New Solid Waste Facility – Preliminary Design Report

FINAL Report

APRIL 21, 2006

New Solid Waste Facility – Preliminary Design Report

City of Yellowknife

05-4719-2000

Colin Joyal - Project Manager

Submitted by

Dillon Consulting Limited

(In reply, please refer to)
Our File: 05-4719-2000

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April 21, 2006

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Attention: Dennis Kefalas

New Solid Waste Facility – Preliminary Design Report

Dear Mr. Kefalas:

Attached are five hard copy and five CD's of the final preliminary design report for the New Solid Waste Facility. This report is a summary of the preliminary investigation and design of the proposed new Solid Waste Facility to be located in the quarry north of the existing landfill.

This report includes information from other studies and serves as a compilation of efforts to date on the development of new landfill capacity. Recommendations for future work and next steps are contained throughout the report and in the summary.

Yours sincerely,

DILLON CONSULTING LIMITED

Colin Joyal, P.Eng.
Associate

CEJ/cgk

Attachment

Encl.

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1 INTRODUCTION AND BACKGROUND

1.1 Scope of Report

The scope of this report is to illustrate the rationale and criteria used in the development of the preliminary design as shown in the preliminary drawings included in this report. Drawing references are cited throughout this report and correspond to the attached figures in the appendix.

Other aspects of existing and future site development have been reviewed as separate work items such as the siting criteria. These reports are references in this text and have been included in the appendices for convenience.

This report focuses on two areas for development. One area is the landfill entrance and drop off area to be located at the existing landfill baling facility and the other is the new landfill to be located in an existing rock quarry to the north of the existing site. Development of the new facility is not anticipated to begin for 4-7 years. Landfilling is expected to continue at the existing site until that time. The rock quarry, currently operated by NWT Construction Limited, will continue to be used until such time that the area is needed for landfill construction. Refer to Appendix A, Figure 1 - Existing Site Conditions to view the site plan and locations of current operations at the landfill and rock quarry.

This report represents the preliminary design for the development of new landfill expansion. This preliminary design has been based on the following fundamental assumptions which shall be confirmed through further investigation:

- Landfilling will continue for 4-7 years at the existing site. Refer to the Dillon memo for landfill volume assessment dated October 19, 2005 in Appendix C.
- The quarry site to the north of the existing landfill will be the site of the new landfill.
- Quarry operations may continue concurrently with landfilling at the new site.
- The lease limits (January 2006) for the existing landfill and quarry may be modified slightly along the north edge to accommodate landfill construction
- The landfill footprint shall be designed to maximize the area and provide the maximum landfill capacity within the lease restrictions.
- It is assumed that waste will continue to be baled as part of the waste processing operations at the baling facility
- It is assumed that the City will continue to offer recycling services
- It is assumed that waste generation habits will continue as per historic rates

These assumptions are further discussed within the report and must be further investigated as part of the landfill development strategy.

2 SOLID WASTE FACILITY DEVELOPMENT

2.1 General

The existing landfill is licenced under Water Licence No. N1L3-0032 dated May 30, 2002 granted by the Mackenzie Valley Land and Water Board (MVLWB) in accordance with the Northwest Territories Waters Act. The Board approved the renewal of the Water Licence for a period of eight years expiring May 30, 2010.

New landfill developments as well as significant changes to existing sites would trigger review by the Mackenzie Valley Land and Water Board (MVLWB) under the Mackenzie Valley Resource Management Act (MVRMA). The MVRMA provides an integrated system of land and water administration in the Mackenzie Valley, including the area surrounding Yellowknife.

The existing site conditions, lease limits and proposed limits of waste for the maximum capacity of the site are depicted on Figure 4 in Appendix A. For the purpose of this report, a design was shown for the maximum capacity of the site rather than simply designing for a 20 year site life. The design includes a composite liner system, a leachate collection system, surface drainage control, a haul road and potential access for continued quarry operations as described in Section 3.

2.2 Licence Application Process

From *City of Yellowknife New Solid Waste Facility Siting Criteria Draft Report (Dillon, April 2005)*

The Mackenzie Valley Land and Water Board (MVLWB) was established to administer the Part 3 provisions of the *Northwest Territories Waters Act* regarding land and water use activities for which a license, permit or authorization is required or a license is required under the Act.

Although Municipal and Community Affairs (MACA) regulates land use on Commissioner's Land, the City of Yellowknife is Block Land Transferred to City Owned Land and regulates land use through its Community Plan and Zoning Bylaw. However, water use considerations such as leachate and surface drainage from the solid waste site fall under the jurisdiction of the MVLWB. The proposed new Yellowknife Solid Waste Facility will therefore be subject to the requirements of the *Northwest Territories Waters Act* and the approval of the MVLWB.

The *NWT Public Health Act* regulations regarding solid waste disposal facilities are found in the General Sanitation Regulations. These were established to prevent and mitigate disease, and authority is vested primarily in the Chief Medical Health Officer to implement the provisions of this Act.

The Chief Environmental Protection Officer, whose mandate it is to administer and enforce the *NWT Environmental Protection Act*, may require the City of Yellowknife to take whatever actions he/she deems necessary to prevent the discharge of contaminants into the environment. The City may also be required to have on hand the equipment and material necessary to alleviate the effect of any discharge of contaminants.

In the NWT, concerns of the Department of Fisheries and Oceans (DFO) are generally addressed in the license application review process pursuant to the NWT Waters Act (administered by the MVLWB). The *Fisheries Act* states that the DFO may require plans for the new development to be submitted for review and approval before work commences if it is thought that deleterious substances resulting from the solid waste facility may enter a water body frequented by fish.

Likewise, approval by Transport Canada, Municipal and Community Affairs (MACA) and the Department of Transportation (DOT) – Airports Division will be sought during the application review process for matters falling under their respective jurisdictions.

2.3 Siting Criteria

The landfill siting criteria report (Dillon, 2005) in Appendix D should be consulted for details of applicable siting criteria. The applicable siting regulations are summarized in Table 1 below. A constraint map was developed as part of the report and is included in Appendix A. This constraint map provides relevant and poignant representation of the lack of available lands for siting a landfill within the City of Yellowknife municipal boundaries. In fact, the available lands are limited to only a small piece of land to the north of the existing Giant Mine Lease.

The quarry pit to the north of the existing landfill has been identified by the City as the proposed site for the new solid waste facility. Based on the siting report, this location is situated within the 8 kilometer setback from airports as per Transport Canada regulations. An alternative guideline has been applied in the North which uses a minimum setback of 3 kilometers (Establishing Guidelines for the Separation of Solid Waste Disposal Sites and Airports in the Northwest Territories, Soberman, et al.). The proposed site is located just beyond the 3 kilometer boundary. The location of all new solid waste sites near airports is subject to approval by Transport Canada, Municipal and Community Affairs and the Department of Transportation (DOT).

The existing and proposed sites are partially located within the 450m setback from Fred Henne Territorial Park. The Public Health Act, under General Sanitation Regulations requires a setback of 450m if there is permanent human occupancy within this setback. There is no known permanent occupancy at the time of this report.

These criteria should be considered during the design of the proposed landfill along with planning for licencing and operations.

TABLE 1 – Siting Criteria

Criterion	Stipulation	*Acts, Regulations* or Guideline
Distance from airport to avoid hazard to aircraft from scavenging birds	1) 8 kilometer setback 2) 3 kilometer setback	1) *Commissioner's Lands Act* *Air Regulations & Aeronautics Act* 2) Soberman, *et al.* (1990)
Distance from housing	450 metres	*Public Health Act* (1988) and its *General Sanitation Regulations* (1990)
Distance from public roads, railways, right-of-ways and cemeteries	90 metres	*Public Health Act* (1988) and its *General Sanitation Regulations* (1990)
Distance from surface water to minimize fisheries habitat impacts	30 metres from high water mark	*Environmental Protection Act* Department of Fisheries and Oceans policy
Distance from treeline	10 metres if no burning, 30 metres if burning will occur	*NWT Fire Protection Act and Regulations*
Located to ensure protection of drinking water	In a watershed that drains away from the community drinking water supply	*Public Health Act* *Mackenzie Valley Resource Management Act* *Northwest Territories Waters Act* *Environmental Protection Act*
Minimize impacts to land, birds, animals, vegetation	Contaminants may not be discharged to the environment	*Environmental Protection Act (*1988)
City Zoning By-laws	Accordance with current planning documents	*Planning Act*

In addition to the siting criteria stated above, a site feasibility assessment should be completed for the identified site. If the standards for landfills in Alberta (Alberta Environment, 2004) are reference, a new landfill shall not be situated at a location where there exists one or more of the following conditions:

1. there is less than 30 metres of geologic materials between the base of the landfill and an exceptional underlying aquifer where the geologic material has an equivalent vertical hydraulic conductivity great than 1×10^{-8} metres/second; or
2. the geologic materials within 10 metres below the base of the landfill include fractured non-porous bedrock or karst features; or
3. there is less than a 10 metre thick layer of a clayey deposit having an equivalent vertical hydraulic conductivity less than 1×10^{-8} metres/second beneath all waste deposited at or below the original grade unless the person responsible provides evidence in writing to the Director that the groundwater quality will not exceed performance standards at the points of compliance.

These standards are not directly applicable to the Northwest Territories however this would indicate that further investigation of the suitability of the site is recommended.

3 OPERATING FACILITIES

Operations for the new facility will be separated into three main areas:

1. Waste receiving
2. Waste processing
3. Landfill/Balefill operations

The site will be designed to provide efficient and safe facilities for each operation. Although there may appear to be an abundance of space to accommodate the required operations, the design is limited by existing facilities, infrastructure and site features. Figure 3-1, titled "New Solid Waste Site Conceptual Design" (also sited in Figure 3 in Appendix A) depicts the conceptual placement of the following landfilling activities and auxiliary components.

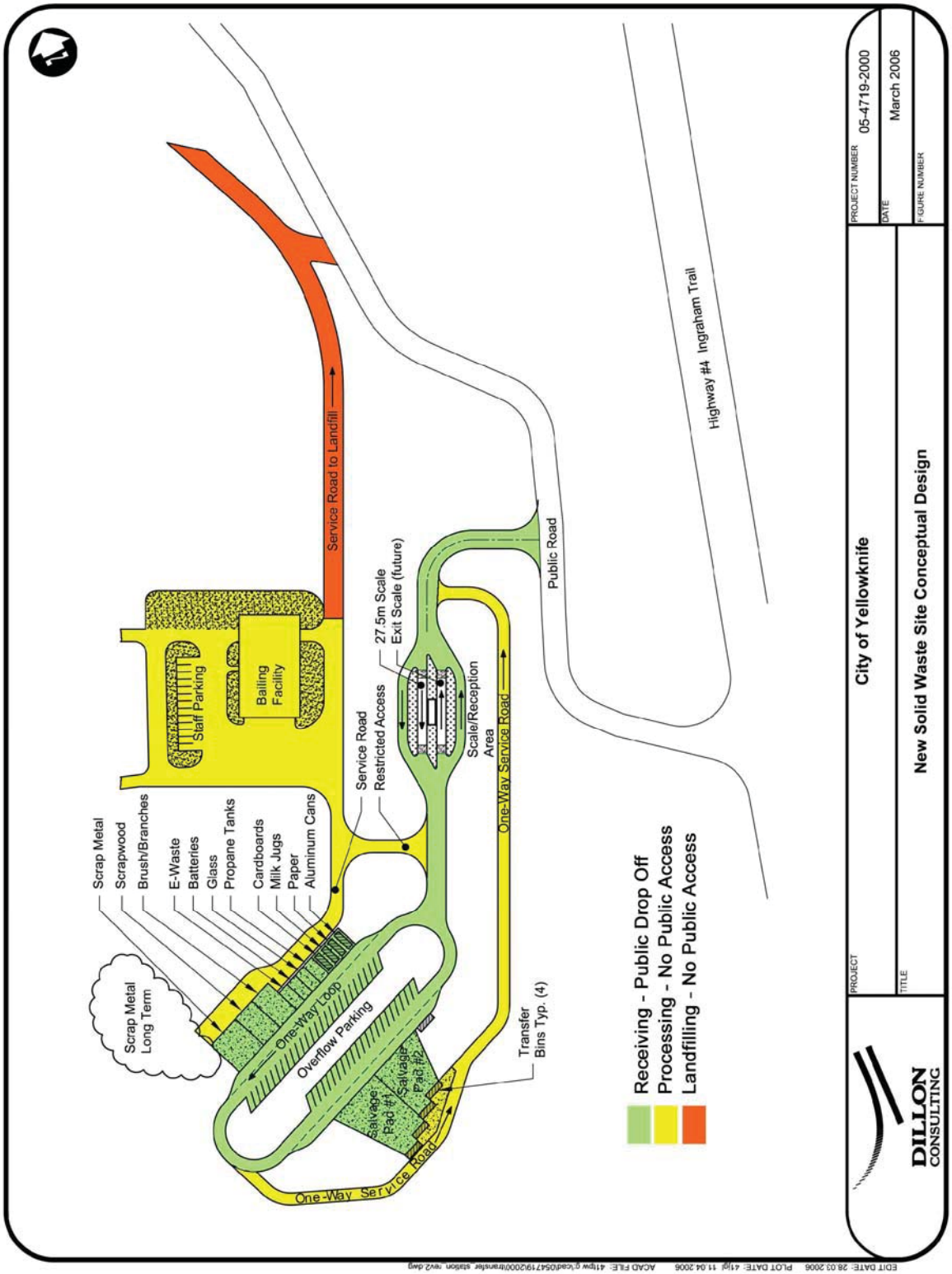
3.1 Waste Receiving

Waste processing methods are currently under review as part of the "External Review of Landfill Operations". For the sake of this report, it has been assumed that waste will continue to be baled as part of the landfill operations and that recycling will continue to be offered in a similar manner to the existing system.

3.1.1 Weigh Scale Reception

Access to the solid waste facility will be limited to one entranceway with a lockable gate. All vehicles entering the Solid Waste Facility must pass through the entranceway and past the gatehouse. Vehicles will be stopped at the gatehouse to either be weighed or directed to the designated area of the facility. The weigh area and gatehouse reception area will be required to accommodate two-27.5-meter long truck scales. Each scale must accommodate 3-meter concrete aprons on either end of the scales in accordance with federal regulations of "weights and measures" from the Specifications Relating to Non-Automatic Weighing Devices. It is anticipated that only one scale will be installed initially but the design shall accommodate a second which may be added in the future to weigh vehicles as they leave the facility. Ideally, the scales would be offset such that the far end of each scale is aligned with the scale house attendant window. This would allow the attendant to communicate with the vehicle driver. It appears however, that site constraints will not allow the scales to be offset; therefore an integrated intercom system or other communication device would have to be installed to enable the gate attendant to correspond with the drivers as they exit. Included in the conceptual design is a by-pass lane for both

Figure 3-1: New Solid Waste Site Conceptual Design



incoming and outgoing traffic. This enables traffic to be diverted around the scales if required. Reference Figure 3 in Appendix A for locations.

The design has incorporated consideration for efficient traffic movements on the site while minimizing the intersection of public flows with operations. Anticipated traffic movements include

- public access to the drop off area (including recycling and salvaging areas)
- waste transfer from the waste transfer bins at the drop off area to the landfill and/or baling facility including routing across the scale
- Operations access to recycling areas
- garbage collection trucks access to the baling facility
- transfer vehicle access to transfer bales from the baling facility to the landfill
- commercial access to the landfill (large loads)
- Staff parking and access to the baling facility

Other site constraints have been considered including existing materials (such as buried waste and scrap steel), bedrock, bogs, ongoing quarry operations and access to other leases, roadway setbacks and sight lines. These conditions must be further investigated as part of the final design.

Design considerations for access to the transfer station considered another access off Hwy #3 opposite the PowerCorp entrance, access off Hwy #4 between the Hwy #3 and #4 junction and the existing access lane, and re-routing existing quarry traffic from a temporary access closer to the Giant Mine Site. Each consideration was deemed not acceptable due to poor geotechnical conditions or DOT and traffic requirements concerning highway traffic.

3.1.2 Residential Recycling Depot

Recycling and waste separation is an important part of the future success of the landfill. The waste receiving plan involves having all public vehicles use the drop off area rather than accessing the waste processing or landfill areas of the facility. The drop off area will serve as a transfer station for wastes and recyclables. The public has access to a recyclable area which consists of collections bins to temporarily store items such as paper, aluminum, plastic jugs and cardboard. Other recyclable areas designated to store items such as batteries, glass, e-waste and propane tanks will also be situated to allow for public drop-off. Refer to Figure 3 in Appendix A- Transfer Station for locations and details regarding the recycle areas. These areas will have a drop-off lane and overflow parking to make the area as user friendly as possible. The landfill staff will also have rear access to these bins from the service lane. Use of the service lane again eliminates any public traffic conflicts.

Wood and branch salvaging and scrap metal salvaging will follow a similar process to the one described above, but have only one designated pad for each material. The pads will be located at the far end of the

public drop off area. The pads will be fenced with large access gates at both the front and rear of the areas. As part of a scheduled rotation, the entire pad will periodically be closed to the public to allow City staff access to push the unused material to a storage area. A storage area would be planned in behind the pads. Material would be pushed into this area and stored until sufficient quantities have accumulated to warrant processing. Scrap metal would require a designated baler to be temporarily mobilized to bale the metal prior to shipping to recycling markets. Historically, the scrap metal baling/crushing has been contracted out and, at the time of this report, will continue in this fashion. Residual wood would be transferred to the landfill and branches would either be chipped for re-used as trail bedding or transferred to the landfill.

Separated pads would also be constructed to accommodate other recyclable materials. These pads would be separated by barriers and/or fencing and include clear signage to promote proper segregation of materials. Materials accepted could include:

- Tires
- E-Waste
- Glass
- Propane tanks
- Batteries
- Appliances and white goods
- Paints

The pad configuration provides flexibility in the locations of the divider fences to reallocate space as needed for various materials based on space requirements.

