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MACKENZIE VALLEY
ENVIRONMENTAL IMPACT
REVIEW BOARD

27 February 2003

Mackenzie Valley Environmental Impact Review Board (MVEIRB)
Box 938, 5102 – 50th Avenue
Yellowknife, NT X1A 2N7

Attention: Glenda Fratton, Environmental Assessment Coordinator

Dear: Glenda

SUBJECT: Snap Lake North Pile PK Frost-heave Testwork

Please accept the attached technical memo titled "Snap Lake North Pile PK Frost-heave Testwork" for submission to the Public Registry. This memo was compiled in response to issues raised by Indian and Northern Affairs Canada (INAC) and Natural Resources Canada during the MVEIRB Technical Sessions.

Additionally, information contained within this memo should address the outstanding concerns identified by INAC in their Request for Ruling to the Board dated 22 January 2003.

Should you have any questions, please feel free to contact the undersigned.

Sincerely,

SNAP LAKE DIAMOND PROJECT

Robin Johnstone
Senior Environmental Manager



DE BEERS CANADA MINING INC.

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TECHNICAL MEMORANDUM



Golder Associates Ltd.

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Fax Access: 604-298-5253

TO: Robin Johnstone **DATE:** February 26, 2003
De Beers Canada Mining

FROM: Dawn Kelly and Rick Schryer **JOB NO:** 03-1322-017.5480

PREPARED BY: Terry Eldridge, P.Eng.

RE: **SNAP LAKE NORTH PILE PK FROST-HEAVE TESTWORK**

The purpose of this memorandum is to provide the results of the frost-heave testwork that was recently completed on the processed kimberlite (PK) from the Snap Lake Diamond Project. This testwork was carried out to demonstrate the behaviour of the paste materials under freezing conditions and to assess the potential for cryoconcentration and expulsion of pore fluids from the North Pile. Cryoconcentration and pore water expulsion during the freezing process is a mechanism by which small quantities of seepage with relatively high chemical concentrations could be released from the pile. Cryoconcentration and pore water expulsion have been identified as an area of concern by interveners because of the potential for this water to reach Snap Lake.

The PK will be deposited as a paste into the North Pile. The design pulp density (the ratio of the weight of the solids in a unit volume of the paste to the total weight of the unit volume of paste) of the paste in the pipeline is 72.7%, which equates to a water content (the ratio of the weight of the water in the paste to the weight of the solids in the paste) of 37.6%. The paste will be discharged from the end of the pipe and will flow along the previously deposited paste until it stops. A small amount of water will drain from the PK as it flows. Further drainage and consolidation of the PK placed during warm periods will occur. Freezing of the PK will occur during the winter.

The frost-heave test was carried out by EBA Engineering Consultants Ltd. in their Edmonton laboratory. The material tested was the full-mix PK comprising the coarse, grits and fines fractions. The grain size distribution of the tested material is presented on Figure 1, along with the PK paste design grain size distribution.

