5

ESKIMO LAKES DREDGING STUDY

GULF OIL CANADA LIMITED

NOVEMBER 1975

COMMENTS ON DRAFT REPORT:

GEOTECHNICAL INVESTIGATION OF POTENTIAL SAND AND GRAVEL RESERVES INUVIALUIT SETTLEMENT REGION DEPOSIT 155 SOUTH TUKTOYAKTUK, NORTHWEST TERRITORIES

EXECUTIVE SUMMARY

Comments are presented in the following format:
Page/Paragraph[1]/Line(s)[2]: Comments

1/1/1-2 this may imply that INAC is going to do more than what we have actually committed to; please revise as indicated in original comments for site I407 which are repeated below:
- delete "currently", and "a" in line 1
- insert "selected" before "granular"
- change "resources" to singular and after this, insert "deposits."

/3/1-3
- there are discrepancies between volumes presented here and those of Table 11 of draft report
  - proven and probable: 236K and 490K in draft
  - draft indicates there is Class 1 material
  - no volume for prospective (864K in draft)
- are volumes here based on combined data from GNWT and INAC studies? (see also comments on lines 4-5, below)
  - combined data is certainly the most important, but you might lead into it with ⟨SL⟩[3] "This investigation has increased the proven volumes of all material classes (Class *1?* to Class 4) in Site 155 (N and S) by about *x*% to a total of *y*m^3. Total volumes of probable and prospective resources are ..."
- has material originally designated as Class 1 been downgraded to Class 2 primarily on basis of reactivity test results? if so, please reconsider since:
  - concrete is not the only possible use of Class 1 material; even if unsuitable for concrete, may be OK for other Class 1 uses
  - the suite of tests conducted are merely indicators that mix design must consider potentially deleterious aggregates; batch tests are needed before aggregate is used in concrete, but should not pre-judge these results or rule out other uses of otherwise-Class 1 material; low alkali cements are used routinely in western Canada
- delete "estimated" when referring to "proven"
- prospective ⟨sp⟩[3]

NOTES: 1 - from start of section 2 - from start of paragraph
3 ⟨SL⟩ = something like; ⟨sp⟩ = spelling/typo error

1/3/3-4 - should give total proven quantities of each material class instead of just range of proportions, since it is the former that must be compared to demands.

/4-5 this sentence suggests above volumes are for 155S only: as noted above, combined data is most important, but you could include summary of data pertaining to this investigation in a separate paragraph; this sentence could be included in new paragraph, but if only combined data presented, will need to delete or modify this sentence

/4/1-3 - refer to "total volumes of proven"
- proven reserves satisfy known demands; should also refer briefly to potential demands for "speculative" projects

/3-5

see comments for pgh 3/lines 1-3, above, and pgh 5/line 2; if there are Class 1 materials, but suitability for concrete doubtful, indicate so here

/5/1

- after "Development", insert <SL> "of the Site 155S deposits investigated in this study,"
- delete "within these deposits"

/2

"Class 1"? - see comments for pgh 3 and pgh 4, above

NORTHERN CONSTRUCTION COMPANY
Division of Morrison-Knudsen Company, Inc.

1304 HORNBY STREET
VANCOUVER, CANADA V6Z 1W6

November 17, 1975

GULF CANADA FILE COPY

Gulf Oil Canada Limited,
P.O. Box 130,
Calgary, Alberta, T2P 2H7

Attention: G. R. Appleton, P.Eng.
Exploration and Production Department

Dear Sirs:

Re: Parsons Lake Gas Plant
Eskimo Lakes - Dredging Study
Work Authorization No. 65329

Attached you will find the Eskimo Lakes Dredging Study which you requested us to provide, by your letter of October 27, 1975.

The study provides knowledge as to what action would be required to make transportation of both river and ocean going barges in the Eskimo Lakes possible. It also includes what action would be required to have a compatible dock site at the Hans Bay and Campbell Island areas.

We have determined the quantities of materials that require dredging in order to accommodate the various sizes of barges.

We have determined the numbers of tugs and barges that are required to handle the assumed quantity (450,000 tons) of supplies in a given year, assuming there is a lightering operation at or near Campbell Island.

In order to determine what action is ultimately taken concerning dredging vs lightering, it is necessary to cost out the various factors.

These factors are:-

(a) Cost of Dredging for maximum draft of 15'
(b) Cost of Dredging for maximum draft of 18'
(c) Cost of Docking facilities at Campbell Island
(d) Cost of Lightering equipment including:
tugs, barges (1000 Series) cranes, camp and communications.
(e) Cost of constructing the Dock at Hans Bay.

Cont'd . . . . . .

We appreciate the opportunity of working on this study with you. Should you wish any further information, please do not hesitate to contact the writer.

Yours very truly,

D. E. Coulter
Area Manager

DEC:ms
Encl.

NORTHERN CONSTRUCTION COMPANY
DIVISION OF MORRISON-KNUDSEN COMPANY, INC.

Contents
November 17, 1975

GULF OIL CANADA LIMITED

ESKIMO LAKES DREDGING STUDY

TABLE OF CONTENTS

SCOPE

The scope of this study is to provide knowledge as to what action would be required to make transportation of both river and ocean going barges in the Eskimo Lakes possible, and also, what action would be required to have a compatible dock site at Hans Bay. (See Gulf Oil Canada Ltd. letter dated October 27, 1975).

In order to provide the necessary knowledge it was necessary to study the Eskimo Lakes chain from Campbell Island to Hans Bay.

- The pertinent fathometer sounding have been plotted.
- The sizes of the various barges that may be used to transport goods through the Eskimo Lakes has been determined
- The volumes of dredge material that may be excavated at the various shallows and narrows to accommodate the above noted barges was determined.
- The docking facilities that may be required have been suggested.

ASSUMPTIONS

(i) Permafrost does not exist in the dredged areas

(ii) Lightering of the Ocean Going Barges may be undertaken

(iii) Maximum volumes of supplies that will be delivered to Hans Bay (450,000 tons).

Information provided by Gulf Oil Canada Ltd. includes:

a) Preliminary Hydrographic Survey of the Eskimo Lake chain

b) Fathometer chart and field notes of the C.E.S. Sounding Survey of the Eskimo Lakes August 1975.

PROCEEDURE

We have included in this section Canadian Hydrographic Chart 7608 Eskimo Lakes. The probable route for barge traffic has been marked from Campbell Island to Hans Bay. Mileages along the route have been shown in nautical miles (1 minute of latitude) and studied areas noted.

We have studied each potentially difficult area in detail expanding existing information where necessary. In each section of this report a short note has been included to show our findings and amplify the drawings and charts.

GULF OIL CANADA LIMITED

P.O. BOX 130, CALGARY, ALBERTA T2P 2H7 • TELEPHONE (403) 268-1110
EXPLORATION AND PRODUCTION DEPARTMENT

NORTHERN CONSTRUCTION COMPANY DIVISION OF MORRISON KNUDSEN CO. INC.

OCT 31 1975

October 27, 1975

Northern Construction Company
1304 Hornby Street
Vancouver, British Columbia
V6Z 1W6

Attention: Mr. D. E. Coulter

Gentlemen:

Re: Eskimo Lakes -- Channel Investigation

Gulf Canada acknowledges receipt of your letter dated October 20, 1975. With this letter, and a previous telephone conversation between Messrs. E. Severson and D. Coulter, Gulf Canada acknowledges an Engineering rate of approximately $300 per day, with the total study costing approximately $3,000.

The study, as you have indicated, should provide knowledge as to what action would be required to make transportation of both river and ocean going barges in the Eskimo Lakes possible. It should also include what action would be required to have a compatible dock site at Hans Bay.

Attached for your further use is the hydrographic data obtained in August, 1975, and some geotechnical data also obtained in August, 1975. The survey strip-charts will be forwarded to you before month-end along with formal authorization of this study.

It is vitally important that Gulf Canada receive the results of your study before November 13, 1975.

If exception is taken to any of the above, an immediate reply is requested.

ACTION BY		REFERRED TO			ACTION BY
	✓	JRH	AOS		
	✓	DDL	WJH		✓
		GRR	WHM		
		JFL	DMG		
		PDCR	SMD		
		DCC	DT		
		DAC			
✓	✓	CEC			

Yours truly,

G. R. Appleton
Co-ordinator Logistics

ETS/hlm

Copy to: W. Morrison

BARGES & CHANNELS

(1) BARGE SIZE & DRAFT

We have considered four different barge sizes and drafts for the purposes of this study.

River Barges

a) 1000 Series 200' long 50' beam) at 5'- 6' draft
1500 Series 250' long 50' beam)

The limiting draft at the Mackenzie River is between five and six feet depending on the river stage.

b) 1000 Series 200' long 50' beam) at 8'-6" draft
1500 Series 250' long 50' beam)

River barges would be suitable for a lightering operation through the Eskimo Lake chain. In relatively sheltered waters a working max draft of 8'6" should be attainable.

Ocean Barges

c) Ocean Barge 250' long 75' beam at 13'6" draft
d) Ocean Barge 400' long 100' beam at 16'0" draft

The 400' x 100' Ocean Barge is the largest unit presently in common use. We have used a max draft of 16'0". This limit is currently observed for tows navigating around the north shore of Alaska.

(2) CHANNELS

Drawing E.L.D.-1-1006 shows the recommended minimum channel dimension for ocean barges. These dimensions have been used for the calculation of dredging quantities. Channel width and depth were calculated using the following important assumptions.

i) Towing speed through the dredged channels would be in the range 2-3 knots. Speed would naturally have to be sufficient to retain steerage way (Dependant a barge tug combination).

ii) Cross currents would not be present.

Experience in closed canals indicates that the ratio of canal cross sectional area to immersed vessel section should be in the order of 4:1. We have assumed therefore that with slow towing speeds and non-enclosed channel section this ratio can be reduced to approximately 2:1.

Speed limitations are important for a second reason; as the keel approaches the bottom a vessel experiences a "squat" or "sinkage". As a rough guide a vessels squat in feet is approximately one-fifth of her speed in M.P.H. Our experience in the shallow waters of the Beaufort Sea indicate that squat for flat bottomed barges might be 50% greater than the one-fifth rule. We feel therefore that all barges require at least 1'6" of water below the keel; 2'0" being the minimum for the larger ocean (100' beam) barges.

(3) OVERDREDGE

We have included in our total dredging quantities an allowance for overdredging of 1'6" below design channel grade.

