calculated

based on a summation of the total capital, operating, closure and post closure costs on a per tonne basis. The total cost of each option in comparison to the revenue collected from tipping fees is shown in the far right column. Interest payment on any debt or credit has been calculated and is accrued from year to year.

4.1 Assumptions

The following assumptions were made for the Lifecycle Cost Assessments:

- Interest rate 3%.
- Lifecycle taken to begin in 2010 and end following end of post closure period for longest option, being 2063 for northern expansion.
- Expansion works to be undertaken in 2010 for western and northern options. Progressive closure of crest of existing landfill to be undertaken in 2010 as part of northern expansion.
- Western expansion to close in 2025, northern expansion to close in 2038.
- For the two landfill expansion options and the standard transfer bin option, once landfill closed, transfer station constructed and waste hauled to Sechelt Landfill as per costs outlined in Section 3.4 utilizing standard transfer bins (without stationary compactors).
- For stationary compactor option, once landfill closed, transfer station constructed and waste hauled to Sechelt Landfill as per costs outlined in Section 3.4 utilizing stationary compactors.
- All dollars in 2008 values.
- Closure fund will be at $500,000 in 2010. Closure fund can only be used for closure works and not other capital works. Closure fund treated as revenue in year of use.
- Tipping fee of $90 assumed for waste disposed at Pender Harbour, either during landfill operations or transfer operations.

4.2 Lifecycle Costs

A summary of the Lifecycle Cost Assessment is shown in Table 4.5, and further described in the following section. In addition to the values calculated in Table 4.1 to 4.4, a Break Even Tipping fee has been calculated and shown. The Break Even Tipping fee is the tipping fee the SCRD would have to charge over the life of the analysis in order for there to be zero debt from the operation of the system in 2063. This value incorporates all operational costs and revenues, as well as interest accrued on any debts or credits, and is the best indicator of the actual cost of the waste system to the SCRD during the analysis period.

In summary, the Lifecycle Cost Assessment shows that operating costs far outweigh capital or closure costs for any of the options. Hence, the option with the lowest operating costs will provide the cheapest solution, which happens to be the transfer station with stationary compactors. The total costs for all options outweighs the revenue created via the $90 tipping fee, with the stationary compactor option having the lowest Break Even Tipping Fee of $115.79 per tonne (cumulative net revenue of -$6.68 million) and hence providing the greatest value to the SCRD. The northern expansion has the highest Break Even Tipping Fee of $142.67 per tonne (cumulative net revenue of -$13.65 million). This indicates that for any option, the SCRD will either have to fund the difference or increase the tipping fee to reach a cumulative net revenue of $0.

The total operating costs, factoring in all expenditures, range from $112 to $139 per tonne, with the stationary compactor option being the lowest, and the northern expansion the highest. The transfer station using standard transfer bins has the lowest capital costs at $0.15 million, while the northern expansion has the highest capital expenditure at $0.41 million. Both of the transfer station options have the lowest closure costs at $0.67 million, while the northern expansion has the highest closure costs at $1.48 million.

For the western expansion if closure were to be undertaken in 2026, the closure fund would easily cover the cost of closure, with approximately $1.7 million in closure funds available. For the northern expansion, if closure were to be undertaken in 2039, the closure fund would easily cover the cost of closure, with approximately $2.2 million in closure funds available. The closure fund would also cover the phased closure in 2010, with $500,000 available at that time. For both transfer station options if closure were to be undertaken in 2010, the closure fund would not have adequate funds to cover this, with approximately $500,000 in closure funds available and closure costs estimated at $666,000.

4.3 Impact of Waste Compaction

SHA utilized the Lifecycle Cost Assessment spreadsheet to determine the impact of waste compaction within the transfer bins on lifecycle costs. If the waste compaction in the standard transfer bins is less than the 0.2 tonnes/m^3 assumed by SHA, and closer to the 0.1 tonnes/m^3 indicated by onsite data, this will increase the operating costs of waste disposal utilizing the standard transfer bins to approximately $147 per tonne, compared with $124 per tonne when compaction is at 0.2 tonnes/m^3. As this method of waste transfer has been factored into the Lifecycle Cost Assessments for the two expansions during the post closure monitoring periods, this will also increase the cost of waste disposal for these options, but to a slightly lesser extent. Only if the waste compaction within the standard transfer bins is below 0.05 tonnes/m^3 will the landfill expansion options become a cheaper form of waste disposal than closing the landfill and constructing a transfer station with standard transfer bins.

This shows the importance of waste compaction to reduce waste transfer haul frequency, and the large economic benefits of utilizing stationary compactors over standard transfer bins. Overall, the Lifecycle Cost Assessment shows that the transfer station with stationary compactors provides the most economic solution for the SCRD, with savings over the lifespan in the range of $2.6 to $7.0 million when compared to the alternatives.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the analysis and assumptions made as part of this assessment, SHA makes the following conclusions:

- If the landfill is expanded, up to 16 years of additional capacity can be achieved with a western expansion, and 29 years can be achieved with a northern expansion.
- A transfer station utilizing standard transfer bins will require 4 new bays with 50 yd bins. Three bins would need to be emptied every 4 to 5 days in 2010.
- A transfer station utilizing stationary compactors will require 2 new bays with 50 yd bins and stationary compactors, and 1 retrofitted bay with a 50 yd bin and stationary compactor. Three bins would need to be emptied every 9 days in 2010.
- A transfer station using stationary compactors will require less waste haul transfers and hence have a lower GHG and environmental footprint than a transfer station using standard transfer bins.
- The western landfill expansion will have fewer environmental impacts than the northern expansion as it has a smaller waste footprint.
- Pursuing either landfill expansion option will increase environmental impacts associated with leachate and LFG generation compared to closing the landfill in 2010.
- Either transfer station option will have smaller environmental impacts than the expansion options (GHG impacts unknown at this stage), reducing leachate and LFG generation at the Pender Harbour site. By pooling capital funds and reducing operational costs, environmental controls can be upgraded at Sechelt Landfill to reduce environmental impacts at the site.
- Further study is required to determine the GHG impacts of expansion versus transfer station options. It may be possible that the reduced LFG emissions due to landfill closure and increased environmental controls may offset increased GHG emissions from waste haul from Pender Harbour to Sechelt.
- The major social issue is that of dealing with waste disposal locally. By expanding the landfill, local residents will be happy with dealing with their own waste, but they may be concerned if waste is hauled to Sechelt. By closing the landfill, some local residents may be happy as they may not like to live near an operating landfill.
- Passive LFG control with biofilter should be incorporated into landfill closures. Biocover should be placed on steep slopes if field investigation determines LFG emissions from that area.
- Steep slope closure requirements need to be confirmed with the MoE.
- More investigation is required into the compaction density in the transfer bins, as current data suggests it is below 0.1 tonnes per m^3, where it should be in the range of 0.2 tonnes per m^3.
- Lifecycle Cost Assessment of transfer station options and expansion options found that stationary compactors transfer station is the cheapest option, with a lifecycle Break Even Tipping Fee of $116 per tonne, compared to $126 per tonne for the standard transfer bin transfer station, $132 per tonne for the western expansion and $143 per tonne for the northern expansion. This is because the operating costs of the Pender Harbour Landfill are very high, whilst operating costs at Sechelt and associated waste transfer costs are lower. This will offer savings over the lifespan in the range of $2.6 to $7.0 million when compared to the alternatives.

- The closure fund does not have enough reserves to cover the closure of the landfill in 2010. If the closure fund continued at the same rate, excess funds will be collected for closure in 2026 or 2039 as per western and northern expansion options.

5.2 Recommendations

Based on the finding of this assessment, SHA's recommends closure of the Pender Harbour Landfill and construction of a transfer station with stationary compactors at the site to haul waste to the Sechelt Landfill subject to the following:

1. An investigation of GHG emissions associated with both the transfer station and expansion options be conducted to estimate environmental impacts; and
2. Public consultation with the affected community be conducted to solicit input on, and determine public support for each option;

The recommendation acknowledges that with respect to:

1. Environmental Impact: closure of the Pender Harbour Landfill in 2010 reduces the environmental impact from waste disposal and lessens any impact on surface and ground water in the area; and
2. Economic Impact: closure of the Pender Harbour Landfill in 2010 and conversion to a transfer station is the most economical life cycle option (i.e. in terms of both capital and long term operating costs).

6 LIMITATIONS

This report has been prepared by Sperling Hansen Associates (SHA) on behalf of the Sunshine Coast Regional District in accordance with generally accepted engineering practices to a level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions in British Columbia, subject to the time limits and financial and physical constraints applicable to the services.

The report, which specifically includes all tables and figures, is based on engineering analysis by SHA staff of data compiled during the course of the project. Except where specifically stated to the contrary, the information on which this study is based has been obtained from external sources. This external information has not been independently verified or otherwise examined by Sperling Hansen Associates to determine its accuracy and completeness. Sperling Hansen Associates has relied in good faith on this information and does not accept responsibility of any deficiency, misstatements or inaccuracies contained in the reports as a result of omissions, misinterpretation and/or fraudulent acts of the persons interviewed or contacted, or errors or omissions in the reviewed documentation.

The report is intended solely for the use of the Sunshine Coast Regional District. Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Sperling Hansen Associates does not accept any responsibility for other uses of the material contained herein nor for damages, if any, suffered by any third party because of decisions made or actions based on this report. Copying of this intellectual property for other purposes is not permitted.

The findings and conclusions of this report are valid only as of the date of this report. The interpretations presented in this report and the conclusions and recommendations that are drawn are based on information that was made available to Sperling Hansen Associates during the course of this project. Should additional new data become available in the future, Sperling Hansen Associates should be requested to re-evaluate the findings of this report and modify the conclusions and recommendations drawn, as required.

