Appendix B

Transect Field Data For Commonwealth and Howard Glacier.

Commonwealth Glacier.

Sample sites marked with a “(C)” are from the first transect run on 1/19&20/99. The distances between each site was "chained out" using a 50 m climbing rope. Sample sites with a “(G)” are from the second transect run on 1/26/99. The distances between each site was determined using hand held GPS. The course of the second transect followed the footprints in snow from earlier transect. The thermometer read +0.4 high (calibrated with slushy water at camp) and the temperatures listed are not adjusted for this error.

T1 (C) Lower Reflector
Bright sun, clear skies
Aspect SE
Slope 2-5 degrees used ice axe and Brunton compass
Snow temp -1.7 C
Ice temp -1.8, -0.5 C
Cryoconite temp +0.8 C (water?)
Air temp -2.6 C
Snow table depth 4, 17, 21, 9 cm
Thin snow over ice 4, 1, 3, 2, 1.5 cm

Ice roughness parallel to beam (cm)

4.5	4.0	2.8	3.0	2.1	2.5	2.9	1.6
2.7	2.5	3.6	3.4	3.8	4.0	1.3	3.0
2.9	5.2	2.8	3.9	4.6	3.0	4.5	3.7
3.3	3.5	4.7	5.0	6.0	6.0	3.0	3.6
3.3	3.3	3.1	1.0	1.8	2.9	4.3	2.9
3.8		Ave 3.4					

Ice roughness perpendicular to the beam (cm)

5.8	2.8	2.9	2.9	1.5	5.4	4.0	7.5
1.7	4.4	2.9	3.4	3.8	3.1	2.7	3.6
3.4	3.6	3.4	3.5	2.5	2.8	4.1	4.3
4.3	3.1	3.1	1.9	2.8	2.0	2.0	3.3
3.5	3.8	3.7	2.5	3.2	3.4	3.4	3.3
3.6		Ave 3.3					

Rough old snow/ice with new snow tables 30 cm high
exposed cryoconite holes 30-90 cm wide
Cryoconite hole depths 21, 26, 12, 18, 18, 28, 7, 12, 12, 12, 7, 17

Snow pit 16 cm deep dug on a snow table

layer	depth (cm)	mass (g)	crystal size (mm)	hardness (measured by inserting an object into the snow layer).
I	12-16	40	1 mm	knife
II	11-12			softer
III	0-11	27	1 facets	four fingers

T1 (G) Lower Reflector “Karl” Jan 26,1999
According to GPS 2.35 km from MARTHA
The area around each site was characterized: relative aerial fractions of type of surface (snow, ice) and any notable features (e.g. crevasse, cryoconite holes). The fractional area of cover (e.g. snow, ice, cryoconite holes) was established by a consensus of estimates between the field data collectors.

Ice	75%
Snow table	10%
Thin snow	15%
Cryoconite	5-10%

Ice roughness parallel to beam (cm)

2.4	1.4	1.4	1.7	1.2	2.4	1.4	3.0
1.1	2.2	3.4	2.9	4.4	3.8	4.0	3.6
2.3	1.8	4.0	4.0	4.5	5.3	3.8	2.1
2.4	2.3	3.6	10.9	11.2	11.0	9.2	5.6
4.7	3.2	3.3	3.5	0.8	4.7	4.2	4.5
5.3		Ave 3.8					

Ice roughness perpendicular to the beam (cm)

5.2	3.9	2.3	1.8	2.7	1.6	1.5	3.6
4.4	3.7	1.2	2.8	1.8	2.6	5.4	5.5
9.4	9.1	9.7	2.8	2.2	1.7	1.6	1.9
0.5	6.7	4.6	3.6	2.2	1.2	2.1	2.3
1.9	3.0	5.6	8.7	6.7	6.4	5.0	6.4
3.5		Ave 3.8					

T2 (C)
Aspect SE
Slope 0, 3, 3, 2 degrees
Snow temp -1.9, -1.7, -1.3 C
Ice temp +0.5, +0.7, +0.6 C (water?)
Snow table depth 7.4, 14.8, 19 cm
Thin snow over ice 2.5, 4.8, 1.5 cm
Snow tables similar to stratigraphy to site #1
15% exposed ice

Suncups facing north like T1, 4-5 cm deep, fewer open cryoconite holes, small cracks SE-NE, and 8cm deep 20 cm wide max to 0.