3.1.3 Public Waste Drop Off

Waste salvaging was evaluated as part of the External Review of Solid Waste Facility Operations and Processes (Dillon, December 8, 2005). Public access to waste is discouraged due to the hazards associated with the public being allowed direct contact with waste and concerns regarding the operation of heavy equipment. In addition, it is noted that tipping fees are charged for the disposal of waste and some citizen/businesses want to see their waste products disposed of and not re-used to protect safety and privacy.

It is recommended that the act of allowing public salvaging be discontinued. Other options have been contemplated by the City including

1. A controlled salvage centre
2. A two-cell transfer station system that is separate from the active area of the landfill.

For the sake of this preliminary design report, provisions have been made to accommodate a two cell transfer station system in the design for possible continued public salvage. Figure 3 in Appendix A – New Solid Waste Site Conceptual Design, shows details and locations of such components as the

gatehouse and reception area, public transfer station and salvage area, recycling area and other auxiliary components.

The public waste drop off area is located such that traffic is routed past all of the recycling areas first then the residual waste is deposited at the public waste drop off area. A defined two-cell system is to be incorporated into the development of this site. Each cell is made of a concrete pad to serve as a collection gallery for salvageable and re-useable materials. Each cell will be made available for waste drop off and salvaging for 3-7 days (depending on waste volumes and use), then the salvage cell would be closed and the second cell would be used. This would allow time for the unused material on the salvage pad to be pushed, by means of a loader, into a roll off style waste transfer bin. The waste bin sits approximately 2.0m below the surface of the concrete salvage pad enabling the loader to push the material off the side edge of the pad into the bin. The collection bins are transported using a roll off hoist style truck. This material may be brought to the baling facility to be baled then placed in the landfill or may be hauled directly to the landfill if it is deemed not suitable for baling (large and uncompressible materials). The two-celled system enables salvagers to enter a salvage pad free of active landfill equipment. At any given time one cell is open to the public for salvaging while the other remains closed for landfill processing and transferring.

Figure 3-2: Waste Transfer Vehicle

The landfill service vehicles access the transfer bins by using a restricted access lane. The service lane to the transfer bins eliminates conflicting traffic movements throughout the salvage area thus, creating a safer environment for the public and City staff.

A locked transfer bin will also be located adjacent to the salvage cells. This will permit the public to deposit waste which they do not wish to be salvaged. This bin will be transported to the baling facility and will not be accessed by salvagers.

3.2 Waste Processing

The landfill operating methods are currently being reviewed by the City. For the sake of this report, it has been assumed that waste will continue to be processed using a waste baler. Waste processing operations would therefore remain similar to the current operations.

The baling facility consists of a 12,000 ft^2 building located inside the landfill entrance gate. It features a stepped (two level) design with the tipping floor on the upper level and the baler/shipping area below. The lower shipping area floor has entry and exit doors on either side of the facility to allow a unidirectional flow of vehicles when loading bales and transporting them to the balefill area with the tandem dump truck. The baling facility is also used to process recyclable materials.

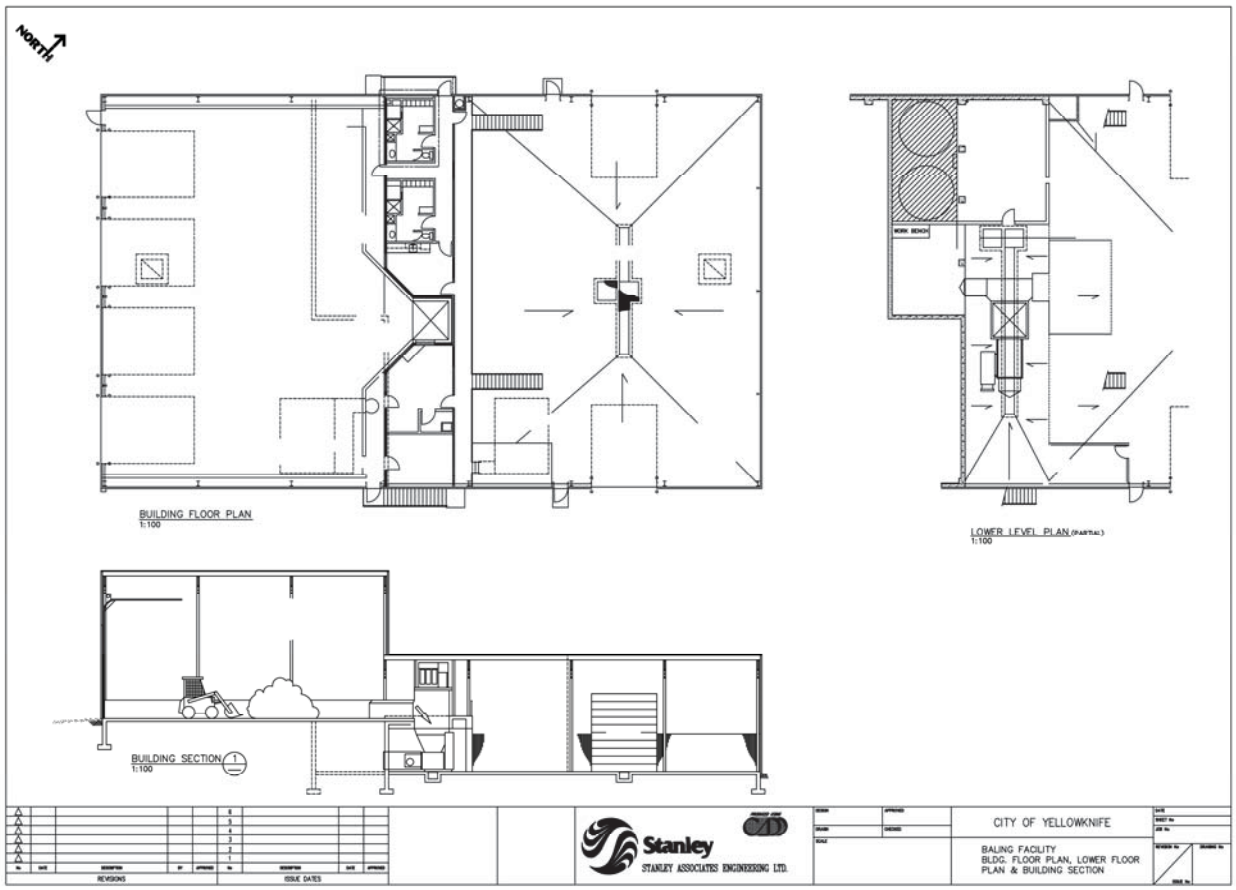


Figure 3-3: Floor Plan of Baling Facility

Waste collection trucks from residential, multi-family housing and commercial businesses arrive at the site and empty their loads onto the tipping floor of the baling facility. The waste is then pushed into the baler hopper, compressed into bales which are bound with wire ties. The bales are loaded onto a tandem truck and hauled to the landfill/balefill for disposal.

Recyclables from the recycling depots are also dumped onto the tipping floor and baled in a similar manner. In addition, the baler is used to bale white goods. Recycling bales are stockpiled at the site until there is sufficient quantity to ship to south to markets.

Not all waste materials are suited for baling. Large, uncompressible or unpredictable wastes cause plugging and damage to the baler and are therefore sent directly to the landfill. It is estimated that 80% of landfilled waste is baled and the remainder is compacted in the landfill.

3.3 Landfill/Balefill Operations

The new solid waste facility will only permit public access to the waste drop off area. The waste processing and landfilling areas will be restricted to City of Yellowknife staff and large commercial waste haulers only.

A landfill would be constructed for the disposal of both bales and unbaled waste. The landfill access and containment would be constructed and operationally, areas of the landfill would be identified for placement of bales and waste in the most efficient manner. Waste placement would be similar to the existing site, where waste is used on top and along the side slopes of bales to assist with shaping of the waste mound.

Although the landfill would provide a total of nearly 40 years of capacity, it should be developed sequentially. This means that only an area to accommodate 5 years worth of waste would be constructed at a time. These areas, referred to as cells, are then filled and covered once they've reached the final contours. The design and development must be closely planned to ensure that there is continuity of the containment system, continuous access and proper management of water and leachate.

The general philosophy of the landfill design is to provide containment of waste and any liquid that has been in contact with the waste to prevent migration of contaminants.

4 LANDFILL DEVELOPMENT

The existing quarry area to the north of the existing landfill has been identified as the location for the new landfill. This would require that the quarry be shaped to accommodate landfill construction as part of the abandonment and restoration plan for the site. The new landfill could then be constructed in this area. It has also been suggested that this area could be used to accommodate quarry operation concurrently with landfill operations. The feasibility of this option has not been investigated. A feasibility study of this option must be completed and should include an evaluation of safe blasting practices, separation distances between quarrying operations and landfill operations, and a geotechnical evaluation of landfill slope stability and design.

Access and allowance for continued quarry operations for NWT Construction Limited will be beneficial to potentially extend the life span of the blasting operations and future growth of the landfill area. An investigation of the potential capacity of the quarry was investigated in a Quarry Use Plan - Draft (Dillon, March 2006) included in Appendix E. Continued use of the site as an aggregate source is estimated to provide an additional 7.5 years of quarry operations and expanding the life span of the landfill to an estimated total of 40 years. For the sake of this report, it has been requested that the conceptual maximum site capacity be used in the preliminary design.

Figure 4-1: City of Yellowknife Aerial Photo (August 2005)

4.1 Waste Generation/Capacity Requirements

City of Yellowknife records show that the total amount of waste that entered the landfill in 2004 was 15,593 tonnes. Of this total, it is estimated that 13,393 t was landfilled. Given a recorded population in 2004 of 19,056 this equates to approximately 0.703 t/person/year of waste to be landfilled. Consideration of NWT Bureau of Statistics growth projections through a 20 year life span for the landfill equates to a total population of 24,866 in year 2026. Assuming that baling methods continue to be used, this would generate an accumulation of 466,000 m^3 of waste over that life span. Including an allowance of 15% for cover material, this equates to a total of 535,800 m3 of landfill capacity that is required to accommodate 20 years of waste generations. Refer to Table 1 in Appendix B – Waste Generation for details on capacity requirements of the new landfill.

4.2 Limits of Waste

The proposed limits of waste are shown on the site development plan on Figure 4 in Appendix A. A setback of 50m from the limit of waste to the lease boundary and the edge of existing landfill operations governed the footprint of the conceptual design for the new landfill. It is proposed that the north lease limit be relocated somewhat to accommodate the existing quarry pit that has already been excavated in this area.

The 50m setback was used at the conceptual phase. Detailed design work may reveal that this setback can be reduced if there is sufficient space to locate the berm, interior ditching, perimeter road, surface water drainage and perimeter fence. A minimum of 30 m separation between the waste footprint and the landfill property line is recommended as per the Alberta standards (Alberta Environment, 2004).

The height of waste in the landfill was set at a limit of 213m ASL, which is similar to what is being applied at the existing facility. Cover material will be applied in addition to this elevation limit. This 213m height allows for drainage of the site away from the landfill mound.

4.3 Landfill Design Requirements

With respect to solid waste facilities, the Environmental Protection Act is mainly concerned with hazardous wastes. There are no current NWT regulations in effect that govern the construction and design of landfills within the NWT. However, the GNWT has produced the "Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites", (GNWT, April 2003). These guidelines offer general solid waste facility design information. For a comparison with other jurisdictions such as Alberta, BC and Ontario refer to Table 2 in Appendix B – Design Guidelines from other Jurisdictions. This will demonstrate other provincial requirements for design and construction for solid waste containment.

4.3.1 Base Liner

The provincial regulations from outside jurisdictions and the NWT guidelines provide a benchmark to design the base of the solid waste site. A composite liner is proposed as the base of the landfill to provide

acceptable levels of containment. Alberta requirements list the following for containment construction and design.

The base layer for a containment cell constructed with a geomembrane liner is a geosynthetic clay liner on top of existing ground, a 0.6m thick clay layer with a hydraulic conductivity of $1*10^{-9}$m/s, followed by a 60mil impervious geomembrane liner. Due to the lack of availability of clay material around Yellowknife, the substitution of a Geosynthetic Clay Liner (GCL), over a natural clay layer, may prove to be a cost effective alternative. GCL's have the capability to provide equivalent parameters to replace a 0.6 m layer of a natural clay liner with a hydraulic conductivity of $1*10^{-9}$m/s. The placement of the GCL is an added benefit over the placement of a compacted clay liner by reducing the labour required for installation.

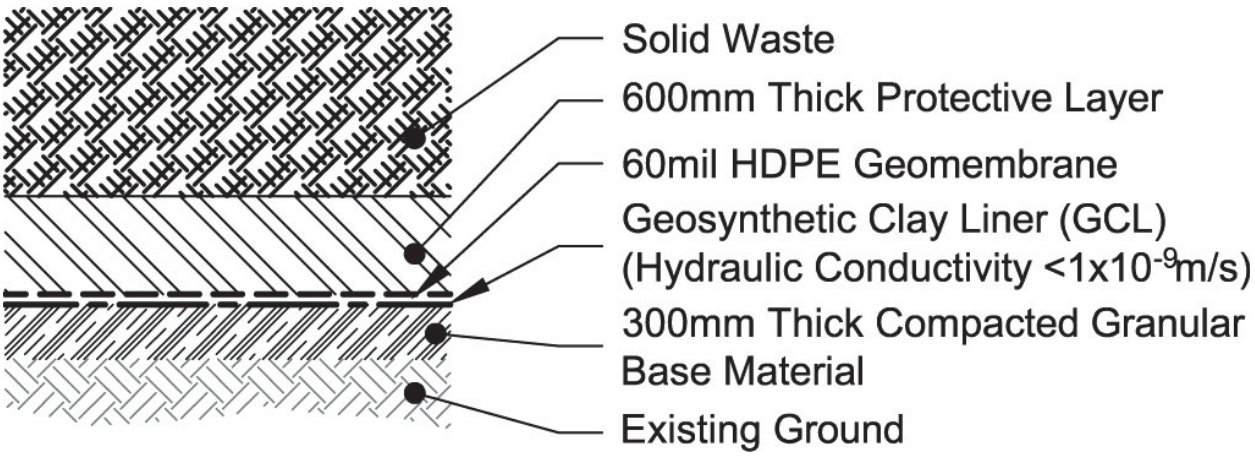


Figure 4-2: Proposed Based Liner Section

The liner would be constructed as an addition to the base grades from Figure 4, in Appendix A, and would include a 0.3 m compacted granular base layer, geosynthetic clay liner (GCL), overlain by a 60 mil High Density Polyethylene (HDPE) geomembrane and a 0.6 m thick protective soil layer.

A high level of quality assurance/ quality control (QA/QC) would be required during the construction and placement of the clay layers and installation of the 60 mil HDPE geomembrane. The QA/QC process includes manufactured materials testing, quality assurance inspection throughout installation including grade control, destructive and non-destruction testing of field seams. QA/QC operations should be fully documented in an installation report.

4.3.2 Landfill Base Grades

With consideration of existing quarry floor elevations and local drainage patterns, the base of the containment area could be constructed such that the landfill area in the quarry can be graded to properly

drain to adjacent surface water drainage. The preliminary base grade elevations for the landfill are presented on Figure 4 – Proposed Landfill Footprint in Appendix A. The grades depicted in Appendix A, on Figure 4, show the final elevations of blasting operations performed by NWT Construction Ltd and former operations by Volker Stevin Ltd. The base of the proposed landfill will utilize the existing quarry floor which lies on a stratum of bedrock, where possible and would be built up with suitable compacted material where required. This produces a solid and stable base for landfill construction.

The cell floor would be graded towards the East to provide a positive drainage path that enables a central leachate collection system to collect leachate at the collection sump. Grades prior to landfill construction and existing conditions at the site are depicted in Appendix A - Figure 4. A grade line showing final design elevation after placement of base material, geomembrane liner and cover material is also shown and annotated on the drawing.

The conceptual design of the containment berm includes 3H:1V side slopes as per the typical berm dimensions in the GNWT guidelines. The berm configuration shall be finalized as part of the final design for the facility. The Quarry Use Plan, produced by Dillon Consulting Limited, April 2006, further describes the potential to include the base construction in the quarry operations and be part of NWT Construction Ltd's restoration plan. This would considerably reduce construction costs incurred by the City of Yellowknife to develop a new solid waste site in the identified location.

4.3.3 Leachate Collection

The positive drainage (referenced in Section 4.3.2) will provide a working grade for the leachate collection system. Each cell will be drained to an independent sump for leachate storage and extraction. The leachate collection system consists of a network of perforated pipe. The pipe is bedded in clean open graded rock contained within a trench graded to the collection sump. The washed drainage rock is then contained within a geotextile blanket to maintain separation between the drainage rock and the protective layer and waste. The sump pit is accessed by a riser pipe system along the external slope of the landfill. The riser pipe is accessed from the exterior of the landfill. Leachate levels are monitored by using a pressure transducer in the riser pipe. Leachate is extracted by inserting a submersible pump into the sump through the riser pipe. Leachate is pumped to maintain a maximum head of 0.3m of the liner. Leachate is pumped to tanker truck and transported to a designated treatment facility.

As part of the leachate management plan, an estimate of leachate generation rates and concentration should be developed. These estimates can be used to evaluate leachate treatment options and identify an acceptable leachate treatment facility.

4.3.4 Proposed Development Sequence

The new landfill site has the ability to be developed in stages. Dillon recommends that the life span for the new Solid Waste Site be broken down in 5 year segments, called cells. This will enable capital costs to be spread out over a 5 year term. Adequate sizing of each segment is necessary to accommodate the

accumulated waste for future population projections. If the feasibility study of concurrent operation of the quarry and landfill is favorable, then it is estimated that up to 40 years of landfill capacity would be available. This scenario would also involve sequential development of landfill capacity.

