Northwest Territories

INUVIK TO TUTOYAKTUK HIGHWAY (PRE-ENGINEERING UPDATE)

NORTHWEST TERRITORIES TRANSPORTATION

INUVIK TO TUKTOYAKTUK ROAD

(PRE-ENGINEERING UPDATE)

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MARCH 1999

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1. INTRODUCTION

This report presents a discussion of some of the engineering components and updated cost estimates to construct a road between Inuvik and Tuktoyaktuk, NT. This report is one of several studies undertaken by the Department of Transportation for the Inuvik to Tuktoyaktuk Road to aid in developing a comprehensive package for further planning and decision making. Environmental Scoping and a Benefit/Cost Analysis are other studies which were undertaken as part of the package.

This report specifically addresses the level of service, route alignment and design standards which were used to develop the cost estimates.

2. LEVEL OF SERVICE

Through consultation with the Inuvik to Tuktoyaktuk Highway Stakeholder Advisory Committee, it was determined that any road link between Inuvik and Tuktoyaktuk should be constructed to an all-weather standard. That is, it should be capable of providing dependable, year round use by passenger vehicles, recreational vehicles and transport trucks with appropriate seasonal weight restrictions. A 'fair weather' road, which would not be capable of handling truck traffic and could be closed for some periods of the summer due to weather or road conditions, would not provide the envisioned benefits of reduced resupply costs, increased tourist traffic and economic opportunities.

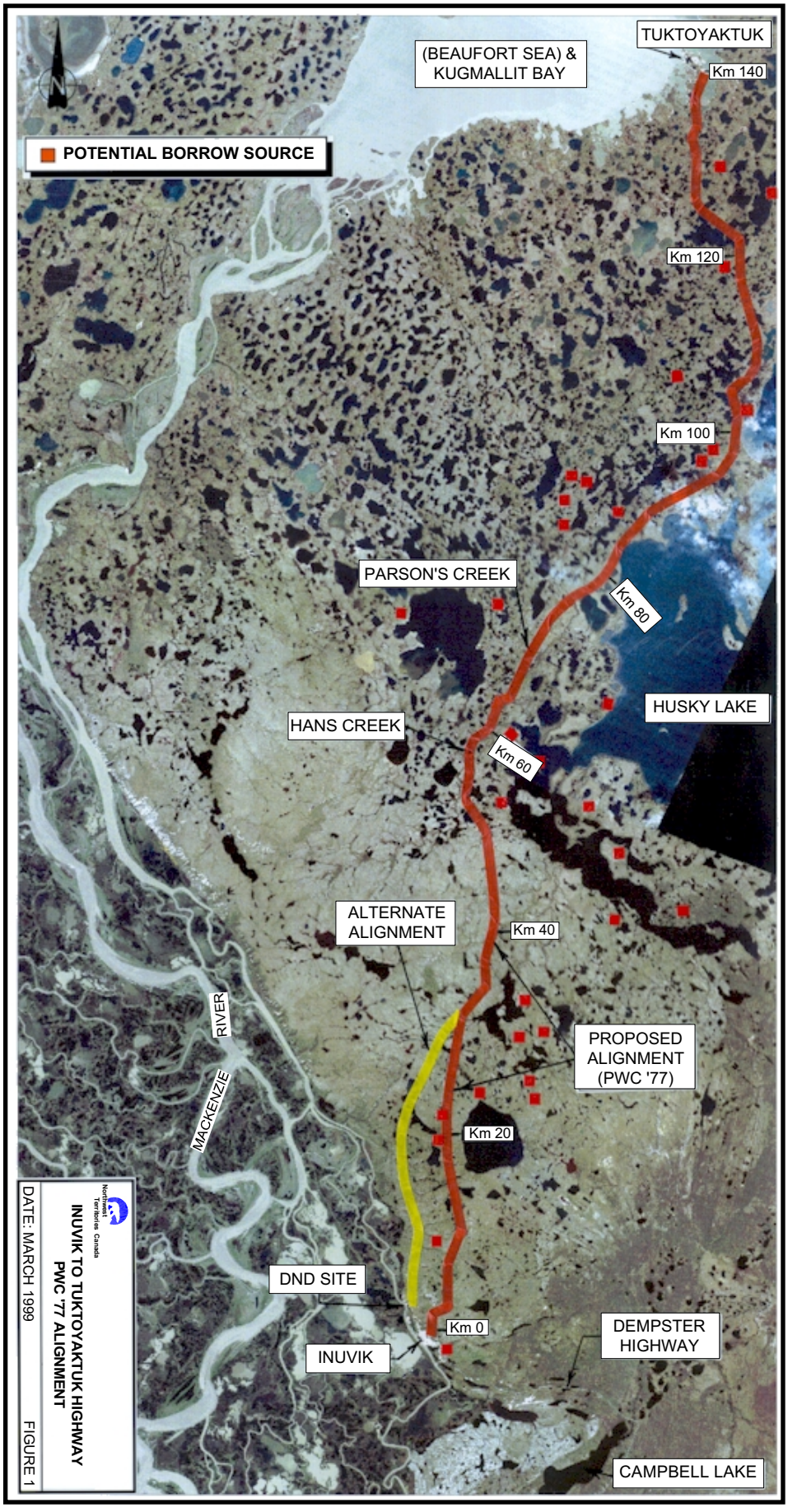
It was decided that this study should look at a low standard, all-weather road with a design speed of 60 kilometres per hour and a similar higher standard, all-weather road with a design speed of 80 kilometres per hour.

