REGIONAL DISTRICT OF NANAIMO

SPECIAL BOARD MEETING
TUESDAY, APRIL 30, 2002
7:30 PM

(Nanaimo City Council Chambers)

AGENDA

PAGES

CALL TO ORDER

DELEGATIONS

ADMINISTRATOR'S REPORT

3-6 Municipal Benefiting Area Amendment Bylaw No. 1216.02 - City of Nanaimo. (All Directors - One Vote)

7-41 Landfill Gas Utilization Study. (All Directors - Weighted Vote)

District 69 Arena Referendum. (Report to be circulated) (Voting - in the report)

UNFINISHED BUSINESS

From the Electoral Area Planning Committee meeting held March 26, 2002: (Electoral Area Directors except 'B' - One Vote)

DP Application No. 0209 – Groves – 5457 West Island Highway – Area H.

That Development Permit Application No. 0209 to vary the maximum height of a dwelling unit in the Residential 2 zone pursuant to "Regional District of Nanaimo Land Use and Subdivision Bylaw No. 500, 1987" from 8.0 metres to 9.5 metres to facilitate the construction of a single dwelling unit and the removal of a single dwelling unit within the Hazard Lands Development Permit Area pursuant to "Shaw Hill-Deep Bay Official Community Plan Bylaw No. 1007, 1996" for the property legally described as Lot 3, District Lot 16, Newcastle District, Plan 15105 be approved subject to the conditions outlined in Schedule No. '1' and pursuant to the notification requirements of the Local Government Act.

COMMISSION, ADVISORY & SELECT COMMITTEE

42-43 Minutes from the Building Addition Committee meeting held on Tuesday, April 23, 2002. (for information) (All Directors - One Vote)

(All Directors - One Vote) (Background report attached for information)

44-50 *That the Board endorse Schematic Design Option 1, which provides for construction of an addition to the RDN Administration Building with the Board Room located on the main floor.*

(All Directors - Weighted Vote)

That the Regional District of Nanaimo retain NSDA Architects, including their listed sub-consultants, to complete the Final Design, prepare the Tender Documents and oversee the Construction Phase of the RDN Building Addition Project for a fixed fee of $88,000 plus disbursements.

ADDENDUM

BUSINESS ARISING FROM DELEGATIONS OR COMMUNICAITONS

NEW BUSINESS

ADJOURNMENT

REGIONAL DISTRICT OF NANAIMO

MEMORANDUM

TO: C. Mason
General Manager, Corporate Services

DATE: March 27, 2002

FROM: N. Avery
Manager, Financial Services

FILE:

SUBJECT: **To amend the municipal sewer benefiting area in the City of Nanaimo**

PURPOSE:

To introduce a bylaw to extend the boundaries of the sewer benefiting area in the City of Nanaimo.

BACKGROUND:

The City of Nanaimo has requested that the municipal sewer benefiting area be extended to include properties along Fielding Rd, which have been connected to the sanitary sewer system. This is a straightforward technical amendment to the bylaw.

ALTERNATIVES:

1. Introduce Bylaw 1216.02 and forward it to the City of Nanaimo for consent.

2. Take no action on the bylaw.

FINANCIAL IMPLICATIONS:

Alternative 1

The properties to be included in the benefiting area will contribute fully to the regional treatment facilities as prescribed by the formula in the Southern Community Sewer Local Service bylaw.

Alternative 2

Each time a new property is connected to the sewer system a boundary amendment is necessary to authorize the application of property taxes. There is no reason not to proceed and Alternative 2 is not recommended.

SUMMARY/CONCLUSIONS:

The City of Nanaimo has advised staff that several properties have been connected to the sanitary sewer system along Fielding Rd. and consequently, contribute sewage to the regional treatment facilities. The sewer benefiting area bylaw identifies properties, which shall be assessed property taxes with respect to the treatment facilities and must be amended, as additional properties are included in the benefiting area. This is a straightforward technical amendment and staff support Bylaw 1216.02.

RECOMMENDATION:

That "Municipal Benefiting Area Amendment Bylaw No. 1216.02, 2002" be introduced for three readings and be forwarded to the City of Nanaimo for consent.

Report Writer

General Manager Concurrence

C.A.O. Concurrence

COMMENTS:

REGIONAL DISTRICT OF NANAIMO

BYLAW NO. 1216.02

A BYLAW TO AMEND THE BOUNDARIES OF THE MUNICIPAL BENEFITING AREA IN THE SOUTHERN COMMUNITY SEWER LOCAL SERVICE AREA

WHEREAS Bylaw No. 888 created a local service area for the purpose of the collection, conveyance, treatment and disposal of sewage;

AND WHEREAS clause 6(a) of Bylaw No. 888 provides that the Regional Board may, with the consent of the Council of participating municipalities, define the boundaries of a benefiting area within the municipality;

NOW THEREFORE the Board of the Regional District of Nanaimo in open meeting assembled enacts as follows:

1. The benefiting area within the City of Nanaimo shall be amended to include those properties listed on Schedule 'B' attached hereto and forming part of this bylaw.

2. Schedule 'A' to Bylaw No. 1216 is repealed and replaced by Schedule 'A' attached to and forming a part of this bylaw.

3. This bylaw may be cited as "Municipal Benefiting Area Amendment Bylaw No. 1216.02, 2002".

Introduced and read three times this 30th day of April, 2002.

Received the consent of the City of Nanaimo this _____ day of _______________, 2002

Adopted this _____ day of _______________, 2002.

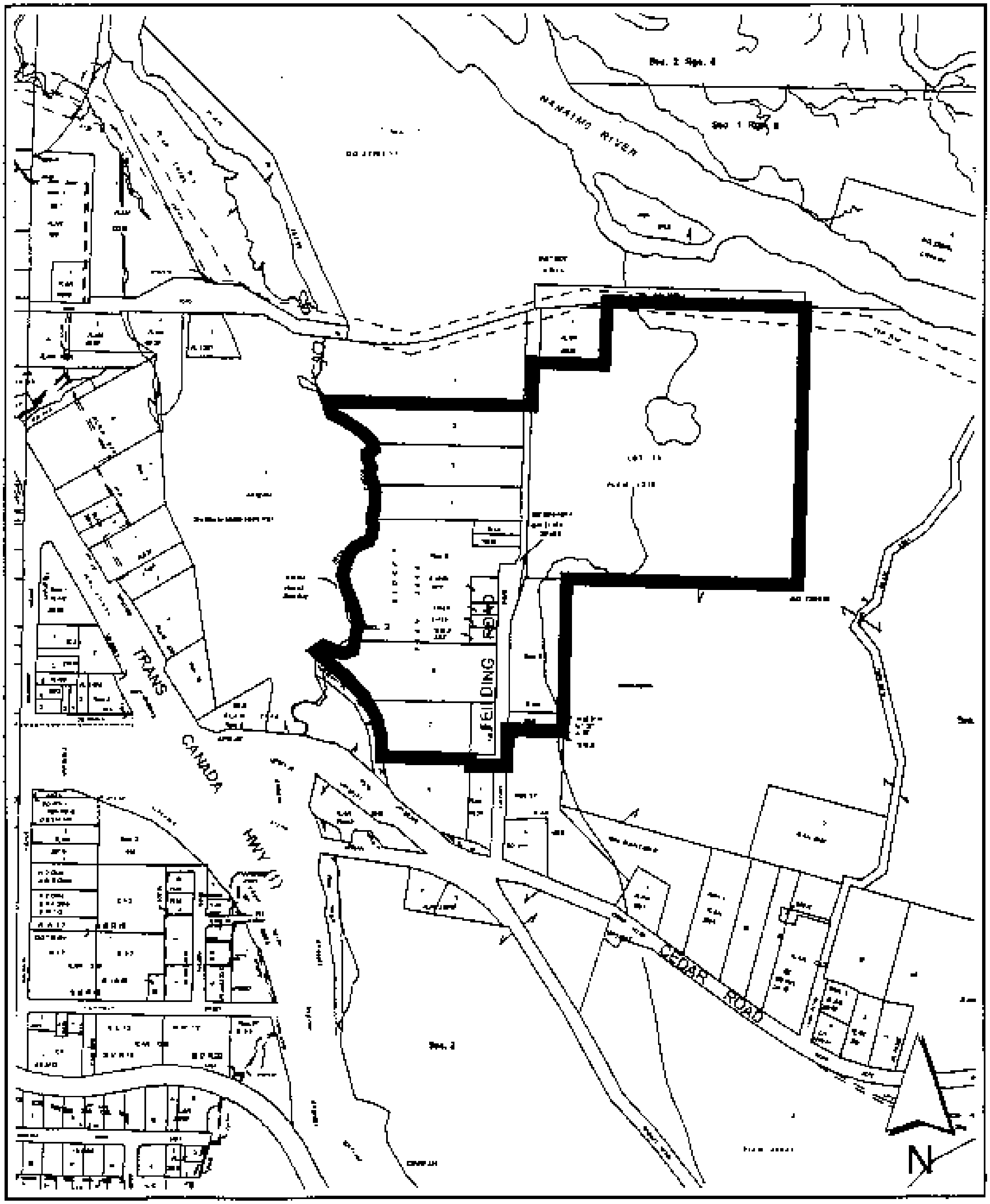
CHAIRPERSON

GENERAL MANAGER, CORPORATE SERVICES

Schedule 'B' to accompany "Municipal Benefiting Area Amendment Bylaw No. 1216.02, 2002"

Chairperson

General Manager, Corporate Services



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REGIONAL DISTRICT OF NANAIMO

MEMORANDUM

TO: John Finnie, P. Eng.
General Manager Environmental Services

DATE: April 9, 2002

FROM: Carey McIver
Manager Solid Waste

FILE: 5360-40

SUBJECT: Landfill Gas Utilization Study

PURPOSE

To report on the results of the Landfill Gas Utilization Study and obtain approval for the implementation of a landfill gas migration monitoring program.

BACKGROUND

In February 2001 the RDN commissioned Connestoga-Rovers and Associates (CRA) to investigate whether the gas generated at the Regional Landfill could be transformed from an environmental liability to a "green" energy asset. Typically, energy recovery from landfill gas (LFG) is considered economical only at large landfills. This study looked at the viability of energy recovery from a relatively small landfill and the technologies appropriate to its size. For this reason, the Federation of Canadian Municipalities' Green Municipal Enabling Fund cost-shared fifty percent of the $58,926 study.

LFG is a moist gas produced as a result of the biological decomposition of organic wastes. LFG typically contains approximately fifty percent carbon dioxide and fifty percent methane, by volume. LFG also contains trace constituents such as hydrogen sulphide, mercaptans, vinyl chloride, and numerous other volatile organic compounds, which may be potentially hazardous and/or carcinogenic. The generation rate of LFG, the composition, and the proportions of the components of LFG vary over time and from landfill to landfill.

The potential environmental and human health impacts related to LFG include the following:

- Odours;
- Explosion, asphyxiation, and toxicity hazards in enclosed areas on or near landfills;
- Release of greenhouse gases to the atmosphere;
- Degradation of local air quality; and,
- Vegetation stress on or near landfills.

Hence, controls on LFG may greatly improve the environmental and human health considerations associated with a landfill especially given that LFG production will continue for years after final closure.

The RDN has had a landfill gas management system in place since 1991. In 1991 the RDN installed passive vents throughout the closed portions of the old landfill to minimize the build-up of LFG. In 1997 the RDN installed a new LFG collection system that collects and flares gas from the closed portions of the landfill for the purposes of odour control. Flaring gas also substantially reduces the greenhouse effect of the collected gas since methane has a global warming potential 21 times that of carbon dioxide by weight.

Landfill Site and LFG Production Assessment

The CRA study consists of three reports. The first report entitled "Landfill Site and LFG Production Assessment" presents a summary of the site geology, operations history, waste deposition history, LFG collection system status and LFG quantity and quality assessment. This report estimates that the current total LFG production rate is approximately 640 cubic feet per minute (cfm). Currently 20 to 40 cfm is used during the winter to heat the landfill maintenance building. A peak LFG production rate is estimated to occur in 2008 at a rate of approximately 750 cfm. This peak LFG production rate is based on a 2008 closure date.

