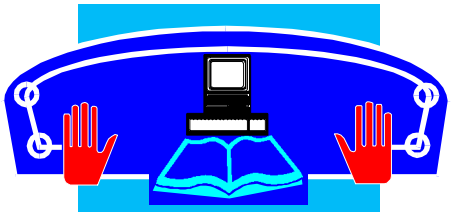

Greenhouse Feasibility Study
Type of Study: Policy / Programs
Agriculture, Greenhouses
Date of Report: 1985
Author: Nova
Catalogue Number: 1-3-11

Novacorp Engineering

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REPORT

FEASIBILITY OF GREENHOUSING - IN INUVIK

Submitted to: Beaufort Food Services of Canada Ltd.

by: Novacorp Engineering Services Ltd.

November 1984

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SUMMARY

An analysis has been done into the economic and technical feasibility of installing a greenhouse in the Inuvik area. The study is preliminary and is based on the greenhouse being an operating unit of Beaufort Foods, a food wholesaler and retailer in Tuktoyaktuk and Inuvik.

It was determined that for a project rate of return after taxes of 15% over 15 years, tomatoes must be sold for $4.00 per Kg ($1.80 to $1.85 per lb.), lettuce for $1.65 per head and cucumbers for $1.35 each. A 20% rate of return gives prices of $4.60 per Kg ($1.95 per lb.) for tomatoes, $1.85 per lettuce and $1.55 per cucumber. These prices are above those charged for vegetables transported from the south but quality would be superior.

Some of the data from the study and consequent design parameters are as follows:

1. A greenhouse of 1858 m2 (20,000 ft.^{2}) was used as a basis for analysis with 743 m2 (8,000 ft.2) of tomatoes, 465 m2 (5,000 ft.2) of cucumbers and 650 m2 (7,000 ft.^{2}) of lettuce. The size and hence production quantities are based on current quantities handled by Beaufort Foods in tomatoes and lettuce, but cucumber consumption would need to be increased. A significantly improved retail trade in Inuvik based on improved quality would be helpful in moving the quantities.

2. The growing period is from late February to the end of September and is limited by the natural sunlight available for growing. Supplemental light is assumed for initial propagation of seedlings, but not for the mature crop in the greenhouse proper.

3* Waste heat is considered as essential to the project, the heating charge otherwise being a heavy burden. A viable source for waste heat is the Northern Canada Power Commission Station at Inuvik. The heat source would be from engines which drive generators and probably would be in the form of coolant.

It is assumed that the waste heat can be obtained free of charge to the user; the requirement being to pay all capital costs for reclamation equipment and any extra operating costs. The Government of the Northwest Territories has first rights to such waste heat.

4. Significant advantages are gained by being an operating unit of Beaufort Foods. The 1858 m2 (20,000 ft.2) greenhouse is not large enough to easily absorb the cost of a full time horticulturist manager, including northern accommodation. It is assumed that the horticulturist manager would work half time for Beaufort Foods in their other endeavors, which could absorb half the cost. All other personnel would be local and hourly. At peak production times, five or six people would be needed.

It is assumed that Beaufort Foods would do all marketing on behalf of the greenhouse and that a vehicle for the modest greenhouse requirement could be available at a modest charge.

A greenhouse smaller than 1858 m2 (20,000 ft.^{2}) could be considered as an initial pilot project, although the economics of waste heat improve with size.

5. Estimated total capital cost of the assumed 1858 m2 greenhouse and waste heat system **is** $377,000. .

6. Succeeding stages to full presentation of an accurately costed and engineered project are as follows:

   (a) Review by Beaufort Foods to determine their wish to proceed further. This might include trial marketing of Alberta greenhouse product.

   (b) A preliminary design for waste heat and a letter of agreement with NCPC. The price to carry out this work is $5,000.

   (c) A tentative lease agreement on the land and confirmation of applicable regulations and some important technical consideration. This price will be presented by December 15.

   (d) Following (a) to (c) a complete study suitable for final project presentation. The price is estimated to be $55,000. Firm pricing can be given after Beaufort Foods review.