(4) LOW WATER ALLOWANCE

The "normal" water level in the Eskimo Lakes is not known. We understand that experienced local people feel that the water level during the C.E.S. August 75 Survey was indeed above "normal". We have therefore shown in our quantity summary an allowance for 1 foot of extra dredging.

NOTES

LIVERPOOL BAY

There is adequate water for all barges coming from open sea until Campbell Island is abeam. There the water (on S.E. of Campbell Island) shelves up to a chart sounding of 2.8 meters. This represents an actual depth of approximately 3.2m (10.5 ft) at most states of the tide.

The entrance to the Eskimo Lakes can be made either to the north or south of Thumb Island (See Fig. L1 of C.H.S. Chart 7608). Both routes are tricky.

Based on Hydrographic Chart 7608 soundings the following routes are to be considered optimum.

River Barges

River barges at river draft should proceed to the west of Campbell Island and north of Thumb Island. River barges at max. draft should also follow the same track but extra care will be needed around the shoals just north of Thumb Island. No. dredging should be necessary in either case.

Ocean Barges

Dredging will be required on four reaches to allow entrance of ocean going barges in to the Eskimo Lakes. Tows will have to run on the east side of Campbell keeping within the 5m contour, west through a series of shoals and island to the N.E. shore of Thumb Island. Thence following deep water on the east shore of Thumb Island navigate around the south tip of Thumb Island. Deep water follows through the "fingers".

Fig. L1 shows the dredging reaches anticipated (in red). Deep water is shown as contained within the 5m contour (green).

The Summary of Dredging Quantities (included with this section) shows the quantities of dredging required.

Navigation throughout this area will be exacting. We have contacted the Canadian Hydrographic Service regarding the soundings in this area. A copy of the original sounding survey (1:50,000 scale) is presently en-route to Vancouver. We will send the chart on to Gulf (with comments) as soon as we have had a chance to review it.

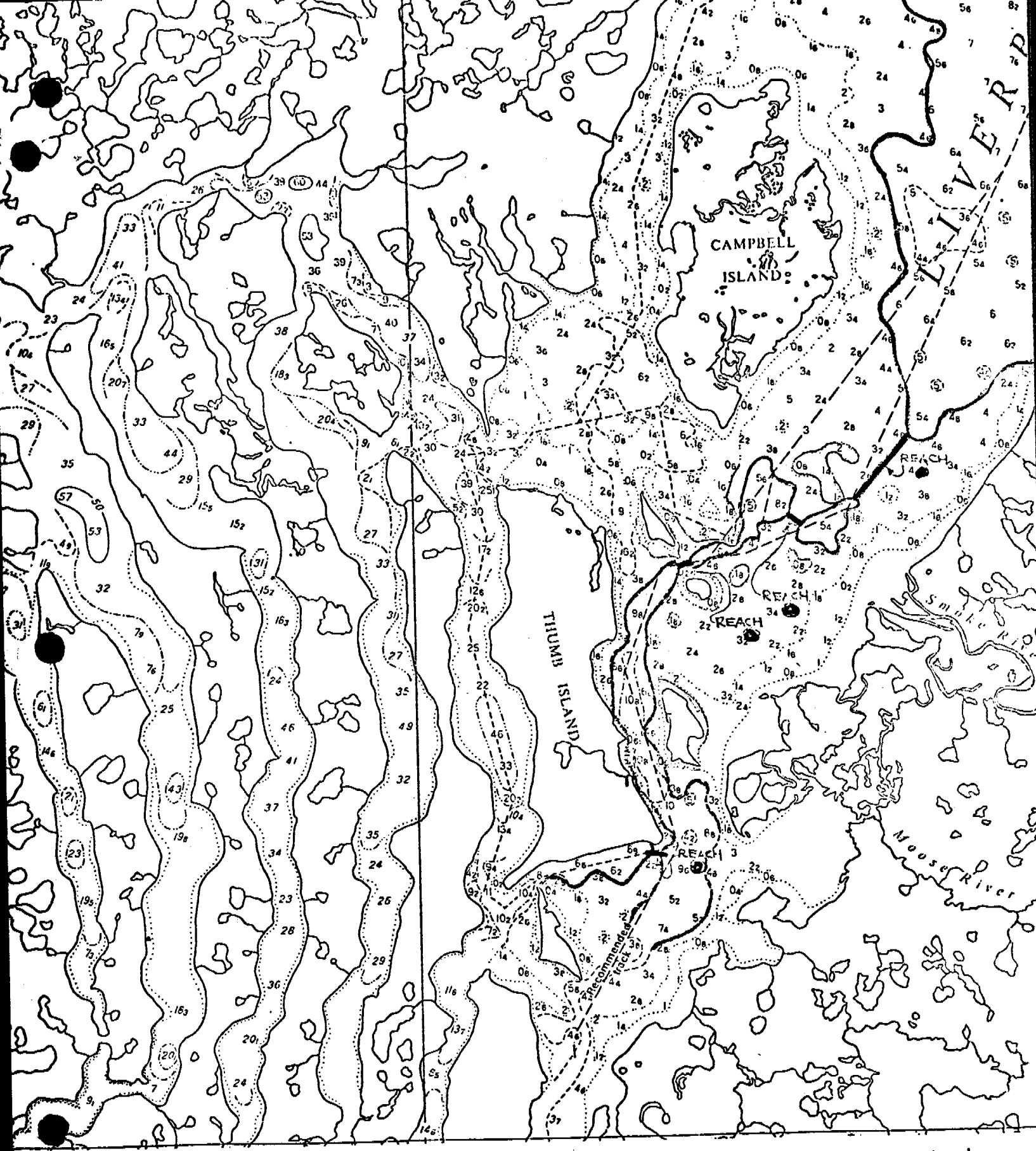
SUMMARY OF DREDGING QUANTITIES

GULF OIL ESKIMO LAKES

November 14, 1975

AREA	MILE	REACH	OCEAN BARGE 275' x 75' x 13.5' DRAFT							OCEAN BARGE 400' x 100' x 16' DRAFT							
			Water Depth Ft.	Cut Ft.	Length Ft.	QUANTITIES C.Y. Neat C.Y. 1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5	Water Depth Ft.	Cut Ft.	Length Ft.	QUANTITIES C.Y. Neat C.Y.1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5
A	76.5	1	12.0	3.0	1800	21,700	10,400	32,100			13.0	5.0	1,800	70,000	20,000	90,000		
		2	13.5	1.5	950	6,000	5,800	11,800			13.5	4.5	950	27,900	8,900	36,800		
		3	-	-	1900	3,000	1,500	4,500			-	-	1,900	16,700	10,000	26,700		
		4	12.0	3.0	1900	24,300	11,700	36,000			12.0	6.0	1,900	70,700	16,700	87,400		
		TOTAL			6550	55,000	29,400	84,400	30,000	114,400			6,550	185,300	55,600	240,900	40,000	280,900
B	83.0	1	11.9	3.1	5600	100,400	46,700	147,100			13.3	4.7	7,700	280,600	85,600	366,200		
		2	11.75	3.25	6300	118,500	52,500	171,000			11.75	6.25	6,300	309,900	70,000	379,900		
		3	11.5	3.5	3000	61,100	25,000	86,100			11.5	6.5	3,000	153,800	33,300	187,100		
	87.0	4	-	-	-	6,000	2,000	8,000			-	-	-	30,500	3,000	33,500		
		TOTAL			14,900	286,000	126,200	412,200	84,800	497,000			17,000	774,800	191,900	966,700	132,900	1,099,600
C	94.0	1	11.0	4.0	1,600	37,500	13,300	50,800										
		2									11.5	6.5	2,900	150,800	33,200	184,000		
		TOTAL			1,600	37,500	13,300	50,800	8,900	59,700			2,900	150,800	33,200	184,000	21,500	205,500
D	91	Alt.4+2	12.0	3.0	750	15,200	7,200	22,400			15.0	3.0	1,950	55,200	26,700	81,900		
	90	Reach 1	14.0	1.0	1,000	5,600	8,300	13,900			15.7	2.3	3,300	57,400	36,700	94,100		
		TOTAL			1,750	20,800	15,500	36,300	13,600	49,900			5,250	112,600	63,400	176,000	42,400	218,400
LIVERPOOL BAY	0	1	11.15	3.85	7,900	176,900	65,600	242,500			11.15	6.85	7,500	426,700	87,400	514,100		
		2	11.15	3.85	2,200	49,800	18,500	68,300			11.15	6.85	2,200	120,100	24,600	144,700		
		3	12.8	2.2	1,500	18,600	12,300	30,900			12.8	5.2	1,500	59,800	16,400	76,200		
	11	4	11.8	3.2	2,200	41,000	18,500	59,500			11.8	6.2	2,200	108,000	24,600	132,600		
		TOTAL			13,800	286,300	114,900	401,200	N.A.	401,200			13,800	714,600	153,000	867,600	N.A.	867,600
TOTAL					38,600	685,600	299,300	984,900	137,300	1,122,200			45,500	1,938,100	497,100	2,435,200	236,800	2,672,000

Liverpool Bay 2 of 4
November 17, 1975



GULF OIL CANADA LTD FIG. L1

ESKIMO LAKES DREDGING STUDY.