Report prepared by:

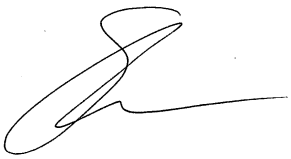

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Table 2.2
Lifespan Analysis
Pender Harbour Landfill

Year	Estimated Population	Annual Growth Rate	Waste Disposed tonnes	Waste Landfilled tonnes	Waste Landfilled m^3	Cumulative Waste LF m^3	Cover Soil m^3	Cumulative Cover m^3	Settlement m^3	Net Airspace m^3	Cumulative Airspace m^3
2006	2,624	1.00%			0	0	0	0	0	0	0
2007	2,650	1.00%			0	0	0	0	0	0	0
2008	2,677	1.00%	809	1,112	1,483	1,483	710	710	219	1,974	1,974
2009	2,704	0.97%	2,452	1,685	2,247	3,730	1,076	1,787	332	2,991	4,965
2010	2,730	0.97%	2,476	1,702	2,269	5,999	1,087	2,874	336	3,020	7,985
2011	2,756	0.92%	2,500	1,718	2,291	8,290	1,097	3,971	339	3,049	11,034
2012	2,781	0.89%	2,523	1,734	2,312	10,601	1,107	5,078	342	3,077	14,112
2013	2,806	0.89%	2,546	1,749	2,332	12,934	1,117	6,196	345	3,105	17,216
2014	2,831	0.83%	2,568	1,765	2,353	15,287	1,127	7,323	348	3,132	20,348
2015	2,855	0.83%	2,589	1,779	2,373	17,659	1,137	8,459	351	3,158	23,507
2016	2,878	0.83%	2,611	1,794	2,392	20,051	1,146	9,605	354	3,184	26,691
2017	2,902	0.83%	2,633	1,809	2,412	22,464	1,155	10,761	357	3,211	29,902
2018	2,926	0.84%	2,654	1,824	2,432	24,896	1,165	11,926	360	3,237	33,139
2019	2,951	0.85%	2,677	1,839	2,452	27,348	1,175	13,100	363	3,264	36,404
2020	2,976	0.87%	2,699	1,855	2,473	29,821	1,185	14,285	366	3,292	39,696
2021	3,002	0.88%	2,723	1,871	2,495	32,316	1,195	15,480	369	3,321	43,017
2022	3,028	0.87%	2,747	1,888	2,517	34,833	1,206	16,686	372	3,350	46,367
2023	3,054	0.85%	2,771	1,904	2,539	37,371	1,216	17,902	375	3,379	49,746
2024	3,080	0.87%	2,794	1,920	2,560	39,931	1,226	19,128	379	3,408	53,154
2025	3,107	0.82%	2,818	1,937	2,582	42,514	1,237	20,365	382	3,438	56,591
2026	3,133	0.82%	2,842	1,953	2,604	45,117	1,247	21,612	385	3,466	60,057
2027	3,158	0.81%	2,865	1,969	2,625	47,742	1,257	22,870	388	3,494	63,551
2028	3,184	0.76%	2,888	1,985	2,646	50,389	1,268	24,137	391	3,522	67,073
2029	3,208	0.72%	2,910	2,000	2,666	53,055	1,277	25,415	394	3,549	70,623
2030	3,231	0.68%	2,931	2,014	2,686	55,741	1,286	26,701	397	3,575	74,198
2031	3,253	0.62%	2,951	2,028	2,704	58,444	1,295	27,996	400	3,599	77,797
2032	3,273	0.55%	2,969	2,040	2,721	61,165	1,303	29,300	402	3,621	81,418
2033	3,291	0.50%	2,985	2,052	2,735	63,900	1,310	30,610	405	3,641	85,059
2034	3,308	0.50%	3,000	2,062	2,749	66,649	1,317	31,927	407	3,659	88,718
2035	3,324	0.48%	3,015	2,072	2,763	69,412	1,323	33,250	409	3,678	92,396
2036	3,340	0.43%	3,030	2,082	2,776	72,188	1,330	34,580	411	3,695	96,091
2037	3,355	0.43%	3,043	2,091	2,788	74,976	1,336	35,916	412	3,711	99,802
2038	3,369	0.43%	3,056	2,100	2,800	77,776	1,341	37,257	414	3,727	103,530

Settlement =	10.0%	per year
Waste Disposal Rate =	0.907	tonnes/person/year
Waste Landfill Rate =	0.623	tonnes/person/year
Waste to Cover Ratio =	2.09	vol/vol
Waste Density =	0.75	tonnes/m^3

	Weight	Density	Vol	W:C
Waste Disposed 2007	1652	0.75	2202.67	2.08757
Cover soil 2007	1952	1.85	1055.14	

Option	Airspace (accounting for Final Cover)	
Northern Expansion	100,619	m3
Western Expansion	53,284	m3

Option	Virgin Area Impacted	
Northern Expansion	14,744	m2
Western Expansion	5,424	m2

Option	Ratio Volume to Virgin Area	
Northern Expansion	7	m3/m2
Western Expansion	10	m3/m2

Table 3.1
Transfer Station Haul Frequencies

Year	Waste Requiring Transfer (tonnes/yr)	Waste Requiring Transfer (m3/yr)	Waste Requiring Transfer (m3/d)	Transfer Station Capacity (m3)	Frequency of All Bins at Capacity (days)	Time to Fill 40yd Bin (days	Time to Fill 50yd Bin (days)
2009	1,685	8,426	23.1	214	9.3	1.33	1.66
2010	1,702	8,508	23.3	214	9.2	1.31	1.64
2011	1,718	8,590	23.5	214	9.1	1.30	1.63
2012	1,734	8,669	23.8	214	9.0	1.29	1.61
2013	1,749	8,746	24.0	214	8.9	1.28	1.60
2014	1,765	8,824	24.2	214	8.9	1.27	1.58
2015	1,779	8,897	24.4	214	8.8	1.26	1.57
2016	1,794	8,971	24.6	214	8.7	1.25	1.56
2017	1,809	9,045	24.8	214	8.6	1.23	1.54
2018	1,824	9,120	25.0	214	8.6	1.22	1.53
2019	1,839	9,197	25.2	214	8.5	1.21	1.52
2020	1,855	9,275	25.4	214	8.4	1.20	1.51
2021	1,871	9,355	25.6	214	8.4	1.19	1.49
2022	1,888	9,438	25.9	214	8.3	1.18	1.48
2023	1,904	9,519	26.1	214	8.2	1.17	1.47
2024	1,920	9,600	26.3	214	8.1	1.16	1.45
2025	1,937	9,684	26.5	214	8.1	1.15	1.44
2026	1,953	9,763	26.7	214	8.0	1.14	1.43
2027	1,969	9,844	27.0	214	7.9	1.13	1.42
2028	1,985	9,923	27.2	214	7.9	1.13	1.41
2029	2,000	9,999	27.4	214	7.8	1.12	1.40
2030	2,014	10,071	27.6	214	7.8	1.11	1.39
2031	2,028	10,139	27.8	214	7.7	1.10	1.38
2032	2,040	10,202	28.0	214	7.7	1.09	1.37
2033	2,052	10,258	28.1	214	7.6	1.09	1.36
2034	2,062	10,309	28.2	214	7.6	1.08	1.35
2035	2,072	10,360	28.4	214	7.5	1.08	1.35
2036	2,082	10,410	28.5	214	7.5	1.07	1.34
2037	2,091	10,455	28.6	214	7.5	1.07	1.34
2038	2,100	10,500	28.8	214	7.4	1.06	1.33
2039	2,109	10,545	28.9	214	7.4	1.06	1.32
2040	2,118	10,591	29.0	214	7.4	1.05	1.32
2041	2,127	10,637	29.1	214	7.4	1.05	1.31
2042	2,136	10,682	29.3	214	7.3	1.05	1.31
2043	2,146	10,729	29.4	214	7.3	1.04	1.30
2044	2,155	10,775	29.5	214	7.3	1.04	1.30
2045	2,164	10,821	29.6	214	7.2	1.03	1.29
2046	2,174	10,868	29.8	214	7.2	1.03	1.28
2047	2,183	10,915	29.9	214	7.2	1.02	1.28
2048	2,192	10,962	30.0	214	7.1	1.02	1.27
2049	2,202	11,009	30.2	214	7.1	1.01	1.27
2050	2,211	11,057	30.3	214	7.1	1.01	1.26
2051	2,221	11,105	30.4	214	7.0	1.01	1.26
2052	2,231	11,153	30.6	214	7.0	1.00	1.25
2053	2,240	11,201	30.7	214	7.0	1.00	1.25
2054	2,250	11,249	30.8	214	7.0	0.99	1.24
2055	2,260	11,298	31.0	214	6.9	0.99	1.24
2056	2,269	11,346	31.1	214	6.9	0.98	1.23
2057	2,279	11,395	31.2	214	6.9	0.98	1.23
2058	2,289	11,444	31.4	214	6.8	0.98	1.22
2059	2,299	11,494	31.5	214	6.8	0.97	1.21
2060	2,309	11,543	31.6	214	6.8	0.97	1.21
2061	2,319	11,593	31.8	214	6.7	0.96	1.20
2062	2,329	11,643	31.9	214	6.7	0.96	1.20
2063	2,339	11,693	32.0	214	6.7	0.96	1.19

Uncompacted Waste Density	0.2	tonnes/m3
1yd =	0.765	m3
Existing 40 yd bins	2	units
New 50 yd bins	4	units

