Feasibility Study on Solid Waste Management in Pangnirtung, NU

Report

September 2007

Planning and Design of Sludge Disposal Facility
Pangnirtung, Nunavut

Department of Community and Government Services, Government of Nunavut

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1.0 INTRODUCTION AND BACKGROUND

The Hamlet of Pangnirtung (Hamlet) is located on the east shore of Baffin Island, approximately 300 km north of Iqaluit. Government of Nunavut (GN) data estimate the Hamlet's 2005 population at 1687 persons.

Solid waste from the Hamlet is currently disposed in a landfill located approximately 800 m from the edge of the Hamlet. The existing solid waste site is: inappropriately sited due to ecological concerns, odour and windblown litter; poorly operated and maintained; and is nearing its' capacity under the current configuration and waste sources/loadings.

The Government of Nunavut (GN) is assessing options for managing the Hamlet's solid waste, including: siting a new landfill further from the Hamlet, constructing an incinerator or a combination of both.

This report describes the requirements for siting a new landfill and incinerator for the Hamlet and provides a comparative evaluation of each option

1.1. Scope of Work

The Scope of Work (SOW) for this assignment is described in a November 13, 2006 memo from the GN and is summarized in Dillon's November 29, 2006 proposal. The SOW includes the following components:

Part A: Incineration:

Evaluate two new incinerator turn-key packages on the following basis:

- Capital and Operating Costs, including 15 year life-cycle and fuel consumption considerations.
- Potential to accept biosolids
- Feasibility for retrofitting with waste heat recovery and/or cogeneration options.
- By-product management
- Complexity of operation and man-power requirements.
- Ash generation and quality.
- Air emissions quality.
- Building requirements
- Class "D" budgeting estimate.

Part B: New Landfill Site

- Liaise with the Hamlet to identify a suitable local site for a new landfill.
- Develop conceptual site requirements including relevant design and siting constraints, site access requirements and documentation of available required equipment, expertise and construction materials.
- Evaluate the proposed site.
- Provide a Class "D" budgeting estimate.

2.0 FEASIBILITY STUDY ASSUMPTIONS

2.1. Population Projections

Population estimates were generated using values provided in the Nunavut Bureau of Statistics report Nunavut: Community Population Projections, 2000-2020. 2007 is used as the base year, and the population estimates for 2012 and 2017 were interpolated assuming a constant growth rate between the values for 2010 and 2015 provided in the population projection report and the estimate for 2022 was extrapolated using the growth rate from 2015 to 2020. The population estimates for the Hamlet are summarized in Table 2.1-1.

Table 2.1-1: Pangnirtung Population Estimates

Year	Population Estimate
2007	1,756
2012	1,955
2017	2,160
2022	2,366

2.2. Waste Generation

Solid waste generated in Pangnirtung includes: municipal solid waste generated in the community, sewage sludge generated in the waste water treatment plant (WWTP) and fish waste generated at the fish plant.

Below are Dillon's projections of the sludge waste and solid waste (garbage) generation rates for the 15 year planning horizons. 2007 is used as the initial year for planning purposes. Actual waste generation measurements for the community are limited. Where possible, waste generation projections have been derived based on actual measurements. Standard reference information was used when site specific information was not available. Population projections were acquired from the Nunavut Bureau of Statistics.

Table 2.2-1 summarizes the categories of waste generated in Pangnirtung.

Table 2.2-1: Pangnirtung Waste Categories

Type of Waste	Source	Delivery Method
General Waste	Residential, Commercial, Institutional,	Waste Collection Public drop off
Scrap metal	Residential, construction	Waste Collection Public drop off
White goods (appliances etc)	Residential, construction	Public drop off
Fish processing offal	Fish Processing Plant	Delivered by the fish plant (approximately 1.5 to 2 m^3 per day during plant operation; total approx 230 m^3/yr)
Sludge bags	Wastewater treatment Plant	Delivered by the Hamlet

2.2.1. Sludge Generation

Pangnirtung's municipal wastewater is treated using a mechanical treatment plant. Only municipal wastewater is currently treated in this facility, and process water from the fish plant is discharged into the former sewage lagoon located adjacent to the community's landfill.

Sludge is presently removed from the aerobic digester approximately one or two times per week. However, this frequency should be increased to four times per week based upon recent optimization work completed at the WWTP.

Table 2.2.1-1 summarizes the sludge generation rate estimates for the next 15 years in Pangnirtung.

Table 2.2.2-1: Projected Sludge Generation Rate

Year	Population	Current Sludge Generation Rate		Proposed Sludge Generation Rate	
		(m^3/day)	(m^3/year)	(m^3/day)	(m^3/year)
2007	1,756	0.74	270	1.01	369
2012	1,955	0.82	299	1.13	412
2017	2,160	0.91	332	1.16	423
2022	2,366	1.00	365	1.36	496

Improvements to the dewatering process at the WWTP are also recommended, and these improvements will reduce the water content of the sludge, and therefore will reduce the volume of sludge generated.

2.2.2. Solid Waste Generation

Solid waste generation information is required to estimate the solid waste disposal facility volume requirements. Detailed solid waste generation information for the Hamlet is not available. Waste generation was, therefore, estimated using average values documented in the Guidelines for the Planning, Design, Operations and Maintenance of Modified Landfill Sites in the NWT, April, 2003 (NWT Landfill Guidelines). According to the NWT Landfill Guidelines the average un-compacted residential solid waste volume is 0.015 m^3/person/day and the estimated compaction rate is 3:1 in a landfill. This gives an estimate of 0.005 m^3/person/day of landfill space required. Table 2.2.2-1 summarizes the un-compacted and compacted annual solid waste generation volume estimates for Pangnirtung.

Table 2.2.2-1: Annual Solid Waste Generation Summary

Year	Population	Un-compacted Municipal Solid Waste Generation Rate		Compacted Municipal Solid Waste Generation Rate	
		(m^3/day)	(m^3/year)	(m^3/day)	(m^3/year)
2007	1,756	26.34	9,614	8.78	3,205
2012	1,955	29.33	10,705	9.78	3,570
2017	2,160	32.4	11,826	10.8	3,942
2022	2,366	35.5	12,958	11.83	4,318

In addition, offal from the fish processing plant is disposed of at the solid waste disposal facility. Fish plant management estimate that the plant operates for approximately 115 days/year and that 1.5 to 2 m^3 of fish waste is generated per day, or 230 m^3 per year. The GN and the fish plant are investigating alternative disposal methods for the fish waste (e.g. ocean dumping), which would remove the waste from the Hamlet's solid waste disposal stream. However alternative disposal arrangements are currently not in place, so fish waste disposal is assumed to occur at the landfill for the purpose of volume estimates used in this report.

A summary of the total solid waste accumulation (compacted municipal solid waste, proposed sewage sludge volume and fish plant waste) is provided in Table 2.2.2-2. Detailed volume calculations are included in Appendix A.

Table 2.2.2-2: Summary of Yearly Solid Waste Generation Volumes

Year	Population	Cumulative Annual Volume (m^3)
2007	1,756	3,804
2012	1,955	23,989
2017	2,160	46,261
2022	2,366	70,642

3.0 LANDFILL EVALUATION

3.1. Siting Options

The following is information related to the proposed landfill site collected during the January 14 to 23, 2007 site visit. At this site investigation were representatives from Dillon Consulting Limited and Community Government and Services. During the investigation, there was a meeting with the community council and community representatives. Key points brought forward in the meeting were:

- A total of three visits to the community – the current visit, one to deliver the preliminary design (this trip will likely involve community consultation) and one to deliver the final design.
- The Hamlet expressed an interest in becoming more involved in the process – possibly using a sub-committee.

Solid Waste Siting Specific comments:

- The council would like the existing facility to be moved.
- A contingency plan will be required for whichever option is selected in order to ensure garbage is dealt with in the event of a storm or other shutdown.
- The landfill will be divided into different areas with each area accepting a different type of waste.
- There is some discussion about the GN possibly collecting and removing scrap metal from the communities.

A constraint map was developed (see attached **Figure 1, Appendix A**) to show the areas that are available for siting a landfill. Constraints on the mapping include:

- A 3 kilometre setback from the airport runway (transport Canada)
- A 450 meter set back from habitable buildings (Public Health Act)
- 100 m from the high water mark (Environment Canada)

This was used to help guide the selection of a potential site.

3.2. Selected Site

The council and community representatives have identified a proposed new site which is located about 10 to 15 minutes from the community by snow machine, as shown on **Figure 1**. The proposed site located at: 0382437W 7343348N, 36m ASL (elevation approximate). In comparison, the gravel pit is located at: 0381348W 7341242N, 0m ASL (average sea level), and the hotel (western side of town) is located at: 0377523W 7338820N, 15m ASL. All reading were recorded during the site investigation using a hand help GPS (global positioning system). The readings are accurate within 30 meters.

The site proposed by the community was visited using snow machines. A description of the site follows:

- Proposed site located in flat area north of community, behind a high point of land that extends into Pangnirtung Fiord. The photo taken during the summer (see photo plate 1, **Appendix B**), looking towards the site from Mt. Duval provides a good overview.
- Area is quite large, relatively flat with some large boulders, etc – typical tundra.
- Access from the south along the east side of Pangnirtung fiord.
- Access is rocky, bouldery, cobbly.
- Large low wet area immediately east of the proposed site – would have to be crossed by access road – not flowing water so much as muskeg.
- Several smallish drainages at the north end of the access route – precise number difficult to discern because the water flow appears to spread out into a number of channels before entering the fiord.
- One large channel of approximately 35m about half way along the access route.
- Second large channel coming down the north side of Mt. Duval – this drainage discharges into the existing community gravel pit.
- Large tidal flats alongside access road.
- Area above road is steep – looks like potential rock fall hazard in some sections. Did not appear to be sufficient snow accumulation for avalanche hazard, but may be different in years with higher snow falls.

Photo Plates 2 and 3 show the general area during the site investigation.

3.2.1. Access Requirements

The access to the proposed site will be approximately 5,800 metres. This will be comprised of some existing road, and some newly constructed road. **Figure 2** shows the access to the new site. The road from the community to the community granular area is an existing road. From the community granular are to the proposed solid waste site will require approximately 3,900 metres. The road will be required to carry garbage haul vehicles, as well as maintenance vehicles to the landfill area. A typical standard for roads in Nunavut is an 8.0 metre width as a top surface. This is comprised of 2 @ 3.5 metre lanes, plus two 0.5 meter shoulders.

3.3. Conceptual Design

3.3.1. Access Road

The proposed road alignment (preliminary at this stage) is shown in **Figure B**. The road alignment is along the base of the fiord, and as such, the area drainage is down the hill through the road alignment and into the bay. To address this issue, there are a number of areas where the road crosses the drainage paths that will require passage of spring run off and rain water. These will need to be bridged with either culverts, small bridges, or large diameter culverts. Sample culvert details are shown on **Figure 3**. The major crossings are as follows:

- At the start of the new road works at the granular resource area. This is a major drainage path, and the expected span length is 30 to 50 metres.
- At approximately 500 meters into the new road construction a culvert will be required.
- At 800 metres into the new road construction there is a dispersed drainage outfall area. This will require multiple culverts, or potentially a small bridge structure.
- At approximately 900 metres there is a broad drainage area.
- At approximately 2,100metres there is a main drainage path that will require a large diameter culvert.
- Other small diameter culverts maybe required as identified in the detailed design.

The road will be constructed on a side slope. On the up gradient side of the road there will need to be a drainage ditch to direct the run off water to a culvert. Rip rap will be required in some areas to prevent erosion.

The road design criteria are to meet the most recent transportation standards. The design speed of the road should be set to 30 kilometres per hour. Curves, turning radii and other geometric parameters should be designated based on this design speed.

3.3.2. Waste Management Facility

There are two approaches to landfilling typically used in the north; these are a Modified landfill and a sanitary landfill. There are described below.

The modified landfill is very similar to the open dump/landfill. However a modified landfill has periodic cover material placed over the waste mass. This operation requires planning and operation of the facility with more care than a simple open dumping approach. A modified landfill site requires attention to planning the use of the landfill area to optimize the space used for waste entombing, and thereby maximize the expected life of the facility.

A separate area for bulky and hazardous wastes is required.

A sanitary landfill requires daily compaction and cover with soil. It is a labour and equipment intensive operation that requires a high level of supervision and planning. It is further complicated in the north by the inability to easily access cover material in the winter months. The sanitary landfill has been widely accepted as the standard in southern locales.

Due to the difficulties in operating a landfill in the north as a sanitary landfill, the recommended approach in Pangnirtung is a modified landfill.

The main features of the waste management area will include;

- A restricted access gate to control entry on to the site. Controlled entry is a means that the Hamlet can use to prevent unwanted dumping, and to limit the liabilities that the Hamlet accepts as part of the landfill operation.
- Area drainage. As much run off water is to be diverted away from the waste management area. Where possible, runoff from the site should be directed away from the waste mass. Both of these drainage control features mitigate against the development of leachate. Managing leachate from a solid waste site is challenging and can be expensive.
- The waste management area is to be fenced. The fence provides two functions. First it controls the access to the site to prevent unwanted dumping. Second; it reduces the amount of wind blown litter leaving the site. Given the proximity of the water body to the site, reducing the amount of wind blown little leaving the site will reduce unwanted pollution of the water body. See **Figure 5** for typical fence details.
- There will be areas identified for designated waste streams. The waste streams will include;
    - Sludge from the Sewage Treatment Plant
    - Domestic Waste
    - Bulky metals
    - White good
    - Hazardous waste. This will be further designated as areas for;
        - Used paint and solvents
        - Batteries (auto and vehicle)
        - Used oil and lubes
        - Other unclassified waste.
- Signs to indicate the waste areas

A conceptual layout of the landfill site is shown in **Figure 4**. The site requires an area of approximately 150 by 350 meters, or approximately 5.2 hectares.

3.3.3. Operations and Maintenance

This section of the report was developed to present operational and maintenance procedures that will be required of the designated operators of the landfill facility in Pangnirtung. Each set of procedures is explained individually. The final section provides a summary of operational and maintenance procedures broken down into daily, weekly, monthly and annual tasks.

3.3.3.1.Acceptable Waste

The disposal site is organized into four separate disposal areas:

Refuse Disposal Area:

This is the largest disposal area at the landfill. General household, restaurant, institutional, store and construction wastes are placed here.

Bulky Waste Area:

Large non-combustible items such as automobiles, snow mobiles, old furnaces and holding tanks are placed in the bulky waste disposal area.

Hazardous Materials Area:

Hazardous materials such as paint, household hazardous wastes and aerosol containers are disposed of in the hazardous materials area. It consists of a fenced area approximately 10 ft^2.

Sewage Plant Sludge:

The quantity required for this area is yet to be determined. However the disposal of sludge from the Sewage plant is an issue to be addressed at a future date.

3.3.3.2.Equipment List

The following equipment is available to operate the solid waste disposal site:

- Cat Loader 950F.
- Cat Loader 936.
- Cat Dozer D6D.
- Cat Excavator 225BLC.
- Ford Dump Truck LT 8513.

The loader and dozer will be required to complete the waste compaction and cover operations. The excavator will be required semi-annually to complete site drainage work, and excavate new landfill cells.

3.3.3.3.Site Personnel

The Senior Administrative Officer is responsible for the overall operation of the landfill facility. The daily operation and maintenance of the landfill is the responsibility of the Municipal Works Supervisor. Two or three people are employed by the Hamlet to operate the garbage collection vehicle.

3.3.3.4.Operation Procedures

These procedures must be carried out on a regular basis to ensure the landfill operates safely and efficiently.

3.3.3.5.Basic Operations

1. All wastes are to be dumped in the appropriate area as indicated on the dumping plan, posted at the landfill entrance,
2. Dumping should be restricted to a manageable portion of each area at a time,
3. Waste should be compacted a minimum of 4 times a year, or as needed,
4. After compaction, each waste layer should not be more than 2.5 m thick,
5. The compacted waste should be covered with material (granular or mineral soils) to a depth of 500 mm.
6. Each layer of solid waste and cover material should be sloped to allow drainage.

3.3.3.6.Cover Operations

A minimum of twice per year, a compaction and cover cycle is to be conducted at the landfill as generally described below:

- The accumulated waste is spread and compacted by driving over it several times,
- The compacted material is worked back up slope a bit at a time to form compacted layers of waste, not more than 2.5 m thick,
- Each 2.5 m layer is covered with material obtained from the earth mound located on the east side of the facility,
- Cover material should form a layer 0.5 m thick in top of the compacted layers,
- Compact the cover material,
- Slope the compacted cover and waste to allow drainage.

3.3.3.7.Hazardous Waste Area Operation

The hazardous materials storage area is a fenced area, approximately 10 ft^2. A large, open drum can be placed here for the disposal of household hazardous waste, aerosol containers, etc. Used batteries are to be placed on pallets in this area. Specific information on handling hazardous waste materials, including final disposal requirements, can be found in the following Department of the Environment, GN guidelines. Where those don't exist, the NWT guidelines can also be re-fenced for best practices guidelines.

- Environmental Guideline for Industrial Waste Discharges,
- Environmental Guideline for the General Management of Hazardous Waste,
- Environmental Guideline for Waste Asbestos,
- Environmental Guideline for Waste Paint,
- Environmental Guideline for Waste Solvents,
- Environmental Guideline for Ozone Depleting Substances,
- Environmental Guideline for Waste Batteries,
- Environmental Guideline for Waste Antifreeze,
- Environmental Guideline for Waste Lead and Lead Paint

3.3.3.8.Bulky Waste Area Operation

The bulky waste disposal area is an open area. Separate areas should be assigned for storage of tires, appliances and discarded wood. To ensure effective operation:

- Place bulky wastes in an organized manner, starting from the back and working towards the front,
- Stack bulky wastes whenever possible to conserve space,
- Ensure that waste is stacked in such a way that it is safe to walk through the site.