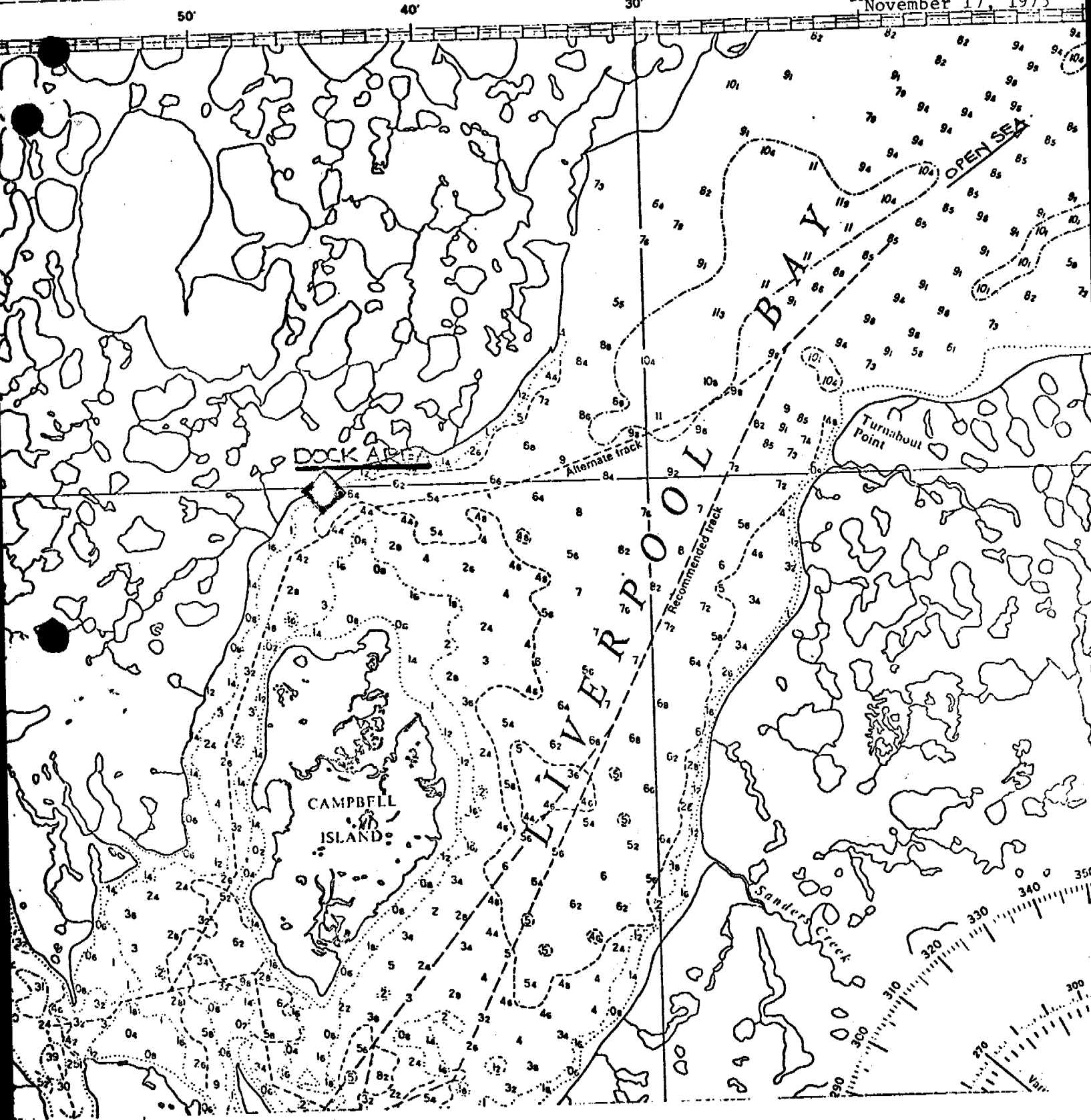
ENTRANCE TO ESKIMO LKS.

November 17, 1975
Liverpool Bay 3 of 4

SCALE 1:150,000 FROM C.H.S. CHART 7608 NORTHERN CONST CO. 14th NOV 75

— 6m.

— DREDGING REQUIRED



GULF OIL CANADA LTD FIG. L2

ESKIMO LAKES DREDGING STUDY.

LIGHTERING DOCK. POSSIBLE LOCATION.

SCALE 1:150,000 FROM CH.S CHART 7608

NORTHERN CONST. CO
14th NOV/75

NOTES

AREA X MILE 70

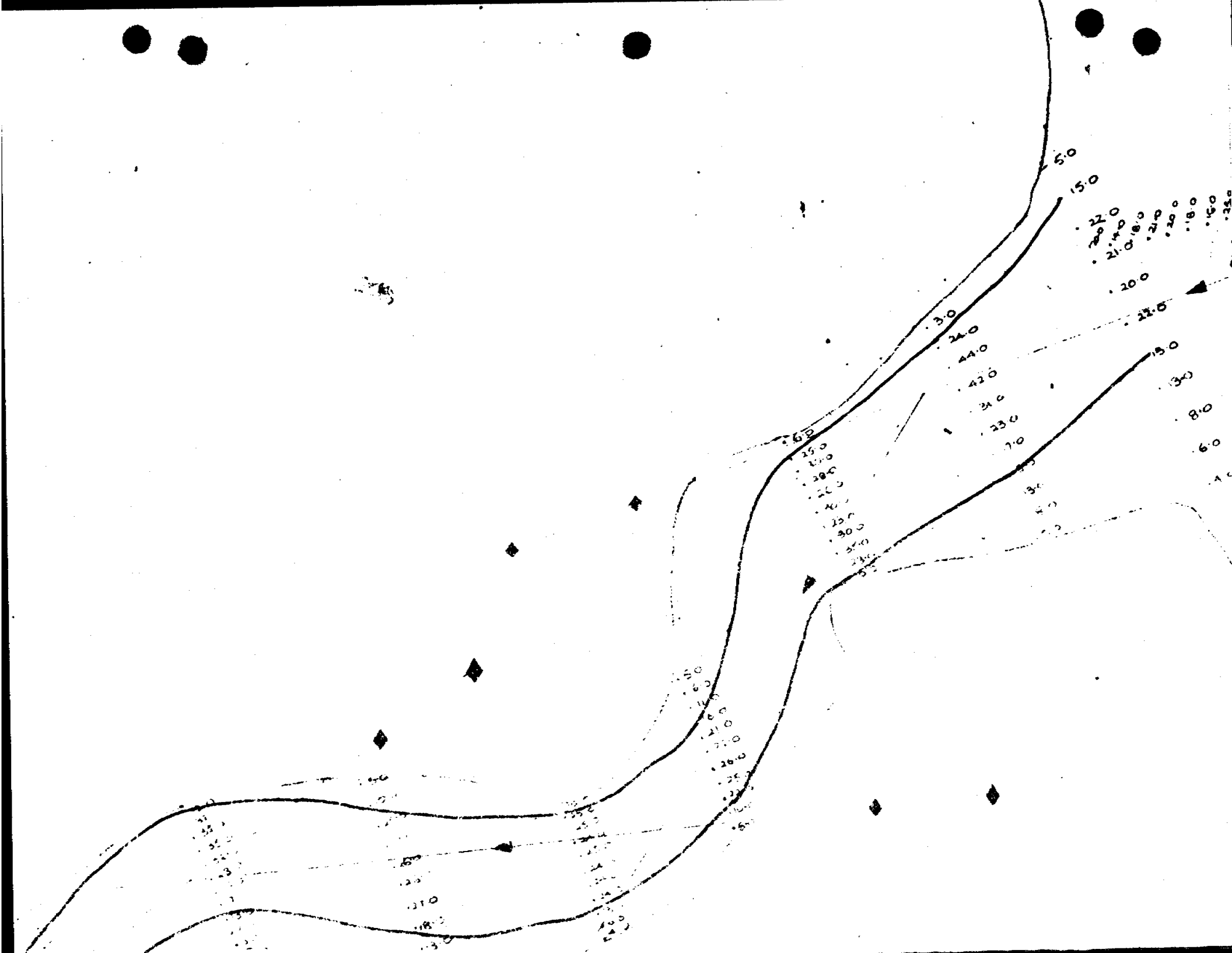
Drawing E.L.D.-4-1001 shows Area X to a scale of 1:5,000.

The channel here is narrow and winding but deep. Minimum channel width is about 250 feet.

A 3-4 knot current was observed running east to west at the time of M. Tarbottons site visit in September 75. Bearing in mind the distance to open sea (70 N.miles) it is unlikely that this current is a tidal effect. We believe that the currents observed here and at Area C are caused by wind stacking from the open sea (see conclusion).

We do not believe dredging will be required in this area. River barges should have no problem in negotiating the bend, however a second tug will be required to assist tows through the worst bends. Provision for Ocean barges by virtue of their size, will have to be more elaborate. Turning dolphins and/or anchor barges should be considered for each of the three turns.

Channel markers (shown diagramatically on Drw. E.L.D.-4-1001) will have to be an essential part of any navigational program.



NOTES

AREA A MILE 76

Drawings E.L.D.-4-1002 shows Area A to a scale of 1:5,000.

No dredging will be required here for river barges either at river or maximum draft.

A current (2-3 knots?) was observed here at the time of M. Tarbottons site visit. As the configuration of flow was very similar to the proposed dredged channel we do not anticipate serious navigational problems.

Dredging will be required to accommodate ocean barges. The proposed channel has been divided into four reaches taking full advantage of deep water. The Summary of Dredging quantities (included in this section) shows the volumes and reach lengths anticipated.

The bottom contours in this area are complex. Additional soundings are required

a) at closer centres along the proposed channel

b) extending north and east from reach (4).

Deep water was not delineated north of reach (4) during the C.E.S. Survey August 75.

Additional push tugs will be required to assist tows through the narrow dredged channel. River tugs would be ideal as their shallow draft (4'- 5') would enable them to work well outside the dredged channel.

