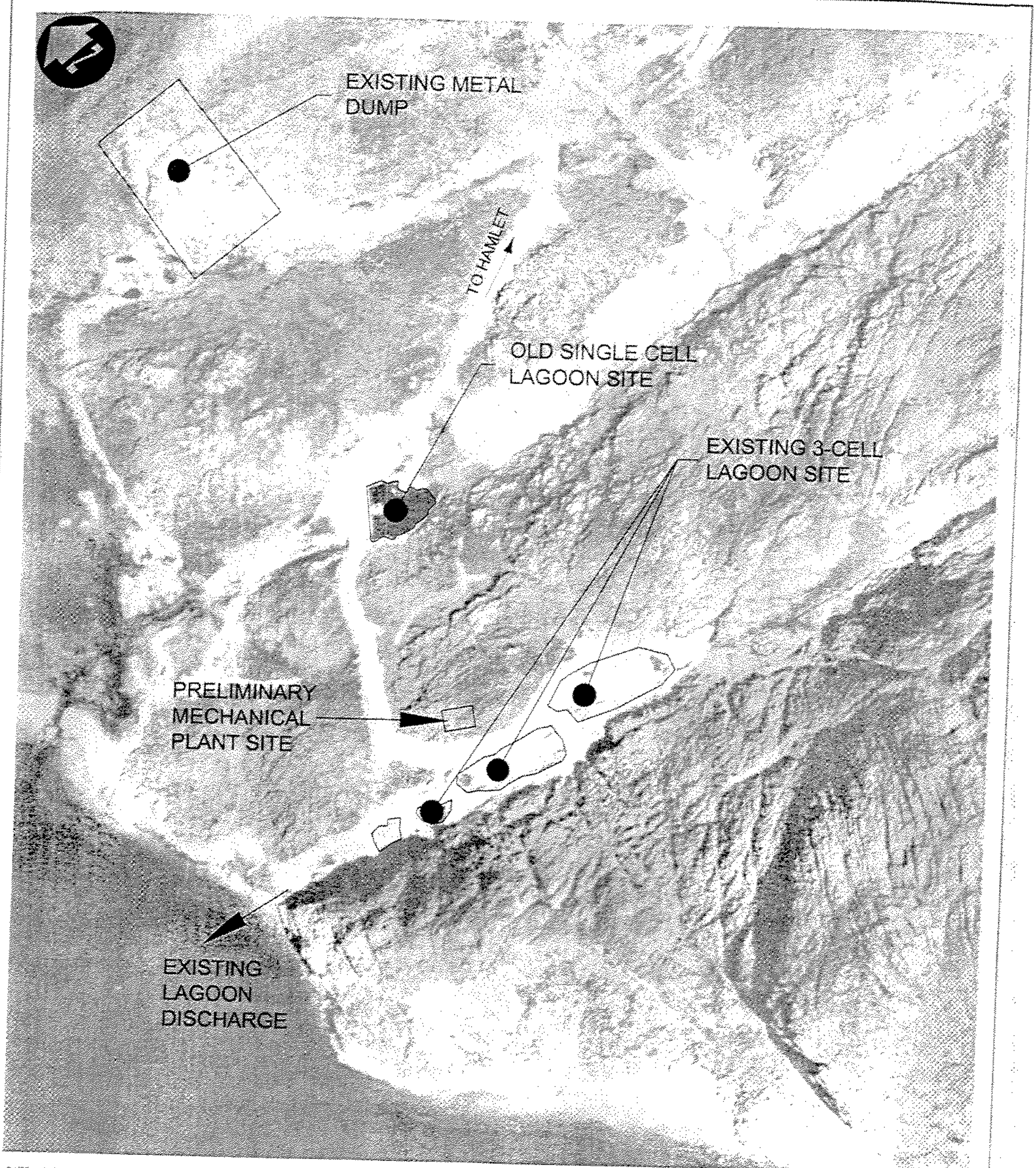

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DILLON CONSULTING	PROJECT: CAPE DORSET SEWAGE MANAGEMENT REIVEW CAPE DORSET, NUNAVUT	PROJECT NUMBER: 031943-1000
	TITLE: EXISTING SEWAGE LAGOON SITE	DATE: JULY 2003
		FIGURE NUMBER: 3

The lack of capacity has been most evident in winter. During Dillon's April 2003 site visit the lower 2 cells appeared to be full with sewage running over the ice with little or no retention time prior to discharge to Telik Inlet.