T2 (G)
GPS 2.10 km from MARTHA (change=250 m)

Ice	85%
Snow table	10%
Thin snow	5%
Cryoconite	5%

Ice roughness parallel to beam (cm)

1.7	1.9	4.9	2.6	2.5	2.3	1.2	1.5
3.1	2.3	2.5	2.4	2.4	2.6	2.2	4.4
4.8	5.6	3.5	3.5	2.0	2.7	3.4	2.7
1.6	1.2	3.8	2.1	2.0	2.0	1.8	2.3
1.8	3.5	3.9	2.4	2.9	2.6	1.9	1.5
1.8		Ave 2.6					

Ice roughness perpendicular to the beam (cm)

1.7	1.8	1.4	2.6	3.8	2.4	2.2	2.8
2.0	1.7	1.8	1.9	3.0	2.8	3.9	5.3
4.3	3.0	3.4	3.1	2.4	1.5	1.1	1.1
1.5	2.3	7.8	3.0	2.5	2.4	1.4	1.0
2.0	3.6	3.6	4.4	5.5	4.0	3.2	2.3
1.8		Ave 2.7					

T3 (C) about 200 m SSW of Metrological station
Aspect SE
Slope 0, 2, 0 degrees
Snow temp -0.9 (near surface), 3.0 (2 cm deep, water?)
Ice temp -0.6, +0.6 C (water?)
Snow table depth 26, 25, 16, 16
Thin snow over ice 2.2, 2.8, 1.0, 2.5

Ice roughness parallel to beam (cm)

8.5	8.5	5.0	5.0	2.8	2.8	1.7	3.4
3.0	6.2	3.0	3.6	3.1	1.5	3.3	3.8
4.7	2.6	1.7	1.7	4.9	2.8	2.3	5.2
1.9	1.5	2.0	4.0	2.3	4.4	5.4	2.8
6.6	5.3	4.1	5.9	5.9	4.2	2.5	2.6
1.6	2.0		Ave 3.7				

Ice roughness perpendicular to beam (cm)

6.9	6.9	5.9	7.5	7.2	5.0	6.7	4.3
7.4	4.6	3.0	4.2	6.5	6.0	5.4	5.2
7.0	6.0	1.9	1.1	6.2	5.5	15.2	7.3
8.0	8.0	7.1	13.8	5.1	3.0	4.4	2.8
2.8	11.0	3.2	2.6	1.6	1.5	5.6	2.5

1.4 (occasionally in cryoconite hole) Ave 5.5

Some cryoconite holes depth 12, 5, 17, 7 cm, diameter 9-100 cm.

Exposed ice 25%
Snow tables 50%
Thin snow over ice 25%

T4 (C)
Aspect SE
Slope 4, 3
Snow temp -0.4, -2.0, -2.3
Ice temp +3.0 (water?), -2.1 (under snow), +0.5 (water?)
Snow table depth 19, 20, 19, 13
Thin snow over ice 2, 1.8, 3.6, 3.8

Snow tables 40%
Exposed ice 25%
Thin snow over ice 35%
Few obvious cryoconite holes, could be snow covered

T4 (G)
GPS 1.67 km from MARTHA (change=500 m)
Across from met station, just a bit downhill

Ice 35%
Snow table 30%
Thin snow 35%
Cryoconite 0%

Ice roughness parallel to beam (cm)

