YA-YA LAKE ESKER COMPLEX:

SITE DEVELOPMENT AND RESTORATION PLAN

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Prepared for

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An undisturbed portion of Ya-Ya esker complex with Ya-Ya Lake in the background (Block A-D).

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1. INTRODUCTION

1.1 Terms of Reference

Terrain Analysis and Mapping Services Ltd. was retained by Indian Affairs and Northern Development on July 7, 1976 to prepare an optimal strategy for the orderly extraction of granular materials from the Ya-Ya esker complex and its final restoration.

The final report was to include: (1) recommendations regarding the feasibility of subdividing the site into contiguous blocks with the identification of blocks that could be combined for concurrent development. Each block was to be evaluated as an individual development that would form an integral part of an extraction and development plan for the complete complex; (2) development plans for each pit operation setting out in detail the removal and disposal of overburden; schedules for stripping, stockpiling, and drainage maintenance; treatment of massive ice; operator responsibility; and restoration measures; (3) discussion of the level of information to be provided by the operator on each block prior to development; (4) guidelines relating to approved uses of granular materials contained in the Ya-Ya esker complex; (5) procedures for modifying the development strategy during extraction operation; and (6) requirements for inspection, monitoring, and supervision by Indian Affairs and Northern Development (IAND) officials.

During report preparation, fisheries and survey consultants retained by IAND officials were to be collaborated with in order that extraction of granular materials may be conducted with the maximum

protection of productive waterbodies and with reference to permanent, surveyed markers.

1.2 Consultations

An attempt was made to discuss all aspects of granular material extraction from the Ya-Ya esker complex with all interested parties. In conjunction with the field investigation of the Ya-Ya esker complex, present and anticipated problems of inspection and supervision of operations at the esker were discussed with IAND officials at Yellowknife (Mr. C. Cuddy) and Inuvik (Mr. N. Slatterly and Mr. B. Veldhoen). At the Ya-Ya site pit operations were discussed with Mr. E. Tetarin, pit foreman for Imperial Oil Ltd. (IOL), and at Bar C (IOL's staging site on the south end of Richards Island) with Mr. G. Turnock of IOL Field Services.

Following the above discussions and a field investigation of the Ya-Ya esker complex and associated extraction operations, meetings were held with IOL engineers (Frontier Planning - Messrs. W. Jazrawi and G. Rempel; Beaufort Gas Project - Messrs. L. Keeling and J. McDougall; Field Services - Messrs. B. Eby, M. Arnett, A. Hugo-Persson; Consultant - Mr. D. Haley of EBA Engineering Consultants Ltd.) and with other concerned industry personnel in the afternoon (Messrs. D. Mowbray and M. Myden of Gulf; Messrs. D. Duncan, C. Bonke, and E. Hopkin of Shell; Mr. L.V. Jankowski of Sun; Messrs. G. Rempel, B. Eby, and W. Jazrawi of IOL; Mr. D. Haley of EBA Engineering Consultants Ltd.). Discussions centred on projected borrow requirements; pit operational problems, i.e. stripping, thaw rates, drainage control, treatment of massive ice, stockpiling; deployment of

granular materials obtained at the Ya-Ya esker complex; geotechnical data that would be required of operators wanting to extract granular materials from the complex; and rationale of a limited vs. an unlimited number of operators extracting granular materials from the complex. Both meetings were arranged through the courtesy of Mr. G. Rempel of IOL.

Finally, clarification of the IAND objectives in a development plan for the Ya-Ya esker complex was obtained through continued discussions with Messrs. I. Petrie and J. Inglis of the Land Management Division.

1.3 Investigations

A field examination of the Ya-Ya esker complex was carried out to determine the distribution of sand, gravel, and overburden, to determine the drainage patterns within and adjacent to the esker complex, and to observe effects of massive ice and its melting on pit operations. Casual observations of IOL's present extraction and stockpiling operations were carried out during the field examination.

Office investigations involved detailed analysis of existing aerial photographs, mosaics, contour maps, borehole logs, geological cross-sections, and reports dealing with the Ya-Ya esker complex and adjacent sources of granular material (Reference 1-6), and a search of geotechnical literature re general problems encountered in obtaining granular materails and their use in areas of continuous permafrost. Information obtained during the above investigations was used as a

guide in the preparation of a plan for the orderly development and restoration of the Ya-Ya esker complex. Aquatic Environments Ltd.'s assessment regarding the effect of siltation of certain ponds and lakes on the fish potential of the immediate and surrounding area was considered in plan preparation.

2. PLAN OBJECTIVES AND CONSTRAINTS

Optimal strategy for the orderly development and restoration of the Ya-Ya esker complex must be within the requirements and constraints of a regional overview. Although no regional plan is presently available, it would seem that the availability of granular materials at a reasonable cost and with minimum disturbance to the environment is desired. To achieve these aims, orderly development should attempt to realize *maximum economical extraction with minimum disturbance*, not only at the Ya-Ya esker, but within a regional context. Thus although maximum extraction at the Ya-Ya esker complex site might call for stockpiling outside the immediate area of extractable granular materials, for systematic removal of granular material to depths that require added expense in maintaining pit drainage, and for temporary siltation or permanent changes in local pond and lake levels, these undertakings are minor compared to the general deterioration of the environment, most notably its aesthetic quality, and probable added expense that extraction from the many smaller sources in the vicinity of the Ya-Ya esker complex might involve if maximum extraction from the complex was not invoked. Although present maximum 5-year projections (Table 1) do not exceed the best

TABLE 1

PROJECTED ESTIMATE OF GRANULAR MATERAILS TO BE STOCKPILED, ASSUMING AN APRIL 1977 GAS PIPELINE APPROVAL[1]

		cubic yards	
Summer 1976	IOL	360,000	
	Gulf	100,000	
	Shell	5,000	
	Sun	20,000	
	Total for Summer		485,000
Summer 1977	IOL	705,000	
	Gulf	100,000	
	Shell	500,000	
	Gas Line	290,000	
	Sun	20,000	
	Miscellaneous	10,000	
	Total for Summer		1,625,000
Summer 1978	IOL	455,000	
	Gulf	100,000	
	Shell	300,000	
	Gas Line	1,054,000	
	Sun	20,000	
	Miscellaneous	20,000	
	Total for Summer		1,929,000
Summer 1979	IOL	95,000	
	Gulf	100,000	
	Shell	60,000	
	Gas Line	456,000	
	Sun	20,000	
	Miscellaneous	20,000	
	Total for Summer		751,000
Summer 1980	IOL	100,000	
	Gulf	100,000	
	Shell	60,000	
	Gas Line	50,000	
	Sun	20,000	
	Miscellaneous	20,000	
	Total for Summer		350,000
GRAND TOTAL			5,160,000

[1]These figures are based on data obtained during late July 1976 and are subject to revision.

available estimate of granular material that could be extracted without extracting from below the level of adjacent lakes or without melting major areas of massive ice (9.5 to 10.5 million cubic yards), these estimates undoubtedly eventually will be exceeded if oil and gas discoveries require further production and support facilities. A major portion of the total granular materials available at Ya-Ya esker eventually will be required (16 to 18 million cubic yards).

If the total available granular materials at Ya-Ya esker are not consumed, *this plan outlines a development schedule that allows as much as possible for the Ya-Ya esker complex to be preserved in a pristine state.* Extraction would centre on disturbed areas until they were depleted.

Because the final amount of granular material to be extracted depends on requirements, most specifically of industry and government, and restrictions placed on usage of Ya-Ya granular material, it is impossible now or probably at any time in the near future to determine an exact schedule of extraction. However, the plan basically attempts to allow the *complete development and restoration of each section subject to reasonable costs.* In the event that the pit or parts of it may be abandoned from time to time, the plan has been devised in order that the operators discontinuing activity leave the pit in such a state *that drainage and thaw are maintained to allow the next operator to remove the maximum amount of material from any area.*

Finally, the plan protects the aesthetics and environment of Ya-Ya Lake. No extraction is to be carried out adjacent to Ya-Ya Lake.

Although some extraction activities will be visible from Ya-Ya Lake, the pit should not be visible from the lake when the esker is depleted and restoration is completed.

3. ZONING

3.1 General

The Ya-Ya esker complex and the immediate bordering area as outlined on Drawings 1-4 (Appendix A) should be designated through existing regulations as a development area. Within this development area, smaller areas would be designated for certain specific activities, namely (1) extraction, (2) drainage control, (3) stockpiling, (4) camps and supporting activities, and (5) access. A number of blocks designated for extraction should be designated as reserve areas, with development dependent on future reappraisals of supply and demand of granular materials.

The zoning of the Ya-Ya esker complex and adjacent area allows for maximum extraction with a minimum amount of disturbance and allows a maximum area of the partially developed esker to be available for extraction in any one year.

3.2 Extraction

All that part of the esker complex containing granular materials that might be extracted at a reasonable expense has been zoned for extraction. Generally, areas of which a major part are covered by a reasonable thickness of granular material, e.g. two yards minimum thickness

for extensive tabular bodies but less than one yard at the edge of wedge-shaped bodies, and where extraction operations can be carried out according to objectives outlined in section 5 are included. However, it would be the ultimate responsibility of the operator as outlined in section 6 to define the exact areas where granular materials are actually available for extraction.