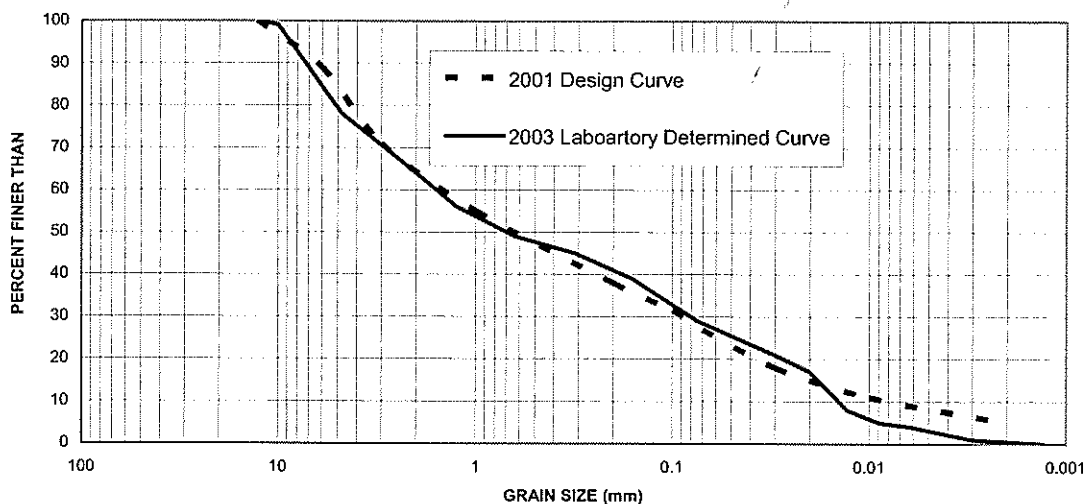
For the frost heave test, the PK sample was prepared with a moisture content of 29.5%, placed in the test cell and consolidated to a vertical stress of 20 kPa. The tested sample will therefore be similar to the PK located one to two metres below the surface of the pile. After consolidation, the frost heave test was run for a period of five days with the top of the sample maintained at a temperature of 2.2 °C and the base of the sample

maintained at a temperature of -3.4°C . The laboratory data sheets and output graphs are provided in Appendix I.

The sample exhibited water intake and frost heave. The rate of heave varied from about 4 mm/day when heave was initiated to about 1 mm/day at the end of the test. A 15 mm zone near the freezing front at the end of the test contained ice lenses up to 3 mm thick.

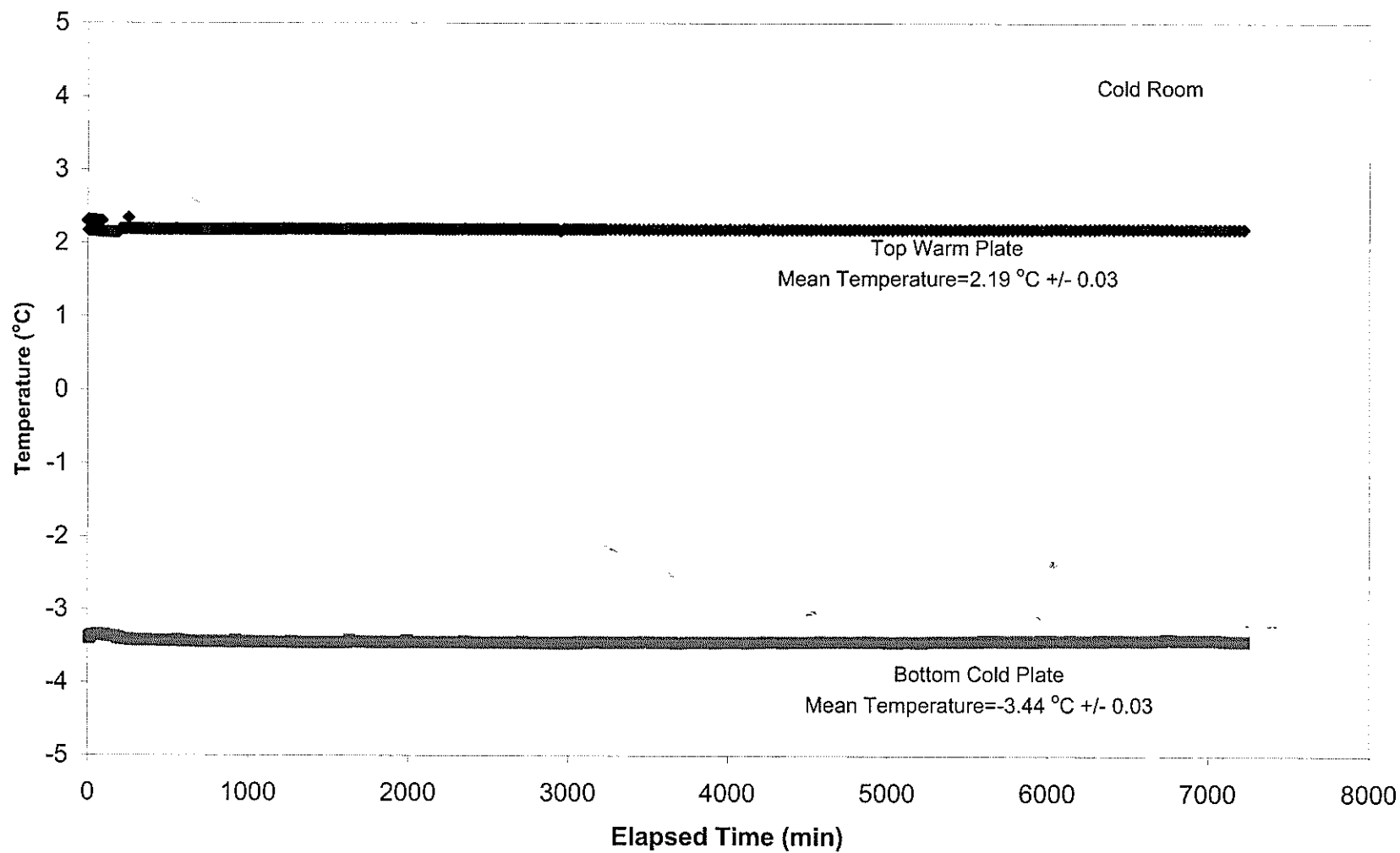
The results of this test demonstrate that, during the freezing process, the pore water of the paste PK is accommodated as ice lenses in the material and is not expelled in advance of the freezing front. The potential for cryoconcentrated water being released from the paste PK as it freezes is therefore low. Nevertheless, a seepage collection system will be constructed around the perimeter of the North Pile and seepage and runoff from the pile will be pumped to the water treatment plant.