Breaches to the containment berms have been caused by spring runoff from Malik Mountain flooding the lower 2 cells. The fine-grained material used in the berm construction is susceptible to erosion. In addition, the berms do not appear to have any rock armour protection, as recommended by Dillon in 2001. The gradient of the valley floor is relatively steep and the resulting flow volumes and velocities have led to historical breaches to the berm in Cells #2 and #3. A diversion ditch was constructed in 2002 but it appears that substantial runoff still enters the lower 2 cells. Photographs of the lagoons and the breached cells are included in Appendix C.

3.2 History of Treatment Options

The decision to proceed with a mechanical treatment plant was made after previous studies and community consultations failed to identify a suitable location for a new sewage lagoon. In March 2001 Dillon Consulting Limited was retained by the GN to conduct a planning study with the goal of identifying the most viable sewage treatment option. The following briefly highlights the options considered and the recommendations at the time of the report:

Expand Existing Lagoons: This option had the highest estimated capital cost. The work would involve modifications to the existing lagoons and excavation in rock to expand the total capacity to approximately 70,000 m3. This option was not considered further due to the high cost relative to the other options. An additional 25,000 to 30,000 m3 of excavation would be required to achieve required volumes for an annual storage lagoon in the year 2024. The feasibility of expansion to this extent is unknown based on currently available information.

Site R Lagoon Option: The report concluded that the Site R lagoon was the most viable option. Site R is located near the airport granular resource stockpile, and the terrain is suitable for a sewage lagoon. This option was rejected in the summer of 2002 due to concerns over the proximity to the airport runway and the increased bird strike hazard.

The remaining two options were for mechanical treatment. These two systems would have similar requirements including an access road, lot grading, building enclosure, process equipment, and building services.

Macerator and Deep Water Discharge: The macerator is a mechanical plant option that reduces the particle size of the sewage to remove floating material and takes the sewage away from the shoreline via a deep water discharge. Deep water discharge consists of a pipe leading from the plant along the ocean floor to a point of deep water where the sewage is discharged through diffusers. This option had the lowest estimated capital cost but was not considered further due to concerns over the future regulatory acceptance of deep water discharges. A similar system is in operation in Rankin Inlet. Design and operational problems, combined with expressed regulatory concerns with deep water discharge led to a decision by GN not to further pursue this option for Cape Dorset.

Primary Treatment Mechanical Plant: This option considered enhanced primary treatment with a mechanical "Proteus" type system. Effluent quality would be similar to a lagoon. Experience in the community of Fort Simpson has shown the cost of implementing this system is essentially equivalent to that for a standard/conventional secondary sewage treatment plant. As a result, GN subsequently decided to focus on conventional systems when evaluating mechanical treatment options.

Regulatory pressure for a long term solution intensified during 2002. Two additional lagoon sites were suggested by community representatives, these were as follows:

Q – Lake Lagoon Option: Q – Lake is small water body located east of the community. The lake was used as an emergency water supply in the winter of 2001/2002 and therefore this option was dropped from further consideration at the request of the community.

P – Lake Lagoon Option: P –Lake is located south of the community. Development of this site requires approximately 1 km of new access road with steep grades and large quantities of rock excavation. This option was *initially* rejected due to concerns over high development costs.

By the summer 2002 the GN advised regulators of the decision to proceed with a secondary mechanical treatment plant for Cape Dorset. The plant was to be similar in scope to the mechanical plant being constructed in Pangnirtung. In early 2003, Dillon commenced detailed design of the mechanical plant for Cape Dorset. Process equipment vendors submitted price quotations which ranged from $835,686 to $1,877,300. The vendors proposed to use Sequencing Batch Reactor (SBR) technology, and operating costs were estimated to range from $135,000 to $150,000 per year.

Due to concerns over operating costs and long term funding, the GN subsequently requested that Dillon re-visit the P-Lake lagoon option. Preliminary site surveys were undertaken for the plant and a portion the lagoon access road. The lagoon and the mechanical plant options were compared on the basis of life cycle cost in a letter report to the GN dated 7 May 2003. The report stated that the life cost of the lagoon was marginally lower. At this stage the GN requested this further study to confirm which of the two treatment options (mechanical plant or lagoon) is better suited for Cape Dorset.