Table 3.2
Transfer Station Haul Frequencies - Stationary Compactors

Year	Waste Requiring Transfer (tonnes/yr)	Waste Requiring Transfer (m3/yr)	Waste Requiring Transfer (m3/d)	Transfer Station Capacity (m3)	Frequency of All Bins at Capacity (days)	Time to Fill 40yd Bin (days	Time to Fill 50yd Bin (days)
2009	1,685	4,213	11.5	115	9.9	2.65	3.31
2010	1,702	4,254	11.7	115	9.8	2.63	3.28
2011	1,718	4,295	11.8	115	9.8	2.60	3.25
2012	1,734	4,335	11.9	115	9.7	2.58	3.22
2013	1,749	4,373	12.0	115	9.6	2.55	3.19
2014	1,765	4,412	12.1	115	9.5	2.53	3.16
2015	1,779	4,448	12.2	115	9.4	2.51	3.14
2016	1,794	4,485	12.3	115	9.3	2.49	3.11
2017	1,809	4,523	12.4	115	9.3	2.47	3.09
2018	1,824	4,560	12.5	115	9.2	2.45	3.06
2019	1,839	4,598	12.6	115	9.1	2.43	3.04
2020	1,855	4,637	12.7	115	9.0	2.41	3.01
2021	1,871	4,678	12.8	115	9.0	2.39	2.98
2022	1,888	4,719	12.9	115	8.9	2.37	2.96
2023	1,904	4,760	13.0	115	8.8	2.35	2.93
2024	1,920	4,800	13.2	115	8.7	2.33	2.91
2025	1,937	4,842	13.3	115	8.7	2.31	2.88
2026	1,953	4,882	13.4	115	8.6	2.29	2.86
2027	1,969	4,922	13.5	115	8.5	2.27	2.84
2028	1,985	4,962	13.6	115	8.4	2.25	2.81
2029	2,000	5,000	13.7	115	8.4	2.23	2.79
2030	2,014	5,035	13.8	115	8.3	2.22	2.77
2031	2,028	5,070	13.9	115	8.3	2.20	2.75
2032	2,040	5,101	14.0	115	8.2	2.19	2.74
2033	2,052	5,129	14.1	115	8.2	2.18	2.72
2034	2,062	5,155	14.1	115	8.1	2.17	2.71
2035	2,072	5,180	14.2	115	8.1	2.16	2.70
2036	2,082	5,205	14.3	115	8.0	2.15	2.68
2037	2,091	5,227	14.3	115	8.0	2.14	2.67
2038	2,100	5,250	14.4	115	8.0	2.13	2.66
2039	2,109	5,273	14.4	115	7.9	2.12	2.65
2040	2,118	5,295	14.5	115	7.9	2.11	2.64
2041	2,127	5,318	14.6	115	7.9	2.10	2.63
2042	2,136	5,341	14.6	115	7.8	2.09	2.61
2043	2,146	5,364	14.7	115	7.8	2.08	2.60
2044	2,155	5,387	14.8	115	7.8	2.07	2.59
2045	2,164	5,411	14.8	115	7.7	2.06	2.58
2046	2,174	5,434	14.9	115	7.7	2.06	2.57
2047	2,183	5,457	15.0	115	7.7	2.05	2.56
2048	2,192	5,481	15.0	115	7.6	2.04	2.55
2049	2,202	5,505	15.1	115	7.6	2.03	2.54
2050	2,211	5,528	15.1	115	7.6	2.02	2.53
2051	2,221	5,552	15.2	115	7.5	2.01	2.51
2052	2,231	5,576	15.3	115	7.5	2.00	2.50
2053	2,240	5,600	15.3	115	7.5	1.99	2.49
2054	2,250	5,624	15.4	115	7.4	1.99	2.48
2055	2,260	5,649	15.5	115	7.4	1.98	2.47
2056	2,269	5,673	15.5	115	7.4	1.97	2.46
2057	2,279	5,698	15.6	115	7.4	1.96	2.45
2058	2,289	5,722	15.7	115	7.3	1.95	2.44
2059	2,299	5,747	15.7	115	7.3	1.94	2.43
2060	2,309	5,772	15.8	115	7.3	1.94	2.42
2061	2,319	5,797	15.9	115	7.2	1.93	2.41
2062	2,329	5,822	15.9	115	7.2	1.92	2.40
2063	2,339	5,847	16.0	115	7.2	1.91	2.39

Compacted waste density	0.4	tonnes/m3
1yd =	0.765	m3
Existing 40 yd bins	0	units
New 50 yd bins	3	units

Table 4.1: Cash Flow Analysis
Western Expansion

Year		Total Residual tonnes/year	Tipping Fee Revenue $ / yr	Capital Cost $ / yr	Phased Closure Cost $ / yr	Annual Operating Cost $ / yr	Post Closure Cost $ / yr	Reserve for Landfill Closure $/yr	Total Cost $ / yr	Net Revenue $ / yr	Cumulative Net Revenue $
2010	1	1,702	$153,140	$155,378		$264,542		$41,200	$461,120	($307,980)	**($317,219)**
2011	2	1,718	$154,627			$267,110		$41,600	$267,110	($112,484)	**($439,220)**
2012	3	1,734	$156,043			$269,557		$41,981	$269,557	($113,514)	**($565,910)**
2013	4	1,749	$157,434			$271,960		$42,355	$271,960	($114,526)	**($697,414)**
2014	5	1,765	$158,830			$274,372		$42,731	$274,372	($115,542)	**($833,878)**
2015	6	1,779	$160,146			$276,645		$43,085	$276,645	($116,499)	**($975,393)**
2016	7	1,794	$161,477			$278,944		$43,443	$278,944	($117,467)	**($1,122,122)**
2017	8	1,809	$162,818			$281,260		$43,803	$281,260	($118,442)	**($1,274,228)**
2018	9	1,824	$164,164			$283,585		$44,166	$283,585	($119,422)	**($1,431,876)**
2019	10	1,839	$165,540			$285,962		$44,536	$285,962	($120,423)	**($1,595,255)**
2020	11	1,855	$166,946			$288,391		$44,914	$288,391	($121,446)	**($1,764,558)**
2021	12	1,871	$168,397			$290,899		$45,305	$290,899	($122,501)	**($1,939,997)**
2022	13	1,888	$169,879			$293,458		$45,703	$293,458	($123,579)	**($2,121,776)**
2023	14	1,904	$171,350			$296,000		$46,099	$296,000	($124,650)	**($2,310,078)**
2024	15	1,920	$172,807			$298,516		$46,491	$298,516	($125,709)	**($2,505,090)**
2025	16	1,937	$174,313	$146,250		$301,118		$46,896	$447,368	($273,055)	**($2,853,298)**
2026	17	1,953	$1,887,537		$991,980	$223,176	$24,645		$1,239,801	$647,736	**($2,291,160)**
2027	18	1,969	$177,186			$224,253	$24,645		$248,898	($71,712)	**($2,431,607)**
2028	19	1,985	$178,617			$225,318	$24,645		$249,963	($71,346)	**($2,575,901)**
2029	20	2,000	$179,983			$226,335	$24,645		$250,980	($70,997)	**($2,724,175)**
2030	21	2,014	$181,274			$227,296	$24,645		$251,941	($70,667)	**($2,876,568)**
2031	22	2,028	$182,504			$228,212	$24,645		$252,857	($70,353)	**($3,033,218)**
2032	23	2,040	$183,634			$229,053	$24,645		$253,698	($70,064)	**($3,194,278)**
2033	24	2,052	$184,639			$229,801	$24,645		$254,446	($69,807)	**($3,359,913)**
2034	25	2,062	$185,563			$230,489	$24,645		$255,134	($69,571)	**($3,530,282)**
2035	26	2,072	$186,487			$231,177	$24,645		$255,822	($69,335)	**($3,705,525)**
2036	27	2,082	$187,381			$231,842	$24,645		$256,487	($69,106)	**($3,885,797)**
2037	28	2,091	$188,189			$232,444	$24,645		$257,089	($68,900)	**($4,071,271)**
2038	29	2,100	$189,001			$233,049	$24,645		$257,694	($68,692)	**($4,262,101)**
2039	30	2,109	$189,817			$233,657	$24,645		$258,302	($68,485)	**($4,458,449)**
2040	31	2,118	$190,636			$234,268	$24,645		$258,913	($68,276)	**($4,660,479)**
2041	32	2,127	$191,459			$234,881	$24,645		$259,526	($68,067)	**($4,868,361)**
2042	33	2,136	$192,285			$235,497	$24,645		$260,142	($67,857)	**($5,082,268)**
2043	34	2,146	$193,115			$236,116	$24,645		$260,761	($67,646)	**($5,302,382)**
2044	35	2,155	$193,948			$236,737	$24,645		$261,382	($67,434)	**($5,528,888)**
2045	38	2,164	$194,785			$237,361	$24,645		$262,006	($67,221)	**($5,761,976)**
2046	39	2,174	$195,625			$237,988	$24,645		$262,633	($67,007)	**($6,001,842)**
2047	40	2,183	$196,469			$238,617	$24,645		$263,262	($66,793)	**($6,248,690)**
2048	41	2,192	$197,317			$239,249	$24,645		$263,894	($66,577)	**($6,502,728)**
2049	42	2,202	$198,169			$239,884	$24,645		$264,529	($66,360)	**($6,764,170)**
2050	43	2,211	$199,024			$240,522	$24,645		$265,167	($66,143)	**($7,033,238)**
2051	44	2,221	$199,883			$241,162			$241,162	($41,279)	**($7,285,514)**
2052	45	2,231	$200,745			$241,805			$241,805	($41,060)	**($7,545,140)**
2053	46	2,240	$201,611			$242,451			$242,451	($40,840)	**($7,812,333)**
2054	47	2,250	$202,481			$243,099			$243,099	($40,618)	**($8,087,322)**
2055	48	2,260	$203,355			$243,751			$243,751	($40,396)	**($8,370,337)**
2056	49	2,269	$204,233			$244,405			$244,405	($40,173)	**($8,661,620)**
2057	50	2,279	$205,114			$245,062			$245,062	($39,948)	**($8,961,417)**
2058	51	2,289	$205,999			$245,722			$245,722	($39,723)	**($9,269,983)**
2059	52	2,299	$206,888			$246,385			$246,385	($39,497)	**($9,587,579)**
2060	53	2,309	$207,781			$247,050			$247,050	($39,270)	**($9,914,476)**
2061	54	2,319	$208,677			$247,719			$247,719	($39,042)	**($10,250,952)**
2062	55	2,329	$209,578			$248,390			$248,390	($38,813)	**($10,597,294)**
2063	56	2,339	$210,482			$249,064			$249,064	($38,582)	**($10,953,795)**
		111,084	**$ 11,709,379**	**$ 301,628**	**$ 991,980**	**$ 13,525,606**	**$ 616,125**	**$ 704,307**	**$ 15,476,538**	**$ (3,767,159)**	

Current Tipping Fee = $90.00 per tonne of waste

Interest rate = 3.00%

Annual Operating Cost (per tonne of waste) = $ 155.47

	Total Cost	$/tonne
Total Revenues =	$11,709,379	105.41
Total Landfilling Cost (excluding interest) =	$15,476,538	139.32
Total Capital Cost =	$301,628	2.72
Total Closure Cost =	$991,980	8.93
Total Operating Expenses =	$13,525,606	121.76
Total Post Operating Cost =	$616,125	5.55
Total Landfilling Cost (including interest charges)	**$15,435,338**	**138.95**