Figure 1 Grain Size Distribution Curves for Processed Kimberlite Paste

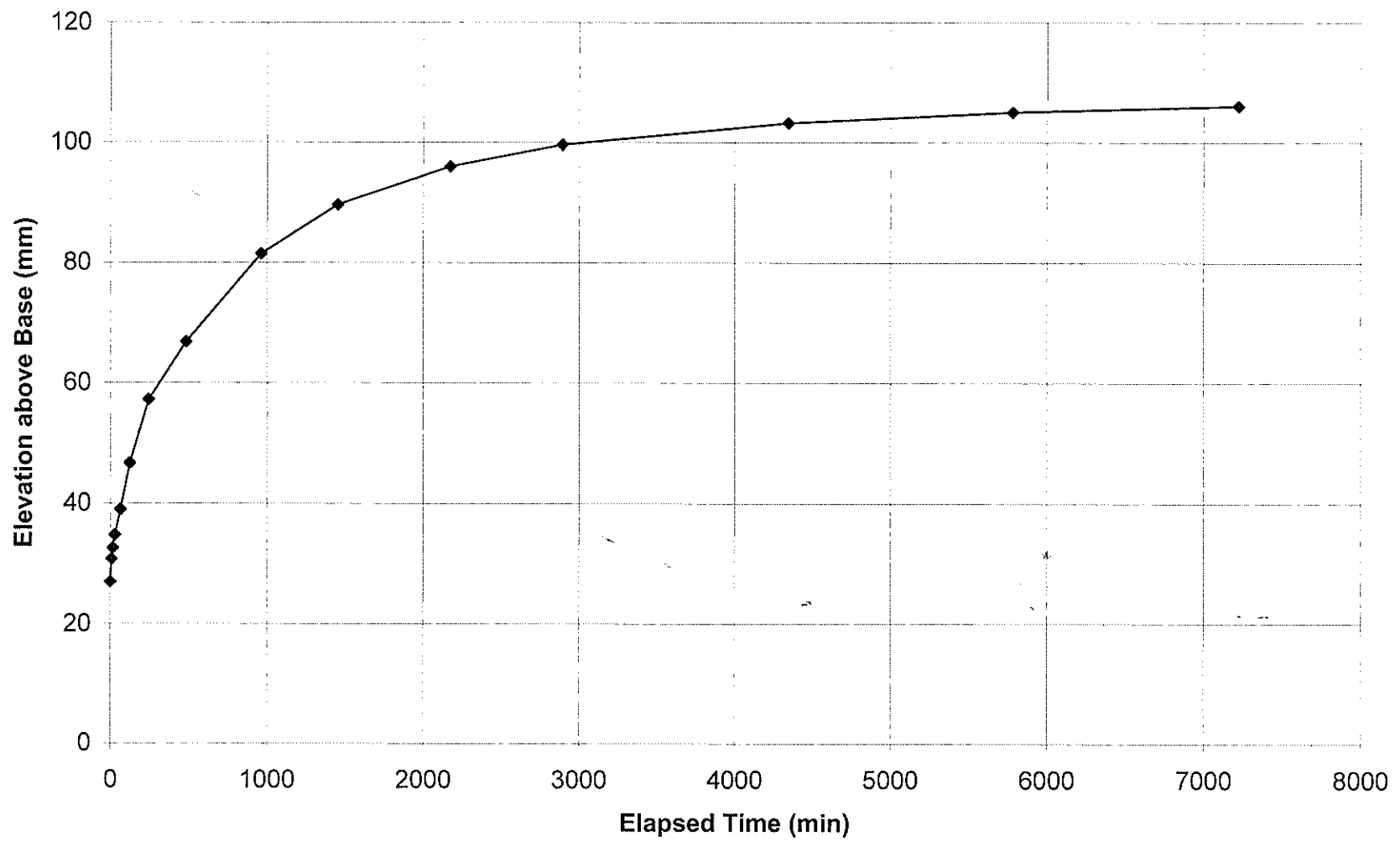


APPENDIX I
FROST HEAVE TEST LABORATORY DATA

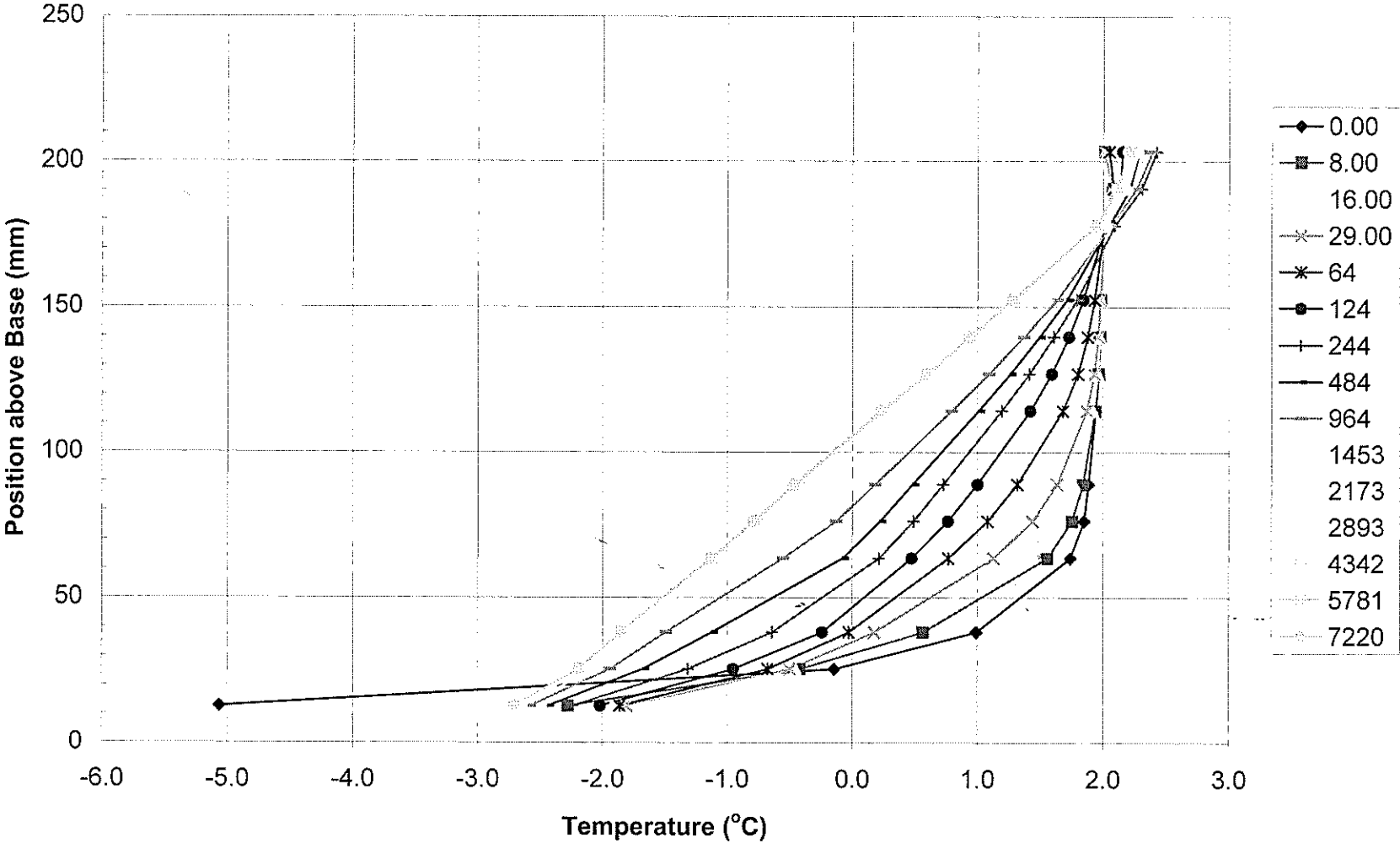
1100021: Boundary Temperature Data



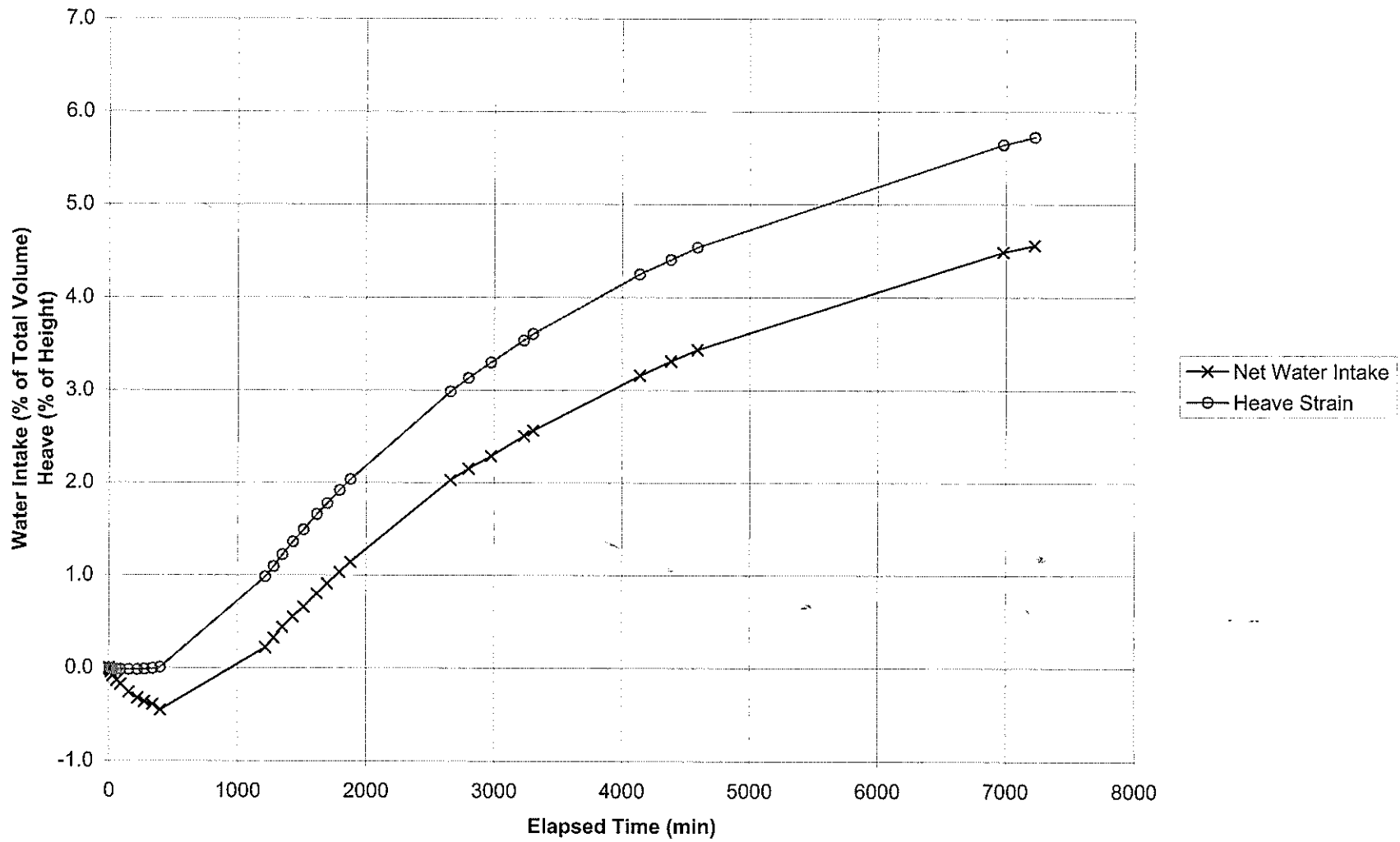
1100021: Position of 0 °C isotherm



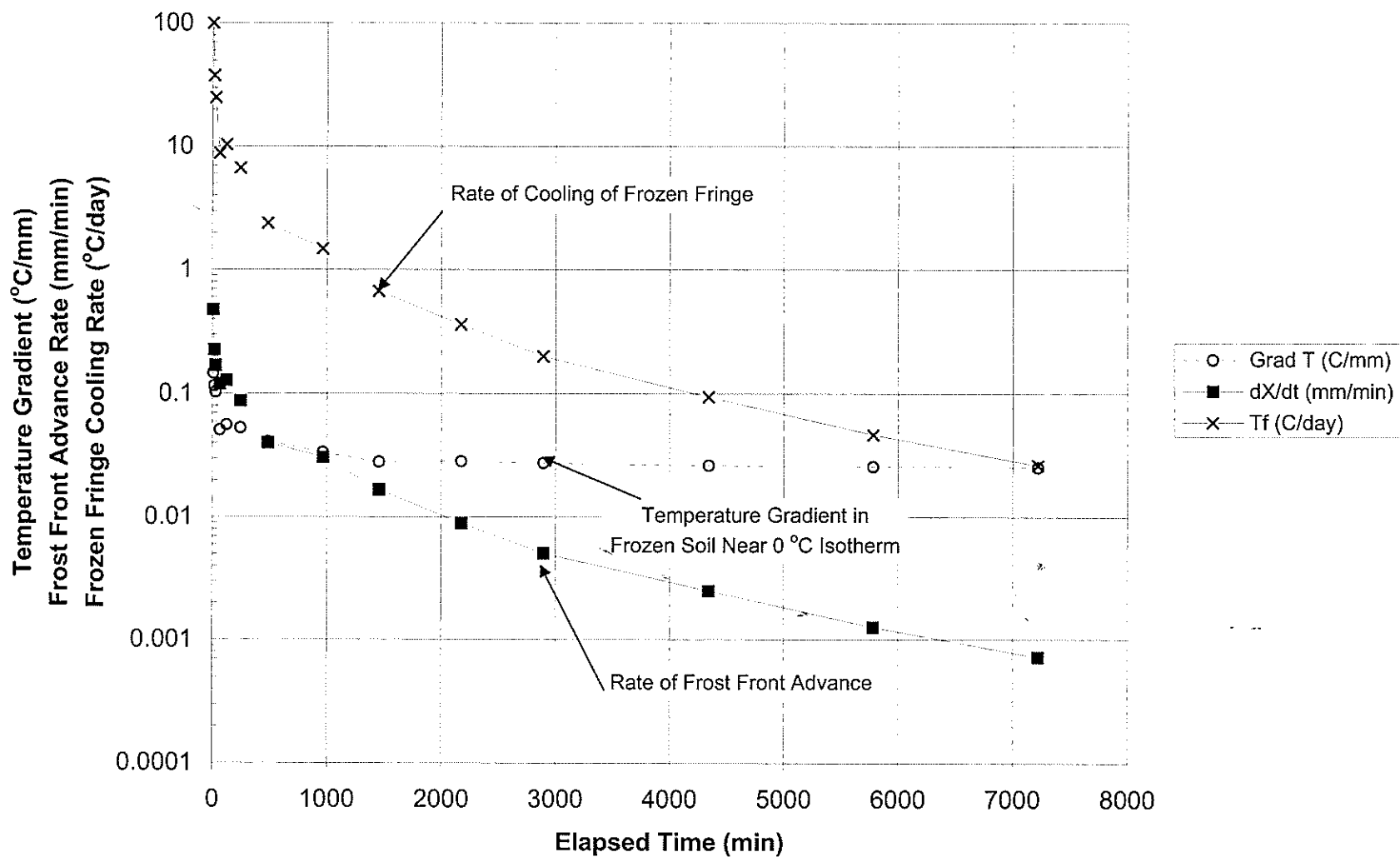
1100021: Temperature Profiles



1100021: Heave and Water Intake



Temperature Gradient, Frost Front Rate, and Freezing Rate