While this work was ongoing the GN was experiencing delays in the final commissioning and start-up of the new Rotating Biological Contractor (RBC) mechanical plant in Pangnirtung. It is understood that the delays were related to finalizing the connection details between the sewage truck and the plant.

3.3 Regulatory Background

The following is a summary of recent regulatory activities, inspections, and permits related to sewage treatment at the 3-cell lagoon system in Cape Dorset:

- **Indian and Northern Affairs Canada (INAC)** - conducted a site inspection in September 2000. At the time of the inspection Cell #1 (the upper cell) was full and the Hamlet had reverted to using the old sewage lagoon. The lower cells were breached. The inspector recommended the Hamlet consider alternate lagoon locations or treatment technologies as a long term solution. The inspector noted that the community did not have a water licence and was therefore in contravention of the regulations.

- **Department of Health and Social Services** (GN) - conducted a site inspection in February 2001. At the time of the inspection the Hamlet was using the old sewage lagoon, which was discharging under the road and then to Telik Inlet. The inspector described the situation as "inadequate". Recommendations were made similar to those by the INAC inspector.

- **Environment Canada** - issued a Directive under *The Fisheries Act* to the GN and the Hamlet dated March 2002. The directive identified raw sewage into Telik Inlet as a "serious and imminent danger" to fish bearing waters, and required that the Hamlet take immediate remedial steps. In August 2002 the GN replied to the EC Directive. The letter addressed repairs and mitigation to the existing lagoon cells, the expected treatment effectiveness, and a long term sewage treatment strategy that was to include construction of a mechanical sewage treatment plant.

- **Nunavut Water Board** – In April 2001 the Hamlet made application for a water licence from the Nunavut Water Board. The licence application included the operation of the water supply system, the solid waste disposal site, and the sewage treatment facility. The Hamlet was granted Water Licence NWB3CAPO207 in September 2002. Key effluent criteria established for discharge of treated sewage to Telik Inlet are 120 mg/l BOD_5 and 180 mg/L Total Suspended Solids. An amendment to the water licence will be required in the event a new sewage treatment facility is adopted.

Regulatory background letters are included in Appendix D.

4.0 Option No. 1: Mechanical Treatment Plant

4.1 Mechanical Plant Description

Mechanical plants are commonly used to treat municipal sewage in southern Canada. In northern Canada sewage lagoons are far more common, however mechanical plants have been installed at certain mine sites, and in the community of Pangnirtung, as previously mentioned. In the context of this report "mechanical plant" refers to a pre-manufactured process package which is installed in a building constructed on site.

Currently the most common types of package treatment plants are Rotating Biological Contractors (RBC's), Extended Aeration (EA), and Sequencing Batch Reactors (SBR's). Of these the RBC and the SBR are considered the most suitable for Cape Dorset due to their smaller overall footprint compared to the EA process. A few of the advantages and disadvantages of mechanical treatment plants are as follows:

Advantages

- Relatively small footprint for treatment
- Can meet and exceed existing water licence
- Effluent quality can be improved with process changes