1. INTRODUCTION

The work done by Noval Enterprises is documented here along with recommendations of content and costs of a second more detailed stage of the examination. The work statement is outlined in the proposal to Beaufort which is included here as Appendix A. Briefly stated, the work included the following:

1) Examination of local growing conditions, local market conditions, appropriate capital and operating costs and the possibilities for waste heat greenhousing.

2) Based on 1) make preliminary recommendations on greenhouse size, design and economic viability.

Part of the initial fact gathering was a trip to Inuvik and Tuktoyaktuk to assess potential sites and to discuss economic aspects with Beaufort Foods. The analysis was done assuming that the greenhouse would be an offshoot of Beaufort Foods (i.e. the greenhouse would have no selling function or product transport capability) .

Noval Enterprises is involved in design, construction and management of waste heat greenhouses in Alberta, 0.83 hectare at Princess near Brooks and 1.95 hectare at Joffre near Red Deer. Our analysis has been structured to make as much use as possible of our design and operating experience. In discussions of available light and heating requirements, comparisons are made between Inuvik (or Aklavik) and Edmonton, the closest station to Joffre which has solar energy data reported. Appendix B gives two papers presented by Ellis and Ho Lem, and by Ellis, and the Prairie Sun brochure.

The information presented will be climatic data and its horticultural consequences, description of a possible greenhouse design, discussion of waste heat possibilities, market analysis, capital and operating cost summary, and the economic analysis for the operation.

2. DISCLAIMER

It should be noted that this is a feasibility study based on a simplified model with many assumptions. In most cases, the numbers quoted have been reviewed by Noval in the light of its own operating experience, however their accuracy in the northern situations can be assured only from the results of a more detailed study. Reference to design details as they occur in the text cannot be construed as a finalized design with engineering approval.

3. CLIMATE DATA AND HORTICULTURAL IMPLICATIONS

Table 1 gives the mean monthly global solar radiation at Inuvik and Edmonton obtained over many years of measurements. Global solar radiation is the sum of ‘ direct radiation and diffuse radiation. Diffuse radiation is that part which is reflected from various parts of the sky. This total radiation is a rough indication of the light available for photosynthesis in plants. (It is only a rough indication because plants cannot use all wavelengths for photosynthesis.) The measurements of Table 1 do afford some comparison for Edmonton and Inuvik.

TABLE 1

MEAN MONTHLY SOLAR RADIATION IN LANGLEYS *

	AKLAVIK/ INUVIK	EDMONTON
January	4	87
February	45	167
March	180	301
April	374	419
May	482	495
June	528	523
July	446	538
August	294	432
September	154	304
October	56	189
November	10	96
December	0	64

(1 langley/minute = 697 W/m^2)

* Source - Climate Canada, F.K. Hare and M.K. Thomas John Wiley and Sons 1979

In December at Joffre (about 140 km south of Edmonton) it is difficult to maintain a mature crop and ripen fruit. Mean monthly radiation is 64 langleys. In October in Inuvik, mean monthly radiation is 56 langleys. It was therefore assumed that growing would cease at the end of September.

An assessment was made for cost effectiveness of light produced from electric sources such as high pressure sodium lamps. This is not considered economic for a fully spaced crop as will be explained in the section on heating and energy costs. It is, however, recommended that lights be considered for starting seedlings in a small area.

It is general greenhouse practice to produce seedlings by germinating seeds. Once seeds are germinated, they are transplanted into small pots. These pots are then placed together in a separate area known as the propagation house. When large enough, they are outplanted into the main greenhouse where area available per plant is increased about fifty times to allow for growth and aisle room to pick fruit. Supplementary lighting of propagating seedlings is therefore much less costly than supplementary lighting of a spaced mature crop.

4. GREENHOUSE DESIGN

A greenhouse of relatively standard design has been chosen as a basis for the project evaluation. The size chosen is 1,858 m2 (20,000 ft2 or roughly 1/2 acre). This was chosen largely on the basis of the market for the greenhouse product.