Once a cell has been constructed and filled with waste up to the final contours, final cover material would be placed on the exterior slopes. The final cover will allow for water to be shed from the surface of the landfill rather then seeping through the waste and creating leachate. Placement of the final cover layer will include vegetation which will help to control erosion of the slopes.

4.3.5 Intermediate Cover

Alberta requirements for intermediate cover, for landfills annually servicing over 5,000 tonnes, require cover to a depth of 0.15m every 48 hours. Exceptions are between Nov 15 and April 15. According to the Guidelines for the Planning, Design, Operations and Maintenance of Modified Landfills in the NWT it is recommended to use 0.30m of native cover every spring and fall.

It is recommended that intermediate cover be places every 48 hours as a means of reducing attractants to birds and animals. The cover material will also help reduce windblown waste. Alternative covers should be investigated for use during the winter months.

4.3.6 Final Cover

The conceptual design was developed using side slopes of 6H:1V and a top grade of no less than 3%. This promotes positive drainage and prohibits water collection on top of the landfill. This 3% grade produces a dome-top and encourages water shed off the landfill area to reduce infiltration. A maximum waste elevation of 213m ASL is used to limit development. This elevation is the same as is being used for the existing landfill. Final cover would be placed in addition to this elevation limit.

Alberta requirements for the final cover for a landfill include a clay cap with a hydraulic conductivity of $1*10^{-7}$m/s to a depth of 0.6m plus subsoil and topsoil equaling the following parameters

i) for pasture and recreational uses, 0.20m of topsoil and 0.35m of subsoil, and
ii) for cultivated land use or forestry, 0.20m of topsoil and 0.80m of subsoil.

Depending on availability of such clay materials in Yellowknife, an impervious geomembrane liner could potentially be substituted to provide a final cover to the landfill.

4.3.7 Stormwater Management

Stormwater and surficial drainage must be managed to control water accumulation and to manage the water that is in contact with the waste. The design and construction of the perimeter berm and haul road along the crest of the landfill pit will provide structure for the interceptor ditch to assist in controlling surface water and restricting it from entering the landfill containment area. The design surface water ditch will flow to the existing quarry pit ditch used to remove surface water from within the pit. This ditch drains out past Highway #4.

There will also be an interior ditch system which will collect water that is shed off of the landfill slopes. This water is directed to a storage pond where is can be tested for suspended solids and contamination prior to being discharged.

4.3.8 Perimeter Berm and Service Road

Access to the landfill is controlled through the gatehouse at the main entranceway. This is the only access point for vehicles entering the landfill. All vehicles must pass by the gatehouse and only large commercial vehicles with wastes that cannot be baled will be directed to the landfill. These vehicles will access the landfill via the same haul road that the transfer vehicle hauling bales uses, along the east side of the baling facility to the site of the new landfill. For the purpose of this study, a road width of 8.0m was used. A perimeter service road will also be required around the site to provide access for maintenance purposes and to access the leachate collection points. The locations of the perimeter berm and haul roads are depicted in Figure 4 – Appendix A.

If the site is used for concurrent quarry use along with the landfill operations, an additional access point would likely be required off the quarry access road for hauling vehicles. The inclusion of haul roads will permit access to NWT Construction Limited to continue blasting operations at the west end of the lease limits. This potential haul road would be a two lane gravel road approximately 10-12m wide to allow for heavy equipment mobilization throughout the pit. It should be located along the South toe of the quarry pit and would progress to the West as the pit extends.

This preliminary design includes a perimeter berm that has been developed with a minimum height of 2.0m, but is typically 2.5 to 3.5 m above the existing grades. For the purpose of this design concept, the berm has a crest width of 2.0m and follows the natural contours and elevations of the existing site conditions. The inside of the berm is at a 3H:1V slope and the outside is at a 2H:1V slope. The compacted clay base (see base liner – Section 4.3.1) overlays the constructed berm and is suitable for a 0.5m wide anchor trench to key in the 60 mil HDPE geomembrane. The perimeter berm is shown in Appendix A on Figure 4 Section A and B.

4.3.9 Landfill Gas

Landfill gases are generated as part of the process of waste decomposition. Landfill gas is composed of a mixture of hundreds of different gases. By volume, landfill gas typically contains 45% to 60% methane and 40% to 60% carbon dioxide along with small amounts of several other gases. Methane is a potent greenhouse gas and can migrate underground and accumulate in explosive concentrations.

The rate and volume of landfill gas produced at a specific site depend on a variety of factors including the characteristics of the waste such as composition and age of the refuse along with a number of environmental factors such as the presence of oxygen in the landfill, moisture content, and temperature.

Depending on the combination of these factors the generation of landfill gas may be quite succinct (20 year range) or prolonged for long periods of time (100+ years).

The volumes of gas produced at landfills in the Northwest Territories has not been studied and the requirement to manage it is, therefore, unsupported. Alaska requires air quality controls if a landfill facility is over 2.5 million cubic metres (GNWT, 2003)

A landfill gas management plan should be included in the final solid waste facility design.

5 SITE CAPACITY AND MATERIAL BALANCE

Table 1 – Waste Generation, in Appendix B, depicts the total volume of waste generation throughout a 20-year life span of the solid waste site. The required total landfill capacity is nearly 466,000 plus approximately 70,000m^3 in cover material. The total airspace required for 20 years worth of waste is therefore 535,800m^3. As described in section 4, it may be possible to continue quarry operations and provide up to 40 years of landfill capacity in the available land.

The potential to continue blasting operations and removal of approximately 50,000m^3 of rock per year from the quarry site opens up more useable area for landfill operations. As previously stated, at this rate the quarry operation could be sustained for another 7.5 years. A comparison between the waste generated per year and the volume of rock removed, shows that for every year of blasting occurs, nearly two (2) additional years are available for landfill operations.

6 SUMMARY AND CONCLUSION

This report and attached figures show the preliminary design for a new landfill and entranceway at the proposed location in the quarry to the north of the existing landfill. As the development progresses, the following is recommended as a course of action.

1. Evaluate the siting constraints. In particular the airport setback as the handling of this issue is unknown at this time and may be a limiting factor on the siting of a new landfill facility.
2. Initiate preliminary discussions with the MVLWB
3. Evaluate the landfilling plan for the existing site and develop time lines for development of new landfill capacity.
4. Conduct a study of the feasibility of concurrent operation of the quarry along with landfilling at the proposed site. This study should include an evaluation of safe blasting practices, separation distances between quarrying operations and landfill operations, and a geotechnical evaluation of landfill slope stability and design.
5. Confirm that the existing (January 2006) lease limits for the existing landfill and existing quarry may be modified slightly along the north edge to accommodate landfill construction as proposed in figure 4 – Appendix A.
6. Continue to track waste generation rates and update airspace requirements planning as required, in particular following the first year of implementation of the new user pay program implemented on January 1, 2006.
7. Complete Final Design of the New Landfill.
8. Submit a permit application for the new landfill to the MVLWB

The development of new landfill capacity is a major step for the City of Yellowknife. Careful planning and a proactive approach to dealing with design, public education and regulatory issues is recommended throughout the process.

7 GLOSSARY OF TERMS

Airspace: In landfill terms, airspace refers to the volume, measured in cubic meters (m^3), of space that can be used to dispose of solid waste.

Active Area: A region of the solid waste facility that is undergoing some form of processing. This usually takes the form of operating heavy machinery to facilitate compaction and covering of the waste that has been recently deposited.

Baler: A machine that uses a hydraulic compactor and tie wire to compress and bind solid waste and recyclable materials, such as paper, scrap metal, or plastic jugs into rectangular shaped bales.

Baling Facility: The building that houses the baler machinery and surrounding structures/equipment that supports the baler operation.

Balefill: A balefill is a landfill specifically designed for disposing of compacted waste bales. The bales are made using a hydraulic compactor, then stacked in rows, and covered.

Cover material: Refers to soil or other material approved for use in sealing cells at the landfill.

Landfill: A method for final disposal of solid waste on land. The refuse is spread and compacted and a cover of soil applied so that effects on the environment (including public health and safety) are minimized. Landfills are often required to have liners and leachate treatment systems to prevent contamination of ground water and surface waters. An industrial landfill disposes of non-hazardous industrial wastes. A municipal landfill disposes of domestic waste including garbage, paper, etc. This waste may include toxins that are used in the home, such as insect sprays and powders, engine oil, paints and solvents.

Leachate: Liquid that has percolated through solid waste or other medium and has extracted, dissolved or suspended materials from it, which may include potentially harmful materials. Leachate collection and treatment is of primary concern at municipal waste facilities. Modern landfills (and balefills) are designed to prevent leachate from seeping out into the groundwater or nearby surface waters.

Solid Waste Facility: Describes the entire site used for the processing and final disposal/shipping of solid waste/recycling. This includes the baling building, landfill and balefill areas, on-site recycling bins, scrap lumber and metal areas, salvaging face, hazardous waste storage, waste tire stockpile, etc.

Modified Landfill: Modified landfilling is a method of disposing solid waste on land in a manner that protects human health and the environment. Applying engineering principles, solid waste is confined to

the smallest practical area, reduced to the smallest practical volume and covered routinely with a cost-effective layer of earth.

Sanitary Landfill: A specially engineered site for disposing of solid waste on land, constructed so that it will reduce hazard to public health and safety. Some qualities include: an impermeable lower layer to block the movement of leachate into ground water; a leachate collection system; gravel layers permitting the control of methane; and daily covering of garbage with soil.

Tipping Face: The region of the landfill that is dedicated to active dumping. The extent of the active tipping face should be delineated by signage and limited to the minimum practicable for waste placement and compaction.

Transfer Station: a site at which refuse is concentrated or accumulated for transportation either to the landfill area or the baling facility.

8 REFERENCES

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GNWT, Department of Municipal and Community Affairs, *Background Report for Updating the Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories,* prepared by Ferguson Simek Clark Engineers & Architects, April 2003.

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Standards for Landfills in Alberta, May 2004 (website)
http://www.qp.gov.ab.ca/documents/codes/LANDFILL.CFM

Government of British Columbia, Ministry of Environment, Environmental Protection Division (website)
http://www.env.gov.bc.ca/epd/epdpa/mpp/lcmsw.html

Government of Ontario, Ministry of Environment (website)
http://www.ene.gov.on.ca/envision/land/landfill/index.htm

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APPENDIX A

DRAWINGS

LEGEND

- ELECTRIC FENCE
- CREST
- TOE OF SLOPE
- 122.0 MAJOR CONTOUR
- MINOR CONTOUR
- LANDFILL GAS WELL
- SIGNIFICANT AREAS
- RECYCLABLES
- BALED WASTE
- CONSTRUCTION & DEMOLITION
- SPECIAL WASTE (LAND FILLED)
- RESIDENTIAL WASTE LOADS (SALVAGABLE)

NOTES

- ALL INFORMATION AND LOCATIONS ON THIS DRAWING HAVE BEEN OBTAINED BY OTHERS AND ARE BASED ON THE BEST POSSIBLE INFORMATION AT THE TIME. ANY FEATURES SHOULD BE VERIFIED IN FIELD.
- SURVEY BY SUB-ARCTIC SURVEYORS JULY 26 AND JULY 27, 2005.

REVISIONS

CHANGE	DATE	DESCRIPTION	CHECK

DESIGN	DRAWN	CHECKED	DATE
	41TPW		AUGUST 05

City of Yellowknife

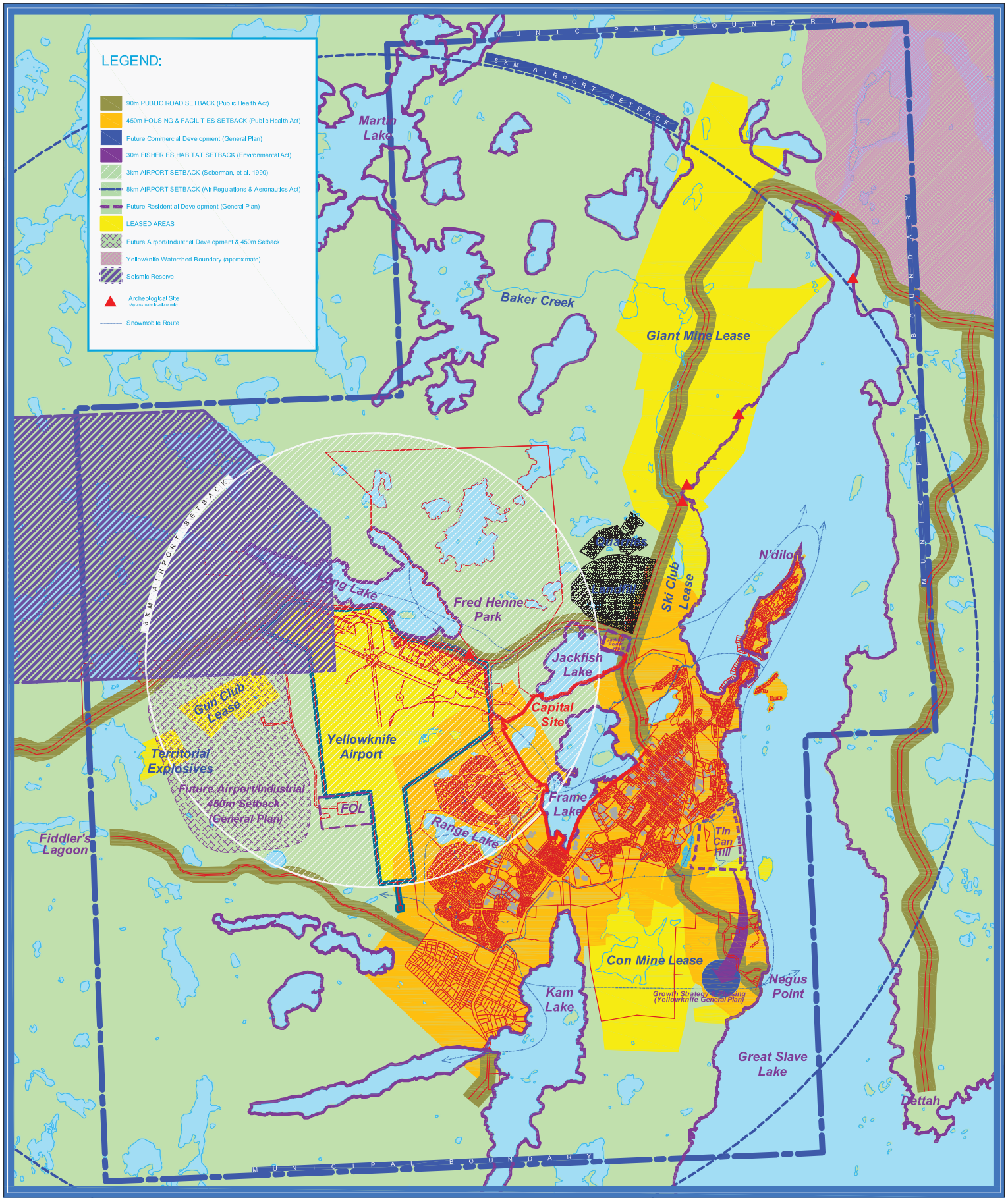
PROJECT
CITY OF YELLOWKNIFE
SOLID WASTE FACILITY

TITLE
EXISTING SITE CONDITIONS

DILLON CONSULTING

SCALE	1:1500
DILLON PROJECT NUMBER	05-4719-1000
CLIENT PROJECT NUMBER	
DRAWING NUMBER	1

EDIT DATE: 24.03.2006 PLOT DATE: 41tpw 24.03.2006 ACAD FILE: 41tpw g\cad\054719\landfill\existing site conditions.dwg