Landfill Gas Management Plan

The second report entitled "Landfill Gas Management Plan" presents an assessment of the existing LFG collection system and also outlines potential control system upgrades for improved odour control and gas utilization.

The report outlines three potential LFG collection options: These design options are based on the need to collect LFG for (1) the sole purpose of LFG migration and odour control which is the status quo, (2) utilization, and (3) optimized/aggressive collection for the purpose of maximizing the utilization potential of LFG as an energy source. Under Option 1, the collection efficiency (rate of LFG collected/rate generated by the landfill) would be less than 50 percent, while Options 2 and 3 would provide for collection efficiencies of 70 and 80 percent respectively.

The report also examines the potential for LFG migration and presents a site-specific migration monitoring program. This due diligence program includes the installation of migration monitoring probes, implementation of a building monitoring program, a data evaluation plan, and a contingency plan.

Landfill Gas Utilization Feasibility Assessment

The third report, entitled "Landfill Gas Utilization Feasibility Assessment" presents an assessment of several possible LFG utilization options. These options include: direct use of LFG as a low grade fuel, electrical generation, and LFG upgrade to natural gas quality fuel.

Two utilization options were identified to have significant potential:

- direct use of LFG as a low-grade fuel at either an existing facility (Harmac, aquaculture, or greenhouse facilities) or the development of a facility adjacent to the landfill, and;

- generation of electricity at a facility located at, or adjacent to the landfill.

Based upon current market conditions and preliminary revenue and capital cost estimates, an economic analysis was conducted. For the purpose of this analysis, a utilization project life span of twelve years was selected based upon a 2008 closure date. All capital costs were assumed to be financed over the term of the project (twelve years) at a real interest rate (net of inflation) of six percent.

The analysis concludes that the annual net revenue to the RDN for utilization of LFG as a low-grade fuel would be $105,473 based on Option 2 (utilization), and $129,423 based on Option 3 (aggressive utilization). Both these options assume collection of gas at levels beyond our current objective of preventing LFG migration and odour control. The annual net revenue to the RDN for generating 1.5 MW of electricity under Option 2, utilization would be $205,013. This would be enough electricity to provide the needs for 1,500 homes. The full report outlining the details of this economic analysis is attached.

At this preliminary stage, it is uncertain as to which option offers the most benefit to the RDN. However, the existence of a series of such options is very promising in that it will enhance the value of LFG through competitive private sector interest in the project. If successful the gas could be a revenue source for the RDN and/or decrease the RDN's cost to operate the system. Both Harmac and B.C. Hydro have expressed interest in this project.

Next Steps

Prior to selecting the most beneficial LFG utilization option is it essential for the RDN to implement a full LFG Management Plan. There are three components to the LFG Management Plan: The LFG collection system, the LFG migration monitoring system and the contingency response plan.

Staff recommend that CRA be retained in 2002 to implement the migration monitoring system and contingency response plan as a measure of due diligence. An LFG migration monitoring program is required regardless of gas utilization. This system consists of the installation of 14 methane gas detection probes to monitor for the potential migration of methane as well as the installation of a methane monitoring system in on-site building structures.

CRA will also be engaged to integrate existing landfill operations and post-closure end use planning into the design of an expanded LFG collection system. Once the final end-use plan is completed in 2002, the design of an expanded collection system can proceed in 2003 in conjunction with selection of the most beneficial utilization option.

ALTERNATIVES

1. Proceed with the implementation of an LFG Management Plan and beneficial LFG utilization as outlined in the CRA reports.

2. Do not proceed with the implementation of an LFG Management Plan and beneficial LFG utilization as outlined in the CRA reports.

FINANCIAL IMPLICATIONS

The 2002 Annual Budget for solid waste includes $325,000 in reserves for the future expansion of the LFG collection system. A total of $650,000 is included in the Capital Plan to expand the LFG collection system. The CRA study was not completed until December 2001, therefore the detailed costs associated with the implementation of a Landfill Gas Management Plan were not included in the 2002 Provisional Budget. These costs are now known and can be deducted from the existing reserve.

The estimated cost to implement the LFG migration monitoring program and contingency response plan in 2002 is $80,000. This includes installation of the methane migration monitoring system as well as integration of other existing landfill projects into system expansion. The workplan, schedule and budget to design and construct an expanded LFG collection system will be considered in 2003 provisional budget deliberations. A preferred LFG utilization option will be identified in 2003.

There are no financial implications under Alternative 2.

CITIZENS/PUBLIC RELATIONS IMPLICATIONS

Although the RDN has undertaken two methane migration studies in the last ten years that indicate no off-site migration, installation of a permanent monitoring system is integral to providing a higher standard of care to landfill neighours. Expanding the LFG collection system in 2003 will provide even greater improvements in odour control. In 2002 staff will consult with landfill neighbours to obtain their input on the expansion of the LFG collection system and options for LFG utilization.

ENVIRONMENTAL IMPLICATIONS

Beneficial utilization of the LFG generated at the Regional Landfill could provide a "green" energy source that could either offset the use of natural gas or provide up to 1.5 MW of electricity while at the same time significantly reducing greenhouse gas emissions.

SUMMARY/CONCLUSIONS

In February 2001 the RDN commissioned Connestoga-Rovers and Associates (CRA) to investigate whether the gas generated at the Regional Landfill could be transformed from an environmental liability to a "green" energy asset. Two utilization options were identified to have significant potential: direct use of LFG as a low-grade fuel at either an existing facility (Harmac, aquaculture, or greenhouse facilities) or the development of a facility adjacent to the landfill; and, generation of 1.5 MW of electricity at a facility located at, or adjacent to the landfill. At this preliminary level, it is uncertain as to which option offers the most benefit to the RDN. However, the existence of a series of such options is very promising in that it will enhance the value of LFG through competitive private sector interest in the project. If successful the gas could be a revenue source for the RDN and/or decrease the RDN's cost to operate the system. Prior to expanding the LFG collection system and selecting a beneficial use in 2003, staff recommends the implementation of a LFG Management Plan in 2002, commencing with the installation of a permanent methane migration monitoring system.

RECOMMENDATION

1. That the Board approve the implementation of an LFG migration monitoring program; and,
2. That the Board proceeds with the investigation and identification of a beneficial LFG utilization option as outlined in the CRA reports.

Report Writer

General Manager Concurrence

CAO Concurrence

COMMENTS

LANDFILL GAS UTILIZATION FEASIBILITY ASSESSMENT
NANAIMO REGIONAL DISTRICT LANDFILL

NANAIMO, BRITISH COLUMBIA

Prepared For: The Regional District of Nanaimo

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EXECUTIVE SUMMARY

This report, entitled "Landfill Gas Utilization Feasibility Assessment" is presented as part of the Regional Landfill Gas Utilization Study for the Regional District of Nanaimo (RDN).

This report presents an assessment of several possible Landfill Gas (LFG) utilization options. These options include: direct use of LFG as a low-grade fuel, electrical generation, and LFG upgrade to natural gas quality fuel. For the purpose of undertaking this LFG utilization feasibility study, it is presumed that odour control and LFG migration control will be voluntarily undertaken by the RDN as part of their LFG management plan.

Two utilization options for the LFG from the Regional District Landfill were identified to have significant potential for being undertaken: electricity generation using reciprocating engine technology and direct use of LFG as low-grade fuel. Based upon current market conditions and preliminary revenue and capital cost estimates, an economic analysis was conducted. At this preliminary level, it is uncertain as to which alternative offers the most benefit to the Regional District. However, the existence of a series of such alternatives is very promising in that it will enhance the value of LFG through competitive market forces.

1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) is pleased to submit the following report entitled "Landfill Gas Utilization Feasibility Assessment". This report is presented as part of the Regional Landfill Gas Utilization Study for the Regional District of Nanaimo (RDN). The Regional District Landfill (Landfill) is located at 1105 Cedar Road, Nanaimo, British Columbia, as indicated in Figure 1 and is currently owned and operated by the RDN.

This report presents an assessment of several viable Landfill Gas (LFG) utilization options. These options include: direct use of LFG as a low-grade fuel, LFG upgrade to natural gas quality fuel, and electrical generation. For the purpose of undertaking this LFG utilization feasibility study, it is presumed that odour control and LFG migration control will be voluntarily undertaken by the RDN as part of their LFG management plan. The economic feasibility of utilization opportunities will be assessed using as a base point the capital costs associated with constructing, operating and maintaining a LFG control system for the purpose of odour and gas migration control. Opportunities for utilization are therefore assessed on the basis of the economics related to expanding the collection system for utilization and implementation of a utilization facility.

2.0 LITERATURE REVIEW AND REFERENCES

The following reports were reviewed for the purpose of preparing this document:

- Conestoga-Rovers & Associates Ltd., July 2001. *Landfill Site and LFG Production Assessment.*
- Conestoga-Rovers & Associates Ltd., December 2001. *Landfill Gas Management Plan.*
- Environment Canada, March 1996. *Guidance Document for Landfill Gas Management.* Report prepared for Waste Treatment Division, Hazardous Waste Branch, Ottawa, Ontario EPS 2/UP/5E.
- U.S. Environmental Protection Agency, February 1998. *Emerging Technologies for the Management and Utilization of Landfill Gas.* EPA-600/R-98-021.
- U.S. Environmental Protection Agency, August 1998. *Electric Power Generation Using A Phosphoric Acid Fuel Cell on a Municipal Solid Waste Landfill Gas Stream.* EPA-VS-GHG-01.

3.0 LANDFILL GAS SUMMARY

LFG is a moist gas (close to saturation), produced as a result of the biological decomposition of organic wastes, that typically contains approximately fifty percent carbon dioxide and fifty percent methane, by volume. LFG also contains trace constituents such as hydrogen sulphide, mercaptans, vinyl chloride, and numerous other volatile organic compounds, which may be potentially hazardous and/or carcinogenic. The generation rate of LFG, the composition, and the proportions of the components of LFG vary over time and from landfill to landfill.

The potential environmental and human health impacts related to LFG include the following:

- odours;
- explosion, asphyxiation, and toxicity hazards in enclosed areas on or near landfills;
- release of greenhouse gases to the atmosphere;
- degradation of local air quality; and
- vegetation stress on or near landfills.

Hence, controls on LFG may greatly improve the environmental and human health considerations associated with a landfill. LFG utilization benefits the public by reducing the aforementioned negative impacts by the collection and combustion of the methane and trace gases, thereby reducing potentially harmful conditions.

LFG may also represent a significant renewable energy resource, which provides the potential for energy recovery from municipal solid waste. As a result, the collection and use of LFG as an energy resource offers both important environmental benefits as well as providing value as an energy resource.

4.0 RDN LANDFILL OVERVIEW

The following is a brief review of key points presented in CRA's "LFG Production Assessment" report (July 2001) and the "Landfill Gas Management Plan" (December 2001) prepared for the RDN.

4.1 SITE OVERVIEW

The Landfill encompasses a total area of approximately forty hectares and is constrained by Cedar Road to the north and Fielding Road to the southwest. The total current landfill footprint (2001) is approximately twenty-one hectares. The current estimated refuse in place is approximately 1.2 million tonnes.

The RDN Landfill is composed of three cells (A, B and C) as illustrated in Figure 2. Cell A is an unlined closed cell. Cells B and C are lined and currently active. LFG collection activities are currently limited to Cell A.

4.2 LFG PRODUCTION SUMMARY

One of the most important factors in determining the potential for LFG utilization is the availability of LFG over the duration of the project. While the LFG production life span is potentially up to 100 years, the period of rapid production of LFG is considerably shorter. Therefore, LFG production assessments must not only address existing LFG quantities, but also project how much LFG will be available in the future. The typical LFG utilization project duration is approximately twenty years, although some utilization projects are considerably longer if refuse disposal continues at the landfill.

An assessment of the LFG production and emissions at the Landfill is presented in the CRA (July 2001) report. The LFG production estimates presented in this report are based upon the following key assumptions, which are relevant to potential utilization:

- Municipal solid waste deposition commenced (for the purpose of LFG generation calculations) in 1971;
- RDN Landfill closure is assumed to occur between 2005 and 2008;
- A 1.7 percent population growth rate is assumed for 2001 through 2008; and
- There is approximately 1.2 million tonnes of waste currently in place.