Table 4.2: Cash Flow Analysis
Northern Expansion

Year		Total Residual tonnes/year	Tipping Fee Revenue $ / yr	Capital Cost $ / yr	Phased Closure Cost $ / yr	Annual Operating Cost $ / yr	Post Closure Cost $ / yr	Reserve for Landfill Closure $/yr	Total Cost $ / yr	Net Revenue $ / yr	Cumulative Net Revenue $
2010	1	1,702	$633,140	$266,846	$480,000	$264,542		$41,200	$1,052,588	($419,448)	**($432,031)**
2011	2	1,718	$154,627			$267,110		$41,600	$267,110	($112,484)	**($557,476)**
2012	3	1,734	$156,043			$269,557		$41,981	$269,557	($113,514)	**($687,714)**
2013	4	1,749	$157,434			$271,960		$42,355	$271,960	($114,526)	**($822,872)**
2014	5	1,765	$158,830			$274,372		$42,731	$274,372	($115,542)	**($963,100)**
2015	6	1,779	$160,146			$276,645		$43,085	$276,645	($116,499)	**($1,108,492)**
2016	7	1,794	$161,477			$278,944		$43,443	$278,944	($117,467)	**($1,259,213)**
2017	8	1,809	$162,818			$281,260		$43,803	$281,260	($118,442)	**($1,415,432)**
2018	9	1,824	$164,164			$283,585		$44,166	$283,585	($119,422)	**($1,577,317)**
2019	10	1,839	$165,540			$285,962		$44,536	$285,962	($120,423)	**($1,745,059)**
2020	11	1,855	$166,946			$288,391		$44,914	$288,391	($121,446)	**($1,918,856)**
2021	12	1,871	$168,397			$290,899		$45,305	$290,899	($122,501)	**($2,098,923)**
2022	13	1,888	$169,879			$293,458		$45,703	$293,458	($123,579)	**($2,285,470)**
2023	14	1,904	$171,350			$296,000		$46,099	$296,000	($124,650)	**($2,478,684)**
2024	15	1,920	$172,807			$298,516		$46,491	$298,516	($125,709)	**($2,678,753)**
2025	16	1,937	$174,313			$301,118		$46,896	$301,118	($126,805)	**($2,885,921)**
2026	17	1,953	$175,740			$303,582		$47,280	$303,582	($127,843)	**($3,100,341)**
2027	18	1,969	$177,186			$306,081		$47,669	$306,081	($128,895)	**($3,322,246)**
2028	19	1,985	$178,617			$308,553		$48,054	$308,553	($129,936)	**($3,551,850)**
2029	20	2,000	$179,983			$310,913		$48,422	$310,913	($130,930)	**($3,789,335)**
2030	21	2,014	$181,274			$313,143		$48,769	$313,143	($131,869)	**($4,034,884)**
2031	22	2,028	$182,504			$315,268		$49,100	$315,268	($132,764)	**($4,288,694)**
2032	23	2,040	$183,634			$317,220		$49,404	$317,220	($133,586)	**($4,550,940)**
2033	24	2,052	$184,639			$318,955		$49,674	$318,955	($134,316)	**($4,821,785)**
2034	25	2,062	$185,563			$320,551		$49,923	$320,551	($134,989)	**($5,101,427)**
2035	26	2,072	$186,487			$322,148		$50,171	$322,148	($135,661)	**($5,390,131)**
2036	27	2,082	$187,381			$323,692		$50,412	$323,692	($136,311)	**($5,688,146)**
2037	28	2,091	$188,189			$325,089		$50,629	$325,089	($136,899)	**($5,995,689)**
2038	29	2,100	$189,001	$146,250		$326,492		$50,848	$472,742	($283,740)	**($6,459,300)**
2039	30	2,109	$2,395,853		$997,680	$233,657	$29,222		$1,260,559	$1,135,295	**($5,517,785)**
2040	31	2,118	$190,636			$234,268	$29,222		$263,490	($72,853)	**($5,756,172)**
2041	32	2,127	$191,459			$234,881	$29,222		$264,103	($72,644)	**($6,001,501)**
2042	33	2,136	$192,285			$235,497	$29,222		$264,719	($72,434)	**($6,253,980)**
2043	34	2,146	$193,115			$236,116	$29,222		$265,338	($72,223)	**($6,513,822)**
2044	35	2,155	$193,948			$236,737	$29,222		$265,959	($72,011)	**($6,781,248)**
2045	38	2,164	$194,785			$237,361	$29,222		$266,583	($71,798)	**($7,056,484)**
2046	39	2,174	$195,625			$237,988	$29,222		$267,210	($71,584)	**($7,339,763)**
2047	40	2,183	$196,469			$238,617	$29,222		$267,839	($71,370)	**($7,631,325)**
2048	41	2,192	$197,317			$239,249	$29,222		$268,471	($71,154)	**($7,931,419)**
2049	42	2,202	$198,169			$239,884	$29,222		$269,106	($70,937)	**($8,240,299)**
2050	43	2,211	$199,024			$240,522	$29,222		$269,744	($70,720)	**($8,558,227)**
2051	44	2,221	$199,883			$241,162	$29,222		$270,384	($70,501)	**($8,885,476)**
2052	45	2,231	$200,745			$241,805	$29,222		$271,027	($70,282)	**($9,222,322)**
2053	46	2,240	$201,611			$242,451	$29,222		$271,673	($70,062)	**($9,569,053)**
2054	47	2,250	$202,481			$243,099	$29,222		$272,321	($69,840)	**($9,925,965)**
2055	48	2,260	$203,355			$243,751	$29,222		$272,973	($69,618)	**($10,293,361)**
2056	49	2,269	$204,233			$244,405	$29,222		$273,627	($69,395)	**($10,671,557)**
2057	50	2,279	$205,114			$245,062	$29,222		$274,284	($69,170)	**($11,060,874)**
2058	51	2,289	$205,999			$245,722	$29,222		$274,944	($68,945)	**($11,461,645)**
2059	52	2,299	$206,888			$246,385	$29,222		$275,607	($68,719)	**($11,874,214)**
2060	53	2,309	$207,781			$247,050	$29,222		$276,272	($68,492)	**($12,298,932)**
2061	54	2,319	$208,677			$247,719	$29,222		$276,941	($68,264)	**($12,736,164)**
2062	55	2,329	$209,578			$248,390	$29,222		$277,612	($68,035)	**($13,186,283)**
2063	56	2,339	$210,482			$249,064	$29,222		$278,286	($67,804)	**($13,649,676)**
		111,084	**$ 12,683,618**	**$ 413,096**	**$ 1,477,680**	**$ 14,664,847**	**$ 730,550**	**$ 1,344,662**	**$ 17,327,372**	**$ (4,643,754)**	

Current Tipping Fee = $90.00 per tonne of waste

Interest rate = 3.00%

Annual Operating Cost (per tonne of waste) = $ 155.47

	Total Cost	$/tonne
Total Revenues =	$12,683,618	114.18
Total Landfilling Cost (excluding interest) =	$17,327,372	155.98
Total Capital Cost =	$413,096	3.72
Total Closure Cost =	$1,477,680	13.30
Total Operating Expenses =	$14,664,847	132.02
Total Post Operating Cost =	$730,550	6.58
Total Landfilling Cost (including interest charges)	**$17,286,172**	**155.61**