The design would be of double polyethylene roofing material purchased from a manufacturer. Every effort would be made to keep electrical energy consumption within the greenhouse to a minimum. The heat transport medium would be either water or an ethylene glycol-water mixture. This fluid would go into pipes running through the greenhouse giving up its heat by radiation and convection. Cooling would be achieved by utilizing roof vents (see page 8 of the Prairie Sun brochure]. The heating and cooling systems in Princess greenhouse #2 are similar to that proposed, however the exterior walls and roof are fibreglass which is different from the more energy efficient double polyethylene suggested here. Pricing for the feasibility study was based on this type of design but any final design would require project life costing of various alternatives.

Design in permafrost is an important aspect of construction of a greenhouse. Since operating is assumed to be seasonal, and to provide thermal insulation from the permafrost it may be possible to use a thick gravel pad, possibly with a layer of insulating material. Discussions with National Research Council personnel indicated this as a possibility, but any final recommendation would require further analysis. The techniques, now being used in the north, of placing

culverts in the gravel to allow cold winter air to penetrate to keep the ground cool, may be required. Greenhouse costing is based on a compacted gravel pad foundation. Because of high initial and continuing transportation costs for other growing media, the initial recommendation for a growing system is the nutrient film technique, a relatively new hydroponics system. Further work is required to confirm this choice but the analysis is based on it.

Nutrient film technique (NFT) is a plant growing technique in which the root systems have a nutrient solution in constant circulation over them. Typically a plastic trough is used and sloped such that the nutrient solution is pumped to one end, flows freely over the roots, and returns to a nutrient solution tank.

The advantages of NFT are:

1. Low capital cost.
2. Elimination of soil sterilization, preparation, variables, etc.
3. Precise control of nutrients is maintained.
4. Maintenance of optimal root temperature is achieved.
5. Simplicity of installation and operation.
6. Stress between irrigations is eliminated.
7. Conservation of water is achieved as compared to other techniques.
8. Systemic insecticides and fungicides may be used.

The disadvantages are:

1. Adjustments to change formulation must be made based on local water analysis and changes.

2. Detailed regulator analysis is required of solution and plant tissue.
3. Constant monitoring is required.
4. Disease could spread quickly.

In summary, NFT is a system attractive in the north because of minimized transportation costs, but to achieve the high yields, considerable expertise and care is needed.

5. HEAT AND POWER COSTS AND POSSIBILITIES FOR WASTE HEAT

Power is available in Inuvik from the Northern Canada Power Commission (NCPC) generators. Heat is available from NCPC in the form of hot water at high pressure piped in an "Utilidor" district heating network. The analy'sis done assumes rates charged by NCPC for heat and power. NCPC'S heat cost schedule is included as Table 2. Table 3 gives power cost schedule.

TABLE 2

NCPC HEAT COST

INUVIK, N.W.T.

CENTRAL HEATING SERVICE
NONGOVERNMENT: Available to any nongovernment residential or commercial customer within the Community of Inuvik, N.W.T. requiring central heating utility service.

Minimum Bill:	$13.54 per month
Energy Charge:	$15.30 per million BTU

CENTRAL HEATING SERVICE
GOVERNMENT: Available to any government residential or commercial customer within the Community of Inuvik, N.W.T. requiring central heating utility service.

Minimum Bill:	$13.54 per month
Energy Charge:	$16.65 per million BTU

FUEL CLAUSE: The above rate shall be increased (or decreased) by 9.199¢ per million BTU for every 1.0¢ per gallon change in the price of fuel f.o.b. the site relative to the indicated March, 1983 price.

TABLE 3

NCPC POWER COST

INUVIK, N.W.T.