LFG production estimates were generated utilizing the Scholl Canyon model. Based on the data presented in the CRA (July 2001) report, it is estimated that the current total LFG production rate is approximately 1085 m^3 per hour (640 cfm). A peak LFG production rate (based on the above stated assumptions) is estimated to occur in 2008 at a rate of approximately 1274 m^3 per hour (750 cfm). This peak LFG production rate is based upon the 2008 closure date scenario presented in the CRA (July 2001) report.

The CRA (July 2001) report also includes data on total non-methanogenic organic compounds (NMOCs) generated at the site. The NMOCs form the basis by which the province of British Columbia (BC) regulates the need to install a LFG collection system at landfills with a total design capacity greater than 100,000 tonnes. Data presented in this report indicates that the estimated peak NMOC emissions from the Landfill will be approximately 3.0 tonnes per year. This value is significantly below the 150.0 tonnes per year NMOC trigger (imposed by BC regulations) which would require the installation of a LFG collection system. As a result, any LFG collection activities conducted by the RDN should be acknowledged as strictly voluntary.

4.3 CURRENT LFG UTILIZATION

Currently, LFG utilization at the Landfill is restricted to heating the garage facility located on the Landfill property. Field measurements made by CRA personnel indicate that a maximum of 68 m^3 per hour (40 cfm) is utilized for heating during the winter months.

4.4 PROPOSED LFG COLLECTION DESIGN ALTERNATIVES

The CRA LFG Management Plan outlines three potential LFG collection alternatives: LFG odour and migration control, utilization, and aggressive utilization. Each of these utilization schemes is discussed below.

4.4.1 DESIGN ALTERNATIVE #1 - ODOUR AND LFG MIGRATION CONTROL

To achieve the objective of odour and LFG migration control, it is sufficient to flare the LFG in either an open or enclosed flaring apparatus. As discussed in the Landfill Gas Management Plan report, the NMOCs are not an issue at the Landfill. Therefore the sole interest of the proposed collection system design is to ensure that LFG emissions to the atmosphere remain below the threshold level at which odour could become a concern. This threshold level is estimated to be in the range of 680 to 1020 m^3/hr (400 to 600 cfm). This design alternative presents only the opportunity for attainment of greenhouse gas credits for the flaring of 595 m^3/hr (350 cfm) on average as discussed further in Section 7.0.

4.4.2 DESIGN ALTERNATIVE #2 - LFG UTILIZATION

In order to achieve both odour and LFG migration control and LFG utilization, this proposed design alternative involves the optimization of the collection of LFG . This alternative relies upon vertical LFG extraction wells and can be achieved by installing additional vertical wells beyond those required for design alternative #1. Utilizing vertical LFG extraction wells (in conjunction with an appropriate final cover design), a collection efficiency (rate of LFG collected / rate generated by the landfill) of seventy to seventy-five percent can potentially be achieved. Based on the average LFG production rate estimated by CRA in the July 2001 Report, a LFG collection rate of approximately 935 m^3 per hour (550 cfm) could be attained. The vertical LFG collection wells could be installed in increments as final closure is achieved, thereby permitting optimal collection of LFG and realization of the LFG utilization potential. Assuming that approximately 68 m^3 per hour (40 cfm) will be required for heating the landfill operations building, an approximate net quantity of 850 m^3 per hour (500 cfm) will be available for additional utilization

4.4.3 DESIGN ALTERNATIVE #3 - AGGRESSIVE UTILIZATION

Design alternative #3 presents the opportunity to achieve both odour and LFG migration control, and optimized/aggressive LFG collection for the purpose of maximizing the utilization potential of the LFG as an energy source. This alternative uses a composite system composed of both vertical extraction wells and horizontal trenches, and this is based upon the assumption that a geosynthetic cover will be incorporated into the final closure plan.

This design alternative demonstrates how collection of LFG could be improved for the purpose of aggressive utilization, with the result of achieving collection efficiencies greater than seventy-five percent of the total LFG production. For the purpose of this study it is assumed that approximately 1020 m3/hr (600 cfm) would be available for additional utilization.

This report assumes that design alternative #1 (odour and LFG migration control) will be voluntarily implemented by the RDN as part of its LFG management plan. As a result, for the purpose of this feasibility study, the incremental costs beyond those estimated for odour and LFG migration control will be utilized. The net total capital cost and net annual operations and maintenance (O&M) cost of each design alternative, not including the base cost associated with design alternative #1, are referred to as the "incremental" costs. For the purpose of this feasibility study, CRA has generated a preliminary total capital cost estimate (Table 1) for the three proposed LFG collection system design alternatives. In association with the total capital costs, Table 2 presents a preliminary estimate for annual operation and maintenance costs for these LFG collection system alternatives.

It should be noted that Table 1 assumes the installation of an enclosed flare unit for the odour and LFG migration control design alternative only. The capital cost estimate for design alternatives #2 (utilization) and #3 (aggressive utilization) assumes that a candlestick flare will be selected for periodic use when the utilization facility is not operational.

5.0 LFG UTILIZATION

5.1 CATEGORIES OF LFG PROCESSING

Over the past twenty-five years, a number of options for LFG utilization have been adopted and/or are currently being investigated at various landfills throughout the world. These options have encompassed the spectrum, from mass burning of the LFG as a boiler fuel, to substantial processing of LFG for utilization as a vehicle fuel. The most important differentiating feature, which influences the viability of a given LFG utilization technology, is the degree to which the LFG is processed. The level of processing dramatically influences the economics of the application. The three general categories of LFG processing are as follows:

1. low-grade LFG fuel;
2. medium-grade LFG fuel; and
3. high-grade LFG fuel and by-products.

The processing of the LFG is necessary due to its composition. LFG is composed of a mixture of methane, carbon dioxide, trace sulphur and chlorinated compounds, and is close to saturation with water vapour. The sulphur and chlorinated compounds, in association with water vapour, contribute to the corrosive nature of LFG. Unprocessed LFG typically has a heating value per unit volume of approximately one-half that of natural gas. This is due to the lower methane content and the presence of carbon dioxide, which absorbs heat energy during combustion.

5.2 EXAMPLES OF LFG PROCESSING

A number of opportunities exist for LFG utilization associated with the Landfill. Specifically, these include the following options:

5.2.1 LOW-GRADE FUEL

LFG as a low-grade fuel has been utilized for the heating of industrial space, heating of greenhouses, and direct combustion as part of plant operations (e.g. cement kiln, asphalt plant, chemical plant). Processing low-grade fuel involves a minimal level of effort, which is generally restricted to decreasing the moisture content of the LFG through a water knockout system.

Low-grade fuel is typically utilized as boiler fuel to produce steam, which can be used for either heating or electrical generation. The combusted LFG comes into contact solely with the boiler tubes prior to being discharged through an exhaust stack. Therefore, any corrosion due to contact with LFG generally occurs on robust static components rather than on the precision engine or turbine components.

There is minimal cost incurred for the processing of the LFG to meet low-grade fuel requirements. As a result, this LFG utilization option has considerable appeal. However, the economics of this utilization scheme is sensitive to the proximity of the potential LFG utilization proponent. Low-grade LFG can only be transported in the order of a hundred metres without significant condensate blockage issues arising within the pipeline unless moisture removal is adopted. In general, if there is not a large industrial or other commercial facility close to the landfill, the opportunity for this type of utilization is not feasible due to the capital cost of piping the LFG, and the associated annual operations and maintenance costs.

5.2.2 MEDIUM-GRADE FUEL

LFG may be upgraded to medium-grade fuel by reducing its moisture content, trace contaminants and particulates. Processing of the LFG to medium-grade fuel involves the removal of volatile organic compounds (VOCs), mercaptans, sulfur compounds and moisture with a scrubber/filter system and a dehydration system. Processing eliminates some of the concerns regarding the corrosive potential of the LFG and therefore permits more sophisticated end-uses. This type of processing also decreases the moisture levels in the LFG, thereby permitting substantially increased transport distances without incurring significant risk of flow blockage as a result of condensate formation in the transmission pipeline.

Medium-grade LFG can be used to fuel a wider range of industrial boilers, dryers, kilns and gas furnaces or to produce electricity through the use of reciprocating engines, gas turbines or combined-cycle (gas turbine and steam turbine) systems.

5.2.3 HIGH-GRADE FUEL

The use of LFG as a high-grade fuel requires substantial upgrading of LFG relative to that required for low-grade or medium-grade fuel. Processing includes the removal of moisture and trace contaminants such as VOCs, mercaptans, carbon dioxide, sulfur compounds and hydrogen sulfide. Upgrading the LFG to the high-grade fuel level permits any of a number of end uses including:

- High calorific value heating fuel (pipeline quality gas);
- Electrical generation;
- Commercial sale of carbon dioxide;
- Production of chemical products (e.g. methanol); and
- Emerging LFG utilization technologies (i.e. vehicle fuel).

As apparent from the above, a considerable array of LFG utilization options exist. Determination of which of the available options to undertake (if any), is determined by the costs of upgrading of the LFG and the revenue stream available from utilization.

Economies of scale are highly relevant in determining which utilization option is the most appropriate for a given landfill site.

5.3 RISKS ASSOCIATED WITH LFG UTILIZATION

An important consideration when analyzing potential for LFG utilization is the risk associated with the various options. Risks in undertaking a LFG utilization project include the following:

Projected Quantity and Quality of the LFG Resource

Forecasting the quantity and quality of LFG available for energy production over the life of the utilization project represents an uncertainty and therefore contributes to financial risk. Due to the quantity and quality of data available with regards to LFG production at the Landfill, this risk is minimal. However, the single largest source of uncertainty related to utilization at the Landfill is the final closure date. The later the date at which final closure is achieved, the longer the duration of LFG production and, as a result, the more viable a given utilization project.

Stability of End User

The potential exists that supply of LFG to a private end-user has risks associated with the stability of the user itself. These risks are related to the possibility that sometime during the utilization project's lifespan, the end-user's demand for the product may diminish. It is assumed, for the purpose of this study, that relative to a small private operation, a large corporation may provide a lower degree of risk associated with long-term financial stability.

Approvals and Permits

The time required to obtain the necessary approvals and permits can affect the scheduling of a LFG utilization project. Franchising permits to allow LFG to be piped to an end-user are an example of permits which may require a significant amount of time to obtain.

Access to Markets

Limited access to markets for sale of LFG products is a significant impediment to LFG utilization. The market for the sale of electricity generally consists solely of the provincial electrical utility (BC Hydro). Currently, BC Hydro is pursuing a new direction in which independent power producers (IPPs) will be permitted to connect to BC Hydro's transmission lines under a long-term contract. This will permit electrical power to be sold to Hydro at a rate assumed to be approximately $0.05 per kilowatt-hour (kWh).

Financial Returns from Greenhouse Gas Credits

There is uncertainty regarding the value of greenhouse gas (GHG) credits. As indicated in Section 7.0, the current value of GHG early action credits is low with the expectation that there will be a considerable increase in the future.

Hazardous/Carcinogenic Aspects of LFG

As discussed in Section 3.0, LFG itself possess several risks. However, LFG collection and utilization can alleviate concerns such as odor and LFG migration, and controlled and monitored combustion effectively removes the trace gases in LFG. When utilized in association with effective safety protocols, risks associated with LFG can be managed.

5.4 INHIBITING FACTORS TO LFG UTILIZATION

Although more than thirty landfills in Canada are recovering LFG for the purpose of utilization, many other projects have been stalled for one or more reasons. Inhibitory factors, which are potentially significant to LFG utilization, are as follows:

Regulatory Issues

In British Columbia, LFG recovery is addressed in the Landfill Criteria for Municipal Solid Waste (June 1993). This document, published by the British Columbia Ministry of Water, Land and Air Protection (BC MWLA), contains policy that must be considered by the Ministry's regional waste managers when preparing operations certificates for municipal solid waste landfills. The Criteria specify that, for landfills exceeding a total capacity of 100,000 tonnes, an assessment of the potential emissions of non-methane organic compounds (NMOCs) must be conducted. If the total emission of NMOCs exceeds 150 tonnes per year, installation of a LFG recovery and management system is required. As indicated in Section 4.2, the Landfill does not exceed this regulatory NMOC emission rate. Therefore, the RDN is not required to operate a LFG collection system and does so voluntarily as part of their long-term LFG management plan.