SUMMARY OF DREDGING QUANTITIES

GULF OIL ESKIMO LAKES

November 14, 1975

AREA	MILE	REACH	OCEAN BARGE 275' x 75' x 13.5' DRAFT							OCEAN BARGE 400' x 100' x 16' DRAFT							
						QUANTITIES C.Y.							QUANTITIES C.Y.				
			Water Depth Ft.	Cut Ft.	Length Ft.	Neat C.Y. 1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5	Water Depth Ft.	Cut Ft.	Length Ft.	Neat C.Y.1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5
A	76.5	1	12.0	3.0	1800	21,700	10,400	32,100			13.0	5.0	1,800	70,000	20,000	90,000		
		2	13.5	1.5	950	6,000	5,800	11,800			13.5	4.5	950	27,900	8,900	36,800		
		3	-	-	1900	3,000	1,500	4,500			-	-	1,900	16,700	10,000	26,700		
		4	12.0	3.0	1900	24,300	11,700	36,000			12.0	6.0	1,900	70,700	16,700	87,400		
		TOTAL			6550	55,000	29,400	84,400	30,000	114,400			6,550	185,300	55,600	240,900	40,000	280,900
B	83.0	1	11.9	3.1	5600	100,400	46,700	147,100			13.3	4.7	7,700	280,600	85,600	366,200		
		2	11.75	3.25	6300	118,500	52,500	171,000			11.75	6.25	6,300	309,900	70,000	379,900		
		3	11.5	3.5	3000	61,100	25,000	86,100			11.5	6.5	3,000	153,800	33,300	187,100		
	87.0	4	-	-	-	6,000	2,000	8,000			-	-	-	30,500	3,000	33,500		
		TOTAL			14,900	286,000	126,200	412,200	84,800	497,000			17,000	774,800	191,900	966,700	132,900	1,099,600
C	94.0	1	11.0	4.0	1,600	37,500	13,300	50,800										
		2									11.5	6.5	2,900	150,800	33,200	184,000		
		TOTAL			1,600	37,500	13,300	50,800	8,900	59,700			2,900	150,800	33,200	184,000	21,500	205,500
D	91	Alt.4+2	12.0	3.0	750	15,200	7,200	22,400			15.0	3.0	1,950	55,200	26,700	81,900		
	90	Reach 1	14.0	1.0	1,000	5,600	8,300	13,900			15.7	2.3	3,300	57,400	36,700	94,100		
		TOTAL			1,750	20,800	15,500	36,300	13,600	49,900			5,250	112,600	63,400	176,000	42,400	218,400
LIVERPOOL BAY	0	1	11.15	3.85	7,900	176,900	65,600	242,500			11.15	6.85	7,900	426,700	87,400	514,100		
		2	11.15	3.85	2,200	49,800	18,500	68,300			11.15	6.85	2,200	120,100	24,600	144,700		
		3	12.8	2.2	1,500	18,600	12,300	30,900			12.8	5.2	1,500	59,800	16,400	76,200		
	11	4	11.8	3.2	2,200	41,000	18,500	59,500			11.8	6.2	2,200	108,000	24,600	132,600		
		TOTAL			13,800	286,300	114,900	401,200	N.A.	401,200			13,800	714,600	153,000	867,600	N.A.	867,600
TOTAL					38,600	685,600	299,300	984,900	137,300	1,122,200			45,500	1,938,100	497,100	2,435,200	236,800	2,672,000

Area A 2 of 3
November 17, 1975

NOTES

AREA B MILE 83-87

Fig. B1 shows reaches (1) through (3) for Area B to a scale of 1:25,000.

Drawing E.L.D.-4-1003 shows reach (4) to a scale of 1:5,000.

At around mile 83 the lake bottom soundings (C.H.S. Chart 7608) indicate reducing water depths. Soundings (C.E.S. Survey) level out at 10-12 feet until mile 86.5 where the channel takes a sharp almost right angle bend.

No dredging will be required for river barges either at river or maximum draft.

Dredging will be required for ocean barges. We have divided the dredging into four reaches. Reaches (1) through (3) (Fig. B1) consists of a total of almost 3 miles of channel. Reach (4) consists of channel improvements required to enable navigation of the bend at mile 86.5. A turning area, enabling barges to turn end for end is shown on drawing 4-1003. We anticipate that a turning dolphin will be required as well as an additional river tending tug.

Additional soundings are required north of reach (2). C.E.S. August 75 Soundings do not delineate deep water.

A copy of the Summary of Quantities (included in this section) shows the dredging quantities and reach lengths.

SUMMARY OF DREDGING QUANTITIES

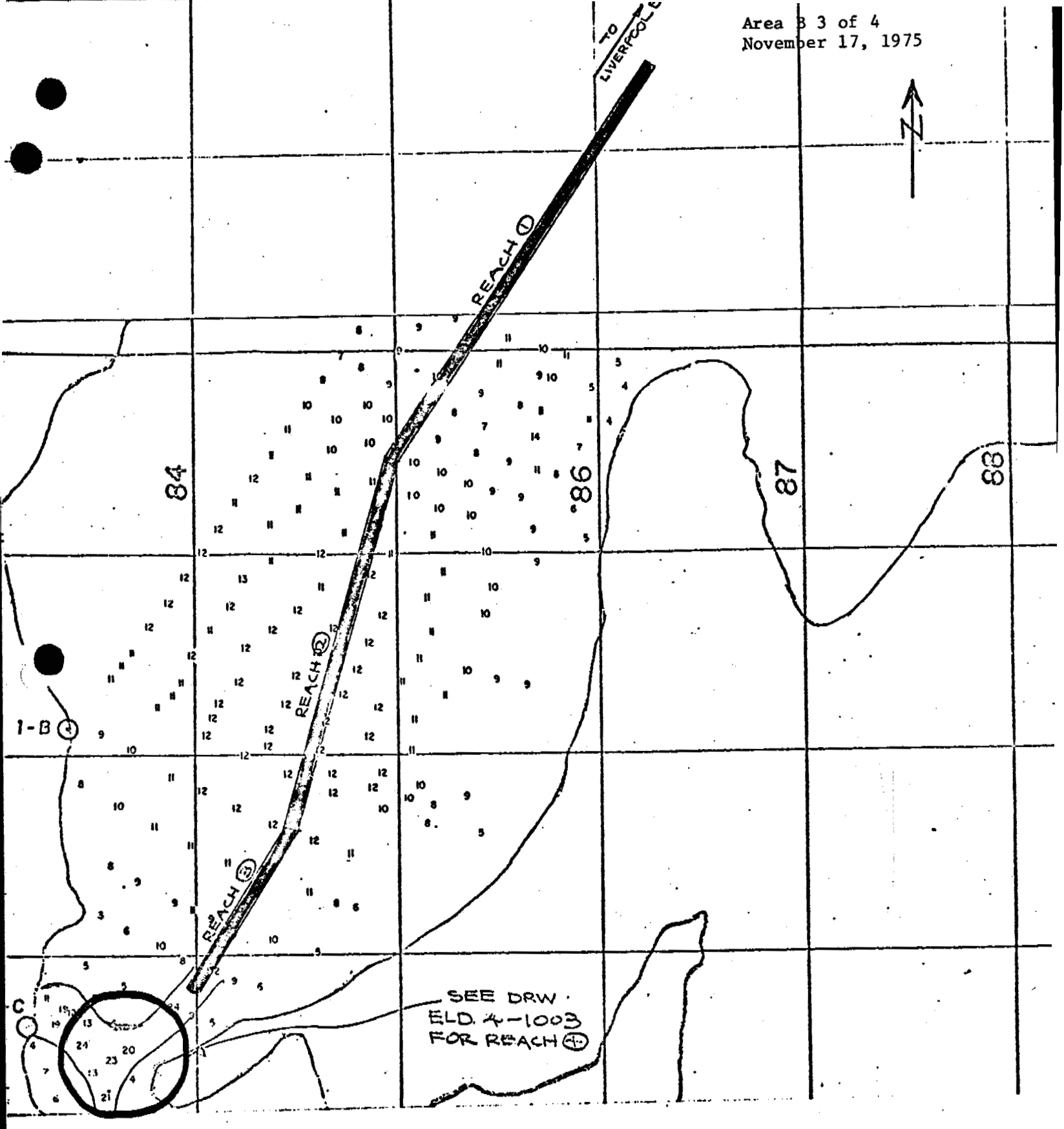
GULF OIL ESKIMO LAKES

November 14, 1975

AREA	MILE	REACH	OCEAN BARGE 275' x 75' x 13.5' DRAFT								OCEAN BARGE 400' x 100' x 16' DRAFT							
			Water Depth Ft.	Cut Ft.	Length Ft.	QUANTITIES C.Y. Neat C.Y. 1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5	Water Depth Ft.	Cut Ft.	Length Ft.	QUANTITIES C.Y. Neat C.Y. 1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5
A		1	12.0	3.0	1800	21,700	10,400	32,100			13.0	5.0	1,800	70,000	20,000	90,000		
		2	13.5	1.5	950	6,000	5,800	11,800			13.5	4.5	950	27,900	8,900	36,800		
	76.5	3	-	-	1900	3,000	1,500	4,500			-	-	1,900	16,700	10,000	26,700		
✓		4	12.0	3.0	1900	24,300	11,700	36,000			12.0	6.0	1,900	70,700	16,700	87,400		
		TOTAL			6550	55,000	29,400	84,400	30,000	114,400			6,550	185,300	55,600	240,900	40,000	280,900
B	83.0	1	11.9	3.1	5600	100,400	46,700	147,100			13.3	4.7	7,700	280,600	85,600	366,200		
		2	11.75	3.25	6300	118,500	52,500	171,000			11.75	6.25	6,300	309,900	70,000	379,900		
		3	11.5	3.5	3000	61,100	25,000	86,100			11.5	6.5	3,000	153,800	33,300	187,100		
	87.0	4	-	-	-	6,000	2,000	8,000			-	-	-	30,500	3,000	33,500		
		TOTAL			14,900	286,000	126,200	412,200	84,800	497,000			17,000	774,800	191,900	966,700	132,900	1,099,600
C	94.0	1	11.0	4.0	1,600	37,500	13,300	50,800										
✓		2									11.5	6.5	2,900	150,800	33,200	184,000		
		TOTAL			1,600	37,500	13,300	50,800	8,900	59,700			2,900	150,800	33,200	184,000	21,500	205,500
D	91	Alt.4+2	12.0	3.0	750	15,200	7,200	22,400			15.0	3.0	1,950	55,200	26,700	81,900		
✓	90	Reach 1	14.0	1.0	1,000	5,600	8,300	13,900			15.7	2.3	3,300	57,400	36,700	94,100		
		TOTAL			1,750	20,800	15,500	36,300	13,600	49,900			5,250	112,600	63,400	176,000	42,400	218,400
LIVERPOOL BAY	0	1	11.15	3.85	7,900	176,900	65,600	242,500			11.15	6.85	7,900	426,700	87,400	514,100		
		2	11.15	3.85	2,200	49,800	18,500	68,300			11.15	6.85	2,200	120,100	24,600	144,700		
		3	12.8	2.2	1,500	18,600	12,300	30,900			12.8	5.2	1,500	59,800	16,400	76,200		
	11	4	11.8	3.2	2,200	41,000	18,500	59,500			11.8	6.2	2,200	108,000	24,600	132,600		
		TOTAL			13,800	286,300	114,900	401,200	N.A.	401,200			13,800	714,600	153,000	867,600	N.A.	867,600
TOTAL					38,600	685,600	299,300	984,900	137,300	1,122,200			45,500	1,938,100	497,100	2,435,200	236,800	2,672,000

Area B 2 of 4
November 17, 1975

Area B 3 of 4
November 17, 1975



GULF OIL CANADA LTD FIG. B1.
ESKIMO LAKES DREDGING STUDY
AREA B. MILE 85

SCALE 1:25,000
FROM C.E.S. 8114-M-2

NORTHERN CONST. CO
14th NOV/75 mo

NOTES

AREA C MILE 94

Drawings E.L.D.-4-1005 shows Area C to a scale of 1:5,000.