Table 4.3: Cash Flow Analysis
Transfer Station

Year		Total Residual tonnes/year	Tipping Fee Revenue $ / yr	Capital Cost $ / yr	Phased Closure Cost $ / yr	Annual Operating Cost $ / yr	Post Closure Cost $ / yr	Reserve for Landfill Closure $/yr	Total Cost $ / yr	Net Revenue $ / yr	Cumulative Net Revenue $
2010	1	1,702	$653,395	$146,250	$666,540	$206,352			$1,019,142	($365,747)	**($376,719)**
2011	2	1,718	$154,627			$207,459	$19,221		$226,680	($72,053)	**($460,074)**
2012	3	1,734	$156,043			$208,513	$19,221		$227,734	($71,691)	**($545,568)**
2013	4	1,749	$157,434			$209,549	$19,221		$228,770	($71,336)	**($633,271)**
2014	5	1,765	$158,830			$210,588	$19,221		$229,809	($70,979)	**($723,248)**
2015	6	1,779	$160,146			$211,568	$19,221		$230,789	($70,643)	**($815,588)**
2016	7	1,794	$161,477			$212,558	$19,221		$231,779	($70,303)	**($910,358)**
2017	8	1,809	$162,818			$213,557	$19,221		$232,778	($69,960)	**($1,007,629)**
2018	9	1,824	$164,164			$214,559	$19,221		$233,780	($69,616)	**($1,107,474)**
2019	10	1,839	$165,540			$215,583	$19,221		$234,804	($69,264)	**($1,209,962)**
2020	11	1,855	$166,946			$216,630	$19,221		$235,851	($68,905)	**($1,315,166)**
2021	12	1,871	$168,397			$217,710	$19,221		$236,931	($68,534)	**($1,423,155)**
2022	13	1,888	$169,879			$218,813	$19,221		$238,034	($68,155)	**($1,534,005)**
2023	14	1,904	$171,350			$219,909	$19,221		$239,130	($67,779)	**($1,647,805)**
2024	15	1,920	$172,807			$220,993	$19,221		$240,214	($67,407)	**($1,764,646)**
2025	16	1,937	$174,313			$222,114	$19,221		$241,335	($67,022)	**($1,884,607)**
2026	17	1,953	$175,740			$223,176	$19,221		$242,397	($66,658)	**($2,007,803)**
2027	18	1,969	$177,186			$224,253	$19,221		$243,474	($66,288)	**($2,134,325)**
2028	19	1,985	$178,617			$225,318	$19,221		$244,539	($65,922)	**($2,264,277)**
2029	20	2,000	$179,983			$226,335	$19,221		$245,556	($65,573)	**($2,397,778)**
2030	21	2,014	$181,274			$227,296	$19,221		$246,517	($65,243)	**($2,534,955)**
2031	22	2,028	$182,504			$228,212	$19,221		$247,433	($64,929)	**($2,675,932)**
2032	23	2,040	$183,634			$229,053	$19,221		$248,274	($64,640)	**($2,820,850)**
2033	24	2,052	$184,639			$229,801	$19,221		$249,022	($64,383)	**($2,969,858)**
2034	25	2,062	$185,563			$230,489	$19,221		$249,710	($64,147)	**($3,123,101)**
2035	26	2,072	$186,487			$231,177	$19,221		$250,398	($63,911)	**($3,280,705)**
2036	27	2,082	$187,381			$231,842			$231,842	($44,461)	**($3,423,588)**
2037	28	2,091	$188,189			$232,444			$232,444	($44,255)	**($3,570,550)**
2038	29	2,100	$189,001			$233,049			$233,049	($44,047)	**($3,721,714)**
2039	30	2,109	$189,817			$233,657			$233,657	($43,840)	**($3,877,205)**
2040	31	2,118	$190,636			$234,268			$234,268	($43,631)	**($4,037,152)**
2041	32	2,127	$191,459			$234,881			$234,881	($43,422)	**($4,201,689)**
2042	33	2,136	$192,285			$235,497			$235,497	($43,212)	**($4,370,952)**
2043	34	2,146	$193,115			$236,116			$236,116	($43,001)	**($4,545,081)**
2044	35	2,155	$193,948			$236,737			$236,737	($42,789)	**($4,724,223)**
2045	36	2,164	$194,785			$237,361			$237,361	($42,576)	**($4,908,526)**
2046	37	2,174	$195,625			$237,988			$237,988	($42,362)	**($5,098,144)**
2047	38	2,183	$196,469			$238,617			$238,617	($42,148)	**($5,293,236)**
2048	39	2,192	$197,317			$239,249			$239,249	($41,932)	**($5,493,965)**
2049	40	2,202	$198,169			$239,884			$239,884	($41,715)	**($5,700,499)**
2050	41	2,211	$199,024			$240,522			$240,522	($41,498)	**($5,913,012)**
2051	42	2,221	$199,883			$241,162			$241,162	($41,279)	**($6,131,682)**
2052	43	2,231	$200,745			$241,805			$241,805	($41,060)	**($6,356,692)**
2053	44	2,240	$201,611			$242,451			$242,451	($40,840)	**($6,588,232)**
2054	45	2,250	$202,481			$243,099			$243,099	($40,618)	**($6,826,497)**
2055	46	2,260	$203,355			$243,751			$243,751	($40,396)	**($7,071,688)**
2056	47	2,269	$204,233			$244,405			$244,405	($40,173)	**($7,324,011)**
2057	48	2,279	$205,114			$245,062			$245,062	($39,948)	**($7,583,680)**
2058	49	2,289	$205,999			$245,722			$245,722	($39,723)	**($7,850,914)**
2059	50	2,299	$206,888			$246,385			$246,385	($39,497)	**($8,125,938)**
2060	51	2,309	$207,781			$247,050			$247,050	($39,270)	**($8,408,986)**
2061	52	2,319	$208,677			$247,719			$247,719	($39,042)	**($8,700,297)**
2062	53	2,329	$209,578			$248,390			$248,390	($38,813)	**($9,000,119)**
2063	54	2,339	$210,482			$249,064			$249,064	($38,582)	**($9,308,705)**
		111,084	**$ 10,497,837**	**$ 146,250**	**$ 666,540**	**$ 12,429,741**	**$ 480,525**	**$ -**	**$ 13,723,056**	**$ (3,225,219)**	

Current Tipping Fee = $90.00 per tonne of waste

Interest rate = 3.00%

Annual Operating Cost (per tonne of waste) = $ 155.47

	Total Cost	$/tonne
Total Revenues =	$10,497,837	94.50
Total Landfilling Cost (excluding interest) =	$13,723,056	123.54
Total Capital Cost =	$146,250	1.32
Total Closure Cost =	$666,540	6.00
Total Operating Expenses =	$12,429,741	111.89
Total Post Operating Cost =	$480,525	4.33
Total Landfilling Cost (including interest charges)	**$13,723,056**	**123.54**

Table 4.4: Cash Flow Analysis
Transfer Station with Stationary Compactors

Year		Total Residual tonnes/year	Tipping Fee Revenue $ / yr	Capital Cost $ / yr	Phased Closure Cost $ / yr	Annual Operating Cost $ / yr	Post Closure Cost $ / yr	Reserve for Landfill Closure $/yr	Total Cost $ / yr	Net Revenue $ / yr	Cumulative Net Revenue $
2010	1	1,702	$653,395	$299,950	$666,540	$183,969			$1,150,459	($497,063)	**($511,975)**
2011	2	1,718	$154,627			$184,870	$19,221		$204,091	($49,464)	**($576,799)**
2012	3	1,734	$156,043			$185,728	$19,221		$204,949	($48,906)	**($643,009)**
2013	4	1,749	$157,434			$186,571	$19,221		$205,792	($48,359)	**($710,658)**
2014	5	1,765	$158,830			$187,418	$19,221		$206,639	($47,809)	**($779,786)**
2015	6	1,779	$160,146			$188,215	$19,221		$207,436	($47,290)	**($850,470)**
2016	7	1,794	$161,477			$189,022	$19,221		$208,243	($46,766)	**($922,751)**
2017	8	1,809	$162,818			$189,835	$19,221		$209,056	($46,238)	**($996,671)**
2018	9	1,824	$164,164			$190,650	$19,221		$209,871	($45,708)	**($1,072,279)**
2019	10	1,839	$165,540			$191,484	$19,221		$210,705	($45,166)	**($1,149,613)**
2020	11	1,855	$166,946			$192,337	$19,221		$211,558	($44,612)	**($1,228,713)**
2021	12	1,871	$168,397			$193,216	$19,221		$212,437	($44,040)	**($1,309,615)**
2022	13	1,888	$169,879			$194,114	$19,221		$213,335	($43,457)	**($1,392,360)**
2023	14	1,904	$171,350			$195,006	$19,221		$214,227	($42,877)	**($1,477,007)**
2024	15	1,920	$172,807			$195,889	$19,221		$215,110	($42,303)	**($1,563,621)**
2025	16	1,937	$174,313			$196,802	$19,221		$216,023	($41,710)	**($1,652,239)**
2026	17	1,953	$175,740			$197,667	$19,221		$216,888	($41,148)	**($1,742,955)**
2027	18	1,969	$177,186			$198,543	$19,221		$217,764	($40,578)	**($1,835,822)**
2028	19	1,985	$178,617			$199,411	$19,221		$218,632	($40,015)	**($1,930,911)**
2029	20	2,000	$179,983			$200,239	$19,221		$219,460	($39,476)	**($2,028,314)**
2030	21	2,014	$181,274			$201,021	$19,221		$220,242	($38,968)	**($2,128,132)**
2031	22	2,028	$182,504			$201,767	$19,221		$220,988	($38,483)	**($2,230,459)**
2032	23	2,040	$183,634			$202,452	$19,221		$221,673	($38,038)	**($2,335,411)**
2033	24	2,052	$184,639			$203,060	$19,221		$222,281	($37,643)	**($2,443,116)**
2034	25	2,062	$185,563			$203,621	$19,221		$222,842	($37,279)	**($2,553,688)**
2035	26	2,072	$186,487			$204,181	$19,221		$223,402	($36,915)	**($2,667,214)**
2036	27	2,082	$187,381			$204,722			$204,722	($17,342)	**($2,764,572)**
2037	28	2,091	$188,189			$205,212			$205,212	($17,023)	**($2,864,532)**
2038	29	2,100	$189,001			$205,705			$205,705	($16,703)	**($2,967,171)**
2039	30	2,109	$189,817			$206,200			$206,200	($16,383)	**($3,072,569)**
2040	31	2,118	$190,636			$206,697			$206,697	($16,061)	**($3,180,808)**
2041	32	2,127	$191,459			$207,197			$207,197	($15,738)	**($3,291,970)**
2042	33	2,136	$192,285			$207,699			$207,699	($15,414)	**($3,406,143)**
2043	34	2,146	$193,115			$208,203			$208,203	($15,088)	**($3,523,415)**
2044	35	2,155	$193,948			$208,709			$208,709	($14,761)	**($3,643,879)**
2045	36	2,164	$194,785			$209,217			$209,217	($14,432)	**($3,767,627)**
2046	37	2,174	$195,625			$209,727			$209,727	($14,102)	**($3,894,758)**
2047	38	2,183	$196,469			$210,240			$210,240	($13,771)	**($4,025,372)**
2048	39	2,192	$197,317			$210,755			$210,755	($13,438)	**($4,159,570)**
2049	40	2,202	$198,169			$211,272			$211,272	($13,103)	**($4,297,461)**
2050	41	2,211	$199,024			$211,791			$211,791	($12,767)	**($4,439,152)**
2051	42	2,221	$199,883			$212,313			$212,313	($12,430)	**($4,584,757)**
2052	43	2,231	$200,745			$212,837			$212,837	($12,091)	**($4,734,391)**
2053	44	2,240	$201,611			$213,363			$213,363	($11,751)	**($4,888,174)**
2054	45	2,250	$202,481			$213,891			$213,891	($11,410)	**($5,046,229)**
2055	46	2,260	$203,355			$214,421			$214,421	($11,066)	**($5,208,682)**
2056	47	2,269	$204,233			$214,954			$214,954	($10,722)	**($5,375,664)**
2057	48	2,279	$205,114			$215,489			$215,489	($10,376)	**($5,547,310)**
2058	49	2,289	$205,999			$216,027			$216,027	($10,028)	**($5,723,757)**
2059	50	2,299	$206,888			$216,567			$216,567	($9,679)	**($5,905,148)**
2060	51	2,309	$207,781			$217,109			$217,109	($9,328)	**($6,091,631)**
2061	52	2,319	$208,677			$217,653			$217,653	($8,976)	**($6,283,356)**
2062	53	2,329	$209,578			$218,200			$218,200	($8,622)	**($6,480,479)**
2063	54	2,339	$210,482			$218,749			$218,749	($8,267)	**($6,683,161)**
		111,084	**$ 10,497,837**	**$ 299,950**	**$ 666,540**	**$ 10,982,006**	**$ 480,525**	**$ -**	**$ 12,429,021**	**$ (1,931,184)**	

