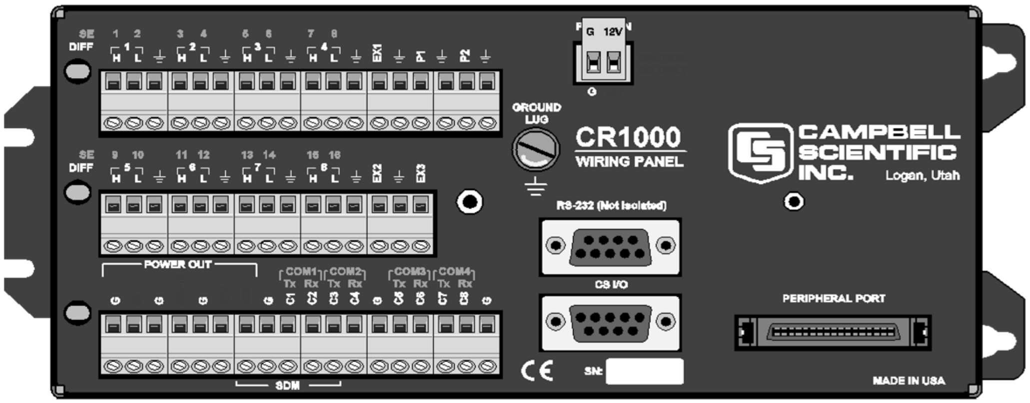
Appendix B - Wiring Diagrams

Appendix B1 - Datalogger Diagrams

CR1000 Wiring Diagram

Company:	Nuna Contracting / SRK Consulting
Project:	Hope Bay Dam project
Documented By:	Mike Ryder - Campbell Scientific Canada Corp.

CR1000 #1 Located in Node B



Ground	Black
12V	Red
Reset	White
Clock	Green
COM H (ODD)	White
COM L (ODD)	Green
COM H (EVEN)	Red
COM L (EVEN)	Black

	G
	5V
	G
	SW-12
AM16/32B #1,#2,#3 - G	**G**
AM16/32B #1,#2,#3 - 12V	**12V**
AM16/32B #4, #5, - 12V	**12V**
AM16/32B #4, #5 - G	**G**
AM16/32B#1, #5 Res	**C1 (COM1 Tx)**
AM16/32B#1, #5 Clk	**C2 (COM1 Rx)**
AM16/32B#2 Res	**C3 (COM2 Tx)**
AM16/32B#2 Clk	**C4 (COM2 Rx)**
	G
AM16/32B#3 Res	**C5 (COM3 Tx)**
AM16/32B#3 Clk	**C6 (COM3 Rx)**
AM16/32B#4 Res	**C7 (COM4 Tx)**
AM16/32B#4 Clk	**C8 (COM4 Rx)**
	G

Battery 12V (Red)	**12V**
Battery G (Black)	**G**

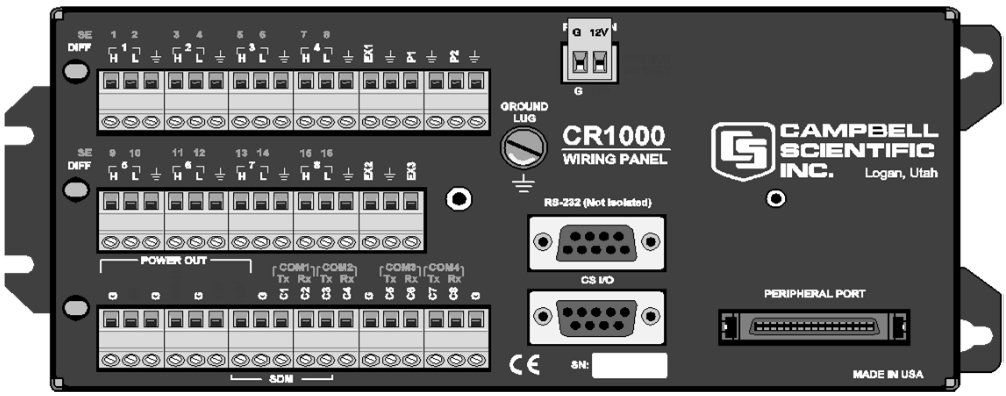
AM16/32B#3 COM L(EVEN) - RES to ⏚	**5H (SE9)**
AM16/32B#4 COM L(ODD) - RES to ⏚	**5L (SE10)**
RES to SE10, SE11, SE12	⏚
AM16/32B#4 COM H(EVEN) - RES to ⏚	**6H (SE11)**
AM16/32B#4 COM L(EVEN) - RES to ⏚	**6L (SE12)**
	⏚
AM16/32B#5 COM L(ODD) - RES to ⏚	**7H (SE13)**
AM16/32B#5 COM H(EVEN) - RES to ⏚	**7L (SE14)**
RES to SE13, SE14, SE15	⏚
AM16/32B#5 COM L(EVEN) - RES to ⏚	**8H (SE15)**
	8L (SE16)
	⏚
AM16/32B #3,#4 COM H(ODD)	**EX2**
	⏚
AM16/32B #5 COM H(ODD)	**EX3**

AM16/32B#1 COM L(ODD) - RES to ⏚	**1H (SE1)**
AM16/32B#1 COM H(EVEN) - RES to ⏚	**1L (SE2)**
RES to SE1, SE2, SE3	⏚
AM16/32B#1 COM L(EVEN) - RES to ⏚	**2H (SE3)**
AM16/32B#2 COM L(ODD) - RES to ⏚	**2L (SE4)**
RES to SE4, SE5, SE6	⏚
AM16/32B#2 COM H(EVEN) - RES to ⏚	**3H (SE5)**
AM16/32B#2 COM L(EVEN) - RES to ⏚	**3L (SE6)**
RES to SE7, SE8, SE9	⏚
AM16/32B#3 COM L(ODD) - RES to ⏚	**4H (SE7)**
AM16/32B#3 COM H(EVEN) - RES to ⏚	**4L (SE8)**
	⏚
AM16/32B#1,#2 COM H(ODD)	**EX1**
	⏚
	P1
	⏚
	P2
	⏚

CR1000 Wiring Diagram

Company:	Nuna Contracting / SRK Consulting
Project:	Hope Bay Dam project
Documented By:	Mike Ryder - Campbell Scientific Canada Corp.

CR1000 #2 Located in Node D



Ground	Black
12V	Red
Reset	White
Clock	Green
COM H (ODD)	White
COM L (ODD)	Green
COM H (EVEN)	Red
COM L (EVEN)	Black

	G
	5V
	G
	SW-12
AM16/32B #8, #9 - G	G
AM16/32B #8, #9 - 12V	12V
AM16/32B #6, #7 - 12V	12V
AM16/32B #6, #7 - G	G
AM16/32B #6 Res	C1 (COM1 Tx)
AM16/32B #6 Clk	C2 (COM1 Rx)
AM16/32B #7 Res	C3 (COM2 Tx)
AM16/32B #7 Clk	C4 (COM2 Rx)
	G
AM16/32B #8 Res	C5 (COM3 Tx)
AM16/32B #8 Clk	C6 (COM3 Rx)
AM16/32B #9 Res	C7 (COM4 Tx)
AM16/32B #9 Clk	C8 (COM4 Rx)
	G

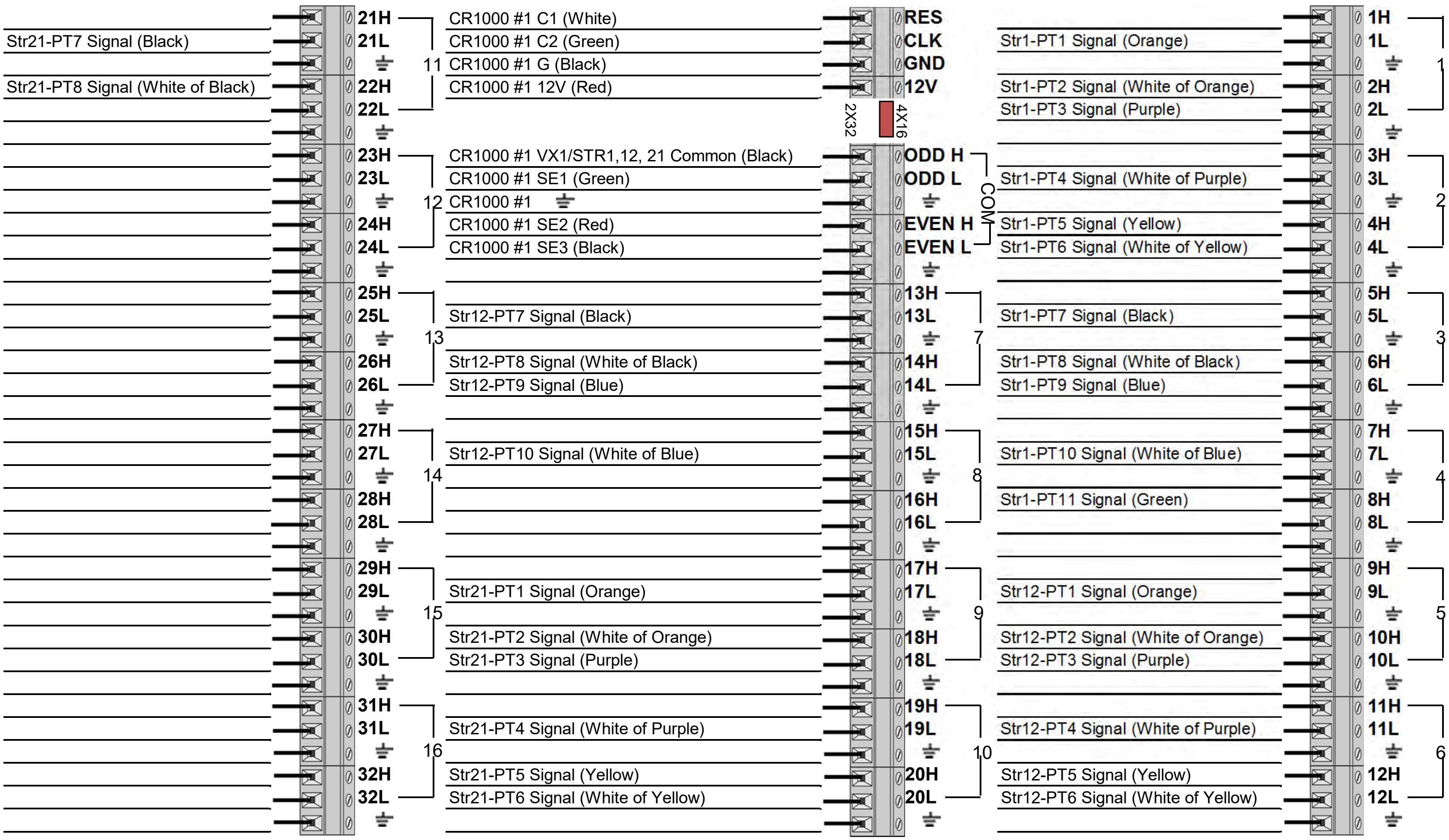
Battery 12V (Red)	12V
Battery G (Black)	G

AM16/32B#8 COM L(EVEN) - RES to ⏚	5H (SE9)
AM16/32B#9 COM L(ODD) - RES24.9 to ⏚	5L (SE10)
RES to SE10	⏚
	6H (SE11)
	6L (SE12)
	⏚
	7H (SE13)
	7L (SE14)
	⏚
	8H (SE15)
	8L (SE16)
	⏚
AM16/32B #8 COM H(ODD)	EX2
	⏚
AM16/32B #9 COM H (ODD)	EX3

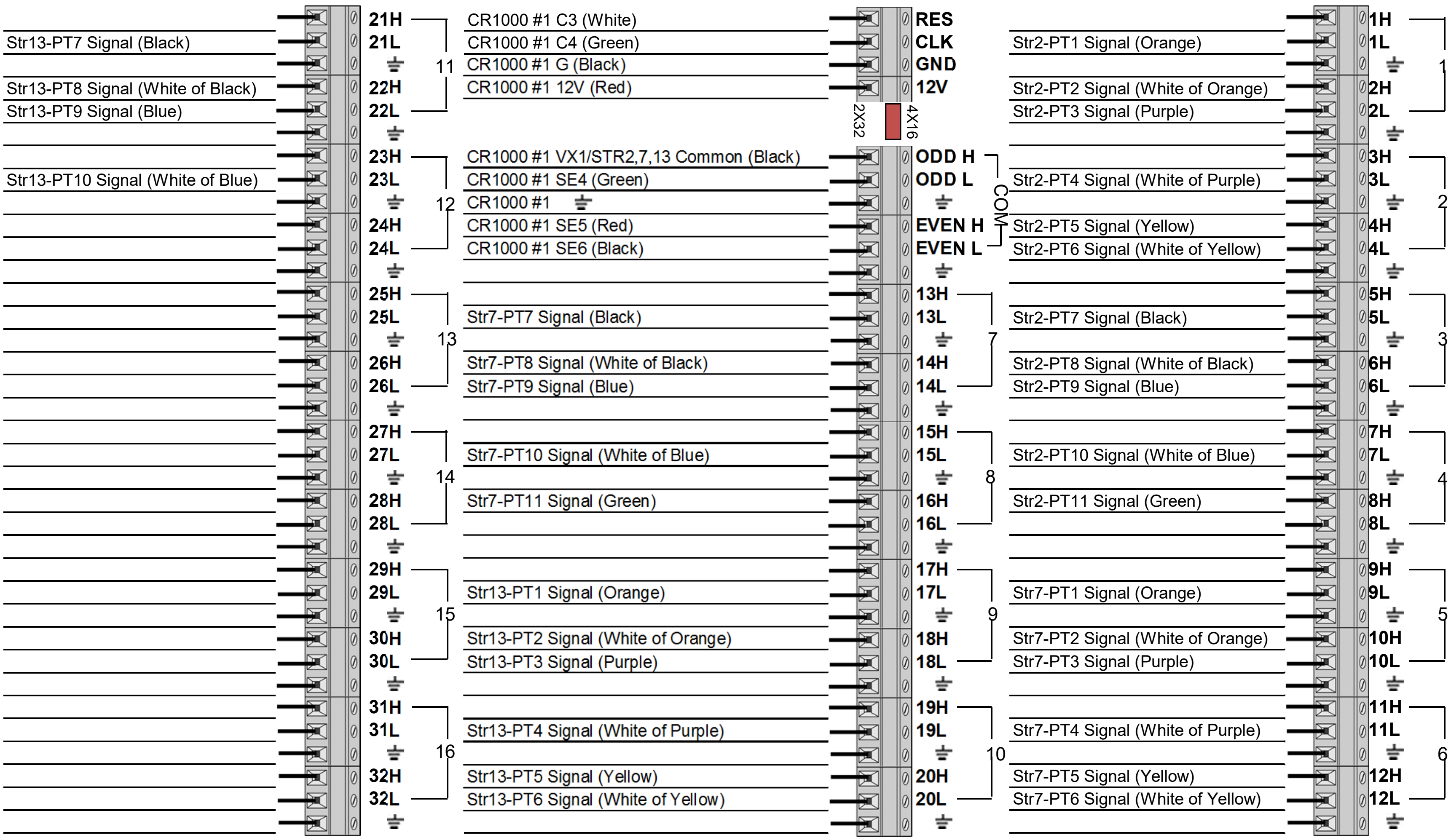
AM16/32B#6 COM L(ODD) - RES to ⏚	1H (SE1)
AM16/32B#6 COM H(EVEN) - RES to ⏚	1L (SE2)
RES to SE1, SE2, SE3	⏚
AM16/32B#6 COM L(EVEN) - RES to ⏚	2H (SE3)
AM16/32B#7 COM L(ODD) - RES to ⏚	2L (SE4)
RES to SE4, SE5, SE6	⏚
AM16/32B#7 COM H(EVEN) - RES to ⏚	3H (SE5)
AM16/32B#7 COM L(EVEN) - RES to ⏚	3L (SE6)
RES to SE7, SE8, SE9	⏚
AM16/32B#8 COM L(ODD) - RES to ⏚	4H (SE7)
AM16/32B#8 COM H(EVEN) - RES to ⏚	4L (SE8)
	⏚
AM16/32B #6, #7 COM H(ODD)	EX1
	⏚
	P1
	⏚
	P2
	⏚

Appendix B2 - Multiplexer Diagrams

AM16/32 WIRING DIAGRAM	NODE A - Multiplexer #1
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.

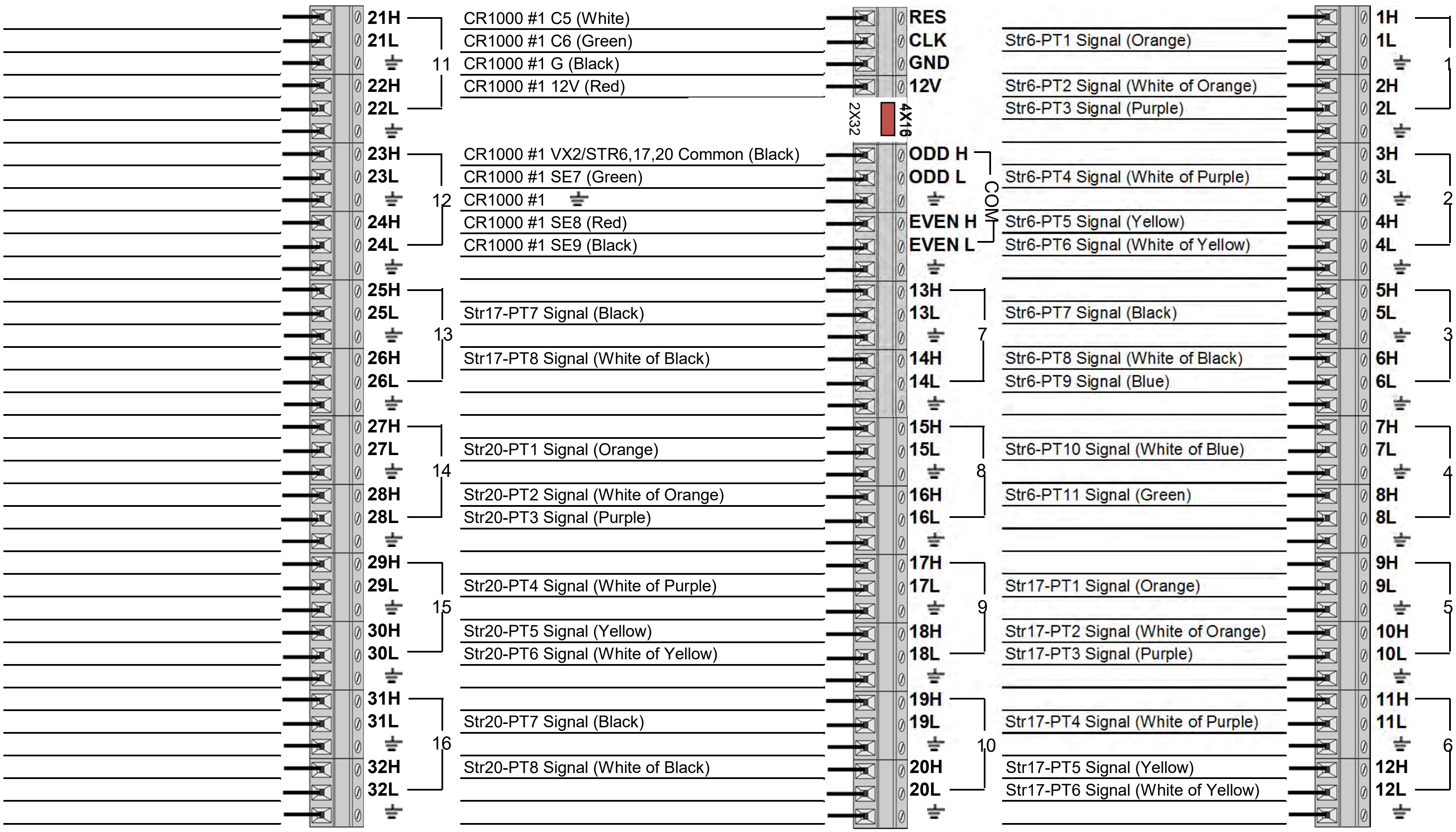


AM16/32 WIRING DIAGRAM	NODE B - Multiplexer #2
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.



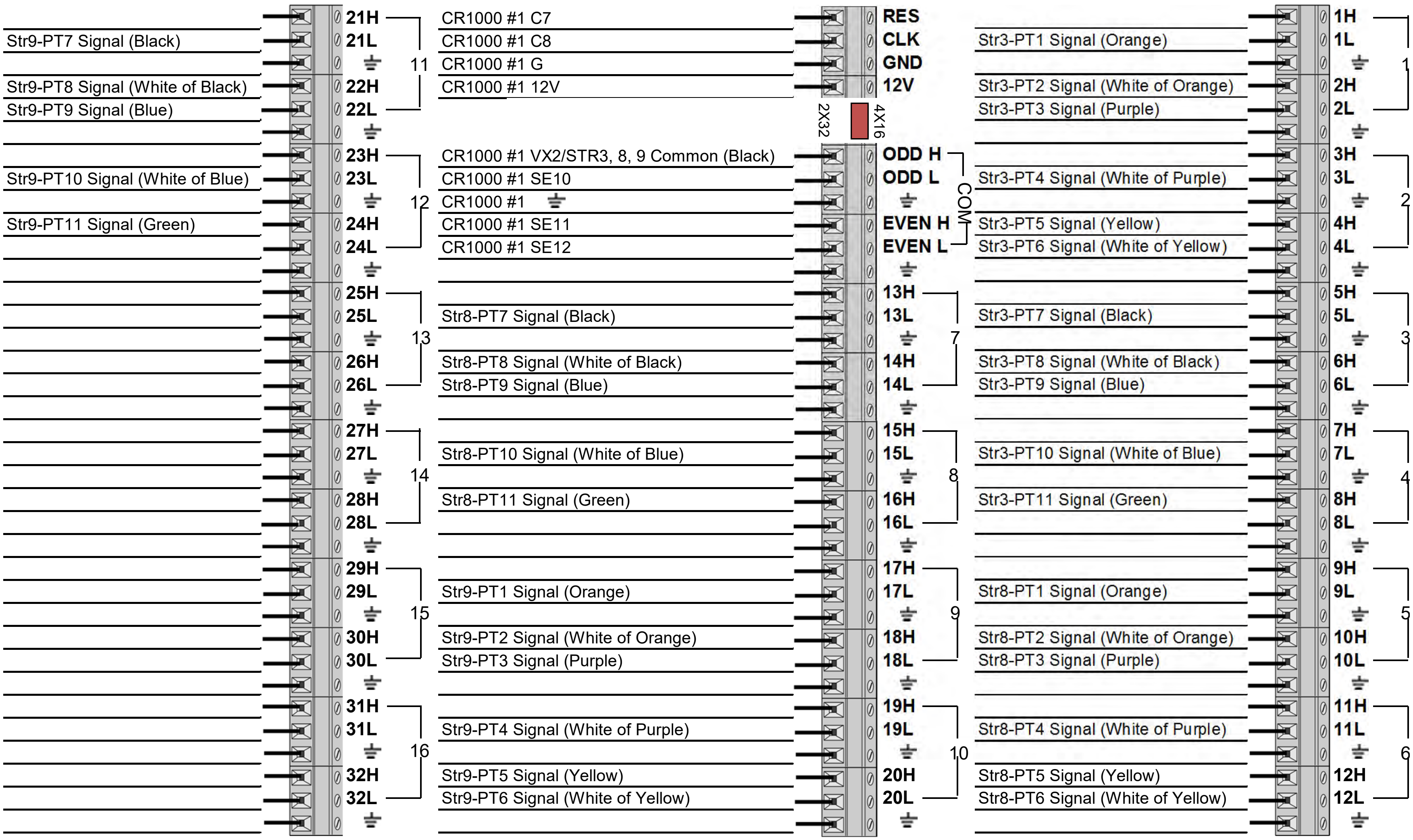
AM16/32 WIRING DIAGRAM NODE B - Multiplexer #3

COMPANY: Nuna Contracting / SRK Consulting
PROJECT: Hope Bay Dam project
documented by: Mike Ryder - Campbell Scientific Canada Corp.



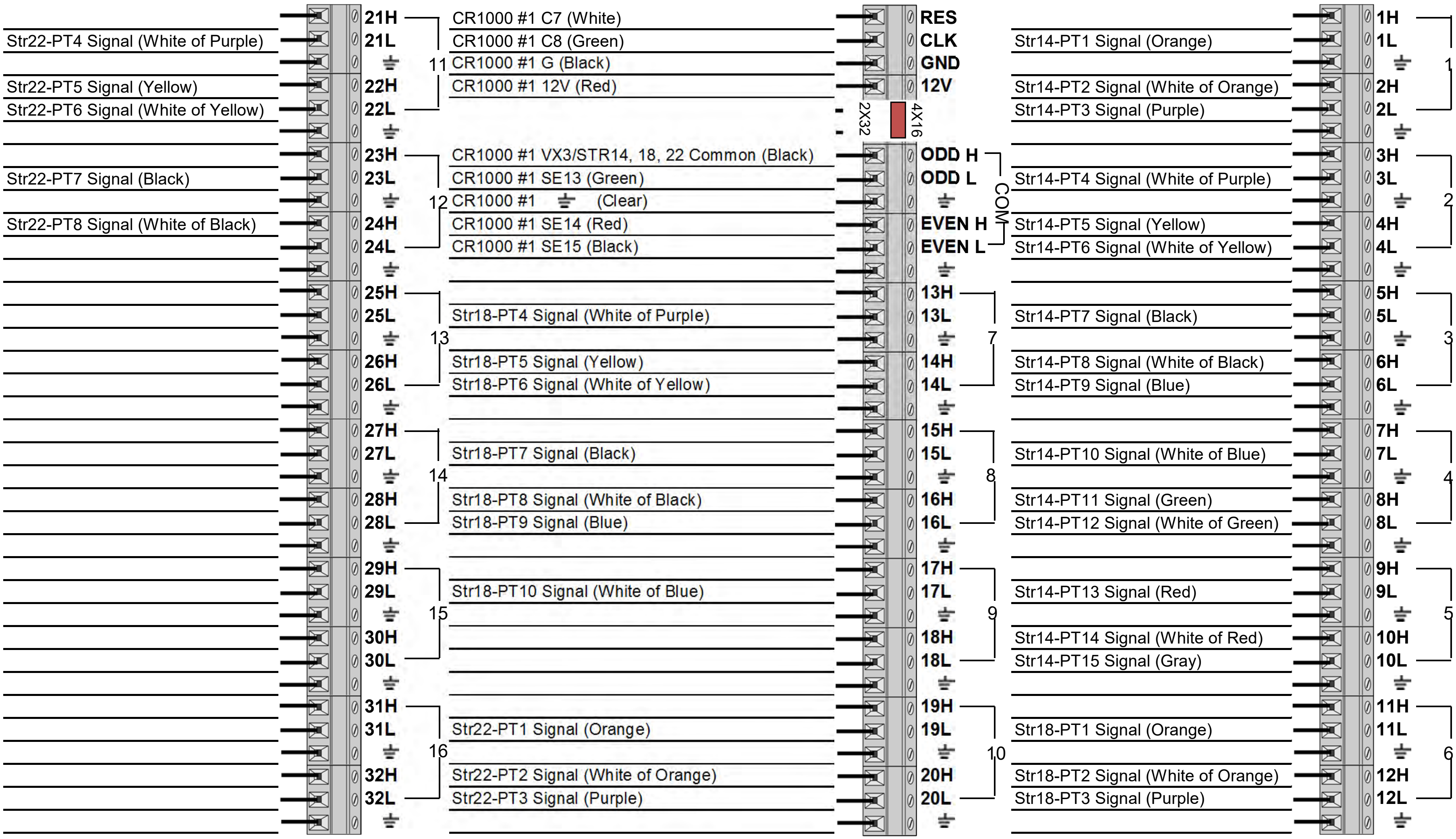
AM16/32 WIRING DIAGRAM NODE C - Multiplexer #4

COMPANY: Nuna Contracting / SRK Consulting
PROJECT: Hope Bay Dam project
documented by: Mike Ryder - Campbell Scientific Canada Corp.



AM16/32 WIRING DIAGRAM NODE C - Multiplexer #5

COMPANY: Nuna Contracting / SRK Consulting
PROJECT: Hope Bay Dam project
documented by: Mike Ryder - Campbell Scientific Canada Corp.



AM16/32 WIRING DIAGRAM	NODE D - Multiplexer #6
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.

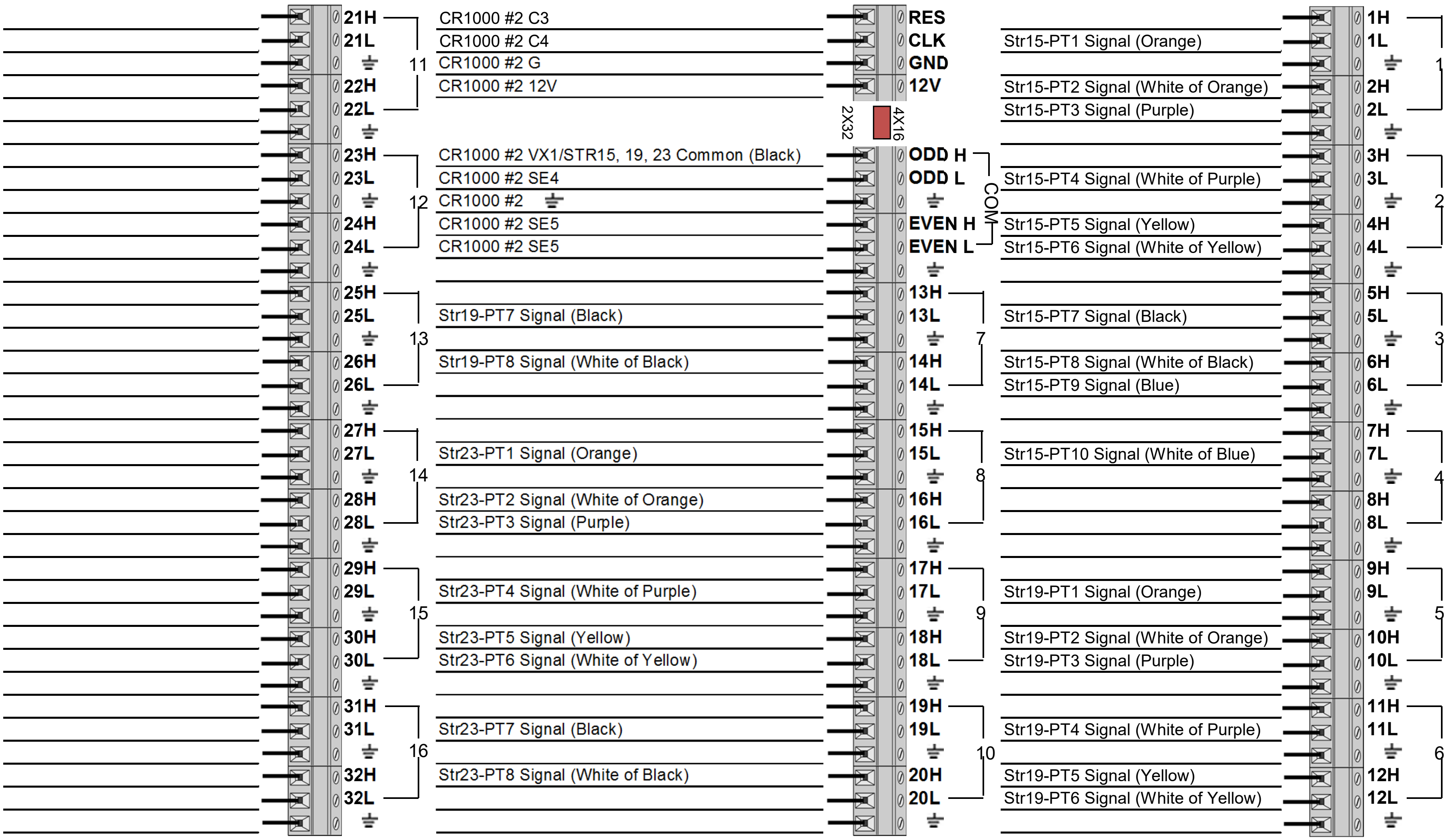
Terminal	Connection
RES	CR1000 #2 C1
CLK	CR1000 #2 C2
GND	CR1000 #2 G
12V	CR1000 #2 12V
ODD H (COM)	CR1000 #2 VX1/STR4, 10, 11 Common (Black)
ODD L (COM)	CR1000 #2 SE1
⏚ (COM)	CR1000 #2 ⏚
EVEN H (COM)	CR1000 #2 SE2
EVEN L (COM)	CR1000 #2 SE3

Switch: 2X32 / 4X16

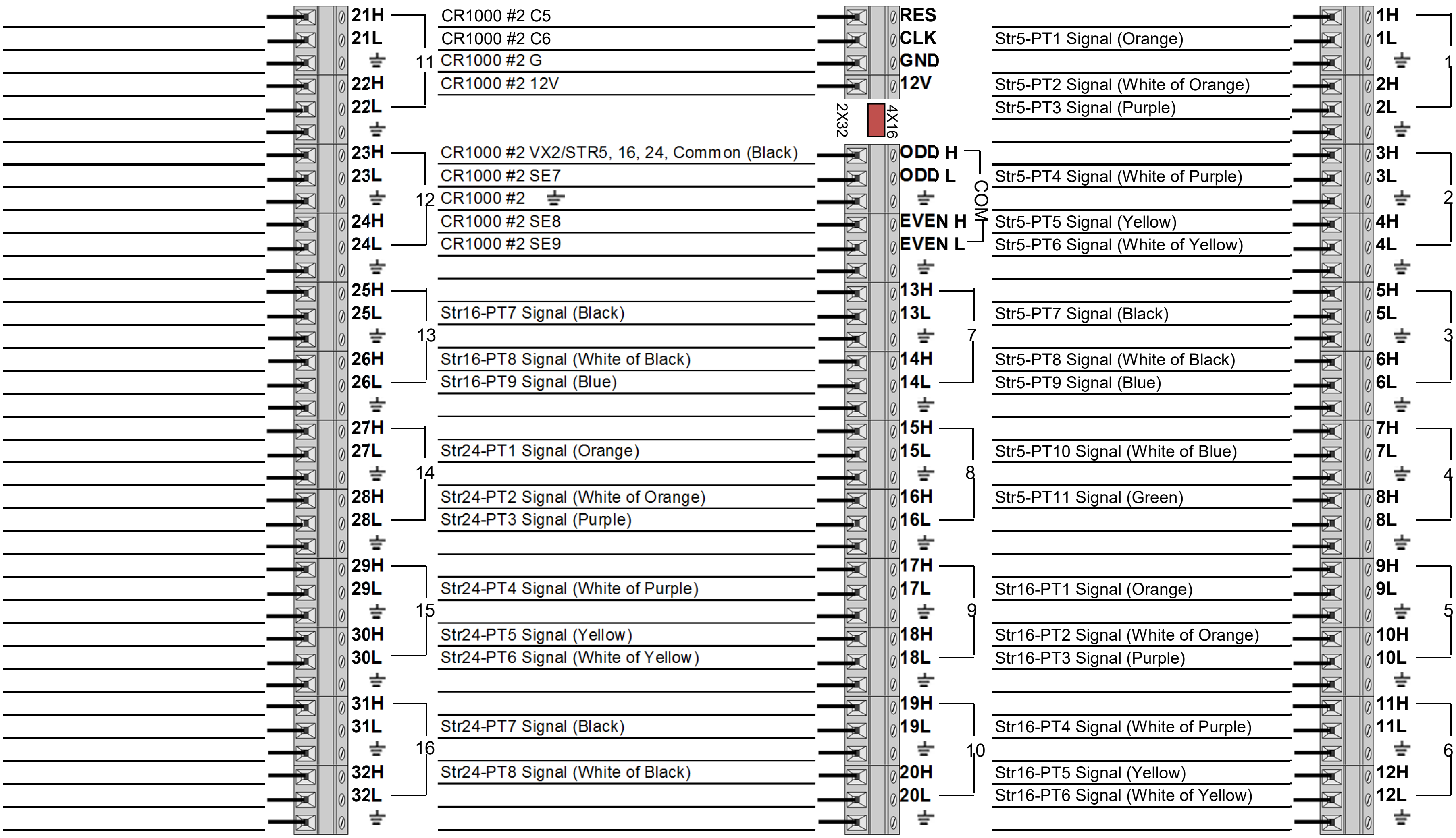
Channel	Terminal	Connection
1	1H	
1	1L	Str4-PT1 Signal (Orange)
1	2H	Str4-PT2 Signal (White of Orange)
1	2L	Str4-PT3 Signal (Purple)
2	3H	
2	3L	Str4-PT4 Signal (White of Purple)
2	4H	Str4-PT5 Signal (Yellow)
2	4L	Str4-PT6 Signal (White of Yellow)
3	5H	
3	5L	Str4-PT7 Signal (Black)
3	6H	Str4-PT8 Signal (White of Black)
3	6L	Str4-PT9 Signal (Blue)
4	7H	
4	7L	Str4-PT10 Signal (White of Blue)
4	8H	Str4-PT11 Signal (Green)
4	8L	
5	9H	
5	9L	Str10-PT1 Signal (Orange)
5	10H	Str10-PT2 Signal (White of Orange)
5	10L	Str10-PT3 Signal (Purple)
6	11H	
6	11L	Str10-PT4 Signal (White of Purple)
6	12H	Str10-PT5 Signal (Yellow)
6	12L	Str10-PT6 Signal (White of Yellow)
7	13H	
7	13L	Str10-PT7 Signal (Black)
7	14H	Str10-PT8 Signal (White of Black)
7	14L	Str10-PT9 Signal (Blue)
8	15H	
8	15L	Str10-PT10 Signal (White of Blue)
8	16H	Str10-PT11 Signal (Green)
8	16L	
9	17H	
9	17L	Str11-PT1 Signal (Orange)
9	18H	Str11-PT2 Signal (White of Orange)
9	18L	Str11-PT3 Signal (Purple)
10	19H	
10	19L	Str11-PT4 Signal (White of Purple)
10	20H	Str11-PT5 Signal (Yellow)
10	20L	Str11-PT6 Signal (White of Yellow)
11	21H	
11	21L	Str11-PT7 Signal (Black)
11	22H	Str11-PT8 Signal (White of Black)
11	22L	Str11-PT9 Signal (Blue)
12	23H	
12	23L	Str11-PT10 Signal (White of Blue)
12	24H	Str11-PT11 Signal (Green)
12	24L	
13	25H	
13	25L	
13	26H	
13	26L	
14	27H	
14	27L	
14	28H	
14	28L	
15	29H	
15	29L	
15	30H	
15	30L	
16	31H	
16	31L	
16	32H	
16	32L	

AM16/32 WIRING DIAGRAM NODE D - Multiplexer #7

COMPANY: Nuna Contracting / SRK Consulting
PROJECT: Hope Bay Dam project
documented by: Mike Ryder - Campbell Scientific Canada Corp.

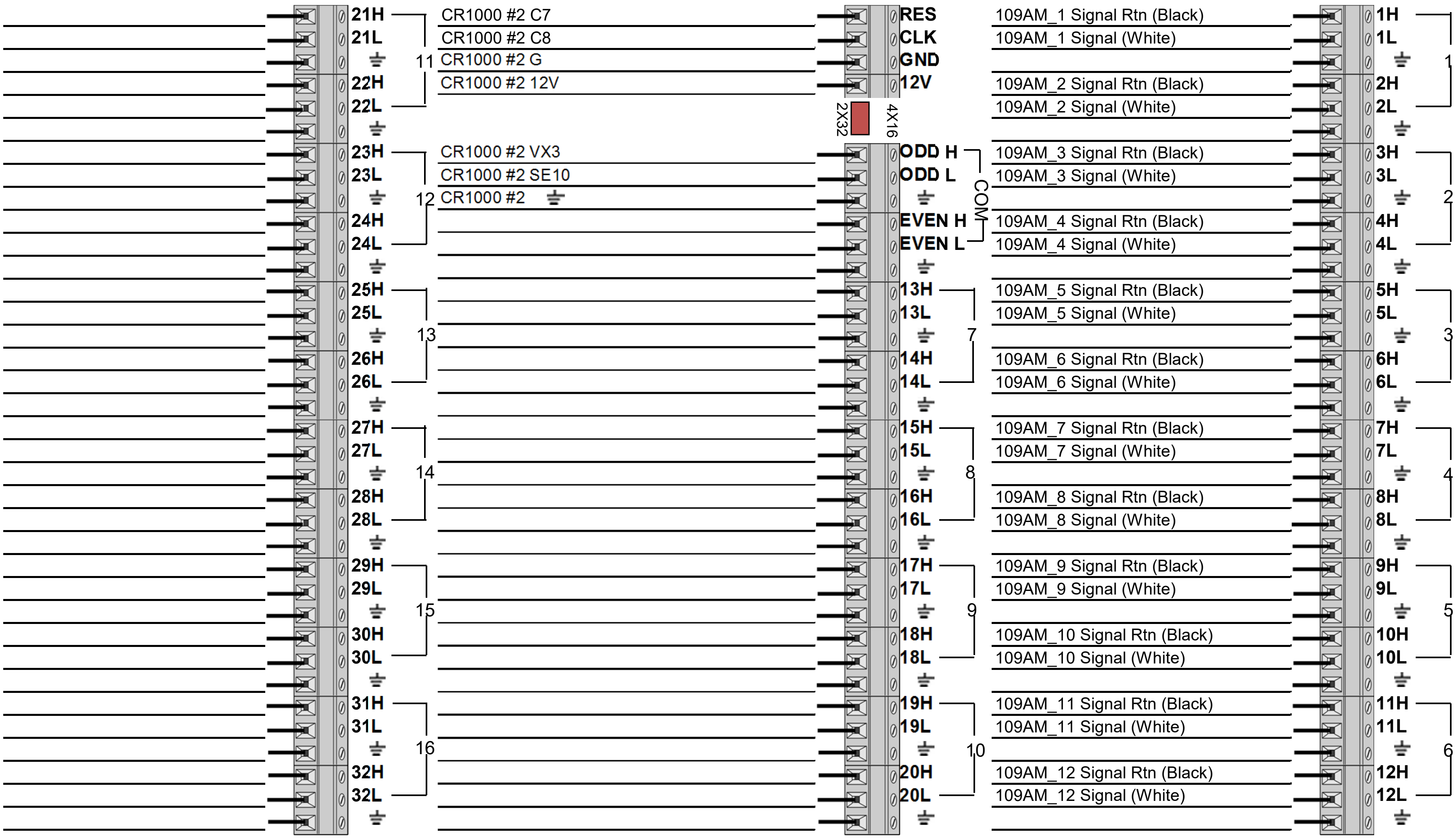


AM16/32 WIRING DIAGRAM	NODE E - Multiplexer #8
COMPANY:	Nuna Contracting / SRK Consulting
PROJECT:	Hope Bay Dam project
documented by:	Mike Ryder - Campbell Scientific Canada Corp.

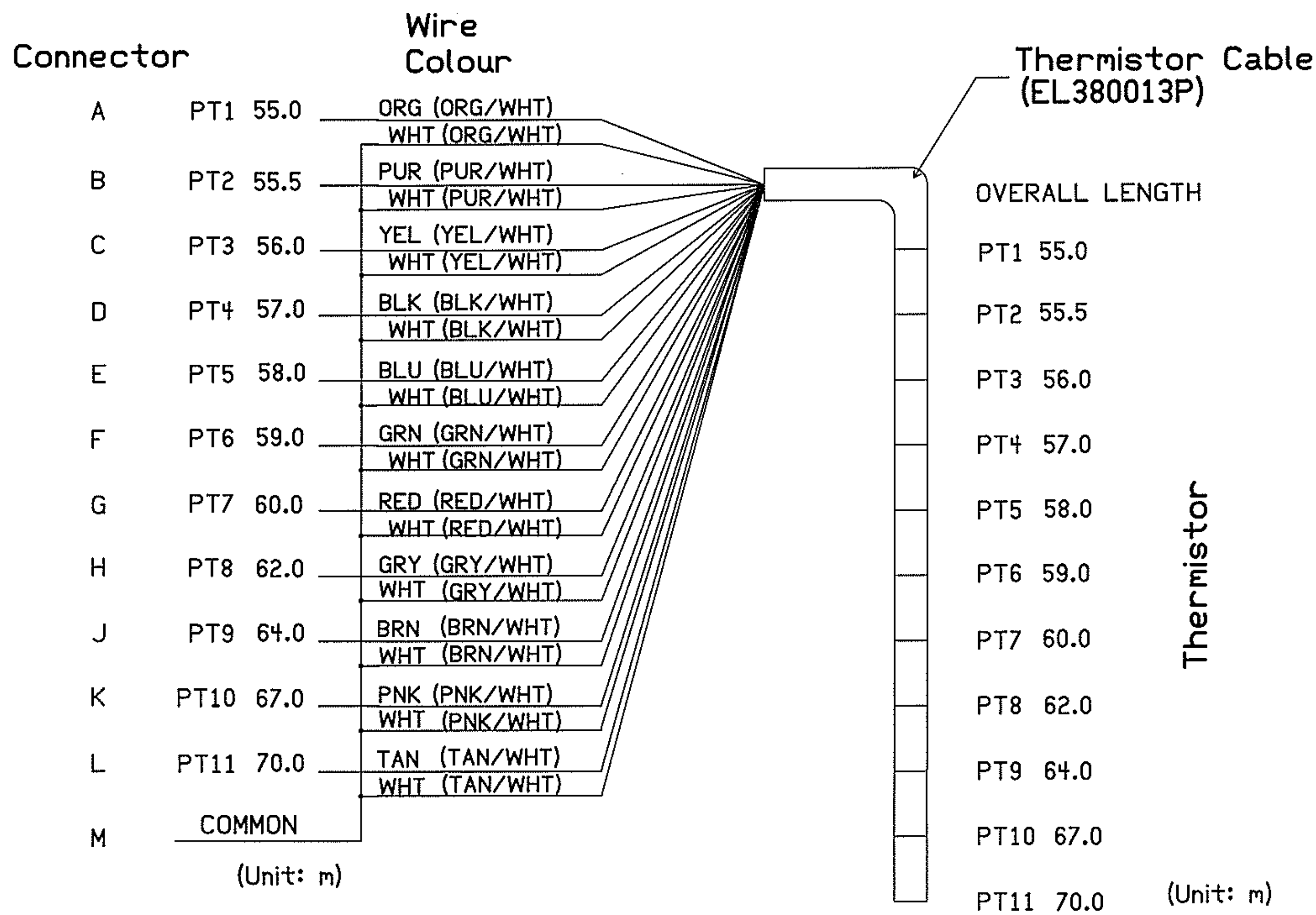


AM16/32 WIRING DIAGRAM NODE E - Multiplexer # 9

COMPANY: Nuna Contracting / SRK Consulting
PROJECT: Hope Bay Dam project
documented by: Mike Ryder - Campbell Scientific Canada Corp.