3.3.3.9.Special Considerations

Winter Operation	A compaction and covering cycle is completed in the fall to prepare for the onset of winter.
Spring Operation	Due to high run off, poor road conditions in the spring, the waste disposal site may be inaccessible from the community.
Wind	A chain link fence is proposed to be constructed at the top of the solid waste disposal area to help control the movement of wind driven material off the landfill site. Typical fence details are shown on **Figure 5**.
Access	The residents of Pangnirtung may express the desire for 24-hour access to the waste disposal site.
Spring Clean-up	A spring clean-up is conducted after the snow has melted to collect waste that has accumulated around the Hamlet over the winter.
Health and Safety	Due to the nature of the facility, safety precautions should be taken by those personnel involved in the operation and maintenance of the landfill: • Water and puncture proof gloves and safety boots are to worn at all times, • Work clothes should not be worn home. • Hands are to be washed frequently, as a minimum after work and before eating, • Personnel should receive appropriate vaccinations and ensure they are kept up to date, • Only personnel trained to handle hazardous materials should do so.
Polar Bear Safety	Bears are known to frequent the community area and likely the site and precautions should be taken.

3.3.3.10. Site Records

Records should be kept to assist in planning for yearly operations and future expansion. The information should be reviewed yearly to evaluate the effectiveness of the operation and to forecast future operational requirements. The records should be kept in the Hamlet Office and maintained by the Operations Manager. As a minimum, the following information should be recorded:

Refuse

- The number of trips and loads per day,
- The dates of compaction and cover.

Bulky Wastes

- Itemize the site contents,
- The number of trips to the site and the dates,
- The date when the site is full.

Hazardous Materials

- The number of trips to the site and dates,
- The type of material placed there,
- The party using the site,
- The date when the site is full.

3.3.3.11. Maintenance Procedures

Proper maintenance of a landfill facility is crucial to ensuring the efficient operation of all the components. Activities can be divided into the following categories:

3.3.3.12. Storage Maintenance

As the first step in the waste collection process, residential and commercial storage containers should be adequately maintained. The following points should be considered:

- Private burning of waste within the Hamlet boundaries should be discouraged as the smoke and fire hazards generally outweigh any benefit from reducing the volume of waste,
- Garbage containers should be covered to prevent wind blown debris from littering the community and to prevent animals from getting into the garbage,
- Bulky wastes should not be left in residential areas for long periods due to aesthetic and safety concerns.

3.3.3.13. Collection Maintenance

The waste collection vehicle should be maintained in good operating condition to ensure the collection service is not interrupted for extended periods. Other maintenance considerations include the following:

- The collection vehicle should be equipped with a shovel to clean up accidental spills during collection,
- The collection vehicle should be cleaned periodically.

3.3.3.14. Access Road Maintenance

The access road is gravel and approximately 3000 m long. Basic road maintenance is to be conducted as follows:

- At least monthly, the road and truck pad is to be graded to smooth and the surface is to be reshaped,
- As necessary during the winter, snow is to be removed to ensure unrestricted access to the site for the garbage collection vehicles.

3.3.3.15. Fence Maintenance

A chain link fence is present along the side adjacent to the solid waste disposal area. The fence is intended to serve the dual purpose of restricting access to wildlife and people and reducing the migration of wind-blown debris out of the landfill. On a weekly basis, the following maintenance procedures should be carried out on the fence:

- Wind blown material should be removed from the fence to reduce lateral loading and to improve the aesthetics of the site.

On a monthly basis, the following maintenance procedures should be carried out on the fence:

- The fence should be examined for holes,
- The fence posts should be inspected for frost heave and excessive settling.

3.3.3.16. Sign Maintenance

A sign posted at the entrance to the site identifies the different disposal areas at the facility and outlines permissible dumping practices for each. The separate disposal areas are identified with their own signs. A warning sign indicating the potential hazards associated with the site is also located at the entrance.

- On a monthly basis, check to ensure the signs are present, have not become obstructed and are readable.

3.3.3.17. Operational and Maintenance Summary

Daily

- Collect waste from the Hamlet and transport it to the landfill,
- Ensure all wastes stay in designated areas,
- Clean up any spills immediately,
- Clear snow from roads and disposal areas as required,
- Record O&M information.

Weekly

- Pick-up wind blown materials which have migrated past the debris fences,
- Pick-up wind blown debris off fence,
- Record O&M information.

Monthly

- Grade and maintain access roads, if required,
- Check and fix fences, if required,
- Check signs to ensure they are in readable condition,
- Record O&M information.

Yearly

- Compact and cover refuse in the spring and fall,
- Review O&M records to assist in planning for the upcoming year.

3.4. Applicable Regulations and Environmental Considerations

There are specific regulations in Nunavut governing the siting of a landfill facility. The disposal of waste within the Hamlet of Pangnirtung is regulated as per the community's water license, and the regulations set forth in the license supersede and/or satisfy all other guidelines/regulations.

The Government of the Northwest Territories (GNWT) has developed several guidelines with sections that are relevant to waste disposal in the NWT. The GN has, in the past, adopted GNWT environmental guidelines with only minor modifications, so the relevant sections of the GNWT guidelines are summarized below for reference purposes.

The Guidelines for the Planning, Design, Operation and Maintenance of Modified Solid Waste Sites in the NWT address the design and management of landfills.

The Guideline for Industrial Waste Discharge in the NWT states that industrial discharges are not subject to the guidelines if a water license is in place. Section 3.2 Process Residuals, states process waste can be landfilled if the leachate standards set out in Schedules III or IV of the guideline are met.

The Guideline for the General Management of Hazardous Waste (EP, GN) governs the storage and disposal of hazardous wastes in Nunavut. There are no licensed hazardous waste disposal facilities in Nunavut for the disposal of municipal generated waste. All hazardous waste needs to be transported to a licensed facility in southern Canada. Storage of hazardous waste must meet the guidelines.

The *Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT* specifically relate to these facilities.

Personnel from the following regulatory agencies were contacted to discuss regulatory requirements for the sludge disposal facility:

- Department of Fisheries and Oceans (DFO);
- Environment Canada (EC);
- Nunavut Department of Health and Social Services (H&SS);
- Department of Indian Affairs and Northern Development (DIAND); and
- Nunavut Department of Environment (DoE).
- Nunavut Water Board (NWB)

The regulators concerns included issues such as compliance with applicable legislation, leachate control, facility management, spill planning and contingency planning. H&SS also indicated that a 450 m setback would be required between the facility and any building used for food preparation.

Members of the Hamlet Council and the SAO were also consulted regarding the proposed disposal facility. This group did not have concerns regarding the waste streams themselves, but indicated a strong preference for moving the existing solid waste disposal facility to a new location. They provided the following reasons for wanting the facility moved:

- Community growth is physically constrained by the local topography, i.e. steep cliffs along the south side of the community and water on the north and west sides. Therefore the only direction for the community to grow is towards the existing solid waste facility. Growth will be constrained by the requirement for a 450 m setback.
- Strong winds blow through this area, towards the community and garbage is picked up from the landfill and strewn around. This creates an eyesore, and also windblown garbage has been deposited in the Hamlet’s drinking water reservoir, which creates a health hazard.
- Odours from the existing solid waste facility are blown towards the community.

In addition, the community indicated there are plans to install an extractor and shredder at the sludge disposal facility, to process and perhaps compost the sewage sludge. Little information was available regarding this proposal, but any such development will impact the design of the facility by altering space and access requirements.

3.5. Estimated Costs

3.5.1. Capital Costs

Table 3.5.1-1: Estimated Capital Costs

Item	Description	Units	Unit Price	Estimated Quantity	Unit total
1	Mobilization and Demobilization	Lump Sum	150000	1	$150,000
2	Road Works				
	Common Fill	m^3	35	41321.28	$1,446,245
	Road Surfacing Material	m^3	40	3973.2	$158,928
	Riprap	m^3	20	3973.2	$79,464
3	Culverts 500 mm	m^3	100	80	$8,000
4	Culverts 2000 mm	m^3	300	80	$24,000
5	Bridges (single lane)	m^2	2000	320	$640,000
6	Site grading	m^2	10	45000	$450,000
7	Fence	lm	100	940	$94,000
8	Signs	each	5000	4	$20,000
9	Ditching	lm	30	940	$28,200
	Total				**$3,098,837**
	Contingency (20%)				**$620,000**
	Total				**$3,718,837**

3.5.2. Operating Costs

Table 3.5.2-1: Landfill Operating Cost Estimate

Frequency	Operation	Equipment						Personnel						Total Equipment hours per Activity	Total staff hours per activity	Total Cost per Activity
		Truck		Loader		Dozer		Trade or operator		Labour		Foreman				
		Hours	Rate	Hours	Rate	Hours	Rate	Hours	Rate	Hours	Rate	Hours	Rate			
Daily																
	Collect waste from the Hamlet and transport it to the landfill,	1500	$100	0	$180	0	$220	1500	$60	0	$30	0	$75	1500	1500	$240,000
	Ensure all wastes stay in designated areas,	0	$100	50	$180	0	$220	50	$60	100	$30	0	$75	50	150	$15,000
	Clean up any spills immediately,	25	$100	100	$180	0	$220	125	$60	100	$30	20	$75	125	245	$32,500
	Clear snow from roads and disposal areas as required,	0	$100	200	$180	20	$220	120	$60	0	$30	12	$75	220	132	$48,500
	Record O&M information.	0	$100	0	$180	0	$220	0	$60	0	$30	1	$75	0	1	$75
Weekly																
	Pick-up wind blown materials which have migrated past the debris fences,	0	$100	0	$180	0	$220	0	$60	100	$30	20	$75	0	120	$4,500
	Pick-up wind blown debris off fence,	0	$100	0	$180	0	$220	0	$60	100	$30	10	$75	0	110	$3,750
	Record O&M information.	0	$100	0	$180	0	$220	0	$60	0	$30	50	$75	0	50	$3,750
Monthly																
	Grade and maintain access roads, if required,	0	$100	24	$180	0	$220	24	$60	0	$30	0	$75	24	24	$5,760
	Check and fix fences, if required,	0	$100	0	$180	0	$220	0	$60	12	$30	12	$75	0	24	$1,260
	Check signs to ensure they are in readable condition,	0	$100	0	$180	0	$220	0	$60	0	$30	12	$75	0	12	$900
	Record O&M information.	0	$100	0	$180	0	$220	0	$60	0	$30	24	$75	0	24	$1,800
Yearly																
	Compact and cover refuse in the spring and fall,	0	$100	50	$180	50	$220	100	$60	0	$30	10	$75	100	110	$26,750
	Review O&M records to assist in planning for the upcoming year.	0	$100	0	$180	0	$220	0	$60	0	$30	24	$75	0	24	$1,800
	Annual Totals													2,019.00	2,526.00	**$386,345**

4.0 INCINERATOR

The intent of this portion of the feasibility study is to provide information on incineration systems that may provide a practical solid waste management option for the community of Pangnirtung. Incineration, i.e. burning solid waste at high temperature inside a specially designed and purpose-built unit, is an efficient way to reduce waste volume and demand for landfill space, and modern combustion technology and air pollution controls are effective in minimizing associated environmental impacts.

The following sections provide a review of the considerations and parameters involved in selecting suitable incinerators, and a comparative evaluation of two turn-key packages determined to be suitable for this application.

4.1. Incinerator History

Incineration has a long history of use as a waste disposal method, but early incineration techniques such as open pit or barrel burning were major contributors to air pollution. Incineration was a common waste disposal method in the US until the mid 1900's when incineration's popularity declined due to poor combustion and the lack of pollution controls.[1]

Modern, more efficient and cleaner incinerator technology has increased the popularity of incineration as a solid waste management option. Incineration is popular in countries where land is a scare resource, such as Japan, since it does not require as much area as landfilling. Some European countries, such as Sweden and Denmark, extensively use incineration to dispose of wastes and generate energy or heat. Newer municipal solid-waste incinerators are often designed as waste-to-energy plants that generate electric power or waste heat.[2]

4.2. Incinerator Types

"Incineration" thermally decomposes matter through oxidation. An "incinerator" is the device used to complete the combustion process. Types of combustion incinerators used to manage solid waste include single chamber units, multiple chamber units, and trench incinerators. There are also non-combustion technologies (where there is no or very little oxygen) available such as biogasifcation and pyrolysis, however these methods often require more pre-processing of wastes, processing time and/or produce end products that can be difficult to manage.

In general, an incineration facility will incorporate the following processes:

- Waste storage and feed preparation;
- Waste pre-processing;
- Combustion producing hot gases;

[1] http://www.forester.net/mw_0109_history.html
[2] http://books.nap.edu/openbook.php?record_id=5803&page=38

- Waste heat or electricity generation (if desired);
- Air-pollution control (if needed); and
- Residue (ash) handling.

There are three main classes of solid waste combustion incinerators including mass burn, refuse-derived fuel (RDF), and modular combustors.

Mass burn units combust waste without pre-processing. The waste is moved through the unit by a grate, with excess combustion air supplied both below and above the grate. These units are generally quite large; they can combust in the range of 50 to 1,000 tonnes per day, and are often built on site. Mass burn units include mass burn waterwall, mass burn rotary waterwall combustor, and mass burn refractory wall.

Waste must be pre-processed to burn in RDF combustors. The waste must be sorted to remove non-combustibles and shredded so that it is suitable for co-firing with pulverized coal. RDF combustors are also quite large, combusting in the range of 320 to 1,400 tonnes per day. RDF subtypes vary depending on the boiler design.

Modular combustors are smaller in size than the previous two classes, generally combusting 5 to 140 tonnes of waste per day. They represent a large portion of municipal solid waste combustors and are generally prefabricated. There are two main types of modular combustors: controlled air (or starved air) and excess air and both utilize two combustion chambers, the primary and secondary chambers. The waste feed for either type typically does not require pre-processing.

Modular controlled air is the more common of the two types. Waste is batch fed into the primary chamber and then, depending on the size of the unit, the waste may be moved through the primary chamber by hydraulic transfer rams or reciprocating grates. Air is added at sub-stoichiometric levels to the primary chamber of starved air units. The amount of air introduced into the primary chamber dictates the rate at which the waste burns. Minimal turbulence in the primary chamber also reduces the carry-over of particulate. The waste retention time in the refractory lined primary chamber is up to 12 hours at temperatures in the range of 650 to 980°C. Bottom ash is collected from the primary chamber, and the flue gas leaving the primary chamber is rich in partially combusted hydrocarbons.

Further combustion of hydrocarbons and other chemicals requiring oxidation occurs at high temperatures, typically 980 to 1,200°C, in the secondary chamber. Additional air is added to the flue gas in the refractory lined secondary chamber to assist in completing the burn process.

Waste heat boilers are often included in new installations.

High temperatures and thorough mixing of flue gas and air in the secondary chamber provides good combustion, which results in relatively low carbon monoxide and trace organics in the emissions. The restricted amount of air introduced in the primary chamber results in a low gas velocity and thus relatively low amounts of particulate matter in air emissions.

Excess air combustors are similar in design to the controlled air units; however they use excess air in the primary chamber, usually in the range of 50 to 250 percent excess air. Due to higher air turbulence in the secondary chamber, particulate matter emissions are higher than those from controlled air units; however, nitrogen oxide emissions appear to be lower (US EPA AP42 Section 2.1.2.7).

Modular combustors would likely be the best suited to the community of Pangnirtung since a relatively small amount of waste is produced and currently no pre-processing of waste is conducted. The prefabricated units are also relatively easy to assemble which provides an additional benefit.

4.3. Emissions

Emissions from incinerators, whether single or multi-chamber are governed by the factors of time, temperature and turbulence. Time is the retention of the waste gas at the designed destruction temperature and the turbulence is the degree of mixing which must be enough to complete destruction but not enough to carry-over particulate or ash. Typical incinerator regulations include a requirement for a minimum residence time of one second in the combustion zone at the minimum combustion temperature specified in the design. For multiple chamber incinerators, this residence time is calculated from the secondary burner flame front, or, if air is introduced downstream of the flame front, from the final air injection point.

The CCME guidelines will apply to the emissions from the incinerator. The 1989 CCME Guidelines for Municipal Waste Incineration have been used by some jurisdictions and these reference the Canada Wide Standards to which Nunavut is a signatory. However, emissions estimates should be discussed with the GN Department of Environment to determine exactly what emissions limits will be set for the incinerator.

The contaminants listed in Table 4.3 are emitted from every incinerator used to dispose of municipal solid waste. Emission quantities vary with incinerator temperature, design and control systems. Table 4.3 also shows the CCME limits for this type of incinerator.

Table 4.3: CCME Emission Limits for Municipal Waste Incinerators

Contaminant	Unit	CCME Limits
Total Particulate Matter (TPM)	mg/Rm3 @ 11% O2	20 [a]
Sulphur dioxide (SO2)	mg/Rm3 @ 11% O2	260 [b]
Hydrogen chloride (HCl)	mg/Rm3 @ 11% O2	75 (or 90% removal) [a]
Nitrogen oxides (as NO2)	mg/Rm3 @ 11% O2	400 [b]
Carbon monoxide (CO)	mg/Rm3 @ 11% O2	57 [a]
Cadmium (Cd)	ug/Rm3 @ 11% O2	100 [b]
Lead (Pb)	ug/Rm3 @ 11% O2	50 [b]
Mercury (Hg)	ug/Rm3 @ 11% O2	20 (70 for sewage sludge)[c]
Dioxins and furans (I-TEQ)	Pg/Rm3 @11% O2	80 [d]
Notes a) CCME Operating & Emissions Guidelines for MSW Incinerators 1989 Table 4.2 b) CCME Operating & Emissions Guidelines for MSW Incinerators 1989 Table 4.3 c) CWS for Mercury Emissions d) CWS for Dioxins & Furans		

4.3.1. Emissions Controls

Control systems may be added to reduce acid gases, particulate and dioxins/furans in the exhaust stream following emission from the secondary chamber. Due to the pressure drop on the system with the addition for such controls an exhaust fan is also required. Typical end-of-pipe control systems for this type of incinerator include:

Basic system:

- Stage 1 – Water injection to cool the exhaust gas stream.
- Stage 2 – Water injection at a venturi throat to increase particle sizes and allow particulate removal.
- Stage 3 – Scrubber section for acid gas and particulate removal. The scrubbing may be liquid or dry sorbent injection. If liquid, it is alkaline under pH control to allow recirculation.
- Stage 4 – Either exhaust to atmosphere or further controls (e.g. fabric filter if the dry sorbent method is used.