Current Tipping Fee = $90.00 per tonne of waste

Interest rate = 3.00%

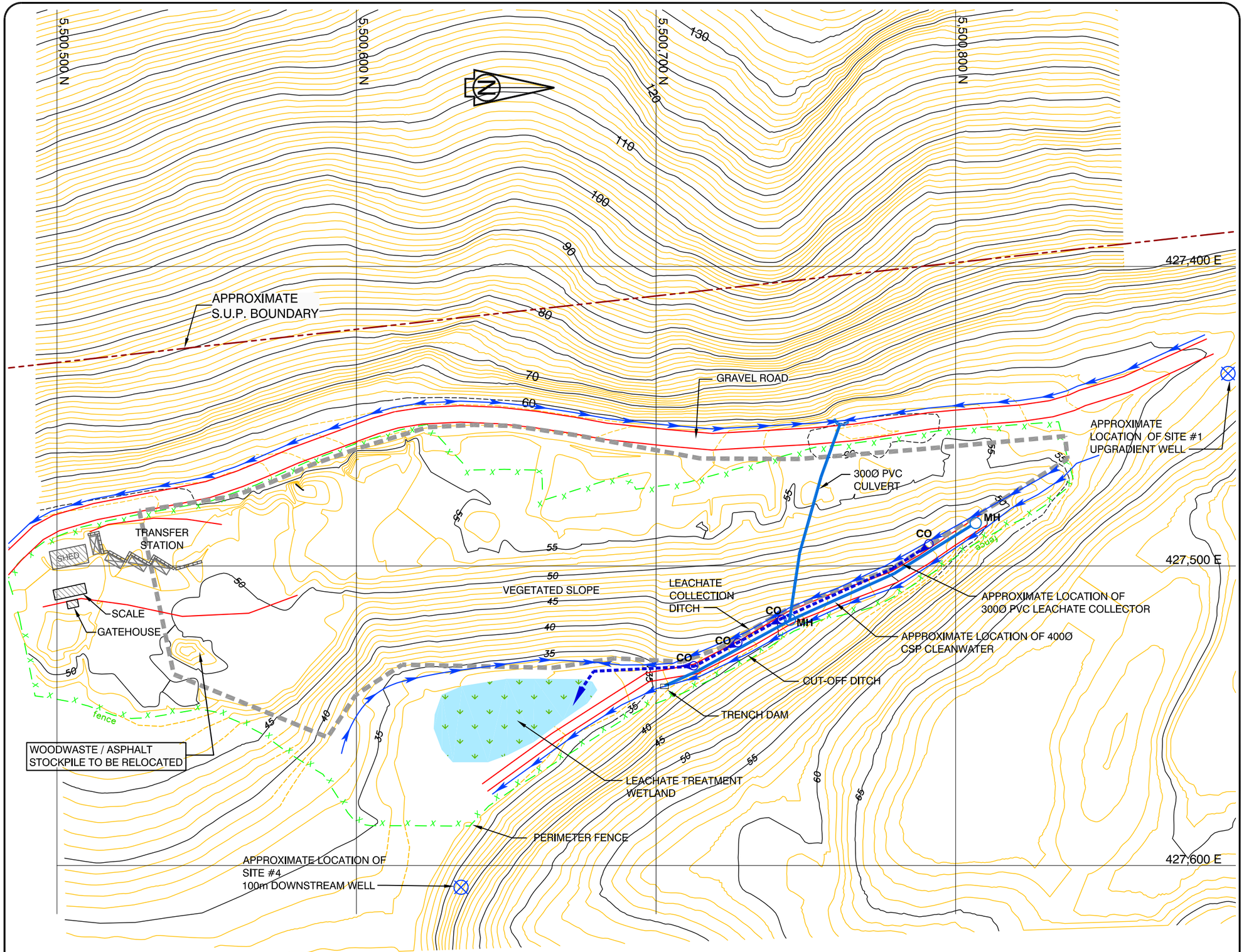
Annual Operating Cost (per tonne of waste) = $ 155.47

	Total Cost	$/tonne
Total Revenues =	$10,497,837	94.50
Total Landfilling Cost (excluding interest) =	$12,429,021	111.89
Total Capital Cost =	$299,950	2.70
Total Closure Cost =	$666,540	6.00
Total Operating Expenses =	$10,982,006	98.86
Total Post Operating Cost =	$480,525	4.33
Total Landfilling Cost (including interest charges)	**$12,429,021**	**111.89**

Table 4.5: Lifecycle Cost Assessment Summary

Disposal Option	Revenue[1] ($Millions)	Capital Costs ($Millions)	Closure Costs ($Millions)	Operational Costs ($Millions)	Post Closure Costs ($Millions)	Landfill Closure Reserve Contribution ($Millions)	Total Cost ($Millions)	Cumulative Net Revenue ($Millions)	Total Operating Costs ($/tonne)	Break Even Tipping Fee ($/tonne)
Western Expansion	11.71	0.30	0.99	13.53	0.62	0.70	15.48	-10.95	138.95	132.27
Northern Expansion	12.68	0.41	1.48	14.66	0.73	1.34	17.33	-13.65	155.61	142.67
Standard Transfer Bins	10.50	0.15	0.67	12.43	0.48	0.00	13.72	-9.31	123.54	125.92
Stationary Compactors	10.50	0.30	0.67	10.98	0.48	0.00	12.42	-6.68	111.89	115.79

1. Includes contribution from closure reserve



SPERLING HANSEN ASSOCIATES

#8 - 1225 East Keith Road North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723 Fax: (604) 986-7734

LEGEND:

- 5m EXISTING CONTOURS
- 1m EXISTING CONTOURS
- PROPERTY LINE
- ROAD
- LOCK BLOCK WALL
- DITCH
- FENCE
- STRUCTURE
- APPROXIMATE EDGE OF WASTE

CLIENT:

SUNSHINE COAST REGIONAL DISTRICT

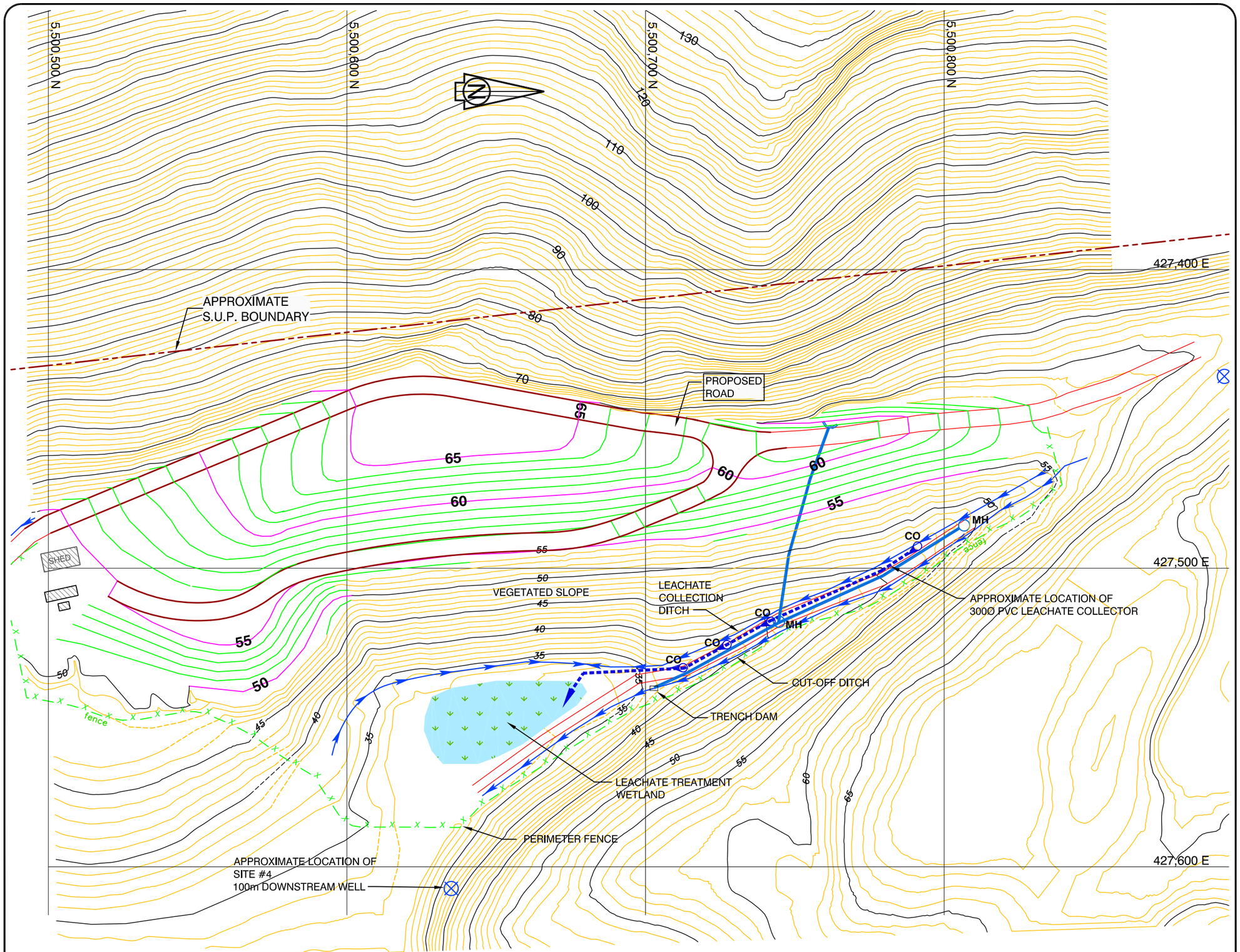
PROJECT:

PENDER HARBOUR LANDFILL WASTE MANAGEMENT OPTIONS

TITLE:

SITE PLAN AND TOPOGRAPHY (APRIL 2008)

SCALE:	DATE:	PROJECT NO:
1:1250	2008/12/17 yyyy/mm/dd	PRJ 08037
DESIGNED	SF	DRAWING NO:
DRAWN	BR	**FIGURE 1-1**
CHECKED	TS	