1.0	1.4	1.7	1.4	1.7	2.1	3.4	4.4
4.3	6.0	5.5	6.1	5.9	3.0	4.6	4.3
3.9	4.8	4.2	4.5	4.0	5.2	4.1	5.0
3.4	2.3	1.9	1.2	1.0	1.9	2.9	3.7
5.2	5.5	4.6	4.0	3.9	4.4	4.9	5.9
5.8		Ave 3.7					

Ice roughness perpendicular to beam (cm)

2.6	1.9	1.0	1.5	3.9	3.3	2.5	2.5
3.7	3.1	2.4	2.1	1.5	1.3	1.6	2.4
2.5	2.0	1.1	1.4	1.8	1.4	1.5	2.5
2.4	2.8	2.8	3.0	2.8	3.7	3.0	2.0
2.3	2.7	2.6	1.9	1.5	2.3	2.9	2.6
1.3		Ave 2.2					

T5 (C)
Aspect SE
Slope 5, 3
Snow temp -1.7
Ice temp +0.3 (water?)
Snow table depth 20, 25, 30, 24
Thin snow over ice 6.3, 4.2, 3.8, 5.4

Ice roughness parallel to beam (cm)

2.7	1.3	1.3	1.7	1.9	1.5	1.4	1.1
1.4	1.4	1.5	1.7	2.1	1.9	1.8	2.8
1.6	1.1	1.5	1.8	2.1	3.8	6.5	7.2
7.0	5.8	4.7	5.1	2.4	2.7	2.8	3.2
3.1	2.4	3.2	2.5	1.8	4.1	2.6	2.4
2.4		Ave 2.7					

Ice roughness perpendicular to beam (cm)

1.0	1.8	2.8	2.4	3.7	1.4	1.6	1.9
2.9	3.2	3.2	1.6	3.0	4.8	7.0	8.0
7.9	8.3	7.7	8.2	7.2	5.9	2.9	3.4
4.2	4.0	1.6	1.6	1.3	2.9	3.0	3.6
1.9	2.0	2.7	2.7	2.0	1.6	1.2	2.3
1.2		Ave 3.4					

Snow pit 8 cm deep two layers

layer	depth (cm)	mass (g)	crystal size (mm)	hardness
I	6-8	27	windblown	knife
II	0-6	37	1.0 hoar	fist

Snow tables 25%
Exposed ice 10%
Thin snow over ice 65%

Some cryoconite holes, crevasses 7cm wide and along transect.

T6 (C)
Aspect WSW
Slope 0, 4
Snow table depth 22, 21, 9, 30
Thin snow over ice 1.8, 6.0, 2.8, 3.0

Snow tables 15%
Exposed ice 10%
Thin snow cover 75%
Hummocky snow, little ice exposed
Cryoconite holes evident

T6 (G)
GPS 1.17 km from MARTHA (change 500 m)

Ice	75%
Snow table	15%
Thin snow	10%
Cryoconite	5-10%

Ice roughness parallel to beam (cm)

1.4	1.0	1.2	1.9	2.7	2.4	3.8	3.3
2.5	1.7	1.0	2.9	3.5	2.7	2.6	2.1
1.7	1.8	1.3	1.1	1.4	2.2	2.4	2.0
1.9	2.3	3.3	2.4	2.7	1.4	2.7	2.7
1.8	2.5	4.4	4.6	3.9	1.7	1.5	1.9
1.3		Ave 2.2					

Ice roughness perpendicular to beam (cm)

1.3	1.8	1.9	1.9	2.1	2.5	3.2	3.1
3.5	2.6	1.6	2.5	3.2	2.8	2.7	2.7
1.9	1.4	2.3	2.9	3.1	2.5	2.9	3.2
3.9	3.5	2.3	2.8	3.6	3.6	2.6	2.3
2.9	3.2	3.0	2.9	3.7	3.0	2.3	2.5
2.3		Ave 2.6					

T6 SECOND DAY, second entry
Jan 20, 1999 10:30
Overcast no new snow since yesterday, surface remains same.
Air temp -0.9
Snow temp -2.8, -2.3, -3.7
Ice temp -3.5