Within an area zoned for extraction, the following activities would be permitted: all operations related to extraction, i.e. removal of overburden, wasting of ground ice, thawing of materials to be extracted, windrowing, drainage maintenance, drainage and siltation of contained ponds, temporary or permanent dyking of adjacent lakes and ponds to prevent pit flooding, construction of temporary roads for local pit development and pit access, and any activity related to site restoration.

No stockpiling or support activities should be allowed in areas zoned for extraction unless the area is depleted of granular resources to a point where the thickness of granular material is sufficient only to provide a pad for a camp or other support activity. Unforeseen circumstances can lead to a delay in the removal of stockpiles and abandonment of camps and other support facilities; these circumstances could lead to unacceptable hinderance in extraction in subsequent years.

3.3 Extraction - Conditional

Parts of the Ya-Ya esker complex appear to have marginal value as a source of granular material and have been zoned for extraction, subject

to the following conditions. These blocks should only be considered for extraction after more detailed drilling investigations have been carried out to determine if the quantity and quality of material warrants extraction and landscape disturbance. If a drilling program or other investigation should indicate that the areas do not warrant extraction, they could be rezoned for stockpiling or supporting activities.

Ideally, these areas should be rezoned before proceeding with development of adjacent areas, especially if their development was to be integrated. For example, block A-Bd should be drilled in detail before extraction was allowed to proceed in Block A-Bc. Similarly, block A-Be should be investigated before extraction of block A-Bb.

3.4 Drainage Control

Certain areas fringing the areas zoned as extraction, stockpiling, support activities, and access should be zoned for drainage control. Areas zoned for drainage control in most cases would not be utilized or disturbed. They would only serve (1) as possible corridors for drainage ditches or systems draining water out of ponds within the Ya-Ya esker to surrounding water bodies or (2) as contingency areas where ditches could be dug to control downslope overflow from pitting operations. The operator would be required to demonstrate that drainage control could not be carried out within the areas zoned for extraction, stockpiling, support facilities, and access before use of areas zoned for drainage control would be allowed.

Lakes are designated for temporary or permanent drainage, as

settling ponds, or to be the recipient of water from sumps and settling ponds (Drawings 1 and 2, Appendix A).

3.5 Stockpiling

Well drained areas adjacent to the Ya-Ya esker complex should be reserved for stockpiling of granular material. This would release all areas underlain by granular material for continuous extraction. Stockpiling would not necessarily be restricted to those areas zoned as such, but would also be allowed in depleted extraction areas as described in section 3.2. Limited drainage control, siltation of adjacent ponds, access roads, and activities related to restoration as justified by the operator or regulatory agencies would be permitted.

3.6 Camps and Support Facilities

Camps and support facilities should be confined to certain areas adjacent to the esker. This would allow environmental damage to be limited, but still would allow for maximum extraction. It is recognized that camps are the only source of possible chemical and long-term pollution, and as such, they should be insulated from water bodies.

3.7 Access

Certain corridors have been zoned for access roads, recognizing that the major mode of transportation of material from the Ya-Ya esker is through trucking along major stream and delta channels, and lakes in winter. Areas zoned for access also could be considered for drainage

control as outlined in section 3.4.

Operators should be required to present geotechnical background and road designs that indicate that no undue drainage or thermal disturbance will occur which might lead to continued thermal erosion and unnecessary siltation of the water bodies when road usage terminates.

4. EXTRACTION BLOCKS

4.1 Definition

Extraction blocks have been defined to allow maximum yearly extraction of between 80,000 and 200,000 cubic yards within most blocks using conventional stripping and windrowing techniques, assumming an annual average extraction depth of two yards. Even for an average depth of one yard, this allows for an extraction of 40,000 to 100,000 cubic yards in most blocks. Based on past schedules of extraction, these yardages would be adequate to fulfil annual requirements of operators who need granular material for staging pads, drilling pads, and artificial islands.

The larger master blocks are defined in order that moderate to large annual requirements can be filled (Table 2) and that complete extraction and restoration can be carried out independent of adjacent master blocks. Each master block has been defined according to topography and internal stratigraphy so that its present drainage, drainage during development, and drainage following restoration are relatively independent of adjacent master blocks.

TABLE 2

VOLUME OF GRANULAR MATERIALS IN EXTRACTION BLOCKS
DEFINED ON DRAWINGS 3 AND 4 (APPENDIX B)

Extraction Block	Estimated Available Granular Materials (cubic yards)	
Master Block A-A		950,000
A-Aa	600,000	
A-Ab	100,000	
A-Ac	250,000	
Master Block A-B		1,700,000
A-Ba	455,000	
A-Bb	540,000	
A-Bc	500,000	
A-Bd	100,000	
A-Be	105,000	
Master Block A-C		2,500,000
A-Ca	590,000	
A-Cb	1,346,000	
A-Cc	119,000	
A-Cd	445,000	
Master Block A-D		980,000
A-Da	540,000	
A-Db	440,000	
Master Block B-A		2,850,000
B-Aa	1,150,000	
B-Ab	1,120,000	
B-Ac	520,000	
Master Block B-B		280,000*
Master Block C-A		950,000
C-Aa	450,000	
C-Ab	400,000	

TABLE 2

(continued)

Extraction Block	Estimated Available Granular Materials (cubic yards)	
Master Block C-B		450,000
Master Block C-C		1,100,000*
C-Ca	150,000	
C-Cb	150,000	
C-Cc	550,000	
C-Cd	250,000	
Master Block C-D		750,000
C-Da	200,000	
C-Db	250,000	
C-Dc	300,000	
Master Block C-E		60,000
Master Block D-A		250,000
Master Block D-B		500,000
D-Ba	250,000	
D-Bb	250,000	
Master Block D-C		100,000

* Includes stockpiles present during late July 1976

4.2 Extraction Schedules

It is impossible to devise an exact extraction schedule because of uncertainties in government and industry policies and plans. However, pending no final agreement between government and industry for gasline construction, it is recommended that the blocks be developed in the following sequence: blocks B-B, C-Ab, C-Aa, C-B, C-Cd, C-Cc, C-Cb, C-Ca, B-Aa, B-Ab, B-Ac, A-Cd, A-Ca, (A-Cc), A-Cb, A-Da, (A-Bd), A-Bc, (A-Be), A-Bb, A-Ba, A-Db.

Some blocks, especially within the group C-A, C-B, and C-C, could be developed congruently because of their present disturbed state. IOL should be directed to continue operating in block B-B, and possibly B-Aa, before being steered into the above sequence. The above schedule fulfils the following objectives: (1) provision of operators with adequate volumes and areas to practically fulfil their requirements; (2) presently disturbed areas would be depleted and restored first; (3) access roads within the pit could be systematically abandoned if necessary; and (4) areas visible from Ya-Ya Lake would only be developed if they were absolutely required.

In the case of a decision by government and industry to proceed with gas plants at Taglu and Niglingtak, and a gas line to southern Canada, the following schedule is recommended: (1) B-A and B-B for Imperial Oil Limited (includes requirements for Taglu gas plants); (2) C-C, with expansion into C-B if required, for Shell (includes requirements for Niglingtak gas plant); (3) C-Ab, with expansion into C-Aa if required, for Gulf; (4) A-C, with expansion into A-Da if required,

for gas line requirements; and (5) C-B, C-Aa, and A-Da for operators having minor requirements.

Again, the following objectives are fulfilled: provision of operators with adequate areas to extract large volumes; few pristine areas would be disturbed; and a minimum of area would be developed where operations would be visible from Ya-Ya Lake during development.

4.3 Reserve Blocks

At present because of haulage distances and alternate sources, it seems inconceivable that Ya-Ya esker would serve as a major source of granular materials for any government, federal, territorial, or municipal requirements. However, Tuktoyaktuk to the east has a projected 25-year requirement of 3,000,000 cubic yards, assumming maximum resource development; and Inuvik and Aklavik to the south have approximate requirements of 2,500,000 cubic yards of high quality aggregate. If, during development of the Ya-Ya esker, some portion of these settlement requirements or other government projects is to be obtained from Ya-Ya esker, the normal extraction schedule can be followed. However, if extraction of material by industry proceeds without any appreciable extraction for public use, it is suggested that blocks D-A, D-B, D-C, A-A, and C-D be held in reserve for public use until all other material in the Ya-Ya esker and adjacent sources that might be approved for extraction are exploited. At this time, regional requirements could be reviewed and a decision made to release these blocks on a first-come, first-served basis, or continue to hold them in reserve.

The blocks held in reserve all contain a moderate amount of the highest quality of granular material available in the immediate area. Blocks D-A, D-B, D-C, and A-C are easily accessible to roads leading south, and block C-D is easily accessible to a road leading east. All blocks could be exploited without continued maintenance of access roads across other parts of the esker, which presumably would have been exploited and restored before exploitation of the reserve blocks.