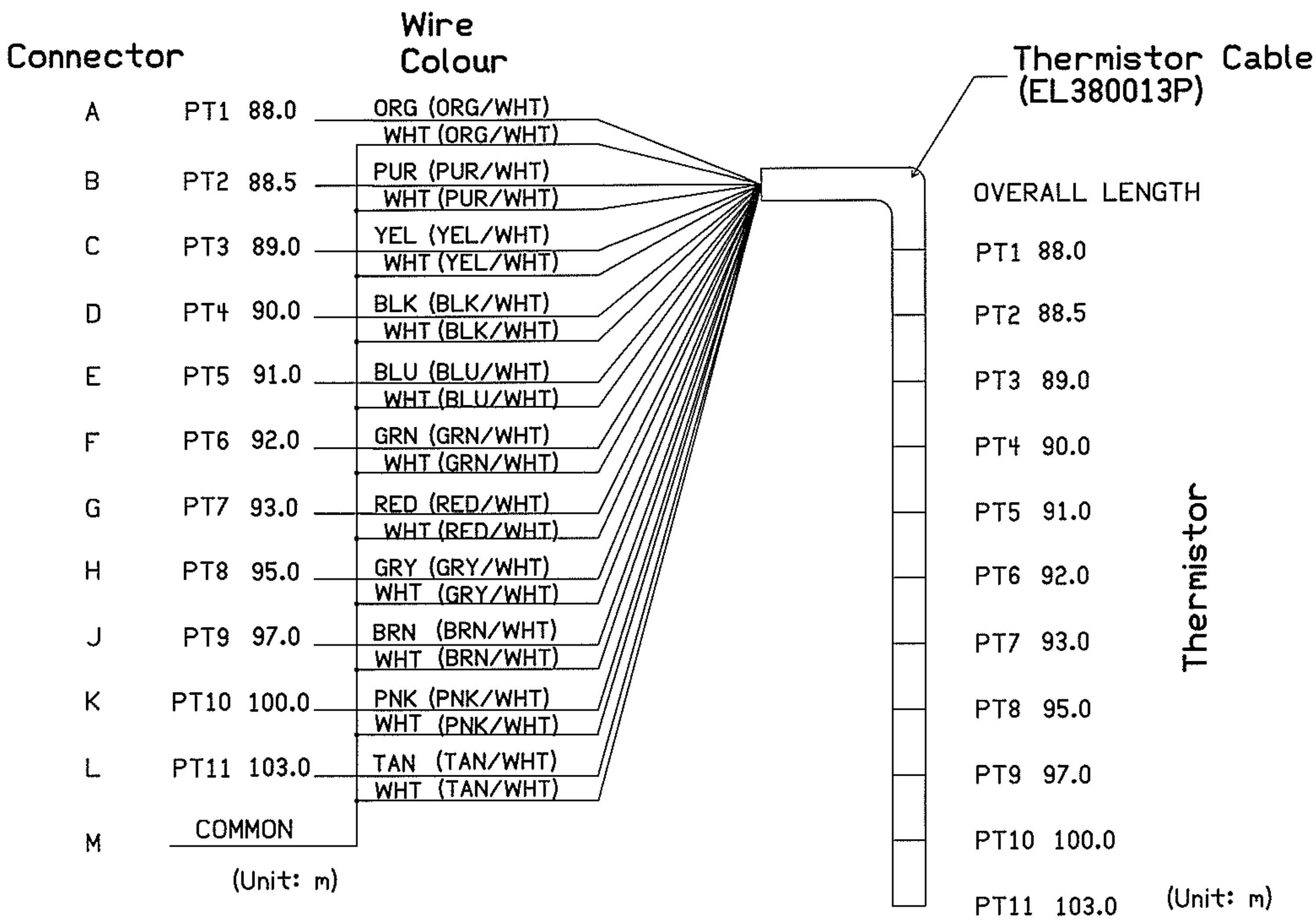
Appendix B3 - Thermistor Cable Diagrams



S/N: TS3080

ID: ND-VTS-040-KT

Co:	RST INSTRUMENTS LTD	
Title:	THERMISTOR CABLE	
J/N:	WOQ018560-1	Revision: A
Author:	CB	Size: A
Date:	2010/10/12	Sheet 1 of 1



S/N: TS3081

ID: ND-VTS-060-KT

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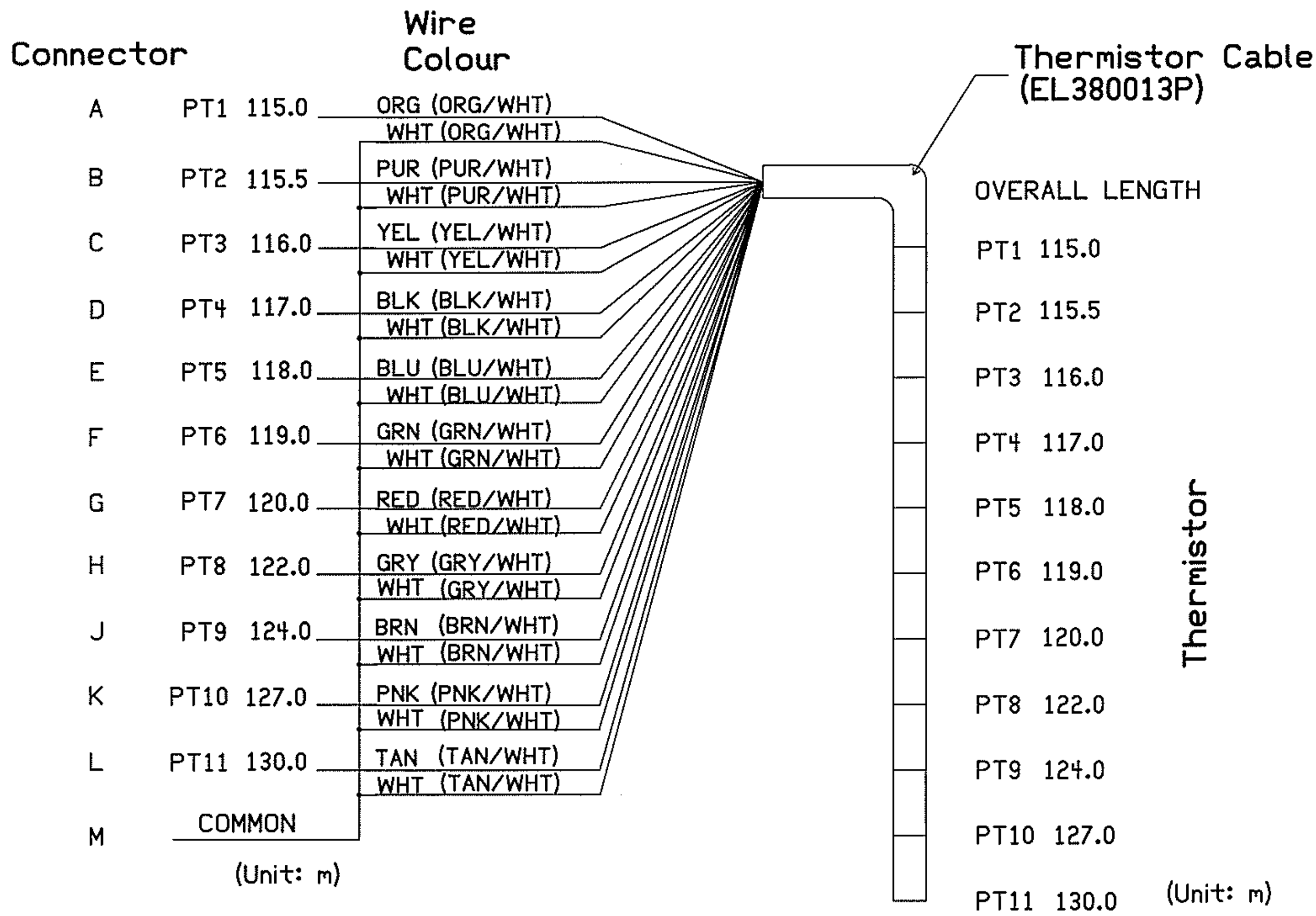
J/N:	WOQ018560-2 Revision: A
Author:	CB Size: A
Date:	2010/10/12 Sheet 1 of 1



S/N: TS3082

ID: ND-VTS-085-KT

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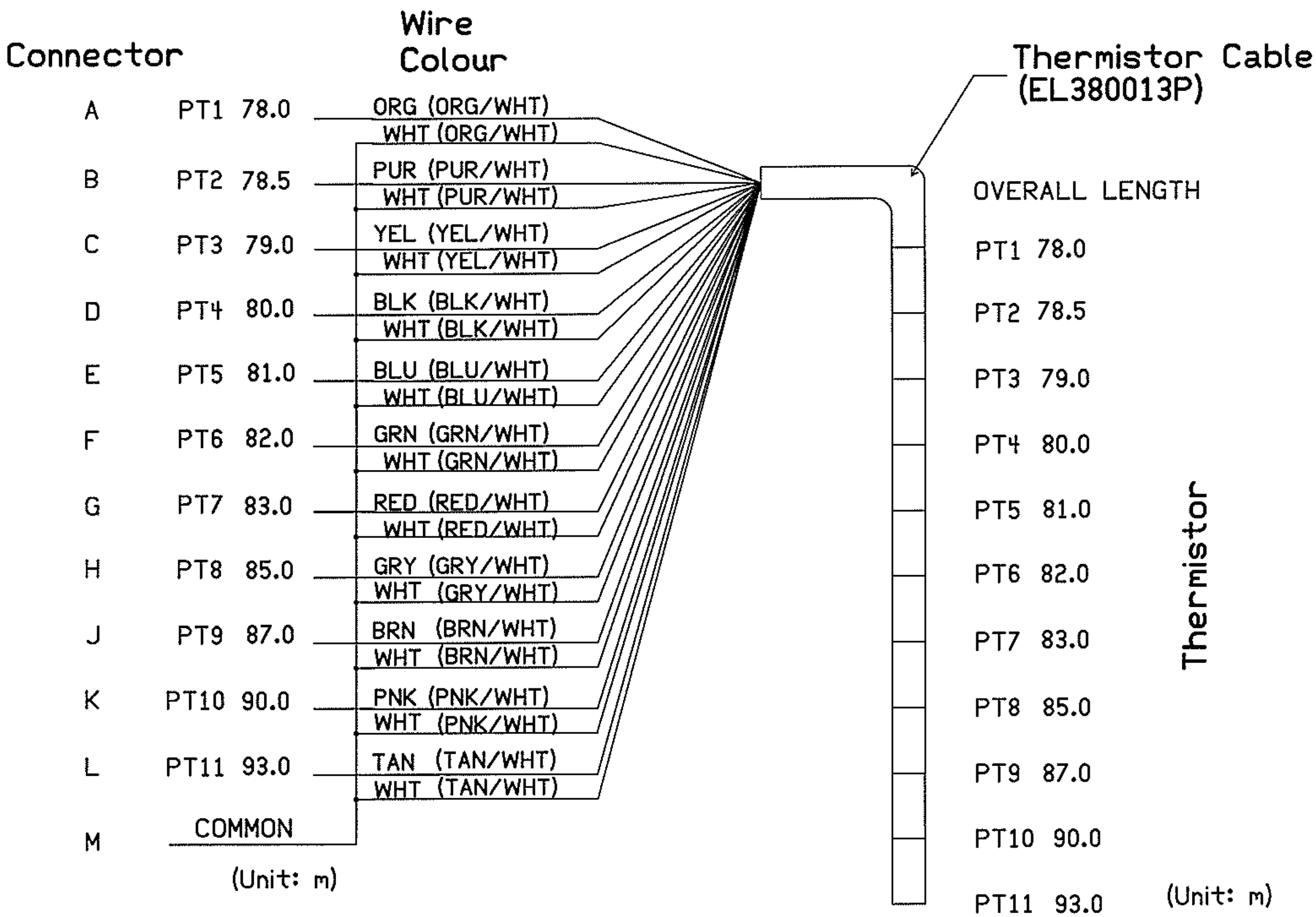
Title:	THERMISTOR CABLE
J/N:	WOQ018560-3 — Revision: A
Author:	CB — Size: A
Date:	2010/10/12 — Sheet 1 of 1



S/N: TS3083

ID: ND-VTS-130-KT

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Author:	CB	Size:	A
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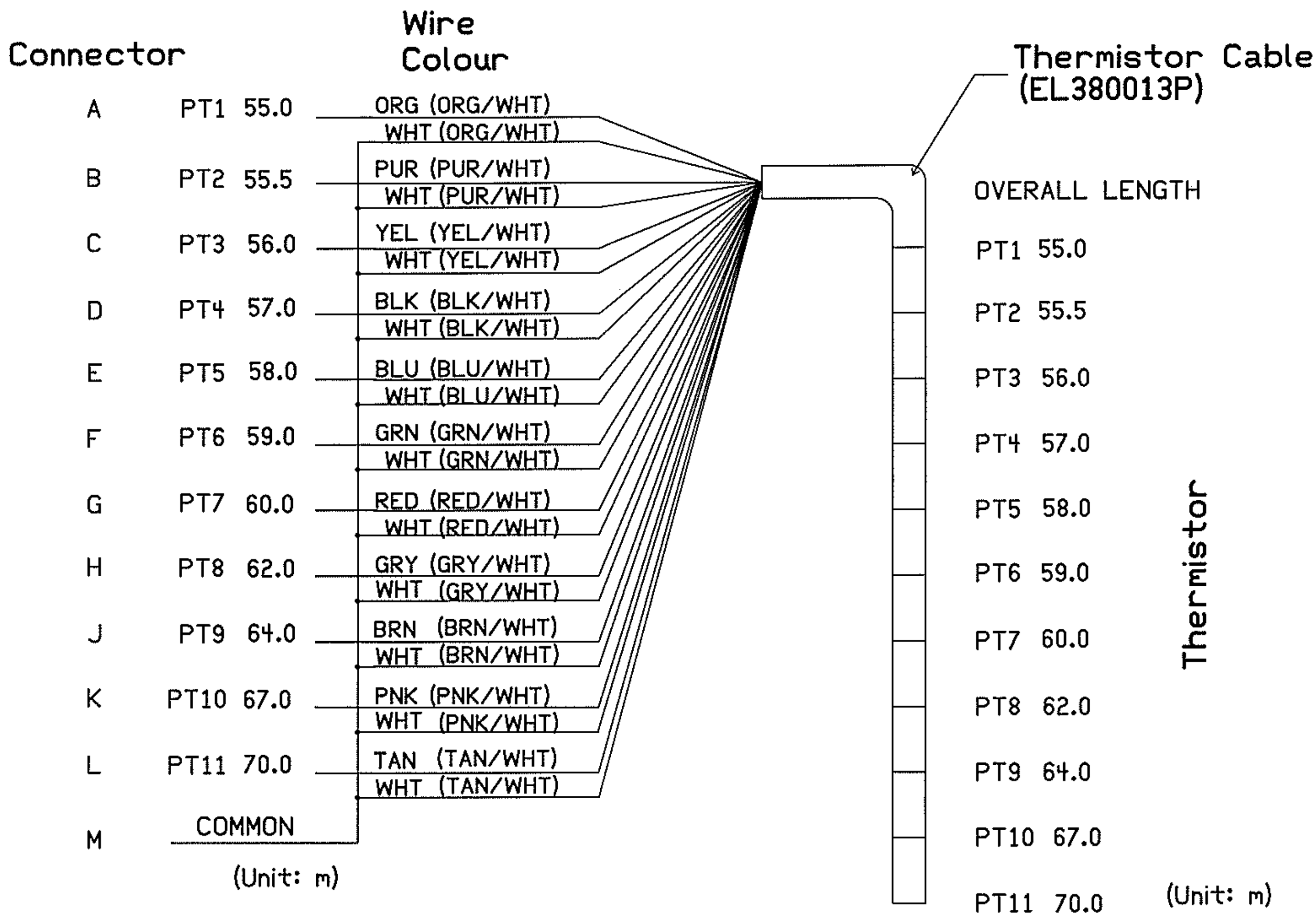

S/N: TS3084

ID: ND-VTS-175-KT

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Author:	CB	Size:	A
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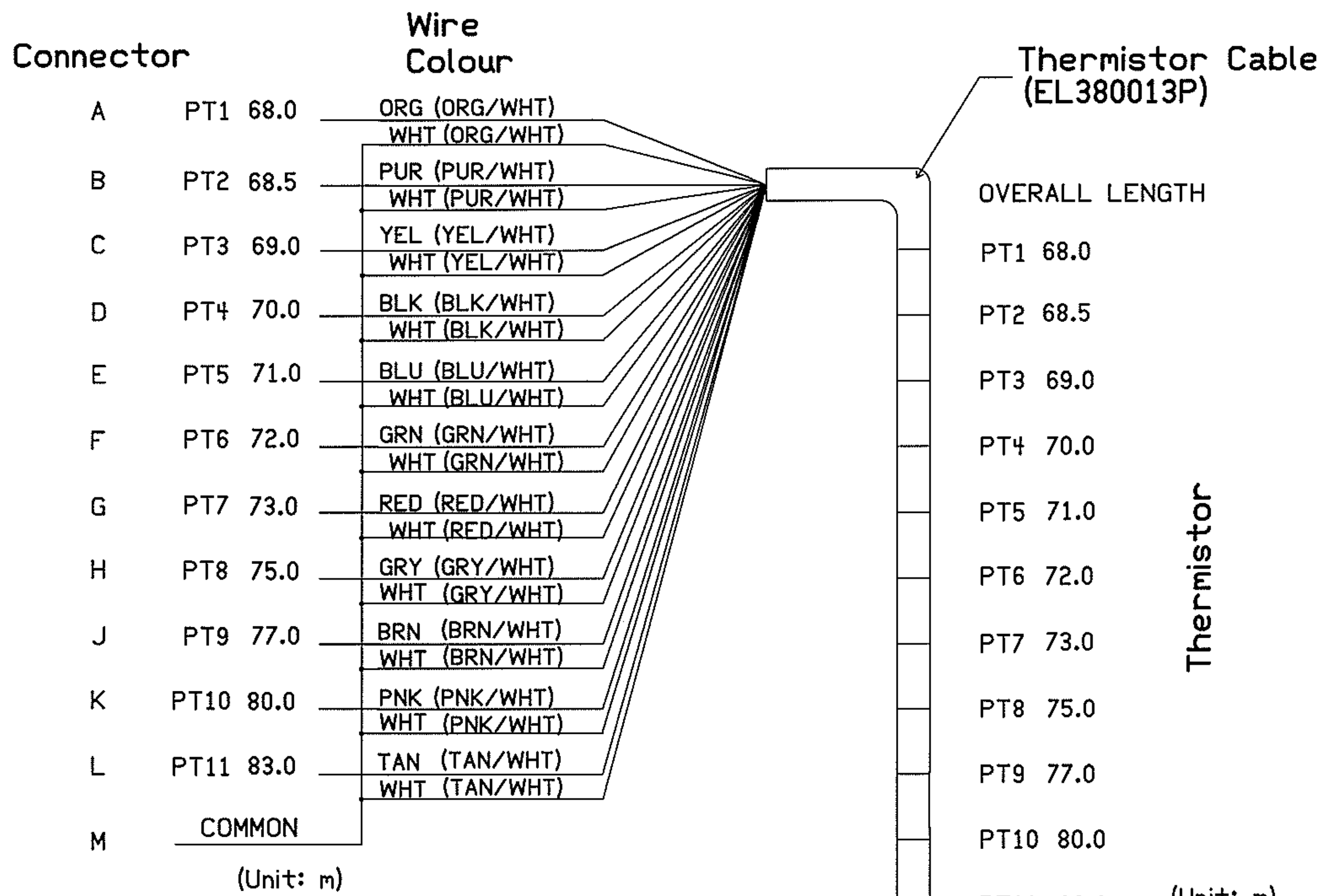

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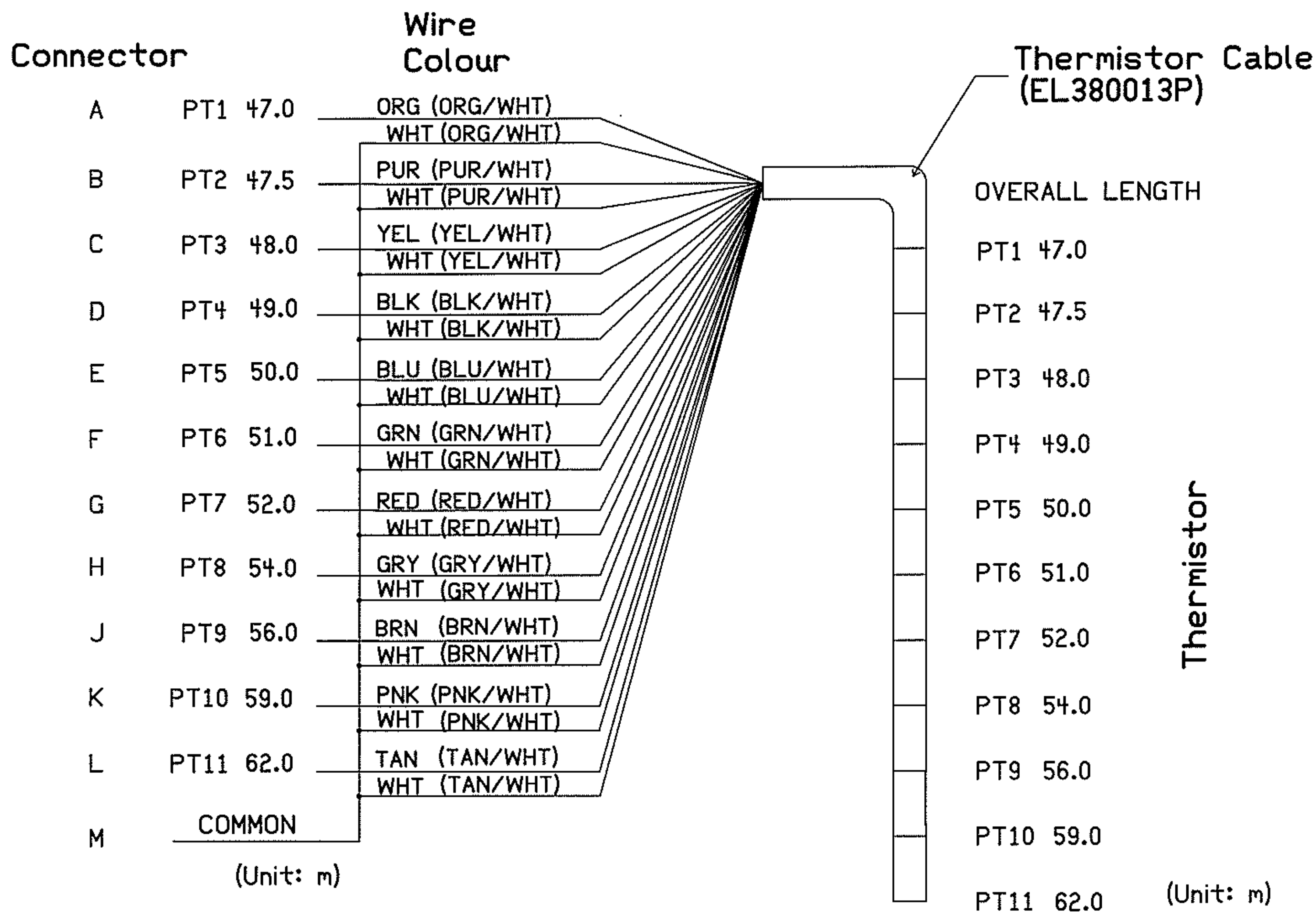
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3086

ID: ND-VTS-060-DS

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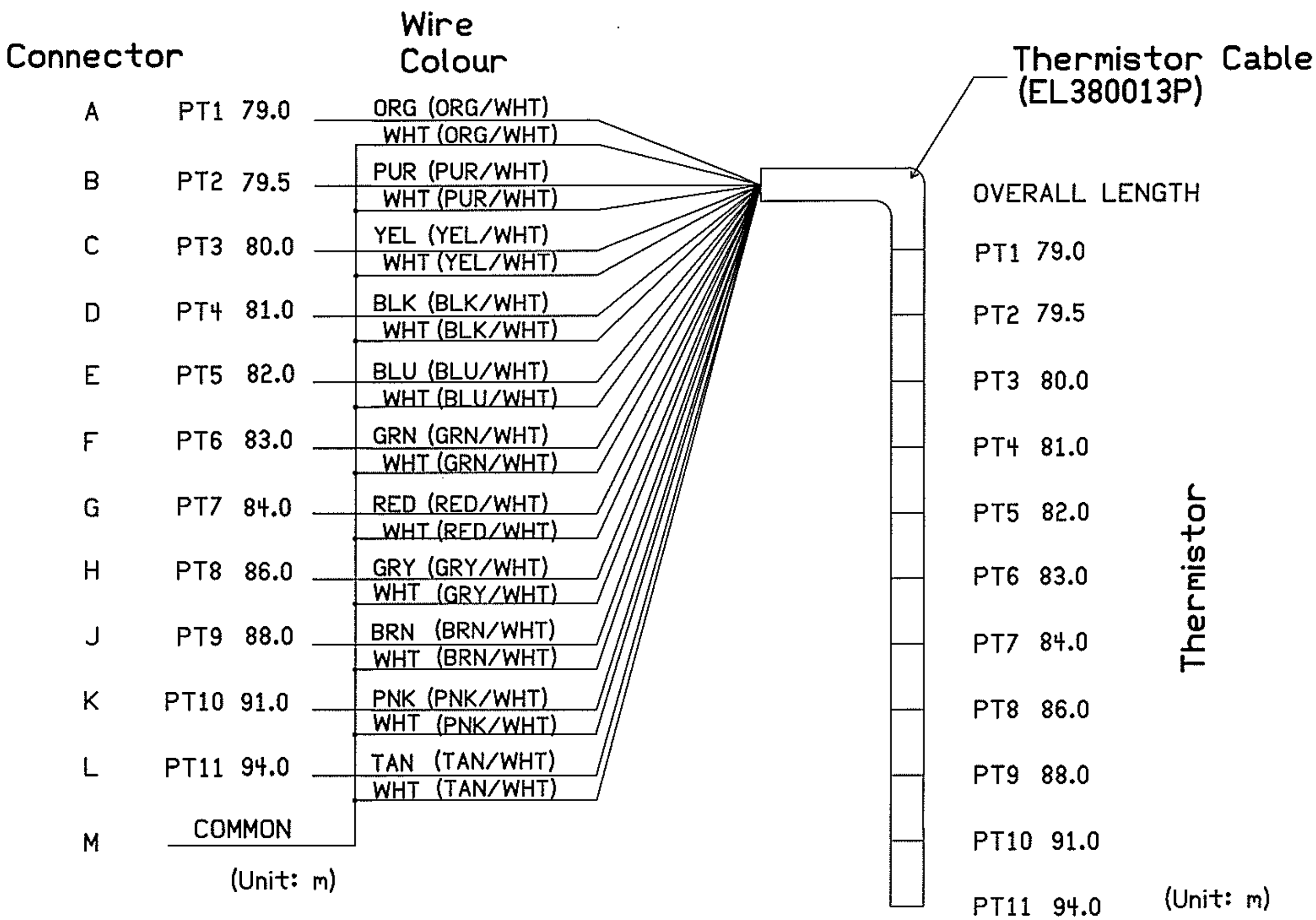
J/N:	WOQ018560-7	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3087

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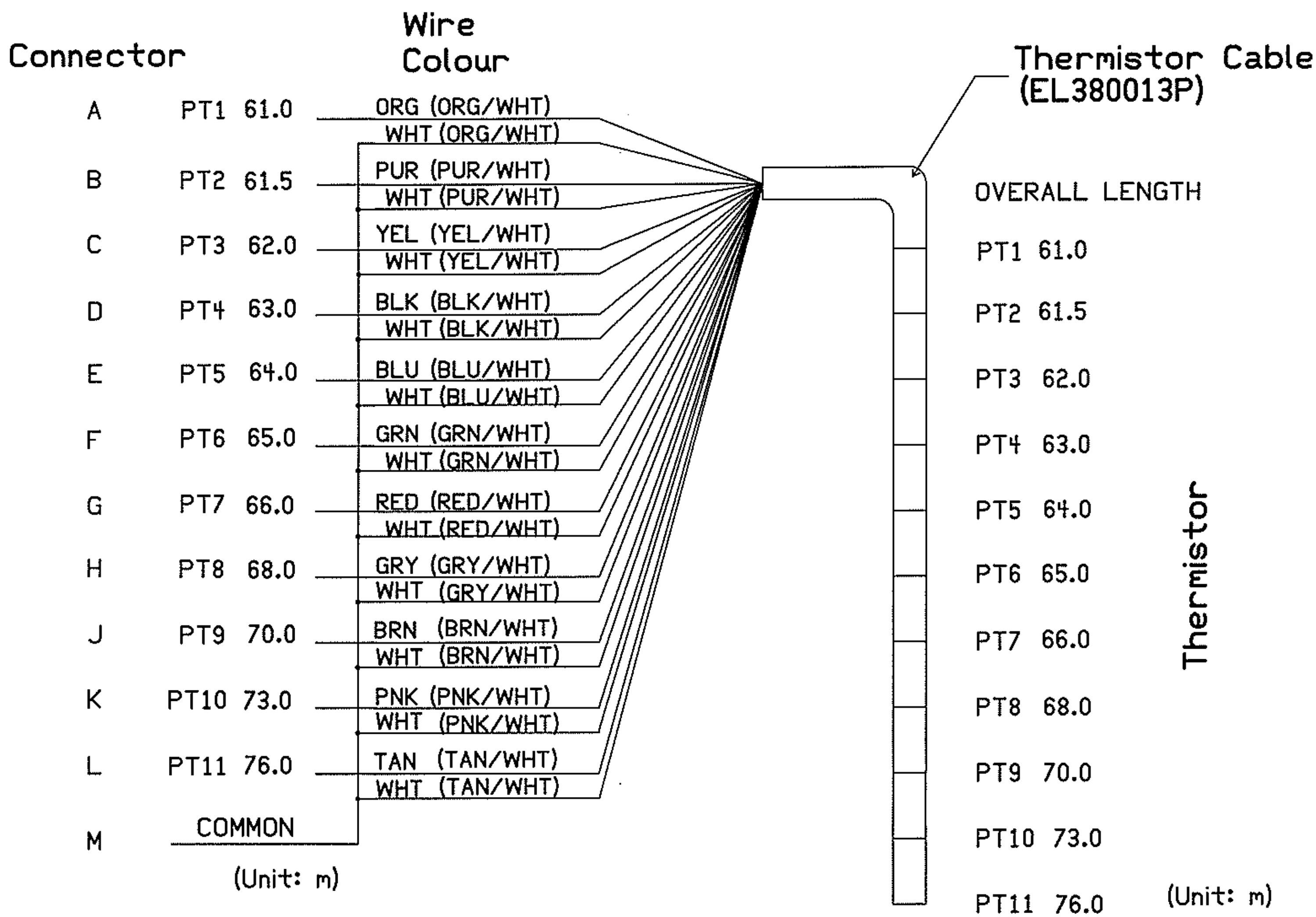
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3088

ID: ND-VTS-085-DS

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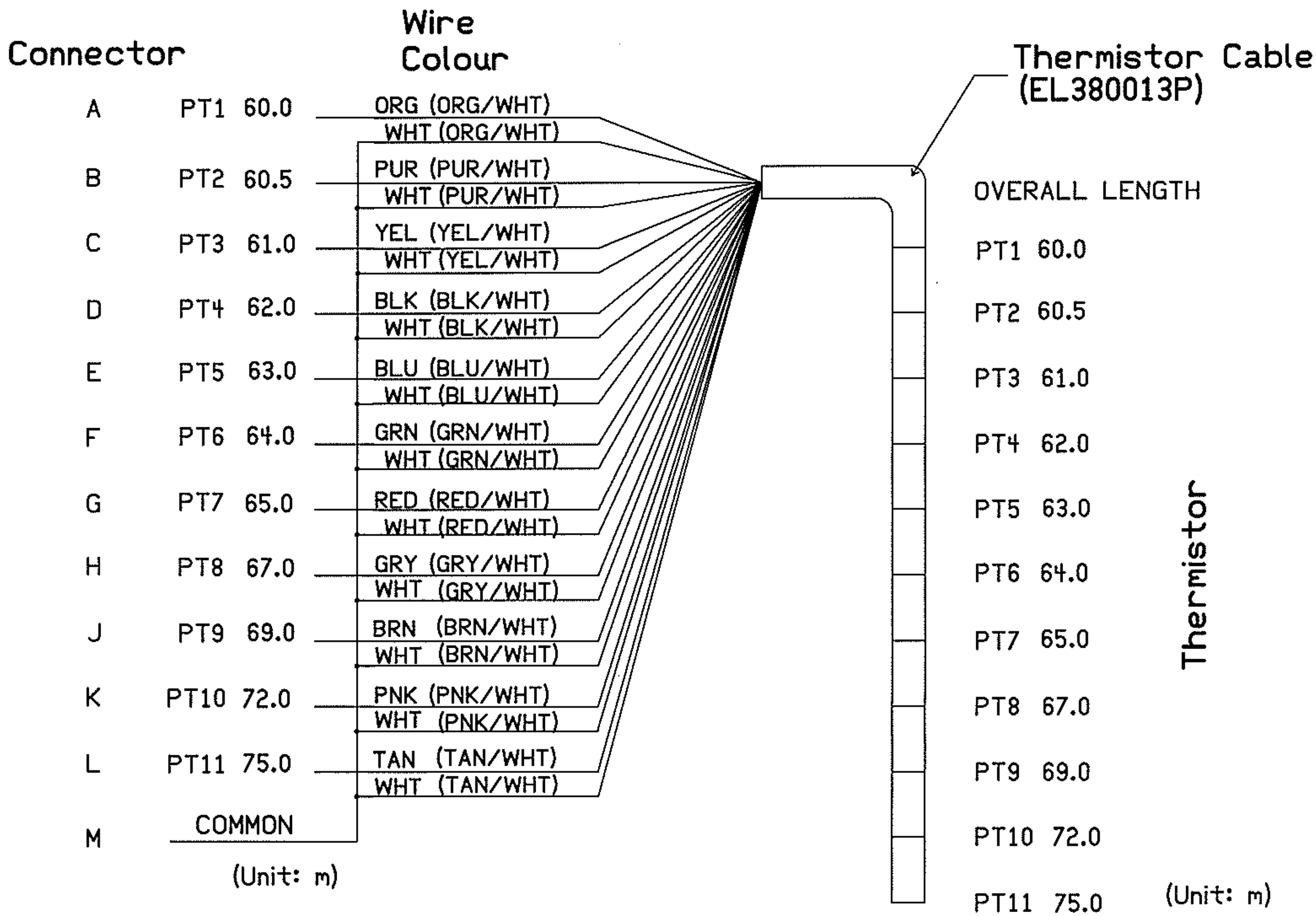
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



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ID: ND-VTS-130-US

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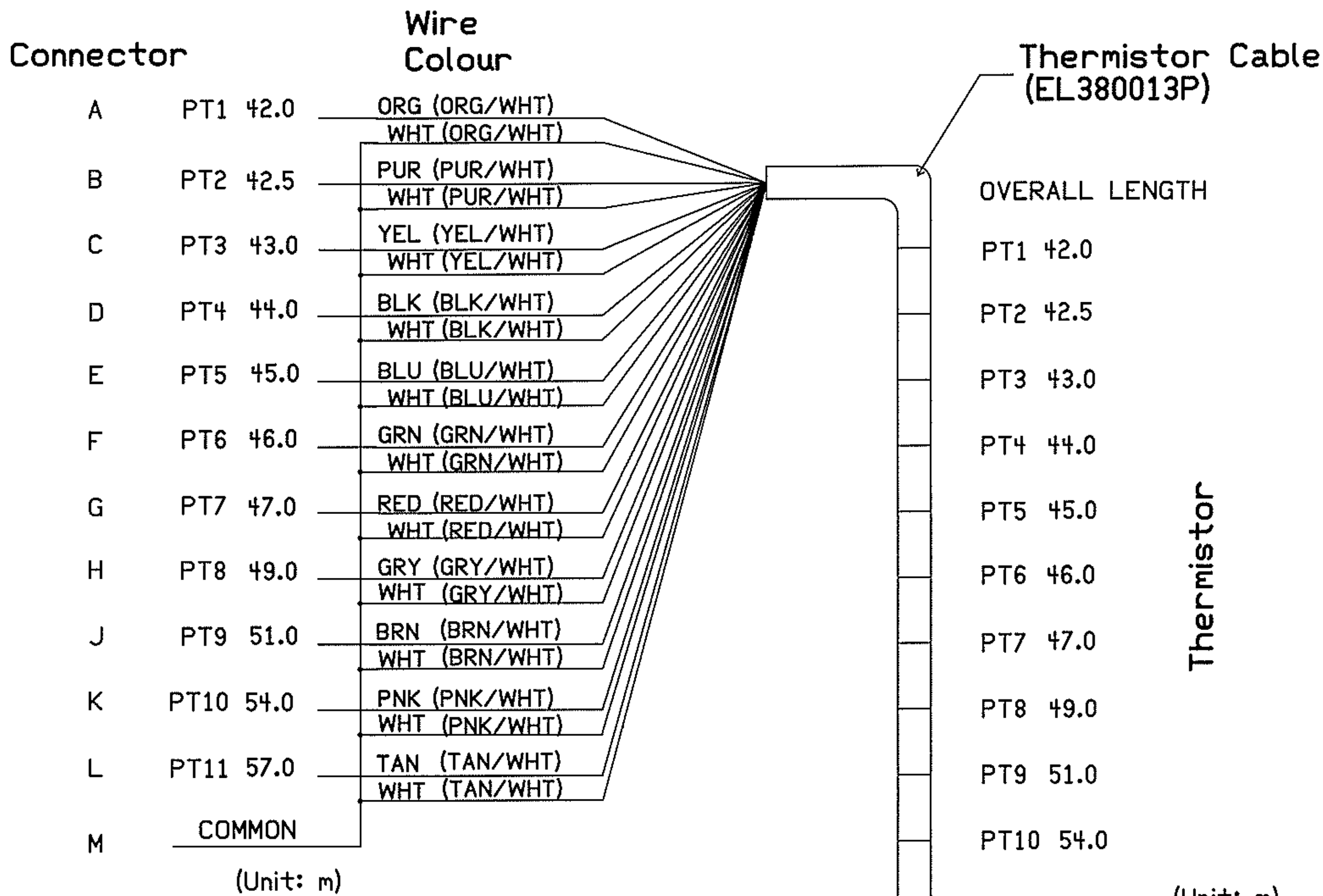
J/N:	WOQ018560-10	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3090

ID: ND-VTS-130-DS

Co:	RST INSTRUMENTS LTD		
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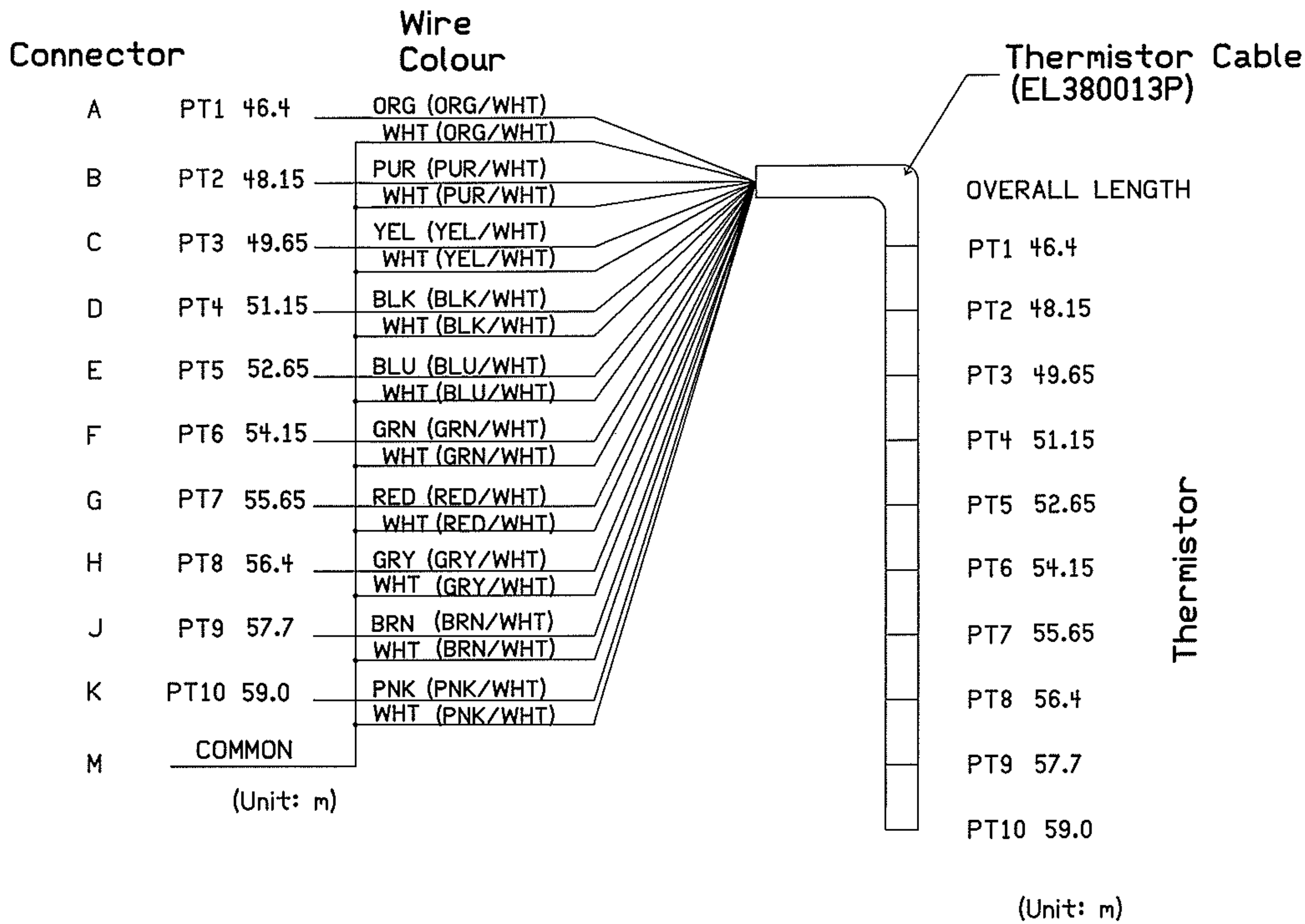
J/N:	WOQ018560-11	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet 1 of 1	