T7 (C)
Aspect S
Slope 4, 1, 1
Snow temp -3.7, -3.7
Snow table depth 35, 30, 33, 33
Thin snow over ice 12, 1, 5, 1

Ice roughness parallel to beam (cm)

11.8	13.4	14.3	16.9	14.2	25.4	13.7	13.8
13.8	13.6	13.4	11.9	8.8	8.8	8.9	9.3
9.1	9.3	8.6	8.4	8.4	8.5	8.4	8.3
8.2	8.2	7.5	7.8	7.4	6.4	6.2	5.7
5.4	5.4	6.5	6.7	6.8	7.2	6.7	7.2
4.5		Ave 9.6					

Ice roughness perpendicular to beam (cm)

4.5	5.2	5.3	5.1	4.5	4.4	5.9	5.9
6.2	6.0	6.4	7.7	6.8	6.7	7.8	9.5
7.4	7.9	7.4	7.7	7.9	8.0	9.2	11.7
9.9	9.4	10.0	8.5	7.9	7.9	7.9	8.3
8.3	11.5	8.8	8.8	8.0	8.8	12.5	11.9
13.2		Ave 7.9					

Exposed ice	5%
Tables	20% (starting to look like sastrugi)
Snow covered ice	75%

T8 (G)
Aspect SE
Slope 5, 4
Snow temp -1.7, -0.7, ice -1.8
Snow table depth 21, 14, 30, 14
Thin snow over ice 3, 4, 2, 2 snow only collects in shallow depressions.

Exposed ice	50%
Snow tables	35%
Snow covered ice	15%

Some cryoconite holes largely hidden by snow
200 m from T7, surface changes to 50-50 ice snow, snow mounded into flat-topped dune-like features.

T8 (G)
Ice roughness parallel to beam (cm)

1.3	3.4	4.2	4.8	6.0	4.9	7.4	6.9
7.4	11.1	11.4	12.4	6.6	8.2	6.7	5.5
6.3	8.5	5.4	5.5	6.3	6.2	5.3	7.0
5.4	5.5	5.8	5.8	5.5	5.2	4.9	5.4
5.7	5.9	6.2	6.3	6.0	6.9	9.6	7.8
14.0	16.0		Ave 6.8				

Ice roughness perpendicular to beam (cm)

10.4	12.0	13.0	14.0	10.1	10.0	10.0	9.5
9.0	8.5	8.4	8.2	8.1	8.1	9.2	12.4
9.4	7.0	6.7	6.9	6.8	6.5	6.8	9.5
20.6	12.0	9.7	7.3	9.7	7.7	11.3	8.1
7.8	8.5	8.1	8.0	8.3	8.4	3.5	7.8
8.8		Ave 9.1					

T8 (G)
GPS 0.67 km from MARTHA (change 500 m)

Snow table	35%
Thin snow	65%

T9(C)
Aspect SE
Slope 5 on ice, 2 on snow table.
Snow temp -2.4, ice -0.8
Snow table depth 27, 22, 19, 16
Thin snow over ice 5, 1, 2, 5

Ice roughness parallel to beam (cm)

3.8	4.3	4.4	4.4	4.1	3.0	3.2	3.3
3.2	3.2	3.4	3.3	3.0	3.1	3.2	3.1
2.7	2.6	2.5	2.4	2.3	2.4	2.3	2.0
1.8	1.9	1.7	4.7	5.3	3.9	1.6	1.5
1.4	1.3	1.0	1.4	1.4	1.4	1.5	1.5
2.0		Ave 2.6					

Ice roughness perpendicular to beam (cm)

4.7	5.3	5.4	5.6	5.5	5.4	5.3	5.5
5.5	5.0	4.7	4.7	4.7	4.5	4.5	4.5
4.5	4.3	4.1	3.6	3.5	2.9	2.8	2.8
2.5	2.4	2.4	2.8	4.5	2.6	2.4	2.1
1.9	2.2	2.4	2.1	1.9	1.8	2.0	2.0
1.4		Ave 3.6					