3. ROUTE ALIGNMENT

The Stakeholder Advisory Committee favoured the route alignment known as PWC'77 shown on Figure 1 as the one that should be considered for construction of an all-weather road. In 1985, the Inuvialuit Land Administration was opposed to this route because of its close proximity to the Husky Lakes and had suggested a longer route which involved a major shift of the alignment to the west, towards Reindeer Station and along the East Channel. At the present time however, there does not appear to be any opposition to the preferred alignment (PWC'77).

The Department agrees that the PWC'77 alignment is the most logical route for a link between Inuvik and Tuktoyaktuk. Any other route would be longer and more costly to construct.

The PWC'77 route is approximately 140 kilometres long and as discussed in the following section, has been thoroughly studied by Public Works Canada. The route is fairly direct between the communities with the exception of the northern portion which veers to the east and follows the coastal plain of the Husky Lakes. This was done to avoid the rolling topography along a more direct route and to maximize the economical use of identified borrow sources.


TUKTOYAKTUK
(BEAUFORT SEA) & KUGMALLIT BAY
Km 140
POTENTIAL BORROW SOURCE
Km 120
Km 100
PARSON'S CREEK
Km 80
HUSKY LAKE
HANS CREEK
Km 60
ALTERNATE ALIGNMENT
Km 40
RIVER
MACKENZIE
PROPOSED ALIGNMENT (PWC '77)
Km 20
DND SITE
Km 0
DEMPSTER HIGHWAY
INUVIK
CAMPBELL LAKE
INUVIK TO TUKTOYAKTUK HIGHWAY
PWC '77 ALIGNMENT
DATE: MARCH 1999
FIGURE 1

The alternate alignment, shown on Figure 1, would utilize 5 kilometres of existing roadway from Inuvik to the Department of National Defence (DND) Receiver site. However, DND held a 3.2 kilometre radius protective reserve around this site and were reluctant to consider a road through the reserve at the time (mid 70's to early 80's). DND's activities in the Inuvik area have since declined and the alternate alignment should be investigated in more detail.

4. PREVIOUS WORK BY PUBLIC WORKS CANADA

The list of Studies and Reports in Appendix A summarizes the work completed by Public Works Canada on the Inuvik to Tuktoyaktuk Road.

In general, detailed horizontal and topographic surveys were completed for the selected alignment shown on Figure 1 and extensive geotechnical investigations were carried out along the alignment and at potential borrow sources. Work was started on a detailed road design, but only ten (10) kilometres of preliminary design at the Inuvik end was completed before the project was put on hold.