Frost Heave Test FH-1				Dial Gauge Reading increases, specimen heaves (+)				
				Burette Reading increases, specimen takes in water (+)				
Project:	Tests on PK Material, Snap Lake, NWT			Initial Height=	173.122	mm	Step Rate Freezing Test	
Project No.	0101-1100021			Cell Diam=	100.6	mm		
Sample	1100021-1			Cell Area=	79.5	cm2		
				Specimen				
Normal Stress	20.0 kPa			Vol.=	1376.1	cm3		
Date and Time	Elapsed Time (min)	Bath Temp. Warm (°C)	Cold (°C)	Cell No. 6		Burette Reading	Net Water	Remarks
				Dial Reading	Heave (mm)		Water Intake (cm3)	
29/01/2003 10:08	0	2	-3.13	25.915	0.000	74.8	0.0	start freezing by nucleation
29/01/2003 10:12	4			25.968	0.053	74.0	-0.8	at -15 C
29/01/2003 10:16	8			25.998	0.083	73.4	-1.4	
29/01/2003 10:20	12			26.015	0.100	72.8	-2.0	
29/01/2003 10:26	18			26.035	0.120	72.2	-2.6	
29/01/2003 10:27	0	1.96	-3.19	26.036	0.000	72.0	0.0	Switch to cold bath at -3C