Economics

The availability of a market for utilization of the LFG is very important. The market for utilization is most effective when it consists of a year-round demand over a period of several years.

6.0 UTILIZATION OPTIONS PERTINENT TO THE RDN LANDFILL

The following section presents some of the utilization options specifically available to the Landfill. Site-specific factors, which must be considered when selecting a viable utilization option, include: geographic location, regional industry, government regulations, and willingness of local utility companies to purchase energy from IPPs.

Utilization Option I - Direct Combustion Application as a Low-grade Fuel

Currently, as indicated in the CRA (July 2001) report, approximately 68 m^3 per hour (40cfm) of LFG is utilized at the Landfill during the winter months for the purpose of providing heat to the maintenance building. This LFG utilization option is seasonal in demand; hence the economics are diminished. There is little or no potential for expanding this activity, as there are no current plans to expand the garage and maintenance facilities.

The sole industry located immediately adjacent to the landfill is a concrete "ready-mix" plant. Due to their limited heating requirements, the plant is not a likely candidate for utilizing the LFG as a low-grade fuel source.

Utilization Option II - Upgrade and Transport of the LFG as a Direct Combustion Fuel for the Harmac Industries Facility

The Harmac Pulp Operation facility (Pope & Talbot Ltd.) is located approximately four kilometers from the Landfill. Discussions with Harmac personnel indicate both their ability to utilize all the available LFG as boiler fuel and an interest to investigate the economics of transporting the LFG, via pipeline to the Harmac facilities. Natural gas fuel consumption data from the facility indicates that Harmac could utilize all the LFG resource made available to it without reduced seasonal demand.

Utilization Option III - Upgrade and Transport of the LFG as an Energy Supplement for Greenhouses

There is a greenhouse operation located approximately three kilometers from the Landfill on McMillan Road. The potential exists for utilization of the LFG as an energy source as part of their operations. However, based on discussions with the owner, their current energy requirements vary seasonally and it is estimated that their peak heating requirements could be satisfied by approximately 100 m^3 per hour of LFG (50 percent methane by volume). This fuel demand would represent only a portion of the total available LFG resource.

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Utilization Option IV - Upgrade and Transport of the LFG as a Direct Combustion Fuel for Utilization at the Aquaculture Facilities Situated on Cedar Road

There is significant demand for heat energy associated with the aquaculture facilities situated on Cedar Road. The potential for utilization of the LFG is excellent due to the fact that a significant energy need exists year-around. This facility is located several kilometres from the landfill, there fore, a pipeline would be required similar to that required of either the Harmac or greenhouse options.

Utilization Option V – Upgrade and Transport to a Facility adjacent to the Landfill

Currently, the land east of the Landfill is undeveloped and presents the opportunity for an organization to develop a business strategy centered on the potential utilization of LFG as an energy source. It is envisioned that, due to the close proximity of a potential utilization facility to the Landfill, little upgrade to the LFG would be necessary to facilitate pipeline transportation. As a result, the economics of low-grade fuel utilization are improved relative to utilization at facilities located at some distance from the Landfill.

Utilization Option VI - Generate Electricity Utilizing the LFG as the Feedstock for Reciprocating Engines

The implementation of a LFG collection system, with a capacity to collect in excess of 850 m^3 per hour, presents the opportunity for the generation of electricity at the Landfill. The generation of electricity utilizing reciprocating engines is a thoroughly tested technology, currently being utilized throughout the landfill industry.

The critical limiting factor preventing widespread utilization of LFG for the purposes of electrical generation has been access to the electricity market. In some situations there has been development of electricity using biogas (Annacis Island), however, the quantity of electricity produced has been historically insufficient to warrant the need to market the electricity external to the Facility.

Until recently, there was considerable resistance from BC Hydro to purchase the power at a price which would make a LFG electricity generation project economically viable in BC. Furthermore, BC Hydro was assessing charges for electricity wheeling at levels which would preclude favorable economics for projects involving electricity transmission to a consumer.

Over the last few months, BC Hydro has been developing an Electricity Purchase Agreement (EPA) wherein there are indications that electricity from LFG may be sold to the grid as eco-efficient or green power. The Power Supply Division of BC Hydro is currently developing the EPA for purchase of power from IPP generation plants having an expected generation capacity of less than forty GWh per year. It is noted that the EPA purchase price of the electricity includes any values associated with electrical offset credits. Further, the agreement currently requires a twenty-year timeframe (although at present, the draft agreement does not contain a penalty clause for non-delivery).

The development of this EPA represents an important first step which will require more in-depth review. For the purpose of this study it is assumed that the EPA will offer IPP's a rate of approximately $0.05 per kWh. This rate would greatly assist the financial interest in undertaking the development of an electrical production facility at the Landfill.

Utilization Option VII - Generate Electricity Utilizing the LFG as the Feedstock for Microturbines

The potential exists for the utilization of microturbines to generate electricity at the Landfill. One of the characteristics of microturbines most relevant to application in LFG utilization projects is that they have been designed to operate on small quantities of LFG. As an example, a commercially available sixty kW microturbine unit will operate on less than 51 m^3 per hour (30 cfm) at fifty percent methane (by volume).

The small incremental microturbine power units permits the operator of an IPP facility to increase or decrease the number of microturbines operating at the Landfill as the quantity of LFG varies over time. However, the utilization of microturbines is still at the research and development stage for utilization with LFG and the long-term durability and operating costs are currently unknown.

Utilization Option VIII - Generation of Electricity Utilizing Fuel Cells

The fuel cell is an emerging technology for LFG utilization that converts hydrogen directly to electricity. Use of fuel cells requires that the LFG be processed to produce high-grade fuel.

The fuel cell system involves the use of a high-grade LFG fuel processor, a fuel cell stack power transformer (direct current to alternating current), and a cooling tower for waste heat treatment. Current fuel cell technologies include:

- Phosphoric Acid Fuel Cell (PAFC);
- Proton Exchange Membrane Fuel Cell (PEMFC);
- Molten Carbonate Fuel Cell (MCFC);
- Solid Oxide Fuel Cell (SOFC); and
- Alkaline Fuel Cell (AFC).

Currently, the only commercially produced fuel cell unit available, which has operated at the pilot project scale utilizing LFG, is a 200 kW PAFC. There are indications from a SOFC producer that SOFC technology may be ideally suited to utilization with a LFG fuel source. However, a commercially available SOFC unit is not currently available, but warrants further investigation as the technology develops.

Discussions with the aforementioned PAFC manufacturer indicated that the greatest challenge regarding the viability of fuel cell technology adaptation to LFG is related to the processing of LFG to high-grade fuel. Further research is required with regard to process controls before fuel cells can be adapted for commercial applications utilizing LFG as a fuel source.

Another significant disadvantage of current fuel cell technology is their high capital cost relative to microturbines and reciprocating engines. This is due largely to economies of scale. As the technology develops and more fuel cell units become commercially available, it is believed that their cost will decrease significantly.

Utilization Option IX - High-grade LFG Utilization for Pipeline Quality, Vehicle Fuel, Feedstock for Chemical Manufacturing, etc.

Use of LFG to produce compressed landfill gas (CLG) is generally only economically viable at very large landfills which recover greater quantities of methane than they can utilize directly (EPA-600/R-98-021). The production of CLG involves both purification and compression of the LFG. As a result, the processing of LFG from the Landfill, to produce compressed high-grade fuel is not economically viable due to economies of scale.

There has also been research conducted to investigate the viability of converting LFG to methanol for use as a chemical feedstock or as a vehicle fuel (EPA-600/R-98-021). However, the quantities of LFG available at the Landfill preclude this option from further investigation.

In general, the substantial capital and O&M costs associated with the processing of LFG to produce high-grade fuel precludes interest in this activity as an economically viable utilization option.

Utilization Option X - Heat Recovery from Landfill Flares

The use of a flare system at the Landfill will be relatively modest, particularly if LFG utilization is adopted. As a consequence, the opportunity for utilization of the flare waste heat is not considered likely to be viable due to lack of economics of scale.

7.0 GREENHOUSE GAS CREDITS

7.1 BACKGROUND TO GHG VALUATION

It is now widely recognized that the Earth's climate is changing, as a result of global warming, in a manner directly comparable with greenhouses. The Kyoto Protocol was developed in response, and included a response by Canada as a co-signatory. It is likely that Canada will ratify the Protocol in the fall of 2001 or shortly thereafter.

The specifications within the Kyoto Protocol require average reductions in greenhouse gas (GHG) emissions to six percent below 1990 levels, with this target to be achieved between 2008 and 2012. However, there is no formal policy on how these reductions will be achieved. In order to encourage activities that contribute to Canada's reduction targets in advance of ratification of the Kyoto Protocol, the federal government is expected to develop a system of "Credits for Early Action". Under this system, companies or sectors that take proactive steps to reduce emissions prior to a formal requirement to do so, would be given some form of credit toward their future reduction burden. Early action credits form the basis of interest for the existing purchase of GHG credits.

The nature of the LFG GHG credits arises due to the composition of LFG. LFG is generated through the anaerobic decomposition of organic wastes in landfills. LFG is one of the most significant sources of anthropogenic methane releases to the atmosphere in Canada. Methane, which comprises approximately fifty percent of LFG, is a potent GHG, which has 21 times the global warming potential of carbon dioxide. Hence, the capture and combustion of LFG to transform the methane to carbon dioxide, dramatically influences the global warming potential of the LFG. Further, the costs for such control and combustion are much less than many of the alternatives available to industry as a result of industrial process change. As a consequence, companies with large potential GHG liabilities have begun to purchase low cost credits from third parties (either as "early actions" or "options" on future GHG reductions). The value of these credits is a function of a company's total exposure, internal cost of GHG future reductions, and perceived quality of the credits (e.g. the likelihood that the project will be eligible for a credit for early action).

The purpose of emissions trading is to avoid quantitative restrictions on individual emitters. The intent is that the aggregate limit on emissions is translated into a market-determined price of emissions faced by individual emitters.

An actual market for credits does not exist at this time, but "over the counter" nominal prices in North America have ranged from $0.50 to $1.00 (CAD) per tonne of CO_2 equivalent prior to 2000. For 2001/2002, indications suggest prices in the range of $2.00 (CAD) per tonne will be reached because the opportunity for purchase of LFG-derived GHG credits is limited in quantity, and these credits represent considerably less expenditure for attainment than many, more expensive options. As a consequence, it is expected that a very competitive market will develop in the near future for the purchase of the LFG credits. If mandatory compliance regulations for GHG emissions are implemented, some industry experts expect that prices could exceed $10.00 (CAD) per tonne of CO_2 equivalents.

7.2 ESTIMATION OF GHG VALUE FOR THE RDN LANDFILL

In conjunction with the existing LFG collection system and the three proposed LFG management options, the potential exists to collect the GHG credits. A summary of the potential value of these credits, based on an assumed value of $1.50 (CAD) per tonne, is presented in Table 3. It is noted that since the value of the GHG credits is variable, these calculations are only indicators of potential value. However, they suggest the order-of-magnitude that these credits may assume.

These GHG credit values do not include potential thermal offsets, which may be available if the LFG is utilized as a low-grade fuel to replace natural gas consumption. In addition, potential electrical offsets are not included as they are assumed to be included as part of the BC Hydro EPA.

8.0 MARKETABILITY AND FINANCIAL ASPECTS OF LFG UTILIZATION

A number of viable site-specific potential utilization options exist as described in Section 6.0. These options include the following:

- Utilization of LFG as boiler fuel at either an existing facility (Harmac, aquaculture, or greenhouse facilities) or the development of a facility adjacent to the Landfill;
- Generation of electricity at a facility located at, or adjacent to the Landfill.