Disadvantages

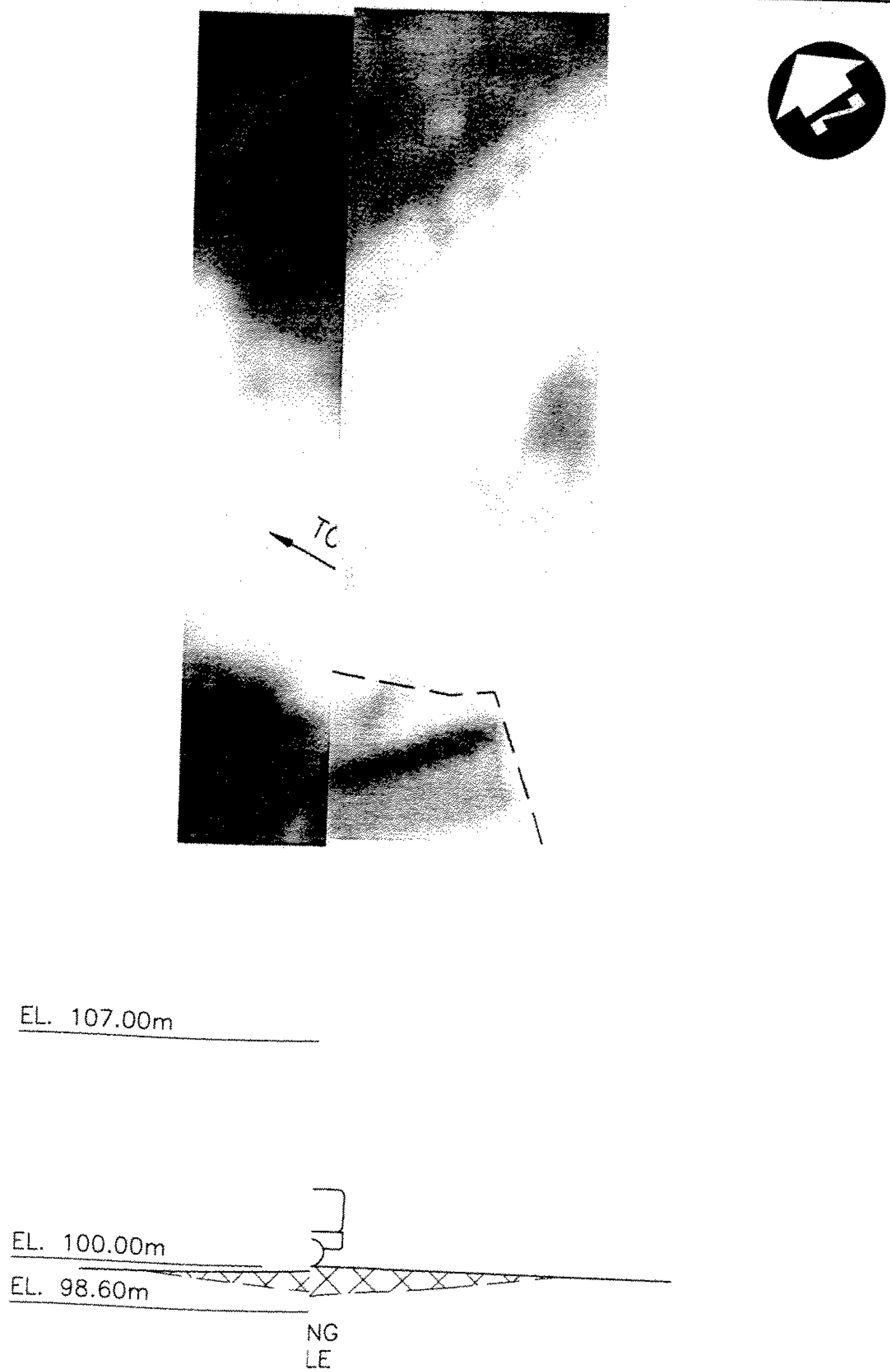
- Higher energy consumption
- Trained operator required

System Components

- Access road and site grading
- Building enclosure
- Process equipment
- Domestic building services
- Sewage effluent discharge
- Sludge discharge / disposal

The preferred location for the mechanical plant is near the existing 3-Cell lagoons. A preliminary site has been identified opposite Cell #1, north of the access road. The building pad would be constructed on bedrock and therefore it will be preferable if all the process tanks are above ground. A concept building plan and section view are shown in Figure No 4.

The treated effluent would be pumped below the access road in a heat traced pipe. The effluent would discharge to Telik Inlet via the existing lagoon drainage swale. Stabilized sludge from the plant would be discharged to the existing lagoons for long term storage. The new facility would also require Nunavut Power Corporation service, involving a service extension of approximately 800 m.



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DILLON CONSULTING

PROJECT

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PROJECT NUMBER
03-1943

DATE
JULY 2003

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4.2 Mechanical Plant Design Basis

The design basis for the mechanical treatment plant was summarized in a concept brief and in the equipment specification in March 2003. The documents were circulated to the GN and to selected equipment vendors. Copies of these documents are included in Appendix E.

A twenty year design horizon was used for the hydraulic and process treatment design. The hydraulic capacity is 265 m^3/ day, based on treating the daily sewage in 2024. Effluent criteria for the plant was set at 20 mg/L BOD_5 and 20 mg/L TSS.. These criteria are more stringent than the current requirements in the Water Board Licence, however are readily achievable using this type of treatment process.