Additional controls may include

- Stage 5 – Drying of the air stream
- Stage 6 – Injection of activated carbon for removal of mercury and organic vapour
- Stage 7 – Fabric filter for final particulate removal.

Requirements for control systems vary with incinerator design, waste type and jurisdiction. In many jurisdictions, once the system is well designed and tested, temperature, residence time and waste screening is adequate to meet emissions limits. In other jurisdictions the basic scrubber system is deemed to be adequate for control. In all case of controls, the resulting liquid or solid waste streams must be accommodated.

If it is mandated that a unit in Pangnirtung must meet the 1989 CCME guidelines then there are 2 control options:

- Establish a rudimentary metals separation program in the town (battery and light bulb drop-off, and similar separation activities for materials that are known to contain metals – see attached document) and then dispose of these materials appropriately (send south after stockpiling or some other option); or
- Process everything into the incinerator (metals and all) and install a sophisticated air pollution control system based on the above to guarantee the emission levels. Note that the community will need to stockpile the discharge from the APC containing hazardous components (e.g. lead, mercury and cadmium) and then dispose of it appropriately. This will likely double the capital and operating cost and be a far more sophisticated piece of equipment to operate and maintain.

4.3.2. Emissions Monitoring

Emission monitoring systems vary widely with the size of the incinerator and the regulatory needs of the jurisdiction. While many jurisdictions encourage the installation of continuous emission monitors (CEM), most manufacturers will log a full set of chamber temperature and flow profiles to enable chamber temperature and residence time to be verified. Some CEM systems may also include a CO or CO/O2 monitoring system to validate the level of combustion and may also include opacity meters and other analyzers in special cases. Such measurement options may add significantly to the capital cost and will require regular calibration and verification testing. One would expect that a new incineration system will be subject to source testing soon after commissioning and may also be subject to periodic testing at the discretion of the appropriate regulatory agency.

Dispersion modelling could also be performed which would provide information on expected air pollution levels around the site simulating both a controlled and un-controlled incinerator. The results of this exercise would provide information on any potential health risks associated with an un-controlled incinerator, and would provide an indication as to whether the air pollution control devices are warranted.

4.4. Ash Disposal

Two types of ash are typically generated during the incineration process. Bottom ash is left behind in the combustion chamber and includes the non-combustible portion of the feed, such as metal cans and glass. Fly ash is collected by the air pollution control device and consists primarily of finely divided inorganic combustion residues.

Both types of ash may contain elevated metals concentrations, and may be considered hazardous if the metals are leachable. Experience described in the literature suggests that bottom ash tends to not leach metals, and is often used as a construction aggregate or as a landfill cover. Fly ash is more likely to leach metals, and should be handled appropriately.

The precise properties of bottom ash and fly ash depend upon the composition of the waste stream, the incinerator design and incinerator operation.

Ash may be managed as separate components or mixed and disposed together as combined ash. The specific properties of incinerator as will depend upon MSW composition and incinerator design and operation, so the ash waste stream generated by an incinerator in Pangnirtung will need to be characterized to determine the most appropriate disposal method.

Landfilling is a common disposal method for MSWI ash. Suitability for landfilling is assessed based upon leachability tests conducted on the waste material. Non-hazardous waste may be disposed in a regular landfill, but hazardous waste would need to be additionally stabilized before it would be considered suitable for landfill disposal.

Schedules III and IV of the GN's Guideline for Industrial Waste Discharges in Nunavut (January, 2002) provides leachate quality standards for assessing whether a given waste material is considered hazardous.

An ash monofill will be required to accept the incinerator ash. The volume of ash generated during the 15 year operating period is summarized in Table 4.4-1.

Table 4.4-1: Ash Volume Estimate

Year	Population	Daily Ash Volume (m^3)	Annual Ash Volume (m^3)	Cumulative Ash Volume (m^3)
2007	1,756	2.7	998	998
2012	1,955	3.0	1,111	6,316
2017	2,160	3.4	1,228	12,216
2022	2,366	3.7	1,345	18,705

The ash monofill will need to be constructed with a liner and leachate collection system. Leachate can be used as a dust suppressant in the monofill and in the incinerator to wet down the ash and keep it from dusting. Ash in the monofill should be covered daily to reduce issues with wind blown ash.

Note that a landfill will be required in Pangnirtung, even with an incinerator, to accept materials such as scrap metal, white goods and household hazardous materials (batteries, solvents, fluorescent lights, etc) that cannot be put into the incinerator. This landfill could be operated in conjunction with the ash monofill.

Temporary ash storage facilities will be required at the incinerator building itself to permit short term stock piling of ash in the event inclement weather makes it difficult to dispose of the ash.

Assumptions regarding feed quantity, composition, volumes, incinerator life cycle, etc.

The life cycle of the incinerator is expected to be fifteen years. The community produces domestic waste, which includes paper, plastic, metals, glass, and organic matter, as well as, wastewater treatment plant (WWTP) sludge. All these materials can be processed by incineration; however, hazardous wastes must be removed and handled appropriately.

The WWTP sludge should be processed to 15% to 25% solids. Waste heat generated by the incinerator could potentially be used to aid the sludge drying process.

The estimated population and solid waste generation for Pangnirtung over the expected life cycle of the incinerator are shown **Table 4.4-2.**

Table 4.4-1: Estimated Incinerator Capacity Requirements

Population and Solid Waste (SW) Generation Estimates			
Year	**Est. Population**	**Est. SW per day**	**Est. SW and Sludge per day**
2007	1756	5.27 (tonnes) / 26.43 (m^3)	5.42 (tonnes) / 27.08 (m^3)
2012	1955	5.87 (tonnes) / 29.33 (m^3)	6.03 (tonnes) / 30.15 (m^3)
2017	2160	6.48 (tonnes) / 32.4 (m^3)	6.66 (tonnes) / 33.31 (m^3)
2022	2366	7.10 (tonnes) / 35.5 (m^3)	7.30 (tonnes) / 36.50 (m^3)

One consideration in selecting an incinerator is whether or not to initially purchase a model large enough to handle waste throughout the life cycle or if the model selected accommodate modular add-ons at a later date.

Fish plant waste is also produced, intermittently, in the Hamlet at a rate of approximately 230 m^3 per year. This material is currently disposed at the landfill, but Dillon understands that alternate disposal methods, such as ocean disposal, are being investigated. Fish waste could be incinerated, but the proportion of waste added to each batch will need to be controlled since the wet fish waste will take longer to dry out and may impact combustion temperature and time. In addition, the fish waste will have a high salt content that will impact the generation of acid gases (HCl), and may also contribute mercury.

This report assumes that fish plant waste is not included in the incinerator feed, though the incinerators have sufficient capacity to handle this material if required.

4.5. Description of selected incinerators

Dillon has identified two incinerators based on the requirements of the community. These include the EcoWaste Solutions ECO 9T Model and the Westland Environmental model CY250CA D "O" model (or larger). A detailed description of both models follows below.

Eco Waste Solution, from Burlington Ontario, recommended their ECO 9T model. This modular controlled air unit is a two-stage process. Various options are available to modify the base unit including waste heat recovery, air pollution control system, loading mechanisms, and an auxiliary waste oil burner. The unit is equipped with an integrated control panel with programmable logic control, supervisory control, monitoring, data acquisition and remote diagnostic capabilities. The ECO 9T model can process 9 tonnes per day, which is batch fed into the primary chamber through top or front-loading options. EcoWaste does not utilize ram feeders since they generally require personnel to directly handle waste, require more man-hours to load, can increase particulate matter and uncombusted items in process, and can have high maintenance costs. The cycle time can be broken down into 8 to 12 for oxidation, 6 to 10 hours for cool down and 1 to 2 hours for ash clean out and reloading. The primary chamber operates at temperature of 650 - 850°C, and the secondary chamber operates at approximately 1000°C with a 1.5 to 2 second gas retention time.

The EcoWaste incinerator can reportedly meet the CCME Dioxin and Furan standards without the air pollution control system. However, the un-controlled incinerator will likely exceed the CCME emission values for particulate, cadmium and mercury. However, a source separation program could be implemented, and this program could potentially reduce the emissions to within the CCME values. Alternately, the air pollution control system could be added and the metals and particulate capture rate would be approximately 99.9%.

It is feasible to start with a smaller ECO model and add on a larger primary combustor at a later date. However, cost savings using this strategy are likely minimal since the rest of the system must be designed to handle the add-on at the beginning, the larger primary combustor will need to be shipped to the Hamlet at a later date and a team of skilled trades will also need to be mobilized to site to install the upgraded primary combustor.

A typical Ecowaste incinerator layout is shown in Figure 7, and typical air pollution control schematics are shown in Figures 8 and 9.

Eco Waste Solutions has installed incinerators in:

- § Remote communities such as Wemindji, Quebec (installed in 2003) and Skagway, Alaska (installed in 1998);
- § Military camps such as CFA Alert, Nunavut (installed in 1994) and CFS Eureka, Nunavut (installed in 2001); and
- § Mining camps such as Voisey's Bay Nickel Mine, Labrador (installed in 2003 and 2004) and Snap Lake Diamond Mine, Northwest Territories (NWT) (installed in 2005).

Westland Environmental, from Edmonton Alberta, has recommended their CY250 CA D "O" model. This includes a two chamber modular controlled air unit with V250AG wet venturi scrubber, quench and mist eliminator, a ram feeder, attached with the Westland Emission polishing system consisting of a heat recovery unit (hot water), emission polishing packed column and HEPA filter. The CY250 CA D "O" model can process 250 kg per hour, which is loaded into the primary chamber using a ram feeder. They have suggested acquiring two units to provide the security of having one unit operating while the other is in service as well as meeting the future waste volumes.

However, 250 kg hour is equivalent to 3 tonnes per day (assuming a 12 hour combustion), which even with two units does not appear to meet the estimated 15 year waste volume for Pangnirtung. Therefore, we have also provided details of the CY400 CA D "O" unit, which can process 400 kg per hour, which provides 4.8 tonnes per day capacity. Again, two units will be required to meet the anticipated 15 year waste volume for Pangnirtung. The cycle for these units typically require 2 hours for ash removal and start-up, up to 12 hours for combustion, and up to 10 hours for burn-down and cool-down. The primary chamber operates at temperatures of 850 - 1000°C, and the secondary chamber operates at approximately 1100°C with a 2 second retention time.

Westland has installed incinerators in:

- § Mining camps such as BHP Ekati Diamond Mine, NWT (installed in 2006) and Voisey's Bay Nickel Mine, Labrador (installed 2001) and Diavik Diamond Mine, NWT (installed in 1995)

A typical Westland incinerator process schematic is shown in Figure 10.

4.5.1. Comparison Parameters

A number of parameters were reviewed as part of the comparative evaluation of the two incinerators. The selected parameters include the following:

Auxiliary fuel type – Incinerators can be designed to use various auxiliary fuel types to initiate and maintain the combustion process. Auxiliary fuel is used during start up and to maintain the desired combustion temperature in the primary and secondary chambers.

Ash quality/volume – Incineration produces both bottom ash and fly ash. Fly is the finely divided non-combustible matter that caught up by the flue gas and sent out through the stack. Bottom ash is the non-combustible material which is not picked up by the flue gas and is generally collected in the primary chamber. The volume of ash remaining after incineration can vary depending on the type, but waste is reduced by 90 to 95% of its original volume. Bottom ash may not be hazardous, depending upon the quality of the incinerator feed, but metals tend to accumulate in the fly ash and this material may hazardous. Leachate testing should be completed on both ash types to determine the appropriate management requirements for the ash residues.

Air emissions quality – Pollutants that may be emitted from incinerators include particulate matter, metals, acid gases (such as carbon monoxide, oxides of nitrogen, sulphur dioxide, and hydrogen chloride), and toxic organics (such as dioxins and furans). Ability to meet emission limits will depend on the type and design of incinerator and any control devices which are included.

Operational complexity – operating an incinerator is more complicated than operating a landfill. Dedicated operators may be required, and operators will require training to operate the facility.

Sensitivity to feed changes, feeding frequency and requirement for pre-sorting – minimal pre-sorting is the most desirable mode of operation for an incinerator in Pangnirtung. Some facilities remove recyclable materials from the feed prior to incineration, but this practice would provide limited value for Pangnirtung since recycling is not widely practiced in Nunavut. Hazardous materials, including fluorescent lighting, batteries, etc. should be removed from the feed to reduce the concentration of metals in the ash and exhaust gases.

Feasibility of recovering waste heat or generating power – power generation is not feasible for the relatively small units appropriate for Pangnirtung. Waste heat recovery is feasible.

Feasibility of including biosolids – biosolids are generated at the Pangnirtung WWTP. The biosolids are currently disposed at the landfill, but an alternate disposal method is desirable.

Capital costs (breakdown of components) – these are the capital costs associated with installing an incinerator in Pangnirtung.

Operational costs (fuel, parts, air, water, filters, etc.) – these include the expected operational costs associated with running an incinerator in Pangnirtugn.

Building requirements (existing building, renovated building, new building) – an incinerator was constructed in Pangnirtung in the late 1970s/early 1980s, and the building is presently located adjacent to the wastewater treatment plant. Re-use of the existing building would reduce the cost of installing an incinerator in Pangnirtung. Alternately, the incinerator could be constructed closer to the community to provide district heating opportunities, which would offset the auxiliary fuel costs. Note that while the manufacturers indicate no odour and visible emissions, the reality is that odours and visible emissions will occur at least occasionally, and the community may object to locating an incinerator closer to the community.

History of successful operation in remote locations – Pangnirtung is a remote location and skilled technical staff is not immediately available in the event of difficulties with the process. Simple processes that are demonstrated to work in similar environments are preferred.

The incinerators recommended by EcoWaste and Westland are compared in Table 4.5.1-1. Note that the primary difference between the two Westland models is size, so the properties of the two Westland models are summarized together.

Table 4.5.1-1: Incinerators Property Comparison Table

Parameter	**Eco Waste Solutions, ECO 9T Model**	**Westland Environmental Services, CY250CA D "O" and CY400CA D "O"**
Capacity	9 tonnes/day	CY250CA D "O" - 250 kg/hour, or 3 tonnes per 12 hour burn. (Two units required) CY400CA D "O" – 400 kg/hour or 4.8 tonnes per 12 hour burn (two units required)
Cycle time	8 to 12 hours for combustion, 6 to 10 hours for cool down, 1 to 2 hours for ash clean out and re-loading.	Up to 12 hours for combustion, Up to 10 hours for burn-down and cool-down, and 2 hours for ash removal and start up.
Auxiliary fuel type	Diesel, fuel oil, JP8, natural gas, arctic diesel, propane, and auxiliary waste oil burners can be added.	Diesel and propane.
Ash volume	Waste is reduced in volume by over 90%.	Waste is reduced in volume by approximately 95%.
Ash quality/volume	Providing hazardous waste is kept out of the waste stream the remaining ash is safe for landfill, glass and metals remain intact for recycling.	Ash quality is dependant on the waste feed. If segregation is done and plastics, heavy metals, batteries, mercury lamps, etc. are removed the ash quality is generally safe for landfilling.

Air emissions quality	Smokeless and odourless, meets CCME CWS provided hazardous materials and mercury are kept out of waste stream. May meet CCME regulations without the air pollution control devices.	Westland models, when operated by qualified technicians and fitted with the manufacturer recommended control systems; do meet CCME 2006 emission standards.
Operational complexity (manpower requirements and training)	Automatic process control, easy operation. One person conducts once per day load and clean out, requiring approximately 2 hours. Operator training provided on-site, no previous knowledge required.	Unit requires two-man team to operate, and unit must be supervised at all times during burn, for a total of up to 14 hours. Westland has a two-day training course offered in Edmonton, which certifies operators. No previous knowledge required.
Sensitivity to feed changes, feeding frequency, and requirement for pre-sorting	Able to adapt to feed composition changes. Waste is batch fed once per 24 hours. Hazardous waste (including batteries and mercury containing fluorescent devices) must be removed.	Able to adapt to feed composition changes. Waste is batch fed to the feeder once per 24 hours, and continuously fed to the incinerator over the combustion period. Hazardous waste must be removed. Batteries and items containing mercury must be removed.
Feasibility of recovering waste heat or generating power	Waste heat can be recovered using an optional heat recovery unit (hot water). Electricity generation is not viable.	Electricity generation is not viable, however, can provide hot water at 40°C in heat recovery. Electricity generation is not viable.
Feasibility of including biosolids	Will combust semi-dry sludge cakes with moisture up to 75% water, quantities of maximum of 2,000 kg per day.	Can process wastewater sludge with water content up to 85% (wet basis). The higher the moisture content the more auxiliary fuel is consumed.
Capital costs	See Table 4.5.1-1	See Table 4.5.1-1

Operational costs	Diesel 470 gallons/burn; If scrubber is selected cost of reagents filters and carbon bed as well as freshwater and wastewater treatment must be accounted. See Table 4.5.1-2.	Diesel 30 gallons/hour @ BTU value of 2,900 BTU – 360 gallons per unit per burn; Slaked lime 1 kg/hour of operation depending on amount of plastic in waste; Water 8 L/min for evaporation (may be lower depending on incoming temp. of water); HEPA filters 1/week ($350.00 each) Note these usages will be larger for the CY400CA D "O" model. See Table 4.5.1-2
Building requirements	Footprint approx. 50' by 50' can be configured to fit existing structure. The footprint will increase if air pollution control devices are selected.	For one CY250CA D "O" the primary chamber skid is 8 ft wide by 20 ft long, the acid gas scrubber skid is 8 ft wide by 25 ft long, and height requirements are 24 ft minimum. Two units are required. The skid size will increase to 30 ft in length for the CY400CA D "O.
History of successful operation in remote locations	Wemindji, Skagway, CFS Alert, CFS Eureka, Voisey's Bay Nickel Mine and Snap Lake Diamond Mine.	BHP Diamond Mine, Voisey's Bay Nickel Mine, and Diavik Diamond Mine.
Additional items	Loading equipment required dependant on building layout and temporary waste storage.	Ram feeder and air pollution system result in higher manpower requirement and operational costs.