This section will further explore the feasibility of these options from a financial perspective. For the purpose of the below economic analysis, a utilization project life span of twelve years was selected based upon the estimated 2008 closure date utilized for the LFG production estimates presented in the CRA (July 2001) report. For the purpose of this comparative analysis, all capital costs are assumed to be financed over the term of the project (twelve years) at a real interest rate (net of inflation) of six percent. All cost and revenue estimates presented in this study are reported in Canadian dollars (CAD).

8.1 UTILIZATION OF LFG AS BOILER FUEL

This option assumes that the LFG would be used as either as boiler fuel at either a facility to be constructed in close to the Landfill or piped to one of the aforementioned existing facilities.

Table 4 presents the estimated energy value of the LFG based on a fifty percent methane content. For the purpose of this study, it was assumed that the RDN could receive an energy payment rate of $1.00 per GJ for the LFG.

Table 5 presents the net annual revenue to the RDN taking into account the value of the LFG as per Table 4, the value of the GHG credits as per Table 3, and the following costs:

- Initial capital expenditure for LFG treatment;
- Annual operation and maintenance (O&M) costs associated with LFG treatment;
- Incremental LFG collection system capital cost; and,
- Annual LFG collection system (O&M);

The data presented in Table 5 assumes that the RDN has already committed the capital to install the LFG odour and migration control system as part of their LFG management plan. Therefore, as discussed in Section 4.4, all capital costs and annual O&M costs above those which would we spent for odour and migration control are referred to as incremental costs (Table 1).

The data in Table 5 also assumes that the RDN will deliver the LFG to their property line and does not account for capital expenditures related to constructing, operating, or maintaining a LFG transmission pipeline.

Table 6 presents a preliminary estimate of the potential net benefits to an end-user of the LFG as boiler fuel excluding any potential thermal offset credits which would likely require negotiations. This net savings analysis assumes that an initial capital investment of approximately 1.1 million dollars would be required to design and construct a four-kilometre pipeline and compressor system. For the purpose of this study, a conservative retail value for natural gas ($4.00 per GJ) was assumed. However, the current volatility of the market place and significant fluctuations in energy prices witnessed in North America in the last year make it difficult to predict future energy trends.

8.2 ELECTRICAL GENERATION

As discussed in Section 6.0, there are three main options available for electrical generation at the Landfill: reciprocating engine technology, microturbine technology, and fuel cell technology. For the purpose of comparison of economics, the utilization LFG collection system option was selected (850 m^3 per hour / 500 cfm). Based upon this assumed LFG collection capability, Table 7 presents the number of electrical generating units which could be sustained. The power output of the microturbine and fuel cell technologies were based on published data from Capstone (60 kW) microturbines and IFC (200 kW) fuel cells. There are several companies producing reciprocating engines with a wide range of power outputs. Three 500 kW reciprocating engines were selected based upon the quantity of LFG available for utilization (i.e. a total of approximately 1500 kW for fifty percent methane LFG).

Table 8 presents the approximate total power output (not taking into account line and parasitic electrical losses), and estimated capital cost for the engine / cell components.

Table 9 presents an estimate of the total capital cost for designing and constructing an electrical generation facility at the landfill. This cost estimate includes a conceptual estimate for LFG treatment, facility enclosure, electrical and mechanical works required, and BC Hydro interconnect costs. It should be noted that a significant issue with regard to microturbine and fuel cell technology is the level of effort required to adequately process the LFG to reduce O&M costs for microturbines and permit fuel cells to function. In addition, it is unknown, at the feasibility stage, to what degree compounds such as siloxanes, halides, and sulphur compounds are present in the LFG. These compounds can significantly impact reciprocating engine wear and, it is assumed would have a similar effect on microtubines. As a result, analytical testing would be required to better estimate the capital costs associated with LFG treatment.

Table 10 presents the estimated net revenue to the RDN for an electrical generation LFG utilization project. This estimated revenue stream takes into account revenue from BC Hydro at a rate of $0.05 kWh and GHG credits (with the exception of electrical offset credits included in the EPA contract). It should be noted that for this preliminary revenue estimate, electrical losses were not accounted for.

8.3 DISCUSSION AND RANKING OF UTILIZATION OPTIONS

It is noted that the revenue and costs, indicated in the preceding section, are generally reasonable preliminary estimates. Four significant unknowns, which must be evaluated during any subsequent detailed engineering assessment, are:

- Landfill closure date;
- The period of time over which sufficient LFG is produced at the Landfill capable of supporting a given utilization facility;
- The cost associated with constructing a pipeline across the Nanaimo River to Harmac, the greenhouses, or the aquaculture facility; and
- The level of effort and associated expenses required to upgrade LFG for utilization as fuel for reciprocating engines, microturbines, or fuel cells.

As previously discussed, the twelve year term utilized in this proposal is based upon a 2008 closure date for the Landfill. Any actions which can be undertaken by the RDN to extend the life of the Landfill, therefore increasing the total refuse disposal space, will directly benefit the economics of any given utilization project. Extensions to the duration of the project, beyond the twelve-year timeframe envisioned in this study, would directly benefit the economics of the project.

Further economic analysis is warranted to estimate pipeline construction costs. These pipeline construction and maintenance costs could be avoided, hence result in significant capital cost savings, if commercial or economic development occurred adjacent to the Landfill.

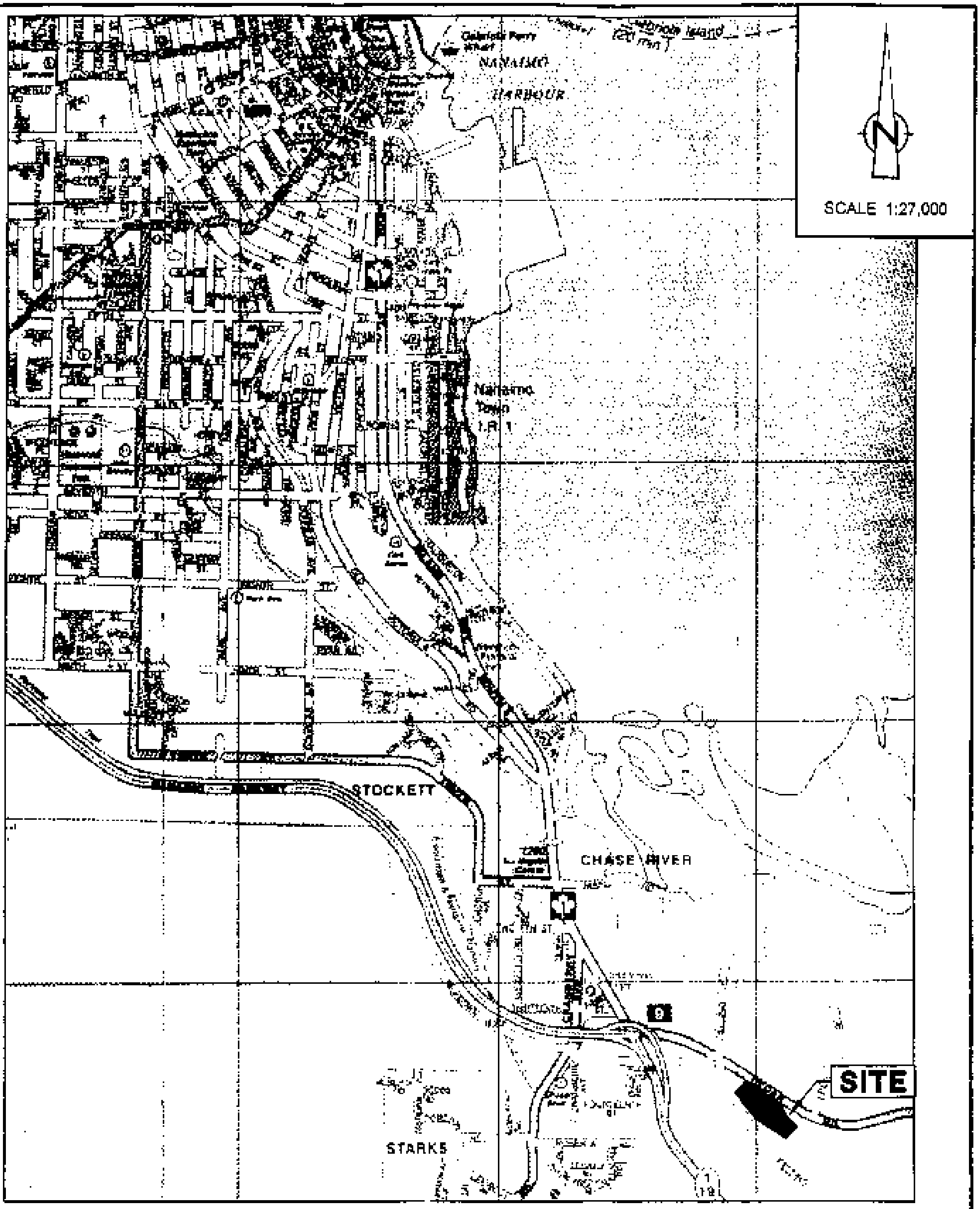
As stated in Section 8.2, the level of effort required to upgrade the LFG for use with reciprocating engine, microturbine or fuel cell technology requires further investigation. The LFG utilization industry has a significant amount of practical experience with the use of LFG as a fuel source for reciprocating engines. However, analytical analysis of the LFG is required to determine the quantities of various entrained compounds, which could impact the operation and maintenance costs. The level of LFG processing necessary for microturbines is significantly less known and virtually unknown for fuel cells. As a result, application of microturbine or fuel cell technology would be considered research or pilot project level and require significant funding to research and implement adequate LFG pretreatment systems.

A ranking matrix based upon the relative level of LFG pretreatment, industry experience with the proposed technology, relative initial capital cost expenditure, and relative estimated level of return is presented in Table 11. This Table reflects the above stated unknown factors (level pretreatment and pipeline costs) as well as the uncertainty as to energy pricing. The estimated revenue from electrical generation is somewhat more predictable (with the exception of the GHG credit value) as a result of the Bc Hydro draft EPA which will fix the energy purchase price for electrical generation.

Based upon the information presented above and synthesized in Table 11, a number of LFG utilization opportunities exist. The most promising strategies for LFG utilization at the Landfill are as follows:

1. Low-grade fuel utilization facility located adjacent to the landfill.
2. Electricity generation utilizing reciprocating engine technology.
3. Low-grade fuel utilization at a facility located at some distance from the Landfill, which can utilize the entire LFG supply without significant seasonal variation.