A process diagram for a typical mechanical sewage treatment plant is shown in Figure No. 5. The major process components specific to Cape Dorset are as follows:

Raw Sewage Handling

Truck delivery of raw sewage occurs 5 days per week. The raw sewage would be stored in holding tanks located inside the building enclosure. The holding tank volume would accommodate 1.5 truck loads, or 15 m^3.

Primary Screening

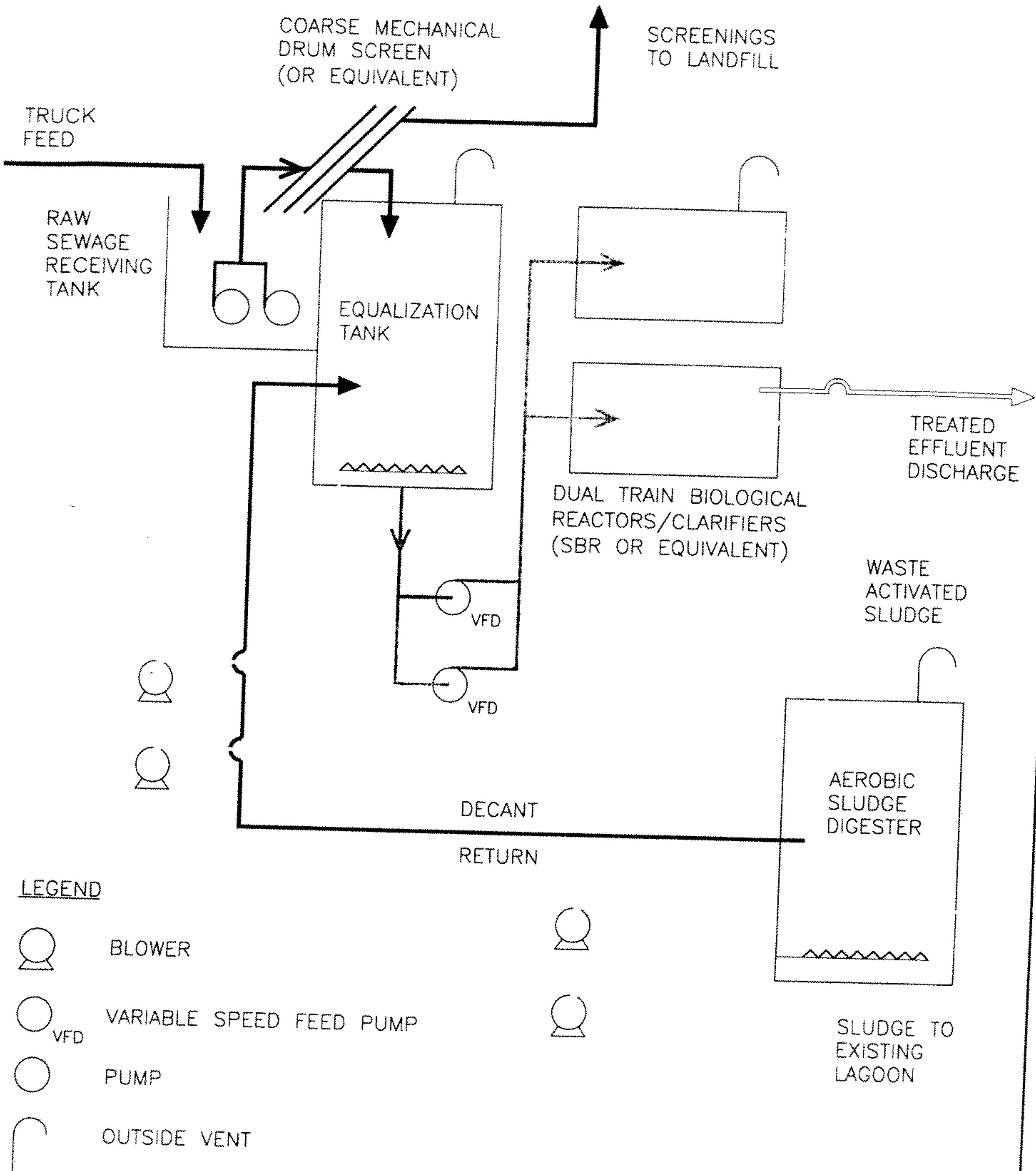
Primary screening is required to remove debris and larger solids from the sewage. An automated rotating drum screen with 12.5 mm (1/2") openings was selected as the design basis. Compacted solids would be automatically bagged and hauled to the existing solid waste landfill.