Capital and operating cost estimates for each incinerator are summarized in **Tables 4.5.1-1 and 4.5.1-2** respectively.

Table 4.5.1-1: Incinerator Capital Cost Comparison

	Ecowaste ECO 9T	**Westland CY250CA D "O"**	**Westland CY400CA D "O"**
Incinerator Unit	$956,000	$596,000	$875,000
Air Pollution Control Device (APCD) - wet venturi	$650,000	Included above	Included above
APCD - BACT	$950,000	$335,800	$495,800
Equipment installation and assembly	$35,000	$35,000	$35,000
Operator Training and Plant Commissioning	$45,000	Included above	Included above
Engineering and Drawing	Included in unit price	$24,000	$24,000
Spare Parts Package - incinerator	$65,000	$46,500	$46,500
Spare Parts Package - APCD	$15,000	Included above	Included above
Heat Recovery Unit	$250,000	$350,000	$350,000
Auxiliary Waste Oil Burner	$25,000	Not available	Not available
Feeder System	Included in unit price	$91,000	$130,000
Waste Ash Carts	$4,000	$43,650	$43,650
Additional unit requirements (access gangway, platforms and stairs)	$5,000	$36,400	$66,400
Packaging and Crating for Shipping	$20,000	$28,000	$58,000
Sealift	$40,000	$30,000	$40,000
Shipping to Montreal	$5,000	$25,000	$25,000
Ash monofill			
Per Unit (need 2 Westland Units)		$1,616,350	$2,164,350
Total Estimated Cost (with APCD)	$2,415,000	$3,232,700	$4,328,700
Total Estimated Cost (without APCD)	$1,465,000		

Table 4.5.1-2: Incinerator Operating Costs

	Ecowaste ECO 9T	Westland CY250CA D "O"	Westland CY400CA D "O"
Personnel	$60,000	$120,000	$120,000
Fuel Costs	470 gal/burn	360 gal/burn/unit	360 gal/burn/unit
	$493,712	$681,374	$681,374
Maintenance Costs	$20,000	$20,000	$20,000
Ash Disposal Costs	$12,800	$12,800	$12,800
Spill clean up	$32,500	$32,500	$32,500
Snow clearing	$24,250	$24,250	$24,250
Road maintenance	$5,760	$5,760	$5,760
Monofill O&M	$2,160	$2,160	$2,160
Administration	$2,000	$2,000	$2,000
Total	$653,000	$901,000	$901,000

4.5.2. Incinerator Case Studies

Incinerators are not currently being used in Nunavut for handling MSW, so other incinerator users were contacted regarding their experiences with the technology. The contacts were selected to provide information on the operation of incinerators of a similar size and from the same manufacturers as the units considered for Pangnirtung. Selected product information from the incinerator manufacturers is included in Appendix B.

Skagway, Alaska

The community of Skagway, Alaska is located in an area where space suitable for siting a landfill and available cover material is scarce. The resident population generates approximately 7.25 tonnes of waste per week during the winter, but the high volume of tourist traffic during the summer months increases the waste generation rate to 7.25 tonnes per day.

An EcoWaste 8T incinerator, with two primary chambers to permit long term additional capacity, was installed in the community in 1998. The incinerator is Class III under US Regulations, so did not require pollution control equipment. Bob Ward, City Manager, was contacted regarding Skagway's satisfaction with the incinerator. Mr. Ward supplied the following information regarding the EcoWaste Facility:

- The community had a strict requirement for 24 hour cycle time. The unit could not meet this requirement when the full waste load was fired in one primary chamber. The first test firing took 48 hours for the full cycle. Therefore, the incinerator is currently operated using both primary chambers simultaneously.
- The EcoWaste incinerators are intended to operate at relatively low temperatures. However, even using both primary chambers, the incinerator must be run at

higher temperatures in order to complete the burn within the required time. Operating the incinerator at the higher temperatures has required premature replacement of the refractory lining. The lining has been replaced four times since the incinerator was commissioned, at an approximate cost of $250,000 (U.S. dollars) per time.

- Skagway had a requirement for no visible emissions. The secondary chamber is intended to be self firing once the incinerator is up to operating temperature, without the requirement for auxiliary fuel. The community's experience has been that visible emissions do occur when auxiliary fuel is not supplied to the secondary burner. Running the secondary burner with auxiliary fuel has greatly increased the fuel requirement of the incinerator to 300 to 500 gallons per burn.
- Actual operation of the facility is straightforward. Once the incinerator has been loaded and ignited, the operator is able to leave and perform other duties.
- Ash is disposed into a landfill located adjacent to the incinerator. Ash handling inside the building was initially problematic due to fugitive emissions, but filtered fans have been installed to create a negative pressure in the ash storage bay which has alleviated the dusting issues. Ash is removed from the storage bay approximately monthly during the summer and once at the end of winter. The ash storage bay is equipped with a sprinkler system so the ash is a "muck" consistency when it is moved. The ash hardens in the landfill, so cover has not been required to control fugitive emissions from the landfill itself. Leachate is collected in a sump, and sample results have not shown the leachate to be toxic. The leachate is typically recycled to the head of the landfill when the level in the sump gets too high. The ash volume generated has been consistent with initial estimates.

Voisey's Bay, Labrador

The Voisey's Bay mine site is not permitted to landfill waste at the site and therefore must incinerate in order to reduce volumes prior to shipment off site. The site has used both Westland and Eco Waste incinerators. The original incinerators at the site were supplied by Westland. However, these units were reportedly undersized and were replaced with an Ecowaste CA-50 and CA-100.

The mine has had up to 1000 people working on the site, but is currently down to about 300. The incinerators burn primarily kitchen waste on a continuous basis, since the site operates 24 hours a day. The incinerators operate on 4 to 6 hour cycles. Approximately 800 lbs of waste are burned daily.

Ken Michelin of Voisey's Bay was contacted regarding the incinerator operation and provided the following information:

- The Westland incinerators were too small and removed some time ago, so he could not comment on their operation. He knew that both Eco Waste and Westland incinerators were evaluated originally.

- The present Eco Waste incinerators are adequate, but were not working that well when the mine was operating with more people. The kitchen waste is wet, so is difficult to burn.
- They have had to replace the incinerator linings twice in the last several years.
- The incinerators do not provide smoke and odour free operation. They are pretty good, but there is still some smoke and odour. Their units are not equipped with air pollution control devices.
- They have found the incinerators to be high maintenance, with fairly constant alarms, thermo-couples going, etc. Voisey's Bay has a good maintenance crew with many skilled trades (e.g. electricians, instrumentation technicians, etc.) and he worries that an incinerator operating in a small community may have difficulty due to a lack of skilled trades. However, he was believed that this issue could possibly be addressed with a well designed training and follow up program, and through remote access to the plc.
- Ash is placed into containers and shipped off-site for disposal. He has no issues with the ash handling process.

*Wemindji, Quebec*The community of Wemindji installed an Ecowaste 3T in 2003. Tony Gull was contacted regarding the operation of the incinerator, and provided the following information:

- The community is accessible by road.
- Fuel was a major cost, so the community has implemented a recycling and waste diversion program to reduce the amount of garbage produced by the community. This has reduced their need to burn everyday and will reduce the fuel consumption. The incinerator uses approximately 200,000 L of fuel per year.
- The incinerator was handling the waste well at full capacity.
- The incinerator operates on a 16 hour cycle, i.e. 8 hour burn followed by 8 hour cool down.
- There was a lot of "wear and tear" on the units in the early stages of operation while the community developed loading techniques. There were also issues with disposal of inappropriate items (e.g. small propane tanks), and the community members required educating about what could be thrown in the garbage and what couldn't. They had success using pictorial educational tools.
- There were some initial issues with the burner – the tubes were located too close to the burner and were being combusted. EcoWaste addressed this issue.
- Ash disposal is relatively straight forward. The ash is disposed in a trench at a designated location, and covered with sand. The area is heavily treed to cut wind, and they have not experienced problems with windblown ash.
- They have found EcoWaste to be good to work with, but have a three year service contract in place (4 maintenance trips per year).
- The operators are happy with the system since it is cleaner than landfilling and the process was relatively easy to learn.
- Overall, they are happy with their choice.

5.0 ASH MONO-FILL

The existing landfill site could be considered as a location for ash disposal, scrap metal/bulky non-combustible materials and household hazardous waste disposal. This location allows for the use of the existing solid waste disposal facility infrastructure such as access roads and fencing, and the scrap metal, white goods and household hazardous waste could be stored on top of the closed landfill. The existing landfill is also located in close proximity to one of the potential locations for the incinerator (the former incinerator building), which would reduce ash transport costs.

Alternately, the ash-fill/bulky materials storage site could be located at the site described in Section 3.2 above, which has been identified as the preferred location for a new landfill for the Hamlet.

As part of the development of the preliminary design of the ash disposal facility, the following design elements will be incorporated.

Fill height: A fill height of 2.0 m will be used to allow for dumping of the ash in a single lift. Maximizing the fill height provides the greatest efficiency, while maintaining a single lift limits the amount of equipment time required for the operation of the sludge disposal facility.

Cover: Cover material is used to limit infiltration of water, and provide a physical barrier to limit fugitive ash emissions caused by wind. A 600mm thick layer of cover shall be used to close out the facility. Experience at other sites indicates that the ash consolidates well when wet and windblown ash has not been a problem. However, the community should assume that cover will need to be placed over the ash every time ash is placed into the facility for this evaluation.

Containment: A perimeter berm is required for containment and to limit the amount of surface water infiltration into the ash disposal facility. The berm will redirect surface runoff water around the ash disposal area rather than through it. The ash disposal facility would include a liner to provide containment of leachate. The facility would be graded to a corner where a sump and pump out would be installed to extract the leachate. The leachate could be used to wet the ash to reduce dusting in the landfill or in the ash storage areas in the incinerator building.

Specifically to the scrap metal/white goods and household hazardous waste disposal area, the following design elements will be incorporated.

Former Landfill Closure: The former landfill should be properly closed, and the closure plan could include levelling and covering the presently exposed waste. This will create a large flat area that will be suitable for industrial use.

Scrap Metal/Bulky Material Disposal Area: A designated area should be identified, delineated and marked for disposal of scrap metal, white goods and other bulky waste material. Material disposed in this location should be deposited in an orderly manner.

Household Hazardous Materials: The GN's Guideline for the General Management of Hazardous Waste excludes household hazardous wastes. However, these materials cannot be burned in the incinerator, and must be dealt with in some fashion. The GN has developed guidelines and policies that are potentially relevant to household hazardous wastes, waste antifreeze, waste batteries, waste paint and waste solvent, waste lead and fluorescent lamp tubes. Waste household hazardous wastes should be stored in a designated and marked area of the former landfill, in a manner that will prevent impact to the environment, e.g. in closed containers, protected from the weather.

The following design elements will be common to both disposal areas.

Fencing: The disposal areas should be contained within a perimeter fence. The fence will control or limit access to the area preventing access by animals and residents.

Signage: Signage will be located at the entrance of the facility to identify the ash disposal area (no solid waste) and the scrap metal/bulky waste and household hazardous waste disposal areas.

Monitoring: A monitoring system is required for the ash disposal facility and the closed landfill. The objective of the monitoring system is to collect data on surface water and groundwater quality to assess impacts to the environment. The monitoring system should yield water samples that:

1. Represent the background conditions of the site.
2. Represent the quality of runoff water from the Ash Disposal Facility and the closed landfill.

The monitoring of the ash disposal facility and scrap metal disposal facility will likely require separate monitoring points.

Given the design elements listed above it is anticipated that the following land requirements are necessary for each design period.

Design period	**Accumulated Ash Volume (m^3)**	**Land Requirement (m^2)**	**Estimated Cell Dimensions - outside berm (m)**
5 years	6,316	3,158	50 x 75
10 years	12,216	6,108	50 x 146
15 years	18,705	9,353	50 x 225

The proposed configuration of the ash disposal cell includes the capping of the existing solid waste disposal facility, re-use of the former landfill site for scrap metal/bulky waste and household hazardous materials and expansion to the east of the present site. Access to the ash disposal cell would be provided though separate access roads off the existing shoreline road. This access would be extended along the top of the berm to provide access to the sump pit for leachate extraction. A perimeter fence to control access would enclose the ash disposal area.

6.0 LANDFILL AND INCINERATOR COMPARISON

The previous sections have developed the rationale for the options. The options carried forward for assessment include:

- An incinerator at a new location (the existing land fill site is selected). The ash fill, hazardous waste storage, and bulky metal storage will be at the existing landfill.
- An incinerator in the existing building. The ash fill, hazardous waste storage, and bulky metal storage will be at the existing landfill.
- A landfill at the site selected by the community.

There is the option to have an incinerator, and a new site for the ash fill, hazardous waste storage, and bulky metal storage. This option would be a combination of the above incineration options and the proposed landfill option. The option of an incinerator and new ash fill is not carried forward at this time.

The table below shows the capital and operations cost estimates for each option.

Table 6.0-1: Capital and Life Cycle Costs for the Options

Cost item	Incinerator in Existing Building	Incinerator in New Building	Landfill
Capital Cost	$2,410,000	$2,410,000	3,099,000
(Building)	$0	$500,000	0
Contingency (20%)	$480,000	$580,000	$610,000
Incinerator Operations	$653,000	$653,000	0
Waste Collection	$240,000	$240,000	$240,000
Landfill Operations	0	0	$146,000
Life Cycle 4% at 15 years.	$9,928,000	$9,928,000	$4,291,000
Total Life Cycle	**$12,818,000**	**$13,418,000**	**$8,000,000**

The above table shows the most economical option for the waste disposal in Pangnirtung is the landfill option.

7.0 COMMUNITY FEEDBACK AND PREFERRED OPTION

The two options, landfill vs. incinerator, were presented to the Hamlet council at a meeting on July 31, 2007. The council provided the following observations on the waste disposal issue:

- A new landfill alone will not meet the long term needs of the community since windblown waste will eventually work its way down Pangnirtung Fiord and into the community, or will pollute the area around the new landfill location.
- A new incinerator alone will also not meet the community's needs since a portion of the waste generated annually will not be suitable for burning and will need to be stored somewhere.
- Providing a new landfill along with an incinerator is viewed as the only viable long term solution for the Hamlet.
- The Hamlet would like to see waste heat recovery or energy generation provided in conjunction with the incinerator.

A response to the Hamlet's request is developed in the following sections.

7.1. Incinerator Component

The community is interested in maximizing waste heat recovery from the incinerator. To this end, Dillon explored the possibility of configuring an incinerator with several smaller primary chambers connected to a common secondary chamber and APCD. This configuration would permit burning on a 24-hour basis. However, the multiple primary chamber configuration has several technical disadvantages that render it impractical including:

- Secondary chamber and air APCD are required to handle exhaust during the cool down phase as well as during the burn phase which makes sizing difficult;
- The isolation system and controls required to isolate and switch chambers will be highly engineered and somewhat experimental due to the harsh environment on the "hot side" of the incinerator. The capital cost of this piece of equipment alone would be high; and
- The increased technical complexity of a multiple primary burner configuration would not be appropriate for a remote community.

Therefore, the most appropriate incinerator option for the Hamlet of Pangnirtung is to use a standard incinerator sized for the community's maximum anticipated waste volume, equipped with a heat recovery system and APCD. Therefore, the Eco 9T described previously is the most appropriate incinerator for use in Pangnirtung.

Eco Waste recommends installing an air pollution control device when incinerators will be operating with heat recovery. Heat recovery systems reduce the temperature in the secondary burner to a level that is optimum for producing dioxins.

The heat recovery system will be associated with the APCD. An estimated 14.5 MM BTU/hr of heat (in the form of hot water) could be recovered from the system. The recovery will only occur during the incineration phase of the cycle.

Assuming an 8-hour burn time, 5 days a week, 50 weeks per year, the incinerator will generate 29,000 MM BTU/year. This heat is approximately equivalent to the heat energy in 207,000 gallons (780,000 L) of diesel fuel. At the current diesel price of $1.11 per litre, this amounts to a potential annual savings of $865,800.

In addition, an option for burning waste oil, glycol and some types of solvents has been included as a potential extra. The unit would be capable of processing up to 250 L per day of selected waste liquids (motor oils, transmission fluid, glycols, hydraulic fluids, lubricating oils and select solvents), and would add approximately $50,000 to the cost of the incinerator.

Two potential locations are suggested for the incinerator in order to take advantage of heat recovery: adjacent to the WWTP or in the area, near the power plant, east of the airport terminal building.

7.1.1. Incinerator Fuel Requirement

The incinerator will use approximately 470 gallons (1,780 L) of diesel per burn. Approximately 445,000 L of fuel will be required annually assuming 5 burns per week, 50 weeks per year. The current maximum fuel storage capacity at the Pangnirtung tank farm is 4,145,000 L. Presently, the hamlet uses approximately 3,800,000 L of diesel fuel annually, which leaves a maximum of 345,000 L.

Note the storage amounts do not account for the reality of supplying fuel to the community when the actual delivery date of the fuel can vary from year to year. This fuel requirement also does not take into account the potential fuel savings realized through waste heat recovery noted above.

Additional fuel storage capacity will need to be coordinated with the Petroleum Products Division of the GN if an incinerator is constructed.

7.2. Landfill Component

Section 5.0 describes the requirement for an Ash Monofill and bulky material disposal area. The Hamlet has identified the location described in Section 3.2 as the preferred location for the landfill component. Table 7.2-1 summarizes the capital costs associated with constructing an ash fill/bulky waste storage area at the proposed location. These costs are based upon the same assumptions as described in Section 3 above, but assume a smaller disposal area to account for the reduction in waste volume achieved with an incinerator.