S/N: TS3091

ID: ND-HTS-040-31.5

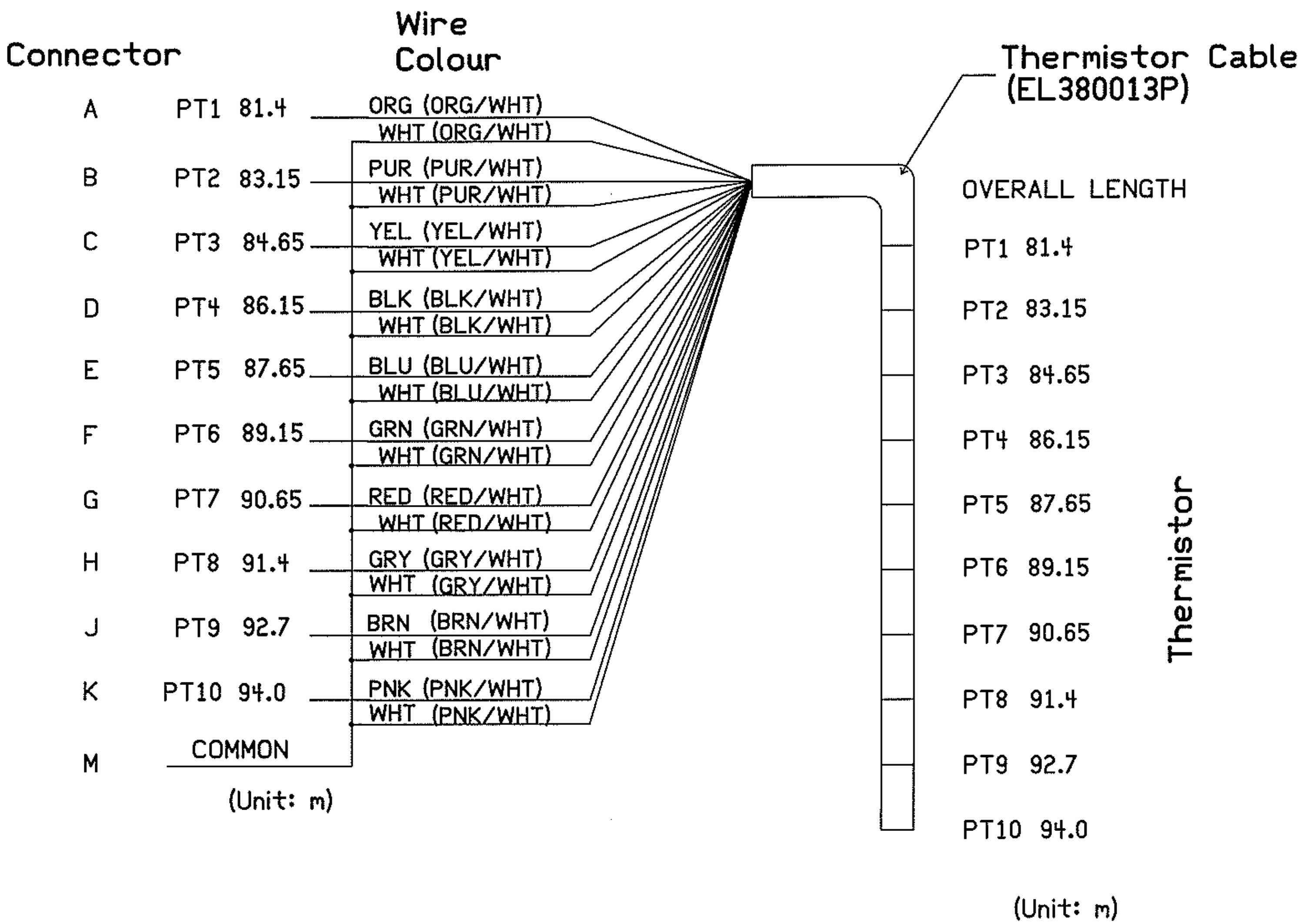
Co: RST INSTRUMENTS LTD

Title: THERMISTOR CABLE

J/N: WOQ018560-12 Revision: A

Author: CB Size: A

Date: 2010/10/12 Sheet 1 of 1



S/N: TS3092

ID: ND-HTS-060-28.8

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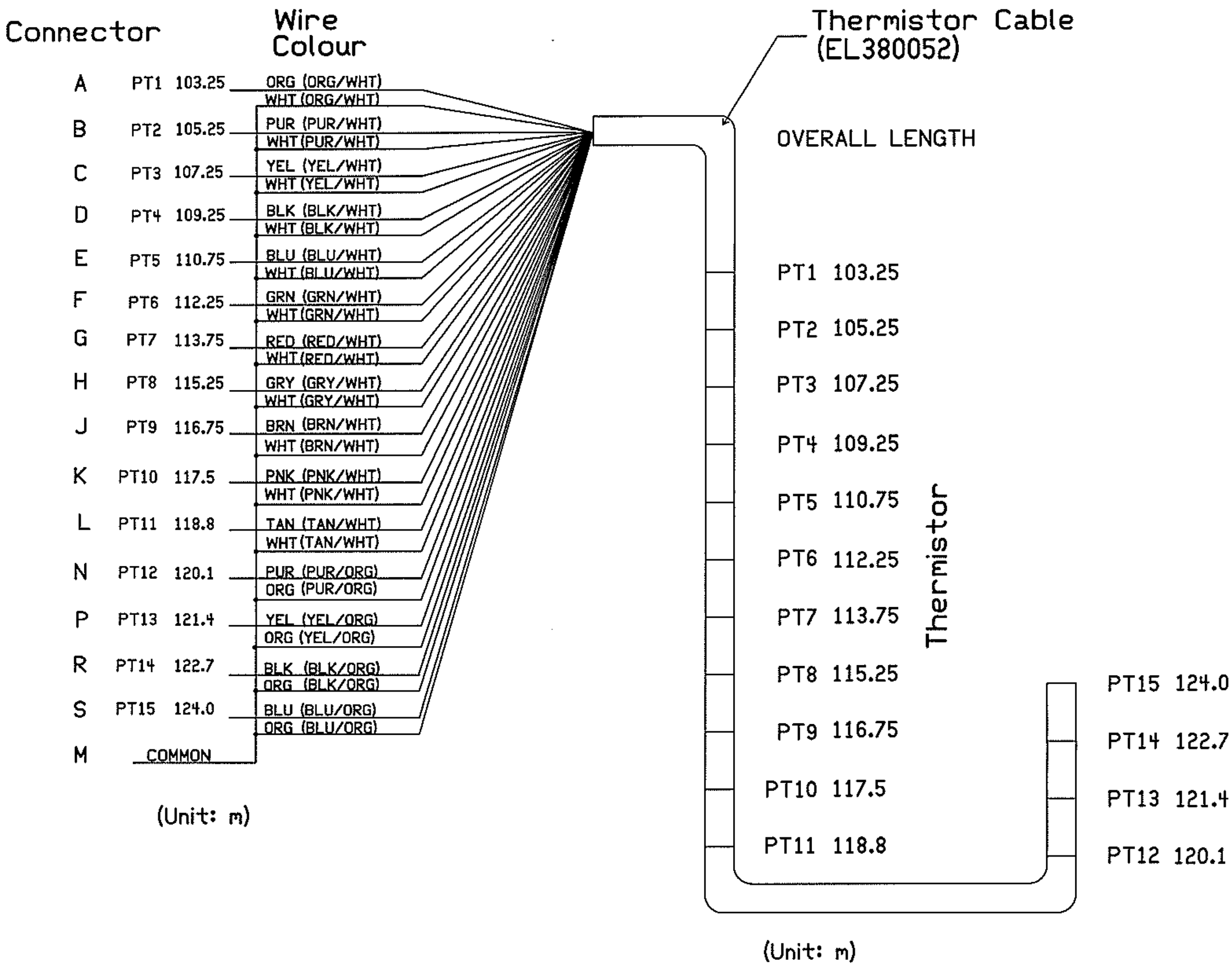
Title:	THERMISTOR CABLE
J/N:	WOQ018560-13 — Revision: A
Author:	CB — Size: A
Date:	2010/10/12 — Sheet 1 of 1



S/N: TS3093

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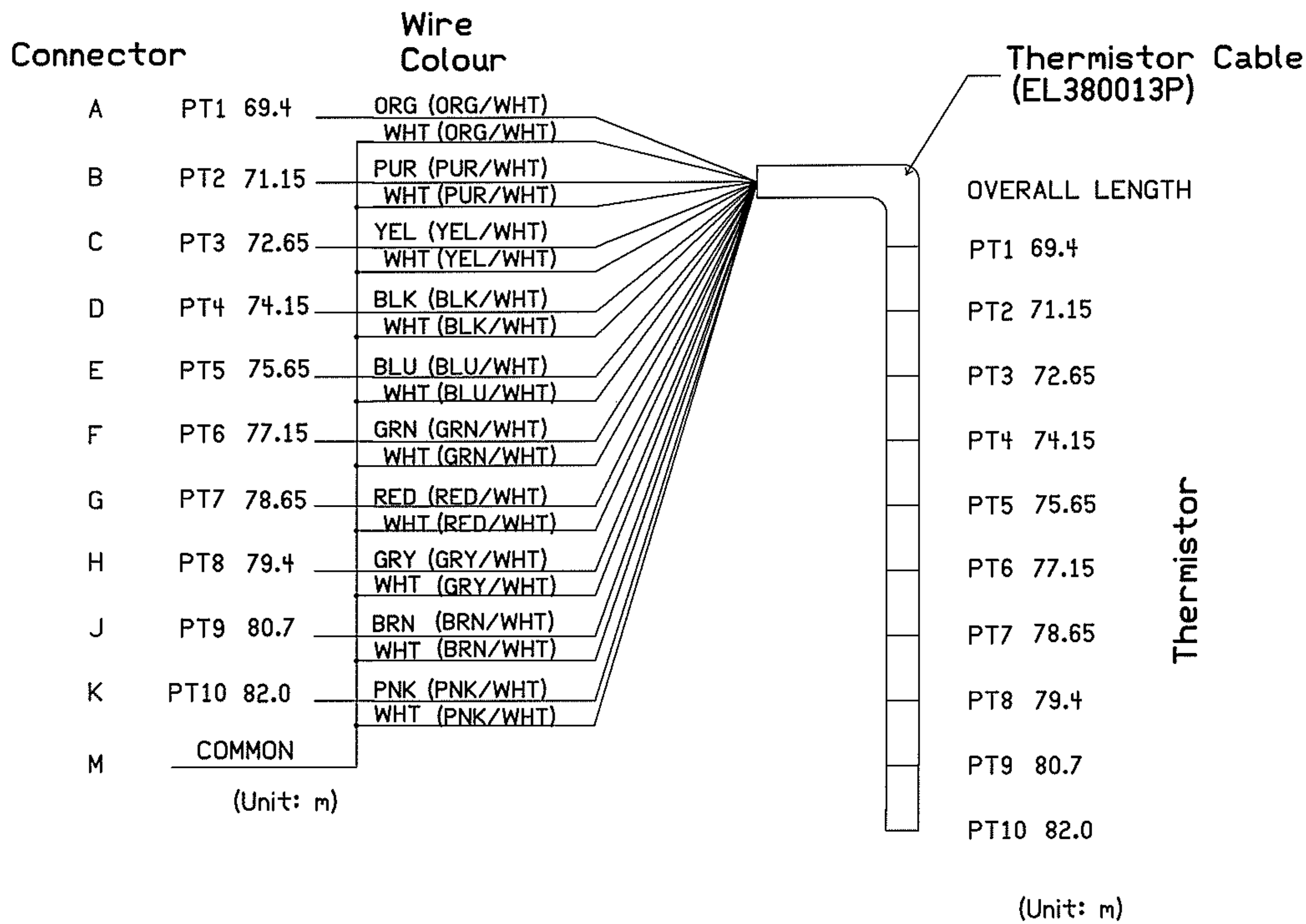
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



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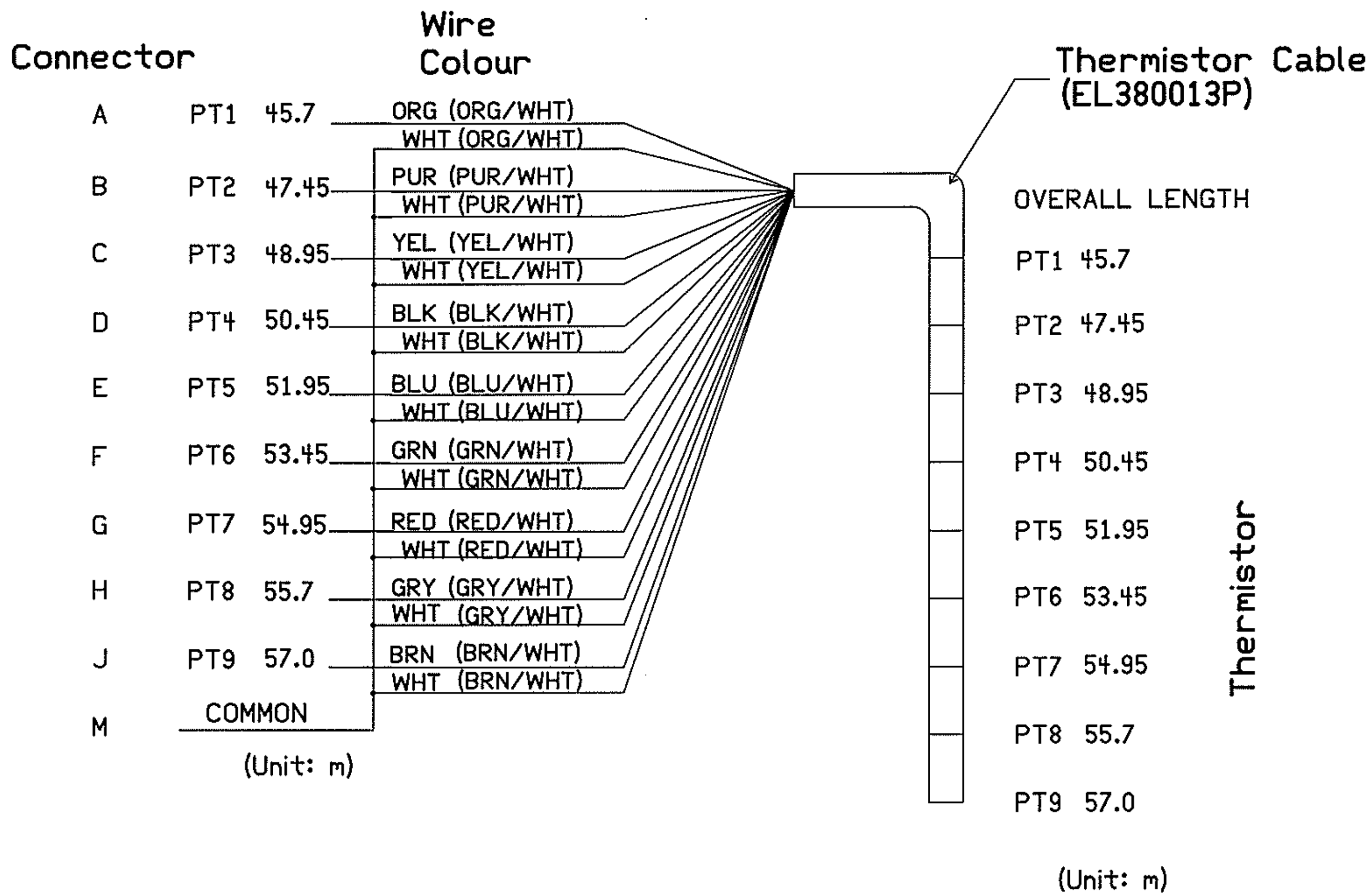
Author:	CB	Size:	A
Date:	2010/10/12	Sheet 1 of 1	



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ID: ND-HTS-175-32.5

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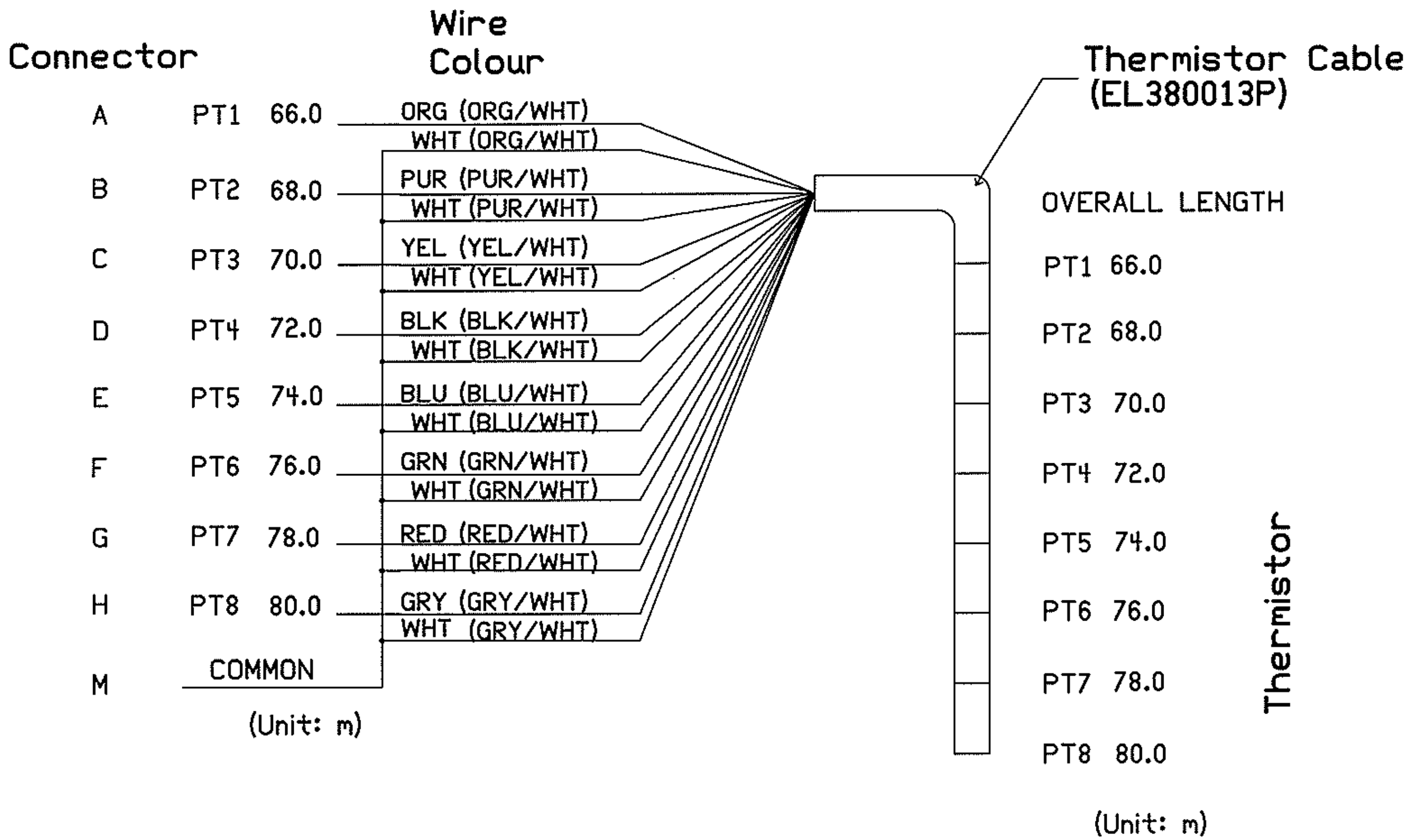
Author:	CB — Size: A
Date:	2010/10/12 — Sheet 1 of 1



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ID: ND-HTS-060-31.0

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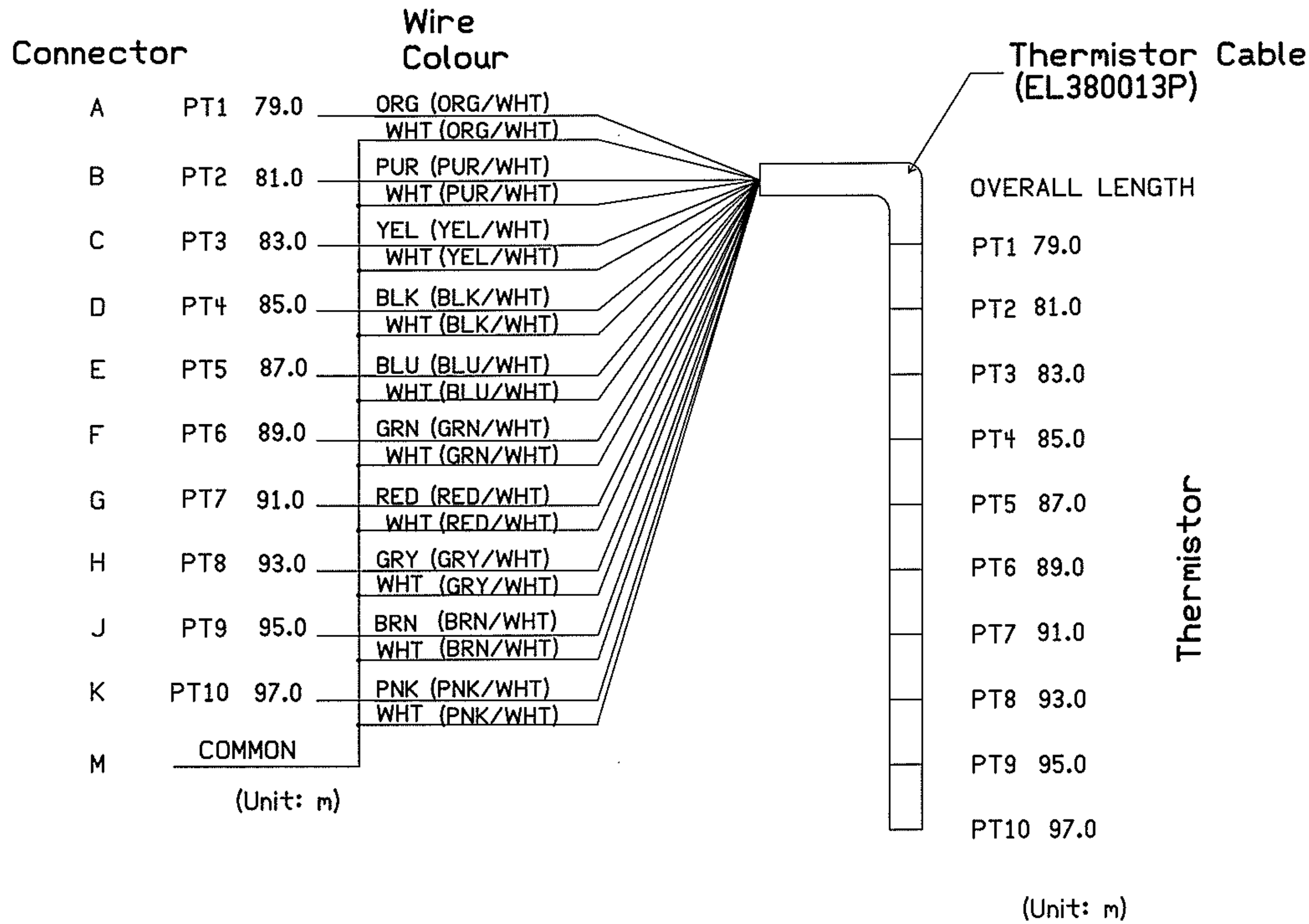

S/N: TS3097

ID: ND-HTS-085-29.4

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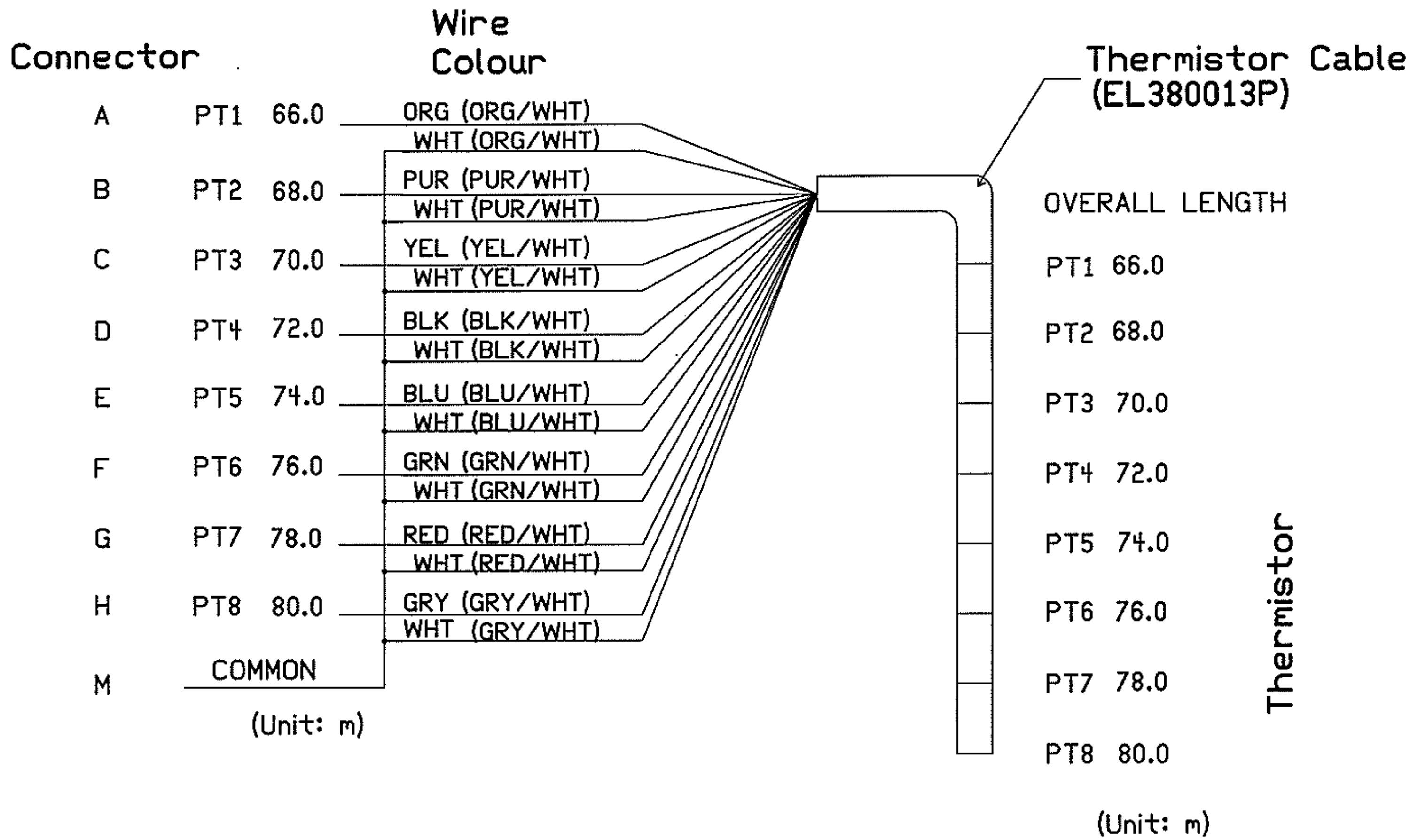
J/N:	WOQ018560-18 — Revision: A
Author:	CB — Size: A
Date:	2010/10/12 — Sheet 1 of 1



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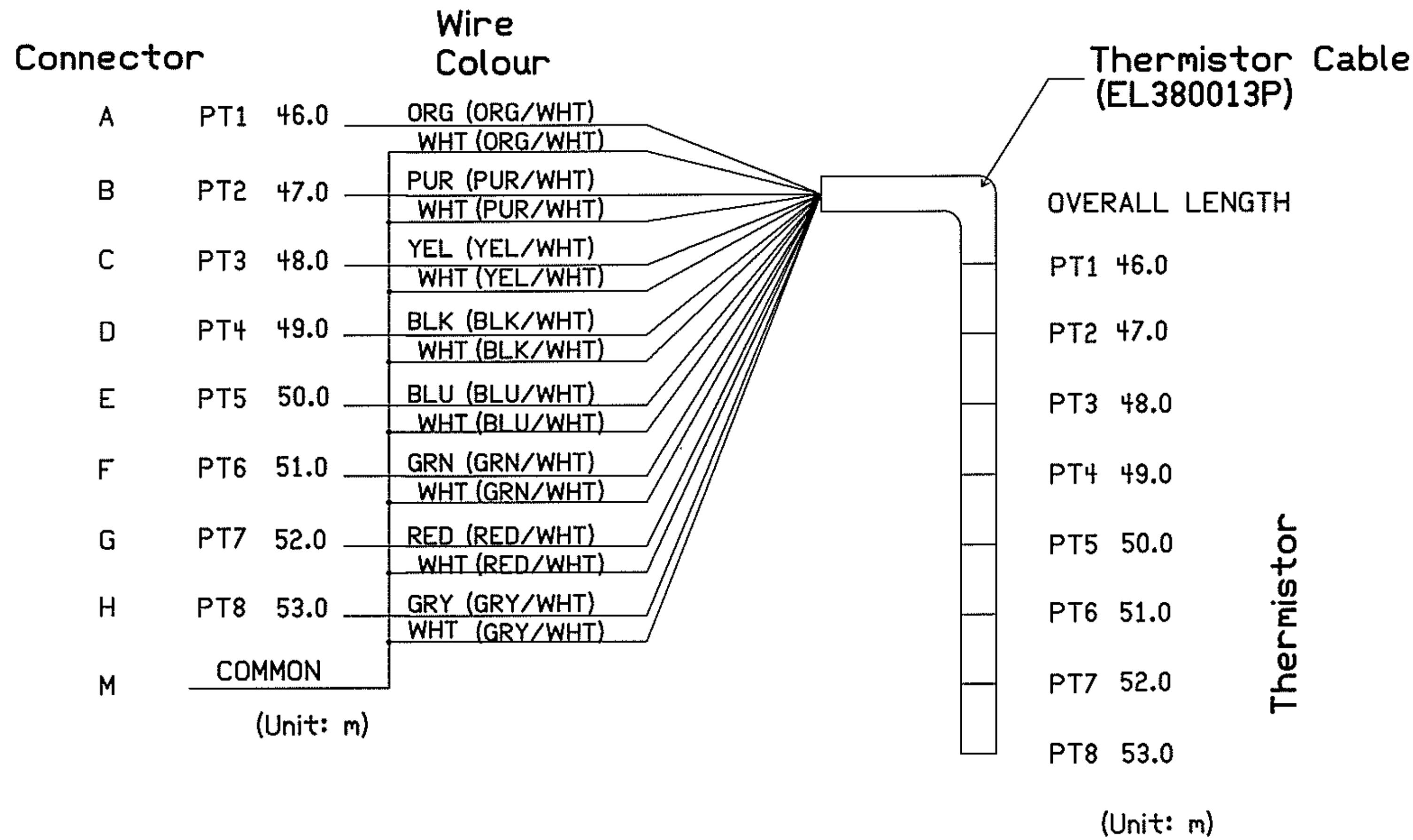
ID: ND-HTS-130-31.0

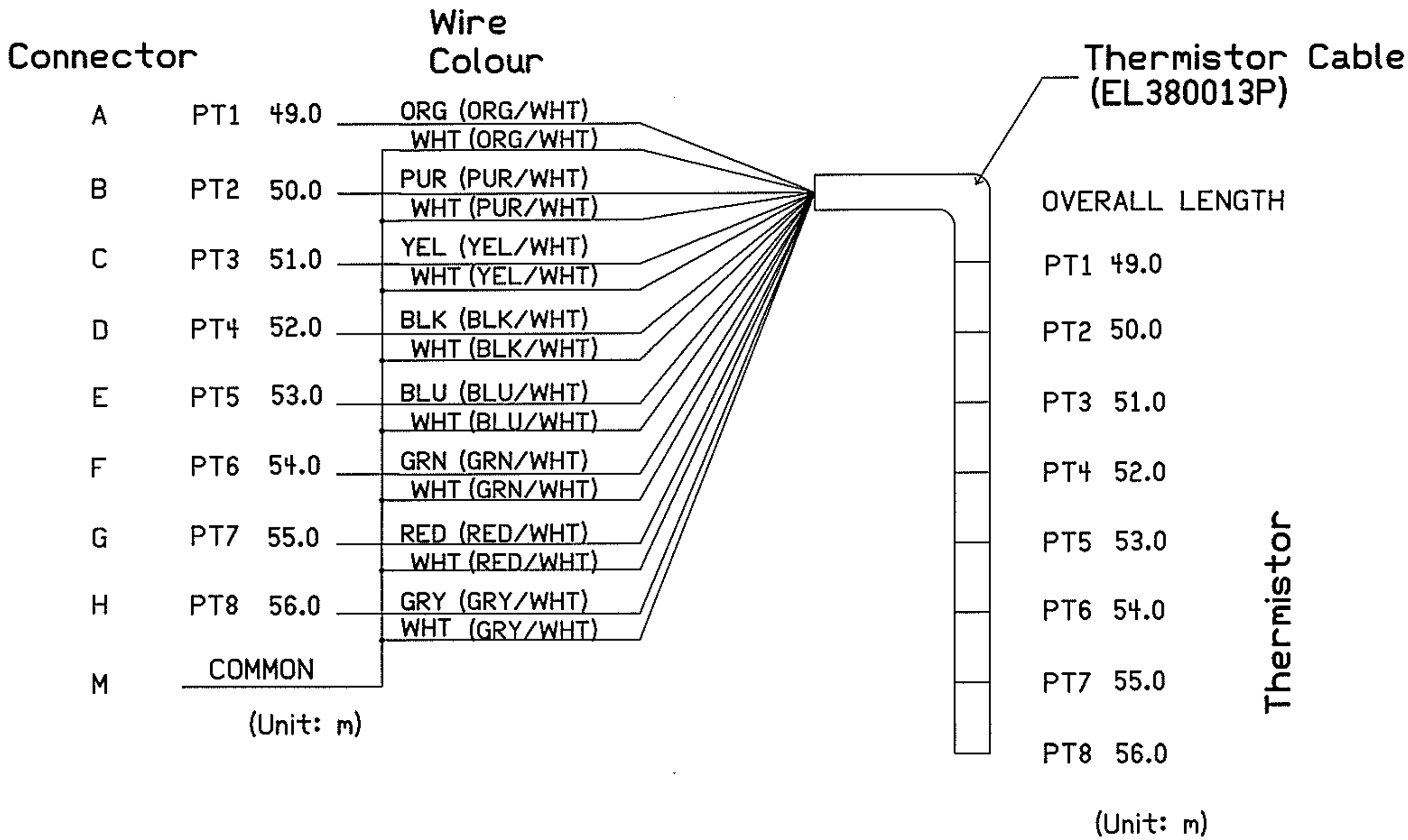
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-19	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3099

ID: ND-HTS-060-33.5

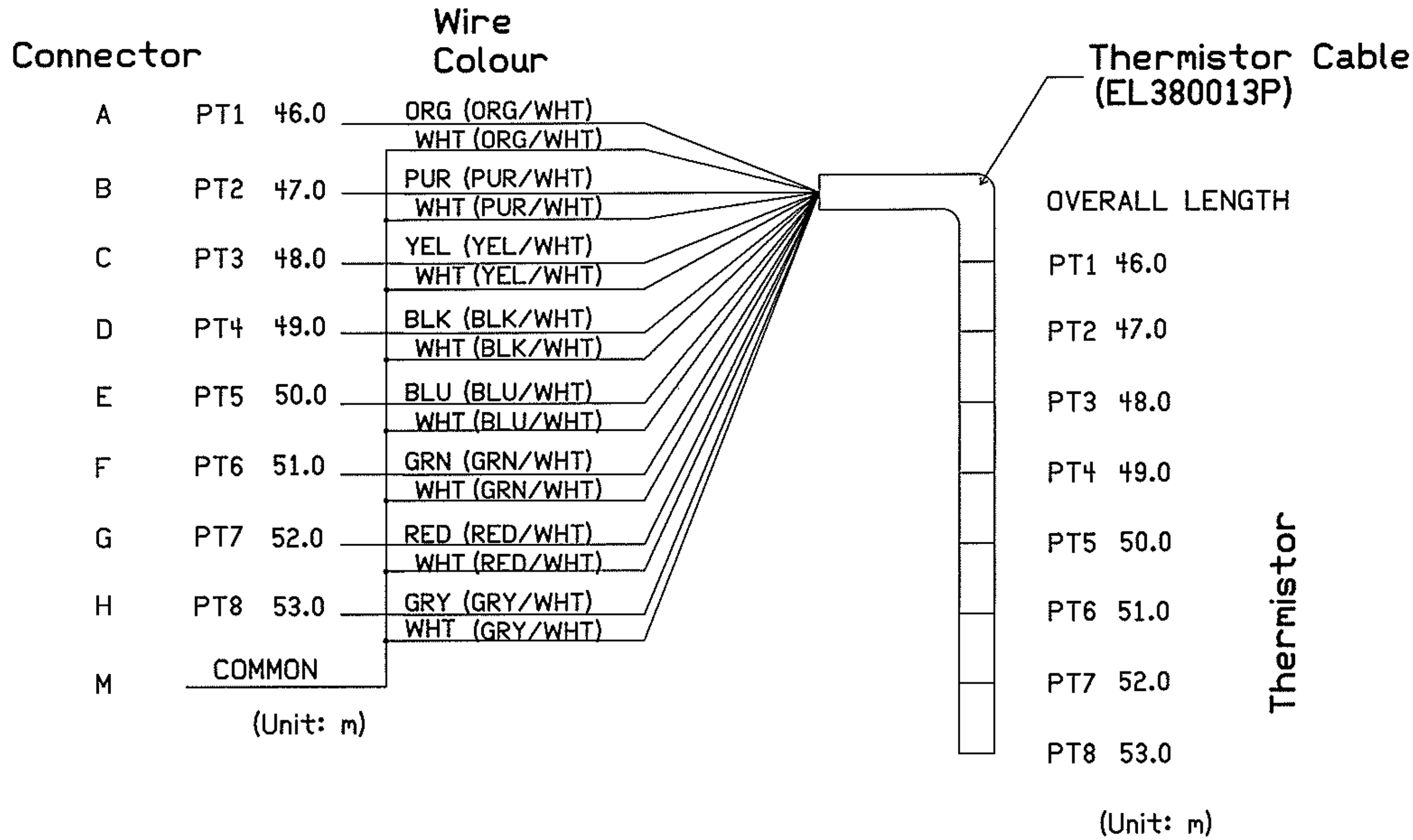
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-20	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3102

ID: ND-HTS-040-33.5

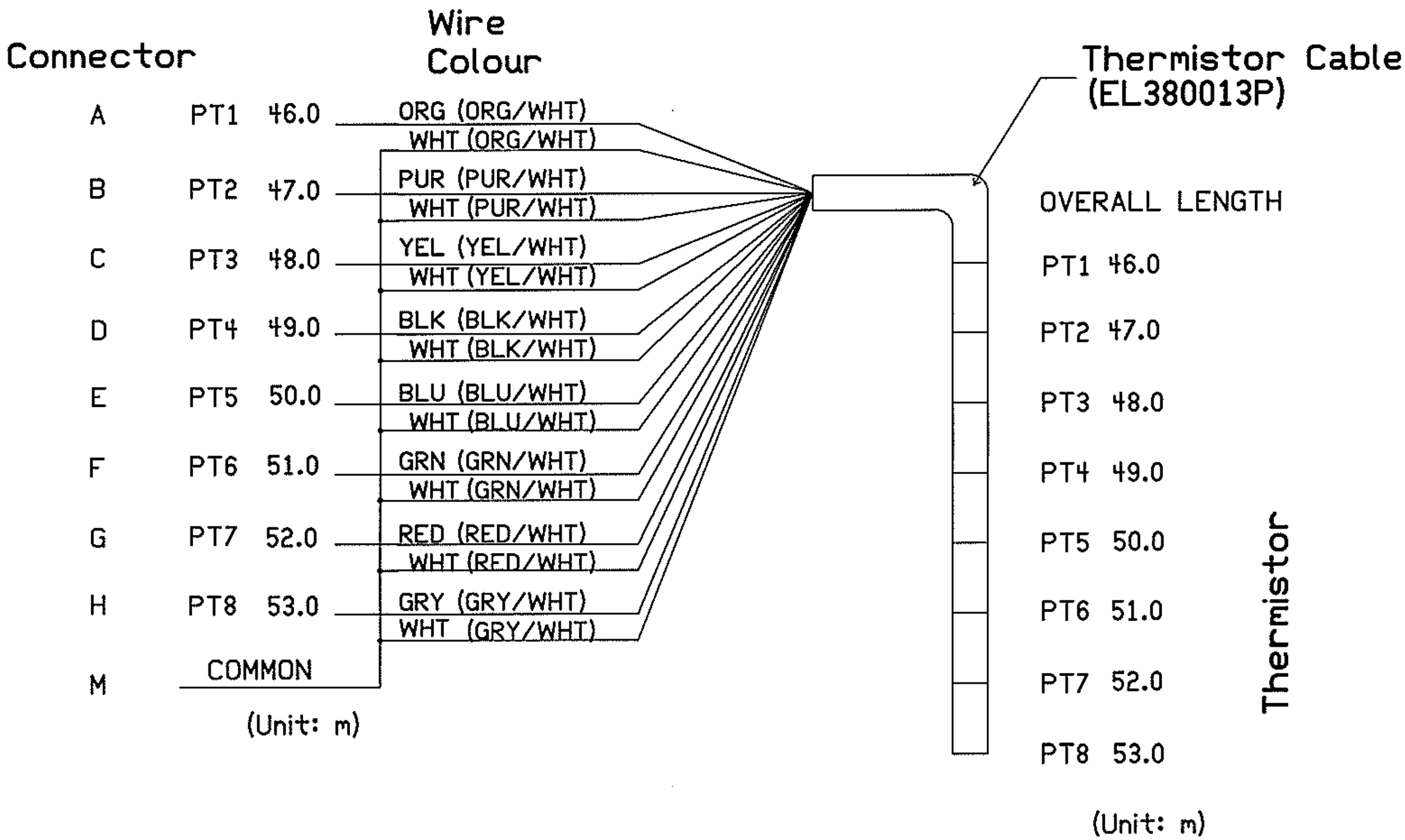
Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-21	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3100

ID: ND-HTS-085-33.5

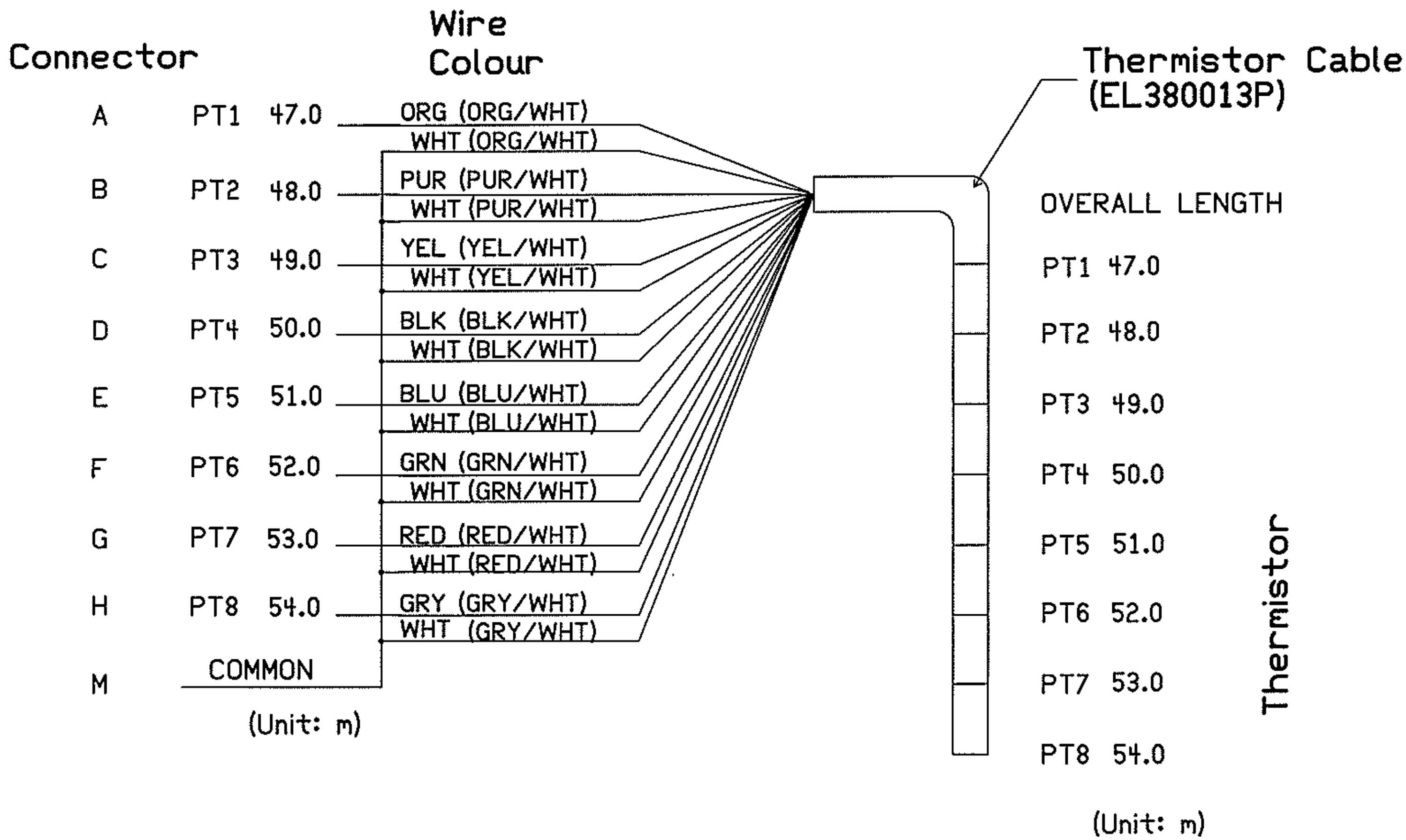
Co:	RST INSTRUMENTS LTD
Title:	THERMISTOR CABLE
J/N:	WOQ018560-22 Revision: A
Author:	CB Size: A
Date:	2010/10/12 Sheet 1 of 1



S/N: TS3101

ID: ND-HTS-130-33.5

Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	WOQ018560-23	Revision:	A
Author:	CB	Size:	A
Date:	2010/10/12	Sheet	1 of 1



S/N: TS3103

ID: ND-HTS-175-33.5

Co:	RST INSTRUMENTS LTD	
Title:	THERMISTOR CABLE	
J/N:	WOQ018560-24	Revision: A
Author:	CB	Size: A
Date:	2010/10/12	Sheet 1 of 1