Dredging for river barges will not be required in this area. Minimum depths 10 feet or more.

Sounding information does not extend far enough North and West to delineate deep water. We have therefore shown two separate channels (reach (1) & (2)) for the two ocean barges (75 ft & 100 ft beam).

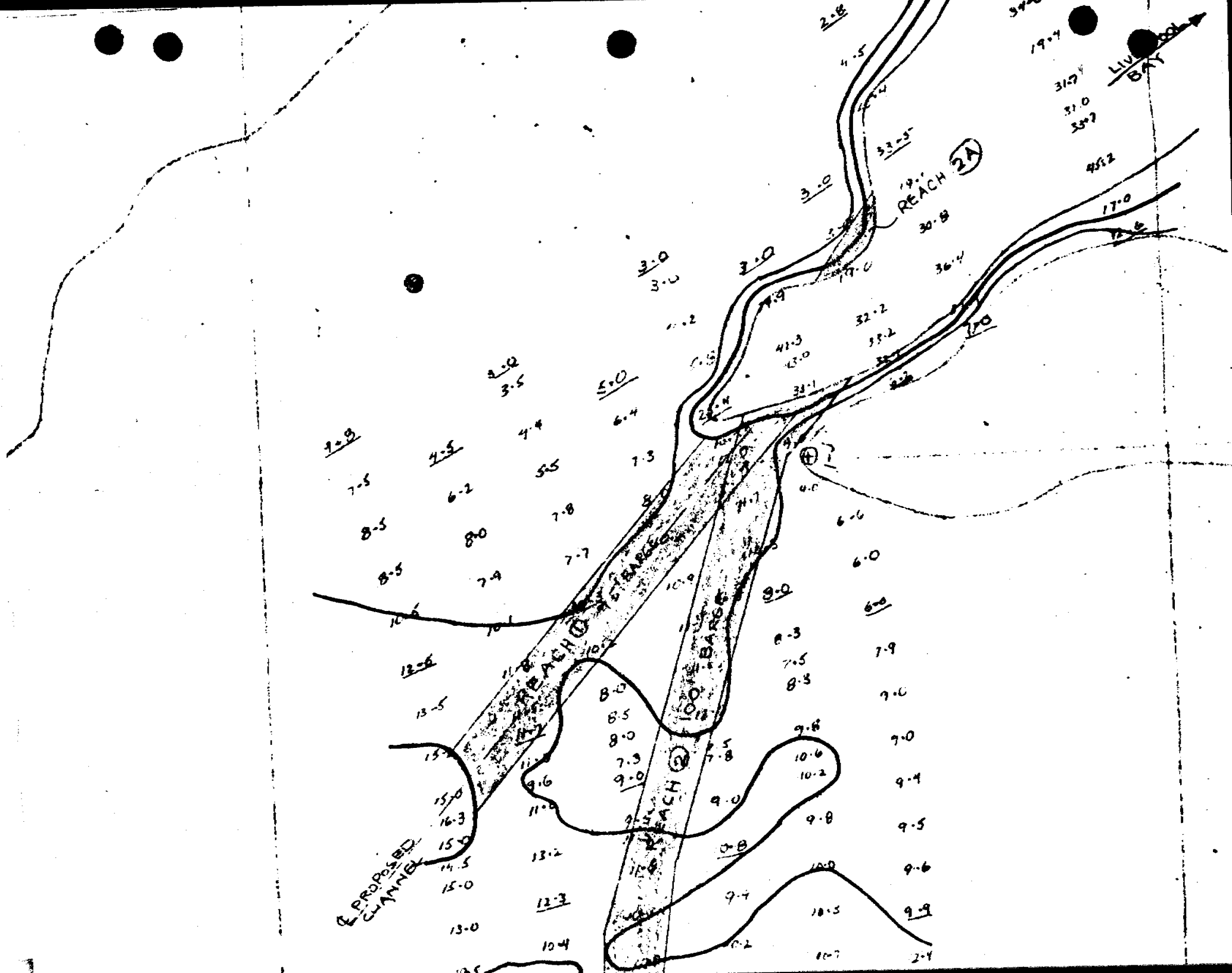
The Summary of Quantities (included in this section) shows the dredging quantities and reach lengths.

Tending tug assistance in this area should not be necessary.

SUMMARY OF DREDGING QUANTITIES — GULF OIL ESKIMO LAKES — November 14, 1975

AREA	MILE	REACH	OCEAN BARGE 275' x 75' x 13.5' DRAFT							OCEAN BARGE 400' x 100' x 16' DRAFT							
			Water Depth Ft.	Cut Ft.	Length Ft.	QUANTITIES C.Y. Neat C.Y. 1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5	Water Depth Ft.	Cut Ft.	Length Ft.	QUANTITIES C.Y. Neat C.Y. 1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5
A		1	12.0	3.0	1800	21,700	10,400	32,100			13.0	5.0	1,800	70,000	20,000	90,000		
		2	13.5	1.5	950	6,000	5,800	11,800			13.5	4.5	950	27,900	8,900	36,800		
	76.5	3	-	-	1900	3,000	1,500	4,500			-	-	1,900	16,700	10,000	26,700		
		4	12.0	3.0	1900	24,300	11,700	36,000			12.0	6.0	1,900	70,700	16,700	87,400		
		TOTAL			6550	55,000	29,400	84,400	30,000	114,400			6,550	185,300	55,600	240,900	40,000	280,900
B	83.0	1	11.9	3.1	5600	100,400	46,700	147,100			13.3	4.7	7,700	280,600	85,600	366,200		
		2	11.75	3.25	6300	118,500	52,500	171,000			11.75	6.25	6,300	309,900	70,000	379,900		
		3	11.5	3.5	3000	61,100	25,000	86,100			11.5	6.5	3,000	153,800	33,300	187,100		
	87.0	4	-	-	-	6,000	2,000	8,000			-	-	-	30,500	3,000	33,500		
		TOTAL			14,900	286,000	126,200	412,200	84,800	497,000			17,000	774,800	191,900	966,700	132,900	1,099,600
C	94.0	1	11.0	4.0	1,600	37,500	13,300	50,800										
		2									11.5	6.5	2,900	150,800	33,200	184,000		
		TOTAL			1,600	37,500	13,300	50,800	8,900	59,700			2,900	150,800	33,200	184,000	21,500	205,500
D	91	Alt.4+2	12.0	3.0	750	15,200	7,200	22,400			15.0	3.0	1,950	55,200	26,700	81,900		
	90	Reach 1	14.0	1.0	1,000	5,600	8,300	13,900			15.7	2.3	3,300	57,400	36,700	94,100		
		TOTAL			1,750	20,800	15,500	36,300	13,600	49,900			5,250	112,600	63,400	176,000	42,400	218,400
LIVERPOOL BAY	0	1	11.15	3.85	7,900	176,900	65,600	242,500			11.15	6.85	7,900	426,700	87,400	514,100		
		2	11.15	3.85	2,200	49,800	18,500	68,300			11.15	6.85	2,200	120,100	24,600	144,700		
		3	12.8	2.2	1,500	18,600	12,300	30,900			12.8	5.2	1,500	59,800	16,400	76,200		
	11	4	11.8	3.2	2,200	41,000	18,500	59,500			11.8	6.2	2,200	108,000	24,600	132,600		
		TOTAL			13,800	286,300	114,900	401,200	N.A.	401,200			13,800	714,600	153,000	867,600	N.A.	867,600
TOTAL					38,600	685,600	299,300	984,900	137,300	1,122,200			45,500	1,938,100	497,100	2,435,200	236,800	2,672,000

Area C 2 of 3
November 17, 1975


REACH 2A
REACH 2
REACH 1
LIVERPOOL BAY
PROPOSED CHANNEL

NOTES

AREA D MILE 89-91

Fig. D1 (to a scale of 1:25,000) shows the north section of the area including reach (1).

Drawing E.L.D.-4-1004 shows the south end of Area D to a scale of 1:5,000.

Area D North Fig. D1

Sounding information in this area indicates that water depths are insufficient for ocean barges drawing in excess of 14 ft. The Summary of Dredging Quantities shows the quantities and reach lengths involved in reach (1).

Area D South

This area has a complex bottom profile. It is the only area where dredging for river tugs at max. draft might be required.

We divided the possible dredge channels for ocean barges into three alternatives. Alt.(1), Alt.(2) (with Alt.(4)), Alt.(3)(with Alt.(4)). At first sight Alt.(1) looked the most attractive, however quantity calculations indicate that Alt.(2)+(4) would require between one fifth and one half the dredging of Alt.(1) (depending on the barge).

To the south of Area D South there is a somewhat twisting and narrow channel. Water depths are excellent. Due to the pressure of time we were unable to study this area in detail. However we believe that channel improvements would only be necessary for the large ocean barges and the dredging quantities would be small.

Additional sounding information will be required in this area. Areas of special attention should be:-

a) West of 1 F Island (Alt.(4) channel)

b) Between Alt.(2) & (3) to determine the best channel location.

c) North of Survey Control Point 1 E along reach (1). Soundings at closer centres.

d) West of reach (1). Could be a channel.

Tender tug assistance will be required for navigation at the south end of Area D for ocean barges.