COMMERCIAL GOVERNMENT:

	a)	energy charge	24.51 per ~~kW~~ hr.
plus	b)	$21.20 per month	
or	c)	demand charge $4.25 per ~~kW~~ per month	

COMMERCIAL NONGOVERNMENT:

	a)	energy charge	~~$23.48¢~~ per ~~kW~~ hr.
plus	b)	$21.20 per month	
or	c)	demand charge $4.25 per ~~kW~~ per month	

Total bill in either case is a) plus whichever is greater of b) or c)

These rates are relatively high compared to those paid by greenhouses located in Alberta, and consequently modifications must be made to operating procedures and designs. One kW drawn 24 hours per day to run a pump or fan would cost $173 per month (an important cost in a , 1858 m2 greenhouse) . High pressure sodium supplemental lighting at 43 watts per m2 power inputs would cost over $10,000 per month (assuming 18 hours of operation per day) . This cost, if added, would make the economics unattractive. Full replacement of natural sunlight by artificial light would require power inputs much greater than the 43 watts per m^2 for supplemental light. This is the basis of our recommendation that lights be used only to start seedlings? and greenhouse operations cease at the end of September.

Heating costs, like power costs, are high. It is difficult to precisely quantify the annual heating bill without resorting to computer data for temperatures and sunlight. An estimate for the March to September cost of heating the proposed greenhouse is in the range of $35,000 to $55,000. This is a very large cost, and as a consequence waste heat is considered essential to this project.

A major source of waste heat is the NCPC plant at Inuvik. Tuktoyaktuk was discounted as a possibility because its NCPC generating plant seldom runs, power generation is generally done in Inuvik with transmission in a line to Tuktoyaktuk. Sufficient power generation (roughly 5 MW) occurs through the year in Inuvik to provide adequate heat for a greenhouse. Six inch supply and return lines

60 HORTICULTURE

Intensive agriculture is not generally associated with areas north of the Arctic Circle. However, the federal government was involved in several studies during the , 50's and 60's to promote market gardening in the Inuvik Area.[1] Despite permafrost, short growing season, infertile soil and other problems, it was demonstrated that many vegetables could be grown in a backyard garden. There are currently two or three gardens grown in Inuvik with a good degree of success.

This section looks at some sheltered crops which can be grown a good portion of the year in the Inuvik or other northern areas. There is a relatively large greenhouse industry in the Anchorage area of Alaska and the yields proposed in this study are similar to ones achieved there.

The greenhouse facility should be double polyethylene covered and have roof vents capable of summer ventilation. Some internal air circulation should be provided as well as a decondensate cycle. Each crop will have its own feeding and irrigation system.

A service building of 500 square feet should be provided and also a propagation area with supplemental lighting for starting plants.

One full-time employee, the manager, would be adequate during the growing season. Part-time help would be required for planting, plant maintenance, picking and packing and should total about 2500 hours per year.

1. R.E. Harris Canada Agriculture 1969

Crop: Tomatoes

Number of Plants: 1600

Area Required: 743 m2

Average Yield Per Plant: 7.79 Kg (16 lbs.) Possible Per Plant: 9.1 Kg (20 lbs.)

Total Yield: 12,320 Kg (27,161 lb.)

Current Volume Handled by Beaufort Foods: 10,000 Kg (22,000 lbs .) Per Year

Seeding Date: Jan. 15 Variety: Dombito Under Lights

Transplanting: Jan. 22-25 Under Lights

Planting Out: March 1

Growing System: Nutrient Film Technique

First Pick: April 20-25

Peak: June 15 - July 15

Termination: Sept. 30

A beefsteak type variety should be used, as the consumer prefers a large tomato. Consumers are usually willing to pay a substantial premium for both size and quality. ATMV(tobacco mosaic virus) resistant variety should be used.

Regular fumigation maintenance of the crop should be practiced once the plants become established to prevent problems from starting.

Summary of Annual Cultural Costs:

	$
Seed:	120
Pots:	160
Fertilizer:	400
Chemicals:	108
Hourly Labour:	6,375
Packaging:	680
Maintenance:	1,840
Miscellaneous:	120

Crop: Lettuce

Number of Crops: 4

Area Required: 650 m2 (7,000 ft2)

Total Expected Yield: 60,000 Lettuce (13,600 Kg)

Current Volume Handled: 13,800 Kg head lettuce plus other lettuce such as Romaine

Note: Greenhouse lettuce is of a leafy variety

Growing System: Nutrient Film Technique

Seeding Date: Commences Feb. 20 - 25 and is sown in rotation to provide continuous cropping for orderly marketing.