FIGURES

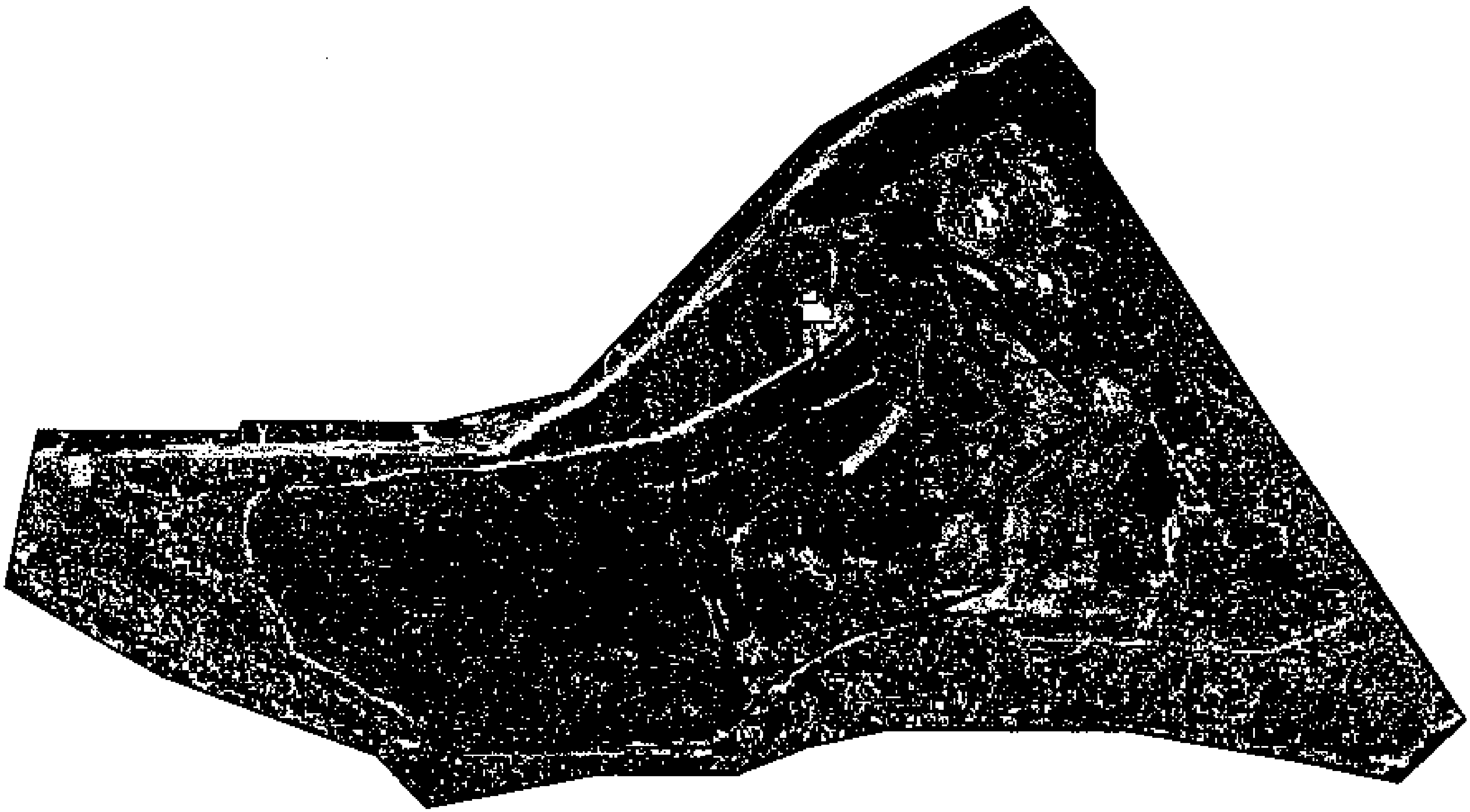


SOURCE: NANAIMO/PARKSVILLE CITY MAP
MAP ART CORPORATION (1996 EDITION)

figure 1

SITE LOCATION MAP
REGIONAL DISTRICT LANDFILL
Regional District of Nanaimo

17064-00(005)GN-VA001 DEC 06/2001



LEGEND:

- CELL A (UNLINED) - (1946-1996)
- CELL B (LINED) - (1996 - PRESENT)
- CELL C (LINED) - (2001 - PRESENT)

figure 2

CELL BOUNDARIES
REGIONAL DISTRICT LANDFILL
Regional District of Nanaimo

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TABLES

TABLE 1
ESTIMATED CAPITAL COSTS
ASSOCIATED WITH LFG COLLECTION SYSTEM

Design Alternative	Estimated Total Capital Cost	Annual Capital Cost Payment[3]	Incremental Capital Cost[4]	Annual Incremental Capital Cost Payment[3],[4]
Odour & LFG Migration[1]	735,000	87,669	N/A	N/A
Utilization[2]	812,000	96,853	77,000	9,184
Aggressive Utilization[2]	899,000	107,230	164,000	19,561

Notes: [1] Assumes the installation of an enclosed flare.
[2] Assumes the installation of a candlestick flare.
[3] Based on a twelve year project duration at six percent interest.
[4] Incremental defined as the cost above the odour & LFG migration control base case.

TABLE 2
ESTIMATED OPERATION AND MAINTENANCE COSTS
ASSOCIATED WITH LFG COLLECTION SYSTEM

Design Alternative	Estimated Total Annual O&M Cost	Incremental O&M Cost[1]
Odour & LFG Migration	55,800	N/A
Utilization	97,200	41,400
Aggressive Utilization	108,000	52,200

Notes: [1] Incremental defined as the cost above the odour & LFG migration control base case.

TABLE 3
ESTIMATED VALUE OF GREENHOUSE GAS CREDITS

Design Alternative	Assumed Average Collection LFG[2] (m^3/hr)	Methane (tonnes/yr)	Carbon Dioxide Equivalent (tonnes/yr)	Annual Value[3] ($)
Current [1]	170	534	11,205	16,800
Odour & LFG Migration	595	1867	39,217	58,825
Utilization	850	2668	56,025	84,000
Aggressive Utilization	1020	3201	67,230	100,840

Notes: [1] It is possible to consider marketing the GHG credits for the existing flaring system since the LFG collection/flaring system was installed in 1997. This may or may not be considered acceptable as an early action credit.
[2] As specified in the Landfill Management report.
[3] Based on $1.50 CAD per tonne CO_2 equivalent.

TABLE 4
ESTIMATED ENERGY VALUE OF LFG

Design Alternative	Assumed Collection Rate of LFG[1] (m^3/hr)	Assumed Collection Rate of LFG (m^3/yr)	Energy Value[2] (Mbtu/yr)	Energy Value[2] (GJ/yr)
Current	170	1,488,331	26,842	28,320
Odour & LFG Migration	595	5,209,167	93,947	99,120
Utilization	850	7,441,667	134,211	141,600
Aggressive Utilization	1020	8,930,001	161,053	169,920

Notes: [1] As specified in the Landfill Management report.
[2] Based on a methane content of 50 percent (%vol/vol) at a rate of $1.00/GJ.

TABLE 5
ANNUAL NET REVENUE FOR UTILIZATION AS LOW GRADE FUEL (BASED ON $ 1.00 / GJ)
INCLUDING GHG CREDITS

Design Alternative	Gross Annual Fuel Revenue	Value of GHG Credits[1]	LFG Process Facility Cost[2]	Annual Process Facility O&M Cost	Annual Incr. LFG Collection System Cost	Annual Incremental LFG O&M Cost	Annual Net Revenue
Utilization	141,600	84,037	44,580	25,000	9,184	41,400	105,473
Aggressive Utilization	169,920	100,844	44,580	25,000	19,561	52,200	129,423

Notes: [1] GHG credit value assumed to be $1.50 per tonne CO_2 equivalent. Natural Gas offsets may represent additional revenue.
[2] Based on a twelve year project duration at six percent interest.

TABLE 6
ESTIMATED NET SAVINGS FOR UTILIZATION OF LFG AS LOW GRADE FUEL
(based on natural gas unit cost of $4.00 / GJ)

Design Alternative	Annual LFG Purchase Price[1]	Annual Capital Payments[2]	Annual O&M Cost[3]	Annual Natural Gas Displacement[4]	Net Savings
Utilization	141,600	136,453	27,290	566,399	261,056
Aggressive Utilization	169,920	136,453	27,290	679,679	343,016

Notes: [1] Based upon LFG at fifty percent methane and a rate of $1.00 per GJ.
[2] Payment of pipeline capital investment at six percent interest over a twelve year period.
[3] Annual pipeline O&M costs assumed to be twenty percent of annual capital payments.
[4] Value of natural gas displaced (at an assumed rate of $4.00/GJ).

TABLE 7
ELECTRICAL GENERATION OPTIONS AND ESTIMATED UNIT COSTS

Generation Method	Approximate Power Output (kW)	LFG Consumption Rate (m^3/hr)	LFG Consumption Rate (cfm)	Approximate Cost per unit[1]
Reciprocating Engine	500	297	175	500,000
Micro-turbines	60	46	27	75,000
Fuel Cell	200	110	65	1,300,000

Notes: [1] Unit cost for supply of generation unit only. Does not include installation or infrastructure costs.

TABLE 8
ELECTRICAL GENERATOR CAPITAL COST ESTIMATE

Generation Method	Unit Power Output (kW)	Number of Units	Total Power Output (kW)	Total LFG Consumption (cfm)	Total LFG Consumption (m^3/hr)	Total Engine Capital Cost[1]
Reciprocating Engine	500	3	1500	525	892	1,500,000
Micro-turbines	60	19	1140	513	877	1,425,000
Fuel Cell	200	8	1600	520	883	10,400,000

Notes: [1] Unit cost for supply of generation unit only. Does not include installation or infrastructure costs.

TABLE 9
ELECTRICAL GENERATION TOTAL CAPITAL COST ESTIMATE

Generation Method	Total Engine Capital Cost	LFG Treatment Capital Cost[1]	Pre-Engineered Building	Electrical and Mechanical	BC Hydro Interconnect	Design/ Construction	Total Capital Cost
Reciprocating Engine	1,500,000	250,000	200,000	200,000	200,000	85,000	2,435,000
Micro-turbines	1,425,000	300,000	200,000	250,000	200,000	95,000	2,470,000
Fuel Cell	10,400,000	400,000	200,000	200,000	200,000	100,000	11,500,000

Notes: [1] Preliminary cost estimate only. LFG analytical testing required to further establish the level of effort required to adequately process the LFG for each of the proposed technologies.

TABLE 10
ANNUAL NET REVENUE FOR ELECTRICAL GENERATION UTILIZATION SCHEME INCLUDING GHG CREDITS

Generation Method	Gross Annual Electrical Revenue[1]	Value of GHG Credits[2]	Annual Utilization Facility Cost[3]	Annual Utilization Facility O&M Cost	Annual Incr. LFG Collection System Cost	Annual Incremental LFG O&M Cost	Annual Net Revenue
Reciprocating Engine	657,000	84,037	290,440	195,000	9,184	41,400	205,013
Micro-turbines	499,320	84,037	294,614	195,000	9,184	41,400	43,159
Fuel Cell	700,800	84,037	1,371,686	195,000	9,184	41,400	-832,433

Notes: [1] Based on a BC Hydro Green Power rate of $0.05 / kWh. Rate includes payment for electrical offsets.
[2] GHG credit value assumed to be $1.50 per tonne CO_2 equivalent.
[3] Based on a twelve year project duration at six percent interest.

TABLE 11
RANKING OF AVAILABLE TECHNOLOGIES

Utilization Option	Level of Pretreatment	Technology Experience	Level of Capital Cost Expenditure	Estimated Relative Level of Return	Overall
Low-grade Fuel					
Pipeline Distance					
< 1000m	1	1	1	1	1
> 1000m	1.5	1	2	1.5	2
Electrical Generation					
Reciprocating Engine	1.5	1.5	2	1.5	2
Microturbine	3	3	3	3	3
Fuel Cell	4	4	4	4	5
High-grade Fuel	4	3	3	3	4

Notes: [1] Scale range from 1-5, where 1 is highest ranking and 5 is lowest.

REGIONAL DISTRICT OF NANAIMO

MINUTES OF THE MEETING OF THE BUILDING ADDITION COMMITTEE HELD ON TUESDAY, APRIL 23, 2002, AT 6:00 PM IN THE NANAIMO CITY BOARD ROOM

Present:

Director G. Holme	Chairperson
Director L. Elliott	Electoral Area A
Director E. Hamilton Alternate	Electoral Area C
Director B. Jepson	Electoral Area D
Director J. McLean	Electoral Area F
Director J. Stanhope Alternate	Electoral Area G
Director J. Pipes	Electoral Area H
Director J. Macdonald	City of Parksville
Director T. Westbroek	Town of Qualicum Beach
Director D. Rispin	City of Nanaimo
Director L. McNabb	City of Nanaimo
Director B. Holdom	City of Nanaimo

Also in Attendance:

K. Daniels	Chief Administrative Officer
C. Mason	Gen. Mgr. of Corporate Services
B. Lapham	Gen. Mgr. of Development Services
N. Avery	Manager. of Financial Services
D. Neale	Neale Staniszkis Doll Adams Architects

ADMINISTRATION

Building Addition – Schematic Design – Verbal Report.

The consultant presented two options for the design of the building addition and responded to questions from the Building Committee.

MOVED Director McNabb, SECONDED Director Hamilton, that the Board endorse Schematic Design Option 1, which provides for construction of an addition to the RDN Administration Building with the Board Room located on the main floor.