5. DEVELOPMENT OPERATIONS

5.1 General

Rather than present a "final plan of development" for each block with inadequate basic data, this plan outlines basic operational procedures that government might expect of operators. The final plan of development integrating the below procedures would be provided by the operator after a more complete assessment of the block being exploited was obtained during the normal course of events outlined in section 6.

5.2 Treatment of Overburden

Areas covered by overburden, generally between 2 and 10 feet thick, and composed of ice-rich peat and silt are present along the esker. Obvious areas of thick overburden are outlined on Drawings 1 and 2 (Appendix A). These areas (Photo 1) and others identified during drilling programs should be carefully outlined and analyzed to determine

if enough granular material is present under them to justify removal of the overburden.

In cases where the underlying material is such that extraction is justifiable, the overburden should be removed and hauled to storage areas outside the pit. Thaw and removal of overburden probably will require most of a season. Thus, this activity should be initiated during the first season of work in any extraction block.

Where extraction of underlying materials is not to be undertaken, disturbance of areas of overburden should be avoided as this promotes unnecessary thermal and aesthetic deterioration.

5.3 Extraction and Stockpiling

Stripping and windrowing of thawed gravel should be carried out in such a manner that a rate of melt is maintained that will allow required volumes to be extracted. Where maximum volumes using conventional summer extraction techniques are required, rigid stripping schedules will need to be established with a short return period as continued baring of frost accelerates the thaw rates and granular material availability. Depths of 6 to 15 feet should be extracted annually under normal conditions depending upon the stripping return periods.

Extraction of materials along the northern edges of blocks A-A, A-D, and D-A should be carried out so that slopes facing away from Ya-Ya Lake are maintained in order that the pit will not be visible from the lake upon abandonment (see Drawing 1, Appendix A). Slopes in other

areas will be governed more closely during extraction by drainage maintenance and wastage of massive ice as outlined below in sections 5.4 and 5.5.

Stockpiling should be outside of potential extraction areas and should be of little concern to government regulation. Improper stockpiling can make winter utilization of stockpiled material extremely difficult. However, it would seem to be in the best interest of the operator to have stockpiles that provide readily extractable borrow for winter haulage. In any event, once material is stockpiled outside potential extraction areas, it will not interfere with further extraction.

5.4 Drainage Maintenance

In order to maintain required extraction rates and to maintain the availability of granular materials for extraction, good drainage must be maintained. Saturated granular material, when refrozen, will have higher ice contents than well drained gravels, which will slow the thaw rates and inhibit the workability of the granular material.

In general, bare slopes should be maintained at a steepness of no less than 5 percent during extraction except under special conditions. Basically, slopes can be maintained by paralleling gross natural slope configurations, at least until the surface of extraction has been lowered to the level of the surrounding terrain. As these levels are approached, extraction schedules will need to be such that drainage is parallel to the axis of the esker complex or is focused on a sump, presumably

Photo 1. A small area of thick overburden as indicated by vegetation cover and drainage in extraction block A-Da.

Photo 2. Small pond between extraction blocks C-Aa and C-B having negative fish potential that could be used as a natural settling pond for meltwater from adjacent terrain.

adjacent to or located where potentially extractable granular materials are deepest.

Negligible amounts of meltwater runoff from ice within the granular materials should be allowed to seep into the surrounding terrain. However, if significant amounts of meltwater are present, they should be directed into natural ponds (Photo 2), sumps, or drainage ditches. If it is necessary to remove the water from the sumps or settling ponds, the water would be left in the sumps or settling ponds until it reaches a turbidity, allowing it to be pumped to other ponds or lakes (Drawings 1 and 2, Appendix A). As the productivity of most lakes and ponds in the area is minimal or the lakes themselves are turbid (e.g. the south end of Ya-Ya Lake), minimal settling, if at all, will be required.

For workings below the level of adjacent ponds and small lakes, there are two possibilities: (1) temporary or permanent drainage of these water bodies through ditching or pumping their water to lakes at lower elevations; pumping of water would be favourable to ditching because it would avoid creation of ditches that might lead to further thermal erosion; or (2) dyking of these water bodies to prevent them from flooding the adjacent pit area (Drawings 1 and 2, Appendix A). The dykes could be formed by leaving frozen ground in place (Photo 3) or by building a barrier of saturated frozen fill. Whether further artificial impervious barriers would be required would be subject to the judgement of the operator.

5.5 Wastage of Subsurface Ice

After a detailed investigation of any extraction block is

completed, an assessment will be necessary to define areas where granular material is to be extracted regardless of massive ice overlying or underlying it. No justification exists for the preservation of massive ice if it prevents the extraction of granular material in an area where it is in short supply. However, it probably would be impractical to thaw massive ice more than 6 feet thick for thicknesses of gravel less than 6 feet.

Given present data, massive ice overlying granular material in blocks A-Bb, A-Be, A-Cd, B-Ab, B-B, C-Ab, C-C, C-Dc, and C-Db will need to be wasted to extract all the available granular material in these blocks. Further investigations carried out by operators as outlined in section 6 will undoubtedly identify more bodies of massive ice, overlying granular material, which will require wasting. Similarly, to exploit completely the granular materials in most blocks, massive ice underlying the materials will need to be exposed and thawed.

Wastage of ice bodies will have to be integrated carefully into extraction plans to maintain pit drainage. In some places ice may be bared early in pit development to initiate its melting and develop drainage ditches or sumps. In other places, it should only be melted once extraction is completed around its periphery in order that meltwater does not inhibit extraction in the surrounding area.

Massive ice peripheral to extraction areas can be let waste until natural slope processes stabilize the slope. In areas of sand this usually takes place with minimal slope erosion in two to five years, especially where the base of the slope is not actively being eroded.

5.6 Restoration

Restoration should return the site to an aesthetically acceptable state as soon as possible following depletion of granular materials. Basically, the area should be cleaned of all debris and irregularities, such as ridges and mounds, resulting from pit operation.

As much of the pit as possible should be flooded and left as a pond or lake. Those areas that cannot be flooded should be smoothly graded; overburden previously removed should be mixed in with the abandoned pit surface of gravel or sand, otherwise the surface should be left in a bare, but smoothly graded state. In fact, the present Ya-Ya esker complex is vegetation-bare relative to the surrounding area (Photo 4).

Flooding of abandoned pits is recommended as it will be a matter of decades before vegetation has reestablished itself to a point where it is indistinguishable from that of adjacent areas, and ponds and small lakes, a common phenomena of the Richards Island environment, would be the most aesthetically and environmentally desirable end result.

For those areas above water level, grades of 3 to 5 per cent should be maintained on areas of silty sand as lower grades tend to promote the formation of shallow pools because of irregular subsidence under bare surfaces where soils contain irregular ice contents; thermal erosion and gullying would be a threat to steeper grades. Surfaces composed of sand or gravel can have grades of 1 to 10 per cent without the development of the above mentioned detrimental phenomena. Isolated

Photo 3. Shoreline of a lake adjacent to extraction block B-Ac where material could be left in place at the shoreline to allow extraction of material below lake level in the background if necessary.

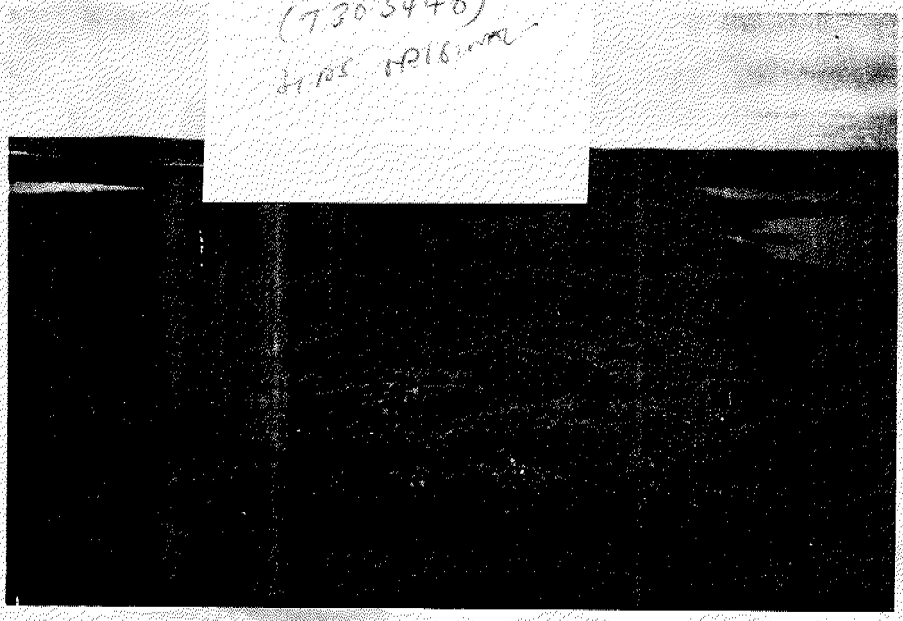


Photo 4. Broken vegetation cover on Ya-Ya esker in extraction block D-A.

trenches and depressions that do develop should be left untended as ice-wedge trenches and thermokarst pits are all part of the natural environment of the area (Photo 5).