Harvesting: When using NFT the whole plant is packaged, including roots to guarantee freshness. To commence April 15 or slightly earlier.

Summary of Cultural Costs

	s
Seed:	123
Pots:	1,120
Fertilizer:	315
Chemicals:	95
Maintenance:	1,610
Miscellaneous:	105
Hourly Labour:	5,250
Packaging:	2,660

Crop: Cucumbers (Long English)

Number of Plants: 500

Area Required: 465 m2 (5,000 ft2)

Yield Per Plant: 48 Possible Per Plant: 60

Total Yield: 24,000

Current Volume Handled: 5,000 of Long English plus a similar amount of White Spine (garden seed type) cucumbers.

Seeding Date: March 1 Under Lights

Transplanting into 4“ pots: March 5 Under Lights

Planting Out: March 20

Growing System: Nutrient Film Technique

First Pick: April 15 - 20

Peak: May 15 - June 15

Termination: Sept. 30

The harvested cucumbers should be cello wrapped manually. An automatic wrapping would not be cost effective for this size of operation.

Diseases other than powdery mildew should not be a problem. The greatest insect problem is two spotted spider mite. Growing in a soiless system should minimize moist problems.

Summary of Annual Cultural Costs

	$
Seed:	1,200
Pots:	200
Fertilizer:	200
Chemicals:	150
Labour:	3,750
Packing Material:	800
Maintenance:	1,150
Miscellaneous:	75

7. CAPITAL COSTS AND RATES OF RETURN

Assumptions

Greenhouse capital cost $145/m^2 ($13.50 /ft^2).

Yields 17 lbs. per plant for tomatoes, 48 cucumbers per plant for cucumbers, and 4 lettuce. These are average yields. If higher yields are achieved rate of return is improved.

Costs as per those given in the horticulture section.

Manager costs $50,000 per year including 25% added for benefits and $8,000 for apartment rental and utilities. Beaufort Foods would employ the manager 50% of the time in its other operations.

Waste heat system cost $107,000. The greenhouse pays this capital cost but heat is then free. It is understood that the Government of the Northwest Territories has first rights to waste heat from NCPC.

Water for the crop is available from the MacKenzie River and a small effluent of run off water is returned to the MacKenzie.

Except for the manager, all labour is hourly and local at $7/hr.

The greenhouse is a division of Beaufort Foods. The greenhouse vehicle requirement can be met with a Beaufort Foods truck at a modest rental.

Except for occasional accounting advice, all bookkeeping is the responsibility of the manager.

The greenhouse sends it produce to Beaufort Foods and has no marketing or distribution function.

The polyethylene roof is replaced every second year.

Insurance, accounting and vehicle costs total $3,000 per year.

Municipal tax is $3,800 per year.

Land lease is $650 per month.

All costs are indexed at 6.5% through the fifteen years.

Total utility cost $4,628 per year.

The total capital cost is assumed to be $377,000 including greenhouse, waste heat system, growing system and service building.

Total revenue is $128,920 and expenses are $72,834 in year 1_0. Rates of return (IRR) on various crops are given in Table 4. Tax is calculated at 46%.

TABLE 4

RATES OF RETURN

	PRICE	IRR % BEFORE TAX	IRR % AFTER TAX
Tomatoes	1.85	21.6	15.5
	2.10	28.2	20.3
Cucumbers	1.35	21.0	**15.0**
	1.55	28.5	**20.5**
Lettuce	1.65	21*O	**15.0**
	1 . 8 5	27.2	**19.6**

Market Analysis

Inuvik population (1980)	2918
Tuktoyaktuk population (1980)	756
Aklavik (estimated)	750

In addition, a summer influx of oil company personnel provides a further market. A total market of the area of 5,000 people will be assumed.

Tomatoes

The production price varies from $4.00 per Kg to $4.60 per Kg depending upon assumed IRR.