Table 7.2-1: Estimated Capital Costs – Ash Fill/Bulky Materials Disposal

Item	Description	Units	Unit Price	Estimated Quantity	Unit total
1	Mobilization and Demobilization	Lump Sum	150000	1	$150,000
2	Road Works				
	Common Fill	m^3	35	41321.28	$1,446,245
	Road Surfacing Material	m^3	40	3973.2	$158,928
	Riprap	m^3	20	3973.2	$79,464
3	Culverts 500 mm	m^3	100	80	$8,000
4	Culverts 2000 mm	m^3	300	80	$24,000
5	Bridges (single lane)	m^2	2000	320	$640,000
6	Site grading	m^2	10	38,500	$385,000
7	Fence	lm	100	940	$94,000
8	Signs	each	5000	4	$20,000
9	Ditching	lm	30	940	$28,200
	Total				**$3,033,837**
	Contingency (20%)				**$607,000**
	Total				**$3,640,837**

7.3. Cost Estimate

Table 7.3-1 summarizes the estimated costs for the Hamlet's preferred option.

Table 7.3-1: Preferred Option Cost Estimate

Component	**Cost**
Incinerator	
Incinerator Capital Cost (includes BACT APCD, heat recovery system, waste oil burner and assumes a new building is constructed) + 20% Contingency	$2,898,000
Optional Liquid Waste Oxidizer	$50,000
Annual Cost for Quarterly Maintenance and Refresher Training Package (assume 1 year)	$34,000
Annual Cost for Semi-annual Maintenance and Refresher Training Package (assume 2 years after the first year)	$22,000
Annual Operating Costs	$643,000
Landfill	
Capital Cost (assuming new site, including access road construction) + 20% Contingency	$3,640,837
Annual Operating Cost	$146,000
Common Costs	

Annual Waste Collection	$240,000
Waste Heat Recovery Fuel Savings	
Savings – heating fuel requirement offset by waste heat recovery.	-$865,800
Total Capital Costs	$6,644,837
Total Annual Costs (Assuming the full value of the waste heat is realized)	$163,200
Life Cycle Cost (4% at 15 years)	**$8,459,295**

Note the difference in the life cycle cost calculated in Table 7-3.1 compared to the life cycle costs calculated in Table 6.0-1 results from the assumption that all the waste heat recovered from the incinerators will be used to displace diesel burned in boilers. The actual savings will depend on how much waste heat recovered from the incinerator can actually be used in place of heating diesel. The actual savings will become better developed through the design phases of the project.

APPENDIX A

Figures

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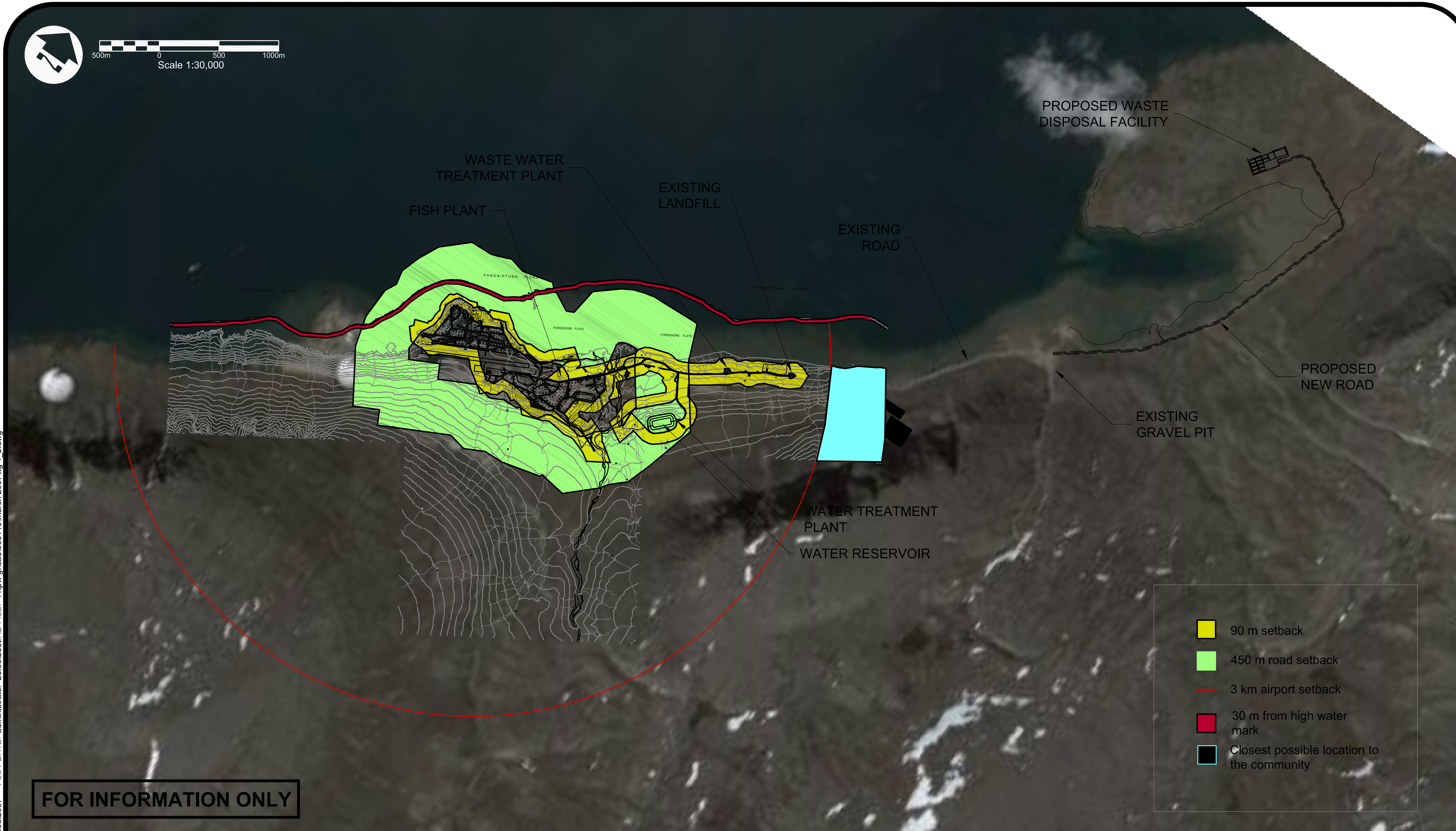


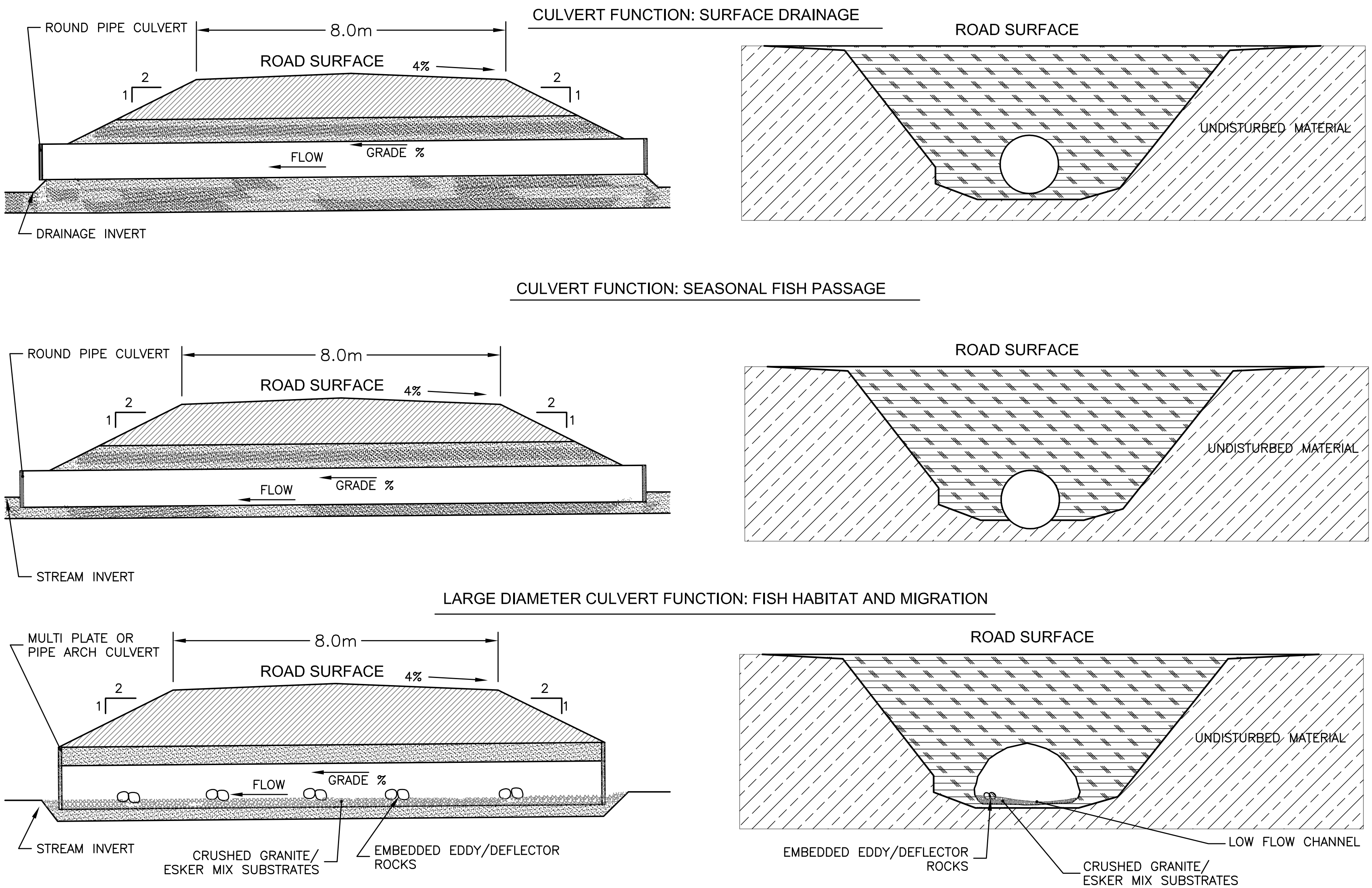
FOR INFORMATION ONLY

DILLON CONSULTING

PROJECT	Pangnirtung Solid Waste Disposal Facility	PROJECT NUMBER 06-6119
TITLE	Site Plan	DATE March 2007
		FIGURE NUMBER 1

DILLON CONSULTING

PROJECT	Pangnirtung Solid Waste Disposal Facility
TITLE	Road to Waste Disposal Facility
PROJECT NUMBER	06-6119-0100
DATE	March 2007
FIGURE NUMBER	2



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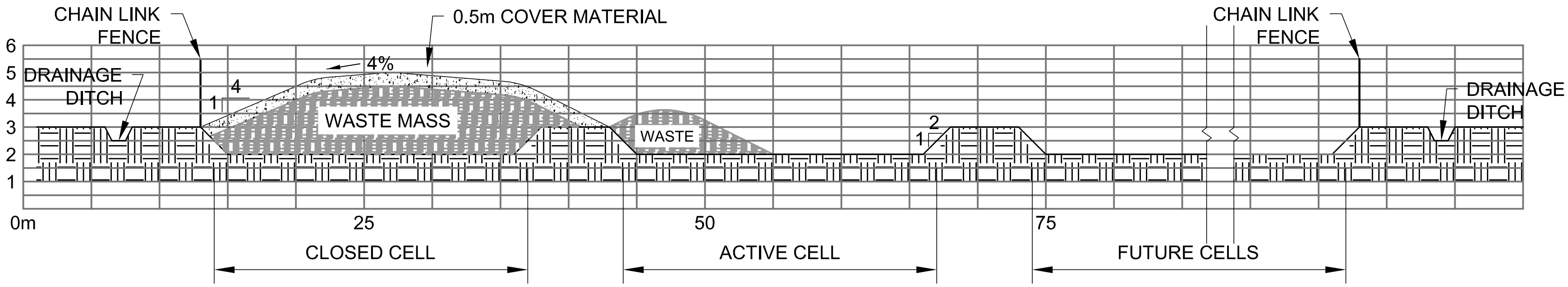
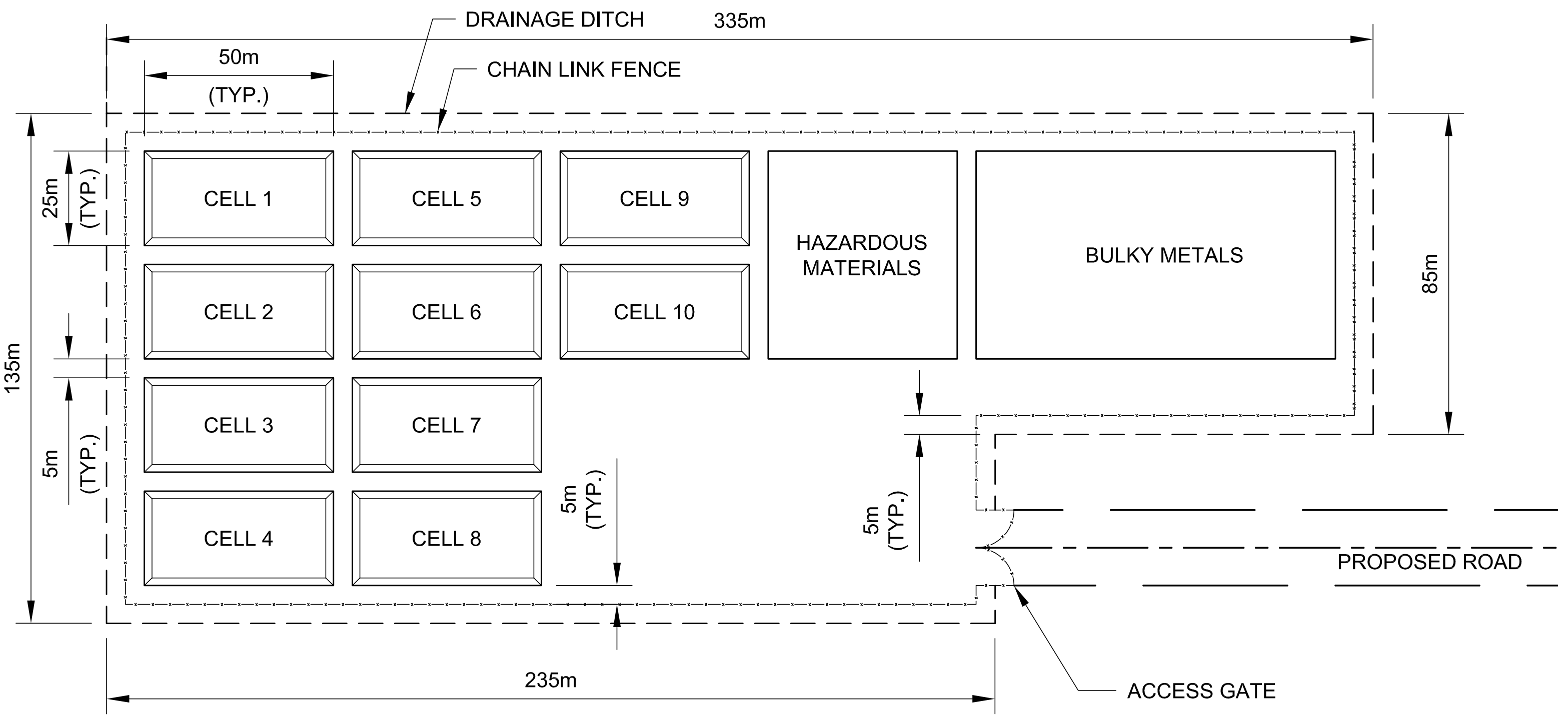
DILLON CONSULTING

PROJECT	Pangnirtung Solid Waste Disposal Facility
TITLE	Typical Culvert Details
PROJECT NUMBER	06-6119-0100
DATE	March 2007
FIGURE NUMBER	3

EDIT DATE: 23.03.2007 PLOT DATE: administrator 23.03.2007 CAD FILE: 41tpw g:\cad\066119\march 2007\fig 4.dwg



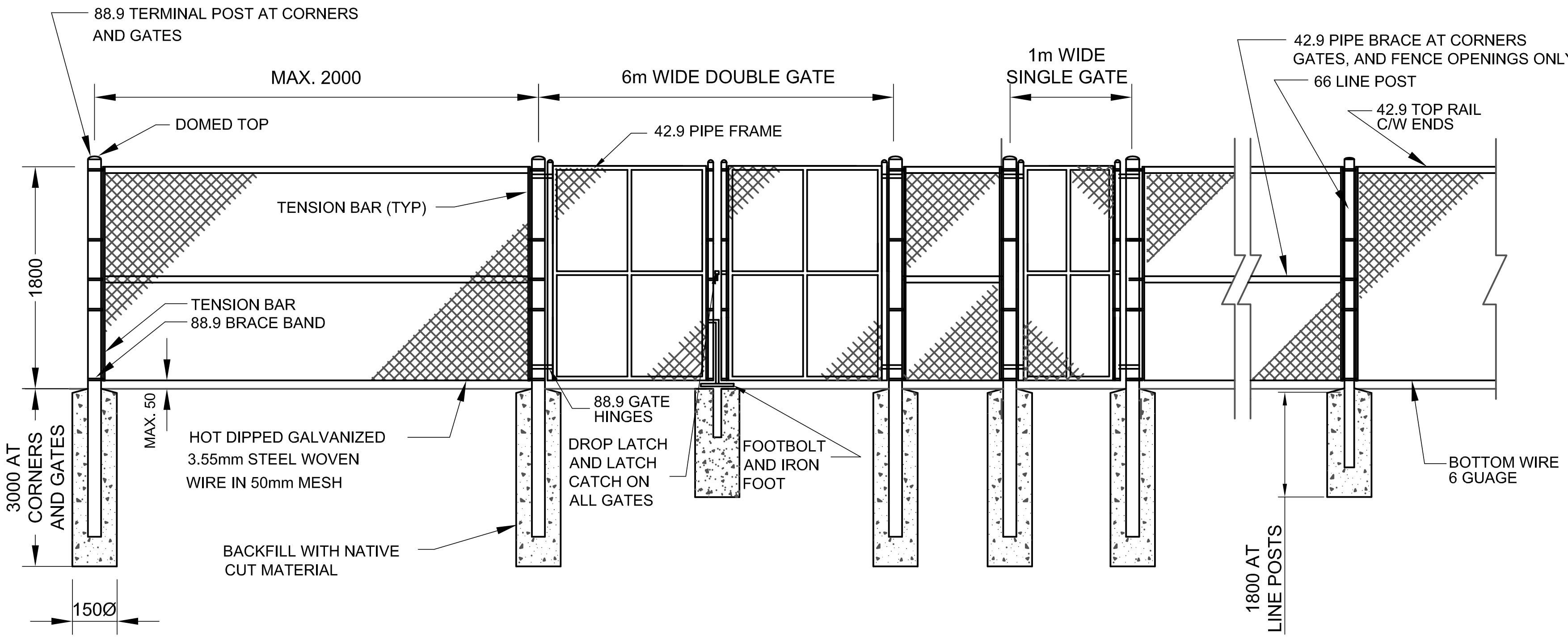
TYPICAL SECTION
SCALE:NTS



WASTE DISPOSAL FACILITY PLAN
SCALE: 1:2000

DILLON CONSULTING

PROJECT	Pangnirtung Solid Waste Disposal Facility
TITLE	Waste Disposal Facility Plan and Section
PROJECT NUMBER	06-6119-0100
DATE	March 2007
FIGURE NUMBER	4