5.7 Restoration of Block B-B

Restoration of block B-B should be completed over the next couple of years after all stockpiles presently within this area are removed and granular materials are completely extracted. This could be accomplished by the construction of a dyke along the southern edge of the two lakes at the northwest corner of the block (Drawing 2, Appendix A). Drainage of this block will be necessary to allow the complete extraction of gravel and sand over much of the block. Following completion of extraction, the pit could be allowed to fill slowly with water or the dyke could be breached. If road access to the east is necessary, a road could be maintained along the dyke or along the southern edge of the block.

6. OPERATOR RESPONSIBILITIES

6.1 General

Once operators have successfully justified their borrow requirements and been awarded a block for extraction, they should supply a reference plan, based on Drawings 1-4 and a ground survey, and a contour map of the block where they plan to operate; a detailed analysis of ground conditions and stratigraphy of the potential pit area and adjacent ground; a plan of operations; and a plan for restoration.

6.2 Block Definition

Areas designated for extraction, drainage control, stockpiling, or support facilities should have all corners clearly marked with semi-permanent markers, preferably angle-iron or 2 by 2's driven at least two feet into the permafrost. Some of these markers should have attached identifying plates; minimal requirements would be the four extremities of the potential extraction area. This method of marking would ease supervision and inspection of operations by government officials and make it clear to all operators where the limits of each operation were located.

As an aid to surveying in all boundaries and boundary markers, IAND has established a number of clearly marked posts along the trend of the esker complex (Drawing 5 and Photo 6).

6.3 Contour Maps and Stratigraphic Investigations

In conjunction with the above location map, contour maps of all areas to be utilized should be prepared with contour intervals of 3 feet and accuracy of ± 1 foot. In areas of active extraction, a new contour map should be prepared by the operator at the end of each years operation.

Areas of potential extraction should be routinely drilled on 50-yard centres to delineate areas of granular material, to outline bodies of massive ice, and to delineate thicknesses of overburden. In areas where massive ice is common, further holes might be required to delineate the configuration of the ice, especially if the ice is to be wasted eventually. All drill holes should penetrate a minimum of 5 yards

Photo 5. Trenches formed over ice wedges in extraction block D-Ba.

Photo 6. Angle iron and identifying plate marking location of survey post established as a reference point for future surveys along Ya-Ya esker complex.

into the material underlying the granular material, or to the base of materials that might eventually be thawed as the result of extraction. Following the termination of each years operations, a general map of surface materials present on the pit surface should be prepared.

The initial contour map and geologic stratigraphic data provided by the drill hole data will provide the operator with a framework for an operational plan and government officials with material to assess the feasibility of the operator's plan. Subsequent contour maps and surface maps of materials will serve as a guide to all concerned of the exact amount of material still available for extraction and to indicate any modifications in operational plans that might be necessary.

6.4 Operational Plan

Before extraction begins, the operator should prepare an operational plan including: (1) details of the volume of overburden and its location, schedule of removal, and the mean and exact location of its disposal; (2) amount and location of granular material to be removed on an annual basis; (3) location of stockpiles on an annual basis; (4) stripping procedures to be followed; (5) details of drainage control including grades that are to be maintained within the pit, location of sumps and settling ponds, location of dykes to control pit flooding, schedule and means of pond and lake drainage, and an indication of lakes that will receive water from drained lakes or settling ponds; (6) contingency plan for drainage maintenance if an unplanned abandonment occurs during operations; and (7) plans and means

for wastage of subsurface massive ice including drainage controls required for meltwater. General accepted procedures for the above operations have been outlined in section 5. Details of operations for each block will require further drilling data and will be subject to operator ingenuity.

6.5 Pit Abandonment

If a pit is to be abandoned before the granular material is completely extracted, a final contour map showing grades and drainage should be prepared by the operator. If procedures outlined in section 5 have been adhered to, the pit should be in such a state that the maximum amount of granular material is available for immediate extraction by the next operator. In addition, each operator should be held responsible for a certain share of final restoration costs.

6.6 Restoration Plan

Based on the initial contour map, stratigraphic data, and operational plan, a final plan of restoration of both the extraction area and any areas used for stockpiling, drainage control, or support facilities should be prepared. Again, basic procedures are outlined in section 5.6.

6.7 Modification of Plans

If during extraction operations, unexpected ice or materials are encountered, it will be the responsibility of the operator to

describe them as completely as possible and to indicate clearly the necessary modifications of his operational and restoration plans in order to maintain pit procedures and standards.

7. REGULATORY SUPERVISION

7.1 Initial Permit

An operator should be assigned a block for extraction once he has justified the necessity of his extracting granular materials from the Ya-Ya esker complex. Actual extraction should be conditional on the operator supplying a plot plan and contour map of the potential pit and adjacent areas, stratigraphic data, and operational plans as outlined in section 6, and such a plan being acceptable to a reviewing regulatory government agency. It will be the responsibility of this agency to assess whether the operational plans satisfactorily maintain pit and areal drainage, maximize the volume of granular material to be extracted, and include an adequate contingency plan for abandonment and acceptable restoration plan. Section 5 of this report indicates some guidelines to be followed in such an assessment, but the assessment will require an evaluation of the stratigraphic information provided by the operator and the compatibility of his operational plan with this data.

7.2 Inspection

Field inspection during operations will involve checking (1) that location markers are properly emplaced; (2) that overburden is

removed according to schedule and stockpiled as indicated in operational plans; (3) that drainage is confined within limits set out in the operational plan; (4) that stockpiles and support facilities lie clearly within areas delimited for these purposes. Actual pit operations will need little attention as it is mainly to the benefit of the operator that he maintain drainage and thaw rates within the pit, and that grades and drainage be maintained in such a manner that the condition of the pit at the end of the season is within the limits set out within the operational plan.

Annual field inspection following operations will involve checking that grades and drainage maintenance within the pit are according to the operational plan accepted by the government and that all areas used for stockpiling and support facilities are maintained in a manner as set out in the operational plan. The semi-permanent markers, whose position and elevation will be plotted on the original contour map produced by the operator, will serve as a guide to a visual assessment of grades in the pit. In case of controversy, the government can simply implement an elevation survey using its own horizontal and vertical control points.

Field inspection following restoration will involve checking that areas used for drainage, stockpiling, and support facilities are returned to the condition outlined in the operator's restoration plan and that the pit configurations be such that certain areas will flood and that other areas which are not to be flooded will have grades and surface materials as set out in the accepted restoration plan.

7.3 Co-ordination of Restoration

In blocks where one operator extracts all materials, it will be that operators responsibility to restore the pit using section 5.6 as a guide. In blocks where a number of operators extract materials, operators that abandon a pit before restoration measures can be realistically initiated, should be held responsible for a proportion of the estimated cost of restoration. The operator or operators who complete the exploitation of any block should be required to carry out restoration, but should receive all sums previously collected for the restoration of same block.

8. GUIDELINES RE USE OF GRANULAR MATERIAL

8.1 Regional Limits

It would appear that the use of granular material from the Ya-Ya esker complex would best be confined on a regional scale to an area bounded by the eastern edge of Shallow Bay, Reindeer Channel, Neklek Channel, and East Channel. This area includes all of Richards Island, the northeastern portion of the Mackenzie Delta, and the shallow waters adjacent to both of the above features.

Areas west of Shallow Bay are better served by sources along the northern Yukon Coastal Plain. Areas south of Reindeer Channel are better served by unconsolidated and bedrock sources immediately east and west of the Mackenzie Delta. Areas east of East Channel are better served by sources flanking the Caribou Hills and Eskimo Lakes.

8.2 Material Utilization

Theoretically, granular material equivalent to the general quality present at Ya-Ya esker should be reserved for support of facilities requiring well drained, non frost-susceptible base and subbase materials and for concrete aggregate. Requirements for concrete aggregate in an area where most facilities are supported by piles or pads is minimal, and little granular material need be reserved for this purpose. Facilities requiring well drained, non frost-susceptible stable surface and non frost-susceptible base and subbase materials are airstrips; roads; permanent pads supporting facilities requiring stability for operation and prevention of breakdowns and accidents; and the surfaces of all pads and any fill requiring erosion resistance to running water. Undoubtedly sandier and siltier material than that available at Ya-Ya esker could be utilized as core material for many pads, but the area that would have to be utilized to extract and drain these materials to allow for stockpiling and winter utilization would be extensive. The large area where the environment would be disturbed indicates that the workability of the materials in the Ya-Ya esker complex makes them a logical material for fill requirements in the area outlined in section 8.1.

Because of the relative scarceness of granular material having the workability of Ya-Ya material, utilization of the Ya-Ya material for offshore construction should be restricted to those areas where sea-bottom materials, having adequate drainage and shear resistance

characteristics for construction of viable artificial islands, are not available. This would be mainly shallow areas within Mackenzie Bay where silty and clayey sea-bottom materials are common and where it would be difficult to barge in materials from other subsea sources.