Costs for other competing tomatoes are as follows:

California	6 x 7	$1.80 per Kg (early October 1984) + .40 per Kg (freight to Inuvik) $2.20 per Kg

Alberta greenhouse tomatoes would be $2.90 to $3.20 per Kg including freight, but they would be picked green to withstand the truck journey from Edmonton. Their quality would be poor as compared to locally grown produce.

Present yearly movements by Beaufort Foods is 10,000 Kg per year primarily in its wholesale activities. The proposed greenhouse analyzed would produce 10,500 Kg per year or about .5 Kg per capita per month. The improved quality over U.S. imports should enhance total consumption.

Noval Enterprises ships tomatoes from Princess greenhouse to Brooks, a town nearby with a market of 10,000 to 15,000 people. In 1984, from May to July 30, 10,000 Kg were shipped or roughly 84.0 Kg per week. This indicates considerable scope for a MacKenzie delta market, since Brooks also consumes larger quantities of reasonable quality imported tomatoes.

Cucumbers

The production price varies from $1.35 to $1.55 per cucumber for the analyzed greenhouse, depending on the assumed rate of return.

Costs for Alberta greenhouse grown Long English cucumbers shipped by truck from Edmonton would be about $1.10 to $1.20 per cucumber. Their quality would be poorer than local produce.

Present yearly movement by Beaufort Foods is 5,000 per year of Long English, and an equal number of field cucumbers. The greenhouse analyzed would produce 24,000 per year or about one cucumber per capita per month.

Lettuce

The production price varies from $1.65 to $1.85 per head, depending upon the assumed rate of return.

Cost for field leaf lettuce shipped by truck would be $0.80 per head or less.

Present yearly movement by Beaufort Foods of all types of lettuce including head is about 13,500 Kg and of leaf types is about 5,500 Kg (a leaf lettuce is roughly .22 Kg) . Production from 650 m2 would be 28,000 lettuce or about one per capita per month.

Quality of the greenhouse product is expected to be quite superior to trucked product.

Peppers (Bell or Sweet) and Other Crops

Peppers can be picked as green or left to ripen to red or yellow. Noval is currently studying the market for red and yellow peppers on its own behalf. Our findings could be incorporated into a further phase. Eggplant and other specialty items could also be considered for small portions of the area.

Summary

Tomatoes and cucumbers are the most common vegetable crops grown commercially in southern Canadian greenhouses. It is therefore no surprise that they showed best in the rate of return calculations herein.

Lettuce is less competitive than the other crops but spoilage of a trucked southern crop is a factor favouring the greenhouse. Air freighting which is assumed to be $1.00 per Kg to Inuvik, would be a cheaper alternative to greenhouse production.

The areas allotted to each crop are based on per capita consumption, but a total project could have different allotments. The final quantities of each depend on Beaufort Food expectations for the wholesale and retail market. Trial air shipments of greenhouse products could help in determination of possible retail quantities.

An initially reduced size of greenhouse (e.g. pilot operation) is feasible and possibly prudent. Many costs could be scaled down in direct ratio to size, but others could not.

Further Study

Upon deciding to go further with the project, the objective would be an accurately costed and engineered plan. This would include firm quotations on all , materials and systems. Steps and costs are outlined below.

Before proceeding with the full study, some smaller steps would be appropriate, these steps being to confirm elements without which the project cannot be viable. They are as follows:

1. Review by Beaufort Foods as to the compatibility of a greenhouse with their corporate objectives. Further consideration of the market, possibly including trial retail sales would be appropriate.

2. A preliminary design of a waste heat system for NCPC at Inuvik should be done including costing. A letter of intent should be the final result. The price to carry out this work is $5,000.

3. Some local aspects of the project such as a tentative lease agreement on the land, compliance with all local regulations, determination of tax classifications, approval to take water from the MacKenzie River and to return small amounts of nutrient rich water, and a determination of site specific flooding and permafrost problems.

The price to carry out this work will be determined after consultation with Beaufort Foods and northern sub-contractors. This price will be presented by December 15, 1984.

Following the successful completion of 1 to 3, a comprehensive study to firm all costs could be undertaken. An exact size of greenhouse and initial crop rotation would be proposed. Drawings would be provided to give an overall layout, and subsystems would include drawings suitable for bid purposes. Firm quotations would be obtained for most systems.