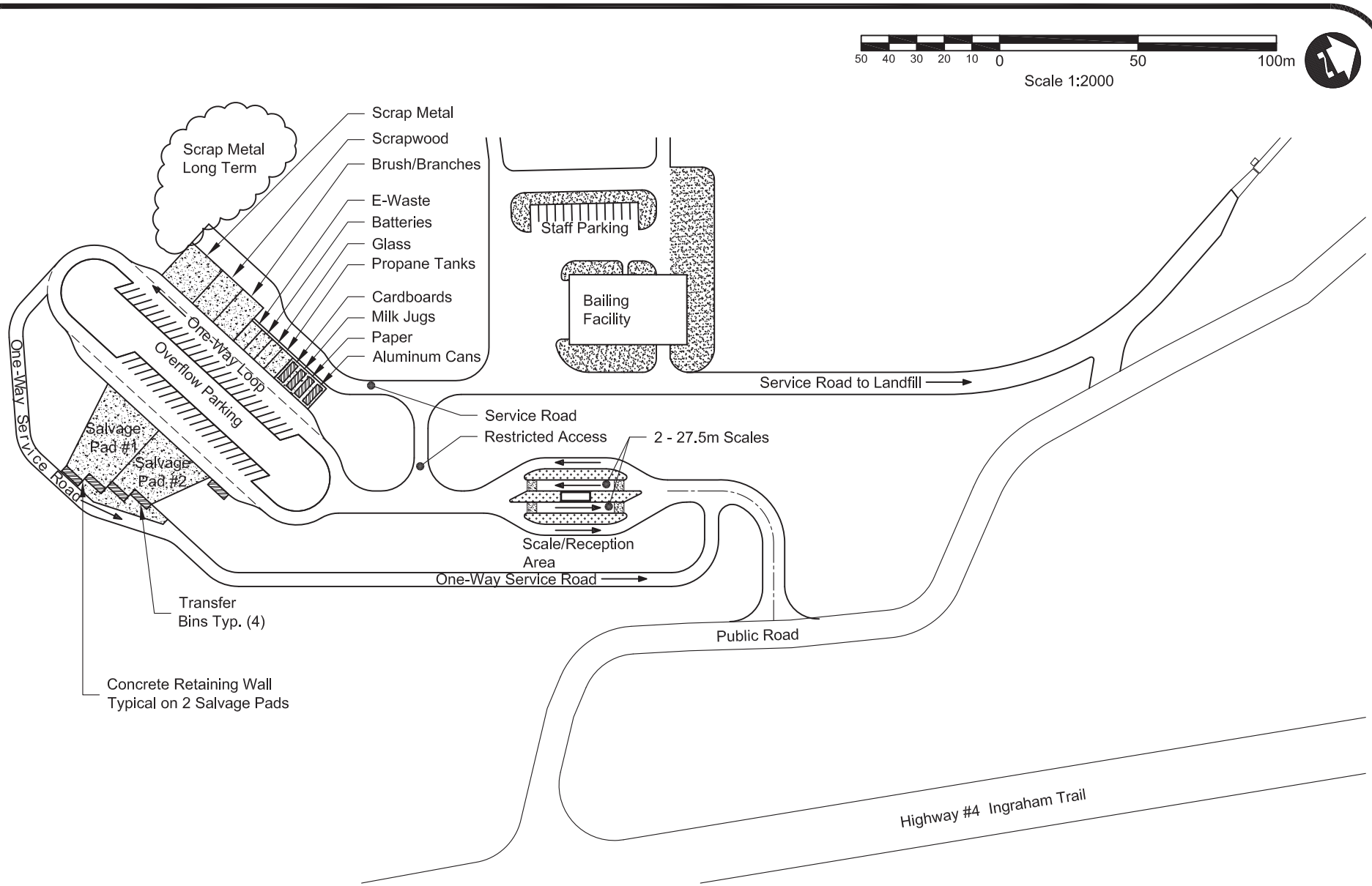


City of Yellowknife

Solid Waste Management Facility Siting Constraint Map

Draft - Revision 1

Mar. 2006



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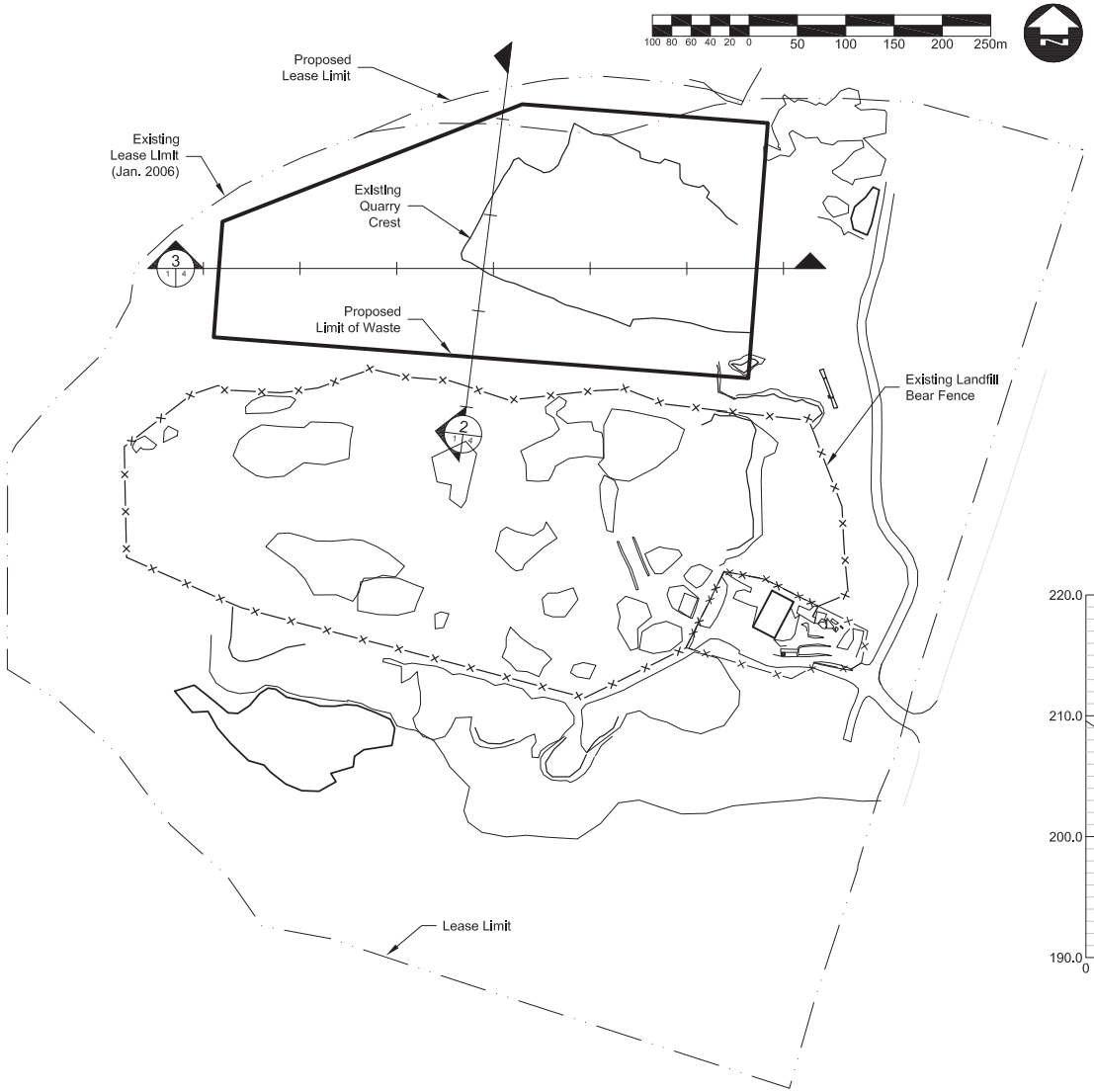
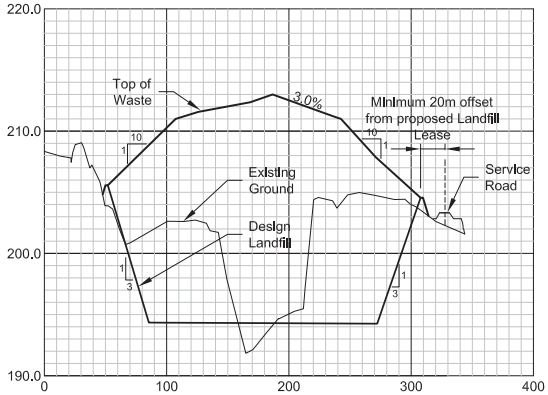
DILLON CONSULTING

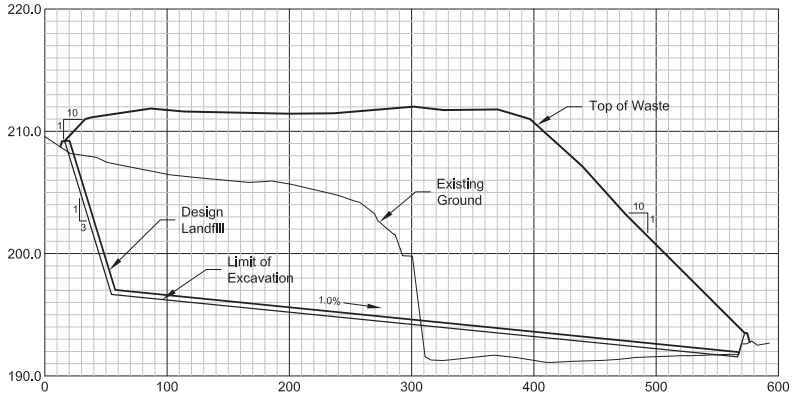
PROJECT	City of Yellowknife
TITLE	New Solid Waste Site Conceptual Design
PROJECT NUMBER	05-4719-2000
DATE	March 2006
FIGURE NUMBER	3



1 SITE PLAN
1 4 SCALE 1:500



2 SECTION A
1 4 SCALE HOR. 1:4000 VER. 1:400



3 SECTION B
1 4 SCALE HOR. 1:4000 VER. 1:400

DILLON CONSULTING

PROJECT	City of Yellowknife Quarry Use Plan
TITLE	Proposed Landfill Footprint
PROJECT NUMBER	05-5510-1000
DATE	March 2006
FIGURE NUMBER	4

EDIT DATE: 28.03.2006 PLOT DATE: 41fpw 28.03.2006 ACAD FILE: 41fpw g:\cad\054719\landfill\dwg\quarry_fig1.dwg

APPENDIX B

TABLES

WASTE GENERATION
City of Yellowknife
New Landfill Site

Waste/Year in 2004 (tonnes) (excluding contaminated soil)	Population 2004	Waste/Person /Year (tonnes)
13,393	19,056	0.703

Bureau Of Statistics

Year	Population
2004	19,056
2009	20,939
2014	22,278
2019	22,996
2024	24,214

BALER

Assumptions: *Baler waste density = 0.75 t/m^3*
Blended waste density = 0.68 t/m^3 assuming that 20% of waste is not baled with a density of 0.5 t/m^3
Cover usage = 15%
No increased waste diversion

Planning Year (Baler)	Calendar Year	Total Population	Waste Generated (t/yr/person)	Waste Generated (tonnes/yr)	Accumulated Waste (tonnes)	Accumulated Volume (m^3)	Accumulated Volume w/ Cover (m^3)
	2004	19,056	0.703	13,393		20,605	23,695
	2005	19,669					
0	2006	19,917	0.703	14,002			
1	2007	20,164	0.703	14,176	14,176	20,846	23,973
2	2008	20,412	0.703	14,350	28,525	41,949	48,241
3	2009	20,939	0.703	14,720	43,245	63,596	73,135
4	2010	20,907	0.703	14,697	57,943	85,210	97,991
5	2011	21,154	0.703	14,871	72,814	107,080	**123,141**
6	2012	21,402	0.703	15,045	87,859	129,205	148,586
7	2013	21,649	0.703	15,219	103,079	151,586	174,324
8	2014	22,278	0.703	15,661	118,740	174,618	200,811
9	2015	22,144	0.703	15,567	134,308	197,511	227,138
10	2016	22,392	0.703	15,741	150,049	220,660	**253,759**
11	2017	22,639	0.703	15,915	165,964	244,065	280,674
12	2018	22,886	0.703	16,089	182,053	267,725	307,884
13	2019	22,996	0.703	16,166	198,219	291,499	335,224
14	2020	23,381	0.703	16,437	214,656	315,671	363,022
15	2021	23,629	0.703	16,611	231,267	340,099	**391,114**
16	2022	23,876	0.703	16,785	248,052	364,783	419,501
17	2023	24,124	0.703	16,959	265,011	389,723	448,181
18	2024	24,214	0.703	17,022	282,034	414,756	476,969
19	2025	24,619	0.703	17,307	299,341	440,207	506,238
20	2026	24,866	0.703	17,481	316,822	465,914	**535,801**

COMPACTOR

Assumptions: *Waste Density = 0.6 t/m^3*
Cover usage = 20%
No increased waste diversion

Planning Year (Compactor)	Calendar Year	Total Population	Waste Generated (t/yr/person)	Waste Generated (tonnes/yr)	Accumulated Waste (tonnes)	Accumulated Volume (m^3)	Accumulated Volume w/ Cover (m^3)
	2004	19,056	0.703	15,593			
	2005	19,669	0.703				
0	2006	19,917	0.703	14,002			
1	2007	20,164	0.703	14,176	14,176	23,626	28,351
2	2008	20,412	0.703	14,350	28,525	47,542	57,050
3	2009	20,939	0.703	14,720	43,245	72,075	86,490
4	2010	20,907	0.703	14,697	57,943	96,571	115,885
5	2011	21,154	0.703	14,871	72,814	121,357	**145,628**
6	2012	21,402	0.703	15,045	87,859	146,432	175,719
7	2013	21,649	0.703	15,219	103,079	171,798	206,158
8	2014	22,278	0.703	15,661	118,740	197,900	237,480
9	2015	22,144	0.703	15,567	134,308	223,846	268,615
10	2016	22,392	0.703	15,741	150,049	250,081	**300,097**
11	2017	22,639	0.703	15,915	165,964	276,607	331,928
12	2018	22,886	0.703	16,089	182,053	303,422	364,106
13	2019	22,996	0.703	16,166	198,219	330,366	396,439
14	2020	23,381	0.703	16,437	214,656	357,761	429,313
15	2021	23,629	0.703	16,611	231,267	385,446	**462,535**
16	2022	23,876	0.703	16,785	248,052	413,421	496,105
17	2023	24,124	0.703	16,959	265,011	441,686	530,023
18	2024	24,214	0.703	17,022	282,034	470,057	564,068
19	2025	24,619	0.703	17,307	299,341	498,901	598,682
20	2026	24,866	0.703	17,481	316,822	528,036	**633,643**

CITY OF YELLOWKNIFE – LANDFILL REGULATIONS IN OTHER JURISDICTIONS			
ITEM	SUMMARY OF JURISDICTION	REQUIREMENT	Applicability in YK
Regulatory Officials	Alberta	Alberta Environment *Standards for Landfills in Alberta*, May 2004 (website) http://www.qp.gov.ab.ca/documents/codes/LANDFILL.cfm	Reference
	Ontario	Government of Ontario, Ministry of Environment (website) http://www.ene.gov.on.ca/envision/land/landfill/index.htm	No
	BC	BC Environment Ministry of Environment - Environmental Protection Division, *Landfill Criteria For Municipal Solid Waste* (website) http://www.env.gov.bc.ca/epd/epdpa/mpp/lcmsw.html	No
	NWT	Mackenzie Valley Land and Water Board (website) http://www.mvlwb.com	YES
	Diavik	Mackenzie Valley Land and Water Board (website) http://www.mvlwb.com *Waste Management Plan*, Vers.#8 *March 2005* (website) http://www.mvlwb.com/pdf/pre2000water/N7L2-1645/N7L2-1645-2004AnnRpt-Appendices/N7L2-1645-AppendixD-WasteMgt-Apr05.pdf	YES
	BHP	Mackenzie Valley Land and Water Board (website) http://www.mvlwb.com	YES
Published Standards and Guidelines	Alberta	Alberta Environment Standards for Landfills in Alberta, May 2004 (website) http://www.qp.gov.ab.ca/documents/codes/LANDFILL.cfm	Reference
	Ontario	Government of Ontario, Ministry of Environment (website) http://www.ene.gov.on.ca/envision/land/landfill/index.htm	No
	BC	BC Environment Ministry of Environment - Environmental Protection Division, *Landfill Criteria For Municipal Solid Waste* (website) http://www.ene.gov.on.ca/envision/land/landfill/index.htm	No
	NWT	No government issued regulations Unofficial – Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT	YES
	Diavik	None available – Must pass regulating committee	YES
	BHP	None available – Must pass regulating committee	YES

CITY OF YELLOWKNIFE – LANDFILL REGULATIONS IN OTHER JURISDICTIONS			
ITEM	SUMMARY OF JURISDICTION	REQUIREMENT	Applicability in YK
Design Plan and Submissions	Alberta	Required at application process	Reference
	Ontario	Required at application process	Reference
	BC	Required at application process	Reference
	NWT	Required at application process to Mackenzie Land and Water Board (MVLWB)	Submit to MVLWB
	Diavik	Required at application process to Mackenzie Land and Water Board (MVLWB)	Submit to MVLWB
	BHP	Required at application process to Mackenzie Land and Water Board (MVLWB)	Submit to MVLWB
Liner Requirements	Alberta	NATURAL 5.0m thick natural clayey deposits with a hydraulic conductivity of $1*10^{-8}$ m/s immediately below waste; and The geological deposits below this layer have a hydraulic conductivity of $1*10^{-8}$ m/s to a depth of 5.0m	NO
		CONSTRUCTED Without a geomembrane liner – requires a 1.0m thick clay cap with a hydraulic conductivity of $1*10^{-9}$ m/s	NO
		CONSTRUCTED With a geomembrane liner – requires a 0.6m thick clay cap with a hydraulic conductivity of $1*10^{-9}$ m/s followed by a 40 – 60 mil impervious geomembrane liner.	YES
	Ontario	CONSTRUCTED Single liner, 60 mil, 0.75m thick natural clayey deposits	NO
		CONSTRUCTED Without a geomembrane liner – requires a 1.0m thick clay cap with a hydraulic conductivity of $1*10^{-9}$ m/s	NO
		CONSTRUCTED With a geomembrane liner – requires a 0.75m thick clay cap with a hydraulic conductivity of $1*10^{-9}$ m/s followed by a 60 mil impervious geomembrane liner.	YES

CITY OF YELLOWKNIFE – LANDFILL REGULATIONS IN OTHER JURISDICTIONS			
ITEM	SUMMARY OF JURISDICTION	REQUIREMENT	Applicability in YK
Liner Requirements (continued)	BC	NATURAL 2.0m thick natural clayey deposits with a hydraulic conductivity of $1*10^{-6}$ m/s immediately below waste; and The bottom of the solid waste cell must be 1.2m above the seasonal high ground water elevation	NO
		CONSTRUCTED Without a geomembrane liner – requires a 1.0m thick clay cap with a hydraulic conductivity of $1*10^{-7}$ m/s	NO
		CONSTRUCTED With a geomembrane liner – requires a 0.6m thick clay cap with a hydraulic conductivity of $1*10^{-7}$ m/s followed by a 40 – 60 mil impervious geomembrane liner.	YES
	NWT	No Official Standard	
	Diavik	No impervious liner used for waste landfills. However, No organic material applied to on-site landfill. All inert and organic material is incinerated	No
	BHP	No impervious liner used for waste landfills. However, No organic material applied to on-site landfill. All inert and organic material is incinerated	No
Final Cover	Alberta	A final cap of clay with a hydraulic conductivity of $1*10^{-7}$ m/s to a depth of 0.6m plus a subsoil and topsoil equaling the following parameters	YES
		(i) for pasture or recreational uses, 0.20 metres of topsoil and 0.35 metres of subsoil, and	YES
		(ii) for cultivated land use or forestry, 0.20 metres of topsoil and 0.80 metres of subsoil.	YES
	BC	A final cap of low permeability soil with a hydraulic conductivity of $1*10^{-5}$ m/s to a depth of 1.0m; and Topsoil of 0.15m thick	YES
Intermediate Cover	Alberta	For Landfills annually servicing over 5,000 tonnes, a cover to a depth of 0.15m every 48 hours. Exceptions are between Nov 15 and April 15.	YES
	BC	For Landfills annually servicing over 5,000 tonnes, a cover to a depth of 0.15m every 24 hours	YES

CITY OF YELLOWKNIFE – LANDFILL REGULATIONS IN OTHER JURISDICTIONS			
ITEM	SUMMARY OF JURISDICTION	REQUIREMENT	Applicability in YK
Leachate Requirements	Alberta	The lowest of the following parameters must be met in order to discharge leachate: (a) surface water background quality, (b) the latest edition of *Alberta Ambient Surface Water Quality Interim Guidelines*, published by Alberta Environmental Protection, or (c) the latest edition of *Canadian Water Quality Guidelines*, published by the Canadian Council of Resource and Environment Ministers.	YES

APPENDIX C

VOLUME ASSESSMENT of CURRENT LANDFILL

MEMO

TO:	Dennis Kefalas
cc:	Bruce Underhay
FROM:	Colin Joyal
DATE:	October 19, 2005
SUBJECT:	City of Yellowknife – Landfill Volume Assessment
FILE NO.:	05-5099-1000

DILLON CONSULTING

Box 1409
303, 4920 47th Street
Yellowknife
Northwest Territories
Canada
X1A 2P1
Telephone
(867) 920-4555
Fax
(867) 873-3328

An assessment of the existing City of Yellowknife landfill site was conducted by Dillon Consulting Limited. The purpose of this assessment is to:

- Survey the existing site
- Develop a drawing showing existing site conditions and model the waste fills
- Develop final fill contours
- Assess theoretic maximum remaining capacity
- Develop a fill contour plan showing waste bale placement

The output of this assessment is a drawing showing the final top of waste fill plan including contours showing number of bale height placement.