Appendix C - CR1000 Program Listing Overview

```
'CR1000 Series Datalogger


'Contact: Iozsef Miskolczi
'SRK Consulting
'2200-1066 West Hastings Street
'Vancouver, BC, V6E 3X2
'Canada

'Phone: 604-681-4196
'Direct Number: 778-785-8460
'email: IMiskolczi@srk.com



'Program overview: CR1000 #1 Station Program
'This program will take themperature measurements on a dam located
'on Hope bay, Nunavut.
' Data will be stored on a compact flash card once every 6 hours

'********************************************************
'Program author: Mike Ryder - Sales & Technical Support
' modified by Iozsef Miskolczi on August 11, 2012

'Campbell Scientific (Canada) Corp.
'11564 - 149 Street NW
'Edmonton, AB T5M 1W7
'Canada

'Main Phone: 780-454-2505
'Direct Number: 780-733-8214
'Fax: 780-454-2655
'Email: Mike.Ryder@campbellsci.ca
'General Email: dataloggers@campbellsci.ca
'Web Site: www.campbellsci.ca
'********************************************************
'================================================================================
'- - - - - - - - - - - - - - - CR1000 Wiring - - - - - - - - - - - - - - - -
'================================================================================

'================================================================================
'- - - - - - - - - - - - - - - Variables - - - - - - - - - - - - - - - - - -
'================================================================================

Public PTemp
Public batt_volt

Public Therm_ResA_1 (34)
Public Therm_mV_A_1 (34)
Public Therm_TempA_1 (34)

Public Therm_ResB_2 (36)
Public Therm_mV_B_2 (36)
Public Therm_TempB_2 (36)

Public Therm_ResB_3 (30)
```

```
Public Therm_mV_B_3 (30)
Public Therm_TempB_3 (30)

Public Therm_ResC_4 (36)
Public Therm_mV_C_4 (36)
Public Therm_TempC_4 (36)

Public Therm_ResC_5 (36)
Public Therm_mV_C_5 (36)
Public Therm_TempC_5 (36)

Dim Index
Dim Index2
Dim Index3
Dim Index4
Dim Index5

StationName (HB_NorthDam_CR1000_#1)

'===============================================================================
'- - - - - - - - - - - - - - - Variable aliases - - - - - - - - - - - - - -
'===============================================================================

Alias Therm_TempA_1 (1) = ND_VTS_040_KT_PT1
Alias Therm_TempA_1 (2) = ND_VTS_040_KT_PT2
Alias Therm_TempA_1 (3) = ND_VTS_040_KT_PT3
Alias Therm_TempA_1 (4) = ND_VTS_040_KT_PT4
Alias Therm_TempA_1 (5) = ND_VTS_040_KT_PT5
Alias Therm_TempA_1 (6) = ND_VTS_040_KT_PT6
Alias Therm_TempA_1 (7) = ND_VTS_040_KT_PT7
Alias Therm_TempA_1 (8) = ND_VTS_040_KT_PT8
Alias Therm_TempA_1 (9) = ND_VTS_040_KT_PT9
Alias Therm_TempA_1 (10) = ND_VTS_040_KT_PT10
Alias Therm_TempA_1 (11) = ND_VTS_040_KT_PT11

Alias Therm_TempA_1 (13) = ND_HTS_040_315_PT1
Alias Therm_TempA_1 (14) = ND_HTS_040_315_PT2
Alias Therm_TempA_1 (15) = ND_HTS_040_315_PT3
Alias Therm_TempA_1 (16) = ND_HTS_040_315_PT4
Alias Therm_TempA_1 (17) = ND_HTS_040_315_PT5
Alias Therm_TempA_1 (18) = ND_HTS_040_315_PT6
Alias Therm_TempA_1 (19) = ND_HTS_040_315_PT7
Alias Therm_TempA_1 (20) = ND_HTS_040_315_PT8
Alias Therm_TempA_1 (21) = ND_HTS_040_315_PT9
Alias Therm_TempA_1 (22) = ND_HTS_040_315_PT10

Alias Therm_TempA_1 (25) = ND_HTS_040_335_PT1
Alias Therm_TempA_1 (26) = ND_HTS_040_335_PT2
Alias Therm_TempA_1 (27) = ND_HTS_040_335_PT3
Alias Therm_TempA_1 (28) = ND_HTS_040_335_PT4
Alias Therm_TempA_1 (29) = ND_HTS_040_335_PT5
Alias Therm_TempA_1 (30) = ND_HTS_040_335_PT6
Alias Therm_TempA_1 (31) = ND_HTS_040_335_PT7
Alias Therm_TempA_1 (32) = ND_HTS_040_335_PT8

Alias Therm_TempB_2 (1) = ND_VTS_060_KT_PT1
```

Alias Therm_TempB_2 (2) = ND_VTS_060_KT_PT2
Alias Therm_TempB_2 (3) = ND_VTS_060_KT_PT3
Alias Therm_TempB_2 (4) = ND_VTS_060_KT_PT4
Alias Therm_TempB_2 (5) = ND_VTS_060_KT_PT5
Alias Therm_TempB_2 (6) = ND_VTS_060_KT_PT6
Alias Therm_TempB_2 (7) = ND_VTS_060_KT_PT7
Alias Therm_TempB_2 (8) = ND_VTS_060_KT_PT8
Alias Therm_TempB_2 (9) = ND_VTS_060_KT_PT9
Alias Therm_TempB_2 (10) = ND_VTS_060_KT_PT10
Alias Therm_TempB_2 (11) = ND_VTS_060_KT_PT11

Alias Therm_TempB_2 (13) = ND_VTS_060_DS_PT1
Alias Therm_TempB_2 (14) = ND_VTS_060_DS_PT2
Alias Therm_TempB_2 (15) = ND_VTS_060_DS_PT3
Alias Therm_TempB_2 (16) = ND_VTS_060_DS_PT4
Alias Therm_TempB_2 (17) = ND_VTS_060_DS_PT5
Alias Therm_TempB_2 (18) = ND_VTS_060_DS_PT6
Alias Therm_TempB_2 (19) = ND_VTS_060_DS_PT7
Alias Therm_TempB_2 (20) = ND_VTS_060_DS_PT8
Alias Therm_TempB_2 (21) = ND_VTS_060_DS_PT9
Alias Therm_TempB_2 (22) = ND_VTS_060_DS_PT10
Alias Therm_TempB_2 (23) = ND_VTS_060_DS_PT11

Alias Therm_TempB_2 (25) = ND_HTS_060_288_PT1
Alias Therm_TempB_2 (26) = ND_HTS_060_288_PT2
Alias Therm_TempB_2 (27) = ND_HTS_060_288_PT3
Alias Therm_TempB_2 (28) = ND_HTS_060_288_PT4
Alias Therm_TempB_2 (29) = ND_HTS_060_288_PT5
Alias Therm_TempB_2 (30) = ND_HTS_060_288_PT6
Alias Therm_TempB_2 (31) = ND_HTS_060_288_PT7
Alias Therm_TempB_2 (32) = ND_HTS_060_288_PT8
Alias Therm_TempB_2 (33) = ND_HTS_060_288_PT9
Alias Therm_TempB_2 (34) = ND_HTS_060_288_PT10

Alias Therm_TempB_3 (1) = ND_VTS_060_US_PT1
Alias Therm_TempB_3 (2) = ND_VTS_060_US_PT2
Alias Therm_TempB_3 (3) = ND_VTS_060_US_PT3
Alias Therm_TempB_3 (4) = ND_VTS_060_US_PT4
Alias Therm_TempB_3 (5) = ND_VTS_060_US_PT5
Alias Therm_TempB_3 (6) = ND_VTS_060_US_PT6
Alias Therm_TempB_3 (7) = ND_VTS_060_US_PT7
Alias Therm_TempB_3 (8) = ND_VTS_060_US_PT8
Alias Therm_TempB_3 (9) = ND_VTS_060_US_PT9
Alias Therm_TempB_3 (10) = ND_VTS_060_US_PT10
Alias Therm_TempB_3 (11) = ND_VTS_060_US_PT11

Alias Therm_TempB_3 (13) = ND_HTS_060_310_PT1
Alias Therm_TempB_3 (14) = ND_HTS_060_310_PT2
Alias Therm_TempB_3 (15) = ND_HTS_060_310_PT3
Alias Therm_TempB_3 (16) = ND_HTS_060_310_PT4
Alias Therm_TempB_3 (17) = ND_HTS_060_310_PT5
Alias Therm_TempB_3 (18) = ND_HTS_060_310_PT6
Alias Therm_TempB_3 (19) = ND_HTS_060_310_PT7
Alias Therm_TempB_3 (20) = ND_HTS_060_310_PT8

Alias Therm_TempB_3 (22) = ND_HTS_060_335_PT1

Alias Therm_TempB_3 (23) = ND_HTS_060_335_PT2
Alias Therm_TempB_3 (24) = ND_HTS_060_335_PT3
Alias Therm_TempB_3 (25) = ND_HTS_060_335_PT4
Alias Therm_TempB_3 (26) = ND_HTS_060_335_PT5
Alias Therm_TempB_3 (27) = ND_HTS_060_335_PT6
Alias Therm_TempB_3 (28) = ND_HTS_060_335_PT7
Alias Therm_TempB_3 (29) = ND_HTS_060_335_PT8

Alias Therm_TempC_4 (1) = ND_VTS_085_KT_PT1
Alias Therm_TempC_4 (2) = ND_VTS_085_KT_PT2
Alias Therm_TempC_4 (3) = ND_VTS_085_KT_PT3
Alias Therm_TempC_4 (4) = ND_VTS_085_KT_PT4
Alias Therm_TempC_4 (5) = ND_VTS_085_KT_PT5
Alias Therm_TempC_4 (6) = ND_VTS_085_KT_PT6
Alias Therm_TempC_4 (7) = ND_VTS_085_KT_PT7
Alias Therm_TempC_4 (8) = ND_VTS_085_KT_PT8
Alias Therm_TempC_4 (9) = ND_VTS_085_KT_PT9
Alias Therm_TempC_4 (10) = ND_VTS_085_KT_PT10
Alias Therm_TempC_4 (11) = ND_VTS_085_KT_PT11

Alias Therm_TempC_4 (13) = ND_VTS_085_US_PT1
Alias Therm_TempC_4 (14) = ND_VTS_085_US_PT2
Alias Therm_TempC_4 (15) = ND_VTS_085_US_PT3
Alias Therm_TempC_4 (16) = ND_VTS_085_US_PT4
Alias Therm_TempC_4 (17) = ND_VTS_085_US_PT5
Alias Therm_TempC_4 (18) = ND_VTS_085_US_PT6
Alias Therm_TempC_4 (19) = ND_VTS_085_US_PT7
Alias Therm_TempC_4 (20) = ND_VTS_085_US_PT8
Alias Therm_TempC_4 (21) = ND_VTS_085_US_PT9
Alias Therm_TempC_4 (22) = ND_VTS_085_US_PT10
Alias Therm_TempC_4 (23) = ND_VTS_085_US_PT11

Alias Therm_TempC_4 (25) = ND_VTS_085_DS_PT1
Alias Therm_TempC_4 (26) = ND_VTS_085_DS_PT2
Alias Therm_TempC_4 (27) = ND_VTS_085_DS_PT3
Alias Therm_TempC_4 (28) = ND_VTS_085_DS_PT4
Alias Therm_TempC_4 (29) = ND_VTS_085_DS_PT5
Alias Therm_TempC_4 (30) = ND_VTS_085_DS_PT6
Alias Therm_TempC_4 (31) = ND_VTS_085_DS_PT7
Alias Therm_TempC_4 (32) = ND_VTS_085_DS_PT8
Alias Therm_TempC_4 (33) = ND_VTS_085_DS_PT9
Alias Therm_TempC_4 (34) = ND_VTS_085_DS_PT10
Alias Therm_TempC_4 (35) = ND_VTS_085_DS_PT11

Alias Therm_TempC_5 (1) = ND_HTS_085_253_PT1
Alias Therm_TempC_5 (2) = ND_HTS_085_253_PT2
Alias Therm_TempC_5 (3) = ND_HTS_085_253_PT3
Alias Therm_TempC_5 (4) = ND_HTS_085_253_PT4
Alias Therm_TempC_5 (5) = ND_HTS_085_253_PT5
Alias Therm_TempC_5 (6) = ND_HTS_085_253_PT6
Alias Therm_TempC_5 (7) = ND_HTS_085_253_PT7
Alias Therm_TempC_5 (8) = ND_HTS_085_253_PT8
Alias Therm_TempC_5 (9) = ND_HTS_085_253_PT9
Alias Therm_TempC_5 (10) = ND_HTS_085_253_PT10
Alias Therm_TempC_5 (11) = ND_HTS_085_253_PT11
Alias Therm_TempC_5 (12) = ND_HTS_085_253_PT12

```
Alias Therm_TempC_5 (13) = ND_HTS_085_253_PT13
Alias Therm_TempC_5 (14) = ND_HTS_085_253_PT14
Alias Therm_TempC_5 (15) = ND_HTS_085_253_PT15

Alias Therm_TempC_5 (16) = ND_HTS_085_294_PT1
Alias Therm_TempC_5 (17) = ND_HTS_085_294_PT2
Alias Therm_TempC_5 (18) = ND_HTS_085_294_PT3
Alias Therm_TempC_5 (19) = ND_HTS_085_294_PT4
Alias Therm_TempC_5 (20) = ND_HTS_085_294_PT5
Alias Therm_TempC_5 (21) = ND_HTS_085_294_PT6
Alias Therm_TempC_5 (22) = ND_HTS_085_294_PT7
Alias Therm_TempC_5 (23) = ND_HTS_085_294_PT8
Alias Therm_TempC_5 (24) = ND_HTS_085_294_PT9
Alias Therm_TempC_5 (25) = ND_HTS_085_294_PT10

Alias Therm_TempC_5 (28) = ND_HTS_085_335_PT1
Alias Therm_TempC_5 (29) = ND_HTS_085_335_PT2
Alias Therm_TempC_5 (30) = ND_HTS_085_335_PT3
Alias Therm_TempC_5 (31) = ND_HTS_085_335_PT4
Alias Therm_TempC_5 (32) = ND_HTS_085_335_PT5
Alias Therm_TempC_5 (33) = ND_HTS_085_335_PT6
Alias Therm_TempC_5 (34) = ND_HTS_085_335_PT7
Alias Therm_TempC_5 (35) = ND_HTS_085_335_PT8

'=============================================================================
'- - - - - - - - - - - - - - - Declare Constants - - - - - - - - - - - - - -
'=============================================================================

' Thermistor constants 3000Ohm @ 25C thermistor
Const ConstC0 = 0.0014051
Const ConstC1 = 0.0002369
Const ConstC2 = 0.0000001019

'=============================================================================
'- - - - - - - - - - - - - - - Data Tables - - - - - - - - - - - - - - - - -
'=============================================================================
'Define Data Tables

DataTable (StationStatus,1,-1)
  DataInterval (0,6,hr,10)
  CardOut (0, -1000)
  Minimum (1,batt_volt,FP2,0,False)
  Sample (1,PTemp,FP2)
EndTable

DataTable (Daily_Samples,1,-1)
  DataInterval (0,6,hr,10)
  CardOut (0,-1000)

  Sample (11,ND_VTS_040_KT_PT1,FP2)
  Sample (10,ND_HTS_040_315_PT1,FP2)
  Sample (8,ND_HTS_040_335_PT1,FP2)

  Sample (11,ND_VTS_060_KT_PT1,FP2)
  Sample (11,ND_VTS_060_DS_PT1,FP2)
  Sample (10,ND_HTS_060_288_PT1,FP2)
```

```
  Sample (11,ND_VTS_060_US_PT1,FP2)
  Sample (8,ND_HTS_060_310_PT1,FP2)
  Sample (8,ND_HTS_060_335_PT1,FP2)

  Sample (11,ND_VTS_085_KT_PT1,FP2)
  Sample (11,ND_VTS_085_US_PT1,FP2)
  Sample (11,ND_VTS_085_DS_PT1,FP2)

  Sample (15,ND_HTS_085_253_PT1,FP2)
  Sample (10,ND_HTS_085_294_PT1,FP2)
  Sample (8,ND_HTS_085_335_PT1,FP2)

EndTable


'=================================================================================
'- - - - - - - - - - - - - - - Main Program - - - - - - - - - - - - - - - -
'=================================================================================
BeginProg
  Scan (6,hr,0,0)' 4 times daily, at midnight, 6AM, noon, 6PM
    PanelTemp (PTemp,_60Hz)
    Battery (batt_volt)
    If TimeIntoInterval (0,6,hr)
      '--------------------
      PortSet (1,1)'Turn On Node A_1 Multiplexer
      Delay (0,150,msec)
      PulsePort (2,10000)
      'Multiplexer A_1
      'Measurement conversions for Multiplexer A_1
      'Calculate resistance for 32 thermistors
      For Index = 1 To 36
        BrHalf (Therm_mV_A_1(Index),3,mv2500C,1,Vx1,3,2500,True ,20000,_60Hz,1.0,0)
        Index=Index+2
        PulsePort (2,10000)
      Next
      PortSet (1,0)
      'Multiplexer C_5
      'Measurement conversions for Multiplexer C_5
      'Calculate resistance for 35 thermistors
      PortSet (1,1)'Turn On Node Node C_5 Multiplexer
      Delay (0,150,msec)
      PulsePort (2,10000)
      For Index5 = 1 To 36
        BrHalf (Therm_mV_C_5(Index5),3,mv2500C,13,Vx3,3,2500,True ,20000,_60Hz,1.0,0)
        Index5=Index5+2
        PulsePort (2,10000)
      Next
      PortSet (1,0)
      'Turn Off Node A_1 and Node C_5 Multiplexer
      '--------------------
      PortSet (3,1)'Turn On Node B_2 Multiplexer
      Delay (0,150,msec)
      PulsePort (4,10000)
      'Multiplexer B_2
      'Measurement conversions for Multiplexer B_2
```

```
    'Calculate resistance for 33 thermistors
    For Index2 = 1 To 36
      BrHalf (Therm_mV_B_2(Index2),3,mv2500C,4,Vx1,3,2500,True ,20000,_60Hz,1.0,0)
      Index2=Index2+2
      PulsePort (4,10000)
    Next
    PortSet (3,0)'Turn Off Node B_2 Multiplexer
    '---------------------
    PortSet (5,1)'Turn On Node B_3 Multiplexer
    Delay (0,150,msec)
    PulsePort (6,10000)
    'Multiplexer B_3
    'Measurement conversions for Multiplexer B_3
    'Calculate resistance for 33 thermistors
    For Index3 = 1 To 30
      BrHalf (Therm_mV_B_3(Index3),3,mv2500C,7,Vx2,3,2500,True ,20000,_60Hz,1.0,0)
      Index3=Index3+2
      PulsePort (6,10000)
    Next
    PortSet (5,0)'Turn Off Node B_3 Multiplexer
    '---------------------
    PortSet (7,1)'Turn On Node C_4 Multiplexer
    Delay (0,150,msec)
    PulsePort (8,10000)
    'Multiplexer B_3
    'Measurement conversions for Multiplexer B_3
    'Calculate resistance for 33 thermistors
    For Index4 = 1 To 36
      BrHalf (Therm_mV_C_4(Index4),3,mv2500C,10,Vx2,3,2500,True ,20000,_60Hz,1.0,0)
      Index4=Index4+2
      PulsePort (8,10000)
    Next
    PortSet (7,0)'Turn Off Node C_4 Multiplexer

    '-----------------------------------------

    'Measurement conversions for Multiplexer A_1
    For Index = 1 To 32
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResA_1(Index) = 10000*(1-Therm_mV_A_1(Index))/Therm_mV_A_1(Index)
      If Therm_ResA_1(Index) > 1000000 OR Therm_ResA_1(Index) <0 Then Therm_ResA_1(Index) = 0
      'Calculate temperature of 35 thermistors using the steinhart-hart equation
      Therm_TempA_1(Index) =
1/(ConstC0+ConstC1*LN(Therm_ResA_1(Index))+ConstC2*(LN(Therm_ResA_1(Index))^3))-273.15
    Next

    'Measurement conversions for Multiplexer B_2
    For Index2 = 1 To 34
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResB_2(Index2) = 10000*(1-Therm_mV_B_2(Index2))/Therm_mV_B_2(Index2)
      If Therm_ResB_2(Index2) > 1000000 OR Therm_ResB_2(Index2) < 0 Then Therm_ResB_2(Index2) = 0
      'Calculate temperature of 35 thermistors using the steinhart-hart equation
      Therm_TempB_2(Index2) =
1/(ConstC0+ConstC1*LN(Therm_ResB_2(Index2))+ConstC2*(LN(Therm_ResB_2(Index2))^3))-273.15
    Next
```

```
      'Measurement conversions for Multiplexer B_3
      For Index3 = 1 To 29
        ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
        Therm_ResB_3(Index3) = 10000*(1-Therm_mV_B_3(Index3))/Therm_mV_B_3(Index3)
        If Therm_ResB_3(Index3) > 1000000 OR Therm_ResB_3(Index3) < 0 Then Therm_ResB_3(Index3) = 0

        'Calculate temperature of 35 thermistors using the steinhart-hart equation
        Therm_TempB_3(Index3) =
1/(ConstC0+ConstC1*LN(Therm_ResB_3(Index3))+ConstC2*(LN(Therm_ResB_3(Index3))^3))-273.15
      Next

      'Measurement conversions for Multiplexer C_4
      For Index4 = 1 To 35
        ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
        Therm_ResC_4(Index4) = 10000*(1-Therm_mV_C_4(Index4))/Therm_mV_C_4(Index4)
        If Therm_ResC_4(Index4) > 1000000 OR Therm_ResC_4(Index4) < 0 Then Therm_ResC_4(Index4) = 0
        'Calculate temperature of 35 thermistors using the steinhart-hart equation
        Therm_TempC_4(Index4) =
1/(ConstC0+ConstC1*LN(Therm_ResC_4(Index4))+ConstC2*(LN(Therm_ResC_4(Index4))^3))-273.15
      Next

      'Measurement conversions for Multiplexer C_5
      For Index5 = 1 To 35
        ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
        Therm_ResC_5(Index5) = 10000*(1-Therm_mV_C_5(Index5))/Therm_mV_C_5(Index5)
        If Therm_ResC_5(Index5) > 1000000 OR Therm_ResC_5(Index5) < 0 Then Therm_ResC_5(Index5) = 0
        'Calculate temperature of 35 thermistors using the steinhart-hart equation
        Therm_TempC_5(Index5) =
1/(ConstC0+ConstC1*LN(Therm_ResC_5(Index5))+ConstC2*(LN(Therm_ResC_5(Index5))^3))-273.15
      Next

      CallTable (Daily_Samples)
      CallTable (StationStatus)
    EndIf
  NextScan
EndProg
```

```
'CR1000 Series Datalogger

'Company: SRK Consulting / Nuna Logistics
'Contact: SRK: Iozsef Miskolczi

'Program overview: CR1000 #2 Station program
'This program will take themperature measurements on a dam located
'on Hope bay, Nunavut.
' Data will be stored on a compact flash card once every 6 hours

'*******************************************************
'Program author: Mike Ryder - Sales & Technical Support

'Campbell Scientific (Canada) Corp.
'11564 - 149 Street NW
'Edmonton, AB T5M 1W7
'Canada

'Main Phone: 780-454-2505
'Direct Number: 780-733-8214
'Fax: 780-454-2655
'Email: Mike.Ryder@campbellsci.ca
'General Email: dataloggers@campbellsci.ca
'Web Site: www.campbellsci.ca
'*******************************************************
'==========================================================================
'- - - - - - - - - - - - - - - CR1000 Wiring - - - - - - - - - - - - - - - -
'==========================================================================

'==========================================================================
'- - - - - - - - - - - - - - - Variables - - - - - - - - - - - - - - - - -
'==========================================================================

Public PTemp
Public batt_volt

Public Therm_ResD_6 (36)
Public Therm_mV_D_6 (36)
Public Therm_TempD_6 (36)

Public Therm_ResD_7 (30)
Public Therm_mV_D_7 (30)
Public Therm_TempD_7 (30)

Public Therm_ResE_8 (30)
Public Therm_mV_E_8 (30)
Public Therm_TempE_8 (30)

Public Therm_109 (12)

Dim Index
Dim Index2
Dim Index3
Dim Index4

StationName (HB_NorthDam_CR1000_#2)
```

```
'===================================================================================
'- - - - - - - - - - - - - - - Variable aliases - - - - - - - - - - - - - -
'===================================================================================

Alias Therm_TempD_6 (1) = ND_VTS_130_KT_PT1
Alias Therm_TempD_6 (2) = ND_VTS_130_KT_PT2
Alias Therm_TempD_6 (3) = ND_VTS_130_KT_PT3
Alias Therm_TempD_6 (4) = ND_VTS_130_KT_PT4
Alias Therm_TempD_6 (5) = ND_VTS_130_KT_PT5
Alias Therm_TempD_6 (6) = ND_VTS_130_KT_PT6
Alias Therm_TempD_6 (7) = ND_VTS_130_KT_PT7
Alias Therm_TempD_6 (8) = ND_VTS_130_KT_PT8
Alias Therm_TempD_6 (9) = ND_VTS_130_KT_PT9
Alias Therm_TempD_6 (10) = ND_VTS_130_KT_PT10
Alias Therm_TempD_6 (11) = ND_VTS_130_KT_PT11

Alias Therm_TempD_6 (13) = ND_VTS_130_US_PT1
Alias Therm_TempD_6 (14) = ND_VTS_130_US_PT2
Alias Therm_TempD_6 (15) = ND_VTS_130_US_PT3
Alias Therm_TempD_6 (16) = ND_VTS_130_US_PT4
Alias Therm_TempD_6 (17) = ND_VTS_130_US_PT5
Alias Therm_TempD_6 (18) = ND_VTS_130_US_PT6
Alias Therm_TempD_6 (19) = ND_VTS_130_US_PT7
Alias Therm_TempD_6 (20) = ND_VTS_130_US_PT8
Alias Therm_TempD_6 (21) = ND_VTS_130_US_PT9
Alias Therm_TempD_6 (22) = ND_VTS_130_US_PT10
Alias Therm_TempD_6 (23) = ND_VTS_130_US_PT11

Alias Therm_TempD_6 (25) = ND_VTS_130_DS_PT1
Alias Therm_TempD_6 (26) = ND_VTS_130_DS_PT2
Alias Therm_TempD_6 (27) = ND_VTS_130_DS_PT3
Alias Therm_TempD_6 (28) = ND_VTS_130_DS_PT4
Alias Therm_TempD_6 (29) = ND_VTS_130_DS_PT5
Alias Therm_TempD_6 (30) = ND_VTS_130_DS_PT6
Alias Therm_TempD_6 (31) = ND_VTS_130_DS_PT7
Alias Therm_TempD_6 (32) = ND_VTS_130_DS_PT8
Alias Therm_TempD_6 (33) = ND_VTS_130_DS_PT9
Alias Therm_TempD_6 (34) = ND_VTS_130_DS_PT10
Alias Therm_TempD_6 (35) = ND_VTS_130_DS_PT11

Alias Therm_TempD_7 (1) = ND_HTS_130_288_PT1
Alias Therm_TempD_7 (2) = ND_HTS_130_288_PT2
Alias Therm_TempD_7 (3) = ND_HTS_130_288_PT3
Alias Therm_TempD_7 (4) = ND_HTS_130_288_PT4
Alias Therm_TempD_7 (5) = ND_HTS_130_288_PT5
Alias Therm_TempD_7 (6) = ND_HTS_130_288_PT6
Alias Therm_TempD_7 (7) = ND_HTS_130_288_PT7
Alias Therm_TempD_7 (8) = ND_HTS_130_288_PT8
Alias Therm_TempD_7 (9) = ND_HTS_130_288_PT9
Alias Therm_TempD_7 (10) = ND_HTS_130_288_PT10

Alias Therm_TempD_7 (13) = ND_HTS_130_310_PT1
Alias Therm_TempD_7 (14) = ND_HTS_130_310_PT2
Alias Therm_TempD_7 (15) = ND_HTS_130_310_PT3
Alias Therm_TempD_7 (16) = ND_HTS_130_310_PT4
```

Alias Therm_TempD_7 (17) = ND_HTS_130_310_PT5
Alias Therm_TempD_7 (18) = ND_HTS_130_310_PT6
Alias Therm_TempD_7 (19) = ND_HTS_130_310_PT7
Alias Therm_TempD_7 (20) = ND_HTS_130_310_PT8

Alias Therm_TempD_7 (22) = ND_HTS_130_335_PT1
Alias Therm_TempD_7 (23) = ND_HTS_130_335_PT2
Alias Therm_TempD_7 (24) = ND_HTS_130_335_PT3
Alias Therm_TempD_7 (25) = ND_HTS_130_335_PT4
Alias Therm_TempD_7 (26) = ND_HTS_130_335_PT5
Alias Therm_TempD_7 (27) = ND_HTS_130_335_PT6
Alias Therm_TempD_7 (28) = ND_HTS_130_335_PT7
Alias Therm_TempD_7 (29) = ND_HTS_130_335_PT8

Alias Therm_TempE_8 (1) = ND_VTS_175_KT_PT1
Alias Therm_TempE_8 (2) = ND_VTS_175_KT_PT2
Alias Therm_TempE_8 (3) = ND_VTS_175_KT_PT3
Alias Therm_TempE_8 (4) = ND_VTS_175_KT_PT4
Alias Therm_TempE_8 (5) = ND_VTS_175_KT_PT5
Alias Therm_TempE_8 (6) = ND_VTS_175_KT_PT6
Alias Therm_TempE_8 (7) = ND_VTS_175_KT_PT7
Alias Therm_TempE_8 (8) = ND_VTS_175_KT_PT8
Alias Therm_TempE_8 (9) = ND_VTS_175_KT_PT9
Alias Therm_TempE_8 (10) = ND_VTS_175_KT_PT10
Alias Therm_TempE_8 (11) = ND_VTS_175_KT_PT11

Alias Therm_TempE_8 (13) = ND_HTS_175_325_PT1
Alias Therm_TempE_8 (14) = ND_HTS_175_325_PT2
Alias Therm_TempE_8 (15) = ND_HTS_175_325_PT3
Alias Therm_TempE_8 (16) = ND_HTS_175_325_PT4
Alias Therm_TempE_8 (17) = ND_HTS_175_325_PT5
Alias Therm_TempE_8 (18) = ND_HTS_175_325_PT6
Alias Therm_TempE_8 (19) = ND_HTS_175_325_PT7
Alias Therm_TempE_8 (20) = ND_HTS_175_325_PT8
Alias Therm_TempE_8 (21) = ND_HTS_175_325_PT9

Alias Therm_TempE_8 (22) = ND_HTS_175_335_PT1
Alias Therm_TempE_8 (23) = ND_HTS_175_335_PT2
Alias Therm_TempE_8 (24) = ND_HTS_175_335_PT3
Alias Therm_TempE_8 (25) = ND_HTS_175_335_PT4
Alias Therm_TempE_8 (26) = ND_HTS_175_335_PT5
Alias Therm_TempE_8 (27) = ND_HTS_175_335_PT6
Alias Therm_TempE_8 (28) = ND_HTS_175_335_PT7
Alias Therm_TempE_8 (29) = ND_HTS_175_335_PT8

Alias Therm_109 (1)= South_31
Alias Therm_109 (2)= South_32
Alias Therm_109 (3)= South_33
Alias Therm_109 (4)= South_34
Alias Therm_109 (5)= South_35
Alias Therm_109 (6)= South_36
Alias Therm_109 (7)= North_1
Alias Therm_109 (8)= North_2
Alias Therm_109 (9)= North_3
Alias Therm_109 (10)= North_4
Alias Therm_109 (11)= North_5

```
Alias  Therm_109 (12)= North_6
'==============================================================================
'- - - - - - - - - - - - - - - Units - - - - - - - - - - - - - - - - - -
'==============================================================================

'==============================================================================
'- - - - - - - - - - - - - - - Declare Constants - - - - - - - - - - - - - -
'==============================================================================

' Thermistor constants 3000Ohm @ 25C thermistor
Const ConstC0 = 0.0014051
Const ConstC1 = 0.0002369
Const ConstC2 = 0.0000001019

'==============================================================================
'- - - - - - - - - - - - - - - Data Tables - - - - - - - - - - - - - - - - -
'==============================================================================
'Define Data Tables

DataTable (StationStatus,1,-1)
 DataInterval (0,6,Hr,10)
  CardOut (0 ,-1000)
  Minimum (1,batt_volt,FP2,0,False)
  Sample (1,PTemp,FP2)
EndTable

DataTable (Daily_Samples,1,-1)
  DataInterval (0,6,Hr,10)
  CardOut (0, -1000)

  Sample (11,ND_VTS_130_KT_PT1,FP2)
  Sample (11,ND_VTS_130_US_PT1,FP2)
  Sample (11,ND_VTS_130_DS_PT1,FP2)

  Sample (10,ND_HTS_130_288_PT1,FP2)
  Sample (8,ND_HTS_130_310_PT1,FP2)
  Sample (8,ND_HTS_130_335_PT1,FP2)

  Sample (11,ND_VTS_175_KT_PT1,FP2)
  Sample (9,ND_HTS_175_325_PT1,FP2)
  Sample (8,ND_HTS_175_335_PT1,FP2)

  Sample (12,Therm_109(),FP2)
EndTable


'==============================================================================
'- - - - - - - - - - - - - - - Main Program - - - - - - - - - - - - - - - -
'==============================================================================
BeginProg
  Scan (6,hr,0,0)' 4 times daily at midnight, 6AM, noon, 6 PM
    PanelTemp (PTemp,_60Hz)
    Battery (batt_volt)
   If TimeIntoInterval(0,6,hr)
      'Mutliplexer in 4x16 mode
      'Turn on all AM16/32B-XT multiplexers
```

```
    PortSet (1,1)'Node D_6

    Delay (0,150,msec)
    PulsePort (2,10000)
    'Multiplexer D_6
    ' measurement conversions for Multiplexer D_6
    'Calculate resistance for 33 thermistors
    For Index = 1 To 36
      BrHalf (Therm_mV_D_6(Index),3,mv2500C,1,Vx1,3,2500,True ,20000,_60Hz,1.0,0)
      Index=Index+2
      PulsePort (2,10000)
    Next
    PortSet (1,0)

    'Multiplexer D_7
    PortSet (3,1) 'Node D_7
    Delay (0,150,msec)
    PulsePort (4,10000)
    For Index2 = 1 To 30
      BrHalf (Therm_mV_D_7(Index2),3,mv2500C,4,Vx1,3,2500,True ,20000,_60Hz,1.0,0)
      Index2=Index2+2
      PulsePort (4,10000)
    Next
    PortSet (3,0)

    'Multiplexer E_8
    PortSet (5,1) 'Node E_8
    Delay (0,150,msec)
    PulsePort (6,10000)
    For Index3 = 1 To 30
      BrHalf (Therm_mV_E_8(Index3),3,mv2500C,7,Vx2,3,2500,True ,20000,_60Hz,1.0,0)
      Index3=Index3+2
      PulsePort (6,10000)
    Next
    PortSet (5,0)

    'Multiplexer E_9 (109 thermistors)
    PortSet (7,1) ' Node E_9
    Delay (0,150,msec)
    PulsePort (8,10000)
    For Index4 = 1 To 12
      Therm109 (Therm_109 (Index4),1,10,Vx3,20000,_60Hz,1.0,0)
      PulsePort (8,10000)
    Next
    PortSet (7,0)


    For Index = 1 To 35
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResD_6(Index) = 10000*(1-Therm_mV_D_6(Index))/Therm_mV_D_6(Index)
      If Therm_ResD_6(Index) > 1000000 OR Therm_ResD_6(Index) <0 Then Therm_ResD_6(Index) = 0
      Therm_TempD_6(Index) =
1/(ConstC0+ConstC1*LN(Therm_ResD_6(Index))+ConstC2*(LN(Therm_ResD_6(Index))^3))-273.15
    Next

    ' Measurement conversions for Multiplexer D_7
```

```
    For Index2 = 1 To 29
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResD_7(Index2) = 10000*(1-Therm_mV_D_7(Index2))/Therm_mV_D_7(Index2)
      If Therm_ResD_7(Index2) > 1000000 OR Therm_ResD_7(Index2) < 0 Then
Therm_ResD_7(Index2) = 0
      Therm_TempD_7(Index2) =
1/(ConstC0+ConstC1*LN(Therm_ResD_7(Index2))+ConstC2*(LN(Therm_ResD_7(Index2))^3))-273.15
    Next

    ' Measurement conversions for Multiplexer E_8
    For Index3 = 1 To 29
      ' Calculate resistance using equation : Rt = 10000*(1-Therm_mV(n))/Therm_mV(n)
      Therm_ResE_8(Index3) = 10000*(1-Therm_mV_E_8(Index3))/Therm_mV_E_8(Index3)
      If Therm_ResE_8(Index3) > 1000000 OR Therm_ResE_8(Index3) < 0 Then Therm_ResE_8(Index3)
= 0
      Therm_TempE_8(Index3) =
1/(ConstC0+ConstC1*LN(Therm_ResE_8(Index3))+ConstC2*(LN(Therm_ResE_8(Index3))^3))-273.15
    Next


    CallTable (Daily_Samples)
    CallTable (StationStatus)

   EndIf
  NextScan
EndProg
```

Appendix D - Suggested Guidelines for Surveying at the North Dam

Suggested guidelines for surveying at the North Dam

Introduction

In the upcoming years, it is expected that at regular interval, monitoring surveys will take place at the North Dam. Various surveyors may be called up to do the work. Following those suggested guidelines will provide consistency in the data acquisition process.

Manpower & Time allocation

If the surveyor is flying to the mine site for the work, three days should be allocated for this work.

- Day one: Fly to site, orientation, equipment testing and calibration.
- Day two: Surveying, data processing.
- Day three: Final data preparation, packing of equipment and fly out.

Equipment and accessories

- Robotic total station and accessories, including barometer and thermometer.
- Back sight kit.
- Extensions for the mini prism for the surveying of the crest monitoring points.
- A source of light to shine into the casing for the surveying of the crest monitoring points.
- A transparent template with circles at 5mm increment to pin point exactly the center of the deep settlement points.

Metadata

There are five control points: ND1, ND2, ND3, ND4 and ND5. Each control point consists of 1 inch Hilti bolt with an approximate height of 15 centimeters (~ 6 inch) from ground. The control points at the North Dam were originally surveyed by GNSS method. Closed leveling loops were performed in 2012 (ND3-ND2) and 2013 (ND3-ND2-ND1). ND5 appears to be weak, being located on a large flat boulder, 2013 survey indicates that it could have shifted.

The data is grid. Scale factor at DN1 is 0.99965099.

Station set-up

For consistency from one survey to the next, the total station should set-up at control point ND1. From this station, all points to be surveyed are visible. Back sight point is ND4. Once the station set-up is completed, it is suggested to transfer the elevation to the total station from ND3. Most total stations have this capability (whether called elevation transfer, remote benchmark, etc). This method helps in reducing the error that could have been introduced in measuring the height of the station with a tape. Once the station is set-up is in orientation and elevation, a check shot on ND2 should be carried before commencing the monitoring surveys.

Surveying - general

As a minimum, each surveyed point should have face 1 and 2 observations. Taking measurements with both faces eliminate the following systematic errors of the total station:

- HZ collimation error
- Tilting axis error
- Compensator index error
- vertical index error

Once all points have been surveyed, if time allows, additional data should be obtained to confirm the observations. Should multiple prisms be used, it is recommended to use prisms that have the same prism constant. By doing so, the chances of introducing a prism constant error are reduced.

Conclusion

This document was simply prepared to help out the surveyor who will do the work. By following the same method in the station set-up as well as using the right coordinate system will help in providing reliable data to the engineering team.

Those guidelines were prepared for the scenario of having only one (1) surveyor allocated to the work. Should there be additional manpower, some of the work should also include traditional leveling method.

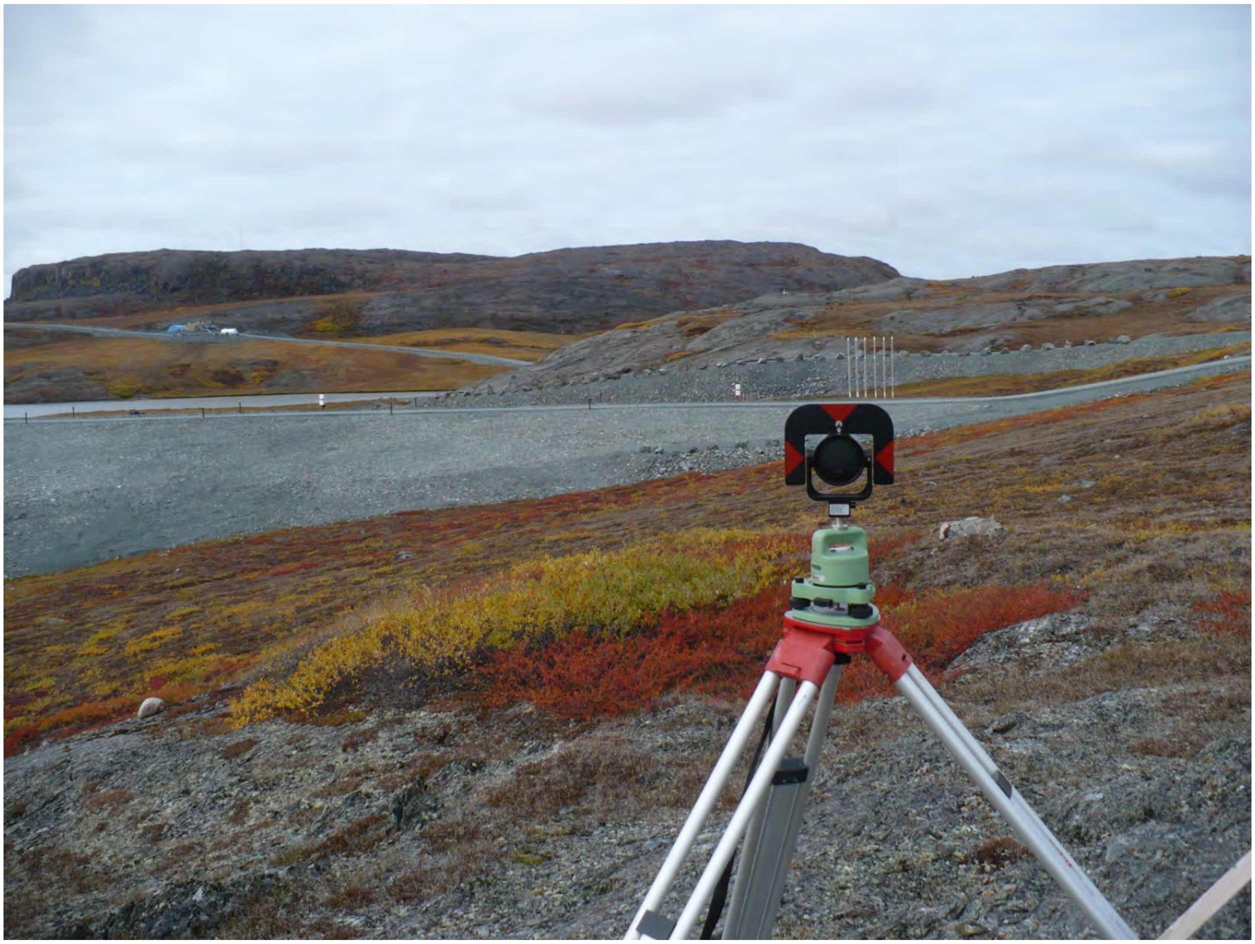
In the following pages are pictures and supplementary information for this work.

Prepared by:

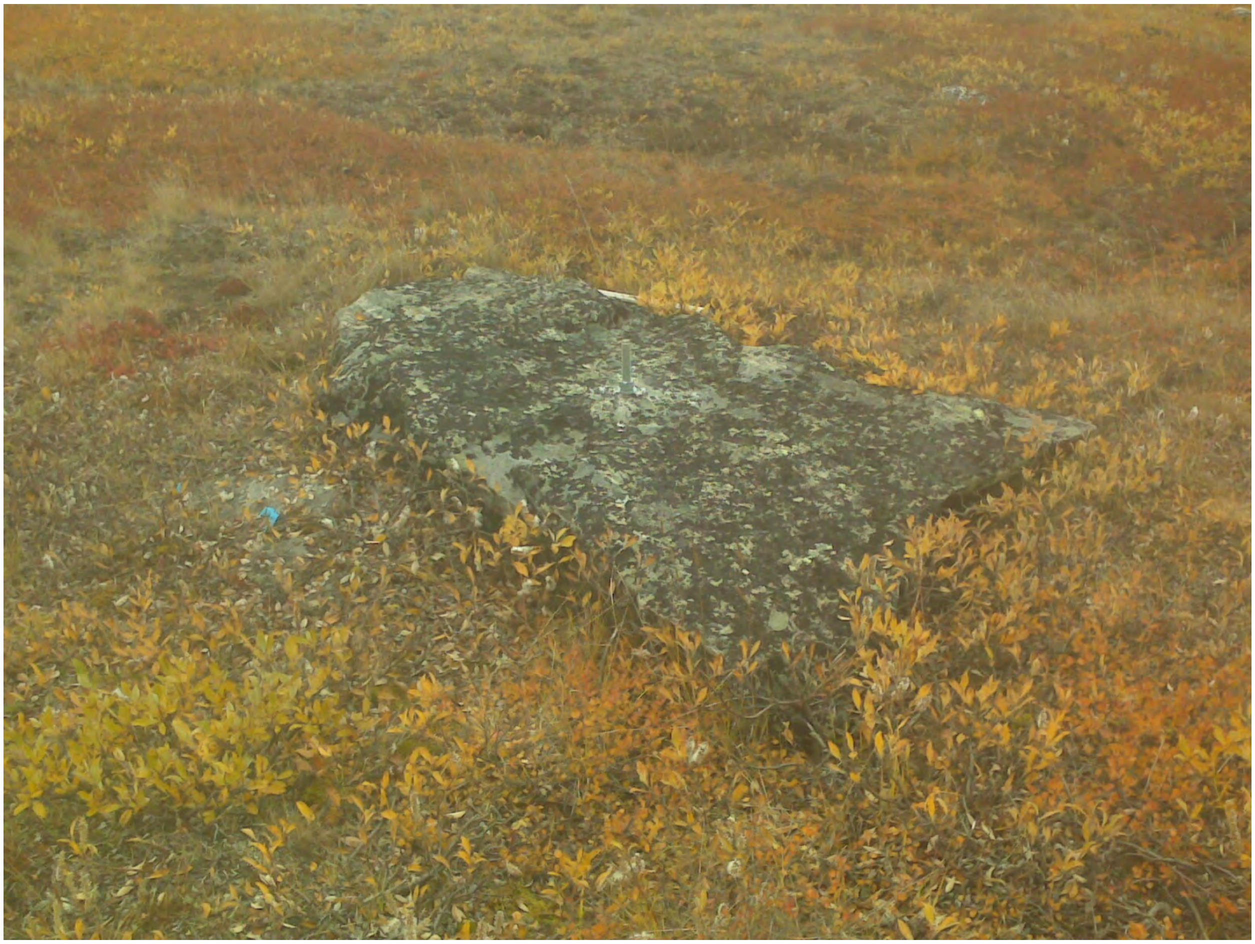
Georges Cornelissen, C.E.T.
E-mail: gc@yk.com
Hopebay, Nunavut
September 10, 2013

A robotic total station kit

Station at ND1



Back sight at ND4

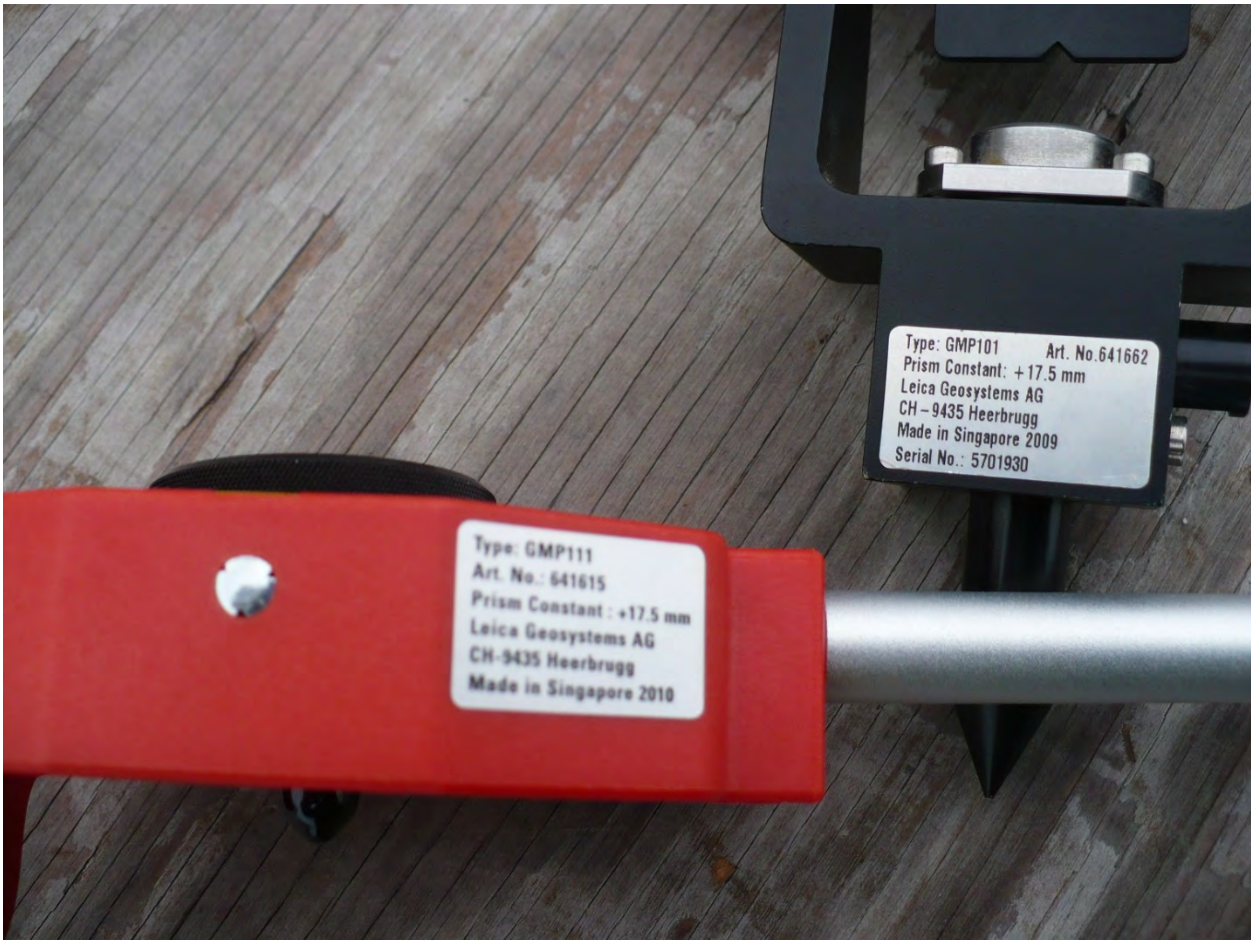


Control Point ND5

Note: Could be weak, not recommended to use for set-up.