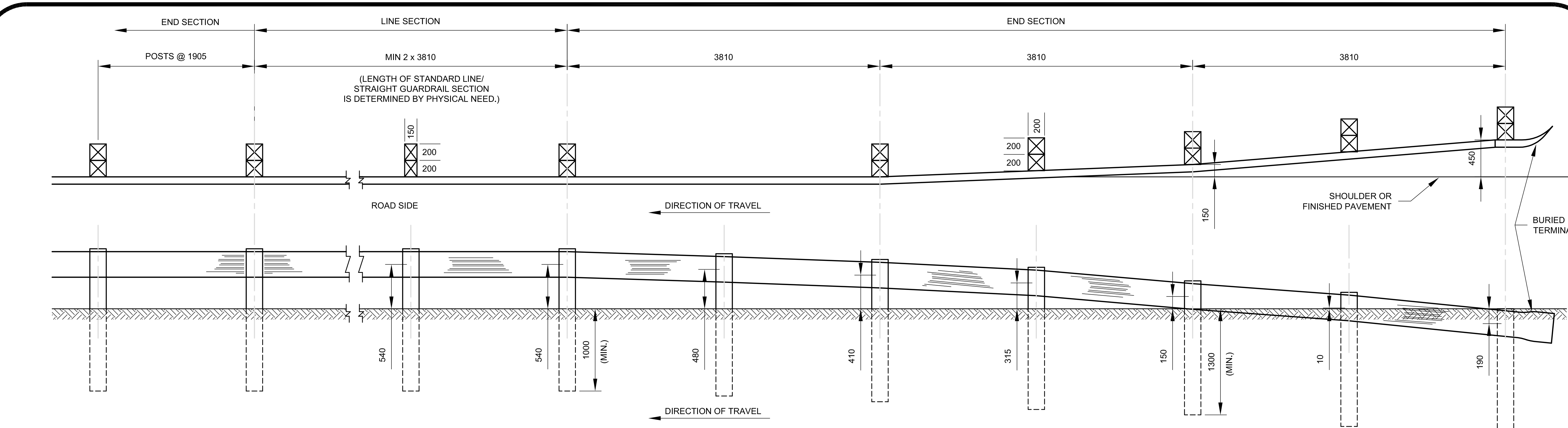
CHAIN LINK FENCE DETAIL

NOT TO SCALE

DILLON CONSULTING

PROJECT	Pangnirtung Solid Waste Disposal Facility
TITLE	Typical Fence Details
PROJECT NUMBER	06-6119-0100
DATE	March 2007
FIGURE NUMBER	5

EDIT DATE: 09/13/04 ACAD FILE: 41tpw g:\cad\043584\fig5_guardrail.dwg



GUARDRAIL DETAIL
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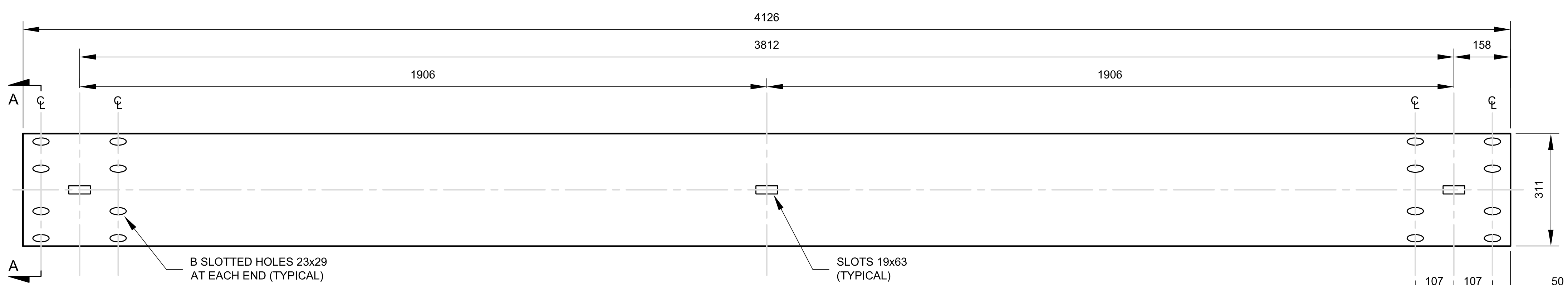

FRONT ELEVATION OF STANDARD STRAIGHT SECTION - (BEAM)
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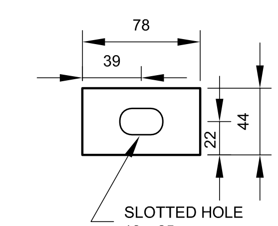

RECTANGULAR WASHER
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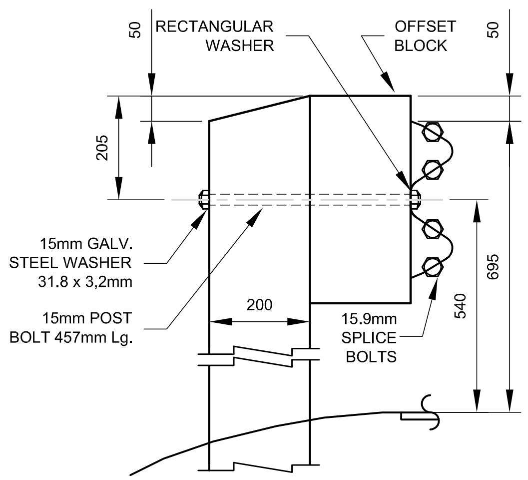
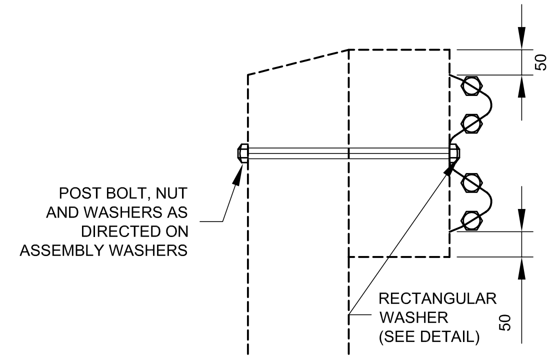


POST DETAIL
SCALE: 1:15



ARRANGEMENT AT POST
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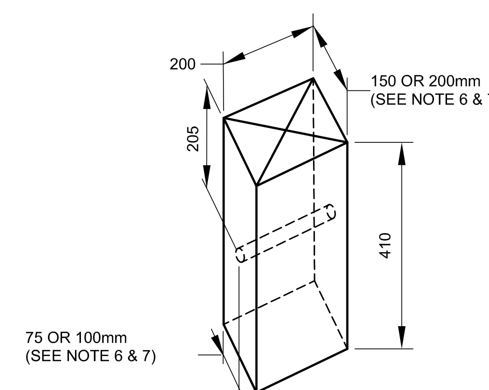

OFFSET BLOCK DETAIL
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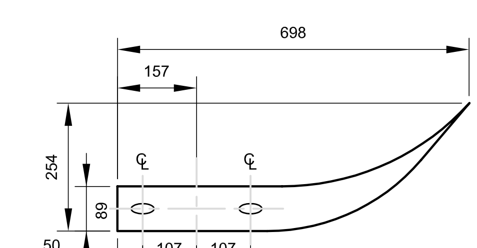

STANDARD WING TERMINAL SECTION
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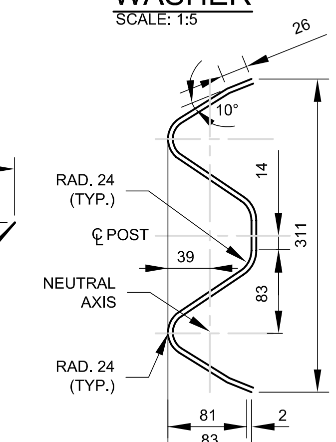


SECTION A-A
SCALE: 1:7.5

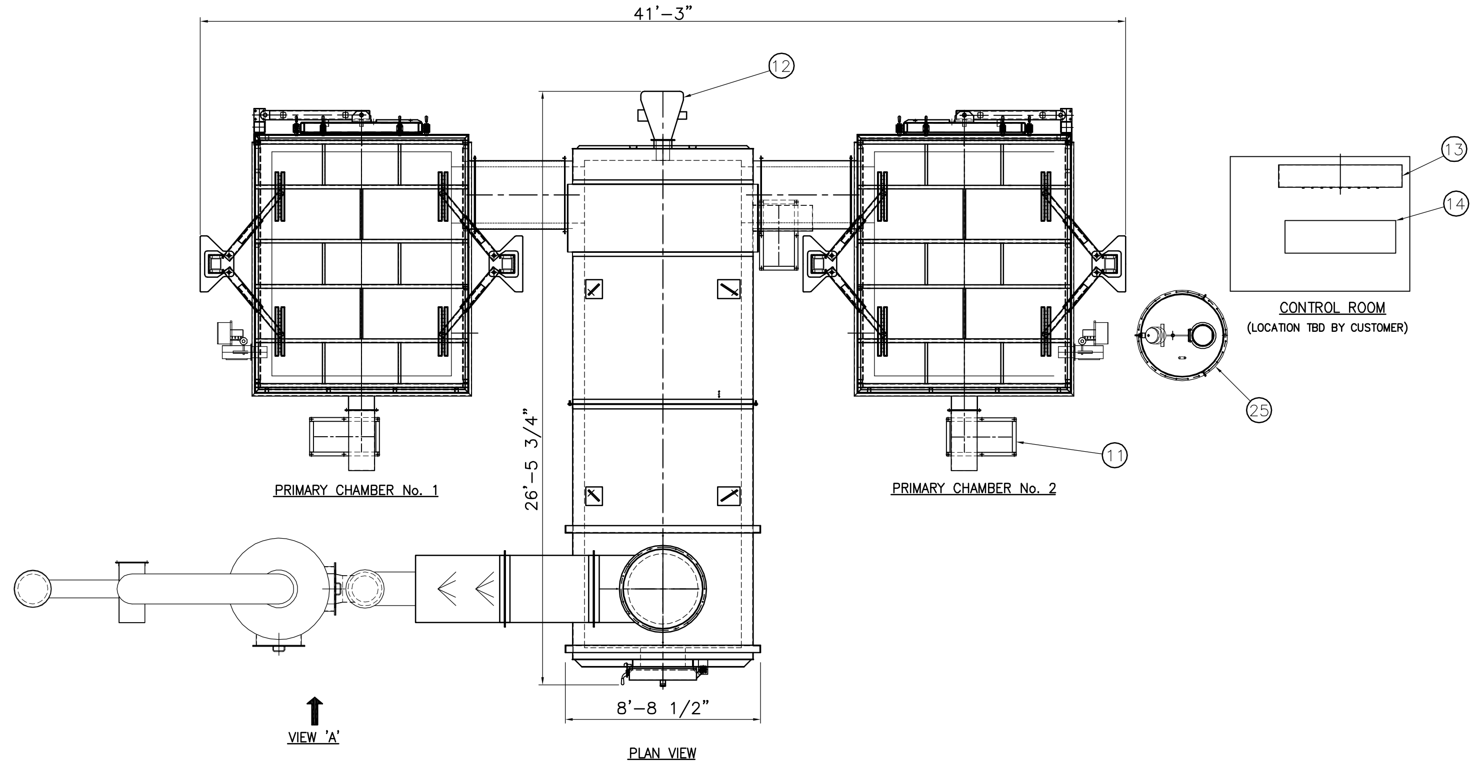
NOTES

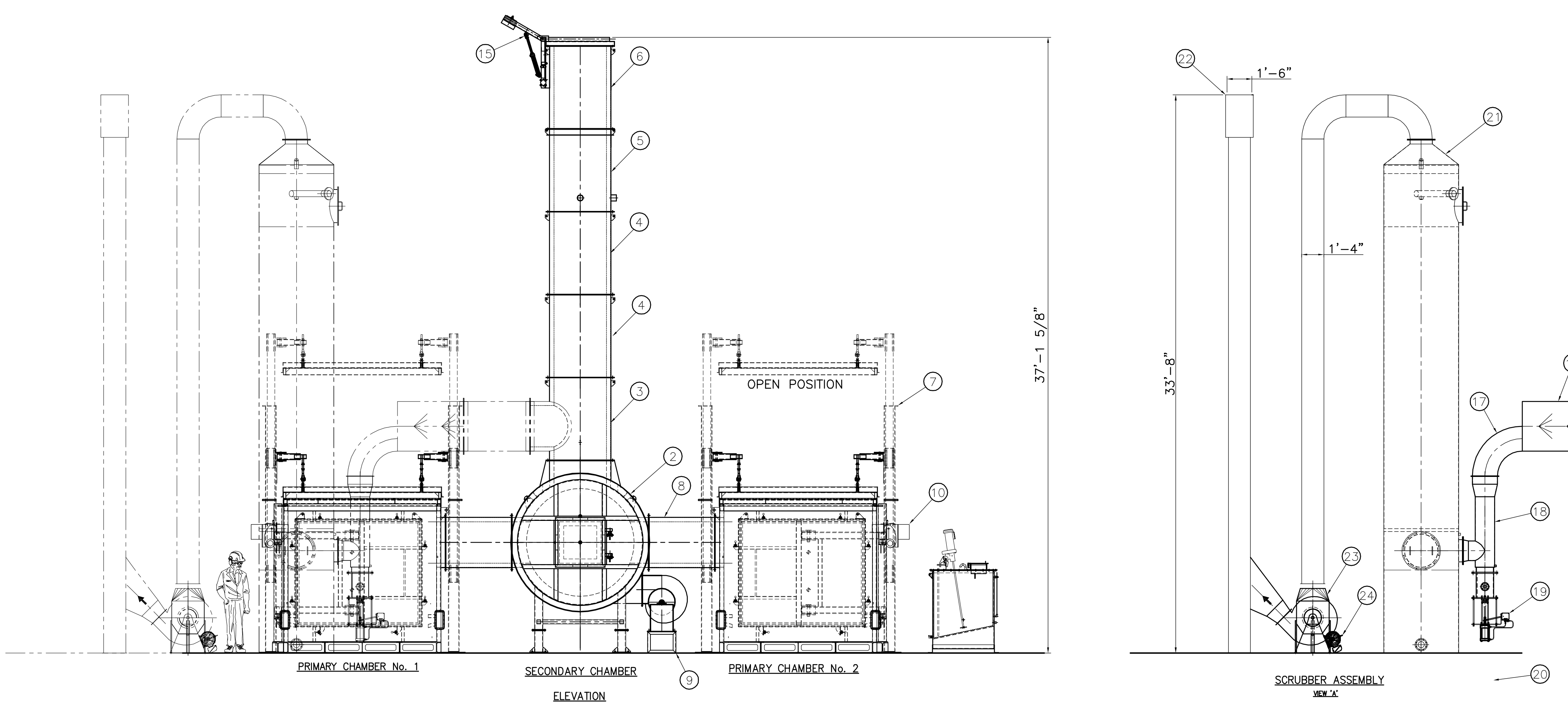
1. THICKNESS OF RAIL TO BE 2.8mm, THICKNESS OF RECTANGULAR WASHER TO BE 4.0mm.
2. ALL DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES UNLESS OTHERWISE INDICATED.
3. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED
4. ALL MEASUREMENTS IN MILLIMETERS
5. END POSTS TO 200mm x 200mm
6. LINE POSTS 150mm x 200mm.
7. OFFSET BLOCKS FOR END POSTS 200mm x 200mm x 410mm.
8. OFFSET BLOCKS FOR END POSTS 150mm x 200mm x 410mm.
9. ALL JOINTS TO BE LAPPED IN THE DIRECTION OF TRAFFIC.
10. BURIED TERMINALS ARE TO BE USED AT BOTH ENDS OF THE GUARDRAIL.

DILLON CONSULTING

PROJECT	Pangnirtung Solid Waste Disposal Facility
TITLE	Guardrail Detail
PROJECT NUMBER	06-6119-0100
DATE	March 2007
FIGURE NUMBER	6

PRIMARY CHAMBER (INTERIOR DIMENSIONS)
WIDTH = 8' LENGTH = 10' HEIGHT = 6' 6"
SECONDARY CHAMBER (INTERIOR DIMENSIONS)
7' I.D. LENGTH (BREECH to STACK) = 17' 4"
BREECH = 30" I.D.
STACK = 38" I.D.