SITE DATA

A topographic survey of the site was conducted by Sub-Arctic Surveys on July 26 and 27, 2005. This information was provided to Dillon Consulting and a base map was prepared, see figure 1. Bruce Underhay, Manager of the Solid Waste Facility, was consulted to assist with defining waste segregation areas.

DEVELOPMENT OF FINAL FILL CONTOURS

The final top of waste fill contours for the site were developed using a maximum top of waste elevation of 213 asl. The closure report for the site titled "A Progressive Yellowknife Landfill Closure Plan, Bryant Environmental Consultants Ltd, April 12, 2001" was consulted to in developing the final slopes for the site. The constraints for the final site development are as follows:

- Maximum top of waste elevation: 213 asl
- Minimum slope: 3%
- Maximum slope: 10%
- Waste limits: The existing bear fence at the site was used as the limit of waste with a setback from the fence of 5m. In some cases existing ground was used as a limiting factor depending on localized grades. The placement of waste bales was limited to the portion of the site west of station 0+200 as shown on figure 2. Waste fills are not limited to this stationing but this was used for the sake of this assessment to coincide with the existing fill slopes.
- Bale height: each bale is 0.76m high. Bales are stacked to a maximum 4 high with a forklift. Fills beyond 4 bales would require more than one lift.

The final cover layer will be placed overtop of the top of waste contours. Once the final cover layer section is finalized, the overall maximum height can be determined.

BALEFILL PLAN

To facilitate the placement of waste bales across the site, a balefill contour map has been generated as shown in figure 2. This drawing shows contours of the limits of bale stack heights. Stationing across the centre line or "spine" of the site has been used as a reference and cross sections taken every 10m are shown in figures 3 and 4. Table 1 has been provided to give offsets from the centerline for bale stack heights. The centre line can be surveyed on the site based on the coordinates provided and the offsets can be used by the landfill attendants to plan the placement of bales.

VOLUME ASSESSMENT

A 3-dimensional model was created for the final waste contours. Based on a overlay comparison of this model and the existing fill contours, an estimate of remaining fill volume was generated. It should be noted that this fill volume is somewhat theoretic in that it may be difficult, inefficient or impractical to fill to these contours in all areas. In some cases such as along the east edge of the site, it may also be undesirable to fill to the maximum theoretic contours due to sight lines from the highway. This does however serve as a planning guide for overall site life.

Based on the assessment, the following was calculated:

- Total area within the bear fence: 178,000 m^2
- Total area within the 5m offset from the bear fence: 168,700 m^2
- Total maximum theoretic fill volume of site: 400,000 m^3

- Area of west side of site from STA 0+200: 88,000 m^2
- Fill volume of west side of site from STA 0+200: 189,300 m^3
- Fill volume for bales of west side of site from STA 0+200: 149,000 m^3

SITE CAPACITY

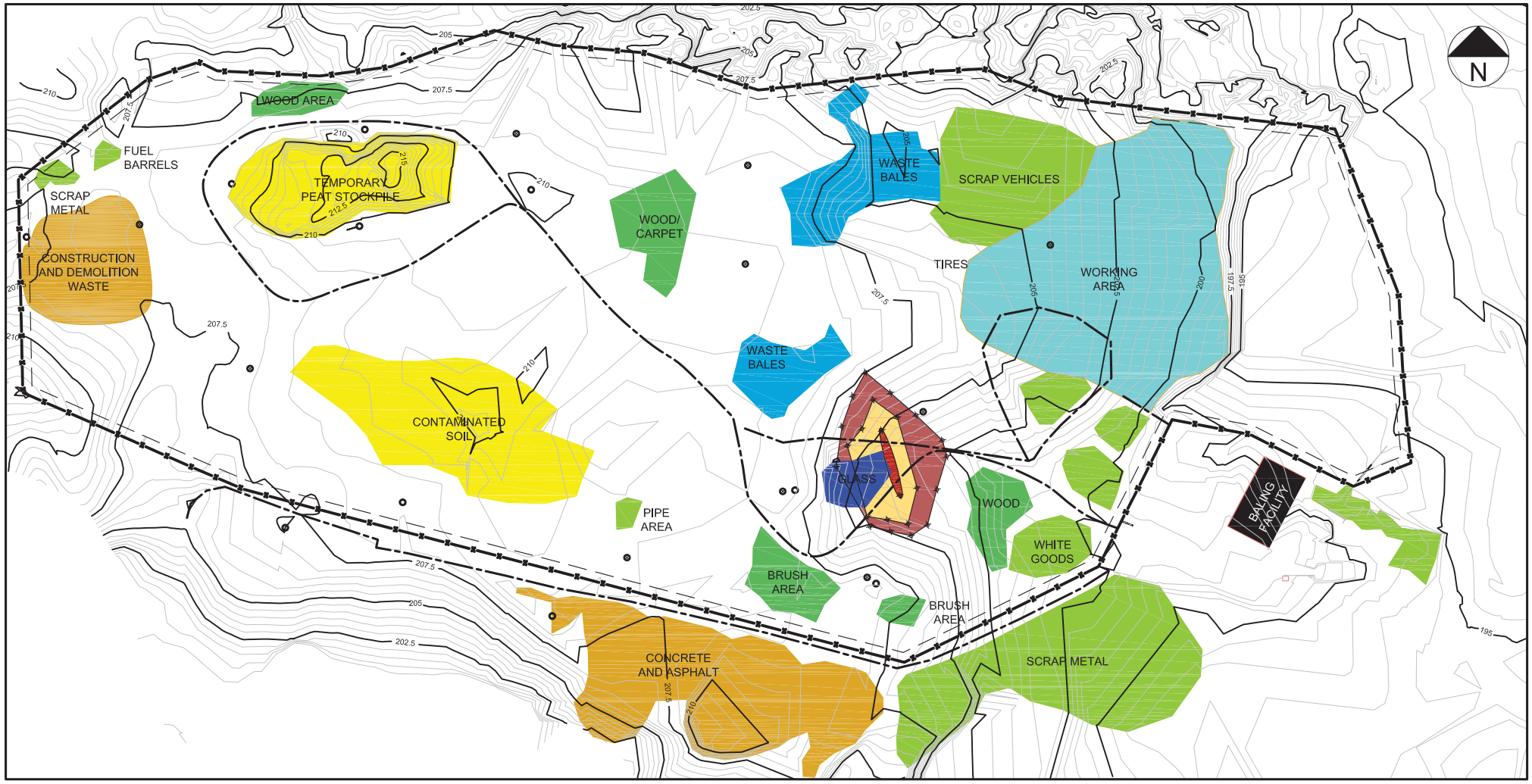
Based on City records, it is estimated that 13,400 tonnes of waste goes into the landfill per year. Using a estimated overall density of 0.65 t/m^3 and a cover usage estimate of 15%, this equates to 23,700 m^3/year. Assuming that waste generation remains constant, this equates to approximately 16.8 years of maximum theoretic remaining site life. Using only the west side of the site, this would provide nearly 8 years of site life.

RECOMMENDATIONS

These estimates have been derived based on information available at this time. As there is relatively little historic information recorded on annual waste tonnages, density, cover usage and site development, further information should be compiled before these estimates are used for planning purposes beyond the short term horizon (5 years+). It is recommended that the City track this information annually to provide better accuracy of future estimates. This should include an annual survey of the site to monitor site usage and to track volume versus recorded waste tonnages.

It is recommended that a site development plan be generated for the fill sequencing of the site. This can be used to plan for an area (likely the west side of the site) to be built up to final contours such that final cover can be placed and the sequential close of the site can begin. This would have to be carefully coordinated with a variety of operations occurring across the site such as contaminated soil treatment and stockpiling of materials.

These figures should be used as a guide for the short planning horizon. If it is the intention of the City to maximize the site life, it is recommended that the impacts of this be studied, such as development sequencing (painting yourself into a corner), the impacts on the water licence for the site, impacts on adjacent site lines and on airport operations.



October 13, 2005

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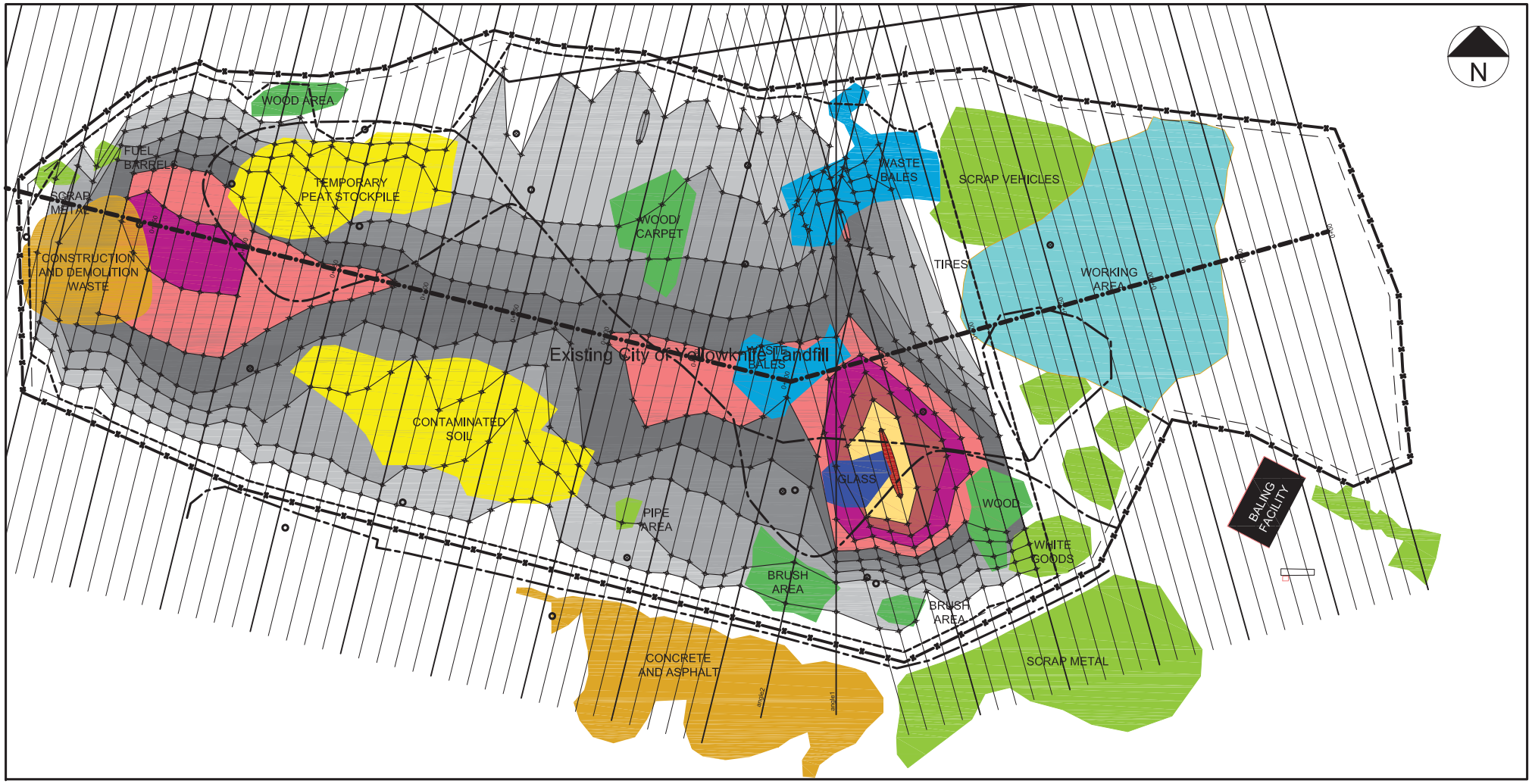
Figure 1: Solid Waste Facility Site Conditions July 26 and 27, 2005



October 13, 2005

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Figure 2: Solid Waste Facility Proposed Top of Waste Fill Contours

October 13, 2005

Not to Scale

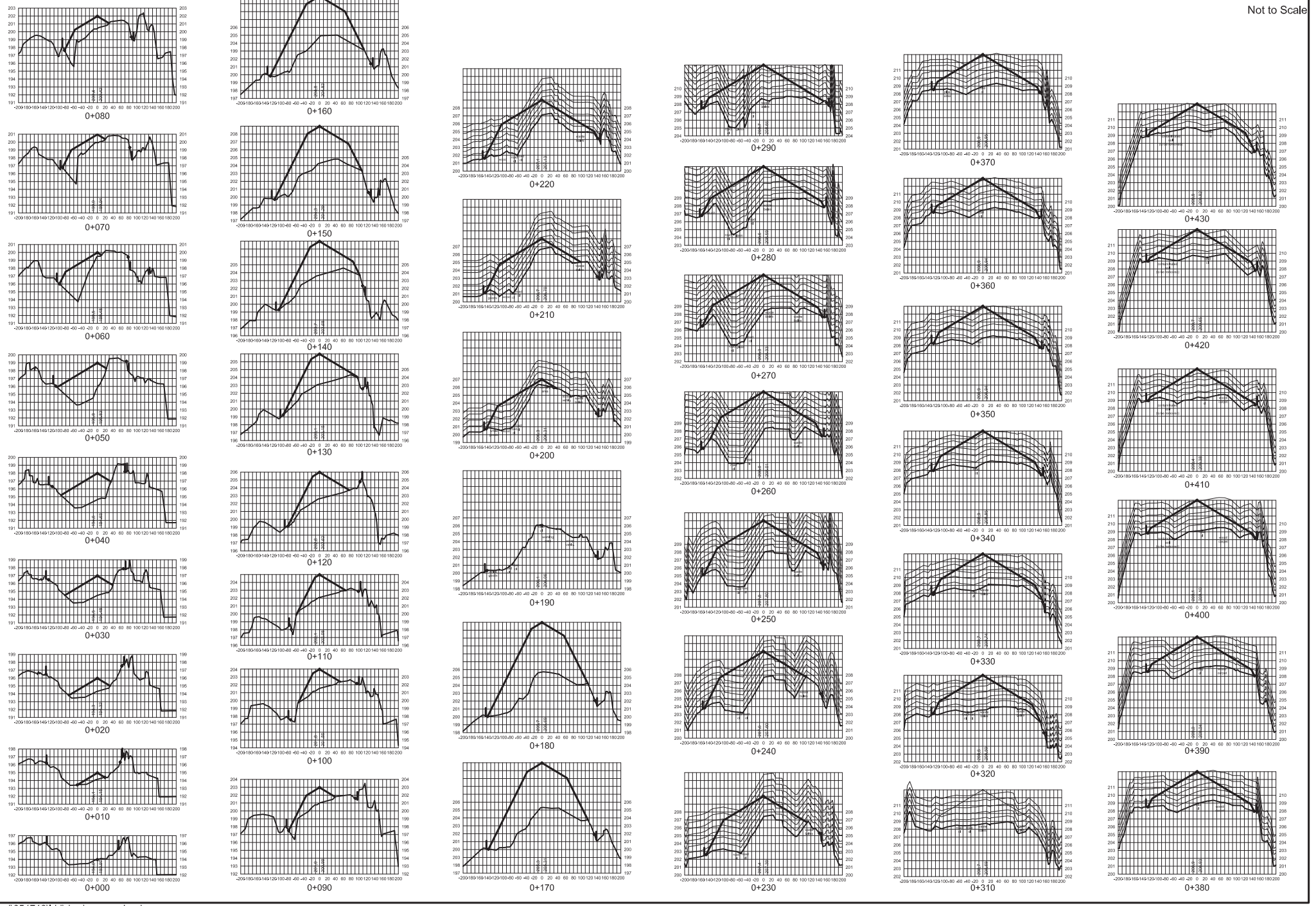

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Figure 3: Proposed Top of Waste Fill Contour Cross Sections