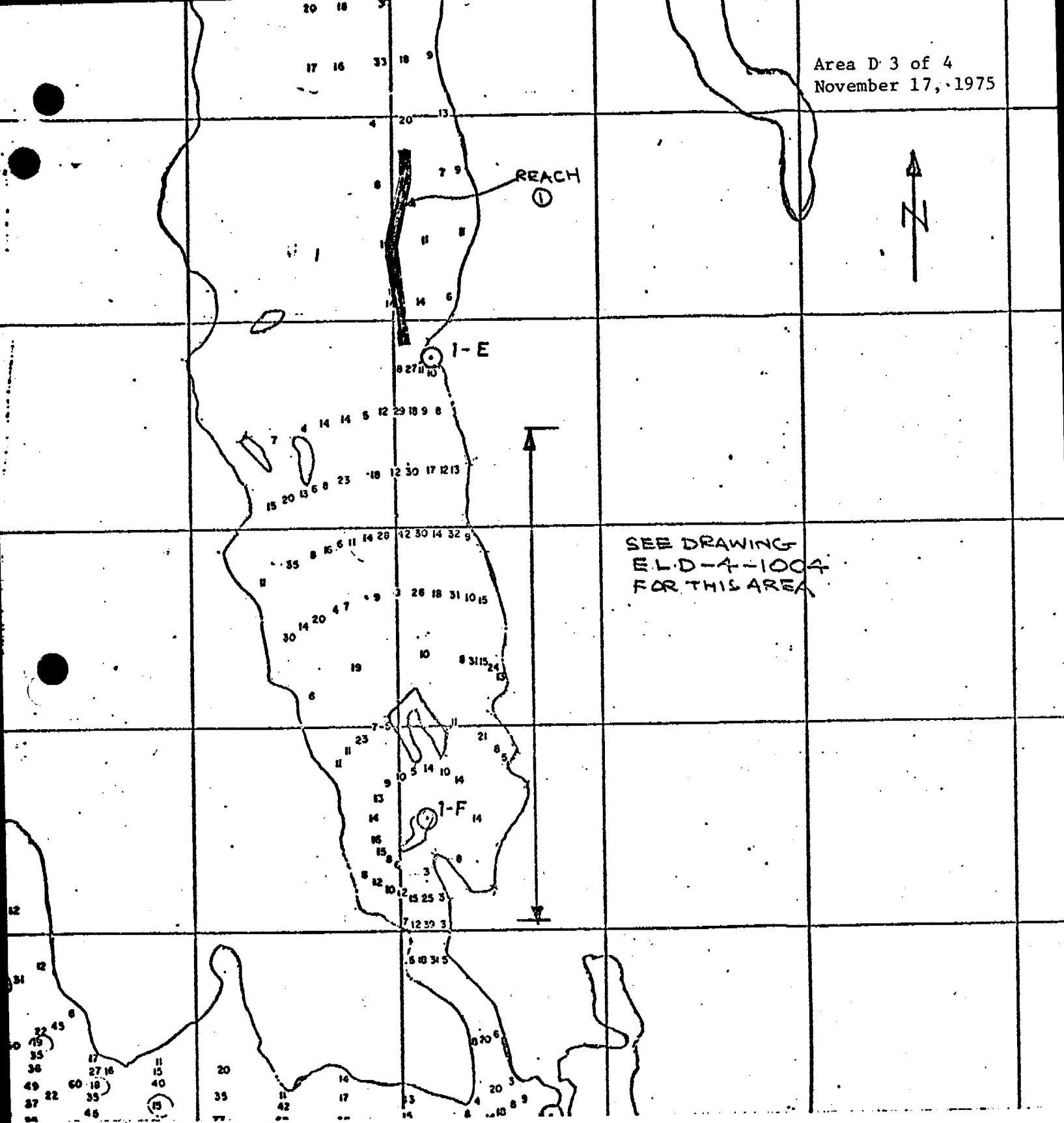
SUMMARY OF DREDGING QUANTITIES

GULF OIL ESKIMO LAKES

November 14, 1975

AREA	MILE	REACH	OCEAN BARGE 275' x 75' x 13.5' DRAFT							OCEAN BARGE 400' x 100' x 16' DRAFT							
			Water Depth Ft.	Cut Ft.	Length Ft.	QUANTITIES C.Y. Neat C.Y. 1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5	Water Depth Ft.	Cut Ft.	Length Ft.	QUANTITIES C.Y. Neat C.Y.1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5
A		1	12.0	3.0	1800	21,700	10,400	32,100			13.0	5.0	1,800	70,000	20,000	90,000		
		2	13.5	1.5	950	6,000	5,800	11,800			13.5	4.5	950	27,900	8,900	36,800		
	76.5	3	-	-	1900	3,000	1,500	4,500			-	-	1,900	16,700	10,000	26,700		
		4	12.0	3.0	1900	24,300	11,700	36,000			12.0	6.0	1,900	70,700	16,700	87,400		
		TOTAL			6550	55,000	29,400	84,400	30,000	114,400			6,550	185,300	55,600	240,900	40,000	280,900
B	83.0	1	11.9	3.1	5600	100,400	46,700	147,100			13.3	4.7	7,700	280,600	85,600	366,200		
		2	11.75	3.25	6300	118,500	52,500	171,000			11.75	6.25	6,300	309,900	70,000	379,900		
		3	11.5	3.5	3000	61,100	25,000	86,100			11.5	6.5	3,000	153,800	33,300	187,100		
	87.0	4	-	-	-	6,000	2,000	8,000			-	-	-	30,500	3,000	33,500		
		TOTAL			14,970	286,000	126,200	412,200	84,800	497,000			17,000	774,800	191,900	966,700	132,900	1,099,600
C	94.0	1	11.0	4.0	1,600	37,500	13,300	50,800										
		2									11.5	6.5	2,900	150,800	33,200	184,000		
		TOTAL			1,600	37,500	13,300	50,800	8,900	59,700			2,900	150,800	33,200	184,000	21,500	205,500
D	91	Alt.4+2	12.0	3.0	750	15,200	7,200	22,400			15.0	3.0	1,950	55,200	26,700	81,900		
	90	Reach 1	14.0	1.0	1,000	5,600	8,300	13,900			15.7	2.3	3,300	57,400	36,700	94,100		
		TOTAL			1,750	20,800	15,500	36,300	13,600	49,900			5,250	112,600	63,400	176,000	42,400	218,400
LIVERPOOL BAY	0	1	11.15	3.85	7,900	176,900	65,600	242,500			11.15	6.85	7,900	426,700	87,400	514,100		
		2	11.15	3.85	2,200	49,800	18,500	68,300			11.15	6.85	2,200	120,100	24,600	144,700		
		3	12.8	2.2	1,500	18,600	12,300	30,900			12.8	5.2	1,500	59,800	16,400	76,200		
	11	4	11.8	3.2	2,200	41,000	18,500	59,500			11.8	6.2	2,200	108,000	24,600	132,600		
		TOTAL			13,800	286,300	114,900	401,200	N.A.	401,200			13,800	714,600	153,000	867,600	N.A.	867,600
TOTAL					38,600	685,600	299,300	984,900	137,300	1,122,200			45,500	1,938,100	497,100	2,435,200	236,800	2,672,000

Area D 2 of 4
November 17, 1975



GULF OIL CANADA LTD. FIG D1
ESKIMO LAKES DREDGING STUDY.
AREA D. REACH ①

SCALE 1:25000
FROM C.E.S. DRAWING 814-M-2

NORTHERN CONST. CO
14TH NOV/75 MD

HANS BAY DOCKING FACILITIES

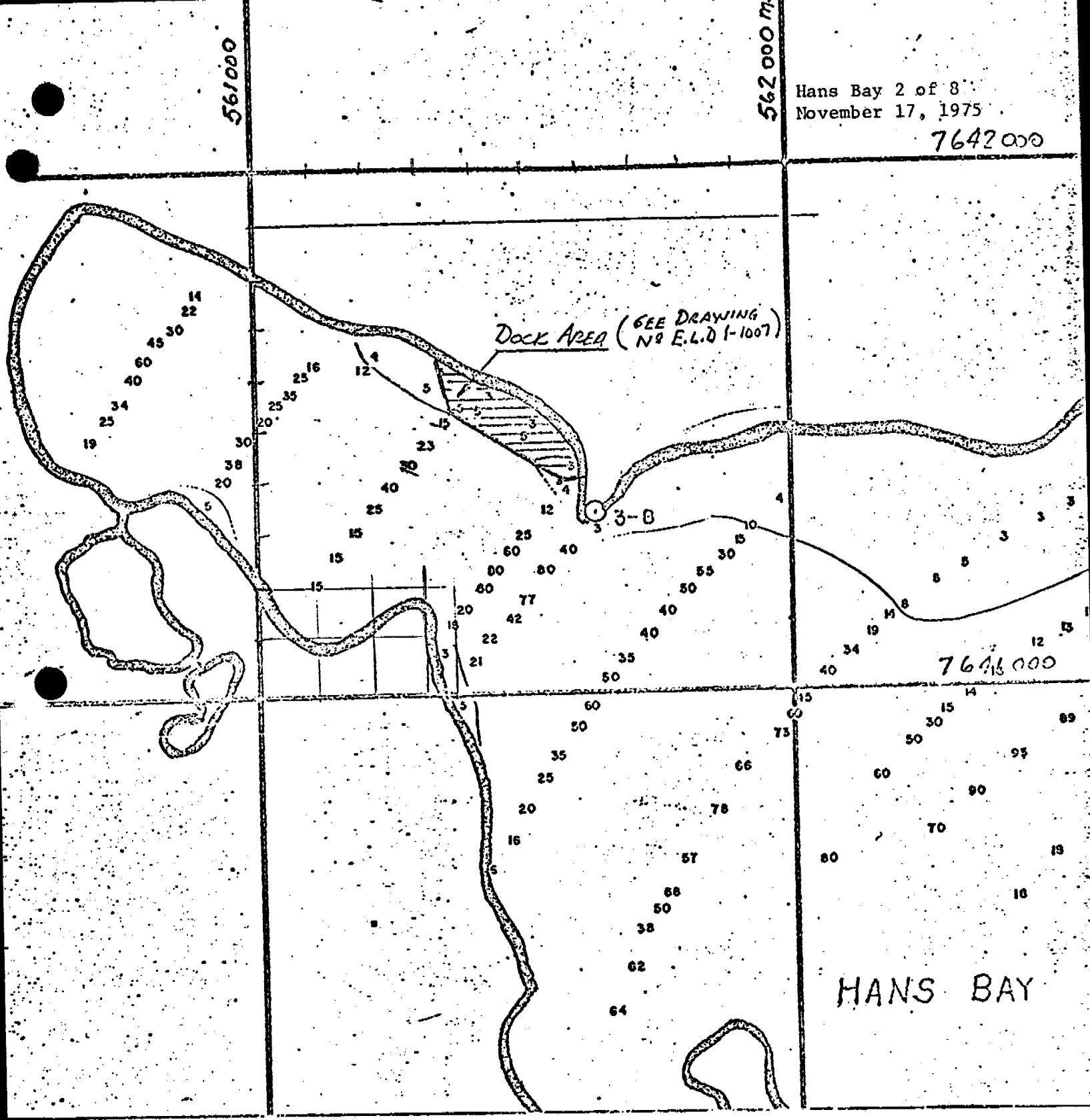
Fig. H1 shows the Hans Bay Dock Site

Drawing E.L.D.-1-1007 shows a typical layout for the wharf on the north shore of Hans Bay

In order that we could assess the scale of facilities required at Hans Bay we have endeavoured to estimate the tonnage and flow of supplies through the facility.