9. SUMMARY

The Ya-Ya development and restoration plan requires that the Ya-Ya esker and immediate vicinity be delimited as a development area and be divided into extraction blocks that would be exploited independently. Smaller blocks would provide operators with annual volumes of 40,000 to 200,000 cubic yards, whereas larger blocks would provide operators with volumes large enough to satisfy requirements for gas plant and gas line construction. Schedules of extraction are proposed that allow for complete or partial exploitation of the esker and that emphasize maximum economical extraction with minimal disturbance both of the Ya-Ya esker complex and of the region as a whole. Development within the esker is to be limited to the minimum area subject to requirements. Where possible, blocks where development has been initiated will be completely exploited before development of untouched blocks is allowed. Certain areas would be held in reserve for the public domain, at least until the remainder of the esker had been exploited.

The maximum amount of granular material will be removed from any portion of the esker complex that is developed regardless of water levels of adjacent ponds and lakes and the presence of overburden or subsurface massive ice. Although present projections of granular material requirements

within the region, given construction of two gas plants and a gas line, are only 5.2 million cubic yards, and the esker complex is estimated to contain 16 to 18 million cubic yards, future developments could easily increase the demand beyond the volume contained within the Ya-Ya esker complex.

The development area has been zoned into areas for extraction, stockpiling, drainage control, access, and camp and support facilities. Given this framework, an operator having justified his need for granular material from the Ya-Ya esker complex, would provide government officials with a reference plan, contour map, stratigraphic data, and plan of operation and restoration before proceeding with extraction activities. The operation plan would include schedules to remove overburden and to stockpile it; plans to strip, windrow, and remove granular material to maximize thaw depths within the block as extraction proceeds; plans to maintain pit drainage to prevent pit flooding and allow efficient pit development and to prevent ice build-up in granular material during winter freeze-backs; plans for wastage of massive ice to maximize the extractable volume of granular material. All stockpiling, camp, and support facilities during development would be positioned so as not to interfere with melting and extraction of granular materials; generally they would lie in areas zoned specifically for such purposes. Each year, following completion of extraction activities, the operator would supply the government with a new contour map and map of surface materials. If a pit is abandoned before being completely exploited, it should be left in such a state that the next operator can immediately extract a

maximum amount of granular material. Restoration plans would include plans for a general clean-up, smoothing of grades, redistribution of overburden, and where possible, flooding of the pit. In extraction blocks where a number of operators were present, they would be required to share the responsibility or cost of restoration.

Government officials would be required to assess and approve submitted plans and to police yearly developments through field inspections and analysis of yearly reports.

10. REFERENCES

1. EBA Engineering Consultants Ltd.
"Ya-Ya Granular Resources Study" report submitted to Arctic Petroleum Operators Association, September 1975.

2. EBA Engineering Consultants Ltd.
"Field Inspection Ya-Ya Gravel Pit, June 1976" report submitted to Imperial Oil Limited, Field Services Department, June 1976.

3. J.D. Mollard and Associates Limited
"Gravel Inventory Survey, Richards Island and Adjacent Areas" report submitted to Arctic Petroleum Operators Association, 1972.

4. V.N. Rampton
"Surficial Geology and Landforms, Mackenzie Delta", Geological Survey of Canada, Open File 96, 1972.

5. V.N. Rampton
"Surficial Geology and Landforms, Aklavik", Geological Survey of Canada, Open File 119, 1972.

6. Ripley, Klohn & Leonoff International Ltd.
"Granular Materials Inventory, Zone 11", report submitted to Department of Indian Affairs and Northern Development, 1972.

11. APPENDIX A

Drawings 1, 2, 3, 4, and 5.

LEGEND

A - Access
C - Camp & Support Facilities
D - Drainage Control
E - Extraction
EC - Extraction - Conditional
S - Stockpiling

Overburden

Potential dykes

Direction of slopes required upon abandonment

x - Lake, drainage allowable, potential settling pond

p - Lake, temporary drainage allowable, potential settling pond

r - Lake, potential receptor of waste water

YA - YA LAKE

YA - YA RIVER

ZONING OF YA-YA ESKER DEVELOPMENT AREA SUPERBLOCKS A & D

Indian and Northern Affairs

Engineering & Architecture Branch

Transportation Division

NOV., 1976

Terrain Analysis and Mapping Services Ltd.

DWG. NO. | of 5

LEGEND

A – Access
C – Camp & Support Facilities
D – Drainage Control
E – Extraction
EC – Extraction – Conditional
S – Stockpiling
Overburden
Potential dykes
Direction of slopes required upon abandonment
x – Lake, drainage allowable, potential settling pond
p – Lake, temporary drainage allowable, potential settling pond
r – Lake, potential receptor of waste water

YA-YA LAKE

ZONING OF YA-YA ESKER DEVELOPMENT AREA SUPERBLOCKS B & C

Indian and Northern Affairs

Engineering & Architecture Branch
Transportation Division

NOV., 1976

Terrain Analysis and Mapping Services Ltd.

DWG NO. 2 of 5

PHOTOGRAPHY FLOWN
JULY 8 75
ROLL NO.
MA 931

NOTES:

1. Horizontal Grid is based on Universal Transverse Mercator System with origin 135°W. Long at the equator. Grid is in METRES, Scale 1 : 10 000.
2. Elevations are shown in METRES and are based on an Assumed Datum. Reference elevation is Found Post C-8, (C.L.S.R. Plan 58536), ASSUMED ELEV. 337.72 metres.
3. See C.E.S. Drwg. 8638-M-1, ground survey control traverse, co-ordinates and elevations.
4. Survey monuments with targets from 1975 photography shown .... △ A.P. 1
   1976 survey monuments marked DIAND shown .... △ D-3

* UTM CO-ORDINATES OF NUMBERED STATIONS ALONG BOUNDARIES ARE GIVEN IN APPENDIX B

LEGEND:

OUTLINE OF YA-YA ESKER DEVELOPMENT AREA	
EXTRACTION BLOCK BOUNDARIES	
BUILDINGS	
ROADS	
TRAIL	
LAKE	
SWAMP	
CONTOURS	330, 320 (metres)
SPOT HT.	322.7 (metres)