The approximate price to carry out this work is $55,000. This approximation can be firmed following the review by Beaufort Foods and consequent firming of any further market study which might be needed.

NOVAL
TECHNOLOGIES LTD.

1984-01-31

Beaufort Food Services
of Canada Ltd.
P.O. Box 268
Tuktoyaktuk, N.W.T.
X0E 1C0

Attention: Mr. John F. Knox
President

Dear Mr. Knox:

It was a pleasure to meet with you and your associates from Beaufort Foods in our offices on January 17, and to discuss your interesting ideas for food production at Inuvik/Tuktoyaktuk. Our group has put together a proposal to assess the feasibility of greenhousing in your area. I sincerely hope we can be of service to you. If you have any questions regarding the proposal or wish to make changes, please do not hesitate to contact myself or Dr. Tim Ellis.

Since our meeting, our group has analyzed the time necessary to spend on the proposed Inuvik/Tuktoyaktuk greenhouse feasibility study. The study consists of two parts; a preliminary one and, if appropriate, a more detailed examination.

Preliminary Study

The work would begin with a visit to the North by Dr. Tim Ellis and Mr. John Murray, our managing horticulturist at our five-acre Joffre greenhouses. This visit is to provide our people with a general familiarization with the North as well as some specific facets of the study as follows:

1. Horticulture

   Required information pertains to local growing conditions and site specific aspects of various hydroponic schemes.

2. Marketing

Detailed questions to be answered are the type and quantities of vegetables presently consumed, along with wholesale and retail prices, including seasonal variation.

An estimated price for various products would be arrived at through mutual discussion. Beaufort Food's northern experience and Noval's experience in marketing premium quality vegetables will both be important. The cost structures (eg. shipping) for the U.S. and Mexican imports would be assessed.

3. Capital COStS (Greenhouse and Waste Heat)

Shipping costs, skilled labour cost and permafrost design are all important components of capital cost and must be quantified. Guidance from Beaufort Foods would be vital in this regard.

4. Operating Costs

Local costs for unskilled labour, shipping costs for supplies, costs' for fuel and power rates are all needed. Beaufort Food's guidance would be important here as well.

5. Waste Heat Aspects

Following preliminary sizing of a greenhouse, waste heat from NCPC and elsewhere would be sought. Visits to powerhouses and discussion with representatives of NCPC would be desirable.

Following the visit to the North, we would analyze our own costs and revenues in Alberta and estimate what they would be for Eeaufort Foods.

We would Produce a report outlining our findings. Some items to be covered are as follows:

1. An overall recommendation including suitable greenhouse size.

2. A list of greenhouse crops appropriate to Beaufort Foods grown hydroponically in greenhouses and their approximate revenues and operating costs.

3. Suggested greenhouse structures suited to the North and their approximate costs.

4. Cost:; for erect ion o f the greenhouse.

5. Required mechanical and electrical material, equipment and installation costs.

6. An appreciation for the scope for waste heat recovery.

If approved, the time to complete this study is 4 weeks.

Cost Schedule

Visit Plus airfare for 2 people plus expenses for 2 days stay (10% handling charge)	$ 4,000.00
Following analysis and report	5,000.00
	$ 9,000.00

Plus Expenses.

Comprehensive Study

Following the overview, a more comprehensive study would be done, if agreed that Noval Enterprises should continue. This depends, of course, on a positive result from the overview. The second phase would provide specific recommendations including greenhouse size, building costs, operating costs and yields for a choice of crop rotations. Information would be for a specific site (or choice of sites) and include services. If waste heat was involved, it would include conceptual design, single line drawings and costing of heat recovery of systems to *251*. Firm quotations on capital cost would be obtained for most systems which are part of the greenhouse.

The cost of this study would depend on the division of work between Seaufort Foods and Noval and the ease of obtaining a suitable waste heat scheme.

Yours very truly,

S. Ho Lem

Stephanie Ho Lem
Vice-President

cc: G.H. McCurdy
J.R. Murray