5. DESIGN STANDARDS

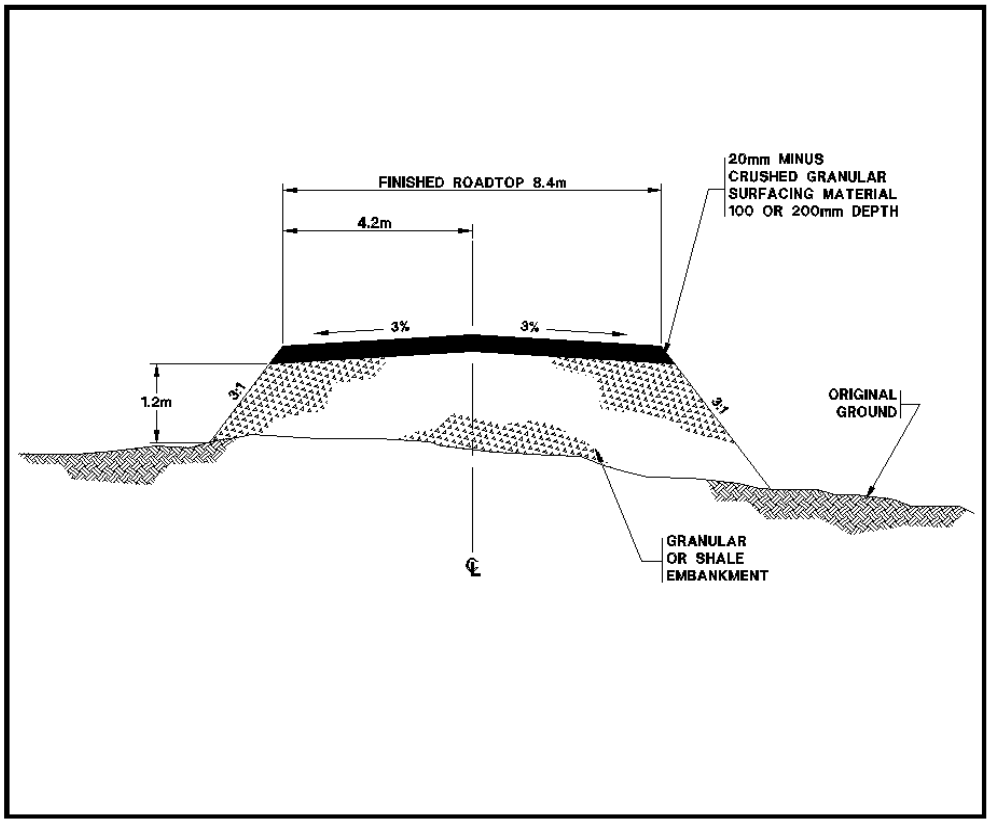
As discussed previously, design standards were developed for two types of all-weather road; a 60 kilometres per hour design and a 80 kilometre per hour design. The design parameters and preliminary cross sections that were selected for the two road designs are shown in Table 1.

TABLE 1
DESIGN PARAMETERS AND PRELIMINARY CROSS SECTION

Design Standard	60Km/hr	80Km/hr
Horizontal Alignment		
Min. Radius (m)	120	230
Min. Stopping Sight Distance (m)	85	140
Vertical Alignment		
Sag 'K' Value	20	30
Crest 'K' Value	15	35
Maximum Gradient (%)	10	8
Cross Section		
Roadtop Width (m)	8.4	8.4
Granular Base Course/Surfacing(mm)	100	200
Subgrade Width (m)	9.0	9.6
Minimum Embankment Fill (m)	1.2	1.2
Side Slope Ratio	3 to 1	3 to 1

It should be noted that the minimum embankment fill of 1.2 metres in Table 1 for both road designs is less than the design thickness originally considered by Public Works Canada for previous estimates and is considered to be the minimum that can be used without incurring substantially higher operation and maintenance costs in the future. It was felt that, when the road traverses over the granular borrow areas, the minimum embankment height of 1.2 metres would provide sufficient structural strength to carry the anticipated traffic loading. Increased embankment heights would be constructed through the fill areas and would most likely fall within the 1.5 to 1.8 metre range.

The typical embankment cross section is illustrated in Figure 2.



6. COST ESTIMATES

The current cost estimate (1998 dollars) for each of the two standards of road is 100 million dollars for the 60 kilometres per hour design and 135 million dollars for the 80 kilometres per hour design. The cost estimates are based on preliminary quantity estimates developed from the Table 1 design standards and probable construction costs for a project in this area over a ten (10) year construction period. A simplified breakdown of the cost estimates for the two designs is given in Table 2.

TABLE 2
CONSTRUCTION COST ESTIMATES

	Estimated Costs	
Description	**60km/hr**	**80km/hr**
1. Embankment Construction	$83,000,000	$110,000,000
2. Base Construction/Surfacing	$6,000,000	$11,000,000
3. Drainage/Drainage Structures	$1,000,000	$1,000,000
4. Major Structure/Bridges	$1,000,000	$1,000,000
5. Engineering/Supervision	$9,000,000	$12,000,000
TOTAL	**$100,000,000**	**$135,000,000**

The above costs calculate to approximately $715,000 per kilometre and $965,000 per kilometre for the 60 kilometre per hour road and the 80 kilometre per hour road respectively. These per kilometre costs are very similar to the costs reported by the Department in a brief report in 1989. At that time, the updated Public Works Canada estimates for the PWC'77 alignment were $715,000 per kilometre for the 60 kilometre per hour road and $1,050,000 per kilometre for the 80 kilometres per hour road. As mentioned previously, the current designs have a somewhat reduced minimum embankment fill thickness. This would account for the apparent lack of any change in construction costs over the intervening nine (9) year period.