29/01/2003 10:33	6			26.028	-0.008	71.7	-0.3	
29/01/2003 10:43	16			26.017	-0.019	71.4	-0.6	
29/01/2003 10:56	29	2.01	-3.13	26.010	-0.026	70.8	-1.2	
29/01/2003 11:27	60			26.004	-0.032	70.1	-1.9	
29/01/2003 11:58	91			26.002	-0.034	69.6	-2.4	
29/01/2003 13:02	155	1.98	-3.11	26.001	-0.035	68.4	-3.6	
29/01/2003 14:09	222			26.000	-0.036	67.5	-4.5	
29/01/2003 15:02	275			26.007	-0.029	67.0	-5.0	
29/01/2003 16:06	339			26.022	-0.014	66.6	-5.4	
29/01/2003 17:05	398			26.045	0.009	65.8	-6.2	
30/01/2003 6:43	1216	2.06	-3.17	27.738	1.702	75.0	3.0	
30/01/2003 7:47	1280			27.927	1.891	76.4	4.4	
30/01/2003 8:55	1348			28.147	2.111	78.0	6.0	
30/01/2003 10:17	1430			28.387	2.351	79.6	7.6	
30/01/2003 11:40	1513			28.615	2.579	81	9.0	
30/01/2003 13:23	1616			28.902	2.866	83	11.0	
30/01/2003 14:44	1697			29.108	3.072	84.5/62.4	12.5	
30/01/2003 16:20	1793			29.353	3.317	84.1	14.2	
30/01/2003 17:45	1878			29.557	3.521	85.6	15.7	