Nº	DATE	REVISION	DRN BY	APPRD BY

BOUNDARIES & TOPOGRAPHY OF YA-YA ESKER DEVELOPMENT AREA SUPERBLOCKS A, B & C

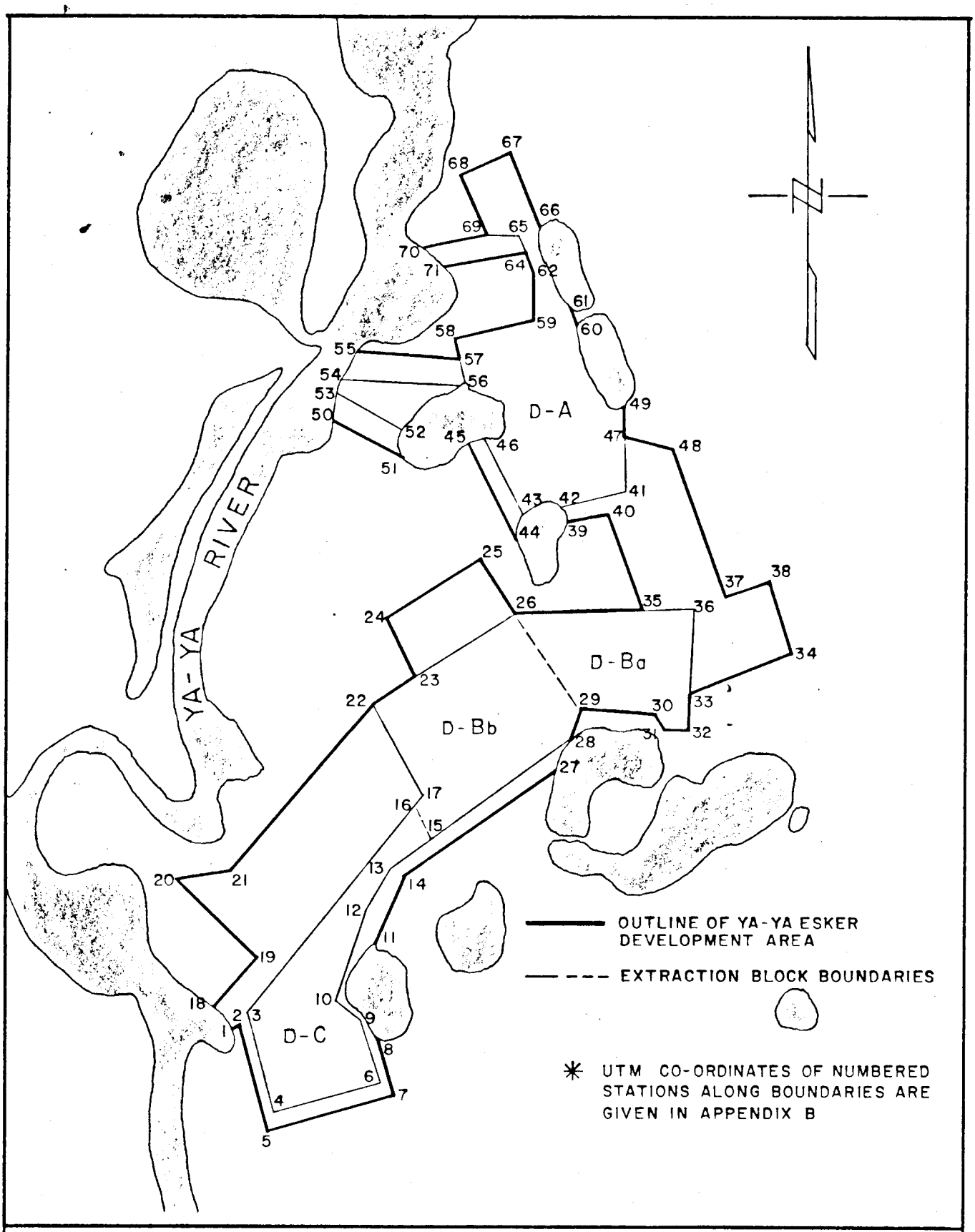
Indian and Northern Affairs

Engineering & Architecture Branch
Transportation Division

NOV., 1976 | Terrain Analysis and Mapping Services Ltd. | DWG. NO. 3 of 5

Approvals	INITIAL	DATE

N.T.S. 107C/3W



BOUNDARIES & TOPOGRAPHY OF YA-YA ESKER DEVELOPMENT AREA, SUPERBLOCK D

Indian and Northern Affairs

Engineering & Architecture Branch

Transportation Division

NOV, 1976

Terrain Analysis and Mapping Services Limited

DWG NO. 4 OF 5

Table of Co-ordinates

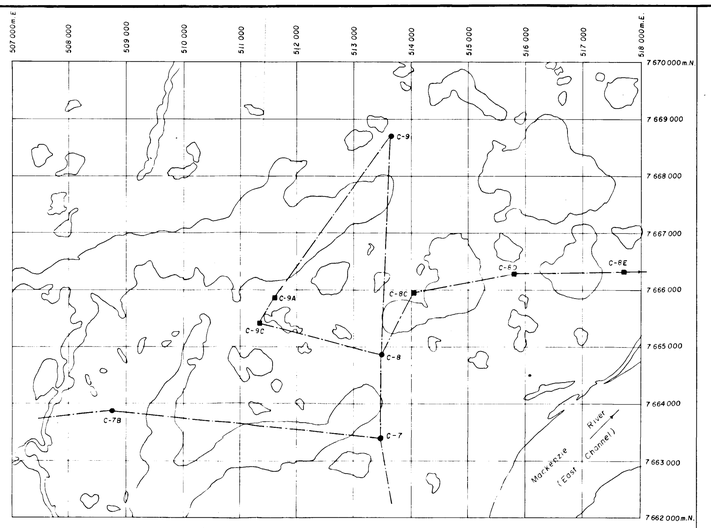
STATION	Sharan '65 Datum, July '69 adjustment U.T.M. Zone 8 N (metres)	E (metres)	ASS'D ELEV. (feet)
C.L.S.R PLAN 58536 (REINDEER A-41)			
Fd. C-4	7 666 379.48	523 230.26	–
Fd. C-7	7 663 417.13	513 448.36	1103
Fd. C-8	7 664 840.56	513 432.31	1108
Fd. C-9	7 668 679.06	513 629.84	–
C.L.S.R. PLAN 59287 (KIKORALOK N-46)			
Fd. C-7B	7 663 897.31	508 753.90	1185.5
C.E.S. DRWG. 7851-M-14 & 7690-M-1			
C-9A	7 665 847.96	511 598.30	–
C-9C	7 665 419.7	511 367.8	1126
C-8E			
ADJUSTED TRAVERSE CO-ORDINATES			
A. D-1	7 663 542.27	508 102.63	1148.5
D-2	7 664 036.49	508 422.74	1124
D-3	7 664 432.65	508 464.00	1131
D-4	7 665 096.82	508 469.89	1076
T.H.4A	7 665 023.76	508 753.62	–
D-5	7 665 613.74	509 753.54	
T.H. 5A	7 665 786.09	510 205.42	–
D-7	7 665 951.65	510 255.04	1069
AP2	7 665 976.80	510 521.01	1129
APA	7 665 646.78	510 462.26	–
D-8	7 665 492.05	510 568.90	1069.5
B. AP1	7 665 069.02	509 464.52	1123.5
APX	7 665 062.21	509 775.85	–
D-6	7 665 064.37	509 922.90	1094
C. D-10	7 664 971.76	511 497.24	1070
T.H.10A	7 664 738.84	511 638.82	–
D-11	7 664 480.66	511 887.87	1063
D-13	7 664 520.12	512 989.98	1065

STATION	Sharan '65 Datum, July '69 adjustment U.T.M. Zone 8 N (metres)	E (metres)	ASS'D ELEV. (feet)
D. AP3	7 665 803.98	511 433.40	1126
AP4	7 665 140.78	513 090.58	1101
E. D-14	7 664 523.88	513 474.19	1062
T.H. 14A	7 664 771.07	513 524.15	–
D-15	7 665 005.86	513 912.81	1077
T.H.15A	7 665 123.16	514 041.87	–
AP5	7 665 332.74	514 277.20	1104.5
D-16	7 664 903.87	514 543.57	1077
D-17	7 665 052.91	515 073.42	1075
T.H.17A	7 665 357.92	515 272.06	–
AP6	7 665 759.51	515 344.19	1111.5
D-19	7 666 009.98	515 582.32	1130
C-8D	7 666 316.71	515 705.40	1149.5
C-8C	7 665 943.46	514 012.00	–
F. AP7	7 665 054.46	514 793.03	1091.5
D-18	7 665 056.51	515 590.56	1078.5
G. D-20	7 665 967.02	515 989.74	1092.5
T.H.20A	7 666 190.44	515 888.06	–
AP8	7 666 265.6	515 738.6	1148.5

(Monuments and Co-ordinates are listed in the order of closures done)

LOCATION PLAN

Scale 1 : 50 000



FIELD NOTES

OF SURVEY OF

POSTS PLANTED

IN

YA-YA ESKER - KAME COMPLEX

69° 05' N. LAT. (APPROX.)

134° 40' W. LONG. (APPROX.)

NORTHWEST TERRITORIES

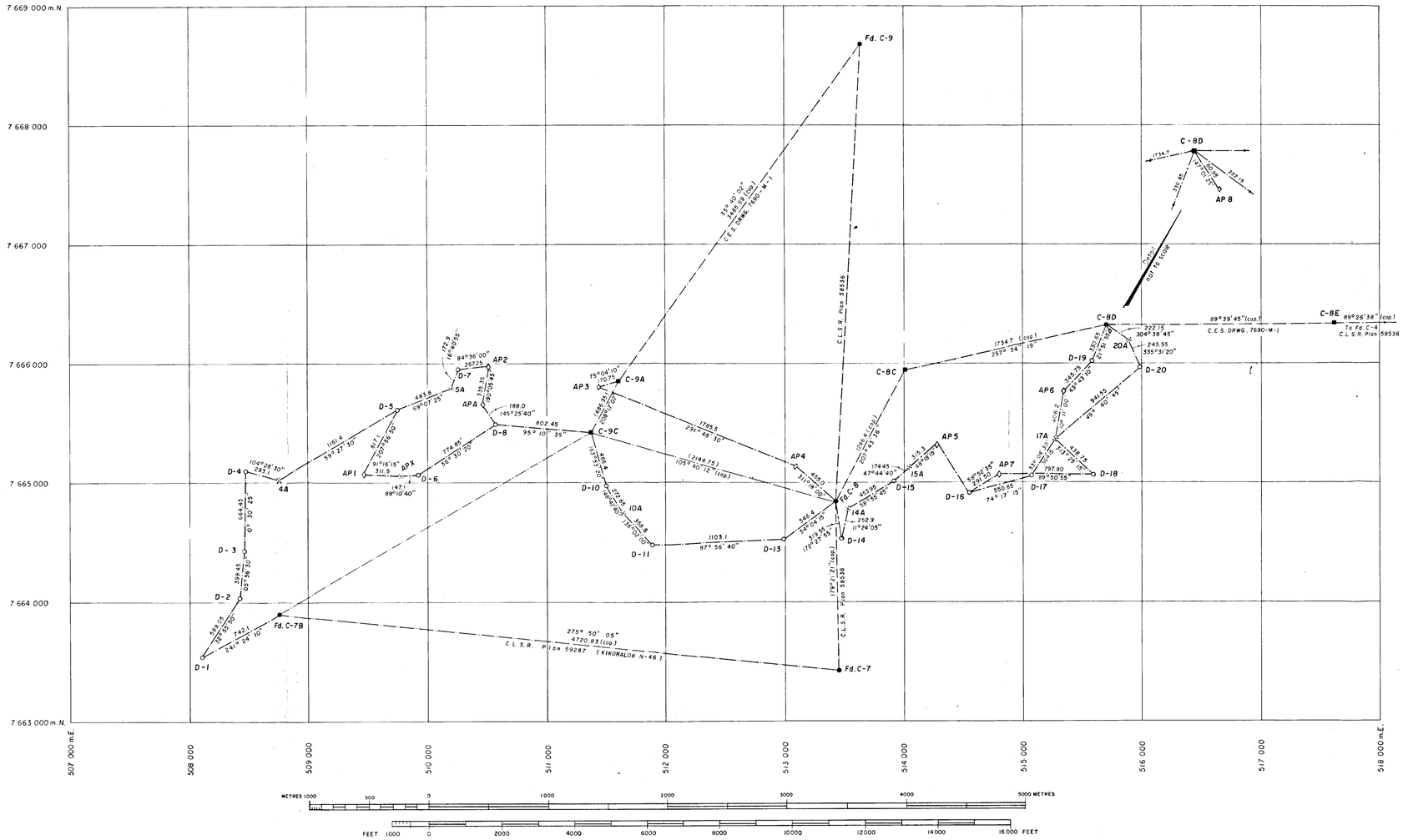
SCALE 1 : 20 000

Surveyed for

DEPT. OF INDIAN AND NORTHERN AFFAIRS

By: Barry R. BISHOP, D.L.S.