SPERLING HANSEN ASSOCIATES

#8 - 1225 East Keith Road North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723 Fax: (604) 986-7734

LEGEND:

- 5m EXISTING CONTOURS
- 1m EXISTING CONTOURS
- 5m PROPOSED CONTOURS
- 1m PROPOSED CONTOURS
- PROPERTY LINE
- ROAD
- LOCK BLOCK WALL
- DITCH
- FENCE
- STRUCTURE
- APPROXIMATE EDGE OF WASTE

CLIENT:

SUNSHINE COAST REGIONAL DISTRICT

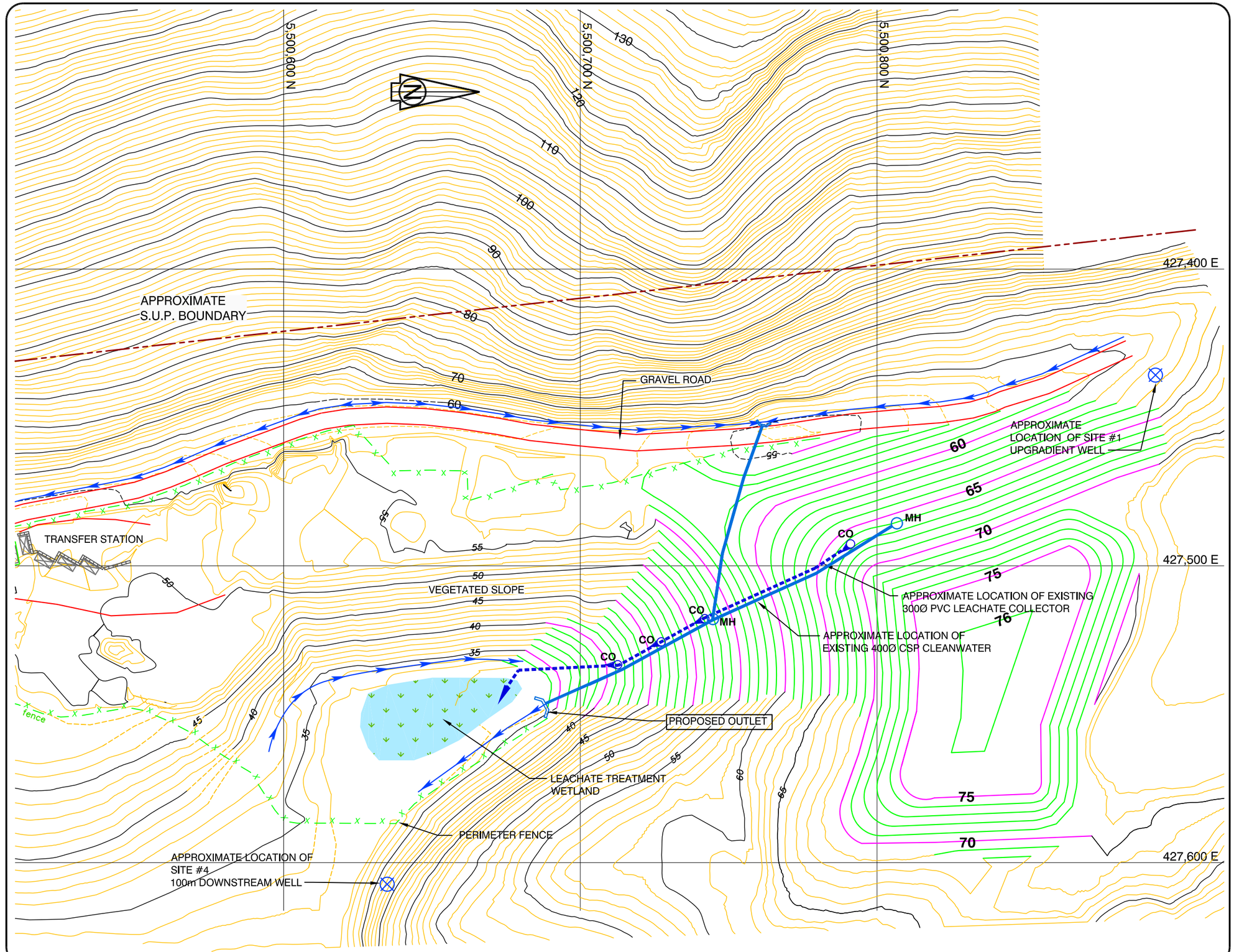
PROJECT:

PENDER HARBOUR LANDFILL WASTE MANAGEMENT OPTIONS

TITLE:

WESTERN EXPANSION

SCALE:	DATE:	PROJECT NO:
1:1250	2008/12/17 yyyy/mm/dd	PRJ 08037
DESIGNED	JL	DRAWING NO:
DRAWN	BR	**FIGURE 2-1**
CHECKED	TS	



SPERLING HANSEN ASSOCIATES

#8 - 1225 East Keith Road North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723 Fax: (604) 986-7734

LEGEND:

- 5m EXISTING CONTOURS
- 1m EXISTING CONTOURS
- 5m PROPOSED CONTOURS
- 1m PROPOSED CONTOURS
- PROPERTY LINE
- ROAD
- LOCK BLOCK WALL
- FENCE
- STRUCTURE

CLIENT:

SUNSHINE COAST REGIONAL DISTRICT

PROJECT:

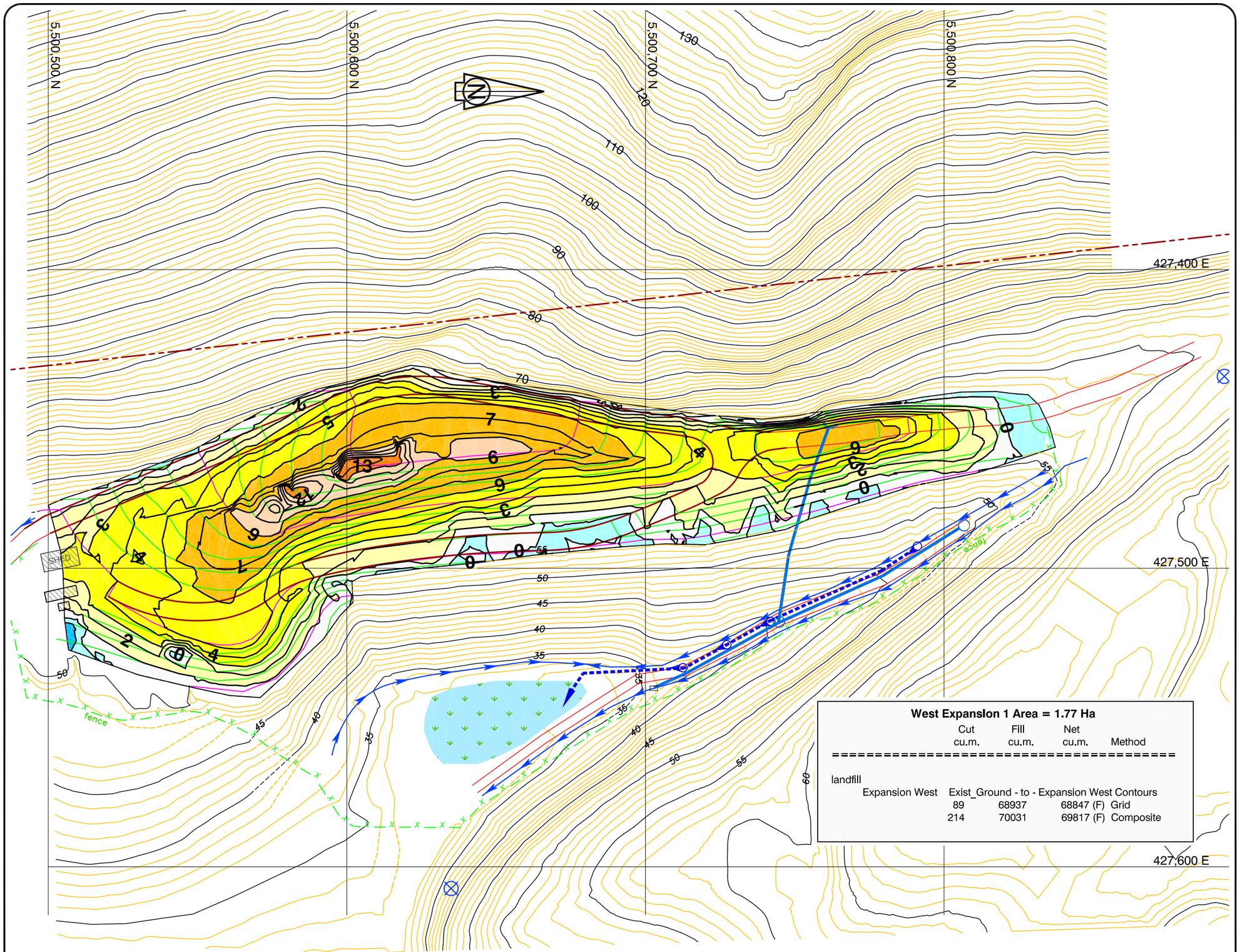
PENDER HARBOUR LANDFILL WASTE MANAGEMENT OPTIONS

TITLE:

NORTHERN EXPANSION

SCALE:	DATE:	PROJECT NO:
1:1250	2008/12/17 yyyy/mm/dd	PRJ 08037

DESIGNED	SF	DRAWING NO:
DRAWN	BR	**FIGURE 2-2**
CHECKED	TS	



SPERLING HANSEN ASSOCIATES

#8 - 1225 East Keith Road North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723 Fax: (604) 986-7734

LEGEND:

Color	Range Beg.	Range End	Percent	Area
	-3.00	-1.00	0.1	23.07
	-1.00	0.00	5.5	982.33
	0.00	1.00	14.0	2496.23
	1.00	3.00	21.5	3835.56
	3.00	6.00	35.2	6279.07
	6.00	9.00	18.5	3294.31
	9.00	12.00	4.6	819.41
	12.00	15.00	0.7	119.26

CLIENT:

SUNSHINE COAST REGIONAL DISTRICT

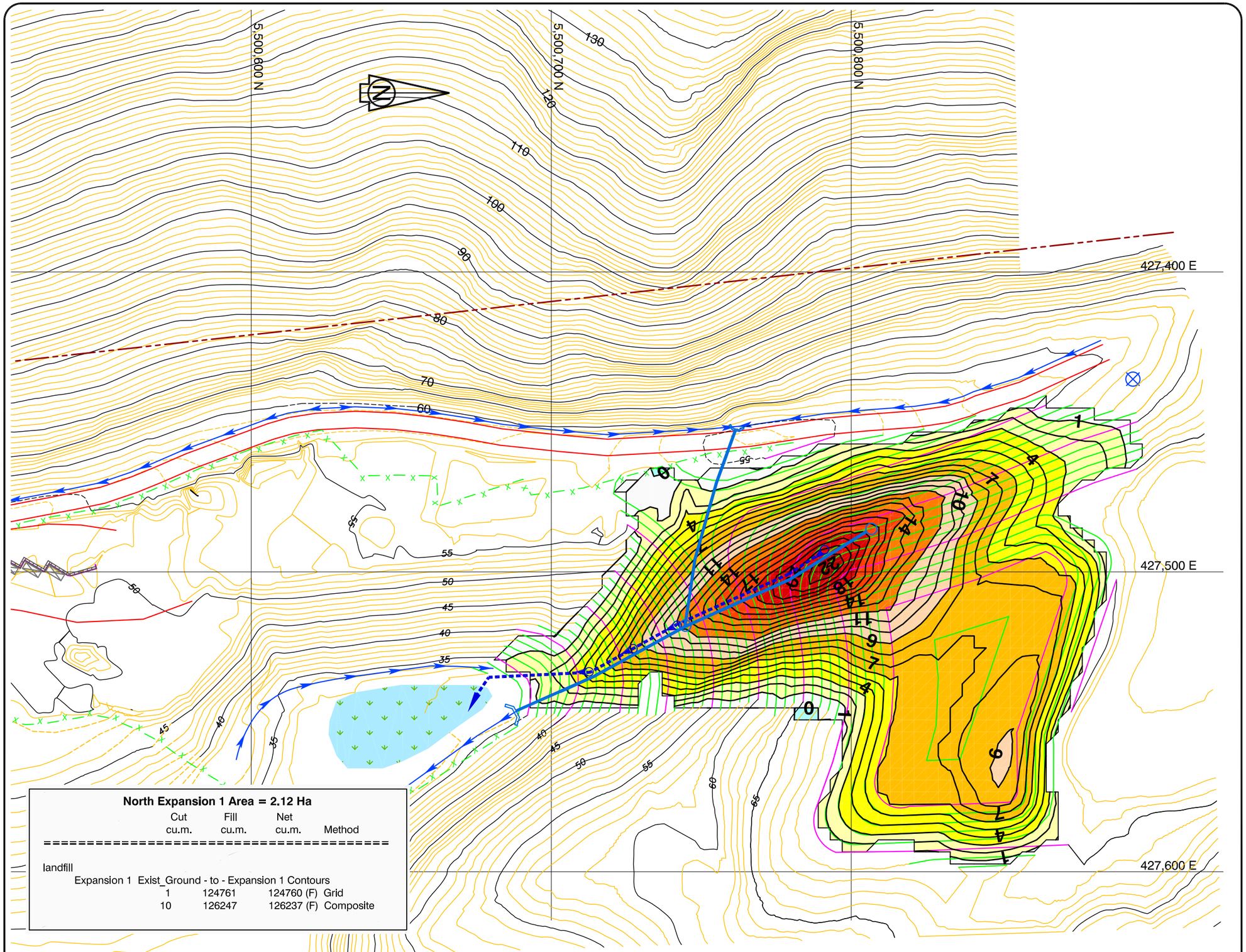
PROJECT:

PENDER HARBOUR LANDFILL WASTE MANAGEMENT OPTIONS

TITLE:

CUT AND FILL FOR WESTERN EXPANSION

SCALE:	DATE:	PROJECT NO:
1:1250	2008/12/17 yyyy/mm/dd	PRJ 08037
DESIGNED	JL	DRAWING NO:
DRAWN	BR	**FIGURE 2-3**
CHECKED	TS	



SPERLING HANSEN ASSOCIATES

#8 - 1225 East Keith Road North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723 Fax: (604) 986-7734

LEGEND:

Color	Range Beg.	Range End	Percent	Area
	-1.00	0.00	0.2	45.20
	0.00	1.00	6.6	1219.76
	1.00	3.00	16.4	3017.32
	3.00	6.00	22.5	4139.76
	6.00	9.00	31.0	5714.36
	9.00	12.00	9.7	1784.95
	12.00	15.00	6.7	1239.93
	15.00	18.00	4.0	744.64
	18.00	21.00	2.4	449.85
	21.00	24.00	0.4	68.23

CLIENT:

SUNSHINE COAST REGIONAL DISTRICT

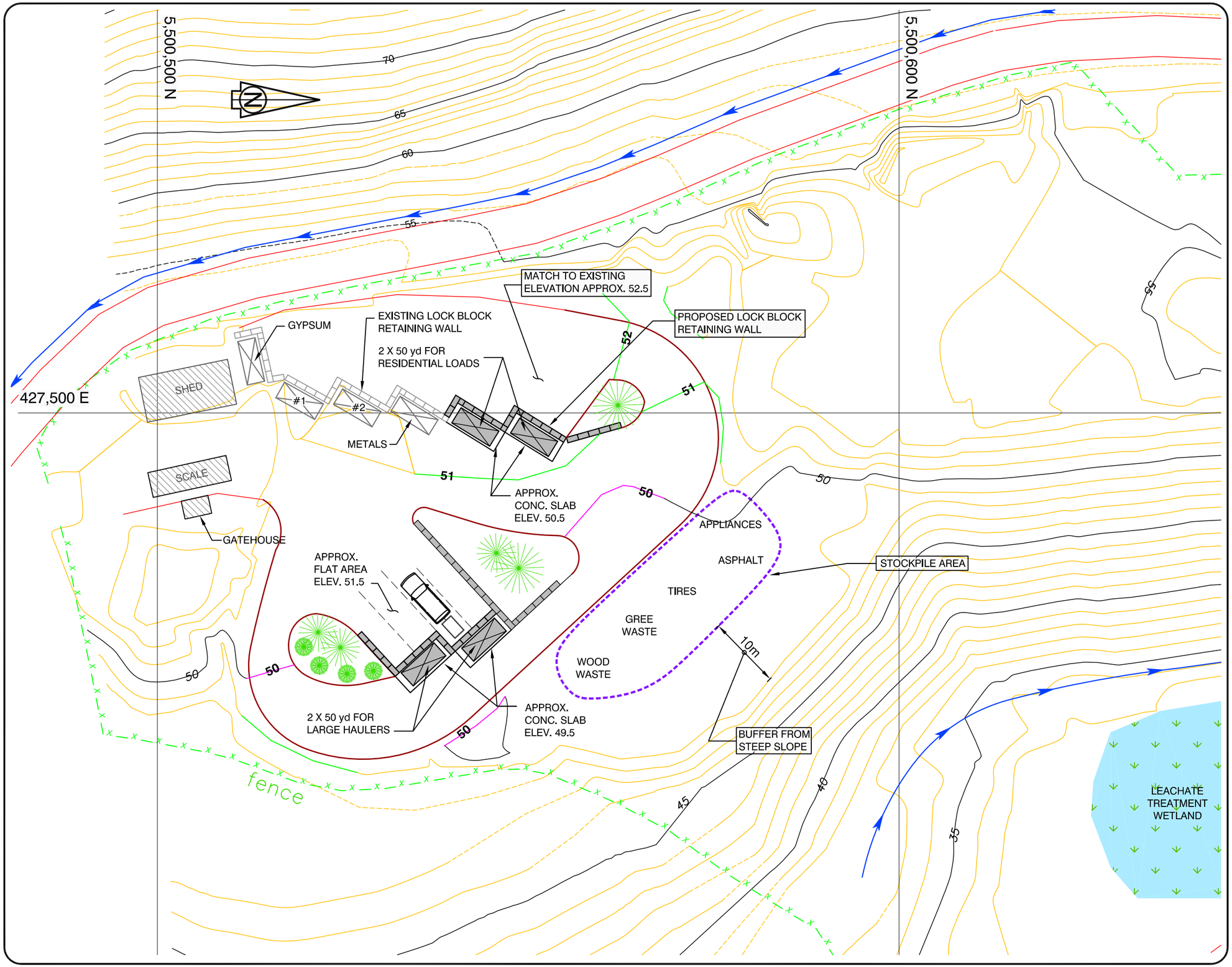
PROJECT:

PENDER HARBOUR LANDFILL WASTE MANAGEMENT OPTIONS

TITLE:

CUT AND FILL FOR NORTHERN EXPANSION

SCALE:	DATE:	PROJECT NO:
1:1250	2008/12/17 yyyy/mm/dd	PRJ 08037
DESIGNED	SF	DRAWING NO:
DRAWN	BR	**FIGURE 2-4**
CHECKED	TS	



SPERLING HANSEN ASSOCIATES

#8 - 1225 East Keith Road North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723 Fax: (604) 986-7734

LEGEND:

- 5m EXISTING CONTOURS
- 1m EXISTING CONTOURS
- 5m PROPOSED CONTOURS
- 1m PROPOSEED CONTOURS
- PROPERTY LINE
- EXISTING ROAD
- PROPOSED ROAD
- EXISTING DITCH
- EXISTING FENCE
- EXISTING STRUCTURE
- EXISTING LOCK BLOCK WALL
- PROPOSED LOCK BLOCK WALL
- EXISTING BIN
- PROPOSED 50 yd BIN

CLIENT:

SUNSHINE COAST REGIONAL DISTRICT

PROJECT:

PENDER HARBOUR LANDFILL WASTE MANAGEMENT OPTIONS

TITLE:

CONCEPTUAL TRANSFER STATION DESIGN

SCALE:	DATE:	PROJECT NO:
1:500	2008/12/17 yyyy/mm/dd	PRJ 08037
DESIGNED	SF	DRAWING NO:
DRAWN	BR	**FIGURE 3-1**
CHECKED	TS	