October 13, 2005

Not to Scale

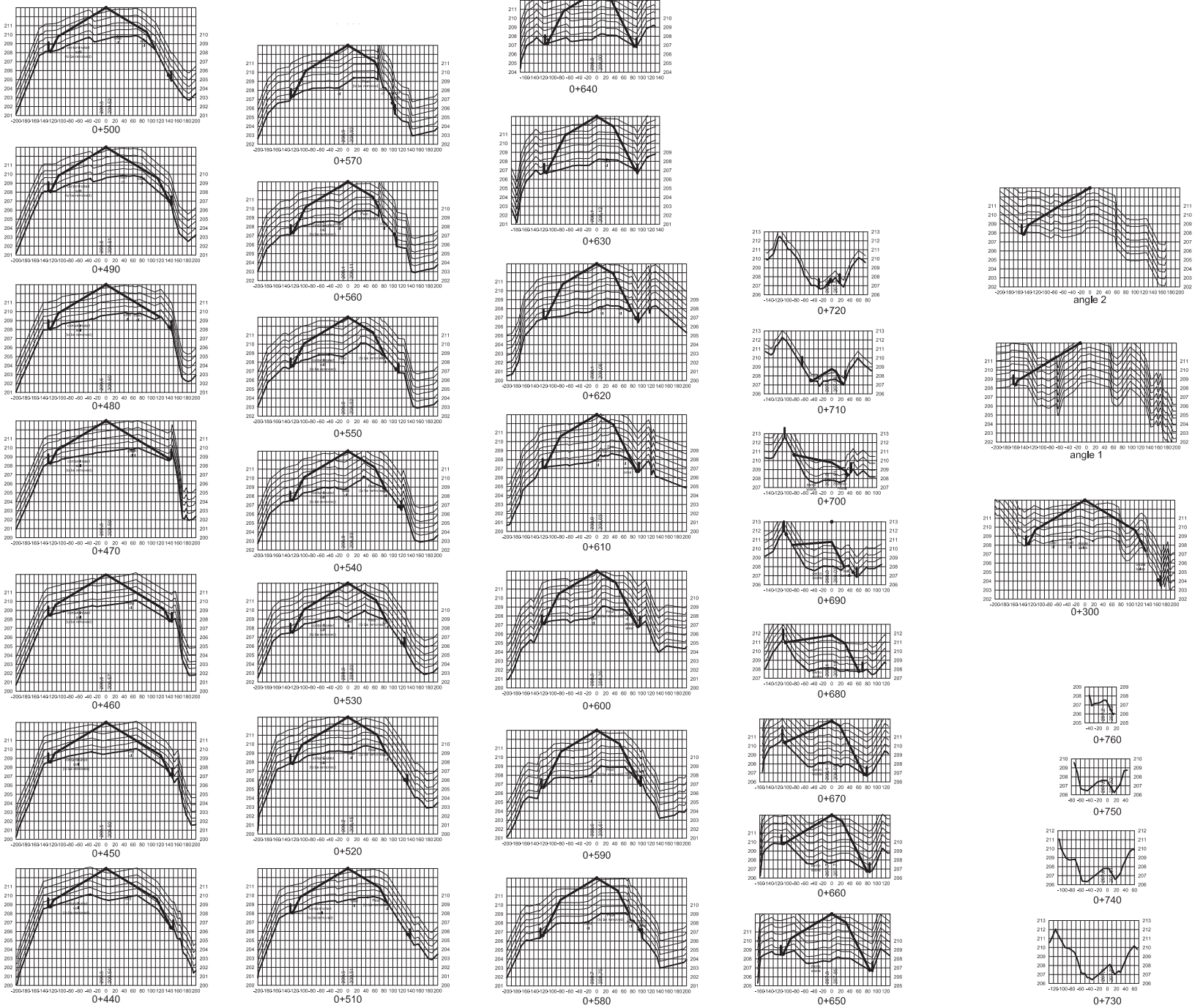

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Figure 4: Proposed Top of Waste Fill Contour Cross Sections

City of Yellowknife Solid Waste Facility
Landfill Final Top of Waste Fill Coordinates

Dillon Consulting Ltd.
05-5099-1000
October 19, 2005

Table 1: City of Yellowknife Solid Waste Facility - Top of Waste Fill Coordinates offset from centreline

Station	Easting	Northing	Design Elevation	1 Bales High		2 Bales High		3 Bales High		4 Bales High		5 Bales High		6 Bales High		7 Bales High		8 Bales High		9 Bales High	
				From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
0+200	635,085.1	6,929,951.3	207.00	23.9 S	132.6 S	31.6 S	125.6 S	46.5 S	118.7 S	58.5 S	110.2 S										
0+250	635,037.0	6,929,937.9	212.00	123.4 N	140.4 S	99.5 N	131.1 S	93.5 N	121.3 S	87.4 N	113.3 S	4.5 N	107.0 S	6.6 S	100.5 S	20.4 S	94.0 S	34.1 S	73.2 S		
0+250	635,037.0	6,929,937.9	212.00									64.0 N	82.2 N								
0+260	635,027.4	6,929,935.2	213.00	138.5 N	128.3 S	102.8 N	122.6 S	95.3 N	117.4 S	87.8 N	113.4 S	26.1 N	109.3 S	3.7 N	103.8 S	6.0 S	97.3 S	21.3 S	90.8 S	37.4 S	76.3 S
0+300	634,988.8	6,929,924.4	213.00	123.8 N	113.1 S	118.5 N	103.1 S	113.8 N	78.3 S	43.1 N	43.3 S	21.3 N	8.8 S								
0+300	634,988.8	6,929,924.4	213.00							81.3 N	100.4 N										
0+350	634,940.3	6,929,936.4	213.00	127.5 N	118.0 S	90.0 N	100.0 S	53.7 N	66.7 S	24.3 N	46.9 S	6.1 N	31.2 S								
0+400	634,891.7	6,929,948.4	213.00	121.8 N	113.1 S	65.0 N	86.2 S	42.6 N	71.0 S	23.6 N	60.7 S	2.8 N	3.8 S								
0+450	634,843.2	6,929,960.3	213.00	126.4 N	114.6 S	51.5 N	70.3 S	32.3 N	32.1 S	11.9 N	14.5 S										
0+500	634,794.6	6,929,972.3	213.00	97.2 N	115.0 S	55.3 N	106.5 S	30.6 N	35.3 S	9.9 N	25.8 S										
0+550	634,746.1	6,929,984.3	213.00	69.8 N	111.3 S	58.8 N	101.0 S	26.0 N	64.5 S	15.3 N	37.3 S	2.7 N	17.5 S								
0+600	634,697.6	6,929,996.2	213.00	69.6 N	107.6 S	57.4 N	98.3 S		N 91.0 S	42.2 N	79.3 S	9.3 N	61.0 S	1.0 N	26.5 S						
0+650	634,649.0	6,930,008.2	213.00	73.9 N	99.2 S	63.2 N	90.6 S	52.2 N	75.3 S	41.7 N	65.9 S	33.7 N	56.9 S	10.6 N	24.4 S						
0+667.72	634,631.8	6,930,012.4	213.00	62.8 N	94.3 S	51.3 N	84.0 S	40.2 N	73.9 S	31.8 N	63.8 S	25.1 N	53.5 S	11.7 N	5.8 S						
0+721.90	634,579.2	6,930,025.4	207.58	Tie-in to Grade																	

Notes: All measurements in meters
All offsets from "spine" as defined by station coordinates above.

APPENDIX D

LANDFILL SITING CRITERIA REPORT - Draft

City of Yellowknife Solid Waste Facility Siting Criteria

DRAFT Report rev1

March 27, 2006

City of Yellowknife Solid Waste Facility Siting Constraint Map

Prepared for the City of Yellowknife

05-4435-1000

Colin Joyal - Project Manager

Submitted by
Dillon Consulting Limited

R:\PROJECTS\DRAFT\054435\Task 1000\Yellownife Landfill Siting Report DRAFTrev1.doc

(In reply, please refer to)
Our File: 05-4435-1000

March 27, 2006

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(867) 873-3328

City of Yellowknife
Department of Public Works and Engineering
Box 580
Yellowknife, NT
XIA 2N4

Attention: Dennis Kefalas, P. Eng
Manager, Public Works

Yellowknife Solid Waste Management
Siting Criteria – Draft Report Revision 1

Dear Mr. Kefalas:

Attached is revision1 of the draft report entitled New Solid Waste Facility Siting Criteria and the accompanying constraint map. In the report we have summarized the regulatory criteria relevant to the siting of a new solid waste management facility for the City of Yellowknife. This information has been displayed on the accompanying map.

It is our intent to provide this information to the City as a planning tool for the development of New Solid Waste Disposal capacity. Please review the report and attached map. Once the report and map are finalized, we will provide a full size (22 x 34") size map mounted on foam core for your use.

The attached constraint map has been updated to show the lease boundaries as revised in January, 2006.

Yours sincerely,

DILLON CONSULTING LIMITED

Colin Joyal, P. Eng
Municipal Engineer

Encl.

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TABLES

APPENDICES

1 INTRODUCTION

As a planning tool for the siting of a new solid waste facility, this report has been prepared outlining potential siting considerations, and applicable regulations. The siting considerations in Table 1 represent considerations relevant to the siting, planning and design. Table 3 presents applicable regulations which would be enforced or negotiated with the related agency. Table 2 presents relevant guidelines for Solid waste facility siting.

1.1 Application Process

Mackenzie Valley Resource Management Act (MVRMA) provides an integrated system of land and water administration in the Mackenzie Valley, including the area surrounding Yellowknife. The Mackenzie Valley Land and Water Board (MVLWB) was established to administer the Part 3 provisions of the Act regarding land and water use activities for which a license, permit or authorization is required or a license is required under the *Northwest Territories Waters Act.*

Although the City of Yellowknife regulates land use within the City through its Community Plan and Zoning Bylaw, water use considerations such as leachate and surface drainage from the solid waste site fall under the jurisdiction of the MVLWB. The proposed new Yellowknife Solid Waste Facility will therefore be subject to the requirements of the *Northwest Territories Waters Act* and the approval of the MVLWB.

The *NWT Public Health Act* regulations regarding solid waste disposal facilities are found in the General Sanitation Regulations. These were established to address the prevention and mitigation of disease, and authority is vested primarily in the Chief Medical Health Officer to implement the provisions of this Act.

The Chief Environmental Protection Officer, whose mandate it is to administer and enforce the *NWT Environmental Protection Act,* may require the City of Yellowknife to take whatever actions he/she deems necessary to prevent the discharge of contaminants into the environment. The City may also be required to have on hand the equipment and material necessary to alleviate the effect of any discharge of contaminants.

In the NWT, concerns of the Department of Fisheries and Oceans (DFO) are generally addressed in the license application review process pursuant to the NWT Waters Act (administered by the MVLWB). The *Fisheries Act* states that the DFO may require plans for the new development to be submitted for review and approval before work commences if it is thought that deleterious substances resulting from the solid waste facility may enter a water body frequented by fish. Likewise, approval by Transport Canada, Municipal and Community Affairs (MACA) and the Department of Transportation (DOT) will be sought during the application review process for matters falling under their respective jurisdictions.

2 SOLID WASTE FACITLITY SITING CONSIDERATIONS

Solid waste facility siting should include a detailed site location investigation that addresses the potential problems outlined in Table 1. This includes water contamination, air pollution, wildlife conflicts, as well as transportation, social and economic factors. The information provided in Table 1 serves as guidance for siting activities. Considerations associated with each of the broad categories of impact are stated along with the impacted receptor and exposure pathway.

Table 1: Solid Waste Facility Siting Considerations

	Composite	Concerns	At Risk	Pathway
A	Water Contamination	1 wells	humans (health)	ground water
		2 creeks, rivers, lakes, etc.	humans (health)	surface water
			aquatic life	surface / ground water
			plant life	surface / ground water
			animal life	surface / ground water
B	Site Air Contamination	1 odour	humans (aesth.)	atmosphere
		2 chemical	humans (health)	atmosphere
			plants	atmosphere
		3 physical (methane gas)	humans (explosion)	soil, rock or atmosphere
			plants	soil and rock
		4 noise	humans (aesth.)	atmosphere
		5 dust	Humans (aesth.) and health	atmosphere
		6 smoke	humans (aesth.) And health	atmosphere
		7 greenhouse gases	humans (global climate)	atmosphere
C	Wildlife Conflicts	1 birds	humans (plane traffic, nuisance)	atmosphere
			humans (human / bear conflict)	direct contact
		2 animals	bears (destroyed as a nuisance)	direct contact
D	Transportation	1 accidents	humans (health)	transportation route
		2 noise	humans (aesth.)	atmosphere
		3 dust	humans (aesth.)	atmosphere
E	Social	1 site aesthetics	adjacent land owners	reduced enjoyment of life
		2 compatible land use	adjacent land owners	reduced enjoyment of life
F	Economic	1 waste transport/transfer	taxpayers	reduced income
		2 capital cost	taxpayers	reduced income
		3 operating cost	taxpayers	reduced income
		4 life and capacity	taxpayers	reduced income
		5 land value	adjacent land owners	reduced net worth
		6 availability of cover	taxpayers	reduced income

3 SOLID WASTE FACILITY SITING CRITERIA

3.1 Solid Waste Facility Siting Guidelines

A summary of the relevant solid waste facility siting guidelines is included in Table 2 below:

Table 2 Solid Waste Facility Siting Guidelines Checklist

Criterion	Stipulation	*Acts, Regulations* or Guideline
Areas in flood plain	Restricted beyond 1 in 200 year return	Guidelines for the planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT (MACA)
Climatic conditions of region; geological and terrain conditions of site	Consider and take into account	Guidelines for the planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT (MACA)
Cover material availability	Where possible, in a location where cover material is readily available	Guidelines for the planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT (MACA)
Distance from community to avoid unsightliness, odour, and smoke	Not visible from community and/or main road (where possible)	Guidelines for the planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT (MACA)
Distance from community to minimize construction and maintenance costs of access road	As close as possible while complying with the previous stipulation	Guidelines for the planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT (MACA)
Geotechnical features of the site	Consider and take into account	Guidelines for the planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT (MACA)
Located to ensure protection of national / territorial parks, game and wildlife reserves, special fisheries areas	Restricted	Guidelines for the planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT (MACA)
Wind direction	Downwind of prevailing winds if possible	Guidelines for the planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT (MACA)
Snow Accumulation	Addressed through site grading and appropriate fencing	Guidelines for the planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT (MACA)

3.2 Solid Waste Facility Siting Regulations

Facilities
The distance between the discharged municipal solid waste (MSW) and the nearest residence, water supply well, water supply intake, hotel, restaurant, food processing facility, school or church is to be a minimum of 450 metres. Greater or lesser separation distances may be approved where justified.

Airports
The distance between an airport utilized by commercial aircraft and a landfill containing food wastes which may attract birds is to be a minimum of 8.0 kilometers, unless bird control measures acceptable to Transport Canada and approved by the Department of Transportation are instituted or the potential for birds causing hazard to aircraft is minimal.

This regulation is often not practical in the North, so an alternative guideline may apply which allows for a minimum setback of 3 kilometers (Establishing Guidelines for the Separation of Solid Waste Disposal Sites and Airports in the Northwest Territories (Soberman, et. al. (1990)). However, there are a number of airport operational factors that affect land uses outside the airport property boundary. Each factor must be considered separately and in enough detail to allow general planning conclusions to be drawn. It is important that all potential landfill sites be judged from the point of view of all relevant factors. Information on this can be found in Part I of the six part Transport Canada publication, TP 1247E – *Land Use In the Vicinity of Airports* (Seventh edition, last amended May 1996). Also refer to TP 312E: *Aerodrome Standards and Recommended Practices*.

The location of all new solid waste sites near airports is subject to approval by Transport Canada, Municipal and Community Affairs and the Department of Transportation (DOT).

Surface Water
The Department of Fisheries and Oceans (DFO) is responsible for the protection of fish habitat in Canada. Fish habitat may be put at risk by poor siting, design or operation of a waste management facility, through seepage of contaminants, poor erosion control measures and so forth. The distance between the discharged MSW and the nearest surface water is to be a minimum of 30 metres. Greater or lesser separation distances may be approved by the Mackenzie Valley Land and Water Board where justified by hydrogeological investigations or by provision of surface water diversion works to reroute the watercourse of concern.

Floodplain
Landfills proposed for locations within the 200 year floodplain and the associated floodway are not to be sited without adequate protection to prevent washouts. Designs for flood protection will be referred to the Mackenzie Valley Land and Water Board for comment.

Table 3: Solid Waste Facility Siting Regulations Checklist

Criterion	Stipulation	*Acts, Regulations* or Guideline
Distance from airport to avoid hazard to aircraft from scavenging birds	1) 8 kilometer setback 2) 3 kilometer setback	1) *Commissioner's Lands Act* *Air Regulations & Aeronautics Act* 2) Soberman, *et al.* (1990)
Distance from housing	450 metres	*Public Health Act* (1988) and its *General Sanitation Regulations* (1990)
Distance from public roads, railways, right-of-ways and cemeteries	90 metres	*Public Health Act* (1988) and its *General Sanitation Regulations* (1990)
Distance from surface water to minimize fisheries habitat impacts	30 metres from high water mark	*Environmental Protection Act* Department of Fisheries and Oceans policy
Distance from treeline	10 metres if no burning, 30 metres if burning will occur	*NWT Fire Protection Act and Regulations*
Located to ensure protection of drinking water	In a watershed that drains away from the community drinking water supply	*Public Health Act* *Mackenzie Valley Resource Management Act* *Northwest Territories Waters Act* *Environmental Protection Act*
Minimize impacts to land, birds, animals, vegetation	Contaminants may not be discharged to the environment	*Environmental Protection Act (*1988)
City Zoning By-laws	Accordance with current planning documents	*Planning Act*

4 NEW SOLID WASTE FACILITY CONSTRAINT MAP

The solid waste facility siting constraints outlined in Table 3 are displayed on the constraint map shown in Appendix A.