This study (which we have included in this section) assumes a lightering operation with additional dock facilities located north of Campbell Island in Liverpool Bay.

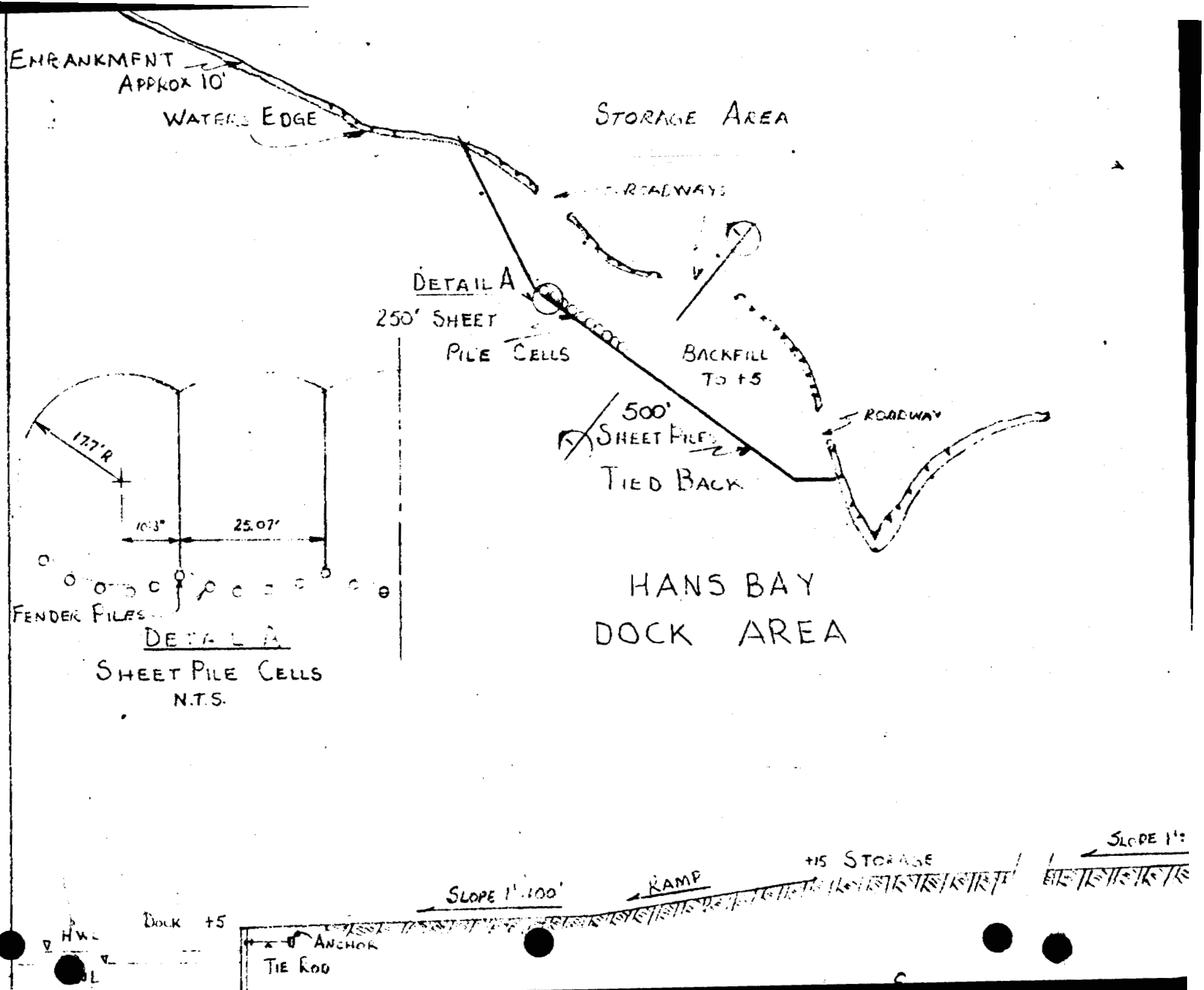
We believe that the scale and general design perameters for the Hans Bay Dock will not be greatly altered by changes in individual barge tonnages or size.



GULF OIL CANADA LTD. Fig. H-1
ESKIMO LAKES DREDGING STUDY
HANS BAY DOCK SITE

NORTHERN CONST. CO.
15th Nov/75

SCALE 1:10,000 FROM CES DRWG 8114-M-1


EMBANKMENT
APPROX 10'
WATERS EDGE
STORAGE AREA
ROADWAYS
DETAIL A
250' SHEET
PILE CELLS
BACKFILL
TO +5
500'
SHEET PILE
TIED BACK
ROADWAY
17.7' R
10'-3"
25.07'
FENDER PILES
DETAIL A
SHEET PILE CELLS
N.T.S.
HANS BAY
DOCK AREA
SLOPE 1:100'
RAMP
+15 STORAGE
SLOPE 1:
DOCK +5
HWL
ANCHOR
TIE ROD

BARGING - LIGHTERING - DOCKING

The Hans Bay Docking Site was viewed and the miscellaneous data supplied by Gulf Oil Canada Limited reviewed.

Not included with the data are the anticipated quantities to be hauled over the gas plant construction period. These quantities are very important in determining the size of the docking facilities required to be compatible with the marine equipment used.

However, in order to give some idea of what would be required for docking facilities we have made the following assumptions;-

1) Total tonnage to be hauled over the construction period- 450,000 tons

2) Tonnage to be hauled each season

Season - 1	75,000 tons
Season - 2	200,000 tons
Season - 3	150,000 tons
Season - 4	25,000 tons
Total Tonnage	450,000 tons

3) 50% of the tonnage to be hauled by Ocean Going Barges

4) 50% of the tonnage to be hauled by 1500 Series Barges Down the Mackenzie River

5) 50% of the tonnage hauled by the Ocean Going Barges would be lightered onto 1000 Series Barges at a point near Campbell Island.

6) Very little Channel Improvement is undertaken.

7) Periods of Operation -
   Ocean Going Barges - Aug. 10 to Sept. 20 - In Arctic Ocean
   1500 Series Barges - July 10 to Sept. 20 - In Ocean & Eskimo Lakes
   1000 Series Barges - July 10 to Sept. 20 - In Ocean & Eskimo Lakes

NUMBER OF BARGES & TUGS REQUIRED

1) Ocean Going Barges
   Maximum tonnage to haul - 50% of 200,000 tons = 100,000 tons
   Average tonnage per Ocean Going Barge - 5,500 tons
   No. of units required 100,000 ÷ 5,500 = 18 Barges say 20 Barges

2) 1000 Series Barges
   Maximum tonnage to lighter from Ocean Going Barges
   50% of 100,000 tons = 50,000 tons.
   Period of hauling Aug. 10 to Sept. 20 = 41 days.

Cycle:-

Load - 900 tons -	12 hours
Haul - 100 miles -	24 hours
Unload - 900 tons -	6 hours
Return - 100 miles -	24 hours
	66 hours
Delays 25%	16.5 "

82.5 hours ÷ 20 hrs/Day = 4.12 days
Say 4.0 days

Loads per Season (41 Days) 41 ÷ 4 = 10.25 Say= 10.0 Loads/Barge

Load = 900 tons/barge or 9000 tons/barge/season
No. of Barges Loads = 50,000 ÷ 900 = 55.5 Say 55 Loads
No. of Barges Required
50,000 tons ÷ 9000 $\frac{\text{tons}}{\text{Barge}}$ = 5.55 Barges Say 6 Barges

3) 1500 Series Barges

Maximum tonnage to be hauled in any one season down the MacKenzie River - 100,000 tons
The 1000 Series & the 1500 Series Barges can be used to haul this load. The 1000 Series can be used from July 10 to August 10 and the 1500 Series from July 10 to Sept. 20. The barges can be loaded in Hay River in June and delivered to the MacKenzie Delta by July 1 to wait for the Sea Ice & Eskimo Lake Ice to break up.

Assuming the ice is broken up on July 10 and the barges can proceed from Tuktoyaktuk to Hans Bay.

Cycles		Date
1st trip starts on July 10 at Tuktoyaktuk		July 10
Haul to Hans Bay 300 miles	2 Days	
Unload 8 Barges @ ½ Day/Barge -	4 "	July 16
Return to Hay River -	10 "	
Sub Total	16 Days	
Delay	2 "	
Total 1st Trip	18 Days	July 28
2nd Trip starts on July 28th at Hay River		
Pick up Tow (Already loaded)	1 Day	
Haul to Hans Bay	10 "	
Unload	4 "	Aug. 12
Return to Hay River	10 "	
Delays	3 "	
Total 2nd Trip	28 Days	Aug. 25

3rd Trip Starts on August 25 at Hay River		
Pick up tow (already loaded)	1 Day	
Haul to Hans Bay	10 "	Sept. 5
Unload	4 "	
Return to Tuk	3 "	
Delays	3 "	
In Tuk	21 Days	Sept.15
Return to Hay River	10 "	
Total 3rd Trip	31 Days	Sept.25

From the above noted cycles it can be seen that the 1500 Series Barges can make 3 trips per season and the 1000 Series Barges might make 2 trips per season.

Assuming the 1000 Series Scows only deliver one load then there is 100,000 tons less 5400 tons left to haul on the 1500 Series Scows.