Snow pit 20 cm, bag 0

layer	depth (cm)	mass (g)	crystal size (mm)	hardness
I	17-20	38	0.5 rounds	pencil
II	10-17	20	1 facet/rounds	fist
III	8-10	28	1 rounds	four finger
IV	1-8	24	2 facets	fist

Snow tables	25%
Exposed ice	30%
Thin snow over ice	45%

T10 Upper Reflector
Aspect SSW
Slope 8 on ice, 4 on snow table.

Snow temp -2.4, ice -1.5
Snow table depth 24, 23, 48, 19
Thin snow over ice 2, 1, 2, 3

Ice roughness parallel to beam (cm)

2.2	2.8	1.4	1.9	1.6	1.2	1.4	1.9
3.9	2.8	2.3	2.0	1.4	1.3	1.5	2.0
2.6	2.2	1.7	1.3	1.4	1.4	1.2	2.3
2.4	2.0	2.4	2.5	2.1	1.4	1.2	1.3
2.3	2.6	2.4	2.0	1.3	1.2	2.0	3.7
2.9		Ave 1.9					

Ice roughness perpendicular to beam (cm)

1.5	1.8	2.1	2.4	2.2	1.5	1.1	1.6
2.8	2.9	2.6	2.5	2.4	2.3	2.5	1.8
4.0	4.0	4.0	3.6	3.5	2.8	2.3	1.5
1.4	2.5	2.5	1.8	1.5	1.4	1.4	1.6
1.8	2.3	1.9	1.5	1.0	1.6	4.2	2.5
1.9		Ave 2.2					

Snow pit 39 cm, bag 0

layer	depth (cm)	mass (g)	crystal size (mm)	hardness
I	10-39	43	0.5 rounds	pencil
II	0-10	26	1 stellar	four

Snow tables	15%
Very thin snow	45% snow less than 1 cm deep
Thin snow	40% snow pockets in ice depressions
Cryoconite holes	5%

Cryoconite holes depths
23, 22, 19, 11, 11

T10 (G) Upper Reflector
GPS @ MARTHA
77° 33' 24.3"
163° 12' 49.3"

Ice	85%
Snow table	10%
Thin snow	5%
Cryoconite	5%

Ice roughness parallel to beam (cm)

1.4	1.2	1.2	1.1	0.9	1.4	1.4	1.0
1.4	2.3	3.4	1.9	1.7	2.3	2.6	2.1
1.5	1.4	1.3	2.0	2.8	2.9	2.5	1.4
1.2	1.3	1.0	1.2	1.3	1.8	1.5	1.5
2.3	2.5	3.0	2.8	1.5	1.3	2.0	2.1
3.0		Ave 1.8					

Ice roughness perpendicular to beam (cm)

1.3	1.8	1.5	1.7	1.8	1.7	2.2	2.0
2.1	2.0	2.4	2.5	1.9	1.8	2.0	2.5
4.7	2.7	2.9	2.4	2.3	2.1	2.2	2.0
1.5	1.7	1.5	2.1	2.5	2.7	2.5	3.0
2.8	2.0	1.8	3.0	3.1	1.5	1.0	1.1
1.4		Ave 2.1					

T11
Aspect WSW
Slope 5 on ice, 5 on snow table.
Snow table depth 13, 25, 14, 21
Thin snow over ice 2, 3, 1, 4
Cryoconite depth 8, 9, 13, 15

Snow tables 10%
Exposed ice 40%
Thin snow 30%
Cryoconite 20%

T13 (G) edge of snow/ice
77° 33’ 11.5"S
163° 11’ 50.2"E
Snow cover 100%
Snow depth
20 15 16 10
Hoar crystals under tables
Snow tables with drifted snow in between