Flow Equalization

Flow equalization (EQ) is required to provide buffer storage and a well mixed sewage prior to entering the biological treatment unit. A minimum of 24 hours hydraulic capacity was selected for this tank during pre-design. Sewage would be pumped from the EQ tank to the biological reactors.

Biological Treatment

A dual train biological reactor system is required to provide appropriate redundancy and process flexibility, with each reactor capable of treating the daily design flow. Reactor sizes, internal components, and control logic vary from vendor to vendor.



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DILLON CONSULTING

PROJECT: CAPE DORSET SEWAGE MANAGEMENT REIEVW CAPE DORSET, NUNAVUT	PROJECT NUMBER: 031943-1000
	DATE: JULY 2003
TITLE: SBR MECHANICAL PLANT BLOCK DIAGRAM	FIGURE NUMBER: # 5

Sludge Handling

A continuously aerated aerobic digester is required to stabilize sewage sludge prior to disposal. Liquid decant from the digester is returned to the flow equalization tank for further treatment. Sludge is pumped from the bottom of the digester for disposal. Cell #1 of the 3-cell lagoon was selected as an appropriate disposal site for digested sludge.

4.3 Supplier's Proposals

Dillon invited proposals from qualified suppliers of package mechanical sewage treatment plants. The invitation was structured such that the supplier was free to recommend the process technology.

Dillon invited and received quotations from APD Engineering and Constructors Ltd., Perma Engineered Sales, and Sanitherm Engineering Ltd. All three suppliers indicated they could meet the required effluent criteria using Sequencing Batch Reactor (SBR) treatment systems. The supplier's proposed floor layouts and process diagrams are included in Appendix F. The use of SBR based treatment processes is consistent with the stated preference of GN to date that use of an SBR would allow for a performance comparison to the recently installed Rotating Biological Contactor (RBC) based treatment process installed in Pangnirtung.

Concern has been recently raised by the GN over the estimated Operating Costs for a mechanical sewage treatment plant. Given this concern, the GN may wish to further consider the selection of an SBR based treatment process over that of an RBC based treatment process. However, preliminary estimates suggest that an SBR will have approximately 30% to 50% higher power consumption rates than a comparable RBC based system, and therefore an RBC presents an opportunity for long-term cost savings.

Key elements of the supplier's submissions are as follows:

1) APD Engineering and Constructors Limited

APD is a Calgary-based firm representing US Filter Jet Tech SBR systems. APD has relevant project experience in the Western Canada and the US but none in the NWT or Nunavut. The APD proposal is for an SBR system with a total of five tanks - two equalization tanks and three SBR tanks. The aluminum tanks are all the same size (3.5 m wide X 15 m long X 5 m high) for a volume of 247 m^3 each. The tanks breakdown into upper and lower pieces for shipment.

The raw sewage would be manually screened, requiring frequent removal of solids by the Hamlet (Dillon specified an automated drum or similar screen in the specifications). The two receiving tanks would be above ground in accordance with the specifications. No estimate of operating costs was provided.

APD did *not* include aeration of the equalization tanks, an aerobic digester, a full description of the electrical and controls, or an estimate of operating costs, as required by Dillon. Due to these submission deficiencies APD was not given consideration for this project.

2) Perma Engineered Sales / FWS

Perma Engineered Sales of Winnipeg proposed an SBR system with a total of six rectangular tanks; one raw sewage (15 m^3), one equalization tank (100 m^3), two reactors (270 m^3 each), and two aerobic digesters (115 m^3 each). In this proposal the raw sewage receiving tank would be installed below ground, and this raises the issue of blasting during construction.

Advantages:

- Pre-installed electrical conduits, piping and fittings
- Opportunity for lower building height due to lower tank heights

Disadvantages:

- Highest overall capital cost
- Unconventional process logic. The plant would run high rate between Monday and Friday and low-rate / stand-by on the weekend. This may cause problems with process stability.
- Below ground receiving tank may require blasting.

3) Sanitherm Engineering Limited

Sanitherm Engineering in Vancouver submitted a proposal based on an SBR. Their proposal calls for six circular tanks, including two receiving / screened sewage (15 m^3 each), one equalization (530 m^3), two SBR's (326 m^3 each), and one digester (197 m^3). The total requested floor space to house the package plant is 580 m^2, including an 11 m X 7 m allowance for mechanical / electrical, generator room, and washroom.