The current cost estimates do not include any royalties or land acquisition costs that may be payable to the Inuvialuit. As nearly two thirds of the alignment is on Inuvialuit Lands, the royalty costs for borrow material (if payable) could be in the order of $5,000,000.00 dollars or averaging two (2) dollars per cubic metre of borrow material (general embankment fill and base granular materials). Even though these costs are a Federal responsibility, they still add to the overall project cost.

Annual operation and maintenance costs for a completed Inuvik to Tuktoyaktuk Road are expected to be in the order of 1.5 to 2.0 million dollars or between $11,000 and $15,000 per kilometre. However, costs may exceed the upper amount in the first four or five years due to more frequent surface repair requirements as any frozen material placed into the embankment thaws in the early years and the embankment distorts and settles. For comparison purposes, the annual maintenance costs for some sections of the Dempster Highway are currently averaging $13,000 per kilometre.

7. PROJECT SCHEDULING

It is anticipated that this project could be constructed most efficiently in any time frame ranging from four years to ten years. A construction period longer than ten (10) years would mean too many of the identified material sources would have to be redeveloped year after year. This could lead to extra effort required for pit drainage and loss of valuable material.

Ideally, all required embankment borrow should be excavated from each material source in one construction season. This is not to say that the project could not be scheduled over a longer period (say 20 years), only that efficiencies are reduced with a longer construction schedule.

8. PROJECT IMPLEMENTATION

A project of this magnitude could be implemented by a series of conventional publicly tendered contracts or by the design-build approach recently used by the Department of Transportation on Yellowknife Highway (No.3). The Department has demonstrated that local employment and training can be maximized by either approach.

A discussion on a community construction approach to the project is included as Appendix B. Under this approach, the emphasis would be entirely on local employment and training through a low level of annual funding and not on completing the road within a reasonable time frame.

9. FURTHER ENGINEERING WORK

The previous work by Public Works Canada has established a good surveyed alignment and substantial geotechnical information on potential borrow sources. However, this data would have to be developed into a detailed design prior to any construction. Most of this would be office based work involving conversion of original survey data from imperial to metric and inputting the corrected data into a computer and preparing the detailed designs.

Since the time of the original alignment surveys in the Tuktoyaktuk area (1975 - 77), some improvements or additions may have been made to the community road system. This will require an assessment to determine if the Inuvik to Tuktoyaktuk Road should or could be realigned, within the community areas, to take advantage of any community road infrastructure investments already in place that would shorten the overall road length. Although this work can be completed just prior to construction activities in the area, it would be best to determine any realignments as early as possible into the project. Costs associated with this assessment work would be minimal, however, if additional preliminary engineering or surveys are required, these costs would be in the twenty to fifty thousand dollar ($20,000 to $50,000) range.

Additional geotechnical drilling and survey field work would be required to assess the alternate alignment shown on Figure 1 which leaves Inuvik from the DND site. This alternate alignment would shorten the construction length by 5 kilometres. However, if borrow sources can not be located near the alignment, it may not be economical. The cost of the field work would be in the order of two hundred fifty thousand dollars ($250,000).

Further geotechnical drilling would also be required at most of the borrow sources in order to delineate the most favourable areas for development. However, much of this work could be done as construction progresses.

Individual contract or design packages and an implementation plan would need to be developed, but these can not be done until a level of project funding is established.

If a decision was made to proceed with the project, all of the pre-engineering surveys, geotechnical investigations, data input, design and contract preparation work required prior to commencing construction, could be completed within a one year period. This is well within the time frame it is expected to take to obtain project approvals and resolve land ownership issues.