REFERENCES

Mackenzie Valley Land and Water Board, City of Yellowknife Water Licence N1L3-0032, May 30, 2002.

Soberman, R.M., M. Lovicsek and S.W. Heinke. Guidelines for the Siting of Solid Waste Disposal Sites in the Vicinity of Community Airports in the Northwest Territories. Government of Northwest Territories Municipal and Community Affairs. March, 1990.

WEBSITES FOR ACTS, REGULATIONS AND GUIDELINES

NWT PUBLIC HEALTH ACT:
http://www.justice.gov.nt.ca/PDF/REGS/PUBLIC_HEALTH/Gen_Sanitation.pdf

NWT ENVIRONMENTAL PROTECTION ACT (administered through The Department of Resources, Wildlife and Economic Development (RWED))
http://www.gov.nt.ca/RWED/library/eps/envirpro.pdf

GUIDELINES FOR THE PLANNING, DESIGN, OPERATIONS AND MAINTENANCE OF MODIFIED SOLID WASTE SITES IN THE NORTHWEST TERRITORIES (RWED).
http://www.gov.nt.ca/RWED/eps/pdfs/solidwaste_guidelines.pdf

MACKENZIE VALLEY RESOURCE MANAGEMENT ACT (MVRMA):
http://www.mvlwb.com/doc/mvrma.pdf

CITY OF YELLOWKNIFE GENERAL PLAN BY-LAWS
http://www.city.yellowknife.nt.ca/City_Hall/Forms_and_Publications/2004_General_Plan_By_law_No__4315.html

NORTHWEST TERRITORIES WATERS ACT:
http://laws.justice.gc.ca/en/N-27.3/88322.html

FISHERIES ACT:
http://laws.justice.gc.ca/en/F-14/

THE MACKENZIE VALLEY LAND AND WATER BOARD:
http://www.mvlwb.com/html/actsandregs.htm

DEFINITIONS

"200 Year Floodplain" means land where the chance of a flood occurring in any given year is at least one in two hundred.

"access road" means a road that leads from a public road to a waste disposal site.

"buffer zone" means land used to separate a facility from other land.

"cover material" means soil or other material approved for use in sealing cells in landfills.

"designated flood" means a flood, which may occur in any given year, of such magnitude as to equal a flood having a 200 year recurrence interval, based on a frequency analysis of unregulated historic flood records or by regional analysis where there is inadequate stream flow data available. Where the flow of a large watercourse is controlled by a major dam, the designated flood shall be set on a site-specific basis.

"floodplain" means a lowland area, whether dyked, flood proofed or not, which, by reasons of land elevation, is susceptible to flooding from an adjoining watercourse, ocean, lake or other body of water and for administration purposes is taken to be that area submerged by the designated flood plus freeboard.

"freeboard" means a vertical distance added to the designated flood level and is used to establish the flood construction level.

"groundwater" means water below the ground surface in a zone of saturation.

"municipal solid waste" means "municipal solid waste" as defined in the Environmental Management Act.

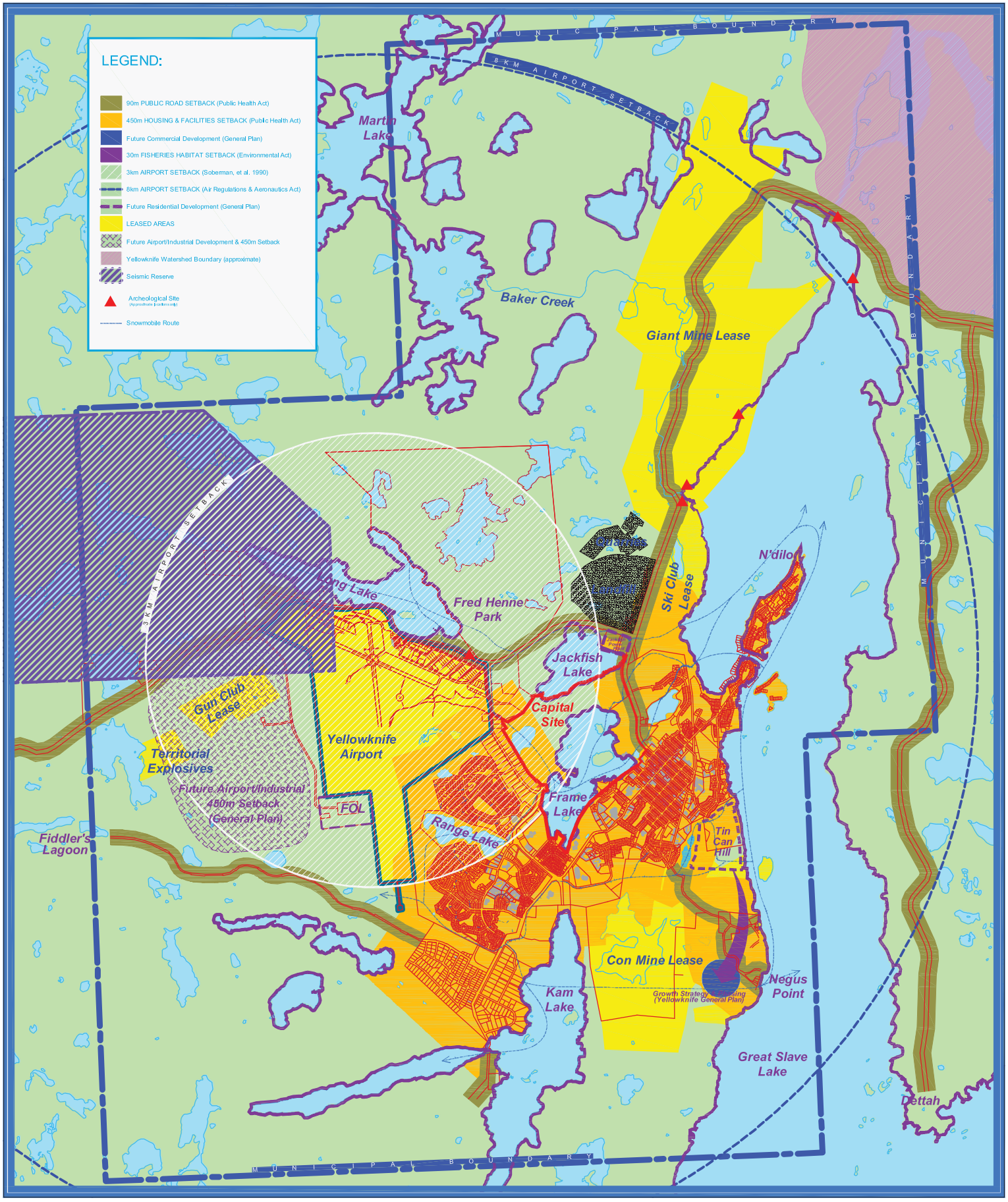
"solid waste facility" refers to a facility designed, constructed and operated for the collection, processing, transferring or disposal of the solid waste stream or components thereof, including but not limited to, transfer stations, material recycling facilities, composting facilities and disposal facilities.

"Solid waste stream" means the aggregate of all solid waste components, and also the process through which they move from point of generation to ultimate disposal.

"surface water" means lakes, bays, sounds, ponds, impounding reservoirs, perennial or ephemeral streams and springs, rivers, creeks, estuaries, marshes, inlets, canals, Great Slave Lake, and all other perennial or ephemeral bodies of water, natural or artificial, inland or coastal, fresh or salt, public or private, but excludes groundwater or leachate collection channels or works.

APPENDIX - A

City of Yellowknife Landfill Constraint Map



City of Yellowknife

Solid Waste Management Facility Siting Constraint Map

Draft - Revision 1

Mar. 2006

APPENDIX E

QUARRY USE PLAN - Draft

City of Yellowknife New Landfill Development – Quarry Use Plan

Report - DRAFT

March 30, 2006

City of Yellowknife New Landfill Development – Quarry Use Plan

City of Yellowknife

05-5510-1000

Colin Joyal - Project Manager

Submitted by

Dillon Consulting Limited

(In reply, please refer to)
Our File: 05-5510-1000

March 30, 2006

City of Yellowknife
Department of Public Works and Engineering
P.O. Box 580
4807-52nd Street
Yellowknife, NT X1A 3N4

Attention: Dennis Kefalas
Manager Public Works

Re: City of Yellowknife New Landfill Development - Quarry Use Plan - DRAFT

Dear Mr. Kefalas:

As part of the new landfill design, a separate study was undertaken to investigate the potential capacity of the quarry site to the north of the existing landfill. This study was undertaken to evaluate the conceptual ultimate capacity of the quarry along with the conceptual ultimate capacity of a landfill in this area.

Attached is a summary of the investigation and findings of this study. If you have any questions or if additional information is required please contact me at 920-4555.

Yours sincerely,

DILLON CONSULTING LIMITED

Colin Joyal, P.Eng.
Associate
Dillon Consulting Limited

Encl.

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APPENDICES

1 INTRODUCTION AND BACKGROUND

1.1 Scope of Report

The scope of this report is to prepare a transition plan from the existing landfill into the quarry pit (currently operated by NWT Construction Limited). This report will help produce a cohesive plan for the continued operations, future phasing out of tenants of the quarry area and the ultimate transformation into a solid waste containment site.

1.2 Existing Site Use

The quarry site is located to the immediate north of the existing landfill. Refer to Figure #1 – Existing Site Conditions in Appendix A for details on locations of the existing landfill and quarry locations. The quarry is on land which falls under the jurisdiction of the Government of the Northwest Territories. This land is included in the City of Yellowknife Lease 105-SK-033; Lease 1698T. The City in turn sub-leases this piece of land to NWT Construction to operate as a rock aggregate quarry. A drawing showing the lease limits for the current City lease and NWT Construction sub-lease are attached in Appendix A – Figure #2 Leases.

Based on discussions with Mr. Willy Zadkovitch, general manager of NWT Construction Limited, it is estimated that approximately 50,000 m^3 of rock is removed from the site annually. This is accomplished by blasting a dedicated area of the site in the spring then crushing and processing the material for use throughout the construction season.

Using aerial photographs and a site survey which was complete in July 2005, the annual volume of rock removed from the site is estimated to be closer to 30,000 m^3. We were unable to further refine this estimate to correspond with estimates from NWT Construction; therefore the estimate of 50,000 m^3 annually will be used for this report.

2 QUARRY USE PLAN

2.1 Site Limitations

The site use is constrained by a series of limitations. In particular, development of the site is limited by the boundary as defined by the lease from the GNWT. This boundary was modified in January 2006 to merge the two previous separate leases for the landfill and quarry. The new lease limits, as referenced as Area #1 (790,000m^2) is shown on Schedule "A" – Map 1 in Appendix B.

2.2 Conceptual Solid Waste Facility Design

A conceptual solid waste facility design was used to evaluate the quarry use. The conceptual design is attached as Figure #1 in Appendix C and incorporates the following assumptions.

Maximum waste slope: 10%
Maximum cut slope: 33% (3:1)
Minimum slope: 3%
Perimeter setback (to accommodate access roads, drainage and fencing): 50m minimum.

The solid waste facility must be designed to maintain positive drainage of the floor throughout operation. It is estimated that this can be accomplished by ensuring that the floor is graded at a minimum of 1% to the east. There is an existing drainage ditch along the north edge of the excavation which drains to the east. Construction of the floor to the prescribed slope accomplishes two things:

- The floor is graded to tie-in to this ditch and promotes positive drainage outside the solid waste containment area and throughout the quarry area during continued blasting operations.
- The containment cells will use the floor slope to efficiently construct a leachate collection system within the confined cell areas.

The surficial water runoff is to be collected and kept separate from the landfill area by using berms and interceptor ditches. The interceptor ditches can also be tied-in to the existing drainage ditch with flow to designated areas. Direct run-off from the solid waste site will also be collected and delivered through a retention pond to allow sediment to settle in designated and controlled areas.

2.3 Maximum Area Available for Development

Incorporating the limitations above, it was shown that the new property limits should be extended to the north slightly to accommodate the existing excavation and future development. The new leases will not be open for review by the Territorial Government for the next two years at a minimum however for the sake of this evaluation; it was assumed that the boundary could be relocated, as agreed with the Manager of Engineering. This proposed limit is shown on Figure 2 in Appendix C.

Using a 50m setback from the proposed boundary and modifying the area to provide a favorable shape for development, a limit of waste was developed. This proposed limit of waste is shown on Figure 2 in Appendix C.

2.4 Conceptual Rock Removal Cuts

Based on the limitations above, it is estimated, using digital terrain modeling software that a total of 384,700 m^3 of aggregate material is to be removed over the life of the site. Assuming that 50,000 m^3 of material is used per year as aggregate, this represents approximately 7.5 years worth of quarry operations. The limits of the conceptual blasting area is shown on Figure 2 in Appendix C.

2.5 Conceptual Solid Waste Facility Fill Capacity

Based on the limitations from the sections described above, the maximum fill capacity of a landfill in this area is estimated to be 1,112,000 m^3 based on the rock removal plan. Using an estimate of 28,000 m^3/yr of waste to be landfilled per year (from External Review of The Solid Waste Facility Operations and Processes, December 8, 2005), this represents potential for nearly 40 years of landfill life.

2.6 Feasibility of Development

The timing for transition from the existing landfill to the new site has not been determined. It is conceivable that landfilling could continue at the existing site for several more years. Once the Quarry Use Plan has been approved, quarry operations should proceed within the area shown on Figure 2 in Appendix C. The abandonment and restoration (A&R) plan for the site should be developed to leave the site in a condition favorable for landfill development, including the quarry floor and side slopes. That A&R plan can be incorporated to coincide with this report.

If it is desired to relocate landfilling operations to the quarry and continue to use this site for quarrying and landfilling concurrently, an investigation of the feasibility of this option must be completed. This investigation would have to include at a minimum the following information:

- an evaluation of safe blasting practices
- separation distances between quarrying operations and landfill operations
- a geotechnical evaluation of landfill slope stability and design

3 LIMITATIONS OF THIS REPORT

This report has been completed on a theoretical basis using information provided by others. An investigation of quarry materials and suitability along with an economic analysis has not been included. It is recommended that the City further investigate the feasibility of this plan and negotiate with the quarry lease contractor.

4 RECOMMENDATIONS

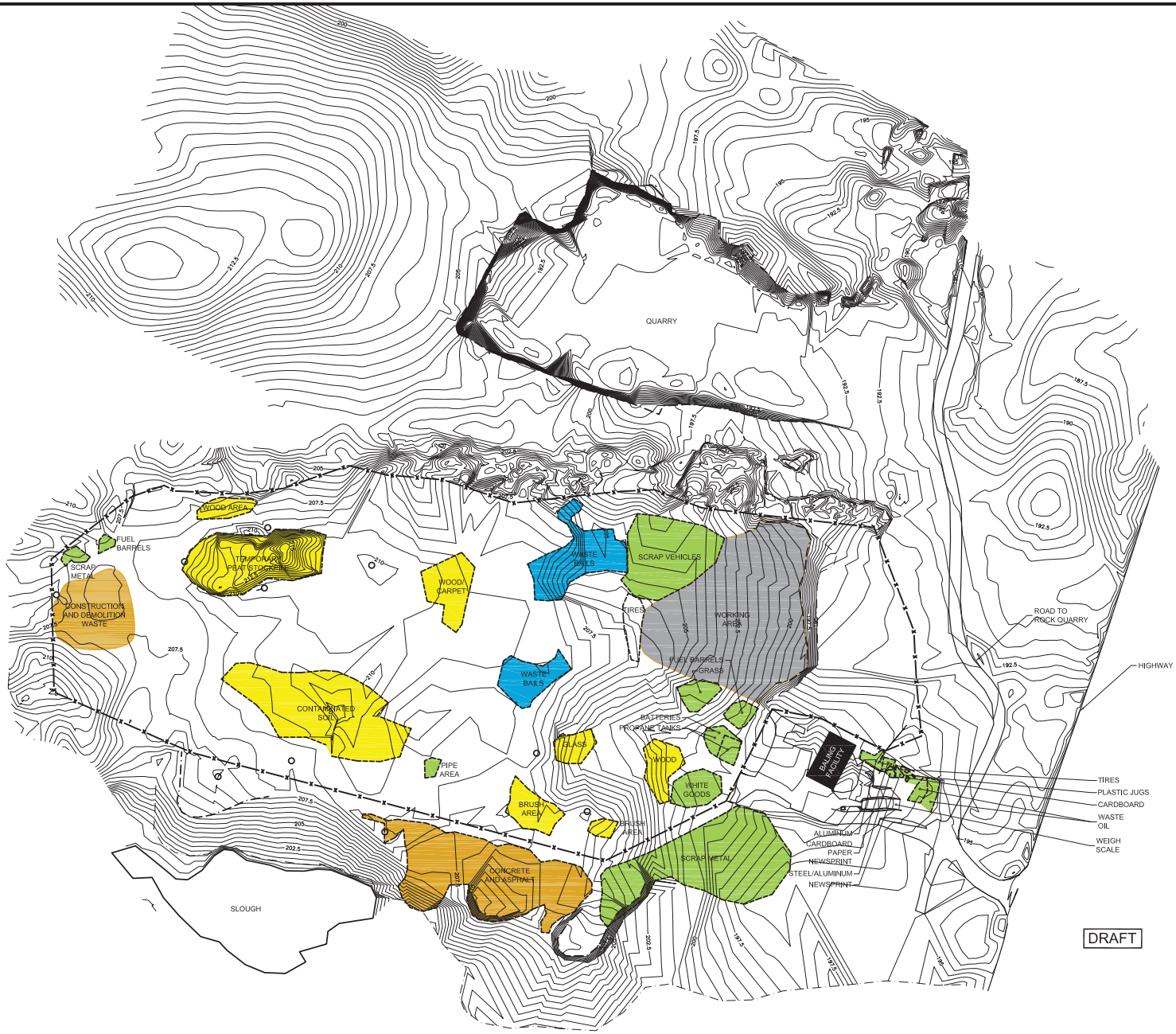
Based on this evaluation, we are recommending the following action as part of the progression of the quarry use plan:

- Evaluate the feasibility of modifying the existing lease limits as proposed in Figure 1 in Appendix C.
- Complete a geotechnical evaluation of the feasibility of concurrent operation of the quarry site for quarry use and landfilling
- Evaluate and negotiate quarry use with the quarry lease contractor in particular to modify the A&R plan to coincide with future landfill construction contours.
- Complete the final design of the proposed landfill in the quarry area.