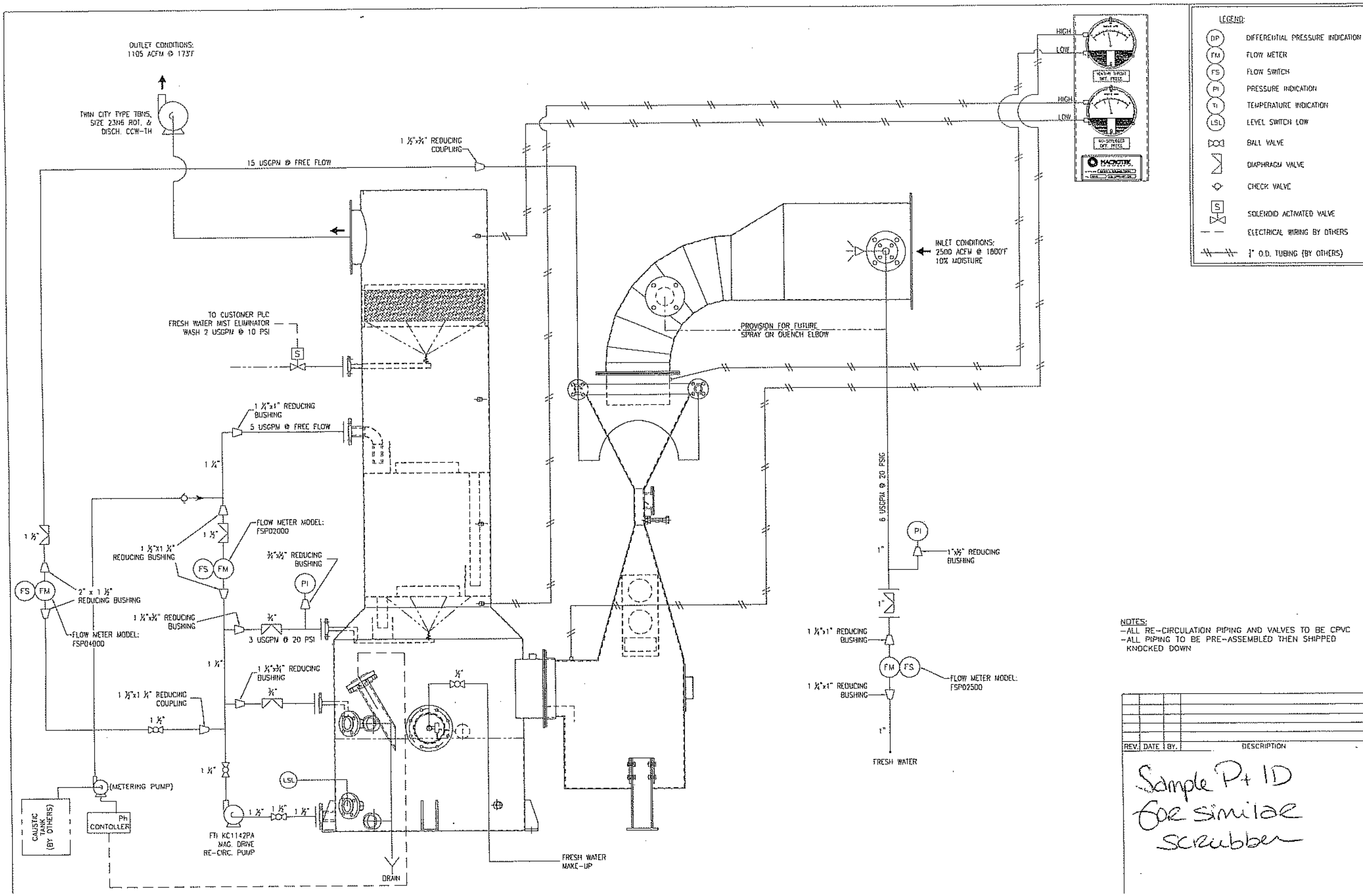
BILL OF MATERIAL			
ITM.	QTY.	DESCRIPTION	PART #
1	2	PRIMARY CHAMBER	0.00
2	1	SECONDARY CHAMBER	0.00
3	1	T-STACK (BAROMETRIC DAMPER)	0.00
4	2	STACK SECTION	0.00
5	1	STACK SECTION (GUY WIRE ATTACHMENT)	0.00
6	1	TOP STACK SECTION	0.00
7	2	LID LIFTER	0.00
8	2	BREECH SECTION	0.00
9	1	SECONDARY BLOWER	0.00
10	2	PRIMARY BURNER	0.00
11	2	PRIMARY BLOWER	0.00
12	1	SECONDARY BURNER	0.00
13	1	CONTROL PANEL	0.00
14	1	OPERATOR WORKSTATION	0.00
15	1	STACK CAP	0.00
16	1	HORIZONTAL QUENCH VESSEL 36"ø AL6XN	0.00
17	1	QUENCH ELBOW & TRANSITION 24"ø AL6XN	0.00
18	1	MVA ANNULAR DISC VENTURI SCRUBBER AL6XN	0.00
19	1	PNEUMATIC ACTUATOR /w 4-20mA ELECTRO PNEUMATIC	0.00
20	1	NOT SHOWN (HEAT EXCHANGER)	0.00
21	1	MP-48-10 PACKED TOWER SCRUBBER 48"ø FRP	0.00
22	1	EXHAUST STACK 16"ø 316L SS	0.00
23	1	EXHAUST BLOWER	0.00
24	1	RE-CIRCULATION PUMP	0.00
25	1	LIQUID WASTE TANK	0.00

REV.	DATE	DESCRIPTION	BY	APPROVED
0	APR.12.06	FOR PROPOSAL	J.S.	S.M.

DRAWN: J.S. DATE: APR.12.06
CHECKED: S.M. DATE: APR.12.06

ECO WASTE SOLUTIONS
ECO BURN INC.

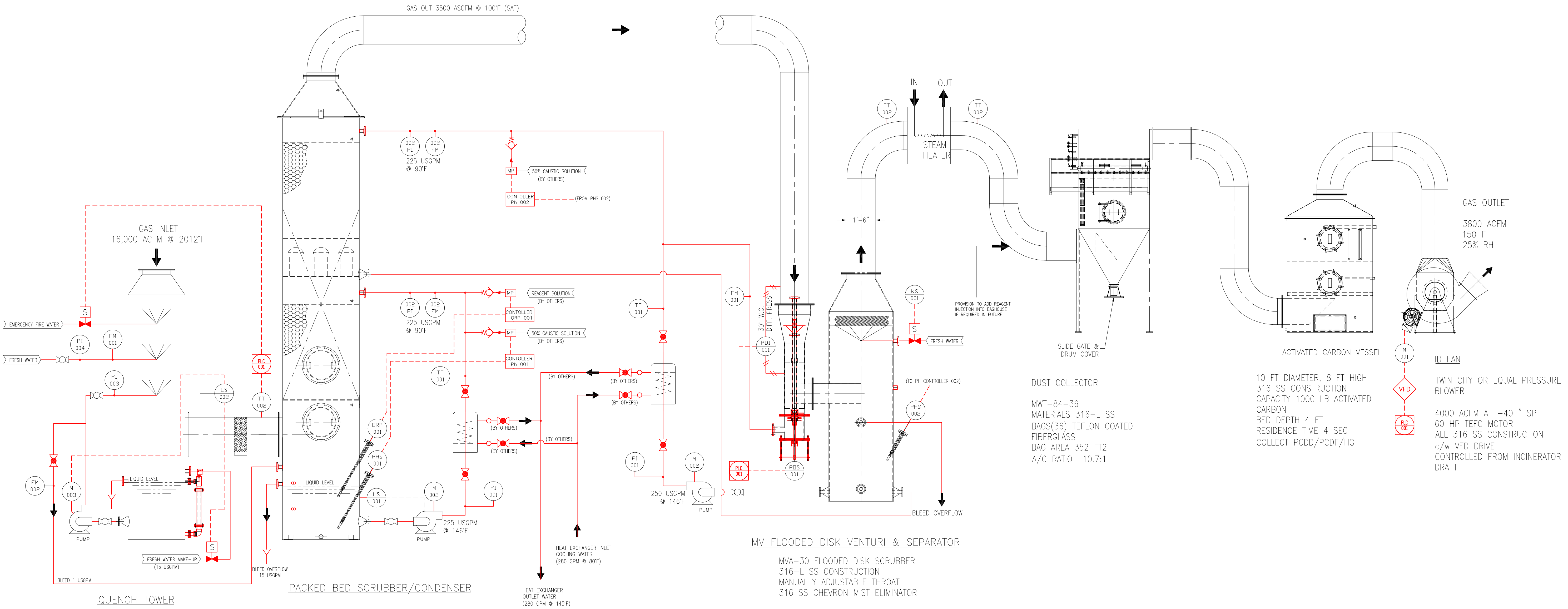
PROJECT NAME: BARRIALES
CUSTOMER P.O.: N/A
PROJECT NUMBER: N/A
CUSTOMER EQUIPMENT. #: N/A
SCALE: 1/4" = 1'-0"
JOB NO.: N/A
TITLE: BARRIALES 3.5 TONNE WASTE OXIDIZER GENERAL ARRANGEMENT
P.1_OF_1
THIRD ANGLE
DWG. NO.: 3.5 TN-2P-VS
REV.: 0



NOTES:
- ALL RE-CIRCULATION PIPING AND VALVES TO BE CPVC
- ALL PIPING TO BE PRE-ASSEMBLED THEN SHIPPED KNOCKED DOWN

REV.	DATE	BY.	DESCRIPTION

Sample P+ID
for similar
scrubber



QUENCH TOWER

HASTELLOY 'C' CONSTRUCTION
36" DIAMETER, 10 FT HIGH
HASTELLOY NOZZLES (2)
CPVC PIPING
FYBROK FRP PUMP, CAPACITY 50 USGPM
2 HP TEFC MOTOR
EVAPORATION 13.5 USGPM
BLEED 1 USGPM
MAKEUP WATER 14.5 USGPM

PACKED BED SCRUBBER/CONDENSER

MP-48-5 (2) STAGES PACKED BED SCRUBBER
316-L CONSTRUCTION
GLASS FILLED POLYPROPYLENE PACKING
SUB-COOL GAS TO 100F
CONDENSE 14.2 USGPM
OVERFLOW 15.2 USGPM
PUMP: GOULD 3196 316 SS ANSI
430 USGPM AT 100 FT HEAD
C/W 30 HP TEFC MOTOR
ALPHA LAVAL HEAT EXCHANGER, PLATE AND FRAME TYPE
TITANIUM PLATES
8.5 MILLION BTU/HR CAPACITY
PH CONTROL SYSTEM, CAUSTIC ADDITION

MV FLOODED DISK VENTURI & SEPARATOR

MVA-30 FLOODED DISK SCRUBBER
316-L SS CONSTRUCTION
MANUALLY ADJUSTABLE THROAT
316 SS CHEVRON MIST ELIMINATOR

SET TO OPERATE AT 30" W.C. THROAT DP

STEAM COIL REHEAT AFTER SEPARATOR
18,000 BTU/HR DUTY
STEAM AT 15 PSIG
STEAM VALVE MODULATED BY OUTLET TEMPERATURE

DUST COLLECTOR

MWT-84-36
MATERIALS 316-L SS
BAGS(36) TEFLON COATED FIBERGLASS
BAG AREA 352 FT2
A/C RATIO 10.7:1

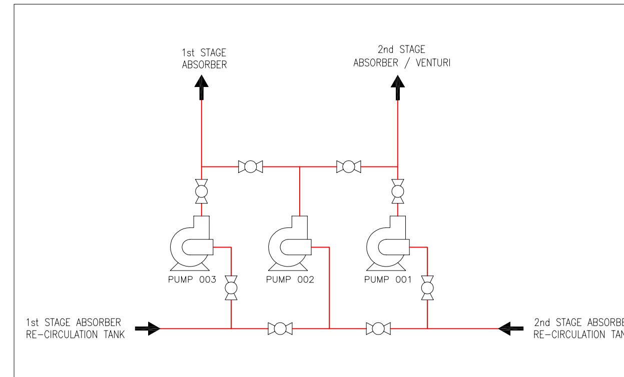
ACTIVATED CARBON VESSEL

10 FT DIAMETER, 8 FT HIGH
316 SS CONSTRUCTION
CAPACITY 1000 LB ACTIVATED CARBON
BED DEPTH 4 FT
RESIDENCE TIME 4 SEC
COLLECT PCDD/PCDF/HG

ID FAN

TWIN CITY OR EQUAL PRESSURE BLOWER

4000 ACFM AT -40 " SP
60 HP TEFC MOTOR
ALL 316 SS CONSTRUCTION
c/w VFD DRIVE
CONTROLLED FROM INCINERATOR DRAFT



SCHEMATIC SHOWING OPTION
FOR BACK-UP PUMP
MANUAL SWITCHING

REV.	DATE	BY.	DESCRIPTION

MACROTEK

CUSTOMER REFERENCE	CAMECO CORPORATION
	PROCESS FLOW DRAWING
PROJECT	INCINERATOR UPGRADE PROJECT

DATE	9/02/05	SCALE	N.T.S.	DRAWING NO.	REV.
DRAWN BY:	M.M.	CH'KD BY:	P.R.	25-019-200	3

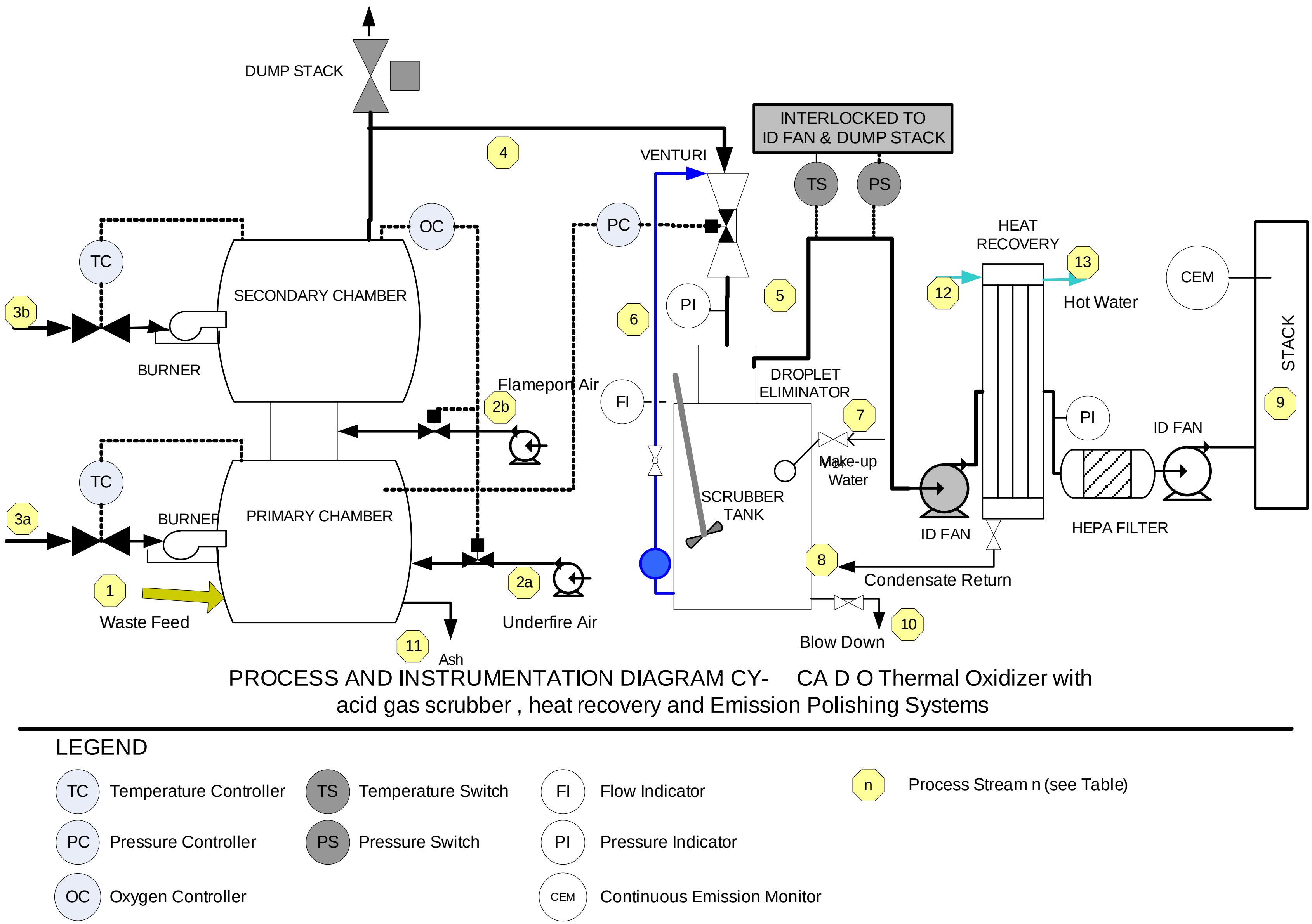


Figure 10: Westland Environmental Services Inc., Typical Incinerator Process Schematic

APPENDIX B

Photographs

LOOKING NORTH TOWARDS SITE FROM MOUNT DUVAL
PROPOSED SITE IN PHOTO CENTER

DILLON CONSULTING	PROJECT	PANGNIRTUNG SOLID WASTE DISPOSAL FACILITY	PROJECT NO. 06-6119-5000
DATE MARCH 2007	TITLE	PHOTO PLATE 1 - SITE OVERVIEW	FIGURE NO. 1

FileName:g:\cad\066119\photoplates.dwg

SMALL DRAINAGES ONTO TIDAL FLATS

DRAINAGES ONTO TIDAL FLATS

DRAINAGES ONTO TIDAL FLATS

GRAVEL PIT LOOKING NORTH

DILLON CONSULTING	PROJECT: PANGNIRTUNG SOLID WASTE DISPOSAL FACILITY	PROJECT NO. 06-6119-5000
DATE: MARCH 2007	TITLE: PHOTO PLATE 2 - ACCESS ROAD	FIGURE NO. 2

FileName:g:\cad\066119\photoplates.dwg

GRAVEL PIT WHERE LARGE DRAINAGE FROM
NORTH SIDE OF MT. DUVAL ENTERS OCEAN

LARGE DRAINAGE ONTO TIDAL FLATS
NORTH SIDE OF MT. DUVAL

ACCESS ROAD ROUTE

LARGE DRAINAGE ONTO TIDAL FLATS

LOOKING SOUTH ALONG ACCESS ROAD ROUTE

DILLON CONSULTING	PROJECT PANGNIRTUNG SOLID WASTE DISPOSAL FACILITY	PROJECT NO. 06-6119-5000
DATE MARCH 2007	TITLE PHOTO PLATE 3 - ACCESS ROAD	FIGURE NO. 3