1976



LEGEND

1. Bearings are referred to longitude 135° W., and are derived from the bearing 359° 21' 21", between found monuments C-7 and C-8, C.L.S.R. Plan 58536 (REINDEER A-41).
2. Authorized Control Monuments found shown ●
   C.E.S. Control Monuments found shown ■
3. Old Pattern Iron Posts planted shown ○
   Iron Bars planted shown ◊ (AP__)
   Traverse Stations, no permanent marks, shown ×
4. Traverse Lines shown ———
5. Distances are measured by CA 1000 Tellurometer, and are shown in METRES and DECIMALS thereof. Distances are shown as measured, reduced to Sea Level.
6. Co-ordinates are based on the Universal Transverse Mercator System with origin 135° W. Long. at the equator. U.T.M. Scale Factor applied to measured distances is 0.9996.
7. Metal Marker Posts placed at all surveyed stations. D.I.A.N.D. control monument markers have a 4" x 4" metal tag stamped "Survey Monument, Do not destroy, D.I.A.N.D. No.....". These are shown in the table as D-1, D-2, etc.
8. Co-ordinates shown have been adjusted, tieing in with previous C.L.S.R. and C.E.S. plans. An overall adjustment using all available data was not necessary for this survey and has not been made.
9. Elevations are shown in FEET and DECIMALS and are related to top of Fd.I. C-8, C.L.S.R. Plan 58536, ASSUMED to be 1108.0 feet.
10. See C.E.S. Drwg. 8638-M-2 for topographic plan prepared from 1975 photography.

AFFIDAVIT

I, Barry R. BISHOP, of the City of Edmonton in the Province of Alberta, Dominion Land Surveyor, make oath and say ;
That I have in my own proper person, according to law and the instructions of the Surveyor General of Canada Lands, faithfully and correctly executed survey shown by this plan and field notes, and that the said plan and field notes are correct and true to the best of my knowledge and belief.
SO HELP ME GOD.

Sworn before me at Edmonton
this 21 day of Sept, A.D. 1976.

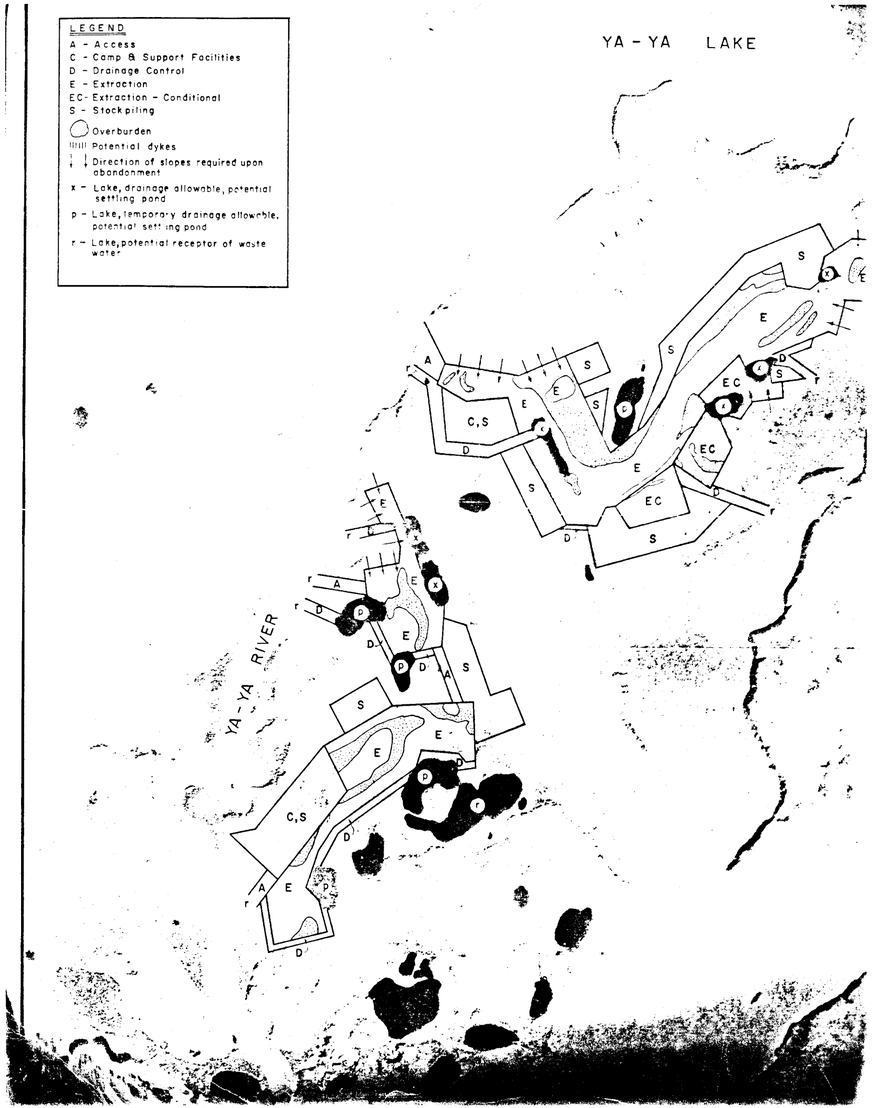
B. R. Bishop
Dominion Land Surveyor

A Commissioner for Oaths in and for The Province of Alberta.

Drawing No. 5 of 5

Canadian Engineering Surveys Co. Ltd.
Edmonton Alberta

Drawn by: SM	DATE: SEPT. 3rd, 1976			N.T.S. MAP SHEET 107C/3W
Checked by: BRB				


LEGEND
A - Access
C - Camp & Support Facilities
D - Drainage Control
E - Extraction
EC - Extraction - Conditional
S - Stockpiling
Overburden
Potential dykes
Direction of slopes required upon abandonment
x - Lake, drainage allowable, potential settling pond
p - Lake, temporary drainage allowable, potential settling pond
r - Lake, potential receptor of waste water
YA - YA LAKE
YA - YA RIVER
C,S
EC
E
S
A
D
x
p
r

12. APPENDIX B

UTM Co-ordinates of Numbered Stations on Drawings 3 and 4

I Super Block A (Drawing 3)

Station	Northing	Easting
1	7 665 150	508 240
2	7 665 380	508 285
3	7 665 075	508 350
4	7 665 125	508 370
5	7 665 205	508 375
6	7 665 035	508 560
7	7 665 060	508 685
8	7 665 175	508 780
9	7 665 005	508 910
10	7 665 260	508 920
11	7 664 820	508 380
12	7 664 825	508 660
13	7 664 835	508 670
14	7 664 925	508 750
15	7 664 680	508 770
16	7 664 895	508 770
17	7 664 950	508 805
18	7 664 920	508 825
19	7 664 625	508 865
20	7 664 475	508 925
21	7 664 495	508 970
22	7 664 920	508 915
23	7 664 750	508 995
24	7 664 515	508 995
25	7 665 340	509 045
26	7 665 205	509 125
27	7 665 125	509 005
28	7 665 085	509 025
29	7 665 065	509 035
30	7 665 150	509 160
31	7 664 900	509 150
32	7 664 845	509 190
33	7 664 805	509 115
34	7 664 590	509 165
35	7 664 530	509 130
36	7 664 505	509 090
37	7 664 315	509 145
38	7 664 600	509 205
39	7 664 480	509 290
40	7 664 975	509 310

I Super Block A

Station	Northing	Easting
41	7 664 790	509 480
42	7 664 605	509 595
43	7 664 465	509 605
44	7 664 710	509 665
45	7 664 860	509 720
46	7 664 650	509 750
47	7 664 675	509 805
48	7 664 610	509 870
49	7 664 650	509 890
50	7 665 010	509 765
51	7 665 095	509 815
52	7 665 105	509 885
53	7 665 125	509 965
54	7 665 200	509 960
55	7 665 205	510 010
56	7 665 195	510 045
57	7 665 095	509 705
58	7 665 195	509 670
59	7 665 140	509 590
60	7 665 210	509 565
61	7 665 320	509 485
62	7 665 375	509 465
63	7 665 435	509 385
64	7 665 275	509 370
65	7 665 245	509 565
66	7 665 300	509 620
67	7 665 275	509 735
68	7 665 240	509 760
69	7 665 300	509 880
70	7 665 310	509 970
71	7 665 695	509 740
72	7 665 640	509 825
73	7 665 700	509 920
74	7 665 625	509 960
75	7 665 220	510 070
76	7 665 365	510 075
77	7 665 400	510 075
78	7 665 425	510 125
79	7 665 420	510 190
80	7 665 605	510 040