Mini-prisms

Note: some points require greater than 40 cm height.



Consistent prism constants

Deep settlement point

Note: Placing a transparent template with circles at 5mm Increment (example) would help to pin point exactly the center of the deep settlement points.

View inside the casing of a crest monitoring point

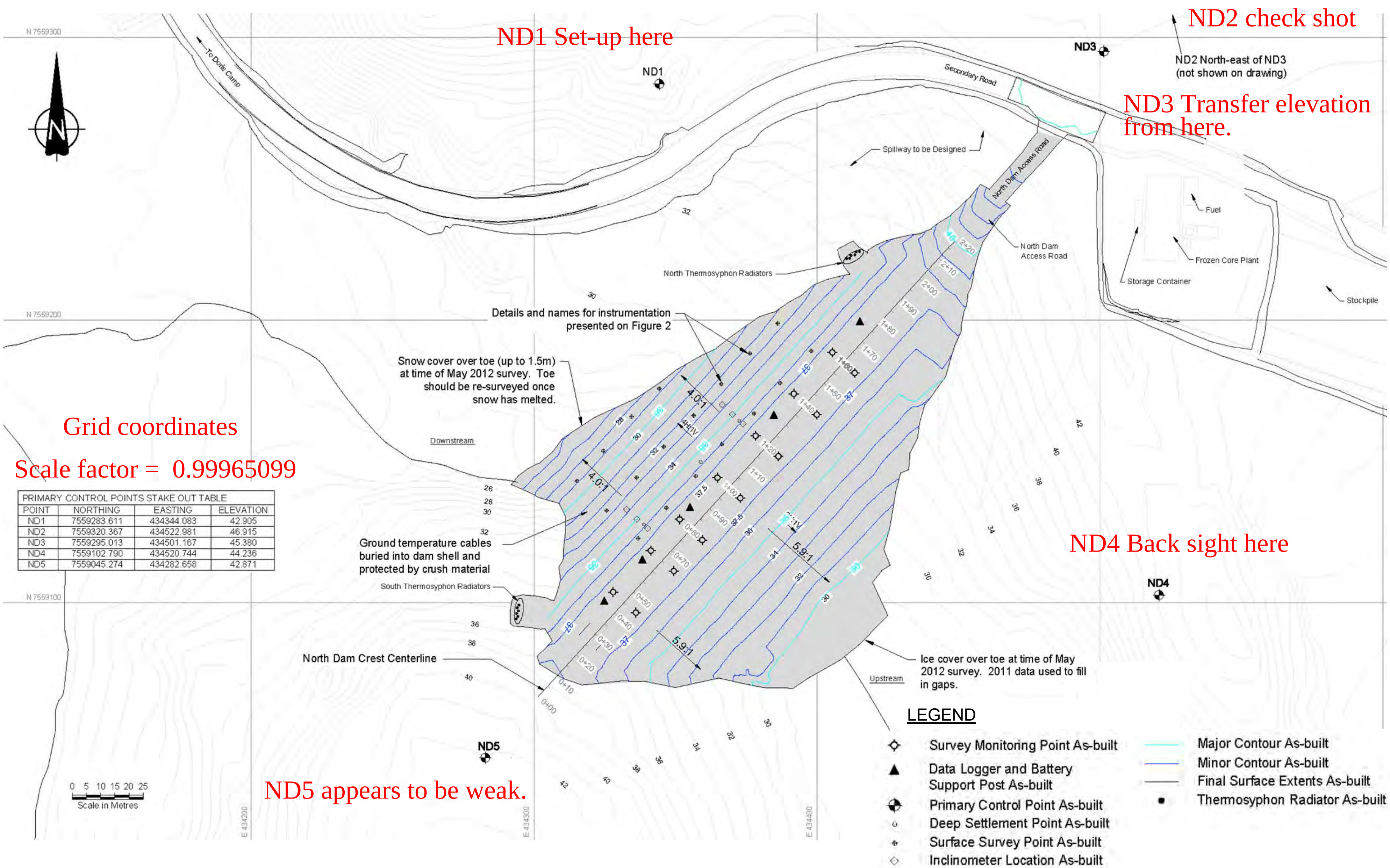
The surface survey points are constructed with same material as control points.

Please remember

The data is grid.

Scale factor at ND1 is 0.99965099.

J:\01_SITES\Hope.Bay\!ACAD\2013 Drawings\North Dam



PRIMARY CONTROL POINTS STAKE OUT TABLE			
POINT	NORTHING	EASTING	ELEVATION
ND1	7559283.611	434344.083	42.905
ND2	7559320.367	434522.981	46.915
ND3	7559295.013	434501.167	45.380
ND4	7559102.790	434520.744	44.236
ND5	7559045.274	434282.658	42.871

srk consulting

TMAC RESOURCES

North Dam Monitoring SOP

North Dam General Arrangement and Primary Control Points

Job No: 1CT022.000

Filename: HopeBay_NorthDamMonitoringSOP_NodeFIGS_1CT022.000_im_jbk_20130709.pptx

Hope Bay

Date: July 2013

Approved: IM / JBK

Figure: 1

Appendix E - North Dam Visual Inspection / Checklist Form

Hope Bay - North Dam
Visual Inspection Form

Frequency: Weekly or as specified by EOR

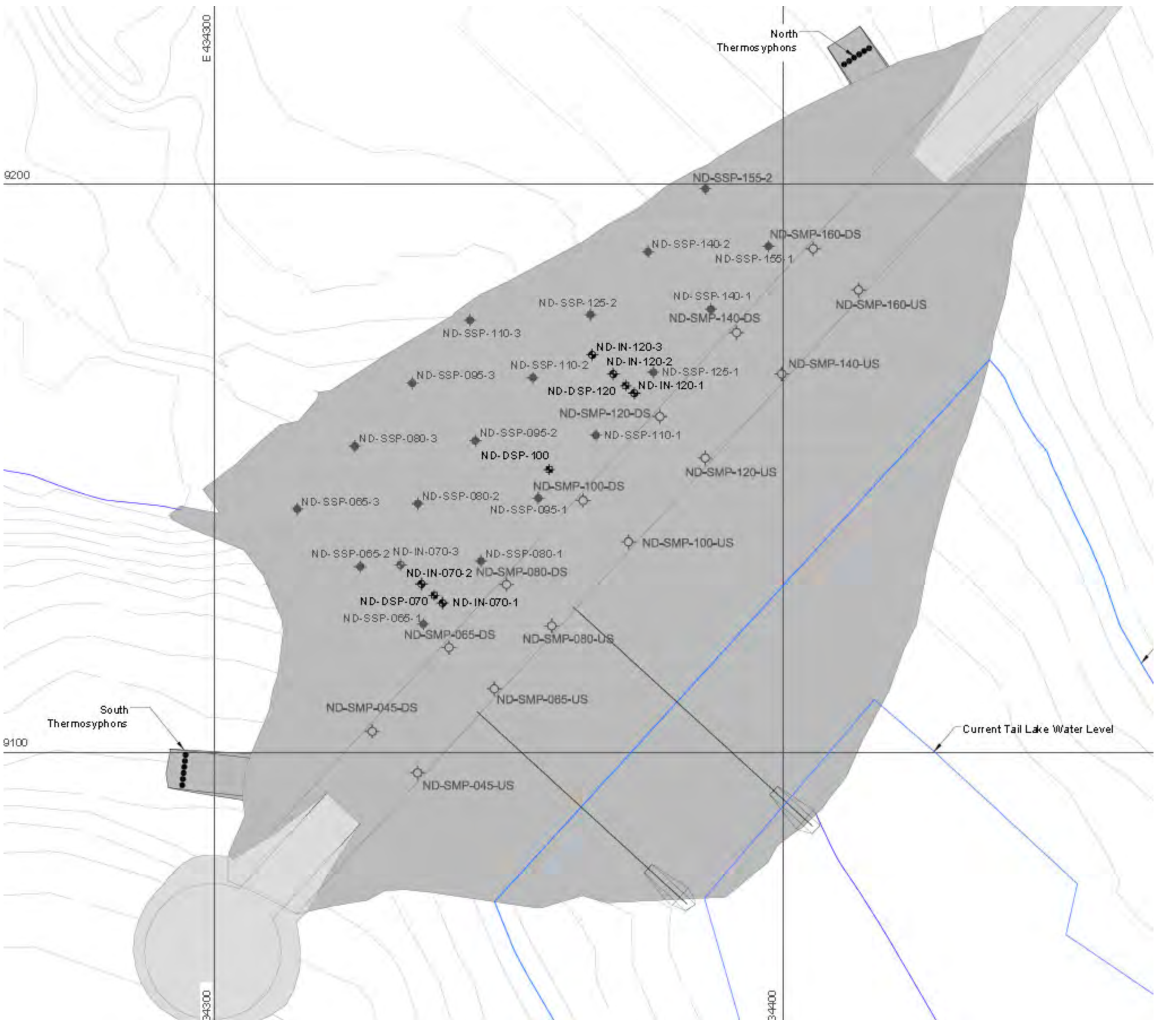
Date:	
Inspected By:	
Conditions:	(ie. snow on ground, clear)

Visual Inspection:

This weekly visual inspection (walk over) report is a means to track the condition on the **North Dam**, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	No
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	No
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	No
Suspended Sediment in the TIA (When not frozen)		
Any suspended sediment visible in the reclaim pond?	Yes	No
Water at the Toe of the Downstream Side of the Dam		
Is water visible on the downstream side of the dam?	Yes	No
Is the water visibly flowing?	Yes	No
If you answered yes to any of the questions above, or made other observations, please provide details and photos. Observations can be sketched on the figure provided on the next page. If water flow near the dam toe been noted estimate the flow rate and report to the Environmental Supervisor: High/Medium/Low: Or, estimate a flow rate if possible:		

Please provide any other observations you have made:



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	 ☐ ☐
Other photos, please describe.	

Appendix F - TIA-2 Station Description

Memorandum

Refer to File: ERM Memo template.dotx

Date: October 30, 2017

To: John Roberts, Vice President, Environmental Affairs, TMAC Resources Inc. (TMAC); Oliver Curran, Director, Environmental Affairs (TMAC); Shelley Potter, Manager, Environment (TMAC)

From: Cameron Evans, E.I.T; Ali Naghibi, Ph.D, P.Eng., Erin Forster, B.Sc., R.P.Bio.

Cc: Peter Luedke (SRK)

Subject: **Hope Bay Project: TIA-2 Station Description**

1. INTRODUCTION

A permanent, year round, water level monitoring station was installed in the Hope Bay Project Tailings Impoundment Area (TIA) at location TIA-2 on September 28, 2017. The new monitoring station has become the primary level monitoring station for the TIA, with the existing levelogger station at the same location becoming the backup station. The existing station was also reinforced during September 2017 to further protect it during the under-ice season. Redundant stations are in place due to the importance of data collected in the TIA and the potential for damage, particularly during the winter season. The purpose of this memorandum is to describe the station location, equipment, and setup as well as management of data collected at the station.

2. STATION DESCRIPTIONS

2.1 Location

The water level monitoring station, TIA-2, is located at UTM 13W 434905 E, 7558709 N. The pressure transducers extend south from the end of the bedrock outcrop. The telemetry tripod and levelogger station box are located on the top of the ridge approximately 25 m from the water edge, at an approximate elevation of 37 meters above sea level (masl).

The station can be accessed by parking at the pullout on the TIA road at the bedrock outcrop just south of the pump house jetty, then walking south approximately 250 m.

2.2 Equipment

Two separate pressure transducers are set up at the TIA-2 location. A telemetry station was newly installed next to the existing levelogger station (Plates 1 to 3). The telemetry station is considered the primary station, with the levelogger acting as a backup in the event the telemetry station stops functioning.

2.2.1 TIA-2 Telemetry (Primary)

The telemetry station uses a 0-15 pounds per square inch (psi) vented PS9800 pressure transducer (Instrumentation Northwest Inc.) with a 125 m long cable, paired with a HOBO Energy Pro Datalogger (Onset Computer Corp). Data is transmitted using a Solarstream solar-powered Iridium satellite transceiver (Upward Innovations Inc.) and accessible on the Data Garrison website (see Section 3). The station is powered by a 12 volt battery connected to a solar panel. Water levels are logged every 15 minutes in the summer, and every 60 minutes in the winter (to save power). Data are uploaded to the Data Garrison website via satellite once every 24 hours.

2.2.2 TIA-2 Levelogger (Backup)

The levelogger station uses a 0-5 m unvented Levelogger Edge, coupled with a barologger located at Doris Camp. The levelogger is connected to a 250 ft direct read cable. The cable connector is protected in a metal electrical junction box located approximately 10 m east of the telemetry station. The levelogger logs every 15 minutes and is set to continuous logging, meaning it will overwrite the oldest data when it becomes full. The logger can store 40,000 readings and is downloaded at minimum once per year to prevent data loss.

2.3 Station Setup

2.3.1 TIA-2 Telemetry (Primary)

The pressure transducer and cable for the telemetry station is protected inside a 2 (inch) diameter high density polyethylene (HDPE) pipe. The 2″ pipe is made up of three 40 ft (foot) sections clamped together to create a 120 ft long pipe. The lowest 40 ft section has holes drilled along the length of the pipe to allow water to pass unimpeded into the pipe so that water level measurement will not be impeded if the end of the pipe becomes buried by sediment in the future. This 120 ft long pipe is protected inside sections of 3″ aluminum pipe to protect the 2″ HDPE pipe from ice damage during the winter. The lowest section of 3″ aluminum pipe consists of two 20 ft lengths clamped together, and extended approximately 30 feet from shore at the time of installation. The lowest 20 feet of aluminum pipe has holes drilled along its length to allow water to pass unimpeded into the pipe in the event that the end becomes buried by sediment in the future. An additional 30 feet of aluminum pipe protects the 2″ HDPE pipe up to the top of the ridge to protect the pipe as water levels in the TIA continue to rise. There are short sections where the 2″ HDPE pipe is exposed to allow the 3″ aluminum pipes to be fit to the bedrock topography. A 1″ aluminum conduit protects the pressure transducer cable from the top of the 2″ HDPE pipe to the telemetry station.

The pressure transducer cable is secured in the pipe with a hose clamp at the top of the 2″ HDPE pipe. This allows for the adjustment, removal and/or replacement of the pressure transducer in the future when water levels are higher.

At the time of installation, the pressure transducer was approximately 30 feet from shore and at a depth of approximately 2.15 m.

2.3.2 TIA-2 Levelogger (Backup)

The existing levelogger station was improved in September 2017 to accommodate rising water levels in the TIA. The pressure transducer and cable for the levelogger station is protected by a combination of 2″ steel drill casing and 2″ HDPE pipe. The 2″ HDPE pipe is further protected from future ice damage by 3″ aluminum pipe.

The previous station consisted of 40 feet of 2″ drill casing that extended into the TIA approximately 35 feet. The pressure transducer and cable are housed in 1″ aluminum conduit that runs down the length of the drill casing, however the connection point to the pressure transducer cable was only 1 m above the current TIA water level and would have been submerged in the spring. The drill casing is now connected to 2″ HDPE pipe that runs 80 feet (two 40 ft sections that are clamped together) up the bank. The 3″ aluminum pipe protects the connection between the steel drill casing and HDPE pipe, as well as a further 30 feet of aluminum pipe up to the top of the ridge to protect the pipe as water levels in the TIA continue to rise to the maximum design elevation. There are short sections where the 2″ HDPE pipe is exposed to allow the 3″ aluminum pipes to be fit to the bedrock topography. A 1″ aluminum conduit protects the pressure transducer cable from the top of the 2″ HDPE pipe to the telemetry station (Plates 1 to 3).

The 1″ aluminum conduit housing the levelogger pressure transducer is clamped to the inside of the steel drill casing to prevent movement of the pressure transducer. This prevents the levelogger from being adjusted, recovered or replaced once the water level exceeds the top of the drill casing. The levelogger will remain in place and continue to gather data for the life of the pressure transducer, approximately 7 to 10 years.

At the time of installation, the pressure transducer was approximately 35 feet from shore and at a depth of approximately 2.3 m.

2.4 Station Bench Marks

Three rock bolts serve as bench marks for water level surveys of the TIA. They are located on the north side of the bedrock outcrop, just south of the reclaim jetty, at UTM coordinates 13W 434790 E, 75558934 N. Geodetic elevations for the bench marks, determined by TMAC surveyors, are presented in Table 1 below.

Table 1: TIA-2 Bench Mark Elevations

Bench Mark Tag Number	Geodetic Elevation
41	32.365
42	32.392
43	32.559

3. STATION DATA

3.1 TIA-2 Telemetry (Primary)

Data collected by the TIA-2 telemetry station are uploaded to the Data Garrison website once every 24 hours. The website displays the most recent water level and battery readings, as well as a graph of historical data. Data can be downloaded from the website in either Hoboware format or tab delimited format. The satellite data subscription must be renewed annually – this is currently performed by ERM.

Website: www.datagarrison.com
Username: 300234010417660
Password: hobo

The value reported by the telemetry station is m (meters) of water above the pressure transducer. To convert to masl, a constant of 27.761 m should be added to the telemetry pressure transducer reading. This constant may change over time due to sensor drift or movement. ERM currently performs bench mark and water level surveys at least twice annually to confirm or modify this constant. Any changes are communicated to TMAC. This procedure should be continued in future years.

3.2 TIA-2 Levelogger (Backup)

Data collected by the TIA-2 Levelogger must be manually downloaded from the connection at the end of the direct read cable, and compensated using the barologger located in Doris Camp. The levelogger data are currently collected and stored by ERM but will only be used in the event the telemetry station is not functioning properly.

The value reported by the levelogger is in m of water above the pressure transducer. To convert to masl, a constant of 27.586 m should be added to the compensated levelogger reading. This constant may change over time due to sensor drift or movement. ERM currently performs bench mark and water level surveys at least twice annually to confirm or modify this constant. Any changes are communicated to TMAC. This procedure should be continued in future years.

Prepared by:

Cam Evans, EIT
Water Resources Engineer
ERM

PHOTOGRAPHIC PLATES

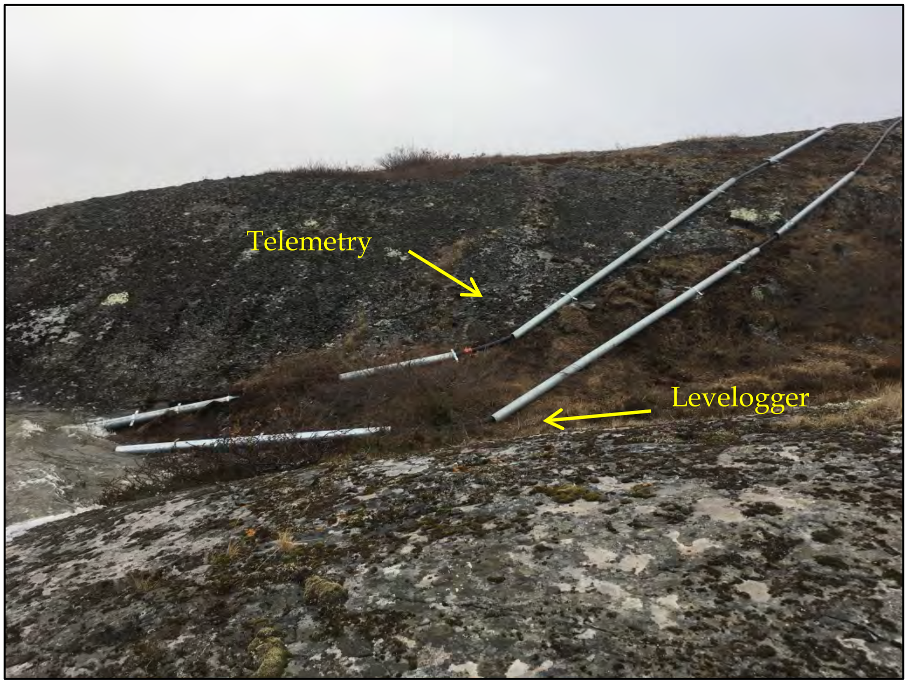


Plate 1: View of 3" aluminum pipes, protecting the 2" HDPE pipes that house the pressure transducer cable, extending from the TIA up to the top of the ridge. September 28, 2017.

Plate 2: View from the top of the ridge looking down at the TIA. September 28, 2017.

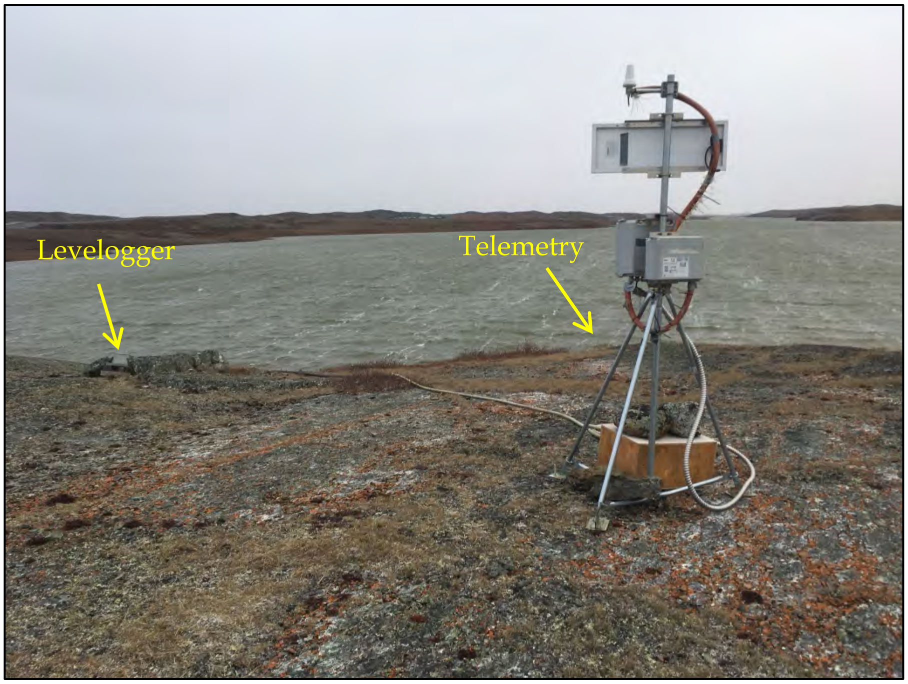
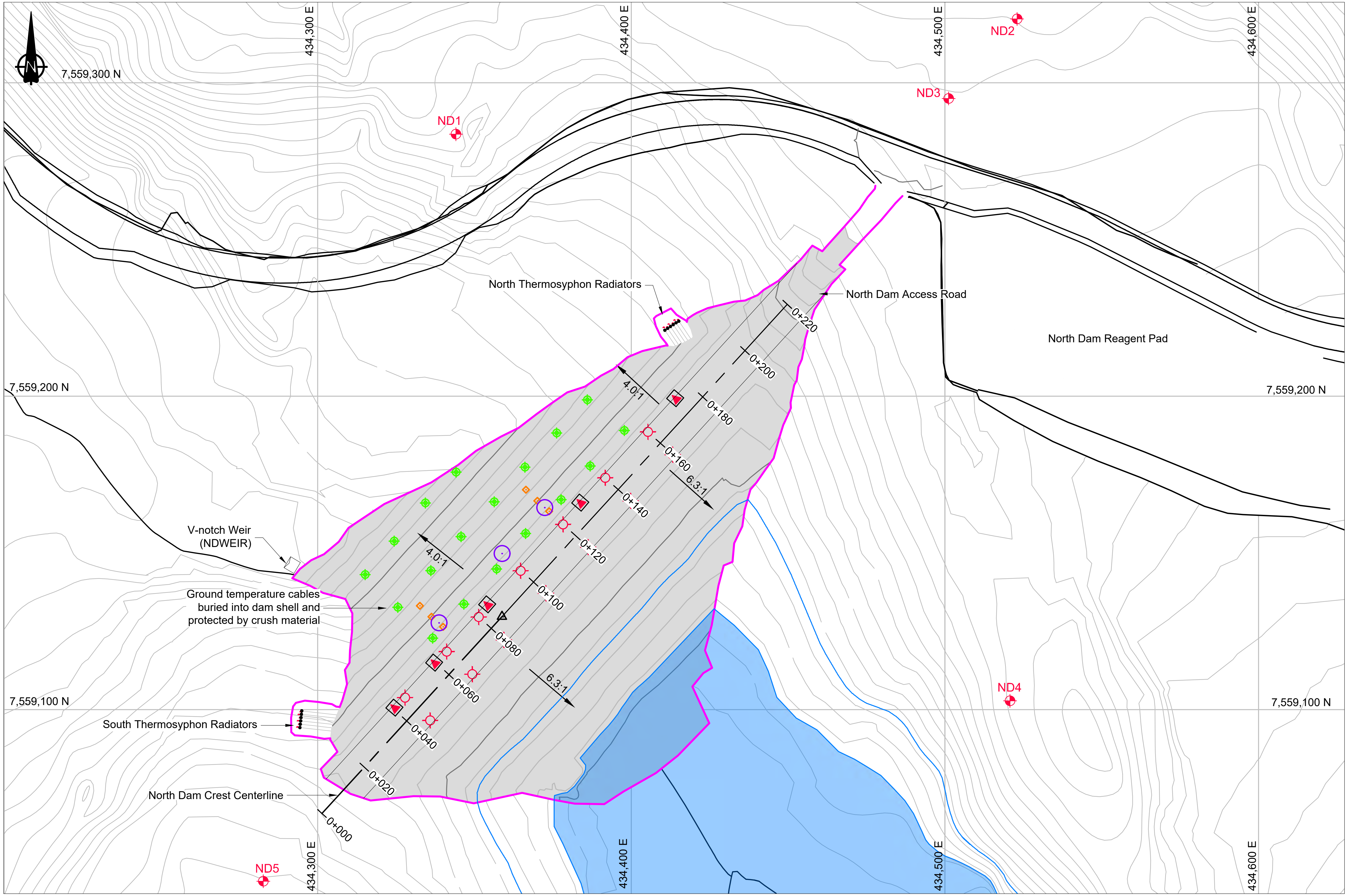


Plate 3: Southerly view of the telemetry station with the junction box housing the levelogger direct read cable in the background. September 28, 2017.

Figures



LEGEND

- Primary Control Point
- Survey Monitoring Point (Crest)
- Deep Settlement Point
- Surficial Survey Point
- Inclinometer Location
- Major Contour
- North Dam Extents
- Full Supply Level (Elev. 33.5m)
- Thermosyphon Radiator
- GTC Instrumentation Node

NOTES

1. Topographic contour data was provided by the Client. As-Built contour data for terrain model was provided by the Contractor.
2. Contours shown at 1.0m intervals.
3. Details and names for instrumentation presented on Figure 2.

REFERENCE

NAD83 UTM Zone 13.

PRIMARY CONTROL POINTS STAKE OUT TABLE

Point ID	Northing	Easting	Elev. (m)
ND1	7559283.611	434344.083	42.905
ND2	7559320.367	434522.981	46.915
ND3	7559295.013	434501.167	45.38
ND4	7559102.79	434520.744	44.236
ND5	7559045.274	434282.658	42.871

0m 10 20 30 40 50

srk consulting

SRK JOB NO.: 1CT022.036.500

FILE NAME: 1CT022.036 - Monitoring SOP.dwg

MAC RESOURCES

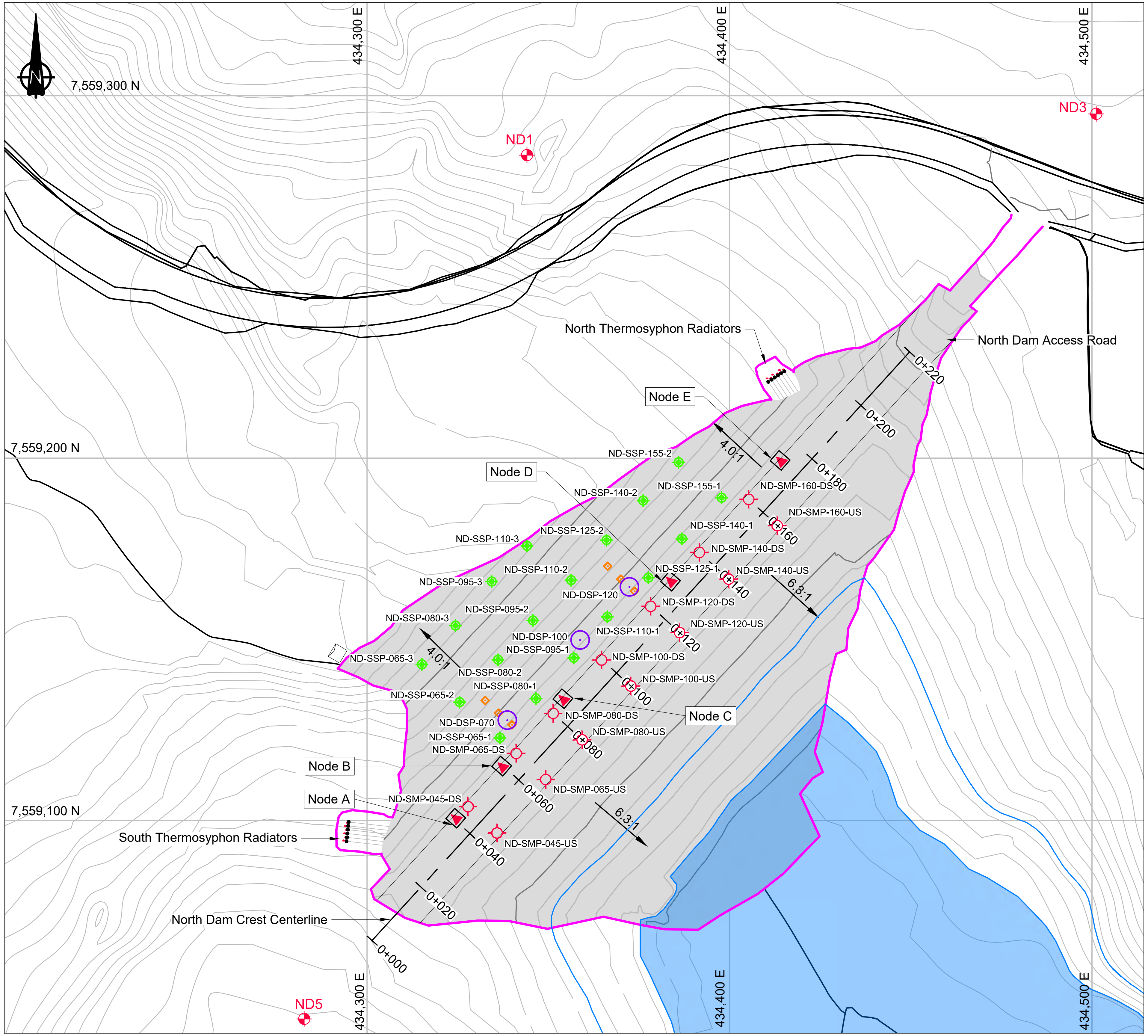
Hope Bay Project

North Dam SOP

North Dam General Arrangement and Primary Control Points

DATE: August 2019 | APPROVED: PL | FIGURE: 1

P:\01_SITES\Hope Bay\!ACAD\2019 Drawings\North Dam SOP\1CT022.036 - Monitoring SOP.dwg



0m 10 20 30 40 50

LEGEND

- Primary Control Point As-Built
- Survey Monitoring Point (Crest)
- Deep Settlement Point
- Surficial Survey Point
- Inclinometer Location
- Major Contour
- Final Surface Extents
- Full Supply Level (Elev. 33.5m)
- Thermosyphon Radiator
- GTC Instrumentation Node

NOTES

1. Topographic contour data was provided by the Client. As-Built contour data for terrain model was provided by the Contractor.
2. Contours shown at 1.0m intervals.
3. Nodes B and D are the two weatherproof enclosures which house the GTC instrumentation nodes

REFERENCE

NAD83 UTM Zone 13.

AS-BUILT DEEP SETTLEMENT POINTS STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-DSP-070	7559127.69	434338.65	36.95
ND-DSP-100	7559149.78	434358.75	36.86
ND-DSP-120	7559164.46	434372.37	36.92

AS-BUILT SURFICIAL SURVEY POINTS STAKEOUT TABLE

ID	Northing	Easting	Elev.(m)
ND-SSP-065-1	7559122.80	434336.67	36.77
ND-SSP-065-2	7559132.67	434325.55	32.81
ND-SSP-065-3	7559143.10	434315.11	29.43
ND-SSP-080-1	7559133.65	434346.59	36.79
ND-SSP-080-2	7559144.37	434336.10	32.92
ND-SSP-080-3	7559153.75	434324.36	29.33
ND-SSP-095-1	7559144.90	434357.04	36.58
ND-SSP-095-2	7559155.21	434345.72	32.85
ND-SSP-095-3	7559165.92	434334.35	28.70
ND-SSP-110-1	7559156.20	434366.29	36.32
ND-SSP-110-2	7559166.31	434356.29	32.88
ND-SSP-110-3	7559175.79	434344.10	28.97
ND-SSP-125-1	7559166.97	434377.61	36.77
ND-SSP-125-2	7559177.37	434366.08	32.91
ND-SSP-140-1	7559177.75	434386.85	36.48
ND-SSP-140-2	7559188.28	434376.19	32.84
ND-SSP-155-1	7559189.07	434397.79	36.80
ND-SSP-155-2	7559198.85	434385.98	32.91

AS-BUILT SURVEY MONITORING POINTS STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-SMP-065-DS	7559118.52	434341.14	38.46
ND-SMP-065-US	7559111.31	434349.30	38.36
ND-SMP-080-DS	7559129.57	434351.35	38.41
ND-SMP-080-US	7559122.27	434359.34	38.40
ND-SMP-100-DS	7559144.32	434364.71	38.39
ND-SMP-100-US	7559137.12	434372.77	38.46
ND-SMP-120-DS	7559159.12	434378.24	38.41
ND-SMP-120-US	7559151.88	434386.24	38.46
ND-SMP-140-DS	7559173.98	434391.69	38.39
ND-SMP-140-US	7559166.62	434399.77	38.42
ND-SMP-160-DS	7559188.64	434405.30	38.40
ND-SMP-160-US	7559181.37	434413.18	38.43

Node (Station)	GTC Name
Node A (0+040)	1.ND-VTS-040-KT
	12.ND-HTS-040-31.5
	13.ND-HTS-040-33.5
Node B (0+060)	2.ND-VTS-060-KT
	3.ND-VTS-060-US
	4.ND-VTS-060-DS
	14.ND-HTS-060-28.8
	15.ND-HTS-060-31.0
	16.ND-HTS-060-33.5
Node C (0+085)	5.ND-VTS-085-KT
	6.ND-VTS-085-US
	7.ND-VTS-085-DS
	17.ND-HTS-085-25.3
	18.ND-HTS-085-29.4
	19.ND-HTS-085-33.5
Node D (0+130)	8.ND-VTS-130-KT
	9.ND-VTS-130-US
	10.ND-VTS-DS
	20.ND-HTS-130-28.8
	21.ND-HTS-130-31.0
	22.ND-HTS-130-33.5
Node E (0+175)	11.ND-VTS-175-KT
	23.ND-HTS-175-32.5
	24.ND-HTS-175-33.5
	25.N Thermosyphons (x6)
	26.S Thermosyphons (x6)

AS-BUILT INCLINOMETER LOCATION STAKEOUT TABLE

ID	Northing	Easting	Elev. (m)
ND-IN-070-1	7559126.41	434340.00	37.44
ND-IN-070-2	7559129.63	434336.27	36.20
ND-IN-070-3	7559133.13	434332.57	34.85
ND-IN-120-1	7559163.31	434373.78	37.44
ND-IN-120-2	7559166.64	434370.03	36.05
ND-IN-120-3	7559170.15	434366.40	34.95

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TMAC RESOURCES

North Dam SOP

North Dam Instrumentation Layout

Hope Bay Project

SRK JOB NO.: -

FILE NAME: 1CT022.036 - Instrumentation LO.dwg

DATE: August 2019 | APPROVED: - | FIGURE: 2

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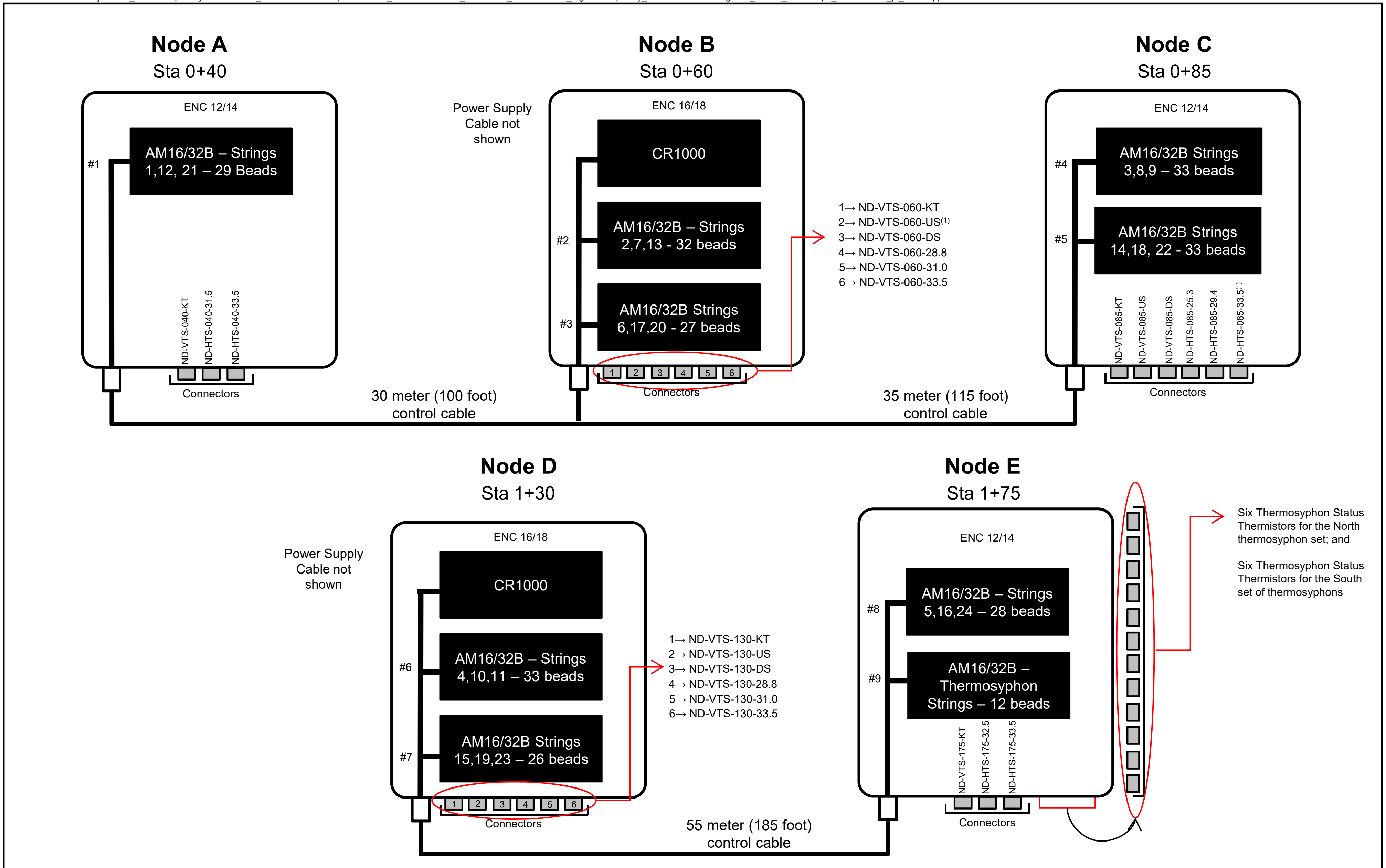
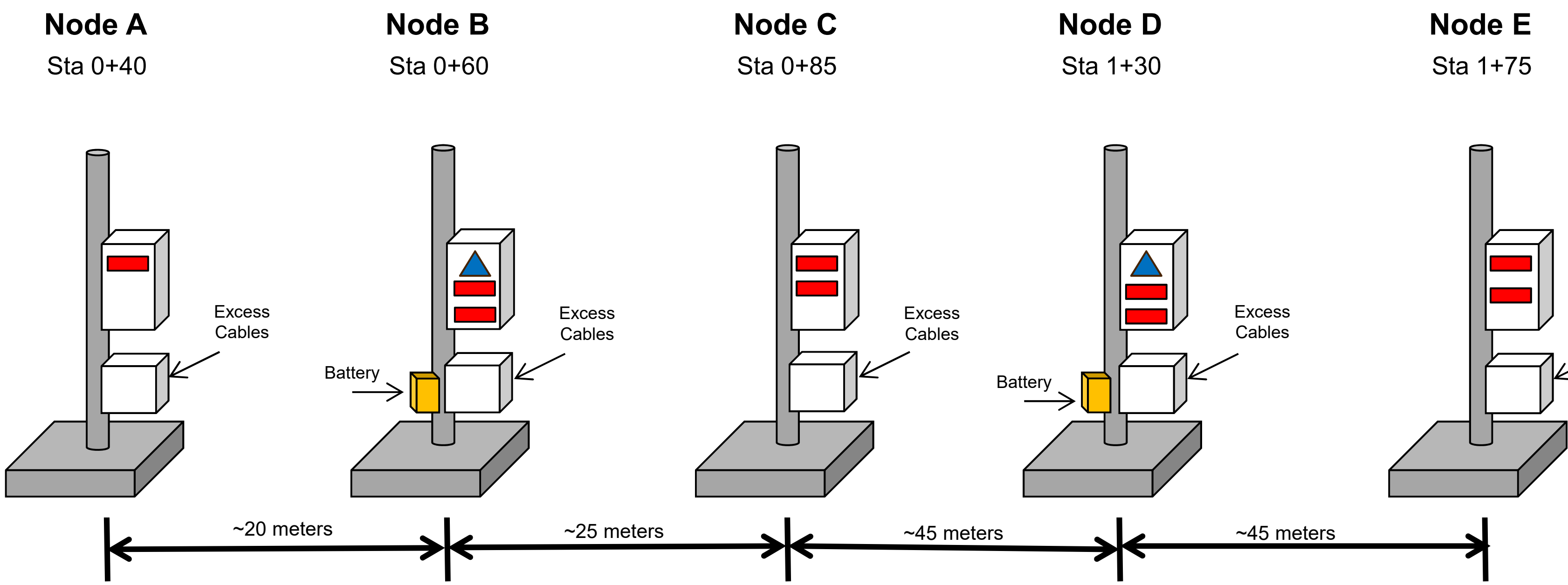


Notes:
Internal temperature of data logger housing is measured continuously.
(1) GTC irreparably damaged, no recorded data.