Advantages:

- Technically complete proposal
- Lowest capital cost of all submissions
- Recent Arctic experience (Pangnirtung)

Disadvantages:

- Tall tanks increase overall building height
- Larger floor area than other submissions

4.4 Capital and Operating Costs

4.4.1 Capital Cost

The original suppliers bids for the process equipment are shown in Table 2. These quotes have formally expired however they are still useful for cost estimating purposes.

Table 2 Equipment Pre-Selection Quotations

Item	APD Engg	Perma/FWS	Sanitherm
Tankage	$837,000.00	$945,100.00	$334,367.00
Major Equipment	$265,000.00	$343,700.00	$271,150.00
Ancillary Equipment	$183,000.00	$473,900.00	$91,019.00
Start-Up and Training	$18,975.00	$97,900.00	$44,000.00
Other	$92,000.00	$16,700.00	$95,140.00
Total	**$1,395,975.00**	**$1,877,300.00**	**$835,676.00**

The low bidder was Sanitherm. APD was dropped from consideration and discussions were held with the remaining suppliers to confirm their design assumptions and prices.

Other major capital costs were estimated as follows:

- Building Structural costs were estimated based on $3000 per square meter of floor space. In addition, concrete foundation costs were estimated based on a 200 mm thick slab @ $2000 per cubic meter.
- Building Mechanical / Electrical: The starting point for these costs was the $970,000 contract for the mechanical and electrical at Pangnirtung. This amount was increased to account for the larger building size for Cape Dorset.
- Nunavut Power Line: The new electrical service for the mechanical plant (NU Power) has an estimated cost of $80,000, based on a service length of 800 m.

The total estimated capital cost for mechanical plant option ranges from $5.6 million (Sanitherm SBR) to $6.1 million (Perma SBR) including engineering and contingencies.

The cost calculations are provided in Appendix G.

4.4.2 Operating Costs

Operating and maintenance (O + M) costs for a mechanical treatment plant are significantly higher than for a sewage lagoon of comparable capacity. Estimating O + M costs for a mechanical plant is complicated because of a lack of operating cost history available for a mechanical plant in NU. Limited O + M data is readily available for SBR's in more southern North American locations, however and conversions must be made to account for differences in power and maintenance costs.

Possible approaches to estimating O + M are as follows:

- **Unit Rate Approach**: in this approach the total annual O + M costs are divided by the annual sewage volume treated to arrive at a unit cost per cubic meter.

- **Itemized Cost Approach**: In this approach operating costs are broken down into power, labor, heating, etc. and added to arrive at the annual cost. This approach was used in Dillon's previous estimates to the GN in May 2003.

- **% of Capital Cost Approach**: In this approach historical O + M costs are divided by the original capital cost to arrive at annual O + M cost as a % of capital cost.

Dillon's May 2003 O + M estimates were prepared using power consumption costs provided by the equipment suppliers. Due to large variations in the annual power costs submitted by the suppliers, Dillon initiated discussions with the suppliers in order to explain the variation, and to attempt to identify which of the two estimates was more realistic. The suppliers resubmitted their power cost estimates, and the revised cost for the Sanitherm plant was one half the original. To these plant power costs Dillon added operator labor, building heat and light, and miscellaneous provisions for items such as testing. The resulting O + M costs ranged from $135,000 to $150,000 per year. Sewage haulage costs are not included.

For this report, we reviewed limited published data for SBR's operating in the US (see Appendix H). The published data indicate that average annual O + M costs were in the range of 9.5 to 10% of the plant capital cost. For Cape Dorset we have assumed O + M costs based on 8.0% of the initial capital cost, after considering the low end estimates from the suppliers and the higher end estimates from the published data. The resulting O + M costs range from about $255,000 to $280,000 per year. It was assumed that these costs would be incurred with the plant operating at full capacity of 265 m^3/day. This is not the case in earlier years and the O + M costs were therefore pro-rated based on the average plant flow in any given year. Calculations are provided in Appendix G.

4.4.3 Equipment Service Life

The design expected life (service life) for the building, pumps, and tanks and piping was established in the concept brief. The design expected life was defined as the *"the practical maximum expected life of a facility assuming no premature failure, destruction, or obsolescence"* and ranged from 20 years for pumps to 30 years for tanks and piping.