I Super Block A

Station	Northing	Easting
81	7 665 650	510 080
82	7 665 580	510 220
83	7 665 580	510 250
84	7 665 580	510 270
85	7 665 680	510 165
86	7 665 720	510 105
87	7 665 765	510 105
88	7 665 795	510 140
89	7 665 900	510 055
90	7 665 860	510 205
91	7 665 860	510 380
92	7 666 030	510 575
93	7 665 910	510 655
94	7 665 785	510 675
95	7 665 695	510 640
96	7 665 560	510 725
97	7 665 565	510 775
98	7 665 555	510 360
99	7 665 650	510 425
100	7 665 615	510 470
101	7 665 630	510 550
102	7 665 450	510 545
103	7 665 440	510 625
104	7 665 500	510 615
105	7 665 490	510 650
106	7 665 420	510 655
107	7 665 360	510 770

II Super Block B (Drawing 3)

Station	Northing	Easting
1	7 665 510	510 955
2	7 665 460	510 940
3	7 665 235	510 795
4	7 665 000	510 760
5	7 665 140	510 980
6	7 665 375	511 005
7	7 665 360	511 075
8	7 665 580	511 250
9	7 665 240	511 210
10	7 665 155	511 220

II Super Block B

Station	Northing	Easting
11	7 664 975	511 315
12	7 665 075	511 370
13	7 665 120	511 520
14	7 665 215	511 565
15	7 665 025	511 450
16	7 664 940	511 415
17	7 664 900	511 525
18	7 664 985	511 560
19	7 664 980	511 605
20	7 665 090	511 705
21	7 665 175	511 670
22	7 665 195	511 620
23	7 665 345	511 370
24	7 665 410	511 255
25	7 665 780	511 245
26	7 665 875	511 045
27	7 665 900	511 025
28	7 666 050	511 110
29	7 665 875	511 080
30	7 665 960	511 115
31	7 665 820	511 395
32	7 665 875	511 475
33	7 665 710	511 420
34	7 665 470	511 420
35	7 665 610	511 540
36	7 665 720	511 770
37	7 665 890	511 770
38	7 665 915	511 930
39	7 665 705	511 825
40	7 665 410	511 665
41	7 664 820	511 740
42	7 664 840	511 740
43	7 664 850	511 920
44	7 664 825	511 930
45	7 664 890	511 940
46	7 664 900	511 915
47	7 664 900	511 850
48	7 664 960	511 805
49	7 665 000	511 880
50	7 665 000	511 960

II Super Block B

Station	Northing	Easting
51	7 664 930	512 025
52	7 665 385	511 870
53	7 665 380	512 090
54	7 665 480	512 510
55	7 665 735	512 510
56	7 665 750	512 675
57	7 665 560	512 670
58	7 665 500	512 605
59	7 665 456	512 690
60	7 665 410	512 690
61	7 665 400	512 830
62	7 664 965	512 250
63	7 665 150	512 465
64	7 665 135	512 590
65	7 665 005	512 690
66	7 664 995	512 785
67	7 664 990	512 805
68	7 664 910	512 850
69	7 664 890	512 840
70	7 664 940	513 015
71	7 664 960	513 005
72	7 665 000	513 045
73	7 665 025	513 040
74	7 665 240	512 950
75	7 665 270	512 965
76	7 665 225	513 320
77	7 665 195	513 475
78	7 665 000	513 585
79	7 664 980	513 590

III Super Block C (Drawing 3)

Station	Northing	Easting
1	7 665 350	513 435
2	7 665 335	513 550
3	7 665 320	513 490
4	7 665 240	513 605
5	7 665 055	513 705
6	7 665 020	513 710
7	7 664 955	513 750
8	7 665 850	513 880
9	7 665 870	513 910
10	7 665 210	513 930

III Super Block C

Station	Northing	Easting
11	7 665 125	513 905
12	7 665 140	513 925
13	7 665 040	514 120
14	7 664 970	514 020
15	7 664 895	514 165
16	7 664 940	514 240
17	7 665 050	514 225
18	7 665 055	514 260
19	7 665 175	514 280
20	7 665 195	514 125
21	7 665 355	514 050
22	7 665 355	514 085
23	7 665 380	514 080
24	7 665 390	514 065
25	7 665 190	514 350
26	7 665 110	514 510
27	7 665 415	514 520
28	7 665 430	514 680
29	7 665 045	514 735
30	7 664 780	514 580
31	7 664 650	514 580
32	7 664 580	514 485
33	7 664 485	514 450
34	7 664 470	514 490
35	7 664 560	514 520
36	7 664 625	514 615
37	7 664 780	514 615
38	7 664 950	514 710
39	7 664 940	514 870
40	7 665 160	514 850
41	7 665 170	514 890
42	7 665 025	515 035
43	7 665 050	515 170
44	7 665 200	515 005
45	7 665 215	515 060
46	7 665 250	515 055
47	7 665 425	514 990
48	7 665 515	514 970
49	7 665 525	514 810
50	7 665 510	514 835

III Super Block C

Station	Northing	Easting
51	7 665 595	514 905
52	7 665 595	514 935
53	7 665 615	514 995
54	7 665 675	515 075
55	7 665 655	515 085
56	7 665 710	515 015
57	7 665 315	515 120
58	7 665 290	515 140
59	7 665 300	515 260
60	7 665 205	515 260
61	7 665 330	515 330
62	7 665 510	515 250
63	7 665 455	515 445
64	7 665 525	515 410
65	7 665 640	515 410
66	7 665 925	515 240
67	7 665 940	515 240
68	7 665 940	515 295
69	7 665 925	515 420
70	7 665 850	515 440
71	7 665 760	515 495
72	7 665 755	515 505
73	7 665 825	515 560
74	7 665 780	515 685
75	7 665 590	515 700
76	7 665 670	515 735
77	7 665 785	515 710
78	7 665 905	515 790
79	7 665 945	515 945
80	7 665 945	515 795
81	7 665 970	515 745
82	7 666 065	515 465
83	7 666 235	515 550
84	7 666 315	515 670
85	7 666 470	515 495
86	7 666 420	515 695
87	7 666 295	515 815
88	7 666 005	515 765
89	7 666 260	516 010
90	7 666 220	516 270

III Super Block C

Station	Northing	Easting
91	7 666 115	516 235
92	7 666 050	516 085
93	7 665 955	516 115
94	7 665 920	516 090
95	7 665 850	516 125
96	7 665 770	516 165
97	7 665 800	516 255
98	7 665 805	516 275
99	7 665 930	516 280
100	7 665 920	516 295
101	7 665 935	516 330
102	7 665 940	516 305
103	7 665 995	516 285
104	7 666 015	516 295

IV Super Block D (Drawing 4)

Station	Northing	Easting
1	7 662 730	507 660
2	7 662 730	507 670
3	7 662 750	507 690
4	7 662 540	507 750
5	7 662 500	507 730
6	7 662 600	507 970
7	7 662 580	508 010
8	7 662 700	507 980
9	7 662 740	507 940
10	7 662 790	507 880
11	7 662 900	507 950
12	7 662 980	507 950
13	7 663 070	508 000
14	7 663 060	508 030
15	7 663 150	508 070
16	7 663 220	508 040
17	7 663 240	408 050
18	7 662 770	507 600
19	7 662 870	507 700
20	7 663 040	507 530

IV Super Block D

Station	Northing	Easting
21	7 663 070	507 650
22	7 663 440	507 950
23	7 663 500	508 040
24	7 663 630	507 980
25	7 663 760	508 170
26	7 663 640	508 250
27	7 663 290	508 350
28	7 663 360	508 380
29	7 663 440	508 410
30	7 663 430	508 570
31	7 663 400	508 590
32	7 663 400	508 640
33	7 663 470	508 640
34	7 663 560	508 800
35	7 663 650	508 530
36	7 663 650	508 640
37	7 663 680	508 720
38	7 663 710	508 810
39	7 663 850	508 370
40	7 663 860	508 450
41	7 663 910	508 490
42	7 663 880	508 350
43	7 663 870	508 260
44	7 663 830	508 250
45	7 664 000	508 150
46	7 664 010	508 180
47	7 664 030	508 490
48	7 664 000	508 600
49	7 664 100	508 490
50	7 664 050	507 860
51	7 663 890	508 000
52	7 664 040	508 000
53	7 664 120	507 860
54	7 664 150	507 870
55	7 664 210	507 900
56	7 664 140	508 140
57	7 664 200	508 120
58	7 664 240	508 110
59	7 664 290	508 290
60	7 664 260	508 380

IV Super Block D

Station	Northing	Easting
61	7 664 310	508 360
62	7 664 390	508 280
64	7 664 440	508 260
65	7 664 470	508 250
66	7 664 490	508 290
67	7 664 650	508 220
68	7 664 600	508 120
69	7 664 470	508 170
70	7 664 440	508 040
71	7 664 410	508 090