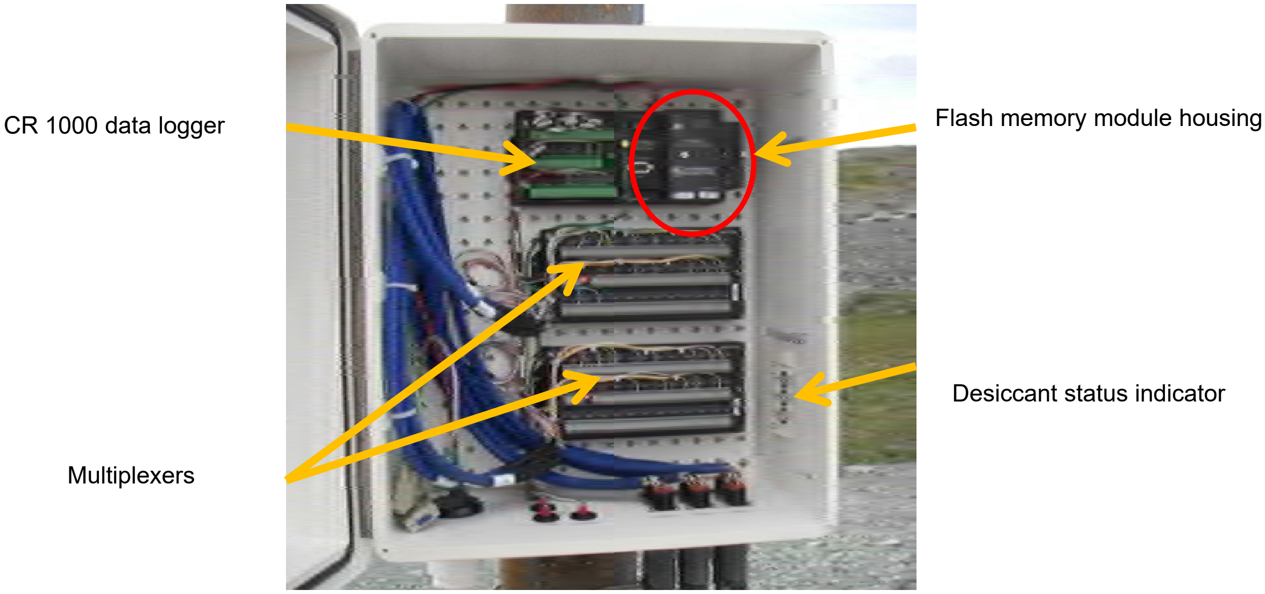
srk consulting	TMAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Monitoring Nodes A through E
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_Rev03_Landscape_1CT022.000_pl_Rev00	Doris Mine	Date: July 2020 / Approved: JBK/IM/PL / Figure: 3



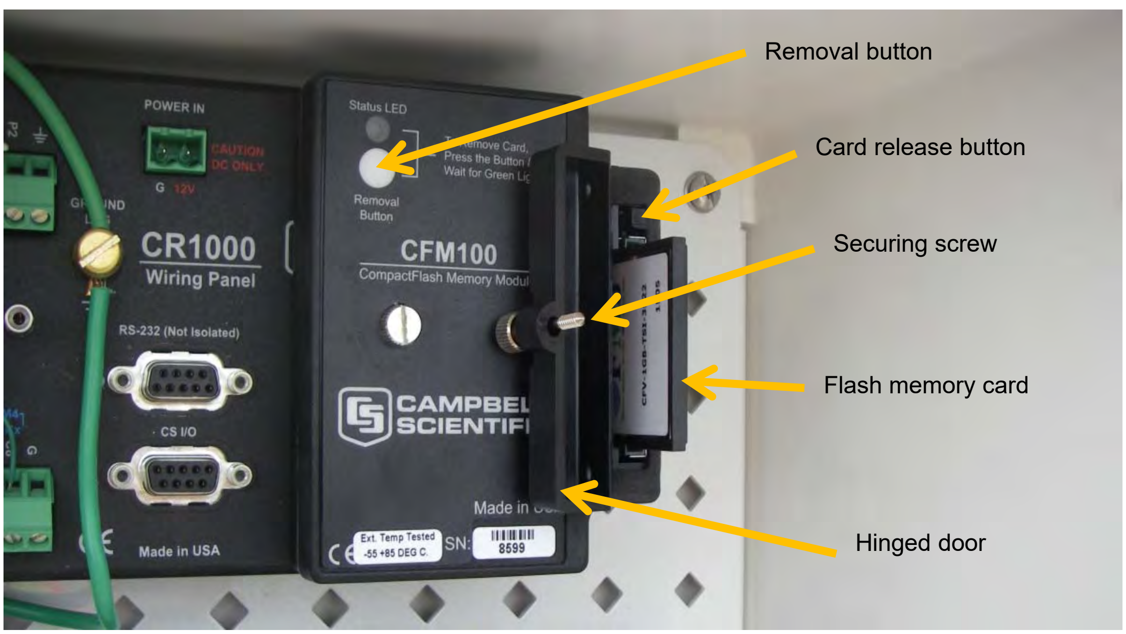
Legend

▬ (red)	AM 16/32 Multiplexer
▲ (blue)	CR1000 Datalogger

srk consulting	MAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Layout of Data Acquisition System
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_Rev03_Landscape_1CT022.000_pl_Rev00	Doris Mine	Date: July 2020 · Approved: JBK/IM/PL · Figure: 4



Key components inside the weatherproof enclosure



Close-up view of the CR1000 data logger and CFM 100 Compact Flash Module inside the weatherproof enclosure

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TMAC RESOURCES

North Dam Monitoring SOP (Revision 3)

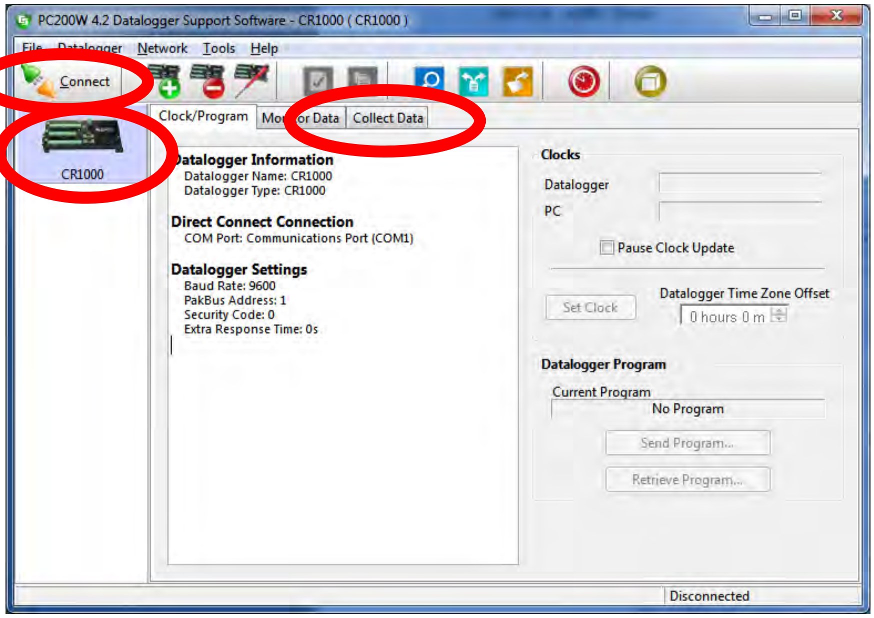
Weatherproof Enclosure and Datalogger Components

Job No: 1CT022.000

Filename: HopeBay_NorthDamMonitoringSOP_FIGURES

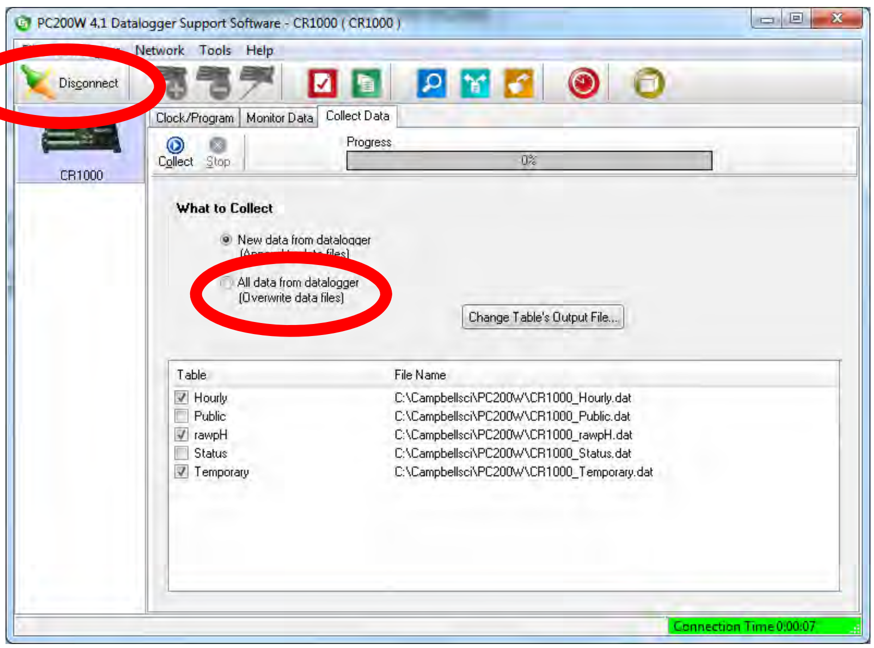
Doris Mine

Date:	Approved:	Figure:
July 2020	JBK/IM/PL	5



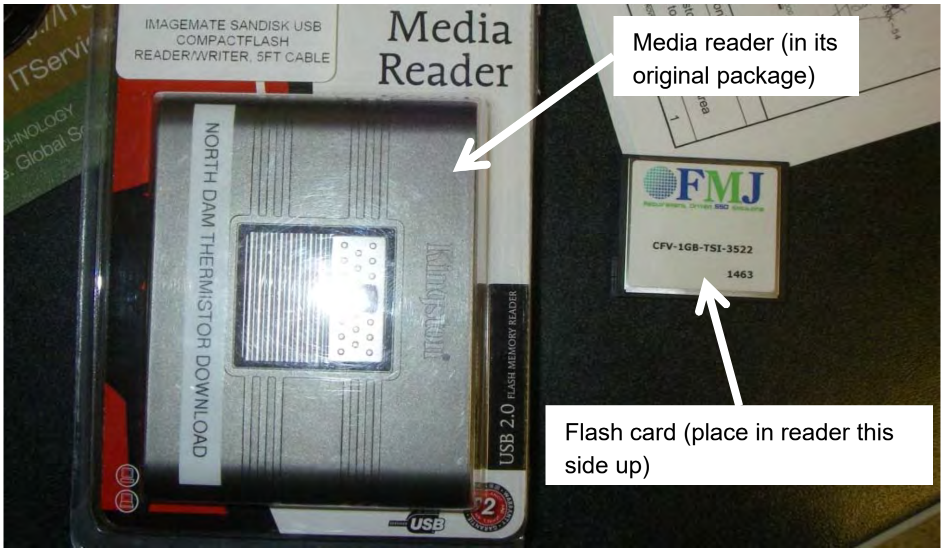
Step 1

PC200W Datalogger connection (Section 4.3.1)

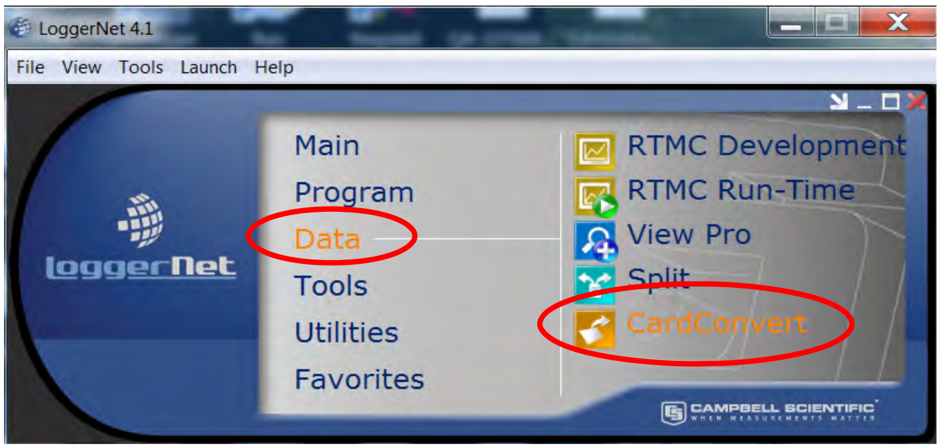


PC200W 'Collect Data' tab (Section 4.3.1)

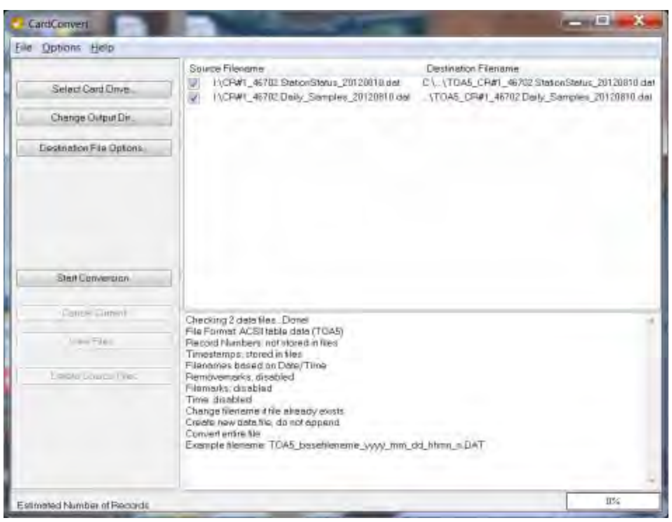
srk consulting	MAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Datalogger Direct Download Details / Screenshots
Job No: 1CT022.000	Doris Mine	Date: July 2020
Filename: HopeBay_NorthDamMonitoringSOP_FIGURES		Approved: JBK/IM/PL
		Figure: 6



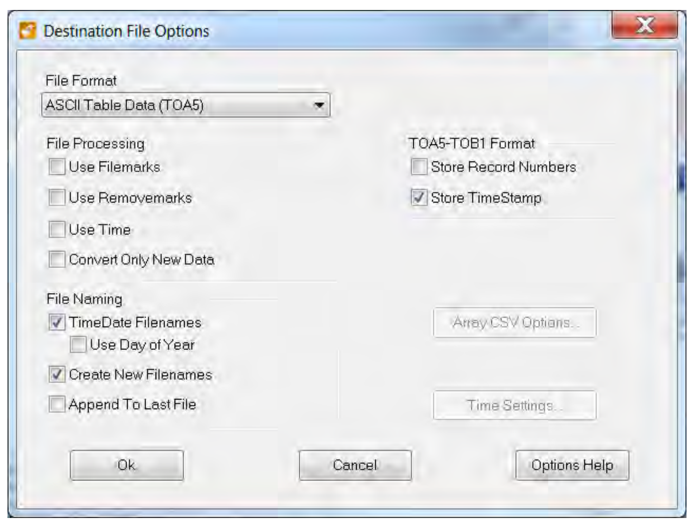
View of media card reader and flash memory card



Screenshot of LoggerNet starting menu (outlined in Section 4.5)



Screenshot of the file selection screen referred to in Step 2 (Section 4.5)



Screenshot of the "Destination File Options" referred to in Step 4 (Section 4.5)

srk consulting	MAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Datalogger Flash Card Exchange Details / Screenshots
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_FIGURES	Doris Mine	Date: July 2020 | Approved: JBK/IM/PL | Figure: 7

\\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.036_2019 General Compliance\080_Deliverables\510_NorthDam_MonSOP\040_Figures\HopeBay_NorthDamMonitoringSOP_REV3_FIGURES 8_11-13_1CT022.000_PL_Rev00.pptx

Simplified Plan Layout of North Thermosyphons

Simplified Plan Layout of South Thermosyphons

Thermosyphon status thermistors attached to thermosyphon risers using epoxy resin and zip-ties.

Thermosyphon status thermistors after being heat-insulated using expanding spray foam.

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TMAC RESOURCES

North Dam Monitoring SOP (Revision 3)

Thermosyphons Status Thermistor Details

Job No: 1CT022.000

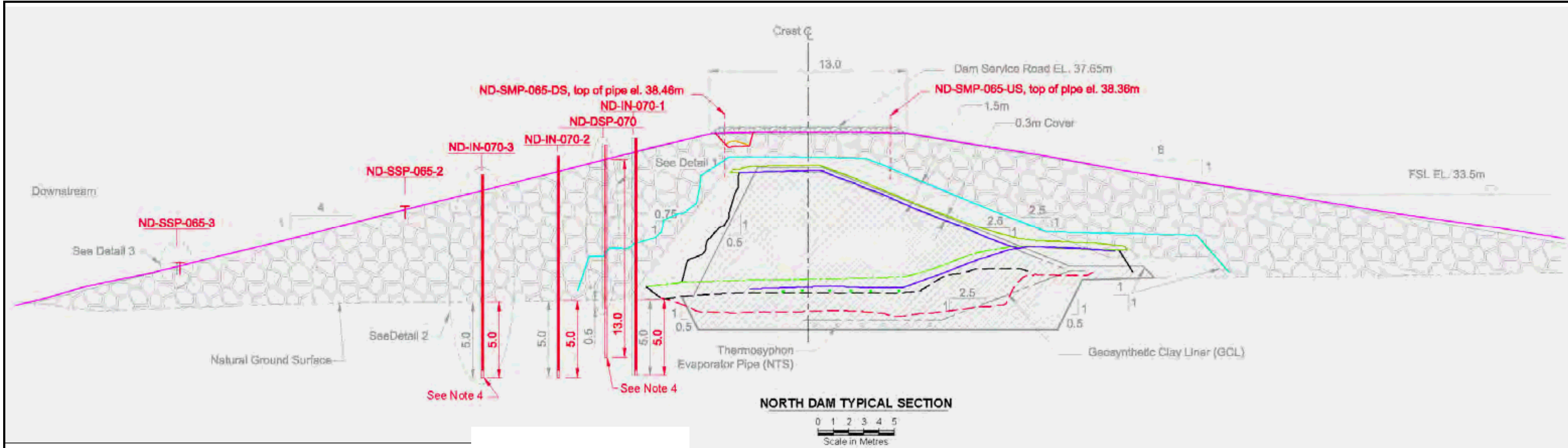
Filename: HopeBay_NorthDamMonitoringSOP_FIGURES

Doris Mine

Date: July 2020

Approved: JBK/IM/PL

Figure: **8**



Core Material
Transition Material
Run of Quarry (ROQ)
Surfacing Material
Bedrock
Peat

GCL As-built
Core Material As-built
Core Material (2011) As-built
Levelling Course (Core Material) As-built
Instrumentation Trench Cover As-built
Key Trench / Instrumentation Trench As-built
GCL Cover Material As-built
Transition Material As-built
ROQ Material As-built
Thermosyphon Evaporator Pipes As-built

Example of as-built instrumentation installed on the downstream of dam.

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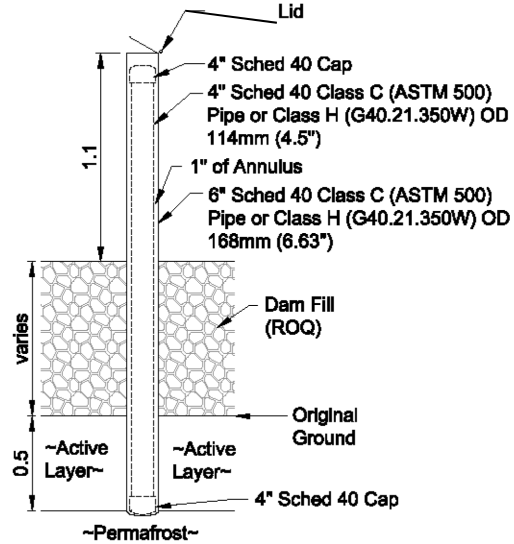
MAC RESOURCES

North Dam Monitoring SOP (Revision 3)

Deformation Monitoring Instrumentation Layout

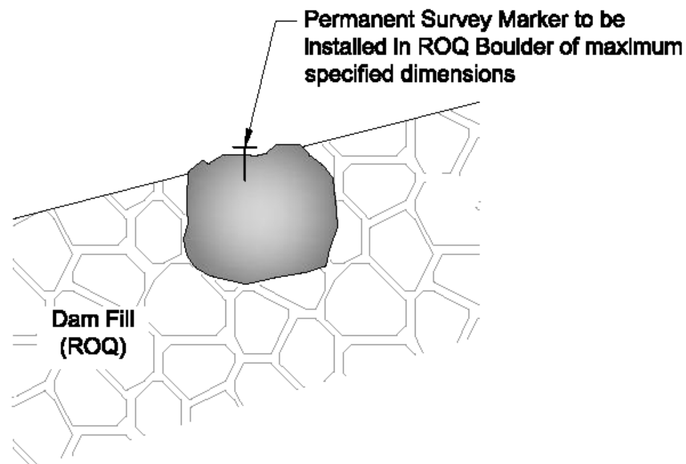
Job No:	1CT022.000	Doris Mine	Date: July 2020	Approved: JBK/IM/PL	Figure: 9
Filename:	HopeBay_NorthDamMonitoringSOP_Rev03_Landscape_1CT022.000_pl_Rev00				



DETAIL
DEEP SETTLEMENT POINT INSTALLATION
Not to Scale

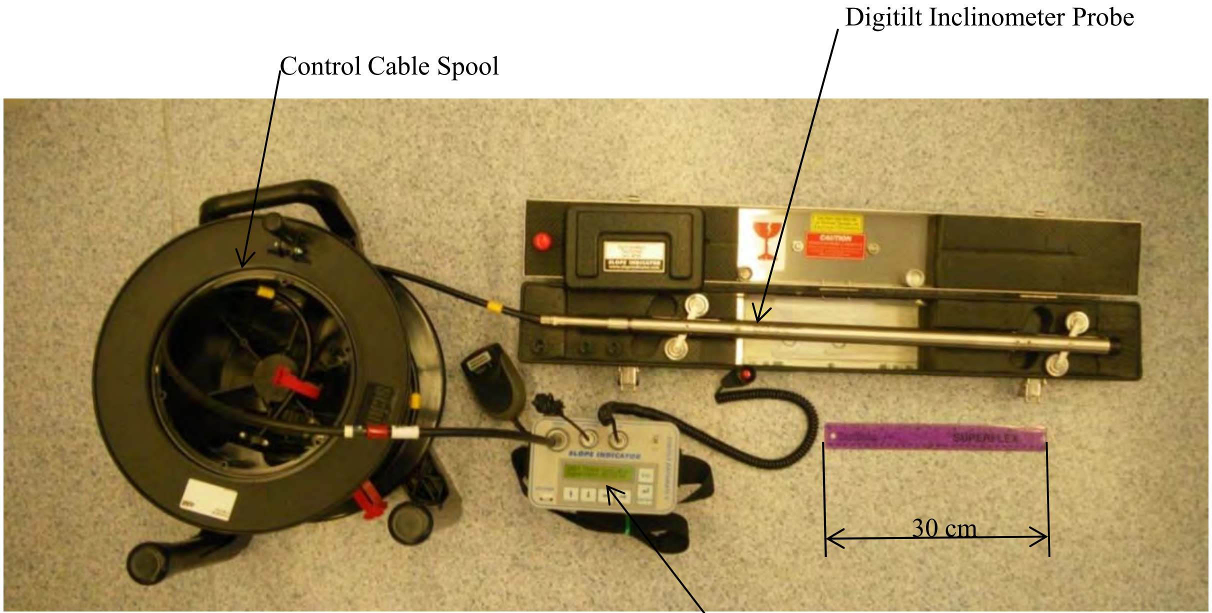
Examples of crest survey monument. Note the small rock bolt /anchor installed in the boulders seated into the dam shell.

Example of deep settlement points installed in the downstream of the dam.



DETAIL
SURFICIAL SURVEY POINT INSTALLATION
Not to Scale

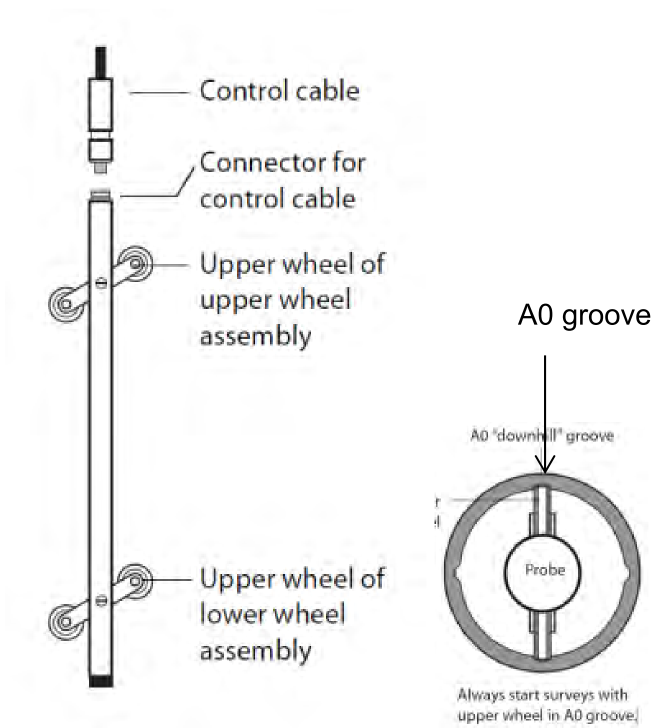
srk consulting	MAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Deep Settlement Points and Surficial Survey Points Details
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_Rev03_Landscape_1CT022.000_pl_Rev00	Doris Mine	Date: July 2020 · Approved: JBK/IM/PL · Figure: 10



Inclinometer probe with readout and control cable spool

Inclinometer instruments packages wrapped up for storage

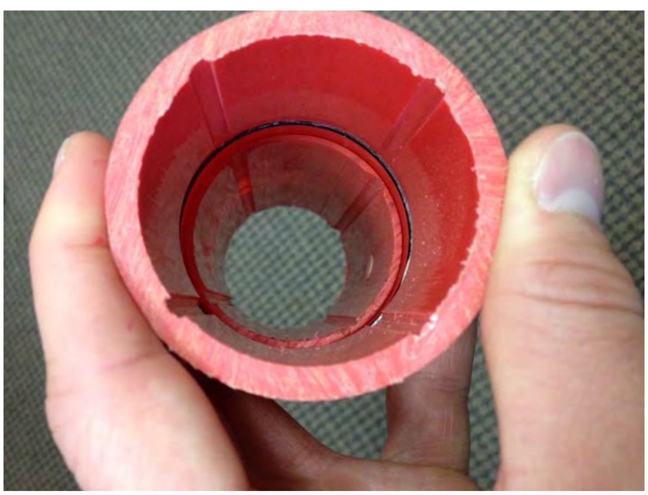
Example of Digitilt Inclinometer Set-Up



Schematic reproduced from www.slopeindicator.com

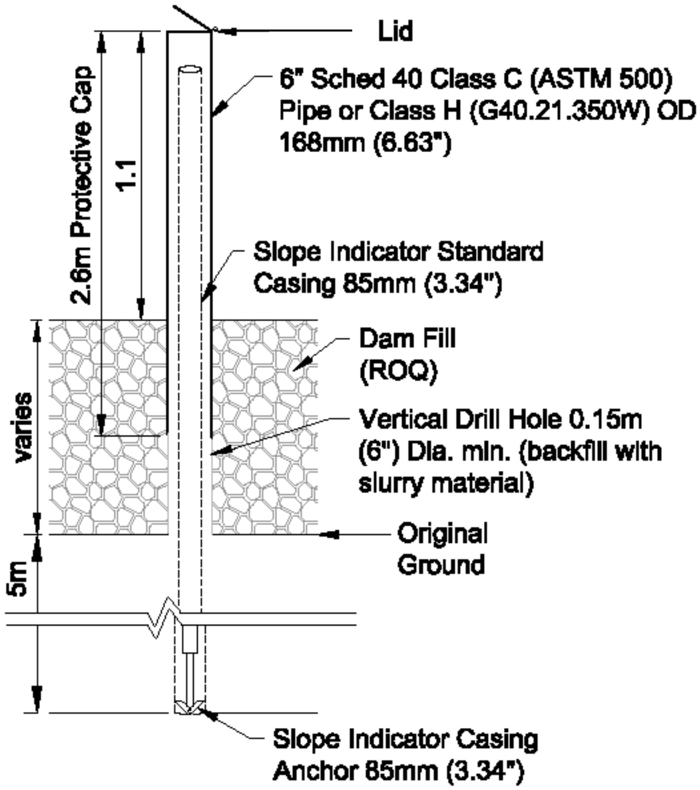
Schematic of Upper wheel and upstream marker from Slope Indicator manual (Appendix A)

Example of inclinometer protective casing, with and without top cap on.



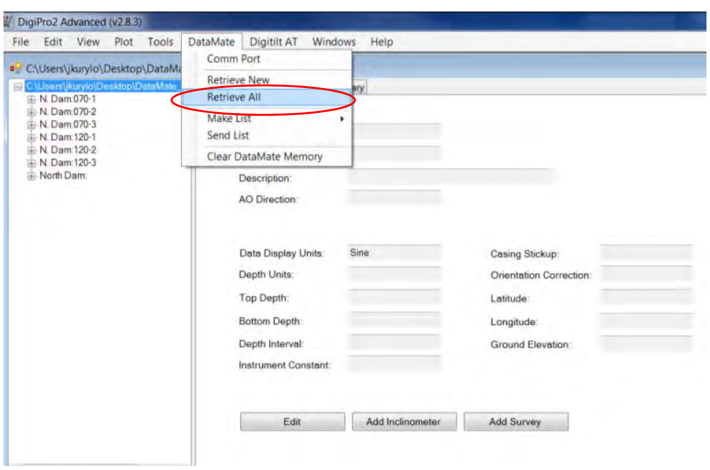
Example of four inner groves spaced at ~90^{o} angles. Note that only one set of grooves is used for the two sets of measurements (i.e. 180^{o} rotation of instrument)

srk consulting	TMAC RESOURCES	North Dam Monitoring SOP (Revision 3)
		Photographs of Inclinometer Set-Up
Job No: 1CT022.000 Filename: HopeBay_NorthDamMonitoringSOP_FIGURES	Doris Mine	Date: July 2020 / Approved: JBK/IM/PL / Figure: **12**

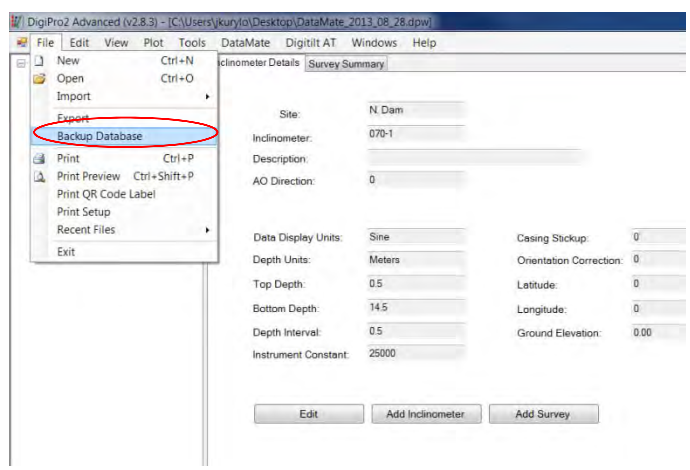


DETAIL
INCLINOMETER INSTALLATION
Not to Scale

Marker being correctly held and aligned with top of inclinometer casing



Main DataMate menu from DigiPro2 Inclinometer software



Backup menu from DigiPro2 Inclinometer software

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MAC RESOURCES

North Dam Monitoring SOP (Revision 3)

Inclinometer Measurements and Software Details

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AGNICO EAGLE

Hope Bay Project, South Dam Monitoring: Standard Operating Procedures – Revision 1

Prepared for

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1CT022.064
Updated by AEM
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Hope Bay Project, South Dam Monitoring: Standard Operating Procedures – Revision 1

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1 Introduction

1.1 Revision Summary

Table 1 provides a summary of the revision history for the South Dam Monitoring Standard Operating Procedures (SOP).

Table 1: Revision History for the South Dam Monitoring SOP

Revision	Status	Date	Major Changes
0	DRAFT - Issued for Review	June 2020	-
1	Issued for Use	August 2020	-
4	Issued for Use	December 2022	Updated to reflect change in ownership

1.2 Background

The South Dam is one of three dams that will be constructed as part of the ultimate Doris tailings impoundment area (TIA). Phase 1 tailings deposition requires the use of two out of the three structures; namely the North Dam and Phase 1 of the South Dam. Future Phase 2 tailings deposition will require the South Dam to be raised with downstream methods to its ultimate crest elevation (46.0m). During Phase 2, as the tailings elevation continues above the containment provided by natural topography around Phase 1 TIA, a third containment structure, the West Dam, will be required.

The South Dam was designed to have tailings deposited off the upstream face to create a beach. Its successful performance is dependent on maintaining the integrity of the frozen foundation through preservation of permafrost underlying the dam. Because of complex foundation conditions, differential settlement longitudinally and transversely across the dam is expected. To track whether foundation conditions and deformations are within the design limits for the dam, a rigorous monitoring program has been established.

Table 2 lists the South Dam monitoring components.

Table 2: South Dam Monitoring Components

Component	Instrument	Quantity
Thermal	Horizontal ground temperature cables	9
	Vertical ground temperature cables	12
	Key trench toe alignment temperature cables	1
	D505 Dataloggers	8
Deformation	Deep Settlement Points (DSP)	3
	Surficial Survey Points (SSP), located on the crest and downstream face	19
	Crest Survey Monitoring Points (SMP), located along the upstream crest	6
	Crest survey monitoring points, located along the downstream crest	6
Water level	Pressure transducer installed in Reclaim pond	1
Seepage	Weekly Walkover Survey, sampling as required	n/a
Visual	Weekly Walkover Survey	n/a

1.3 Objectives

Responsibility for implementing the South Dam monitoring program rests with AEM, and the data must be reviewed annually by the Engineer of Record (EOR) as part of an annual geotechnical inspection. This document provides Standard Operating Procedures (SOP) for carrying out the required monitoring.

2 Monitoring Overview

2.1 Thermal Monitoring

2.1.1 Ground Temperature Cables

The foundation of the Phase 1 South Dam has been designed to remain frozen for the life of the structure. The upstream edge of the key trench base is expected to remain at a temperature of at least -2°C, while the underlying foundation soils remain colder. Twelve functioning vertical GTCs are installed to monitor the foundation temperature, to an approximate depth of 15 m below the base of the key trench or original ground dependent on the cables installed location. Four functioning horizontal GTCs are installed directly above the lower GCL liner to monitor foundation temperatures within the key trench and five functioning horizontal GTCs are installed along the upper GCL liner to monitor temperatures within the above ground dam fill. A single longer horizontal GTC is installed directly above the liner overlap flap, between approximately stations 2+45 and 4+25 to monitor temperature near the interface with the original ground. At the time of writing, six of the installed GTCs are inactive due to irreparable damage or malfunction.

Eight dataloggers were installed at the South Dam. These D505 data loggers are manufactured by BeadedStream and are powered by an internal battery that is charged from solar panels on each unit. Appendix A1, A4 and A5 provides additional details on the D505 data loggers, and Appendix B1 provides additional data logger specifications. Data is stored internally and currently transmitting every 12hrs via satellite telemetry through a two-way satellite transceiver and Iridium antenna. These dataloggers have an operating range of -40°C to +85°C. The SOP for monitoring downloading data from this instrumentation is presented in Section 4.

2.2 Deformation Monitoring

2.2.1 Survey Point Monitoring

The Phase 1 South Dam is expected to undergo deformation because of creep over its design life, which includes differential longitudinal and transverse settlement. A total of 34 survey monitoring points were installed within the structure to track these deformations such that it can be confirmed that they are within the specified design limits.

The installed monitoring points are illustrated on Figures 1 and 2, and include the following:

- **Deep Settlement Points (DSP):** Three deep settlement points are located on the downstream slope of the dam. The deep settlement points are intended to track deformation of the foundation soils directly below the dam. The Deep Settlement Points are constructed of rods attached to plates buried at the foundation of the dam. The rods are contained within a casing that allows free movement of the rod, independent of the dam fill
- **Crest (Fixed) Survey Monitoring Points (SMP):** Twelve crest survey monitoring points are located along the crest of the dam, six of which are intended to monitor deformation below the upstream crest near the upper GCL liner contact and six intended to monitor deformation below the downstream crest under 2 meters of transition material.

- **Surficial Survey Points (SSP):** Nineteen surficial survey points are located at select locations on the crests and downstream shell of the dam. The surficial survey points are intended to track deformation of the dam shell or the foundation soils dependent on their installation location.

The SOP for completing these manual surveys, are included in Section 5.

2.3 Water Balance Monitoring

The Phase 1 South Dam is not designed to retain water. Water level measurements in the Reclaim Pond are monitored with a pressure transducer and data logger. An elevation constant is used to convert the water level to an elevation. This should continue to be used as the primary source of water level data. See the SRK North Dam SOP for additional details (SRK 2020a). Ponded water should never encroach closer than 100 m from the upstream Phase 1 South Dam Crest. As communicated in a number of reports, including the Annual Geotechnical Report (SRK 2020b) and the deposition plan (SRK 2020b, Appendix N). Visual markers approximately 100 m from the Phase 1 upstream dam crest have been placed on each shoreline to assist in visual checks (Figure 1 and 2).

2.4 Visual Monitoring

Visual inspections are critical to the safe operations of the TIA as infrequent or specific instrumentation data alone does not complete the full performance picture. It is expected that the tailings deposition operations are monitored daily by qualified site staff at the dam. These inspections undocumented and are intended to be checks of dam conditions with a focus on atypical conditions or obvious geotechnical concerns at the dam or surrounding infrastructure. A weekly visual inspection must be carried out to thoroughly inspect the dam and formally document any issues observed. More details on the visual monitoring requirements are provided in Section 7.

A comprehensive visual inspection must be carried out as part of the AGI while a Dam Safety Review (DSR) must be completed in accordance with the CDA guidelines, at a frequency dependent on the dam hazard classification and the Canadian Dam Association (CDA) guidelines. It is suggested that the next South Dam DSR be completed in 2021 at the same time as the next North Dam DSR. While this is earlier than the stated CDA guideline minimum frequency requires, this will allow a more comprehensive review of the TIA as a system, rather than just the dam in isolation. A DSR is intended to re-assess the containment facility to validate the safety margin established for day-to-day operation, engineering practices, and legal and/or regulatory requirements. DSRs are completed by an independent review engineer that is not influenced by his or her prior participation in the design, construction, operation, maintenance, or inspection of the dams under review.

2.5 Seepage Monitoring

Dam seepage is not expected, however, if seepage is observed at the toe of the South Dam, monitoring is required in accordance with the SOP provided in Section 8. Ponded water was present in ice-wedge troughs prior to construction of the South Dam. Baseline water quality monitoring of ponded water on the downstream side of the dam is also required in accordance with Section 8 to establish a record of baseline water chemistry.

2.6 Tailings Deposition

Performance of the Phase 1 South Dam is directly dependent on adherence to the tailings deposition plan (SRK 2020b, Appendix N) to specifically establish an adequate tailings beaches upstream of the structure and limit ponding of supernatant water. Annual topographic surveys of the tailings beach above water and bathymetric surveys should be completed to confirm that deposition is consistent with the current plan. The deposition plan can be modified as necessary based on the annual data.

3 Monitoring Protocols

3.1 Monitoring Frequency/Responsibility

A summary of the monitoring requirements and associated responsibility is listed in Table 3. These monitoring requirements can be revised at any time under the direction of the South Dam Engineer-of-Record, or the qualified Licensed Geotechnical Engineer carrying out the AGI.

Table 3: Summary of Monitoring Requirements

<table>
<tr><th>Element</th><th>Item</th><th>Method</th><th>Responsibility</th><th>Minimum Frequency</th></tr>
<tr><td>Thermal</td><td>Ground Temperature Cables</td><td>Data Loggers</td><td>AEM</td><td>Daily[1]</td></tr>
<tr><td rowspan="3">Deformation</td><td>Deep Settlement</td><td>Manual</td><td>AEM</td><td>Monthly (from May to November)</td></tr>
<tr><td>Shallow Settlement</td><td>Manual</td><td>AEM</td><td>Monthly (from May to November)</td></tr>
<tr><td>Surficial Settlement</td><td>Manual</td><td>AEM</td><td>Monthly (from May to November)</td></tr>
<tr><td rowspan="3">Water Balance</td><td>Water Level</td><td>Data Logger</td><td>AEM</td><td>Daily[2]</td></tr>
<tr><td>Seepage Monitoring and Sampling</td><td>Manual</td><td>AEM</td><td>Weekly when observed</td></tr>
<tr><td>Downstream Ponded Water</td><td>Manual</td><td>AEM</td><td>Monthly when observed</td></tr>
<tr><td>Tailings Deposition</td><td>Ground and Bathymetric Surveys</td><td>Manual</td><td>AEM</td><td>Annually</td></tr>
<tr><td rowspan="3">Visual</td><td rowspan="2">Walkover Survey</td><td>Informal (not documented)</td><td>AEM</td><td>Daily</td></tr>
<tr><td>Formal (documented)</td><td>AEM</td><td>Weekly</td></tr>
<tr><td>Annual Geotechnical Inspection</td><td>Manual</td><td>Independent Qualified Licensed Geotechnical Engineer</td><td>Annually</td></tr>
</table>

Element	Item	Method	Responsibility	Minimum Frequency
	Dam Safety Review	Manual	Independent Qualified Licensed Geotechnical Engineer	In accordance with CDA Guidelines

Notes:

1. Currently thermal data is collected and transmitted every 12 hours.
2. Currently water level data is collected every 6 hours and transmitted every 5 days.

3.2 Monitoring Data Management Protocols

All monitoring data collected must be stored electronically. Manual notes must be scanned, and the raw data saved together with any transposed or processed data. All data must be reviewed by appropriate qualified staff immediately following collection to confirm integrity of the instrumentation, as well as to ensure that dam performance is consistent with expectations. If staff is not qualified to draw such conclusions, the EOR must be contacted to perform these duties.

Reporting requirements are specified in each section typically via email, however where appropriate, agreed upon shared drives can be used for file transfer, but a notification email should be sent once the inspection is uploaded. Currently a South Dam monitoring shared folder is stored here:

https://van.files.srk.com/nextcloud/index.php/s/EERtAo85KZLocdy?path=%2FTIA%20Monitoring

4 BeadedStream GTC and Datalogger Standard Operating Procedure

Ground Temperature Cables (GTCs) and Dataloggers at the South Dam are manufactured by BeadedStream. Each of the eight dataloggers installed are powered by an internal battery that is charged by integrated solar panels on each unit (Figure 3). Appendix A and Appendix B1 provides additional details on the D505 BeadedStream data loggers that were installed on site.

These data loggers record the data internally and are currently transmitting data (every 12hrs) to an online portal via satellite telemetry. The BeadedStream online portal can be accessed at the website below, using the login name provided or by creating an account that is created by contacting BeadedStream.

https://app.beadedstream.com

Username: enviro@AEMresources.com

Password: AEMResources1

To access the GTC data, navigate to Projects> Hope Bay South Dam> Sites > Select the GTC name. This data is treated as the ‘raw data’.

SRK has developed a centralized Hope Bay ‘Data Management System’ portal and parallel database for the TIA and more broadly the Hope Bay project overall. The ‘raw data’ from the BeadedStream portal is automatically loaded into the database daily and displayed on the DMS portal. The login details for the portal are provided below:

https://maps.srk.com/hopebay/

Username: enviro@AEMresources.com

Password: HopeBay1!

To create a new account, select “Register as a new user”.

The instrumentation layout (Figure 1 and 2) shows the location of the data logger and GTCs IDs at each monitoring node.

The Operator’s manuals and app based manual download procedures are provided in Appendix A. The cable configurations and calibration sheets for the GTCs are presented in Appendix B.

No regular data collection is currently required for the South Dam GTCs. Data transmitted to the web portal is monitored by the monitoring team at SRK and the EOR, if conditions of concern arise, the EOR will notify site and take appropriate measures. AEM personnel responsible for the monitoring and safe operation of the TIA should familiar with the portal and review the GTC data regularly (Suggestion: Monthly).

4.1 Overall Procedure

The South Dam dataloggers transmit data automatically, and do not normally require manual downloads. The following provides monthly monitoring requirements under automated and manual conditions:

1. **Field Data Collection**

   (a) Automated data collection and transmission of data: No action required, however regular reviews of the data are conducted by SRK and may require input or review from AEM personnel.

   (b) Manual Option 1: Downloading via “Capture by Beaded Stream (Capture app)” (iOS only app) using Bluetooth communication

   (c) Manual Option 2: Downloading via Laptop and Realterm

2. **Inspection.** Dataloggers must be inspected for damage as part of the weekly visual monitoring (Section 7)

3. **Maintenance**. This procedure defines basic maintenance necessary for the ongoing operation of the dataloggers (Section 4.3).

4.2 Field Data Collection

4.2.1 Automated Data Collection and Transmission

Currently the ground temperature is collected and transmitted automatically. No action is regularly required on site to complete the downloads. The Sections 4.2.2 are provided as reference.