T12 four rope lengths from #11 (200 meters)
Aspect S
Slope 4
Snow depth 21, 54, 63, 65
Surface completely snow covered

Snow pit 49 cm

layer	depth (cm)	crystal size (mm)	hardness
I	29-49	2.0 rounds/stellars	fist
II	25-29	dirty layer	one finger
III	22-25	ice layer	
IV	0-22	3.0 hoar crystals	one finger

T14 (G)
77° 33’ 12.1"S
163° 11' 24.2"E
Snow depth
62 53 61 59 63 62 58
Snow pit depth 59 cm
11 cm to top of ice layer, 4 cm thick
15 cm deep to top of next ice layer, 9 cm thick
Not ice, but melt/refreeze snow-compacted grains, had to chop with axe.

T15 (G)
77° 33' 9.6"S
163° 11' 0.9"E
Snow depth
73 79 57 58 69 70
Hard snow
66 37 26

T16 (G)
77° 33' 06.5" S
163° 10' 49.0"E
Snow depth
66 63 57 60 57
Hard snow
47 40 41

Howard Glacier.

Howard Glacier field data taken on 1/27/99 positions are either at mass-balance stake locations or located by GPS.

Site 1 near Stake 31, Metrological station

Ice		75%					
Snow table		20%					
Snow		5%					
Cryoconite holes			15%				
Cryoconite depth			8	10	15	10	14	8

Ice roughness parallel to beam (cm)

3.3	1.3	1.8	1.9	1.9	2.0	2.0	2.0
1.9	2.4	2.6	2.2	1.7	1.4	1.5	1.3
1.0	1.3	1.5	1.3	0.9	1.8	2.0	1.9
1.9	2.4	3.2	4.9	3.2	2.8	1.5	3.4
4.5	5.2	1.8	0.9	2.6	2.9	4.0	2.9
4.3		Ave 2.3					

Ice roughness perpendicular to beam (cm)

1.3	1.8	1.2	1.9	2.3	1.9	1.9	1.8
1.9	2.1	2.8	2.8	3.2	2.0	1.8	1.4
1.3	1.5	2.0	2.6	2.8	2.9	3.4	3.3
3.5	1.7	2.0	2.4	1.8	1.4	2.0	2.3
2.1	2.9	0.9	1.9	1.2	2.7	0.9	1.5
2.9		Ave 2.0					

Site 2 near Stake 30

Ice		15%					
Snow table		10%					
Snow		75%	snow depths		3	5	5	5
Cryoconite		2%					

Ice roughness parallel to beam (cm)

6.0	4.8	4.3	4.0	3.9	3.2	2.5	2.2
1.4	1.9	2.3	2.4	2.3	2.7	3.9	3.0
3.0	2.0	1.9	2.3	2.5	2.5	6.3	5.4
4.7	4.3	4.5	3.6	3.9	2.4	2.1	1.5
1.8	5.0	3.7	4.9	4.7	3.7	3.8	3.9
3.6		Ave 3.3					

Ice roughness perpendicular to beam (cm)

4.3	4.2	4.7	4.0	4.7	4.4	4.5	4.3
4.6	5.8	5.3	5.5	6.7	7.6	7.5	7.9
8.0	8.2	8.5	8.0	6.5	6.5	5.9	4.8
4.7	5.2	3.3	3.0	2.5	2.6	2.5	1.9
2.5	1.4	0.9	1.1	1.6	1.7	2.1	3.5
5.6		Ave 4.5					

Site 3
77° 40' 43.2"
163° 04' 52.6"

100% snow cover approx 10 cm deep

Site 4
77° 40' 35.2" S
163° 04' 50.0" E
(Just a few 10s of meters from last position)

Snow depth	28	18	29	27	22

Site 5
77° 40' 44.5" S
163° 05' 0.00" E
(Almost level with stake 29, just a bit down glacier from it.)

Snow depth	32	42	42	45	44	39