Frost Heave Test FH-1				Dial Gauge Reading increases, specimen heaves (+) Burette Reading increases, specimen takes in water (+)				
Project:	Tests on PK Material, Snap Lake, NWT			Initial Height=	173.122	mm	Step Rate Freezing Test	
Project No.	0101-1100021			Cell Diam=	100.6	mm		
Sample	1100021-1			Cell Area=	79.5	cm ²		
Normal Stress	20.0 kPa			Specimen Vol.=	1376.1	cm ³		

Date and Time	Elapsed Time (min)	Bath Temp. Warm (°C)	Cold (°C)	Cell No. 6		Burette Reading	Net Water Water Intake (cm ³)	Remarks
				Dial Reading	Heave (mm)			
31/01/2003 6:44	2657	2.08	-3.15	31.206	5.170	77.8	27.9	
31/01/2003 9:04	2797			31.457	5.421	79.5	29.6	
31/01/2003 12:00	2973			31.748	5.712	81.4	31.5	
31/01/2003 16:17	3230			32.157	6.121	84.4/60.0	34.5	
31/01/2003 17:30	3303			32.276	6.240	60.8	35.3	
01/02/2003 7:25	4138	2.06	-3.01	33.385	7.349	69	43.5	
01/02/2003 11:29	4382			33.655	7.619	71.1	45.6	
01/02/2003 14:56	4589			33.886	7.850	72.8	47.3	
03/02/2003 6:45	6978	2.08	-3.09	35.805	9.769	87.2	61.7	
03/02/2003 10:50	7223			35.945	9.909	88.2	62.7	

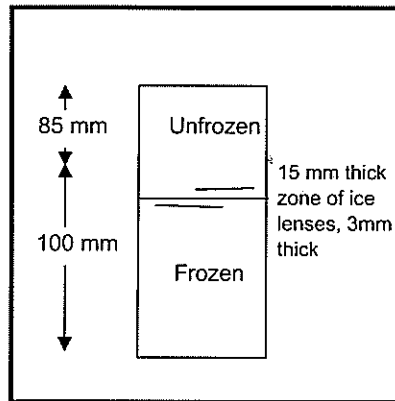
Frost Heave Test FH-1: Specimen Properties

Project: Testing of Processed Kimberlite, Snap Lake NWT
Project No.: 0101-1100021
Sample: 1100021-1

Pre-Test Properties

Diameter (mm)=	100.6
Height (mm)=	173.6
Area (cm ²)=	79.49
Volume (cm ³)=	1379
Mass of wet soil (g)=	3081.5
Mass of dry soil (g)=	2379.5
Moisture Content (%)=	29.5
Wet Density (g/cm ³)=	2.234
Dry Density (g/cm ³)=	1.725
Specific Gravity =	2.78
Void Ratio=	0.61
Porosity (%)=	38.0
Saturation(%)=	134.1

Post-Test Sketch



Post-Test Moisture Content Distribution

Slice No.	Mid-Height (cm)	Mass of Wet Soil (g)	Mass of Dry Soil (g)	Mass of Tare (g)	Moisture Content (%)	
1	0	595.9	493.9	6.6	20.9	
2	0	588.3	481.1	6.5	22.6	
3	0	901.9	725.2	6.6	24.6	ice lenses found here
4	0	721.9	618.9	6.6	16.8	