CARRIED

MOVED Director McNabb, SECONDED Director Stanhope, that the Regional District of Nanaimo retain NSDA Architects, including their listed sub-consultants, to complete the Final Design, prepare the Tender Documents and oversee the Construction Phase of the RDN Building Addition Project for a fixed fee of $88,000 plus disbursements.

CARRIED

ADJOURNMENT

MOVED Director Stanhope, SECONDED Director Hamilton, that this meeting terminate.

CARRIED

TIME: 6:25 PM

CHAIRPERSON

REGIONAL DISTRICT OF NANAIMO

REGIONAL DISTRICT OF NANAIMO

APR 2 4 2002

CHAIR		GMCrS	
CAO		GMDS	
GMCmS		GMES	

Spec Board

MEMORANDUM

TO: K. Daniels
Chief Administrative Officer

DATE: April 24, 2002

FROM: C. Mason
General Manager, Corporate Services

FILE:

SUBJECT: **RDN Administration Building Expansion – Schematic Design**

PURPOSE:

To present the schematic design options for the RDN Administration Building Expansion Project.

BACKGROUND:

At the October 9, 2001 Board meeting, the Board approved proceeding with the construction of an addition to the RDN Administration Building and directed staff to prepare the necessary tenders to undertake this project. The addition includes administrative office and meeting room space, and includes a Board Room with a seating capacity for an audience of 50 persons.

Over the winter months an internal staff steering committee was formed to oversee the project and a detailed proposal document was developed outlining the requirements and specifications of the addition. Several bids were received for the design and the architectural firm of Neale Staniszkis Doll Adams (NSDA) was selected to undertake the Schematic Design and Design Development Phase of the project. Once the Board has approved the Schematic Design of the project, NSDA would proceed to complete the Final Design and oversee the Construction Phase of the Project.

Schematic Design Options:
Two options have been developed and presented to the Building Committee for consideration. As approved by the Board last fall, both options represent an overall addition of approximately 6,200 sq ft. Schematic design drawings outlining both options are attached to this report.

Option 1. Option 1 identifies the Board Room on the ground floor with an adjacent committee room and kitchenette, public washrooms and ancillary rooms. The second floor of the addition contains office space for the Finance Department. An elevator and staircase connects both floors. Due to the higher ceiling requirement of the Board Room, the second floor covers approximately half of the first floor with the Board Room extending out from the addition for the portion of the room with the higher ceiling height. The exterior appearance of option 1 is included in the attached schematic design plans, showing the two rooflines of the proposed addition.

Option 2. Option 2 proposes that the Board Room be located on the second floor. Under this configuration, Finance Department office space, committee room and ancillary meeting space is located on the first floor. The configuration of the building under this option is shaped with one floor located directly above the other floor. Under this option, the second storey roofline would be higher than the existing building due to the higher ceiling height required for the Board Room.

ALTERNATIVES:

1. Approve Schematic Design Option One with the Board Room located on the main floor and retain NSDA Architects and their listed sub-consultants to complete the Final Design, prepare Tender Documents and oversee the Construction Phase of the Project for a fixed fee of $88,000 plus disbursements.

2. Approve Schematic Design Option Two with the Board Room located on the second floor and retain NSDA Architects and their listed sub-consultants to complete the Final Design, prepare Tender Documents and oversee the Construction Phase of the Project for a fixed fee of $88,000 plus disbursements..

FINANCIAL IMPLICATIONS:

There are no anticipated differences in construction cost based upon the options presented. Option one may be the preferred option based upon the functional aspects of the schematic design as presented by the architect. The firm of NSDA has been selected by the steering committee through an RFP process to complete the schematic design of the project. The steering committee recommends that NSDA be retained to complete Final Design and Construction of the project for a total cost of $88,000 plus disbursements, which includes professional services for all required sub-consultants.

CONCLUSIONS:

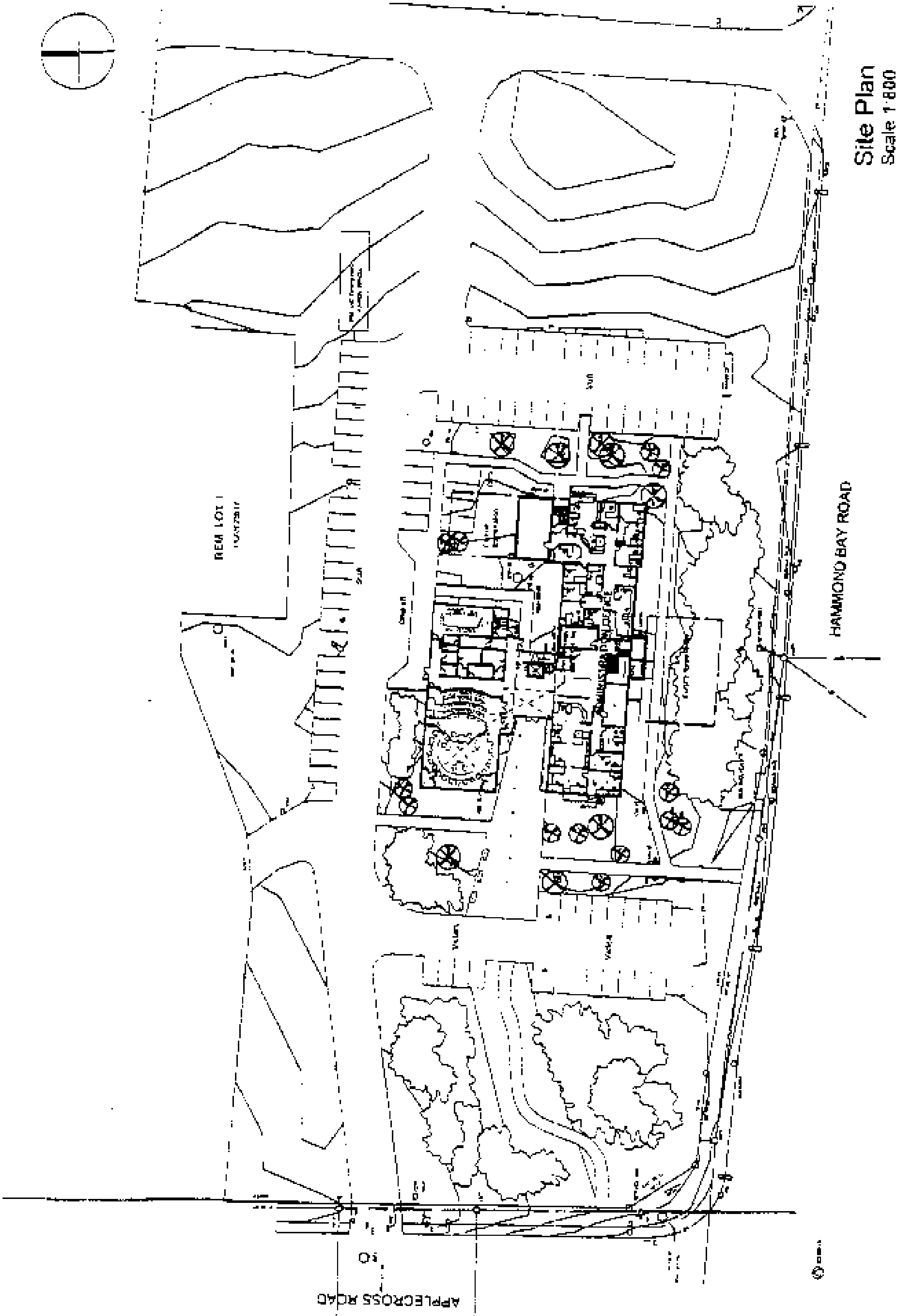
Two options are being presented for the Board's consideration for the schematic design of the building addition. The Board Building Committee has reviewed the two options and has supported option one, as contained in the recommendations set out below.

RECOMMENDATIONS:

1. That the Board endorse Schematic Design Option One, which provides for construction of an addition to the RDN Administration Building with the Board Room located on the main floor;

2. That the Regional District of Nanaimo retain NSDA Architects, including their listed sub-consultants, to complete the Final Design, prepare the Tender Documents and oversee the Construction Phase of the RDN Building Addition Project for a fixed fee of $88,000 plus disbursements.

Report Writer — C.A.O. Concurrence


Site Plan
Scale 1:800
HAMMOND BAY ROAD
APPLECROSS ROAD
REM LOT 1

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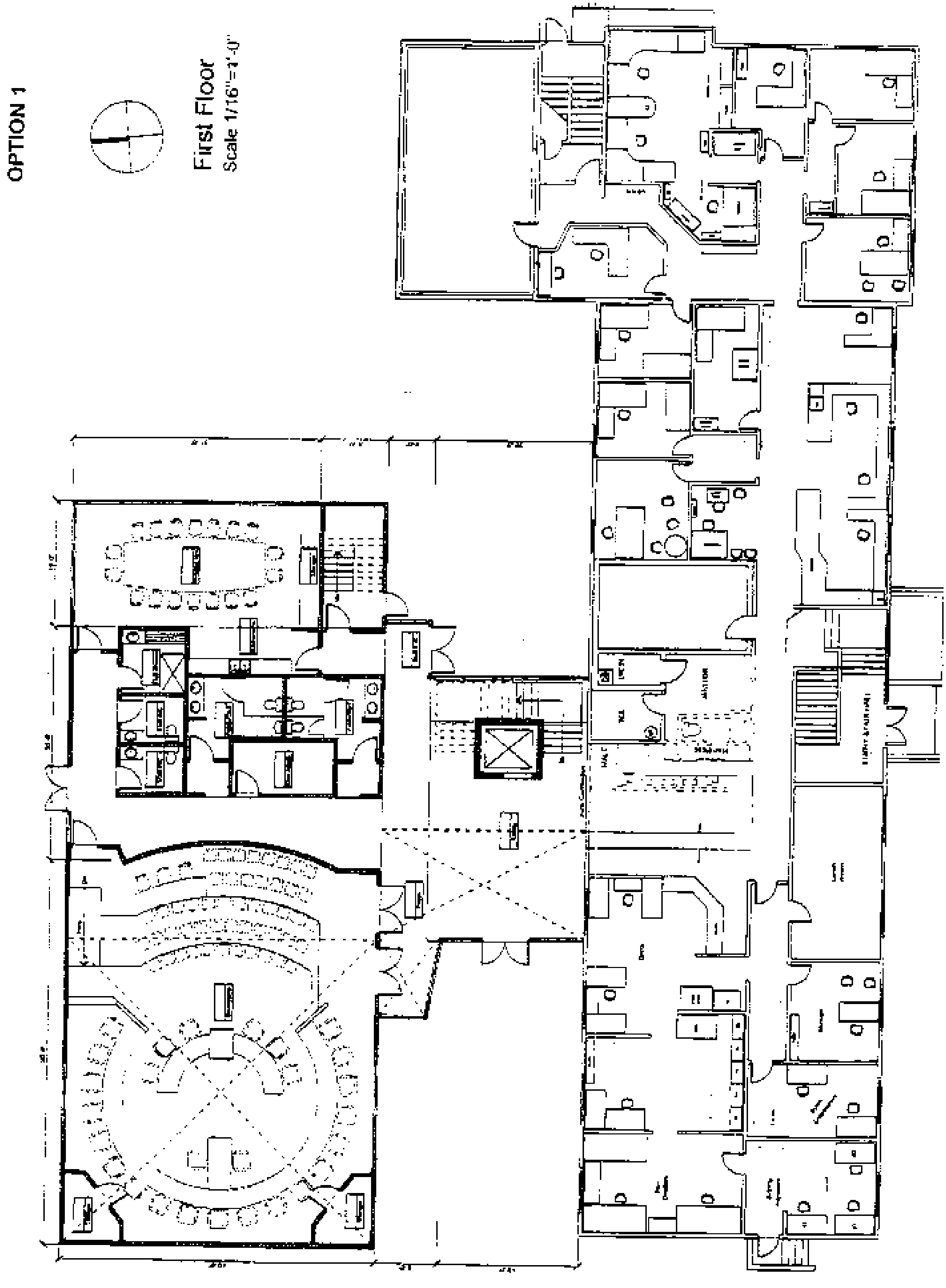