APPENDIX ‘A’

LIST OF STUDIES AND REPORTS

LIST OF STUDIES AND REPORTS
INUVIK TO TUKTOYAKTUK ROAD

Year	Description	Author
1972	Community Granular Materials Inventory Tuktoyaktuk, NT	Ripley, Klohn & Leonoff for DIAND
1972	Community Granular Materials Inventory Inuvik, NT	Ripley, Klohn & Leonoff for DIAND
1974	Granular Materials Inventory Parsons Lake	Klohn & Leonoff for Gulf Oil Canada Ltd.
1975	Alignment Review, Mile 970-1060.6	Public Works Canada
1975 Mapping	Bedrock Sources of Highway Materials Inuvik to Tuktoyaktuk, NT	Terrain Analysis and Services Ltd.
1975	Alignment Update Report, Mile 971-1058	Public Works Canada
1975	Preliminary Environmental Scoping	Public Works Canada
1975	Appendices (A&B) to Report Preliminary Environmental Assessment	Public Works Canada
1976	Alignment Update Report Mile 971-1058	Public Works Canada
1976	Geotechnical Investigation Mile 970-1059	Public Works Canada
1977 Ltd.	Granular Materials Inventory, Tuktoyaktuk, Northwest Territories	R.M. Hardy & Associates
1977	Alignment Update Report, Mile 971-1059 Tuktoyaktuk, Northwest Territories	Public Works Canada
1978	Geophysical Evaluation of Granular Material Resources Tuktoyaktuk Harbour, Northwest Territories	R.M. Hardy & Associates Ltd.
1980	Granular Materials Inventory Sources 160 & 161	Hardy Associates (1978) Ltd.

LIST OF STUDIES AND REPORTS
INUVIK TO TUKTOYAKTUK ROAD

Year	Description	Author
1981	Geotechnical Investigation, Mile 971-1059 Combined Data: 1976-1980 Volume I - Mile 970-995 Volume II - Mile 970-1020 Volume III - Mile 1020-1059	Public Works Canada
1981	Materials Availability and Construction Alternatives	Public Works Canada
1982	Construction Report, Test Embankment	Public Works Canada
1982	Performance Report No.1, Test Embankment	Public Works Canada
1983	Granular Materials Evaluation - Deposits 168 & 211 Tuktoyaktuk Area, N.W.T.	B B T Geotechnical Consultants G V M Geological Consultants Terrain Analysis and Mapping Services Ltd.
1983	Granular Resource Development and Management Plan Tuktoyaktuk, N.W.T.	E B A Engineering Consultants Ltd.
1983	Proposed 1983 Test Embankment Addendum to Performance Report No.1	Public Works Canada
1983	Construction Report, Test Embankment	Public Works Canada
1984	Performance Report No.2, Test Embankment	Public Works Canada
1987	Interim Report - Phase III Winter Drilling Program Deposit 155 Community Granular Management Plan Tuktoyaktuk, N.W.T.	Hardy BBT Limited
1987	Inuvialuit Settlement sand and Gravel Inventory and Recommendations for Development Inuvik, N.W.T.	E B A Engineering Consultants Ltd.

LIST OF STUDIES AND REPORTS
INUVIK TO TUKTOYAKTUK ROAD

Year	Description	Author
1989	Inuvik to Tuktoyaktuk All Weather Road (Background and Cost Estimate)	GNWT Transportation
1992	Final Report on Preliminary Engineering	Public Works Canada

APPENDIX ‘B’

COMMUNITY CONSTRUCTION

APPROACH

INUVIK TO TUKTOYAKTUK
PROPOSED ROAD
COMMUNITY CONSTRUCTION APPROACH

Proposed Funding Plan

For the purposes of this report, it is assumed that one million dollars would be made available each year, and would be split equally between the communities of Inuvik and Tuktoyaktuk.

Project Delivery Methods

Under the Community Construction Approach, there can be several different project delivery methods. One is where the Department of Transportation will manage or oversee the project using local equipment and labor (the method used in this report to develop the Construction Plan). Another is where the Department of Transportation will supplement local equipment with own-forces equipment and have the community administer and deliver the program. The Department retains management responsibility. Yet another method would be that the Department of Transportation would enter into a Contribution Agreement , annual funding arrangements, with the communities and the communities would be responsible for delivering the project and completing the road.

Construction Plan

Project to proceed using the Community Construction Approach for a 60 kilometres per hour or 80 kilometres per hour all-weather road.

The road work program would be divided into two sections:

- Inuvik towards Tuktoyaktuk for approximately 70 kilometres.
- Tuktoyaktuk towards Inuvik for approximately 70 kilometres.