FileName:g:\cad\066119\photoplates.dwg

LARGE DRAINAGE ONTO TIDAL FLATS

DILLON CONSULTING	PROJECT	PANGNIRTUNG SOLID WASTE DISPOSAL FACILITY	PROJECT NO. 06-6119-5000
DATE MARCH 2007	TITLE	PHOTO PLATE 4 - OLD INCINERATOR BUILDING	FIGURE NO. 4

FileName:g:\cad\066119\photoplates.dwg

DILLON CONSULTING

DATE MARCH 2007

PROJECT **PANGNIRTUNG SOLID WASTE DISPOSAL FACILITY**

PROJECT NO. **06-6119-5000**

TITLE **PHOTO PLATE 5 - PROPOSED SITE**

FIGURE NO. **5**

FileName:g:\cad\066119\photoplates.dwg


PROPOSED SITE LOOKING WEST


PROPOSED SITE LOOKING SOUTH


EAST OF PROPOSED SITE
LOW WET AREA LOOKING SOUTH


PROPOSED SITE LOOKING THROUGH GAP TOWARDS TOWN

DILLON CONSULTING	PROJECT: PANGNIRTUNG SOLID WASTE DISPOSAL FACILITY	PROJECT NO. 06-6119-5000
DATE: MARCH 2007	TITLE: PHOTO PLATE 6 - PROPOSED SITE	FIGURE NO. 6

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APPENDIX C

Detailed Volume Calculations

Hamlet of Pangnirtung - Detailed Solid Waste Calculations

Year	Population	Estimated. SW Volume, Uncompacted (m^3/day)	Estimated SW Mass (tonnes/day)	Estimated SW Volume Compacted (m^3/day)	Current Estimated Sludge Generation Rate (m3/day)	Proposed Sludge Generation Rate (m^3/day)	Combined Uncompacted SW and Sludge (m^3/day)	Combined Uncompacted SW and Sludge (tonnes/day)	Compacted SW, Current Sludge and Fish Waste (m^3/year)	Cumulative (m^3)	Compacted SW, Proposed Sludge and Fish Waste (m^3/year)	Cumulative (m^3)
2000	1506	22.59	4.52	7.53	0.64	0.87	23.23	4.65	3211		3295	
2001	1539	23.09	4.62	7.70	0.65	0.89	23.74	4.75	3276		3362	
2002	1575	23.63	4.73	7.88	0.67	0.91	24.29	4.86	3348		3436	
2003	1613	24.20	4.84	8.07	0.68	0.93	24.88	4.98	3423		3513	
2004	1651	24.77	4.95	8.26	0.70	0.95	25.46	5.09	3498		3590	
2005	1687	25.31	5.06	8.44	0.71	0.97	26.02	5.20	3569		3663	
2006	1722	25.83	5.17	8.61	0.73	0.99	26.56	5.31	3639		3735	
2007	1756	26.34	5.27	8.78	0.74	1.01	27.08	5.42	3706	3706	3804	3804
2008	1792	26.88	5.38	8.96	0.76	1.03	27.64	5.53	3777	7483	3877	7681
2009	1831	27.47	5.49	9.16	0.77	1.05	28.24	5.65	3854	11337	3957	11638
2010	1870	28.05	5.61	9.35	0.79	1.08	28.84	5.77	3931	15269	4036	15673
2011	1905	28.58	5.72	9.53	0.81	1.10	29.38	5.88	4001	19269	4107	19781
2012	1955	29.33	5.87	9.78	0.83	1.13	30.15	6.03	4100	23369	4209	23989
2013	1995	29.93	5.99	9.98	0.84	1.15	30.77	6.15	4179	27548	4290	28280
2014	2032	30.48	6.10	10.16	0.86	1.17	31.34	6.27	4252	31800	4366	32645
2015	2074	31.11	6.22	10.37	0.88	1.19	31.99	6.40	4335	36135	4451	37096
2016	2117	31.76	6.35	10.59	0.90	1.22	32.65	6.53	4420	40556	4539	41635
2017	2160	32.40	6.48	10.80	0.91	1.24	33.31	6.66	4505	45061	4626	46261
2018	2202	33.03	6.61	11.01	0.93	1.27	33.96	6.79	4589	49650	4712	50973
2019	2243	33.65	6.73	11.22	0.95	1.29	34.59	6.92	4670	54320	4795	55768
2020	2280	34.20	6.84	11.40	0.96	1.31	35.16	7.03	4743	59063	4870	60638
2021	2323	34.84	6.97	11.61	0.98	1.34	35.82	7.16	4828	63890	4957	65596
2022	2366	35.50	7.10	11.83	1.00	1.36	36.50	7.30	4914	68804	5046	70642
2023	2411	36.16	7.23	12.05	1.02	1.39	37.18	7.44	5002	73806	5136	75778
2024	2456	36.84	7.37	12.28	1.04	1.41	37.88	7.58	5091	78897	5228	81007
2025	2502	37.53	7.51	12.51	1.06	1.44	38.59	7.72	5183	84080	5322	86329

Assumptions: Uncompacted Waste Generation rate: 0.015 m^3/person/day
Compaction Rate: 3:1
Waste Volume: 0.005 m^3/person/day
Fish waste generation: 230 m^3/year

APPENDIX D

Selected Manufacturer's Information

ECO WASTE SOLUTIONS

Clean Burning Solutions

Product Spotlight

ECO Model

technical description

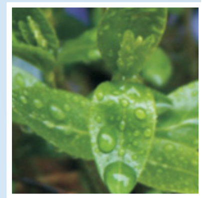
Two Stage Process: 1st stage (Primary Chamber) burns waste and produces inert ash and combustible gases. 2nd stage Afterburner (Secondary Chamber) re-burns gases and renders them safe for exhaust.
Cycle Time: 8-12 hours for oxidation, 6-10 hours for cool down and 1 hour for ash cleanout and reload. 24 hours per batch.
Controls: Integrated control panel complete with programmable logic control, supervisory control, monitoring, data acquisition and remote diagnostic capability with PC computer via modem.
Operating Environment: Inside a building or protected from the weather. Weather proofing options available.
Loading Options: Top or front load, integrated cart tipper, conveyor or manual.
Other Options: Air Pollution Control (APC) Scrubbers, Continuous Emissions Monitors (CEMs)
Warranty: 1 year after start-up on defective parts or workmanship.

technical specifications

External Casing/Finish: 1/4" (0.6 cm) mild steel, sandblasted and coated with rust inhibiting and heat resistant paint.
Burners: Electronic auto spark, packaged industrial burners, secondary burners modulate.
Fuel Supply Options: Diesel, Fuel Oil, JP8, Natural Gas, Arctic Diesel, Propane. Auxiliary waste oil burners can be added.
Operating Temperatures:
Primary Chamber: 1200°F (650°C) - 1560°F (850°C)
Afterburner: 1832°F (1000°C), with a 1.5 - 2 second retention time.
Power: Typically 3 phase, 110/220 V, 60 Hz. Other power supply options available.

advantages

- Sized to meet your needs
- Reduces waste volumes by over 90%
- Smokeless and odourless
- Automatic process control
- Low operating and maintenance costs
- Once per day load and clean-out



acceptable waste streams

Community Waste
Camp Waste
Biomedical Waste
Industrial Waste

capacities

ECO Models	Waste Capacity	
	Domestic	Biomedical
Minimum	1 ton/day	1 ton/day
Maximum	10 tons/day	8 tons/day

- Each system is designed for specific waste composition, density, volume, and weight within the range stated above.
- Configuration can include 1 Primary Chamber or 2 Primary Chambers

ECO WASTE SOLUTIONS
5195 Harvester Road - Unit 6
Burlington, ON Canada L7L 6E9
T 905.634.7022
F 905.634.0831
info@ecosolutions.com
www.ecosolutions.com

ECO WASTE SOLUTIONS

Remote Community **Waste Solution**

Cree Nation of Wemindji
Wemindji, Quebec, Canada

the challenge

Like most communities in Northern Canada, the Cree Nation of Wemindji had to balance the need to protect the environment and the need to manage their community's waste.

The Cree Nation of Wemindji (James Bay Region of Quebec) is a thriving community of 1200. Despite its remote location, it boasts shopping, restaurants, entertainment, eco-tourism and sports. Wemindji is a modern community with a high standard of living. The existing landfill site was over capacity and required periodic open-burning to contain the waste. An extensive search for a new site had determined that very little land was suitable for landfilling. Studies had concluded that once the new site was at capacity the next site location would require waste to be trucked over 50 km from the community. □

our solution

Through extensive research it was determined that Eco Waste Solutions technology was the suitable choice to tackle the waste in Wemindji.

To eliminate environmental impacts from long distance hauling and threats to water and air from leaching garbage and open burning, an alternative was needed. Wemindji commissioned the help of an engineering consultant who gathered expert opinions on environmentally safe incineration. Through their research, the **Eco Waste Oxidizer (ECO Model)** was deemed to be the technology of choice. Technical capabilities of the equipment, customer references and air emissions data were all key decision criteria. □

the results

Total Waste Management Solution

The Eco Waste Oxidizer system processes all of the solid non-hazardous waste generated by the community. □

Environmental Protection

Remaining ash is safe for in-trench disposal. Opening numerous landfills at a distance, producing potentially toxic leachate and the need to open burn has been eliminated. Local air quality has been visibly improved. □

project information

Location:	Wemindji, Quebec Canada
Model:	ECO 3T
Capacity:	3 tonnes per day
Waste Type:	Community Waste
Installation:	2003

ECO WASTE SOLUTIONS □ 5195 Harvester Road - Unit 6 Burlington, ON Canada L7L 6E9 □ T 905.634.7022 F 905.634.0831 □ info@ecosolutions.com www.ecosolutions.com

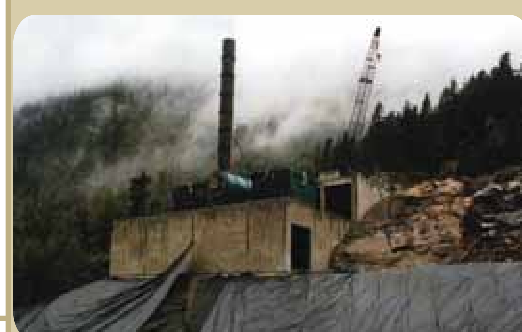
ECO WASTE SOLUTIONS

Remote Community **Waste Solution**

the challenge

Skagway is a key tourist destination for cruise ships making their way along the coast of Alaska each summer. In 1997 the existing landfill in Skagway had only two years remaining before it reached capacity.

In 1997 Skagway had a population of only 800. Each day the community had over 5,000 passengers visit from various cruise lines. The community was unable to accommodate the waste generated from the ships that visited each day as well as the waste created by their community. In this pristine mountainous region, little suitable land was available for the creation of a new landfill. Skagway needed an environmentally responsible solution to address waste produced in the community. ☐



our solution

City council and citizens reviewed their waste disposal options and agreed that Eco Waste Solutions was the best alternative.

The **Eco Waste Oxidizer (ECO Model)** is capable of handling all of the waste produced by the community as well as the additional waste created by the cruise ship passengers. The smokeless and odourless operation of the system allowed for it to be located a mere six miles up the Klondike Highway along the picturesque White Pass Railway. ☐

the results

Cost Reduction

The city owns a sustainable long-term waste disposal option that is less costly than opening new landfills. ☐

Revenue Generation

A contract to dispose of waste from the cruise ships is a revenue source that subsidizes the cost of the operation. ☐

project information

Location:	City of Skagway, Alaska
Model:	ECO 8T
Capacity:	8 tons per day
Waste Type:	Community Waste
Installation:	1998

ECO WASTE SOLUTIONS ☐ 5195 Harvester Road - Unit 6
Burlington, ON Canada L7L 6E9 ☐ T 905.634.7022
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www.ecosolutions.com

DOUBLE CHAMBER CYCLONATOR INCINERATOR

SERIES CY-50-CA

WESTLAND ENVIRONMENTAL SERVICES INC.
www.westlandenvironmental.com

CY-50-CA "D"

- **Built In Safety Features**
- **Surpasses Clean Air Guidelines in Most Areas**
- **Economical Operation**
- **Controlled Air Supply**
- **Stacked Secondary Chamber**

Designed to be used in Permanent Locations for Types I, II, & III Wastes

Capacity
.6 m3, 64 kg per hour
Type No. 1, 2, & 3 waste.

Power Requirements
115 volts 60 cycle single phase

Stack
Stainless Steel
- 14 gauge
- 33 cm diameter
- 3 m high
- c/w stainless steel spark arrester

Casing
12 gauge steel
Lining: high heat duty castable refractory
Over high temperature insulation.

Hearth
Refractory hearth over 6.35 mm steel base.

Doors
6.35 mm steel plate c/w heavy duty blade latch.
Charging: - 46 cm x 61 cm clear opening
- Refractory lined over steel plate

Ash: - 46 cm x 30 cm clear opening
- Refractory lined over steel plate

Air Supply - Adjustable
Forced air fan c/w ducts to primary air jets and to secondary over-fire air jets.

Timers - Adjustable
Cycle timers interconnected to air supply fan and gun type burners enclosed in burner housings.

Burners
455,000 BTU, gun type Primary burner. Gun burner enclosed in protective plate steel housing. 325,000 BTU in secondary chamber.

Fuel Supply: Oil Fired Unit Only
1350 liter fuel storage tank c/w filter and Flexible hose type connection.

Transporter
Incinerator mounted on skid type frame 1.8 m long x 1.5 m wide.

Height
3.9 m tall, with stack folded.
Constructed of W150 I Beam c/w bumper posts.

Weight
3000 kg. (6613 Lbs.)

Options
* LPG Fired burners
* Diesel Fired burners
* 2.3 m Electric power cord
* Temp. controllers in Primary and Secondary chambers.

NOTE: Some waste streams may require the use of waste gas scrubbers.

MANUFACTURED BY:

WESTLAND
Environmental Services Inc.
20204 – 110 Avenue, Edmonton, AB Canada T5S 1X8
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E-MAIL info@westlandenvironmental.com

DISTRIBUTED BY:

What and For Whom ...

This course has been adapted from those developed by the U.S. EPA for certifying operators of hospital and municipal waste incinerators. Westland's experience has been added to include recent developments and the Canadian scenario.

It is designed to give the participants a sound knowledge of the principles of combustion and air pollution control, familiarity with basic design and operational features of incinerator systems, and a good understanding of regulatory and safety requirements.

This course is necessary to prepare the participants to become competent and responsible operators, capable of operating the incinerator system safely and optimally, conducting maintenance inspections, anticipating and preventing operational problems, and meeting regulatory requirements. It does not, however, replace the need for a thorough in-house training with his or her own actual incinerator system.

Current or future operators, and supervisors of small-scale incinerator operation would benefit from taking this course.

Towards a Greener World

R&D Prototype Unit

Starting Installation in Yamaha Motor, India

WESTLAND
ENVIRONMENTAL SERVICES INC.
www.westlandenvironmental.com

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Alberta
Canada T5S 1X9

Anil Chhibber
Phone: 780 447 5052
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Incinerator Operator Training Course

Richard Milner (†), John Dach and Albert Liem doing R&D and Emission Testing (2001)

Rationale

"People can operate cars very well without any knowledge of the principles of internal combustion, nor the designs of the fuel injection, transmission, cooling systems, etc." Yes, indeed.

Cars and home furnaces, for example, have reached the technological stage of "consumer products." To operate them well, it is not necessary to understand how they work. *Current waste incinerator systems have not reached that developmental stage.*

Furthermore, unlike cars and home furnaces where the fuel quality is known and consistent, the composition of the waste can vary a great deal, and in many cases, it may be unknown. Therefore, understanding the principles of combustion and air pollution control, their basic design and operating parameters, regulatory requirements and safety hazards are necessary for safe and optimum operation.

The negative reputation of waste incineration could be attributed to both poor incinerator design in the past and inadequate operator training. This course is designed to remedy the latter, preparing the participants to become competent and responsible operators.

The Course

Day 1

- Introduction and pre-course questionnaire
- Operator responsibility
- Principles of combustion
- Incinerator designs
- Air pollution control (APC) designs
- Monitoring and control

Day 2

- Incinerator operation
- APC operation
- Maintenance
- Typical problems
- Regulatory requirements
- Working safely
- Post-course questionnaire
- Hands-on session

Westland Environmental Services

Evolved from Westland Incinerator Co., which manufactured different types of incinerators since 1975, Westland Environmental Services now offers a wider variety of products and services (www.westlandenvironmental.com). It has assembled a team of instructors, with a combined experience of more than 50 years in R&D, manufacturing and operation, to deliver this comprehensive and practical course in incinerator system operation, maintenance and trouble-shooting.

The Instructors

Albert Liem, Ph.D., P.Eng. Lead instructor. Chemical engineer with 30+ years of experience in incineration and air pollution control. Previous employments with Domtar Research, Alberta Environmental Centre and Alberta Research Council. **Anil Chhibber.** Manager of Westland since 1993, in R&D, marketing, manufacturing and operation. Technical advisors to many foreign governments and organizations on waste management and water treatment. **Greg Graf.** Information Technology specialist with Westland since 2002, instrumental in the implementation of Westland's control system, system commissioning and trouble-shooting.

Incinerator Operator Training Course
Westland's Site, Edmonton
Dates arranged to meet your needs

Registration

Please contact Mr. Anil Chhibber (opposite page) to arrange for dates for the course. Supply the name and title or responsibility of each participant from your company. The cost is $1,800 per participant, including continental breakfast, coffee and lunch during the course.

Please send a copy of your permit or license to operate, and other regulatory requirements with which your company must comply. This will be one of the topics covered in the course.

A detailed schedule will be sent to each participant. CD of the presentation slides and the course material will be given to each participant at the completion of the course.