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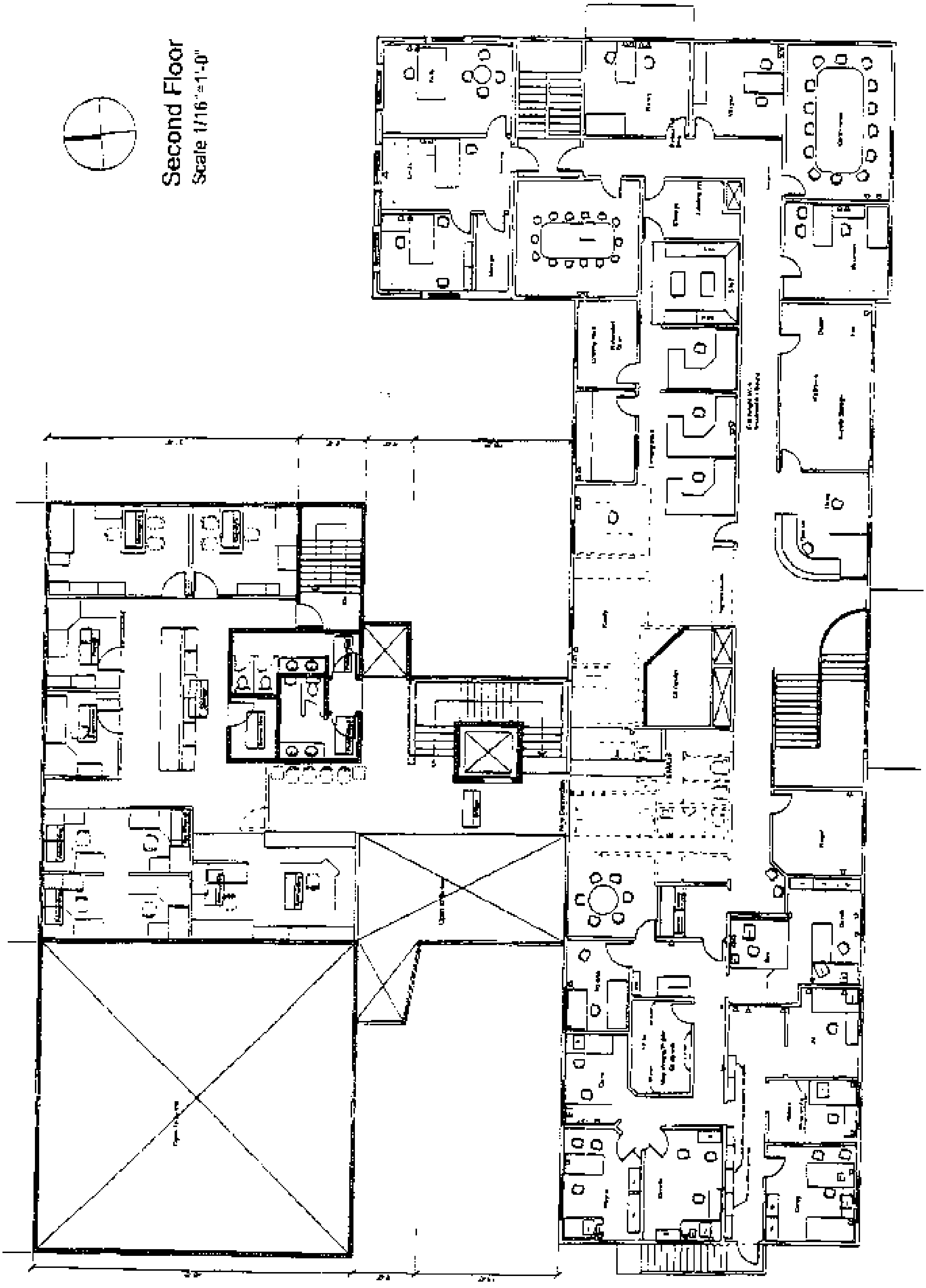
OPTION 1

Second Floor
Scale 1/16"=1'-0"



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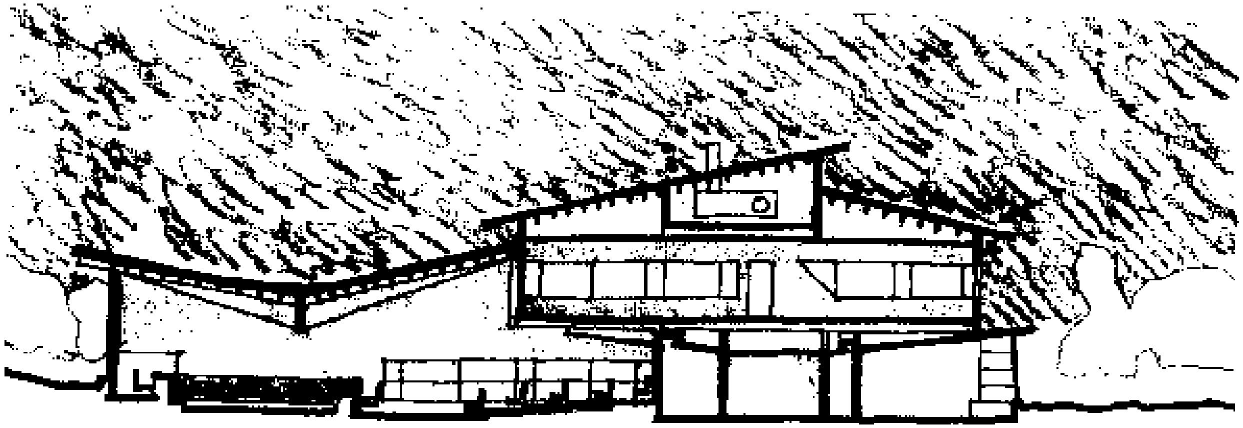
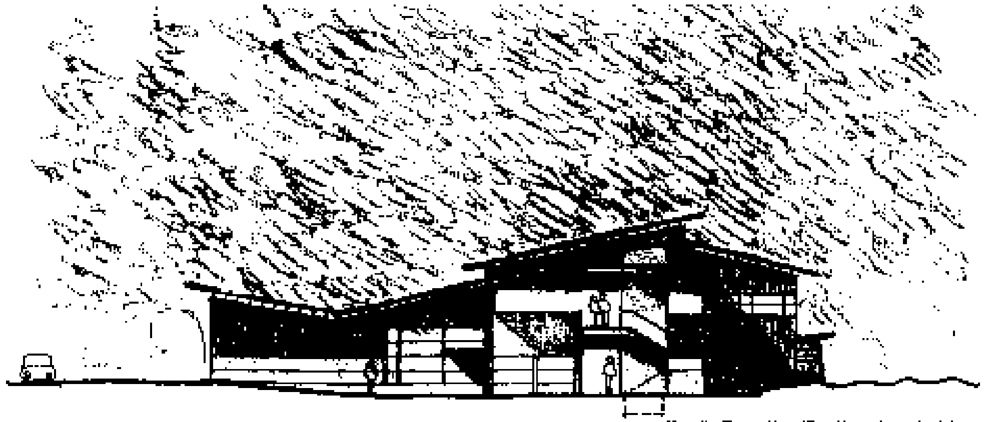
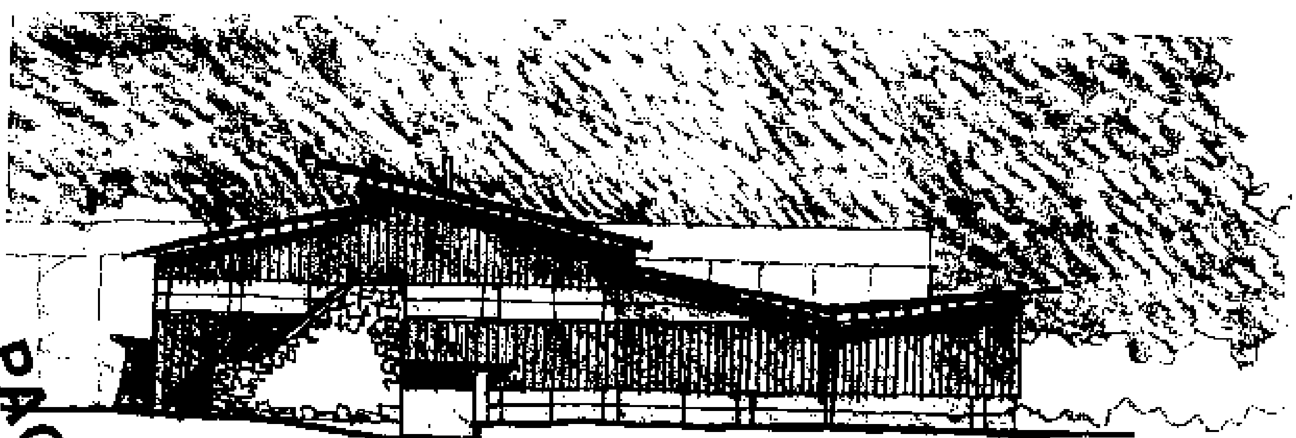
OPTION 1 - ROOF LINE



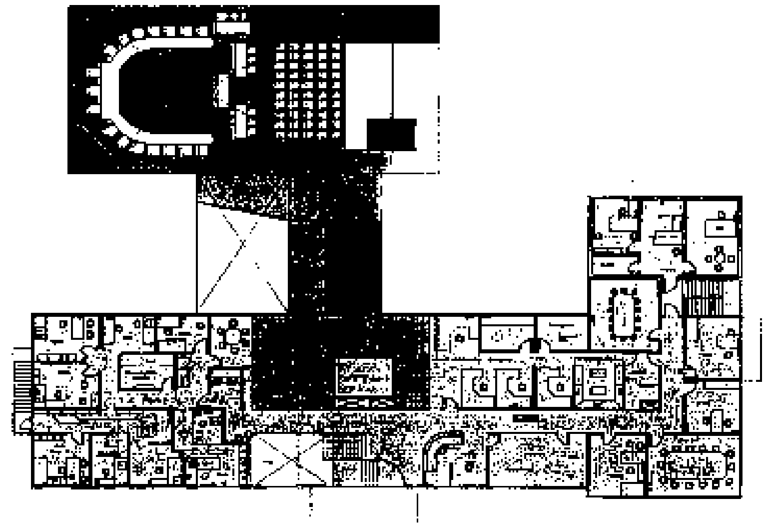


South Elevation/Section thru. Lobby

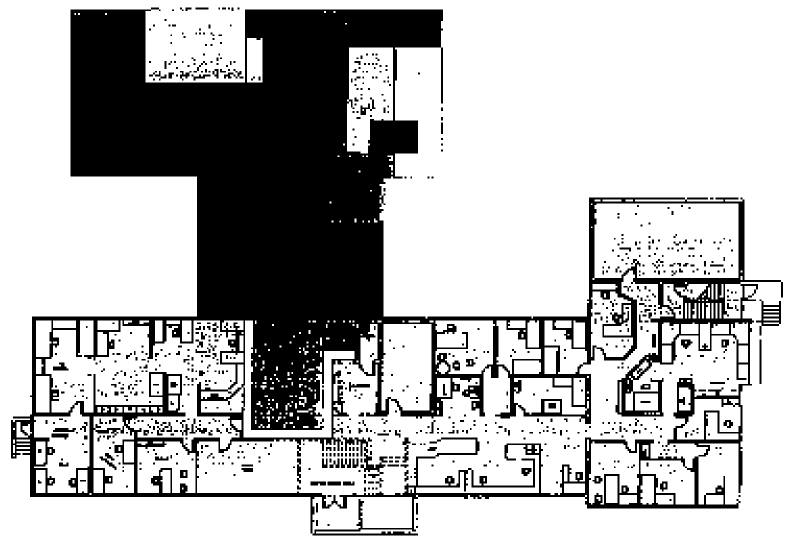


North Elevation

OPTION 2



Option 2 - 2nd Floor



Option 2 - 1st Floor

- Boardroom
- Committee Room
- Kitchenette
- Finance Dept
- Lobby
- Circulation
- Stairs
- Elevator
- Storage
- L.O.C
- Server Room
- Public/Staff Washroom
- Janitor
- Staff Washroom
- Staff Shower
- Mech.

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