Construction will consist of work zones within each section. The equipment fleet and support infrastructure would be scaled to match the available workforce from the local communities. A typical construction Equipment/Employment Plan is attached.

This construction Equipment/Employment Plan shows the minimum equipment that is expected to be utilized for construction activities within the available budget. In order to provide longer periods of employment, the equipment/workforce will have to be scaled back accordingly.

Using the Community Construction Approach, major construction contracts would not be used. Through the Community Construction Approach, the program would be supported and delivered as follows:

- Department of Transportation technical and project management support;
- Equipment rental from local Companies/Contractors;
- Employment Services Contracts with local community agencies; and
- Certified training program for Heavy Equipment Operators and Mechanics.

Employment Outputs

Statistics, obtained from the Bureau of Statistics, for 1996 clearly indicate adequate workforce potential from both communities for each construction section. The Department of Education, Culture and Employment states that the 1997 and 1998 statistics have not changed substantively.

Labour Force 1996 Community Statistics

Community	Persons 15 Years +	Labour Force	Employed	Un-Employed
Inuvik	2,300	1,765	1,575	195
Tuktoyaktuk	610	335	245	90

The Community Construction Approach will consider worker rotation and shut down periods respecting local, traditional and seasonal activities.

It is estimated that approximately 15 to 25 employees would be employed during construction activities for each work zone or section for a period of five to six weeks each year that funding is made available. Approximately 30% of the available funding would go directly towards the wages of these local employees each year.

Employee Training

A certified training program for Heavy Duty Equipment Operators and Mechanics could be set up to train employees on the project.

Funding for the training program should be sought from other sources (i.e. ECE, Pathways, etc.).

Work Schedule

Construction would proceed after the ground has frozen sufficiently to support the construction equipment and sufficient daylight is available (January/February) and would continue until either the funding runs out or spring thaw arrives.

A typical work schedule for either section would be as follows:

- Mobilization of Equipment in January/February;
- Work to commence from the first available material source, constructing the embankment towards each community first, then towards the next material source or mid point;
- Work 14 days then shut down for 4 days or have employee rotation every 14 days;
- Demobilization of Equipment once funding runs out or just prior to spring thaw.

Crushing operations and surfacing would only take place after there is sufficient embankment built that could be used for accessing significant locations along the route (i.e. gas plant, Husky Lakes, Granular Material Sources for community use, etc.).

Production Estimate

For each million dollars of funding available, it is estimated that an average of one kilometre of road could be completed. However, as a normal construction practice, it can be expected that as much as three (3) to five (5) kilometres of road embankment could be worked on, within each work zone or section, during any given construction period. The estimated cost of one million dollars per kilometre includes any through-the-road drainage structures (culverts). Materials and construction of any bridge structures would be extra.

INUVIK TO TUKTOYAKTUK PROPOSED ROAD CONSTRUCTION
Typical Construction Employment/Equipment Plan
(Applicable to each Construction Section)

Major Contract Elements	Positions/Equipment	Typical Equipment	Estimated Costs (includes Operators where required)	Estimated person Days
Embankment Construction				
	Excavator/Hoe	Cat 225	42,000	30
	Trucks (5)	Tandem Dump Trucks	127,500	150
	Dozer	1 Cat D-9	81,000	36
	Dozer	1 Cat d-7	75,000	60
	Fuel Truck	F 9000 c/w fuel tank	5,500	36
	Service Truck	F 9000	7,200	36
	Crew Vehicle	Van/Bus/Crew Cab	7,500	30
Culverts/Drainage				
	Labourers (2)		3,500	10
	Excavator/Hoe	Cat 225	2,800	2
	Misc./Supplies		12,000	
Support Facilities				
	Camp	25 - 30 Person Capacity	52,000	140
	Field Office	1 Trailer	2,500	
	Fuel Storage	Tanks/Pumps	10,000	
	Repair/Storage Shop	Mobile Garage	10,000	
Supervision/Management				
	Foreman		18,000	36
	Mechanic		21,000	30
	Surveyor		5,500	10
	Clerk/Administrator		5,000	40
	Engineering		12,000	
		TOTALS	**$500,000.00**	**646**

NOTE : It is estimated that the above Equipment/Workforce is for an approximate five to six week work period, working an average of ten hours per day and is applicable to each Construction Section.

As indicated above, the proposed equipment list and estimated workforce are for a typical small scale road construction project only. Adjustments to equipment requirements and workforce can be expected, as it is dependant on availability and what operations are being undertaken at the time.