4.2.2 Manual Data Download Methods

Downloading via the *Capture* by Beaded Stream app (iOS app) using Bluetooth communication

Attached is the manufacturer instruction for use of the Capture app with the D505 datalogger titled “D505 & Torpedo 2 | Capture App Guide” (Attachment A1). The attached document is the main reference from which a summary is provided below for quick reference:

1) Download the “Capture by BeadedStream” app from the Apple App Store and install. Prior to heading to the field ensure the App is working and that the iOS device has a full battery. https://apps.apple.com/us/app/capture-by-beadedstream/id1329058755

2) Configure the Settings, including Units (°C, Meters), Lat/Long (Degrees Decimal) and an email for data export (This must be an active email in the Apple “Mail” app).

3) A magnet is required to activate the datalogger Bluetooth in the field. Small silver magnets are provided with the datalogger, as shown in the picture below. Other small magnets

available on-site should also work.

4) Once at the datalogger is in the field, swipe the magnet over the left panel near the blinking light. Swiping the magnet will activate a Red flashing light, indicating the datalogger and Bluetooth have been activated. At this point, the datalogger should be indicated as a "Loggers In Range" in the app.

   Note: do not hold the magnet near the magnet switch for extended periods unless intending to force a reading or otherwise reboot the datalogger (See Appendix A1 for more detail)

5) In the app, click New Capture, select the logger, then download logger data on the next screen. When process completes an email draft should appear, ensure a log of the Datalogger ID is contained within the email text or csv and send this email draft to the pre-defined email address (Typically enviro@AEMresources.com).
   Note: Downloading 300-500 readings can take 5-10 minutes

6) On the opposite side of the logger there is a widow with a green and blue LED.

   a) The Blue LED will be activated during Bluetooth connection or activity.

   b) The Green LED indicates processor activity and will blink every 7 seconds if the datalogger is idle but operational, and solid during a reading or transmission.

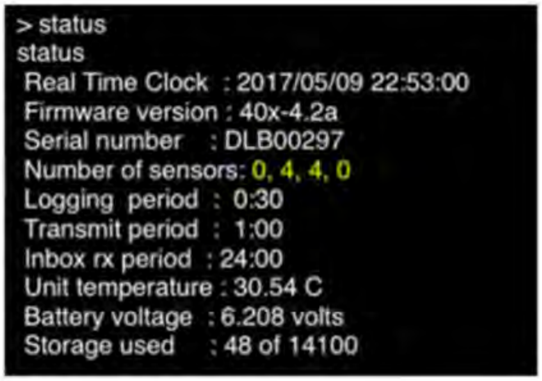
   Note: Details on all logger states and the associated status lights are provided in Appendix A1)

7) Once all data collection is complete, access the emailed files in the office, compile these and send in one email to hopebaymonitoring@srk.com.

Data logger status via the Capture by BeadedStream App

Open the app, navigate to Settings > Terminal Emulator then select the logger. Attachment A1 details all the commands, below are the minimum necessary commands to download the data:

a) Status: This will output a number of records relevant to the status of the datalogger and a quick check for the connected GTC's.



Note the GTC position in the datalogger in “number of sensors”. The GTC is the non zero port. i.e. Number of sensors: 0, 0, 13, 0 would indicate that the GTC is connected to Port 3.

b) Temps: This command will read the current temperatures of the GTC, with the output values displayed on the emulator screen. These can be recorded in a field notebook or a screen capture can be saved.

Forced spot readings and other commands may be required at times. Refer to Appendix A1 for more detail.

Regardless of the method, the green LED should remain on to verify transfer has not stopped or failed.

Downloading via Laptop and Realterm

Communication with the datalogger via Realterm should be used as an alternative method for downloading data from the datalogger. The section below outlines the basic instructions and detailed instruction is provided in the Attachment A5, “D400 Series Data Logger”.
Caution: This guideline should be used for Realterm instructions only, the data logger referenced (D400) is not installed on site.

Realterm software must be installed on a laptop computer.

http://sourceforge.net/projects/realterm/files/Realterm/

A MiniUSB cable will be needed to connect between the laptop computer and the datalogger. In order to connect via USB, a driver is also required that may not be automatically installed on the computer. The proper driver for the laptop operating system is available at:

http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx

Select the correct driver that corresponds to your operating system for installation.

Follow the setup instructions in Attachment A3 page 3 and 4 to setup Realterm. The most important section is the PORT settings and Baud rate. Your computer needs information regarding the nature and location of devices to communicate with the logger. This is designated by assigning ports. At this point, using the miniUSB connector cable, connect the Data Logger to the USB interface on your computer.

To determine what port is being used, access the 'Device Manager', when using a Windows platform. To access the Device Manager, navigate to 'Device Manager' on the computer (under Windows 'Home', 'My PC' or the search bar. Locate the Universal Double-clicking on 'Ports (COM & LPT)' or 'Universal Serial Bus controllers' will reveal which USB Serial Port is being used (i.e. Port_#0005 or COM5 would mean that your computer assigned Port 5 arbitrarily to this device). Return to Realterm.

In Realterm, change the baud rate to 115200, enter the port number and click 'Open'. Open initiates communication between the computer and the data logger, click 'Change' in order for communication prompts to be actualized. At this point, the data logger is synced to the computer and active communication can begin.

To test that this has been set up correctly, while connected to the datalogger via USB, type STATUS into the Realterm interface. This command will prompt the current status of the datalogger and a number of sensors connected. The number of sensors should be output as "Number of sensors: 0, 0, 13, 0", this would indicate that the GTC is connected to Port 3. The GTC could also be connected to Port 1 through 4, if needed.

For each command, the user must hit enter after each request to send the command to the datalogger.

Read X: Read X will output the current temperature at the GTC beads connected to a specific port, where that Port number is X. The temperatures and GTC details will be output on the screen and record a reading into the datalogger. This is only used if necessary.

Temps: Temps will display the temperatures, but not record the measurements.

Data: Typing Data will output all current readings from the day the datalogger was initiated.

To complete the data download, type the following:

Status (Enter)

Data (Enter)

The output the file in a CSV format on the Realterm screen. To capture the data, the user manual states:

In Realterm select the third tab called, 'capture' to save logger data to your computer using the following steps:

1. Next to 'File', select the desired output location of the file that will hold your captured data. Name this something that reflects the data that you are capturing.

2. Uncheck the box that selects ‘Direct Capture’. This will allow you to see the commands that you are typing while they are being captured.

3. If starting a new capture, select ‘Start Overwrite’. If appending data to an existing capture file, select ‘Start Append’. Upon selecting one of these options, the interface will turn RED. This is good and indicates that capturing is imminent.

4. Now you will type commands into the command window. Information typed into this window during a capture will be stored in the output file.

5. Type ‘status’, and then ‘data’. When all data has been captured, simply select, ‘Stop Capture’.

6. All data is now available in the capture output file designated in Step 1.

If this capture method does not work, the text can also be copied into a typical text file in Notepad.

4.3 Maintenance Procedure

The BeadedStream data loggers are designed to be reliable and require minimal recurring maintenance. Below is the key parameters for monitoring the health of the datalogger and the GTC system, and some additional notes on maintenance that may be required.

- Battery Voltage: Maintain above 6.15 Volts.
- Solar panel and housing orientation:
  - Maintain the solar panel orientation in a true south direction with the solar panel facing the horizon, and the cable ports facing down (i.e. 0° vertical tilt).
  - The panel and housing should be kept snow and ice free.
- Moisture: Inspect for condensation on the inside of the housing (inspect the clear portions of the housing, DO NOT OPEN for this purpose).
- GTC Cables: Ensure the GTCs remain securely connected to the datalogger, this can be checked by lightly tugging on the cable.
- A typical BeadedStream datalogger installation on the South Dam is shown in Figure 4.

4.3.1 Battery Maintenance

The D505 Dataloggers should not require recharge due to their low power requirements and solar panel recharging. Annual voltage checks are completed as part of the AGI to confirm the required voltage is maintained. The battery voltage can be monitored via the BeadedStream web portal listed above. The voltage must remain above 6.0 Volts to maintain data logging and transmission function. The battery thresholds are listed below:

- Full battery: 6.6 Volts or more

- Report low battery to EOR or BeadedStream: 6.15 Volts
- Transmission minimum: 6.0 Volts
- Datalogging minimum: 5.5 Volts

Additional steps of irregular battery maintenance (ie an on-site battery change) are listed in Appendix A2.

4.3.2 Desiccant Pack Maintenance

Each D505 Datalogger contains a desiccant pack. These packs absorb condensation moisture inside the housings to protect the internal electronics. If moisture or condensation is noted within the datalogger housing, notify the EOR for further instructions. Desiccant packs must be replaced or oven dried (standard vented oven at 93°C) when moisture inside the datalogger housing is visible. However, replacement of the desiccant packs should only be carried out by someone qualified to do so.

4.4 Reporting Procedures

Any manually downloaded data should be provided in an Excel, *.csv or similar format. Any additional observations (such as noted damage or issues with the datalogger or cables) that may assist with data interpretations should be recorded and sent along with the compiled data downloads or the Visual Monitoring reports (Section 7). All data should be sent to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

5 Ground Survey Standard Operating Procedure

5.1 Objective

Ground surveys of the South Dam control points, monitoring points and the South Dam downstream toe are required to monitor for any deformation that may adversely impact the performance of the dam. The monitoring components include:

- Four Control Points surrounding the South Dam, these are rock bolts installed in bedrock outcrops and are used for survey control during construction and monitoring.
- The three Deep Settlement Points (DSP) are located on the downstream slope of the dam. The three deep settlement points are intended to track deformation of the foundation soils directly below the dam. These consist of rods attached to plates buried at the foundation of the dam. The rods are contained within a casing that allows free movement of the rod, independent of the dam fill.
- The twelve Crest (Fixed) Settlement Monitoring Points (SMP) are located along the crest of the dam. Six of which are intended to monitor deformation below the upstream crest near the upper GCL liner contact and six intended to monitor deformation below the downstream crest under 2m of transition material. These are similar to the DSPs in setup and function.
- The nineteen Surficial Settlement Points (SSP) are located at select locations on the crests and downstream shell of the dam. The surficial survey points are intended to track deformation of the dam shell and/or the foundation soils dependent on their installation location. These are boulders placed at the surface of the dam shell with rock bolts installed near the highest point on their surface. These allow a more dispersed network of surface settlement monitoring across the dam.
- The South Dam downstream toe interface between the ROQ rock fill and the native tundra (vegetation or bedrock)

Figure 1 shows a general arrangement, along with primary survey control points. Figure 2 presents a plan view of the instrumentation layout, including location names and UTM coordinates. Figure 5 shows typical details for the installed deformation monitoring instrumentation, deep settlement points, and surficial survey points.

5.2 Survey Procedures

The ground surveys for deformation monitoring are typically completed with Total Station survey instruments that have high degree of accuracy (typically ± 2mm). Due to control point locations and survey logistics, monitoring is currently completed by a mix of surveying with a Total Station for the Deep Settlement Points and a RTK GPS for the Crest Survey Monitoring Points and the Surficial Survey Monitoring Points. While the horizontal and vertical accuracy for the RTK GPS is ± 10 mm horizontal and ± 15 mm vertical, over time this is expected to provide an adequate indication of displacement trends, and balances accuracy with reduced base station moves in the field. If significant variability in readings is observed, obscuring any potential displacement trends, the EOR may require the monitoring procedure to return to a Total Station only approach, similar to the North Dam deformation monitoring. Surveys must be completed by a qualified AEM surveyor or subcontractor.

The following outlines the procedure for surveying the deformation monitoring points (adapted from input provide by Sub-arctic Surveyors and previous site guidance):

5.2.1 Deep Settlement Points (DSP) and Crest Survey Monitoring Points (SMP) using a Total Station:

1) Setup at the SD2 Control Point. (Rock bolt in bedrock)
2) Use the SD1 Control Point as a back-sight. (Rock bolt in bedrock)
3) Use SD3 as a check measurement

For each of the 3 DSP:

4) Remove the top cap from the orange steel casing
5) Survey the exact center at the top of the inner pipe (within the casing) and replace the top cap.
6) Move on to the next location.

For each of the 13 SMP (shorter than the DSPs):

7) Open the hinged top-plate
8) Survey the exact center of the internal rebar (within the casing) and close the top-plate

A flashlight may be needed to see inside and centralize the prism on the DSP or SMP rod.

Any accumulated dirt or ice around these protective caps or plates should be removed. Before placing the cap back on the monument after the monthly ground survey, all caps should be cleaned. If the caps are moist, it is suggested that the insides of the caps be dried prior to being placed back over the monitoring points to avoid jamming or freezing.

5.2.2 Surficial Survey Point (SSP) with the RTK GPS.

1) Set up the GPS base station over the SD1 Control Point (Rock bolt in bedrock)
2) Using an epoch count of 5, make a check measurement at SD2 Control Point. This is also a rock bolt in bed rock that was used as a check/secondary base point for the South Dam construction. The results of this check measurement should be within 10mm in northing and easting, and 15mm in elevation.
3) Using the same 5 epoch count, all SSP on the South Dam can be surveyed and the results recorded.

5.2.3 South Dam Downstream Toe with the RTK GPS

1) Walk the South Dam toe and complete a survey pick-up of the interface between the ROQ fill and the tundra where snow-free.

2) Survey shots should be collected every 5m or as appropriate to capture the variability in the alignment.

3) When the dam toe is not completely free of snow or ponded water, survey the interface between the ROQ and snow or water, noting this in each of the survey point names

5.2.4 Additional Details

An additional reference on "Suggested guidelines of surveying at the North Dam", with a Total Station, is presented in Appendix D (from Cornelissen 2013). While initially written for monitoring the North Dam, it is expected that this document may be generally applicable to the setup and potential sources of error at the South Dam. Specifically, these guidelines discuss:

- Expected manpower and time allocation;
- Equipment and accessories;
- Metadata/control points;
- Station set-ups; and
- General surveying and survey error reduction.

Any damage noted to any of the survey monitoring locations (DSP, SMP, SSP) should be recorded and submitted with the survey data.

In addition to the monitoring points and the downstream toe, one surveyed elevation of the water level in the TIA Reclaim Pond should be collected on the upstream face of the North Dam. While this is required under the North Dam SOP (SRK 2020a), a survey point taken by GPS is acceptable and may be done while set up at the SD-1 Control Point. This survey point must be collected at least once annually during open water season in the Reclaim Pond (typically completed in August). Additional water level shots during the monthly survey events may be recorded opportunistically, when conditions allow. The water elevation of this point is used to confirm the elevation constant used to convert the TIA-2 water level data collected from the pressure transducer to an elevation above sea level. Refer to the North Dam SOP (2020) for more detail.

5.3 Reporting Procedures

The survey data is expected to be supplied in Excel or *.csv format. For expedient monitoring, please indicate the correct point type and number in the point name to be easily recognizable (e.g. SSP04 or the full SD-SSP-04). Any additional observations (such as noted damage) that may assist with data interpretations should be recorded and sent along with the compiled survey data to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

6 Water Level Monitoring Standard Operating Procedure

6.1 Objective

The South Dam is designed and constructed as a tailings retaining dam with a minimum required tailings beach length, and not a water retaining structure. The minimum beach length of 100 m from the upstream Phase 1 South Dam crest to any open water in the TIA must be maintained (either the Reclaim Pond or other large isolated ponds on the tailings beach), and shoreline markers have been placed to help visually check this. The current beach slope of the tailings is between 0.5% and 1% and therefore this criterion can be approximated by ensuring the water level is at least 0.5 m to 1.0 m (respectively) lower than the minimum beach elevation at the South Dam.

As of August 2019 (previous open water season), the minimum beach elevation was 33 masl, therefore the water level must currently be maintained below 32 masl. The value will be rechecked annually as part of the TIA Annual Geotechnical Inspection.

Water level is a critical monitoring parameter and is currently recorded and transmitted to the online portal every five days.

6.2 Measurement Procedures

The water level is monitored at TIA-2 in the northeast end of the TIA, near Reclaim Barge. Details on the measurement procedures are provided in the North Dam SOP (SRK 2020a)

A visual estimate of the beach length with relation to the water level is required as part of the Visual Monitoring (Section 7).

6.3 Reporting Procedures

No additional reporting is required, however if any observations relating to the water level made (such as ponding water near the dam), please record the relevant information and send to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

7 Visual Monitoring Standard Operating Procedure

7.1 Objective

Formal visual (walk over) inspections of the South Dam, and immediate surrounding area, is required to act as an early notification for potential issues in areas not directly monitored by the installed instrumentation or other monitoring activities. Two levels of inspection are proposed:

1) Daily monitoring to identify issues or observations that may adversely impact the dam.

2) Full weekly visual (walk over) inspections.

7.2 Daily Visual Inspection

It is expected that the tailings deposition operations are monitored daily by qualified site staff at the TIA. The daily inspections are not intended to be an intensive exercise, rather it should include a walking or driving from one end of the dam to the other inspecting for major changes that have the potential to compromise its performance between weekly inspections. These inspections should include:

1. Settlement, depressions, sinkholes, cracking or signs of movement along the crest, the downstream or upstream face of the dam;
2. Significant changes in the observed seepage conditions compared to the prior weekly inspection;
3. Rapidly changing erosion conditions at the interface of the dam and the tundra;
4. The minimum beach length of 100 m from the upstream Phase 1 South Dam crest to any open water in the TIA, either the Reclaim Pond or other large isolated ponds on the tailings beach. Shoreline markers have been placed to help visually check this;
5. Leaks or unplanned discharges from the tailings discharge or reclaim pipeline
6. Any other atypical conditions observed that are concerning or have the potential to compromise the dam performance.

There is no reporting requirement for the daily visual inspections.

7.3 Weekly Visual (Walk Over) Inspection and Reporting

The upstream and downstream slopes, crest and downstream toe of the dam should be the focus during the walk over visual inspections. Specifically, the following should be noted:

1. Erosion
   (a) Any erosion of the dam fill or immediately surrounding tundra over 5 cm in depth should be noted. Erosion locations should be recorded (using a handheld GPS or survey) and photographed.
   (b) If erosion is notable then it should be monitored carefully to ensure that conditions do not worsen (i.e., getting larger, deeper, to greater extent).
   (c) If erosion can be safely measured, then simple visual estimates or measurements with a tape measure should be completed on the larger erosional features.
2. Settlements / Depressions / Sinkholes.
   (a) If observed, the location(s) should be recorded (using a handheld GPS or survey), photographed, and the dimension / extents estimated.
3. Cracks/ Movements

(a) If signs of cracking or movement are observed the locations should be recorded (using a handheld GPS or survey), photographed and the approximate crack dimensions should be measured.

4. Debris and Vegetation

(a) Any debris or vegetation growing on the upstream and downstream slopes of the dam should be noted.

(b) Materials should not be stockpiled on or against the dam surface. Any debris on the dam should be removed to assist with better performing visual inspections over these areas.

(c) Snow can affect thermal performance of the dam. Natural snow drifting over 1.0 m should be noted, along with and snow should not be piled against the dam surface during snow clearing operations.

5. Seepage or Ponding

(a) Seepage is defined as water flowing from the South Dam. Walk the full length of the downstream dam toe to identify any currently flowing seepage locations or location that appear to have evidence of past seepage (which can be monitored going forward).

(b) If seepage water is found, note the location (by dam chainage/station or GPS), photograph and provide a preliminary estimate the seepage rate if possible.

(c) Ponded water exists at the downstream toe of the dam. If new ponded areas are observed or the existing ponds appear to be expanding, note the location and approximate extent on the inspection form and photograph.

(d) Notify the on-site environmental coordinator to conduct water quality sampling monitoring (Section 8).

6. Tailings Beach Development

(a) Inspect the upstream side of the dam. The minimum length of 100 m from the upstream crest of the Phase 1 South Dam to any open water in the TIA must be maintained (either the Reclaim Pond or other large isolated ponds on the tailings beach), and shoreline markers have been placed to help visually check this. Figure 2 provides the 100 m buffer in plan view for reference.

7. Instrumentation

(a) Look for visual damage to instrumentation (i.e., does all instrumentation appear to be intact or has it been damaged by equipment, animals or personnel?).

(b) Inspect the dataloggers and confirm that:

- The GTC cables are properly connected at the base of the data logger (they should not be disconnected or loose);
- No moisture has condensed on the inside of the solar panel; or

- The solar panel faces the southern aspect (downstream side of the dam) and hoar frost or ice has not accumulated on the panel

(c) If damage or other issues are noted, then photographs and notes / observations should be collected to assist with determining if repair of the instrumentation is possible.

The South Dam Walkover Report is presented in Appendix D. This inspection form, along with any photos or notes from the inspection should be formally recorded and submitted to the EOR jkurylo@srk.com, Peter Luedke, pluedke@srk.com, and the SRK team at hopebaymonitoring@srk.com.

The EOR should be notified immediately after any inspection where notable changes to any of the areas / items listed above are observed. The EOR will work with AEM to provide further guidance on monitoring or sampling requirements and to determine if mitigation measures are required.

8 Seepage and Ponded Water Monitoring Standard Operating Procedure

8.1 Objective

Seepage or contact water flowing from the toe of the South Dam must be monitored to confirm that the source of seepage is not seepage from the TIA (or if it is the TIA to better monitor seepage rates and to track flow paths). Additional monitoring of the water ponded (no apparent flow) on the tundra, downstream of the dam is also required (tundra pond water) to establish a record of baseline water chemistry in the former location of the ice wedge.

8.2 Procedure

Seepage is defined as water flowing from the South Dam (SDSEEP). Ponded water is defined as water near the dam without a notable flow rate and is present as shown in Figure 6 between Station 2+60 and 3+60. The primary sampling locations (SDPOND) for ponded water are (435650 m E, 7555910 m N) and (435630 m E, 7555907 m N) (UTM NAD83, Zone 13).

Monitoring and sample collection at the South Dam are to be performed by on-site environmental personnel trained in seepage identification and sample collection methods. The seepage and ponded water monitoring procedure at the South Dam toe is described as follows:

1. Complete a walk over survey on foot. This will consist of walking the full length of the downstream dam toe to identify any locations of currently flowing seepage, areas that appear to have evidence of past seepage (which can be monitored for seepage going forward) or areas of ponded water.
2. At each seepage location, collect water samples for the parameters listed in the laboratory analytical suite (LAS) in this SOP and record the following field data:

- o Pre-determine a Sample ID following the naming convention (SDSEEP-YYMMDD-SN)
  - SN is a sample number. This should be assigned an unique two digit number for that date, for example the first would be SDSEEP-200602-01.
- o GPS coordinates,
- o Photograph (upstream and downstream look directions include the sample location),
- o Volumetric flow rate estimates
  - For samples collected at the toe of the dam, flow volume and velocity can be estimated by taking a container of a known volume and recording the time it takes for the seepage to fill the known volume. Alternatively, estimate the cross-sectional area of the flow and the velocity of the water. To ensure accuracy of the measurement, at least three iterations of the estimate should be completed. Revisit subsection 2.2, bullet number 2 for additional details.
- o Field measurements: temperature, pH, electrical conductivity (EC), chloride, and oxidation reduction potential (ORP),
- o Date and time,
- o Name of sampler, and
- o The sampling frequency is **once per week** while seepage is occurring or at the discretion of the EOR.

3. At the primary pond locations (435650 m E, 7555910 m N) and (435630 m E, 7555907 m N) (UTM NAD83 Zone 13), and where any other independent large continuous ponds of water are observed at or near the downstream toe (typically between Station 2+80 and 3+40) (Figure 6), collect water samples from near the toe of the dam for the parameters listed in the laboratory analytical suite (LAS) in this SOP and record the following field data:

- o Pre-determine a Sample ID following the naming convention (SDPOND-YYMMDD-SN)
  - SN is a sample number. This should be assigned a two digit number for that date, for example the first would be SDPOND-200602-01.
- o GPS coordinates,
- o Photograph (upstream and downstream shots (include the sample location)),
- o Ponded area, and depth estimate,
  - A simple estimate of the pond size and visible depth will help quantify the scale. There is no need to physically measure the pond dimensions at this point.
- o Identify any of the known seeps that are actively flowing into the pond from the rock fill or the downstream toe. Provide a sketch or identification of the active seeps flowing into the ponded water.

  - Field measurements: temperature, pH, electrical conductivity (EC), chloride, and oxidation reduction potential (ORP),
  - Date and time,
  - Name of sampler, and
  - The sampling frequency is **once per year** while the primary ponds are accessible under open water conditions or at the discretion of the EOR. Typically, there should be no ponding directly against the downstream toe of the South Dam, however if this condition does exist then this water should be sampled to help assess seepage potential.

4. Check upstream side of the South Dam for water. If water is observed near or against the upstream side of the dam, the following actions are to be taken:
   - Ensure the EOR jkurylo@srk.com and hopebaymonitoring@srk.com has been notified if the Reclaim Pond is within 100 m of the upstream crest of the Phase 1 South Dam, or any large isolated pond has formed on the tailings beach.
   - Where ponding is observed against the dam, collect water samples for lab parameters listed below (LAS) provided samples can be safely collected while standing on the dam.
   - Record field measurements (temperature, pH, EC, chloride, ORP), and
   - Record field notes as outlined above, e.g. GPS coordinates, photographs, etc.
5. Once per month, collect the following QA/QC samples to validate the geochemical data set:
   - One field duplicate, one travel blank and one field blank for lab parameters listed below (LAS).
   - For the field duplicates only, field measurements (temperature, pH, EC, chloride, ORP).
6. Once per month during routine sampling of SNP station TL-5 (tailings supernatant discharge from the mill), conduct the following for TL-5:
   - Record field measurements (temperature, pH, EC, chloride, ORP), and
   - Collect water samples for lab parameters listed below (LAS).
   - This monthly sampling of TL-5 is a monitoring requirement of the South Dam however is also outlined in Section 9.2 of the North Dam Monitoring SOP (SRK 2020a). Separate samples for each dam monitoring program are not required.

8.3 Laboratory Analytical Suite (LAS)

The laboratory analytical suite (LAS) for the South Dam Seepage Monitoring SOP is as follows:

- Lab pH and EC
- SO_4, Cl
- Alkalinity

- Ammonia, NO_3, NO_2, Total N
- Total CN, Free CN, SCN, CNO
- Total metals (including sulphur and mercury)
- Dissolved metals (including sulphur and mercury)

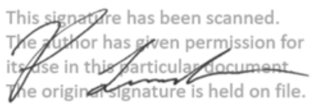
8.4 Sample Shipment and Reporting Procedure

Water samples are to be shipped to ALS Environmental. When samples are shipped, send the appropriate Chain of Custody (COC) form and field data to SRK, and notify the Engineer of Record (EOR) that samples have been collected and shipped. Upon receipt of the lab results, these should also be sent to SRK. All documentation and results should be sent to Lbarazzuol@srk.com (Lisa Barazzuol), rcocuaco@srk.com (Rosie Cocuaco), mting@srk.com (Maritess Ting) and Hopebaymonitoring@srk.com (SRK Hope Bay monitoring account).

9 Tailings Deposition Monitoring Standard Operating Procedure

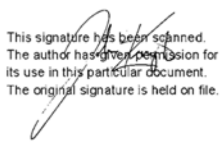
Performance of the Phase 1 South Dam is directly dependent on adherence to the tailings deposition plan (SRK 2020b, as per main text and Appendix N) and specifically establishment of adequate tailings beaches from the structure. Annual topographic surveys of the tailings beach above water and bathymetric surveys should be completed to confirm that deposition is consistent with the current plan. The deposition plan can be modified as necessary based on the annual data. To compliment these surveys monthly checks using satellite data (ex. Sentinel-2) should also be done to help track tailings beach development and tailings spigot movements. AEM site staff should be familiar with the tailings deposition plan and work with SRK to ensure the plan is implemented as specified, any deviations from the plan must be discussed with and approved by the EOR.

This report, “Hope Bay Project, South Dam Monitoring: Standard Operating Procedures – Revision 1”, was prepared by SRK Consulting (Canada) Inc.

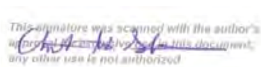


Peter Luedke, EIT
Consultant

and reviewed by:



John Kurylo, Meng, PEng
Senior Consultant



Chris Stevens, PhD
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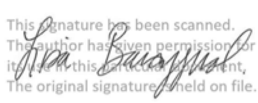

Lisa Barazzuol, PGeo
Principal Consultant (Geochemistry)

All data used as source material plus the text, tables, figures, and appendices of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

10 References

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Appendix A - Operator's Manuals

Appendix A1 - D505 Series Data ‘Capture App’ Guide

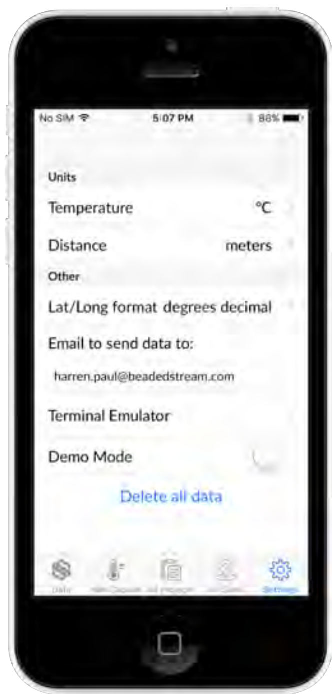
beadedstream

D505 + Torpedo 2 | *Capture* App Guide

"Capture by BeadedStream" is our free app available on the App Store (*iOS only*). It allows interaction over Bluetooth with a D505 logger or our portable 3D-print enclosed "Torpedo 2".

Introduction

The app will first open to the **Data** screen (*below, left)*.



If this is the very first time the app has been opened or if data has been cleared from the **Settings** screen, a button prompt will appear on the **Data**, **Projects**, and **Sites** screens to assist with setup.

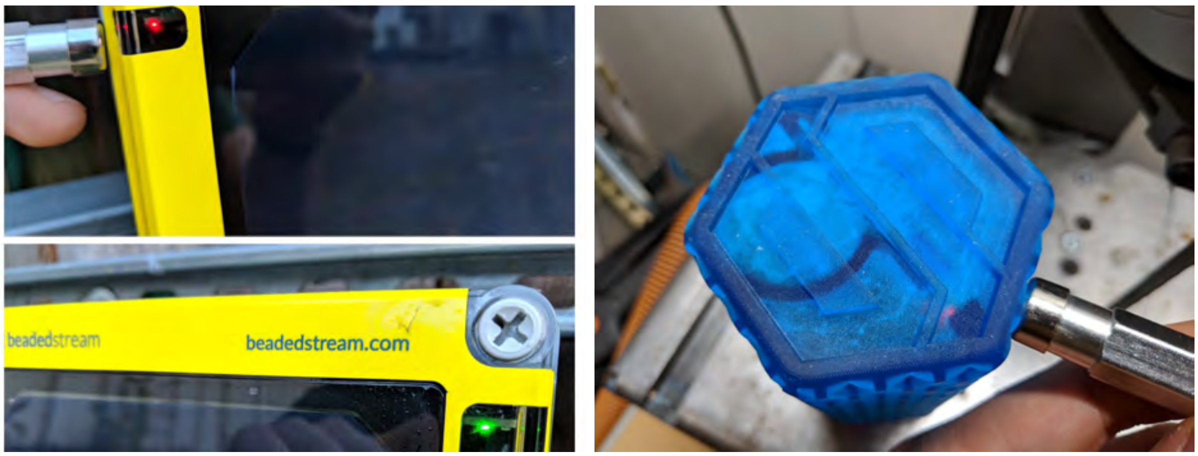
The **Settings** screen should be visited first. The following settings should be changed:

- ***Units***. This will change the temperature and sensor positions units for spot readings taken from the **Capture** screen. The **Data** screen displays captures stored on the iOS device.
- ***Lat/long format.*** This applies to the manually entered or automatically retrieved GPS coordinates that store in the configuration of a **Site**. A **Site** represents the name and location of a permanently installed temperature cable, or the location to be read by a temporary cable in a "spot reading".
- ***Email.*** The email address configured here will be the recipient address when either a collection of ***spot readings*** is exported or a ***data download*** from a logger's memory is pulled.

Logger LED detail and logger states

The D505 logger houses a circuit board inside with three different LEDs that are visible through two decal cutouts. The Torpedo 2 (*below, right*) uses the same circuit board and has identical LEDs and behavior.

- **Red LED** - (*Below, left and right*) Lights up when sensing a magnet.
- **Green LED** - (*Left image below*) Blinks or is solid during processor activity.
- **Blue LED** (*unpictured, is adjacent to the **green LED***) Solid for Bluetooth connection/activity.



The data logger can be in one of these states:

- ***OFF - Unplugged/dead battery***. Indicated by **no LED activity**. The battery molex connection is visible right below the **green LED** location (*D505*) through the decal cutout.
- ***ON, idling***. This is indicated by a **green LED** blink once every 7 seconds. The logger can either be idling between scheduled readings/transmissions, or in a deeper "nap". *See the separate guide called **Nap Mode Notice** for more detail.*
- ***ON, main processor awake.*** **Swiping** a magnet past the **red LED** and getting a blink will wake the main processor for a few minutes. ***THIS IS A REQUIRED ACTION*** before **spot readings, data download,** or **terminal connection.**
- ***ON, busy.*** The logger could be reading temperatures, transmitting, or passing data over Bluetooth. **Using a magnet** to keep the **red LED lit for 2-3 seconds** will trigger an unscheduled reading/transmission (*D505 only*).
- ***ON, connected to the app/busy.*** The **blue LED** will remain lit during connection to an iOS device. The **green LED** will light as the logger performs work. *If this behavior is expected and not occuring, a fresh magnet swipe and disconnecting re-running the app workflow can help.*
- ***Rebooting.*** The logger will quickly flash each of its LEDs as it boots up on battery connection or after a triggered reboot and eventually arrive at the **ON, idle** state. A reboot can be manually triggered by **keeping the red LED lit with a magnet for more than 8 seconds.**

Deploying a logger in the field

Device to logger interaction over Bluetooth can be used in the field to change logger settings, check temperatures, trigger Iridium satellite transmissions, and more. The mechanism for this is the **Terminal Emulator** found at the bottom of the **Settings page.** *Remember to prepare the logger for connecting by waking it with a magnet.*

After selecting the emulator, the **Loggers in Range** screen will appear (*below, left*). Check the logger's label on the side of the enclosure for a serial number to match what appears on the list and select it. The app will connect and **automatically run** the ***status*** command (*below, right*).

Only a single command needs to be run for a typical deployment. The command is **deploy**. It will first ask for confirmation to be run, and then:

1. Re-run the status command.
2. Confirm/allow changing of the logging interval.
3. Confirm/allow changing of the transmission interval.
4. Query all cables on all ports (including a sonic sensor) and display the results.
5. Collect logger configuration and attempt an Iridium transmission.

It is highly recommended that screenshots are taken to store the results of this process.

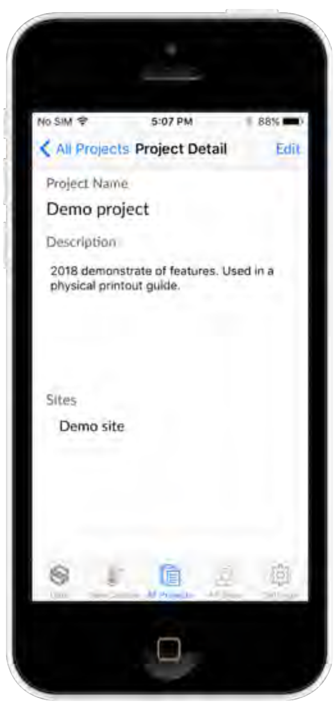
Important note on Step 5 - this step may fail and will ask to try again. One or multiple failures typically means the timing of satellites/other factors was off in that moment, not that the logger isn't working. It can also mean the deployment location is poor (e.g. adjacent to a building and/or not a full hemispherical view of the sky).

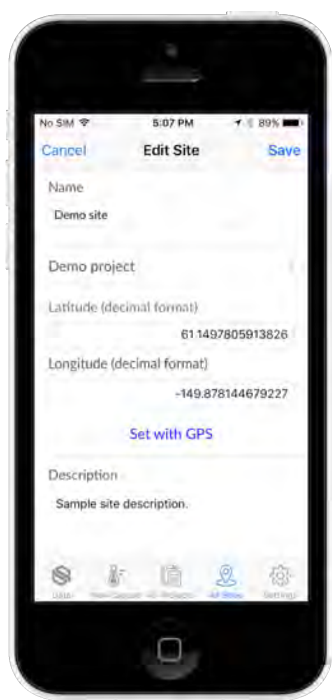
Important note on logging/transmitting intervals - The logger only transmits the **current reading** on each transmission. So logging ***hourly*** and transmitting ***daily*** will NOT send a batch of the days readings at once, it will only send the reading that was just taken at the scheduled time. ***It is still useful*** to set a logging interval that is more frequent than the transmission interval if physical logger recovery for the denser data set fits the project's needs.

Spot capture and data download

"Spot" temperature capture is a native function of *Capture* and can be performed easily after configuring projects and site in the app. A D501/505 logger will act as the interface between the app/iOS device and the DTC (Digital Temperature Cable) being read.

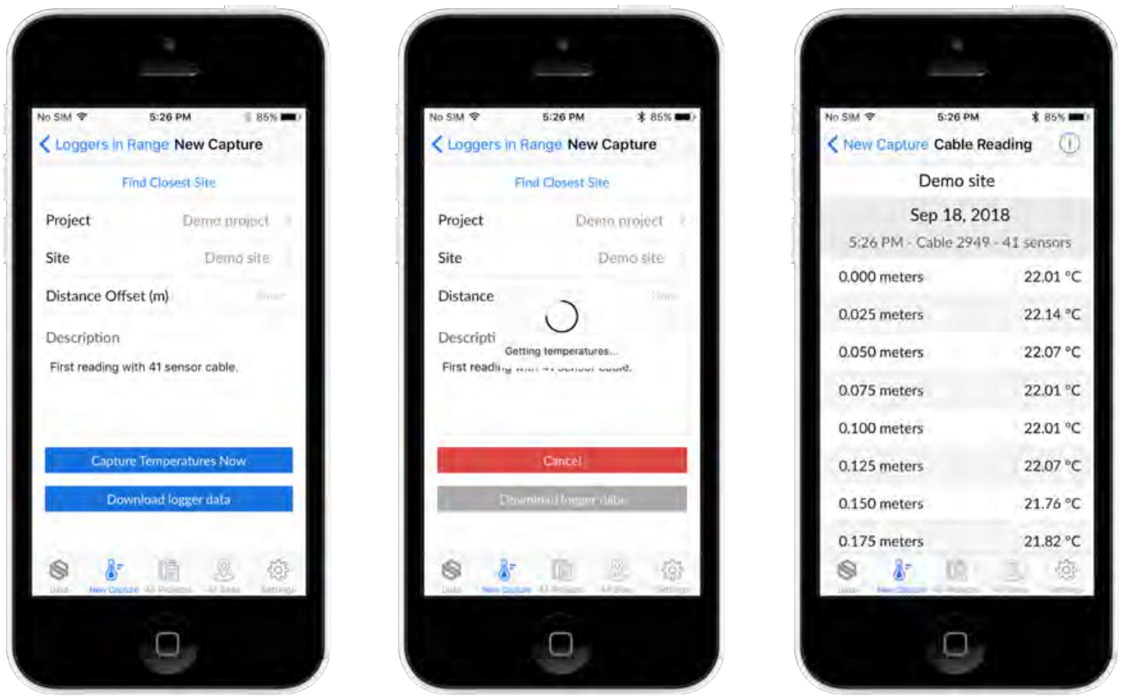
In the app, the first step is to navigate to the **Projects** page and create a first project. Both a Name and Description can be set (*below, left*). Next, the **Sites** page will allow one or multiple sites to be configured. Make sure to ***assign the Site to a Project.*** Latitude and longitude can be set for the site ahead of time (*decimal degrees*), or the location can be acquired on-site using the iOS device's location data with the **Set with GPS** function (*below, right*).





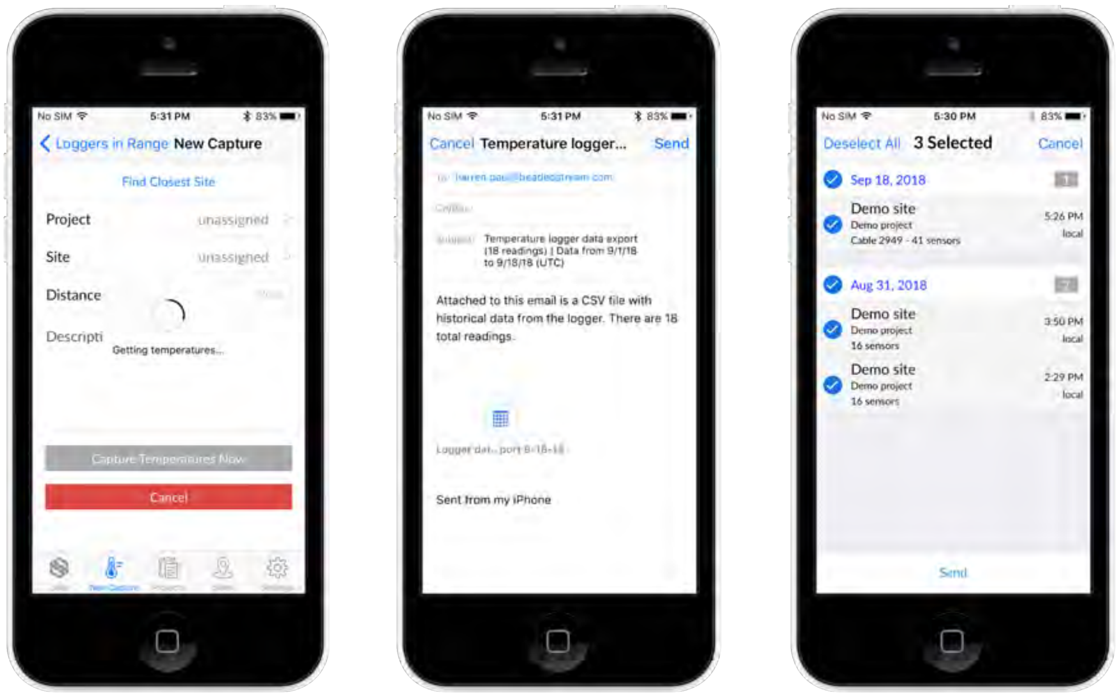
With projects and sites configured, readings can now be taken from the **New Capture** page. After navigating to the page, it will first show the **Loggers in Range** view. The logger in use needs to be magnet-swiped and then connected to using the same workflow as for **Terminal Emulator** connection described previously.

The next screen will show (*below*, *left*), displaying options to prepare for a spot reading as well as a **Download logger data** button. More detail on the items on the screen are below:



- ***Find Closest Site***. This function is an option to expedite selection of a project and site by acquiring the location of the user and matching the location to the closest site (*among those with configured coordinates*).
- ***Project***. This is the **first** item to be chosen. The app will automatically present the **Site selection page** after a project is chosen.
- ***Site.*** A site can either be selected after a project is chosen, or selected directly after a previous capture in the same project is completed.
- ***Distance Offset (m)***. Used to adjust for the shift in relative position of the top temperature sensor relative to a "zero" or ground level. A **positive offset** means the cable is being lifted up.
- ***Description***. This is a freeform field for adding comments to the spot reading. The notes will remain accessible after capture inside the app and will export with the data over email.
- ***Capture Temperatures Now***. This button will trigger a reading. The logger's **blue** and **green** LEDs will light up during capture and data transfer, and the app will display progress in a popup (*above, center*). When complete, the reading will display (*above, right*). Historical readings can be accessed on the **Data** page.

- ***Download logger data***. This button triggers a ***full data download*** from the local storage of the logger (*below, left*). This process can take a few minutes. After the transfer process is complete, an email draft will open (*uses Apple's default mail app*) with an auto-generated email subject and body, as well as an attached CSV (*below, middle*)



- ***Additional detail - exporting spot capture data***. As mentioned before, historical spot capture data can be found on the **Data** page. To begin, choose, the ***Select*** button. Single reading can be chosen, the **day headers** can be selected, or **Select All** can be used (*above, right*). When ready, choosing ***Send*** will collect the readings and generate an email similar to the historical data above.

Appendix A2 - Quick Reference for the D405/505 Battery

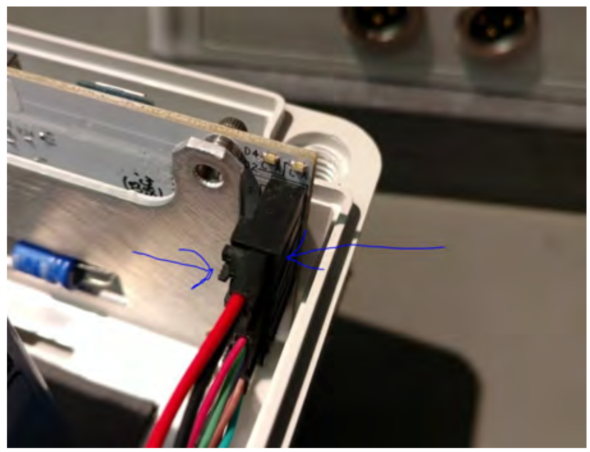
Quick Reference for the D405/505 Battery

- When preparing to change or connect/disconnect the D405/505 battery, first make sure the logger has spent about 30 minutes acclimating to a warm and dry environment.

If the above is not possible, be extra careful with the torque on the screws or they can snap in the cold!

- Start by removing the plastic Vynckier screws, seen below in the first image.

Take care when removing the lid- there will be a small wire connecting the solar panel in the lid to the circuit board in the body of the enclosure.



- With the lid off, follow the red and black wire pair from the battery to the two-pin molex connector. The second image above shows the connection.
- **Simultaneously**, lightly support the female molex receptacle while squeezing the tab on the male connector and pull to release the battery connection. When reconnecting, look/listen for the click of the small locking tab.

When re-attaching the lid...

- Make sure that no wires are caught in the seal or the edges.
- Make sure **not to overtorque** the screws, they only need to be turned to the limit of a light screwdriver grip (fingertip) and then a final 180° turn to complete. The black seal between the lid and base should visibly compress as the screws receive the final twist - *this is a good indicator of enough torque.*

If the battery is being changed...