We would be please to provide further information or assist the City with additional analysis of development options.

APPENDIX A

Existing Conditions and
Quarry Lease/Sub-Lease Information



LEGEND

- ELECTRIC FENCE
- CREST
- TOE OF SLOPE
- 122.0 MAJOR CONTOUR
- MINOR CONTOUR
- LANDFILL GAS WELL

SIGNIFICANT AREAS
- RECYCLABLES
- BALED WASTE
- CONSTRUCTION & DEMOLITION
- SPECIAL WASTE (LAND FILLED)
- RESIDENTIAL WASTE LOADS (SALVAGABLE)

NOTES

- ALL INFORMATION AND LOCATIONS ON THIS DRAWING HAVE BEEN OBTAINED BY OTHERS AND ARE BASED ON THE BEST POSSIBLE INFORMATION AT THE TIME. ANY FEATURES SHOULD BE VERIFIED IN FIELD.
- SURVEY BY SUB-ARCTIC SURVEYORS JULY 26 AND JULY 27, 2005.

CHANGE	DATE	DESCRIPTION	CHECK
1	08/12/05	DRAFT REVIEW	CEJ

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
	41TPW		AUGUST 05

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 065
DILLON CONSULTING LIMITED

NORTHWEST TERRITORIES C. JOYAL

City of Yellowknife

PROJECT
CITY OF YELLOWKNIFE
SOLID WASTE FACILITY

TITLE
SITE FILL CONTOURS AUGUST 2005

DILLON CONSULTING

SCALE N.T.S.
DILLON PROJECT NUMBER 05-4719-1000
CLIENT PROJECT NUMBER
DRAWING NUMBER 1

EDIT DATE: 08/09/2005 PLOT DATE: [illegible]

EDIT DATE: 30.03.2006 PLOT DATE: 41tpw 30.03.2006 ACAD FILE: --- g:\cad\05471\9\landfill\dwg\5 existing leases.dwg

DILLON CONSULTING

PROJECT
City of Yellowknife Quarry Use Plan

TITLE
Existing Leases

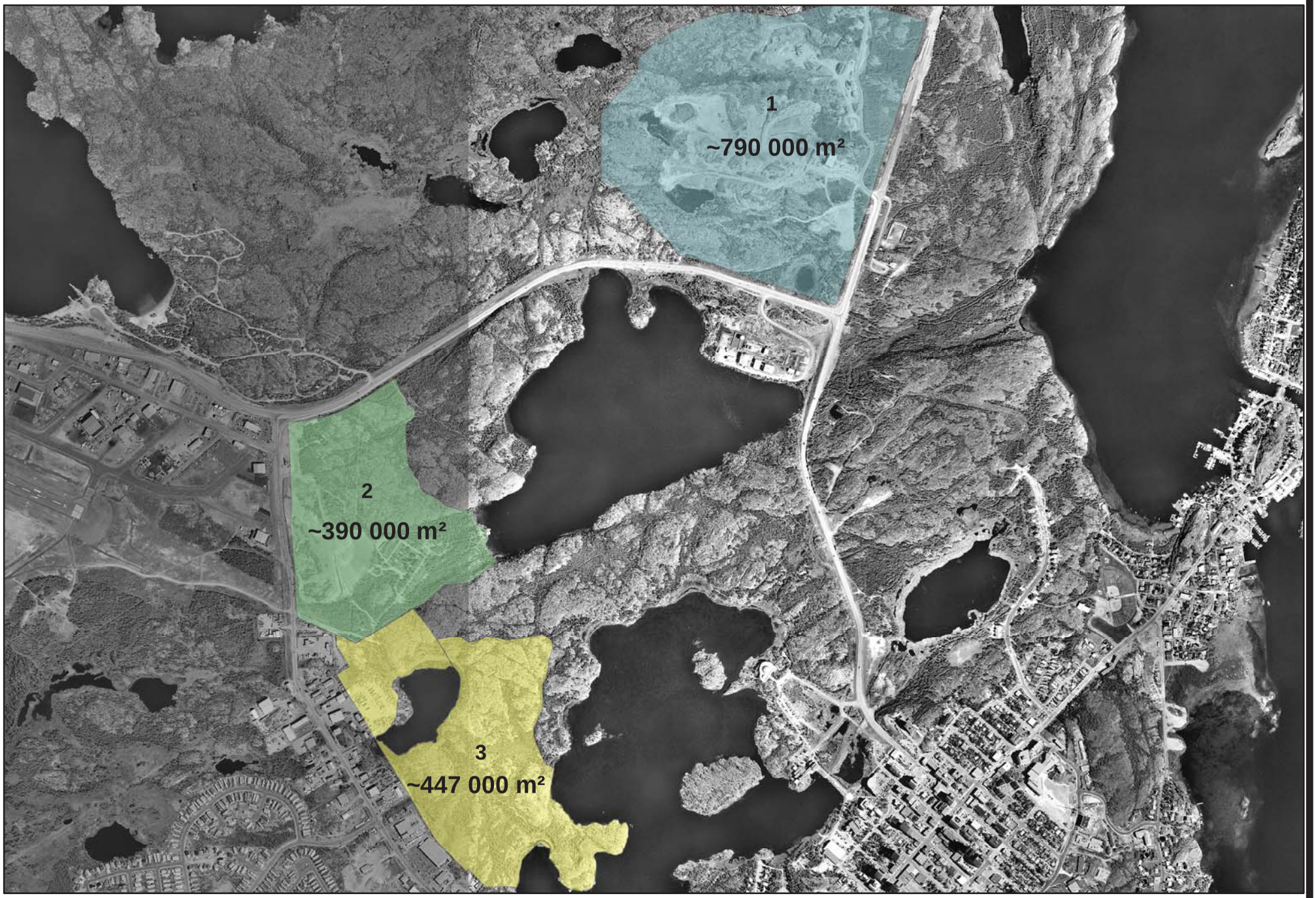
PROJECT NUMBER
05-5510-1000

DATE
March 2006

FIGURE NUMBER
1

APPENDIX B

City of Yellowknife Land Acquisition By-Law No 4372
Schedule “A” – Map 1



City of Yellowknife

Planning & Lands Division

City of Yellowknife -
Land Acquisition By-law No. 4372

Schedule "A" - Map 1

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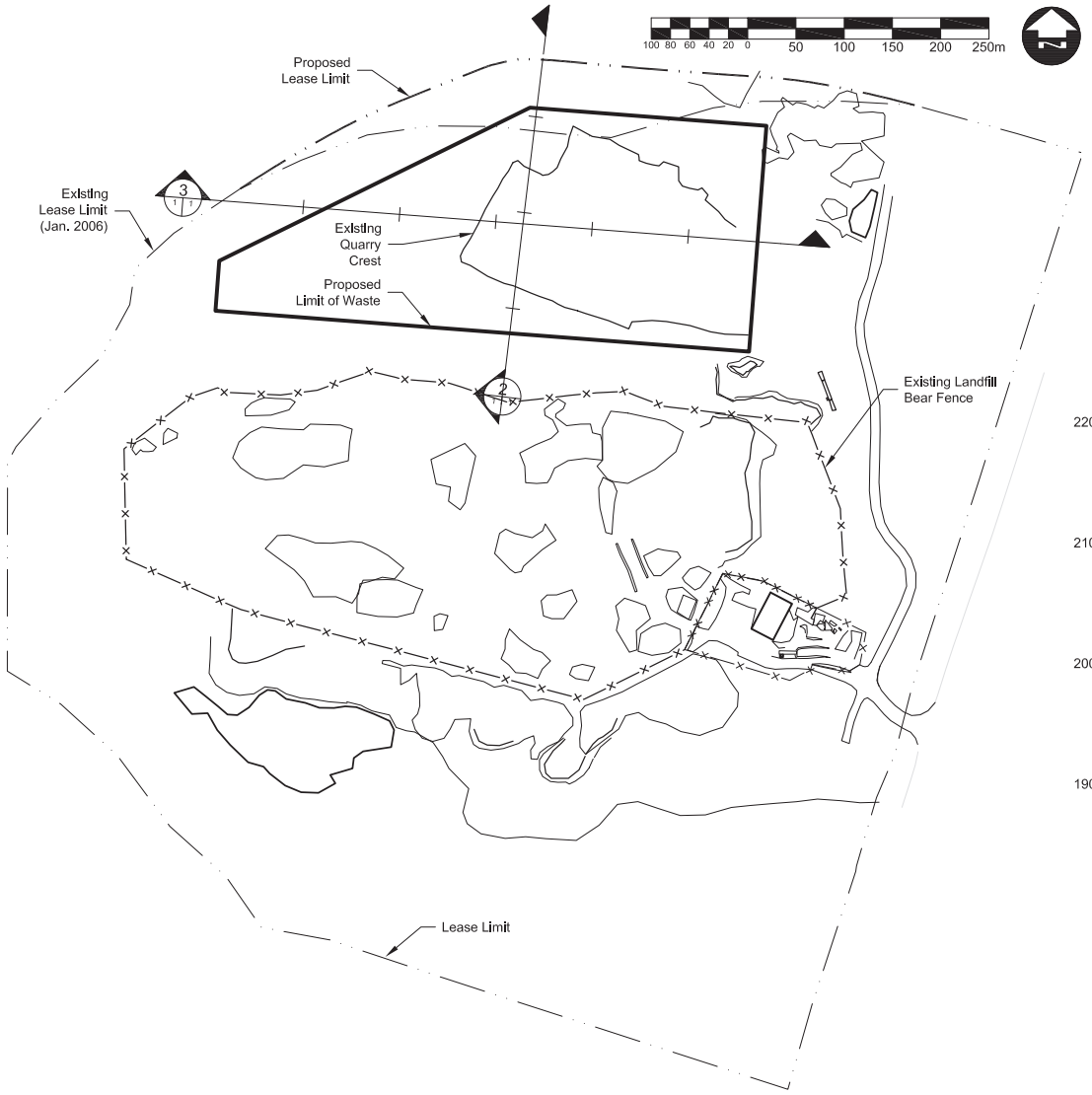
Drawn By:	S.MacLaurin
Date:	July 21, 2005

APPENDIX C

Quarry Use Plan Figures



1 SITE PLAN
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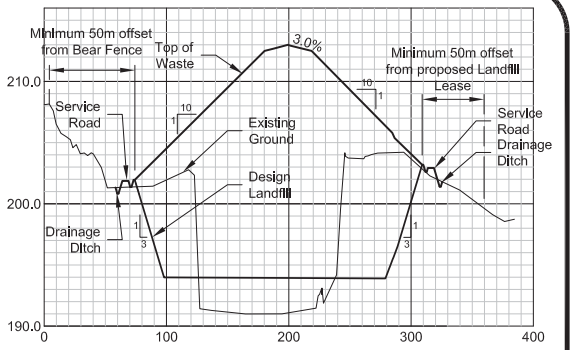

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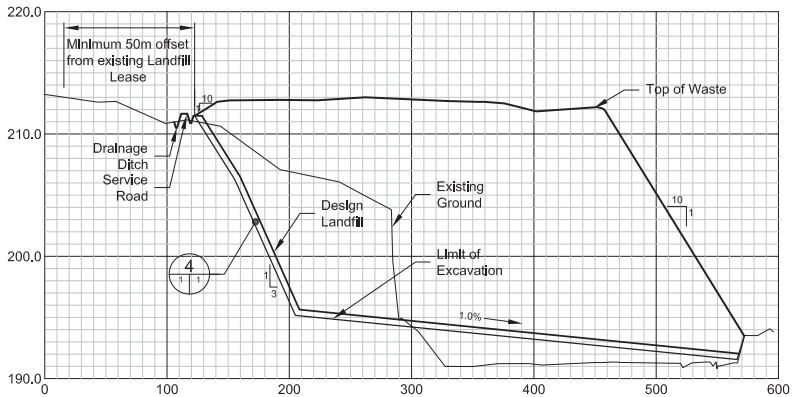

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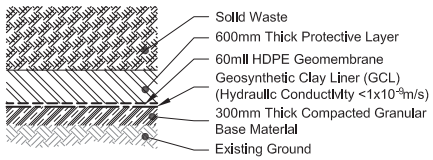


4 BASE LINER SECTION
SCALE 1:10

DILLON CONSULTING

PROJECT: City of Yellowknife Quarry Use Plan

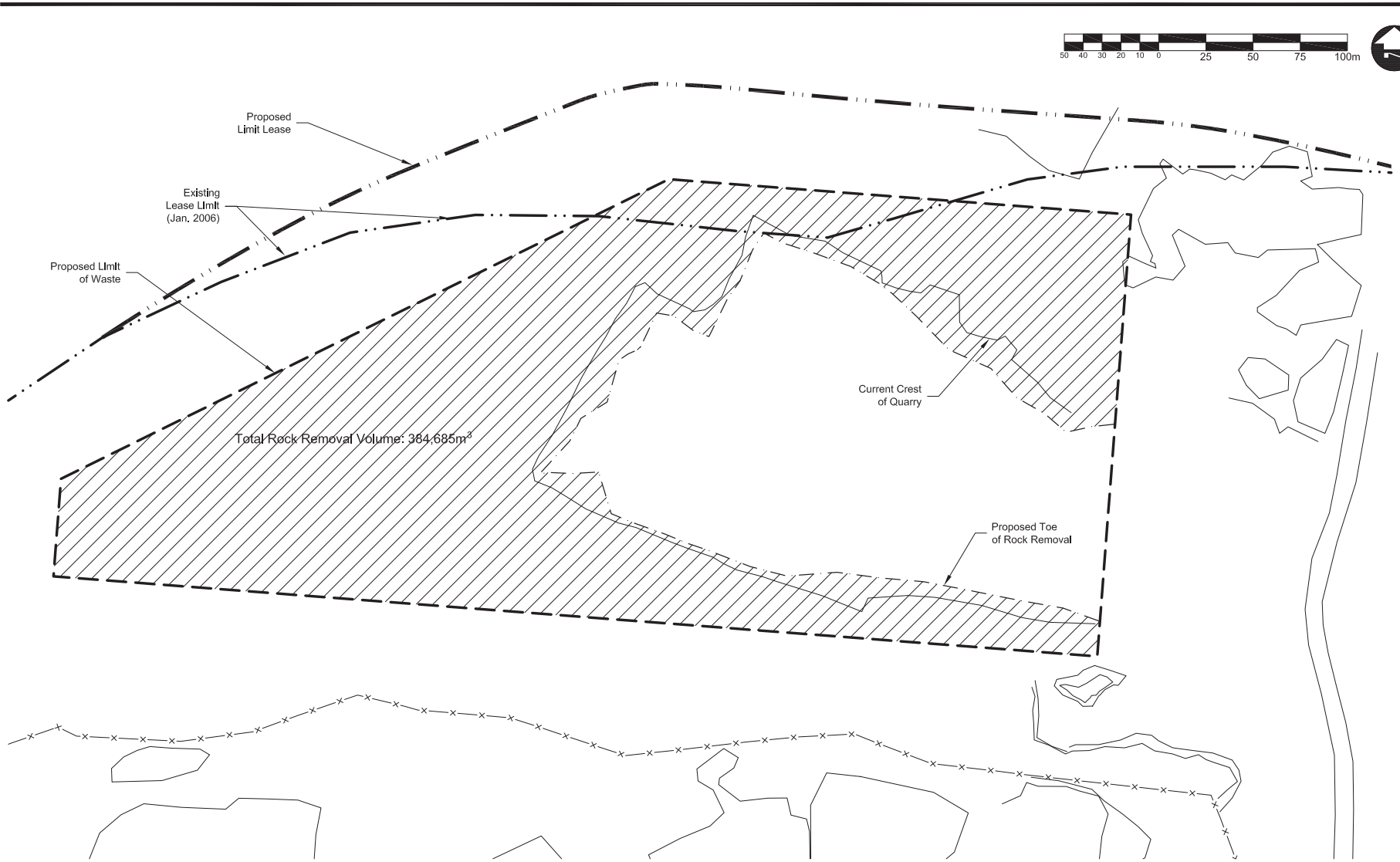
TITLE: Proposed Landfill Footprint

PROJECT NUMBER: 05-5510-1000

DATE: March 2006

FIGURE NUMBER: 1

EDIT DATE: 21.04.2006 PLOT DATE: brad mueller 21.04.2006 CAD FILE: 41tpw e:\cad\054719\landfill\dwg\quarry_fig1.dwg



1 SITE BLAST AREA PLAN
2 2 SCALE 1:200

DILLON CONSULTING

PROJECT	City of Yellowknife Quarry Use Plan
TITLE	Proposed Sequential Blasting Areas
PROJECT NUMBER	05-5510-1000
DATE	March 2006
FIGURE NUMBER	2

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