Load-on 1500 Series Barge 1,250 tons
94,600 tons ÷ 1250 tons = 75.7 say 75 Barge Loads
3 loads/barge/season = 3,750 tons 1 barge
94,600 tons ÷ 3750 tons/barge = 25.2 Barges

Say 24

Assume 8 Barges/Trip plus extra set for loading cycle

1500 Series Barges needed = 32 Barges

4) Tugs Required in River & Eskimo Lake System

On River haul	3 @ 2500 hp
On Eskimo Lake haul	3 @ 1000 hp
Tenders at Hans Bay	2 @ 1000 hp
at Narrows	2 @ 1000 hp
at Campbell Island	1 @ 1000 hp
Spare	1 @ 1000 hp

Total Tugs required 12 Tugs

5) Number of Barges to be unloaded (Maximum Season)

Period July 13 to Sept. 13 = 62 Days

Ocean Going Barges =	20 Barges @	5,500 tons each =	110,000 tons
1500 Series Barges =	75 Barges @	1,250 tons each =	93,750 tons
1000 Series Barges =	61 Barges @	900 tons each =	54,900 tons
	156 Barges		258,650 tons

6) Lightering Operation - Aug. 10 to Sept. 20 = 41 Days

Offload 50% of load	=	2,750 tons @ 250t/hr
Offload 2750 ÷ 250 ton/hr	=	11 hrs
Haul 100 miles ÷ 5 mph	=	20 hrs
Offload 2750 ÷ 250 ton/hr	=	11 hrs
		42 hrs./Barge
Delays		6 "
		48 hrs. or 2 days/Barge

20 Barges x 2 = 40 days < 41 Days OK

7) Maximum No. of Barges to Unload at any given time

Aug. 10 to Sept. 20 = 41 Days

Ocean Going Barge =	20	@ 5,500 tons/Barge	=	110,000 tons
1000 Series Barges =	61	@ 900 tons/Barge	=	54,900 "
1500 Series Barges =	16	@ 1,250 tons/Barge	=	20,000 "
	97			184,900 tons

92 ÷ 41 = 2.4 Barges/Day
184,900 ÷ 41 = 4,510 tons/20hr.Day
= 225 tons/hr.

8) Docks Required

A) Hans Bay
B) Campbell Island

A) Hans Bay

From the above noted calculations it can be seen that a very rapid offloading operation is required to make certain the barges are returned to their home ports within the short Arctic Navigation Season (41 Days). The average unloading time 2.4 barges/day indicates a likelihood of peek periods of 5 or 6 barges/day.

We suggest offloading facilities for at least:-

One Ocean Going Barge	250 feet.
Two 1500 Series Barges	500 feet
Minimum length of Dock Face	750 feet

We suggest a Cellular Type Dock to look after the heavy Modular Units which will likely be hauled on the Ocean Going Barges. This will give the added security of a very stable structure which can be designed to accommodate the concentrated moving loads.

We suggest that the regular containerized freight and supplies can be moved over a tied back Sheet Pile Dock.

The Berthing Area adjacent to the face of the dock should be graded level to allow the Ocean Going Barges to be negatively buoyed and grounded during the offloading operation.

We have shown these concepts on Drawing No. E.L.D.-1-1007

Dolphins will have to be located at several places in the Hans Bay Area for tieing off loaded or empty barges when the dock berths are full.

B) Campbell Island - Lightering Dock

We suggest a dock be constructed north of Campbell Island in Liverpool Bay. The dock should be long enough to accommodate the berthing of two large Ocean Going Barges at 250 feet each or a minimum dock length of 500 l.ft. and be constructed in a cellular configuration.

The berthing area adjacent to the face of the dock should be graded level to allow the Ocean Going Barges to be negatively buoyed and grounded during the offloading operation.

We have shown the possible location of the Lightering Dock near Campbell Island on Figure - L2.

SUMMARY OF DREDGING QUANTITIES

GULF OIL ESKIMO LAKES

November 14, 1975

AREA	MILE	REACH	OCEAN BARGE 275' x 75' x 13.5' DRAFT							OCEAN BARGE 400' x 100' x 16' DRAFT							
						QUANTITIES C.Y.							QUANTITIES C.Y.				
			Water Depth Ft.	Cut Ft.	Length Ft.	Neat C.Y. 1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5	Water Depth Ft.	Cut Ft.	Length Ft.	Neat C.Y. 1	Overdredge C.Y. 2	Total 1 + 2 = 3	Low Water Allowance 4	Total 3 + 4 = 5
A	76.5	1	12.0	3.0	1800	21,700	10,400	32,100			13.0	5.0	1,800	70,000	20,000	90,000		
		2	13.5	1.5	950	6,000	5,800	11,800			13.5	4.5	950	27,900	8,900	36,800		
		3	-	-	1900	3,000	1,500	4,500			-	-	1,900	16,700	10,000	26,700		
		4	12.0	3.0	1900	24,300	11,700	36,000			12.0	6.0	1,900	70,700	16,700	87,400		
		TOTAL			6550	55,000	29,400	84,400	30,000	114,400			6,550	185,300	55,600	240,900	40,000	280,900
B	83.0	1	11.9	3.1	5600	100,400	46,700	147,100			13.3	4.7	7,700	280,600	85,600	366,200		
		2	11.75	3.25	6300	118,500	52,500	171,000			11.75	6.25	6,300	309,900	70,000	379,900		
		3	11.5	3.5	3000	61,100	25,000	86,100			11.5	6.5	3,000	153,800	33,300	187,100		
	87.0	4	-	-	-	6,000	2,000	8,000			-	-	-	30,500	3,000	33,500		
		TOTAL			14,900	286,000	126,200	412,200	84,800	497,000			17,000	774,800	191,900	966,700	132,900	1,099,600
C	94.0	1	11.0	4.0	1,600	37,500	13,300	50,800										
		2									11.5	6.5	2,900	150,800	33,200	184,000		
		TOTAL			1,600	37,500	13,300	50,800	8,900	59,700			2,900	150,800	33,200	184,000	21,500	205,500
D	91	Alt.4+2	12.0	3.0	750	15,200	7,200	22,400			15.0	3.0	1,950	55,200	26,700	81,900		
	90	Reach 1	14.0	1.0	1,000	5,600	8,300	13,900			15.7	2.3	3,300	57,400	36,700	94,100		
		TOTAL			1,750	20,800	15,500	36,300	13,600	49,900			5,250	112,600	63,400	176,000	42,400	218,400
LIVERPOOL BAY	0	1	11.15	3.85	7,900	176,900	65,600	242,500			11.15	6.85	7,900	426,700	87,400	514,100		
		2	11.15	3.85	2,200	49,800	18,500	68,300			11.15	6.85	2,200	120,100	24,600	144,700		
		3	12.8	2.2	1,500	18,600	12,300	30,900			12.8	5.2	1,500	59,800	16,400	76,200		
	11	4	11.8	3.2	2,200	41,000	18,500	59,500			11.8	6.2	2,200	108,000	24,600	132,600		
		TOTAL			13,800	286,300	114,900	401,200	N.A.	401,200			13,800	714,600	153,000	867,600	N.A.	867,600
TOTAL					38,600	685,600	299,300	984,900	137,300	1,122,200			45,500	1,938,100	497,100	2,435,200	236,800	2,672,000

Quantities 1 of 1
November 17, 1975

CONCLUSIONS

(A) DREDGING

SUMMARY

(i) River Barges

a) 1000/1500 Series @ River Draft

These barges will be able to navigate the Eskimo Lakes from Liverpool Bay to Hans Bay without improvements to the present channel. A comprehensive system of land ranges and buoy markers will however be required to expedite navigation.

b) 1000/1500 Series @ Maximum Draft

Again the present channel appears adequate to handle barges drawing a maximum of 8'6" of water. A small quantity of dredging might be required at Area D but we believe this would not exceed 50,000 c.y. Our comment in (a) regarding channel markers applies equally to river barges at max. draft.

(ii) Ocean Barges

a) 250 ft. Long 75 ft Beam 13'-6" Draft

A total quantity of 1,120,000 c.y. of dredging will be required to enable the passage of these Ocean Barges through the Eskimo Lakes. A comprehensive system of channel markers will of course be required. In addition turning dolphins and/or anchor barges with tender tugs will be necessary at the difficult turns.

b) 400 ft. Long 100 ft. Beam 16'-0" Draft

A total quantity of 2,670,000 c.y. of dredging will be required to enable the passagle of larger Ocean Barges through the Eskimo Lakes. Our comments in (a) regarding channel markers and turning dolphins apply equally to the larger Ocean Barges

c) 400 ft. Long 100 ft. Beam 8'6" Draft

250 ft. Long 75 ft. Beam 8'6" Draft

Ocean Barges drawing 8'6" of water should be able to navigate the Eskimo Lakes chain without an extensive dredging program. Dredging quantities in the order of 75,000 c.y. should be considered reasonable. Turning dolphins and/or tending tugs will be required at the difficult turns.

DISCUSSION

The Summary of Dredging Qauntities shows the volumes, cuts and reach lengths calculated for each area. A brief summary of the quantities is listed below.

Area	Barge 75' beam c.y. (13'6" draft)	Barge 100' beam c.y. (16'0" draft)
Liverpool Bay	401,200	867,600
A	114,400	280,900
B	497,000	1,099,600
C	59,700	250,500
D	49,900	218,400
	1,122,200	2,672,000
% of Total in Liverpool Bay $ Area B	80%	74%

It can be seen from the above summary that between 70 & 80% of the total volume is confined to two areas, Liverpool Bay and Area B. Both areas have long channels over level bottoms.

Considering the relatively large volumes of dredging required for Ocean Barge passage, environmental factors will most certainly effect any decision to proceed. We have not contacted the Government Departments involved; However we would suggest that the disposal of dredge spoil would be of prime concern. Based on current information dredge spoil will probably be silt or silty clay. We suggest that material could be disposed of in several of the many enclosed small lakes adjacent to the channel. If a suction dredge was used pumping directly to the spoil lake would be a possibility.

Suggestions for further study in the Eskimo Lakes

1. Additional Soundings:- especially in Liverpool Bay and Area B where the bulk of the dredge quantities are located
2. Current Study:- As we concluded for Area X we believe currents in the Eskimo Lakes are probably caused by wind stacking. A study of historical tide data (from Tuk) along with wind velocity and direction might provide useful data.
3. Water Level Study:- At least three tide gauges should be installed to monitor water level. Soundings should be tied to tide gauge datum. One foot change in water level could alter dredging quatities between 10 & 20%.
4. Borehole Study:- Boreholes should be drilled at each dredging location to determine a) type of material b) presence of perma frost.

(B) DOCKING FACILITIES

Hans Bay

A large docking facility at Hans Bay will be required to handle the volumes of freight envisaged. We believe that a wharf consisting of a combination of cellular and tied back sheet pile will best fulfill these requirements. Cellular units are capable of supporting large loads (such as 1000 T modules) whereas tied back sheet piles provide a economical method of providing considerable wharf lengths and strength to loads reaching 250 tons.

Careful consideration should be given to providing adequate storage space close to the wharf. Any back up of freight during the short navigation season could be crippling.

Lightering Dock (North of Campbell Island)

If channel improvements are not undertaken an additional dock facility may be required in Liverpool Bay. This dock should be of the same form as Hans Bay and must provide adequate onland storage.