- Use a 5/16" hex bit to loosen the hose clamp. Alternatively a flathead screwdriver can be used.
- Grip and twist the old battery initially to break the contact adhesion with the rubber pad below.

Questions? Email us at contact@beadedstream.com or call 844-488-4880

Appendix A3 - D400 Series Data Logger
(Alternative Resource NOT THE MODEL INSTALLED)

D400 SERIES DATA LOGGER

Manually connecting to the D400 series loggers and other useful information

The D401 and D405 Data Loggers are extremely low-powered, programmable units used to log and/or transmit temperature data from BeadedStream TACs. The D401 has been engineered to be easily deployed and log data locally for site visits and manual downloads, while the D405 transmits data in real-time, through the Iridium Satellite Network, to the Internet.

Contents

Direct Communication with D400 Series Loggers

D400 Loggers are shipped ready to be deployed in the field (unless specifically stated otherwise). *However, in the event that the Iridium Link is not used, a manual connection is necessary to configure the logger and download data*.

Terminal Emulator Instructions for Windows

For direct communication with BeadedStream Data Loggers, we use command line software called *RealTerm*. Realterm is a terminal emulator specially designed for capturing, controlling and debugging binary and other difficult data streams. By using Realterm, BeadedStream users will be able to configure data loggers and download temperature data.

Downloading Realterm

Realterm is free command line software that can be downloaded from:

http://sourceforge.net/projects/realterm/files/Realterm/ if not provided directly by BeadedStream.

By downloading the latest version of Realterm, an executable (.exe) file will be placed in your default downloads location. Double-clicking on this executable will initiate installation of Realterm. Follow the installation prompts and accept default settings. Realterm should install on your PC in just a few moments. You may need to restart your computer; otherwise a desktop icon should be available for immediate access to Realterm.

Connecting to your BeadedStream D400 Series Data Logger

To connect to your data logger you will need:

1. A laptop or desktop computer with Realterm installed
2. A standard USB to mini-USB connector cable
3. A data logger

Locate the mini USB connector port within the logger enclosure and firmly plug in the mini-USB. Plug the other end of the cable into your computer.

NOTE: If your USB connection is not working, there are a few potential reasons.

1. *Please check settings on your PC with regards to being able to automatically download USB drivers from the internet.*

2. *The logger can hold a communication connection even if not powered with a battery. In the event that a battery is dead or not connected and a connection is needed, the logger can be powered through the USB connection.* ***In the event that USB power is needed – attach the USB and wait at least 5 minutes – this will allow time for capacitors on the logger to charge and function.***
3. *D400 Loggers require a unique driver that may or may not install automatically on your computer. You can obtain the proper driver by visiting this website >* http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx < Select the correct driver that corresponds to your operating system.

Open Realterm in your computer by double clicking on the Realterm icon on your desktop. Realterm has many advanced applications; however, here we will explain only the steps necessary to interface with your BeadedStream Data Logger.

The Realterm command prompt is characterized by a black window; this is where commands are typed. Below this window there are 10 tabs. **We will only be concerned with the first three (Display, Port and Capture).**

DISPLAY

To begin, we will set some parameters under the display tab. We accept most of the default settings, however under 'Rows' change the default from 16 to 30. This will make the command window larger. The number of rows can be set to any desired number. Additionally check the box for 'Scroll back'. This will allow for the ability to scroll to previous command entries and returns.

PORT

Your computer needs information regarding the nature and location of devices in order to communicate. This is designated by assigning ports. At this point, using your USB connector cable, connect your Data Logger to the USB interface on your computer. To determine what port is being used, you'll need to access the '**Device Manager',** when using a Windows platform. To access the Device Manager, you can type 'Device Manager' in the search bar or right click on '**My Computer'**. This will prompt a menu, where you'll want to select '**Manage'**. This will further prompt the '**Computer Management'** dialog box. Select '**Device Manager'**. Double-clicking on '**Ports (COM & LPT**)' will reveal which USB Serial Port is being used (i.e. COM5 would mean that your computer assigned Port 5 arbitrarily to this device).

Back in Realterm, *change the baud rate to 115200*, enter the port number and click '**Open**'. Open initiates communication between your computer and the data logger, however you must also click '**Change'** in order for communication prompts to be actualized.

At this point, the data logger is synced to your computer and active communication can begin.

Terminal Emulator Instructions for MAC

For direct communication with BeadedStream Data Loggers using a Mac, most new Macs come stocked with a terminal emulator called 'CoolTerm'

Connecting to your BeadedStream D400 Series Data Logger

To connect to your data logger you will need:

1. A laptop or desktop computer with Cool Term installed
2. A standard USB to mini-USB connector cable
3. A data logger

Locate the mini USB connector port on the bottom of the logger enclosure and firmly plug in the mini-USB. Plug the other end of the cable into your computer.

NOTE: If your USB connection is not working, there are a few potential reasons.

1. *Please check settings on your PC with regards to being able to automatically download USB drivers from the internet.*
2. *The logger can hold a communication connection even if not powered with a battery. In the event that a battery is dead or not connected and a connection is needed, the logger can be powered through the USB connection.* ***In the event that USB power is needed – <u>attach the USB and wait at least 5 minutes</u> – this will allow time for capacitors on the logger to charge and function.***
3. *D400 Loggers require a unique driver that may or may not install automatically on your computer. You can obtain the proper driver by visiting this website >* http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx < Select the correct driver that corresponds to your operating system.

Open CoolTerm from your Mac Desktop.

- Select 'Options'
- In the Serial Port menu, 'Re-Scan Serial Ports'
- In Port, select 'SLAB_USBtoUART'.
- Set the BaudRate to 115200
- Click 'OK'
- Choose 'Connect' amongst the menu icons.

At this point, the data logger is synced to your computer and active communication can begin.

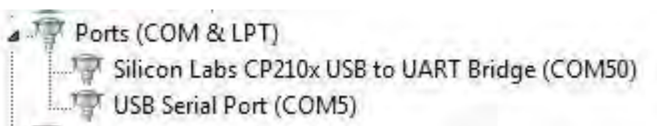
BLE Dongle Instructions

D400 Loggers have a BlueTooth Low Energy (BLE) Radio that can be used instead of a USB cable to establish a connection with either a MAC or PC. The dongle does not come standard with BeadedStream equipment, but can be useful if a wireless connection is necessary using a laptop. The instructions below describe how to use the dongle.

Connect to the Logger via Bluetooth

1. Plugging the BLE dongle into a USB port will prompt your PC to find and download necessary drivers automatically. In your Bluetooth Radios tab under 'Device Manager' – you should now have 'Broadcom 20702 Bluetooth 4.0 Adapter' – or something similar.

2. Your logger will need to be powered (Battery or USB) in addition to having a BLE connection. Plug the logger to your PC via USB and also have the BLE dongle plugged in. You should have one COM port connection at this point. On my computer, <u>the logger has been assigned to COM5 via Bluetooth. *Ignore the COM50 connection specified here.*</u>



3. Back in RealTerm – in the below example, I set a Baud of 115200 and set the port to COM5. I then click 'open' and then 'change'***. My Bluetooth connection has not been made yet*** – there are a few commands to enter.

4. To conserve power on the logger, the Bluetooth Radio is turned off of unless prompted by magnet swipe over a hall effect sensor (labeled MAG on the outside of your logger enclosure). To initiate Bluetooth pairing between the logger and Dongle Radio, you'll need to swipe a magnet over this switch. This will activate the logger for **60 seconds –** to which you will need to go through the sequence below …. Really just a couple of commands

5. Click in the terminal window and type the following command (don't forget you've only got 60 seconds once you've tripped the switch with your magnet) – you may not receive an echo in the terminal, but once you hit carriage return, it should work.

   a. *Type :* atdile (with carriage return)
   b. *Receive:*
      OK

      DISCOVERY,2, **ECFE7E10557C**,0,-070,4,020106-020A04-051208001000-1107796022A0BEAFC0BDDE487962F1842BDA

DISCOVERY,6, **ECFE7E10557C**,0,-070,2,05FF85000000-1109426C7565526164696F73313035333330

DONE,1,1

c. *<u>NOTE: this shows that the Bluetooth Dongle Radio 'sees' the Logger radio. If no 'Discovery' has been made, you may not have triggered the mag swtich. Try again, the connection should be immediate within the 60 second window.</u>*

6. Next you need to type another command – notice the x's below need to be substituted with the bold scratchpad material above:
   a. Type: atdmle, **xxxxxxxxxxxx,** 1
   b. *Type or copy and paste:* atdmle, **ECFE7E10557C,** 1 (with carriage return)
   c. *Receive:*
      OK

      CONNECT,0,1,0,ECFE7E105330

      BRSP,0,1
   d. Note: there will be a couple of error messages – just ignore those. **YOU SHOULD NOW BE CONNECTED TO THE LOGGER VIA BLUETOOTH!!**

Communicating with your BeadedStream D400 Series Data Logger

Click in the black, command prompt box and follow some example syntax below. Commands that you would type are presented in **bold** *italics.* Returns are presented in normal *Italics*.

Help Menu

To set basic parameters in your data logger, start by typing the following commands and pressing ENTER:

help

HELP	*# show monitor commands*
VERSION	*# show firmware version*
DATE [yy/mm/dd]	*# set/get the current year/month/day*
TIME [hh:mm]	*# set/get the current hours:minutes*
SITE [site description]	*# set/get the site description*
SERIAL [serial number]	*# set/get the unit serial number*
DEPLOY [yy/mm/dd]	*# set/get the deployment date*
GPS [lat, long]	*# set/get the latitude and longitude*
LOG_P [hh:mm]	*# set/get the logging period*
TRANSMIT_P [hh:mm]	*# set/get the satellite TX period (hours)*
BAT_V	*# read battery voltage*
TEMPS	*# read current temperatures*
CLEAR	*# erase the log*
DATA [NEW]	*# get all or only NEW logged temperature data*
SEND	*# take a reading and transmit it via satellite*
STATUS	*# show unit status*

Date and Time

Setting Date and Time Manually

To set the time, it is necessary to find an accurate time source, such as www.time.gov . At BeadedStream we generally set the time to Zulu, however, the time can be set to any time zone.

Example Syntax:

date 13/12/31

2013/12/31 22:12:29

time 1:13

2013/12/31 01:13:00

Setting Date and Time with Iridium

If the logger is in contact with Iridium, the time and date will update automatically.

Setting Date and Time using the GPS radio

Similarly, if the logger does not have an Iridium link, the time can be set using the GPS radio by typing the following command while a having a clear view of the sky (likely outside). Entering a time (in seconds) after the command will prompt the GPS radio to attempt connection for that duration. The default time value is 60 seconds

Example Syntax:

rtc-set-from-gps

waiting max 60 seconds for gps update…

61 11.357380 N, 149 59.332136 W

2013/11/11 22:18:35

RTC UPDATED

Status Command

Similar steps are used to set site, deployment date, GPS coordinates, and the logging interval. Once these parameters are set, they can all be easily checked simultaneously by typing:

Status

Real Time Clock : 2013/11/11 22:23:37
Site description : SITE - NOT SET
Serial number : DLB00056
Site deployment : DEPLOYED - NOT SET
GPS description : GPS - NOT SET
Number of sensors: 8
Logging period : 12:00
Transmit period : 12:00
Inbox rx period : 24:00
Unit temperature : 17.37 C
Battery voltage : 6.574 volts
Storage used : 24 of 14600

Using Status is an easy way to get all necessary information regarding your logger in one swoop. Both date and time are presented as well as site description, serial number, site deployment, GPS points, and the number of sensors on your cable (this quickly shows that your logger is in fact reading a Temperature Acquisition Cable (TAC). In addition, the logging period shows that the logger logs cable temperatures every 12 hours, and also transmits them every 12 hours. There is current battery voltage, low battery threshold flag, and storage used. The logger 'know's whether or not it is Iridium enabled (D405). In the case that it is not (D401), only the logging interval is available to set.

Logging and Transmitting Intervals

The logging and transmission intervals, 'log_p' and 'transmit_p', can only be set to factors of a 24 hour day with a minimum of 5 minutes. NOTE: if using a D401, only the logging interval is settable. If using a D405, the logging and transmitting intervals are both settable. The logging interval is displayed in 'status', however, it can also be accessed by typing:

log_p

4:00

To change the logging period to 2 hours, type:

log_p 02:00

To make sure the change has been made, type:

log_p

2:00

Reading Temperature Data

To obtain temperature readings from your logger outside of the normal logging interval, simply type:

Temps

If not connected to a TAC, the logger will return:

Temperature sensors:
0 sensors found
FAULTS: 1

When connected to a TAC, the logger will read and return sensor serial numbers, and temperatures for each sensor.

Temperature sensors: 4 sensors found
1) 02000002CBC8CC28 temp = 19.93 C
2) 15000002CBC02C28 temp = 20.06 C
3) 06000002CBC02228 temp = 20.06 C
4) 0C000002CBD1ED28 temp = 20.00 C

Here, the logger is connected to a 4 – sensor TAC, where ambient air temperatures are at room temperature.

To access all recorded data on your logger simply type:

Data

According to the 'status' readout above, there are 24 entries out of 14600. In addition, headers are not included, but they are shown below to identify what data is returned with the 'data' command. There is date, time, snow depth (In the event that your logger has a depth sensor) and battery voltage. Panel Temp is the onboard temperature reading, while T1 – T4 are the four sensors on the attached cable. Sensor ID uniquely identifies the TAC by the serial number of the first sensor. If more than one TAC is attached to the logger (maximum of 4 TACs), the temperature data from each TAC will be preceded by the sensor ID of the first sensor of each TAC.

Data Flag, Date, Time, Panel Temp, Battery Voltage, Sensor ID (TAC 1), byte flag, T1, T2, T3, T4, Sensor ID (TAC 2), byte flag, T1, T2, T3, T4

02, 11/11/2013, 22:22:55, 17.37, 6.570, 00 00 04 29 c9 fc, 05, 16.63, 14.69, 15.75, 16.81, 00 00 04 29 b9 d4, 06, 16.81, 15.13, 14.76, 15.26
02, 11/11/2013, 22:23:16, 17.31, 6.574, 00 00 04 29 c9 fc, 05, 16.56, 14.63, 15.69, 16.75, 00 00 04 29 b9 d4, 06, 16.81, 15.01, 14.63, 15.07

Verifying Iridium Functionality

In the field, to verify that a D405 logger is working properly, we can use the 'Send' command to have the logger show us that 1. It is reading the TACs correctly, and 2. It is able to successfully send a transmission through Iridium. In this example, there are two, four-sensor TACs connected. In the terminal, we first see what data is going to be transmitted, and secondly, we see if that transmission was successful or not. The 'Faults' can be ignored.

Send

02, 11/11/2013, 22:22:20, 17.49, 6.578, 00 00 04 29 c9 fc, 05, 16.88, 14.88, 15.94, 17.00, 00 00 04 29 b9 d4, 06, 17.00, 15.32, 15.07, 15.63
transmitting ... please wait
SUCCEEDED, 241 tx attempt(s) since last successful tx
FAULTS: 1

Recording Temperature Data from the Logger

Capture Function in Windows

To save logger data onto your computer, we will do what is called a 'capture'. In Realterm select the third tab called, 'capture' and follow these steps:

1. Next to 'File', select the desired output location of the file that will hold your captured data. Name this something that reflects the data that you are capturing.

2. Uncheck the box that selects 'Direct Capture'. This will allow you to see the commands that you are typing while they are being captured.
3. If starting a new capture, select 'Start Overwrite'. If appending data to an existing capture file, select 'Start Append'. Upon selecting one of these options, the interface will turn RED. This is good and indicates that capturing is imminent.
4. Now you will type commands into the command window. Anything that is typed into this window during a capture will be captured in the output file.
5. Some suggestions would be to type **'status'**, and then '**data'.**
6. When all data has been captured, simply select, 'Stop Capture'.
7. All data is now available in the capture output file designated in Step 1.

Capture Function for Mac

1. Select the 'Connection' tab from the main CoolTerm Menu bar
2. Select 'Capture To Textfile'
3. Use options to 'Start | Pause | Stop'

Logger LEDs

Windows in the lid decal of the logger give visual access to LED indicator lights. There are three different LED colors with combined behavior that indicates elements of logger status. In the right hand window you will see activity from a BLUE and GREEN LED, while in the left, a RED LED.

1. GREEN
    a. With regular logging, **between** logging intervals, the logger will blink GREEN about every 8 seconds. This serves as a 'heartbeat' indicating that the logger is functioning normally.
    b. With regular logging, **during** logging intervals, the logger will turn solid GREEN indicating that it is communicating with the TAC to obtain, store and transmit temperature readings.
    c. A flashing BLUE LED coupled with flashing GREEN LED for ~ 30 seconds indicates a logger reset.
2. RED
    a. When the magnet is used to reset the logger, the RED LED will go solid.
    b. When the magnet is used to issue an automatic log and/or transmission, the RED LED will flash briefly
3. BLUE
    a. A solid BLUE LED indicates a Bluetooth connection
    b. A flashing BLUE LED coupled with flashing GREEN LED for ~ 30 seconds indicates a logger reset.

Hall Effect Switch

D400 Data Loggers are built with an externally accessible hall effect sensor that varies its voltage output in response to a magnetic field. Holding a magnet over the left side of the logger (as indicated in Figure 2) will prompt the logger to do either 1) a one-time temperature reading and transmit outside of the set logging interval. In addition this will allow the BLE radio to advertise for a five minute duration, or 2) reboot the logger.

1) Perform a one-time temperature transmit (and advertise BLE):
    a. Hold the magnet in the vicinity of the sensor. When the sensor is tripped the RED LED will shine solid – quickly remove the magnet. Upon removing the magnet, the GREEN LED will shine solid GREEN, indicating that temperatures are being recorded. Once the LED turns GREEN start counting the seconds that it stays GREEN. Most transmissions will take on the order of 10 -25 seconds. In the event that the light stays GREEN for more than 90 seconds, assume the transmission was unsuccessful and try again. The LED will turn off automatically when finished.

2) Reboot the logger:
    a. Hold the magnet in position, wait until the LED shines RED, hold the magnet in place until the RED light turns off (about 7 or 8 seconds).
    b. Next you'll get some flashing of the BLUE and GREEN LEDs.
    c. Then, you'll get some solid GREEN – the logger is searching for a USB connection.
    d. Flashing BLUE – the logger is searching for a Bluetooth connection
    e. In the end, what you really want to see is the logger returning to the Idle mode (above) → GREEN LED blinks every 8 seconds.

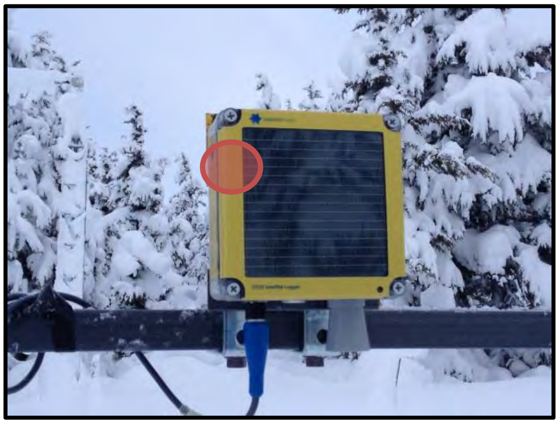


Figure 2: Photo of the D405. The circle demonstrates where the magnet needs to be placed on the outside of the logger enclosure to trip the magnetic switch.

Charging the Battery

D405 and D401 Loggers with Solar Recharge (Lead – Acid)

Each unit is solar rechargeable, thus if the logger is installed properly with the solar panel facing a southerly aspect, the logger should stay charged. Each logger ships with a full battery – ready to deploy. However, the units are always running. If you anticipate not using the logger for an extended period, it is recommended that you either open up the lid and unplug the battery, **OR EVEN BETTER** – just change the logging interval to something infrequent, like once every 24 hours. If the logger has been dormant for a while and you're about to deploy it, either open up the lid and put the battery on a 6V trickle charger (be sure to unplug the power leads from the logger board), **OR EVEN BETTER** – stick the logger out in the sun for a couple days.

D401 Loggers without Solar Recharge (Lithium Ion)

These batteries are a 7.2 V Tadiran Li-Ion, NON-RECHARGEABLE battery. Do not attempt a recharge, these batteries are made custom for BeadedStream – contact us if you need a replacement.

Two-way Communication through Iridium

D405 Loggers have the unique characteristic of being able to receive and process certain commands remotely. Essentially a text message can be emailed to Iridium that will ultimately find its way to the specified D405 Logger. This allows BeadedStream to remotely perform the following actions

- Change logging and transmitting intervals
- Update the RTC
- Determine which TACs are attached to the logger

This has been proven useful to confirm TACs being used, and change intervals either to save power through a long winter or obtain finer temporal resolution during thermal monitoring.

TAC XLR Connector

Each D400 Logger comes standard with 2 ports. These are male-ended XLR connectors. Matching female-ended XLR connectors can be found on the TAC itself. These XLR connectors are pretty darn strong. A couple points to be made here:

1. We recommend a conductive paste when coupling the XLR connectors in harsh, humid environments to prevent corrosion.
2. Make sure you hear a 'click' when plugging the connectors into the logger. Then do a 'tug test ' – they should not come out without needing to press the release tab!

Appendix A4 - BeadedStream Logger Installation Checklist

BeadedStream Logger Installation Checklist

Logger:

- ❏ Oriented to true south (*northern hemisphere*)
- ❏ Minimal vertical tilt**
  Photo left shows large but acceptable tilt.

Sonic sensor:

- ❏ Mounted well above minimum reading distance of 30 cm (~1 foot)
- ❏ Clear path to the ground
- ❏ Flat target on the ground
  Brush cleared/plywood set down

Air temperature sensor:

- ❏ Secured in radiation shield gland shield.

Cables:

- ❏ Connector face coated with **small** amount of "Stuf" paste
- ❏ Connector locked into bulkhead receptacle (*push hard, light tug test, repeat until success*)

System status:

- ❏ Checked out with the Capture app.

Tilt **will DRASTICALLY REDUCE satellite antenna performance. No tilt means logger bottom ports point straight down. In locations with snow, no tilt is a good balance of direct sun and energy reflected from the snow.

See Buoy Installation Instructions for marine environment logger deployments.

Questions? Email us at contact@beadedstream.com or call 844-488-4880

Appendix A5 - Understanding the health of a deployed D505 satellite and sensor system

Appendix B - GTC Specifications and Calibration Certificates

Appendix B1 - D505 Data Logger Specifications

beadedstream

35140-01

D505 | Our latest satellite data logger.

Log your data without logging the miles. The BeadedStream D505 Data Logger is purpose built for remote deployments and reliable performance in extreme conditions. Now with enhanced solar and Bluetooth performance.

Specifications

Hardware / Firmware	• Ultra low-power, high performance industrial microcontroller. • Multi-threaded custom embedded OS. Free firmware updates.
Storage	• Capacity for over 1 million temperature readings. • Non-volatile flash memory survives even if battery dies.
Real Time Clock	• ± 5 minutes per year (temperature compensated). • Periodically synchronizes with GPS network.
Communication	• Bluetooth 4.2 wireless interface. • Compatible with *Capture*, our all new iOS app.
Connections	• Up to 4 DTC ports, up to 2 additional ports for other sensors, power, etc. • 5V driver available to power DTC sensors if needed.
Ultra Low Power	• 6 to 10 VDC (max) input. • Sleep mode: 90 µA typical. Active mode: 70 mA typical.
Battery	• Rechargeable 6V 5.5 Ah sealed lead-acid battery. • 2 months typical w/o solar recharge (Transmitting hourly).
GPS	• Embedded 40-channel dedicated GPS processing module. • 34-second time to first fix (typical). Integrated 1575.42 MHz antenna.
Worldwide Telemetry	• Embedded two-way satellite transceiver and Iridium antenna. • Uses Iridium's mesh network, 66 satellites, 100% pole to pole coverage.
Operating Range	• -40° C to +85° C (-40° F to +185° F). NEMA Type 4X/IP68.
Weight and Dimensions	• 2.3 kg (5.1 lbs) (*without mount*). 7.1" x 7.1"x 3.1" (18 cm x 18 cm x 7.9 cm).
Mounting	• Multi-function pivoting arm mount comes standard.

Specifications (continued)

Integrated Solar	• 3 Watt nominal solar panel with temperature compensated charge control circuit to protect and prolong battery life.
Contactless Switch	• Built-in magnetic switch is immune to dust, dirt, mud and water. • Triggers through the case for spot readings and Bluetooth wake.
Optional Rangefinder	• Small, lightweight, rugged. An ultrasonic outdoor sensor for snow and water level measurement. IP67 rated. • Long narrow detection zone with a 1 cm resolution, minimum detection range of 50 cm, 1 meter maximum. • Filtering algorithms yield excellent noise tolerance and clutter rejection.

Appendix B2 - GTC (DTC) Cable Product Specifications

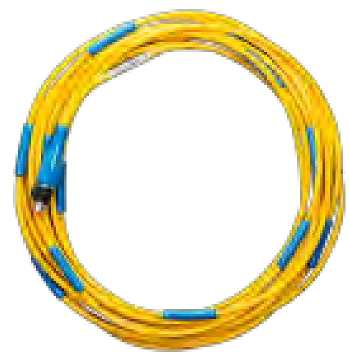
beadedstream

35110-04

Digital Temperature Cable (DTC)

Standard High Visibility Yellow

It all starts with BeadedStream's all-digital temperature cables. DTCs increase the speed and ease of obtaining temperature data and deliver accurate, highly resolved measurements in digital form.



Specifications

Application	• Multi-use industrial temperature monitoring
Length	• Customizable; user specified • Standard maximum length of 450 m (1500 ft)
Diameter	• Cable is 7.0 mm ± 0.1 mm • Straight sensor housing is 11 mm ± 0.5 mm
Maximum Operating Temperature Range	• -55° C to 125° C (-67° F to 257° F)
Field Conditions	• Wet / Dry / Frozen
Colors	• High-visibility yellow; gray (reinforced cable); white • Black or white heat shrink available for sensor sections
Outer Jacket	• BeadedStream S724EX polyurethane jacket formulated for low temperature durability and flex with reduced diameter and weight • Gray option with reinforced shielding for added protection from wildlife and improved crush resistance • UV stabilized • Cut and abrasion resistant • Flexing minimum temperature -40° C/F
Central Strength Member	• Built-in Aramid fibers increase strength in tension and minimize cable stretch
Conductors	• Stranded tinned copper; 22 AWG; Number: 3
Maximum # of Sensors	• 110
Sensor Accuracy	• ± 0.1° C from -10° C to 30° C (14° F to 86° F)

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35110-04

DTC Specifications (continued)

Sensor Spacing	• Customizable; user specified • Variable spacing available upon request • Minimum standard spacing: 10 cm • Closer spacing available – please inquire
Additional Sensor Features	• Requires only one signal line for bidirectional communication • Each sensor has a unique ID for individual communication • Operates using input voltage between 3.0 V and 5.5 V • Converts temperatures in 750 ms (max)

Appendix B3 - GTC Order Sheets

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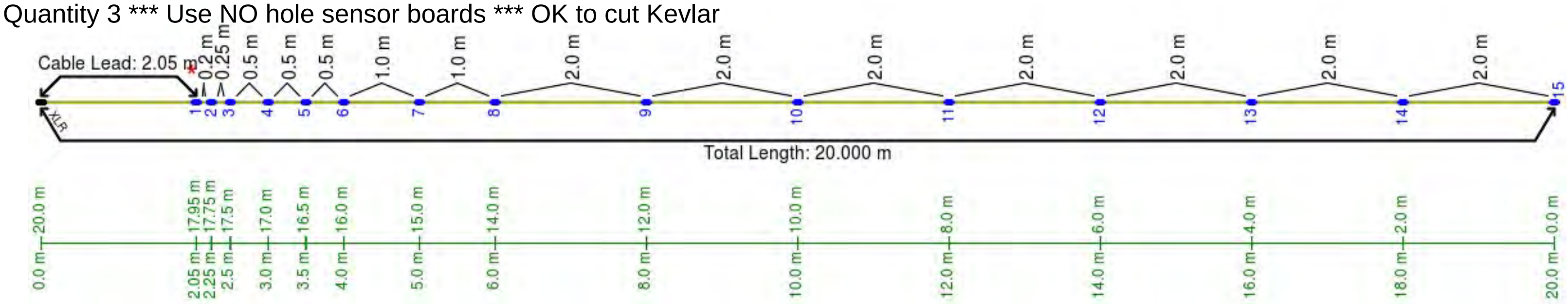
DTC Order Sheet

Customer: SRK Consulting
Project Name: 2018 - Point Hope Phase 1
Order Date:

DTC Name: 15 sensor profiler for the following locations: SRK17-STH-DH-02, SRK17-STH-DH-03, Spare #1
Serial Number: 2839
Units: meters

Object	Mold	Cable	Distance
XLRConnector	**XLR Mold**	**Yellow**	**2.05m**
Protection/Sensor 1	**Straight**	**Yellow**	**0.2m**
Sensor 2	**Straight**	**Yellow**	**0.25m**
Sensor 3	**Straight**	**Yellow**	**0.5m**
Sensor 4	**Straight**	**Yellow**	**0.5m**
Sensor 5	**Straight**	**Yellow**	**0.5m**
Sensor 6	**Straight**	**Yellow**	**1.0m**
Sensor 7	**Straight**	**Yellow**	**1.0m**
Sensor 8	**Straight**	**Yellow**	**2.0m**
Sensor 9	**Straight**	**Yellow**	**2.0m**
Sensor 10	**Straight**	**Yellow**	**2.0m**
Sensor 11	**Straight**	**Yellow**	**2.0m**
Sensor 12	**Straight**	**Yellow**	**2.0m**
Sensor 13	**Straight**	**Yellow**	**2.0m**
Sensor 14	**Straight**	**Yellow**	**2.0m**
Sensor 15	**End**	**N/A**	**N/A**

Comments: Quantity 3 *** Use NO hole sensor boards *** OK to cut Kevlar



* indicates that this sensor contains a protection unit

Return signed order sheet to BeadedStream at
e-mail: contact@beadedstream.com
call: 844-488-4880 for support

Approved

Date

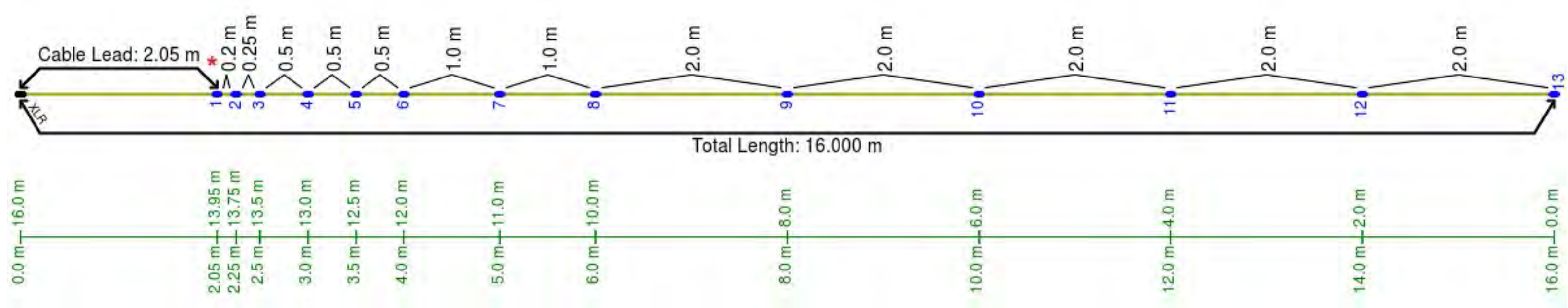
DTC Order Sheet

Customer: SRK Consulting
Project Name: 2018 - Point Hope Phase 1
Order Date:

DTC Name: 13 sensor profiler for: SRK17-BWRP-DH-01, Spare #2
Serial Number: 2841
Units: meters

Object	Mold	Cable	Distance
XLRConnector	**XLR Mold**	**Yellow**	**2.05m**
Protection/Sensor 1	**Straight**	**Yellow**	**0.2m**
Sensor 2	**Straight**	**Yellow**	**0.25m**
Sensor 3	**Straight**	**Yellow**	**0.5m**
Sensor 4	**Straight**	**Yellow**	**0.5m**
Sensor 5	**Straight**	**Yellow**	**0.5m**
Sensor 6	**Straight**	**Yellow**	**1.0m**
Sensor 7	**Straight**	**Yellow**	**1.0m**
Sensor 8	**Straight**	**Yellow**	**2.0m**
Sensor 9	**Straight**	**Yellow**	**2.0m**
Sensor 10	**Straight**	**Yellow**	**2.0m**
Sensor 11	**Straight**	**Yellow**	**2.0m**
Sensor 12	**Straight**	**Yellow**	**2.0m**
Sensor 13	**End**	**N/A**	**N/A**

Comments: Quantity 2 *** Use NO hole sensor boards *** OK to cut Kevlar



* indicates that this sensor contains a protection unit

Return signed order sheet to BeadedStream at
e-mail: contact@beadedstream.com
call: 844-488-4880 for support

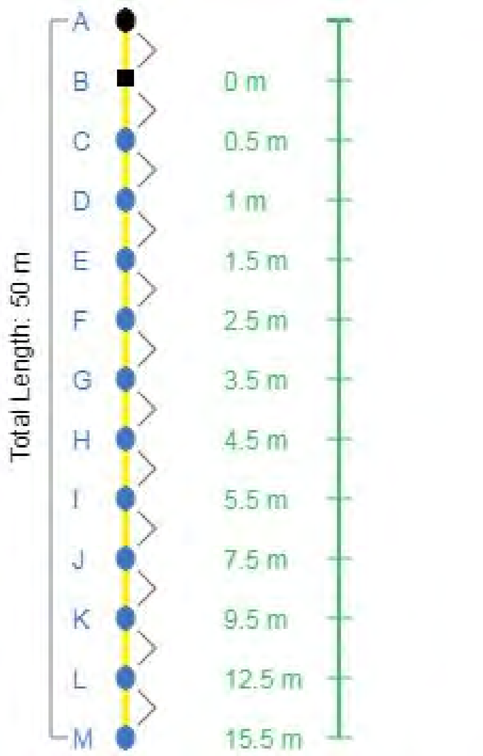
Approved ______________________ Date ______________________

DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 02-20-2018
Project: Hope Bay - South Dam		DTC Name: SD-VTS-155-KTC and SD-VTS-460-KTC
Quantity: 2	Serial Number(s): 3251, 3252	

Client Notes:
Priority 1

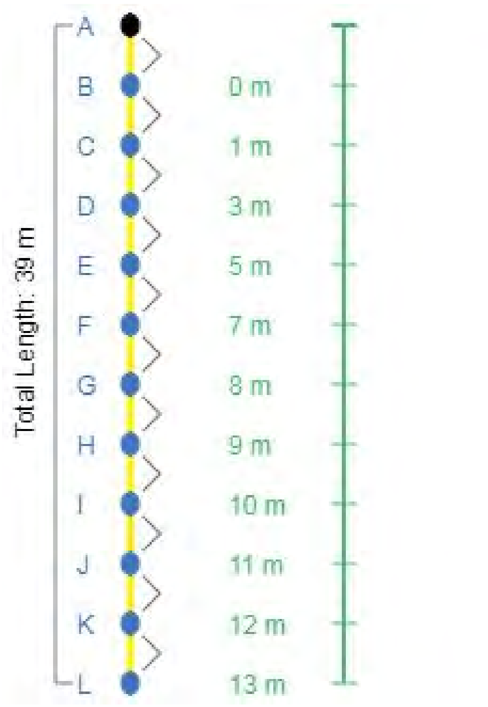
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	34.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Customer: SRK Consulting (Alaska)		Date Generated: 02-20-2018
Project: Hope Bay - South Dam		DTC Name: SD-HTS-155-KT and SD-HTS-460-KT
Quantity: 2	Serial Number(s): 3253, 3254	

Client Notes:
Priority 2

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	26 m	yellow
Protection/Sensor 1	Straight	0 m	1 m	yellow
Sensor 2	Straight	1 m	2 m	yellow
Sensor 3	Straight	3 m	2 m	yellow
Sensor 4	Straight	5 m	2 m	yellow
Sensor 5	Straight	7 m	1 m	yellow
Sensor 6	Straight	8 m	1 m	yellow
Sensor 7	Straight	9 m	1 m	yellow
Sensor 8	Straight	10 m	1 m	yellow
Sensor 9	Straight	11 m	1 m	yellow
Sensor 10	Straight	12 m	1 m	yellow
Sensor 11	End Mold	13 m	- m	-

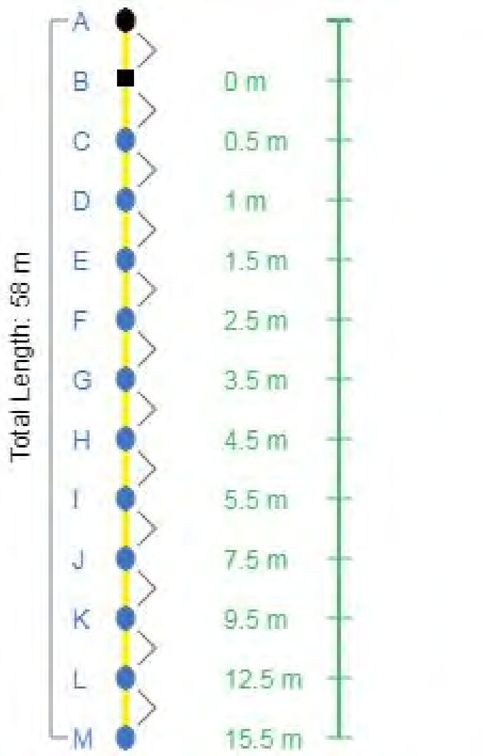


DTC Order Sheet

Customer: SRK Consulting (Alaska)	Date Generated: 02-20-2018
Project: Hope Bay - South Dam	DTC Name: SD-VTS-240-KTC
Quantity: 1	Serial Number(s): 3255

Client Notes:
Priority 1

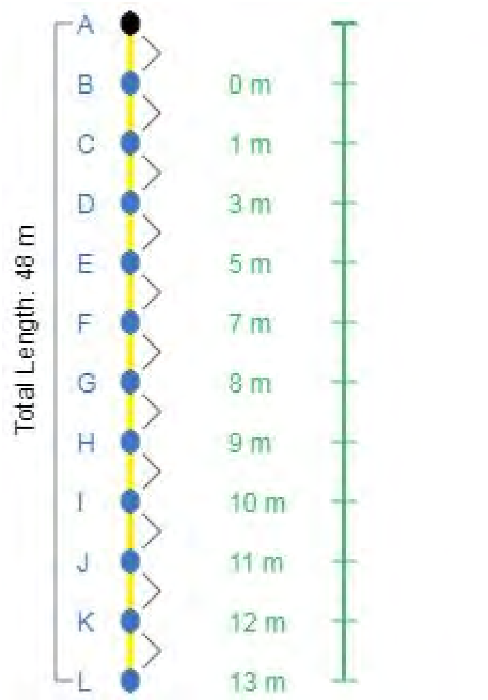
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	42.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Customer: SRK Consulting (Alaska)		Date Generated: 02-20-2018
Project: Hope Bay - South Dam		DTC Name: SD-VTS-240-KT
Quantity: 1	Serial Number(s): 3256	

Client Notes:
Priority 2

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	35 m	yellow
Protection/Sensor 1	Straight	0 m	1 m	yellow
Sensor 2	Straight	1 m	2 m	yellow
Sensor 3	Straight	3 m	2 m	yellow
Sensor 4	Straight	5 m	2 m	yellow
Sensor 5	Straight	7 m	1 m	yellow
Sensor 6	Straight	8 m	1 m	yellow
Sensor 7	Straight	9 m	1 m	yellow
Sensor 8	Straight	10 m	1 m	yellow
Sensor 9	Straight	11 m	1 m	yellow
Sensor 10	Straight	12 m	1 m	yellow
Sensor 11	End Mold	13 m	- m	-

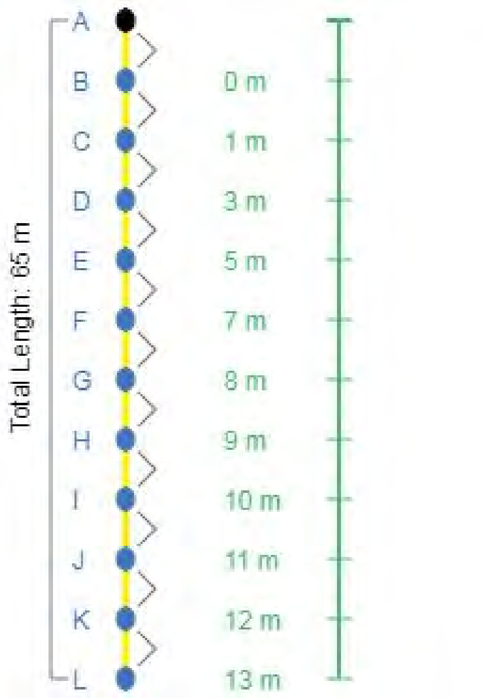


DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 02-20-2018
Project: Hope Bay - South Dam		DTC Name: SD-HTS-365-KT
Quantity: 1	Serial Number(s): 3257	

Client Notes:
Priority 2

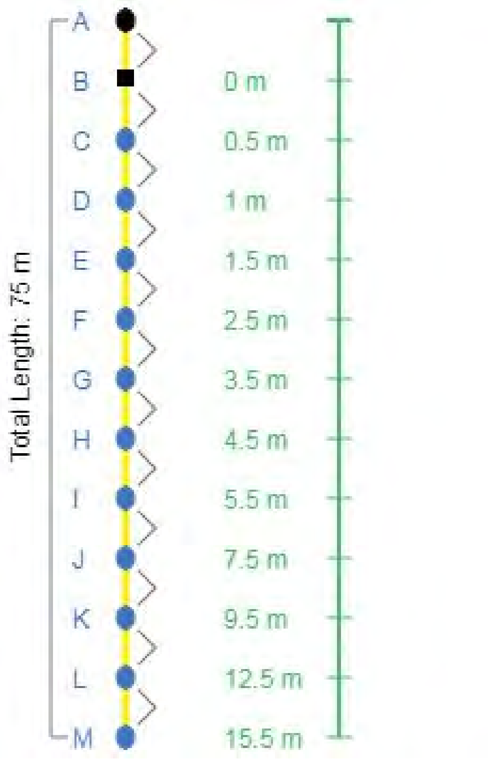
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	52 m	yellow
Protection/Sensor 1	Straight	0 m	1 m	yellow
Sensor 2	Straight	1 m	2 m	yellow
Sensor 3	Straight	3 m	2 m	yellow
Sensor 4	Straight	5 m	2 m	yellow
Sensor 5	Straight	7 m	1 m	yellow
Sensor 6	Straight	8 m	1 m	yellow
Sensor 7	Straight	9 m	1 m	yellow
Sensor 8	Straight	10 m	1 m	yellow
Sensor 9	Straight	11 m	1 m	yellow
Sensor 10	Straight	12 m	1 m	yellow
Sensor 11	End Mold	13 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 02-20-2018
Project: Hope Bay - South Dam	DTC Name: SD-VTS-365-KTC
Quantity: 1	Serial Number(s): 3258

Client Notes:
Priority 1

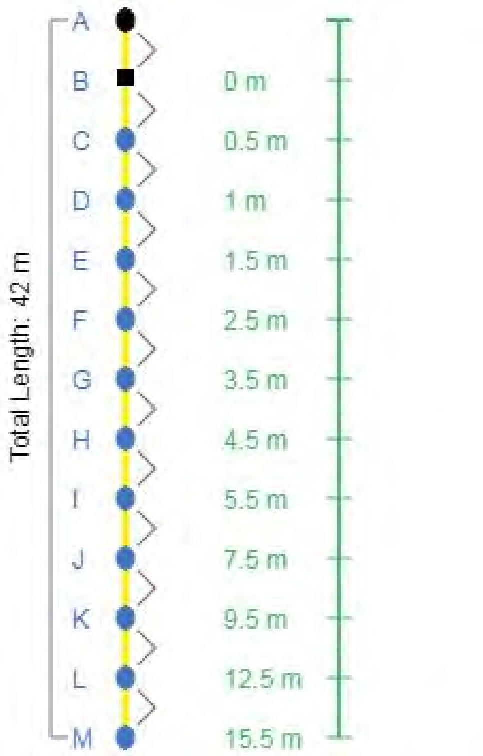
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	59.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 02-20-2018
Project: Hope Bay - South Dam	DTC Name: SD-VTS-065-KTC
Quantity: 1	Serial Number(s): 3259

Client Notes:
Priority 1

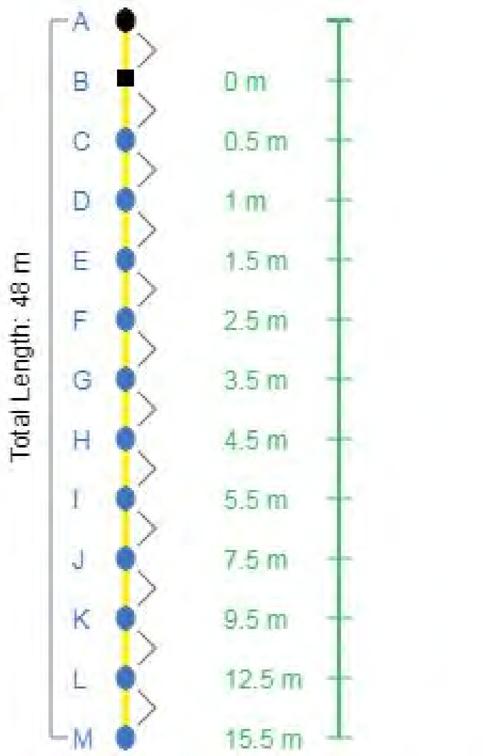
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	26.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 02-20-2018
Project: Hope Bay - South Dam	DTC Name: SD-VTS-510-KTC
Quantity: 1	Serial Number(s): 3260

Client Notes:
Priority 1

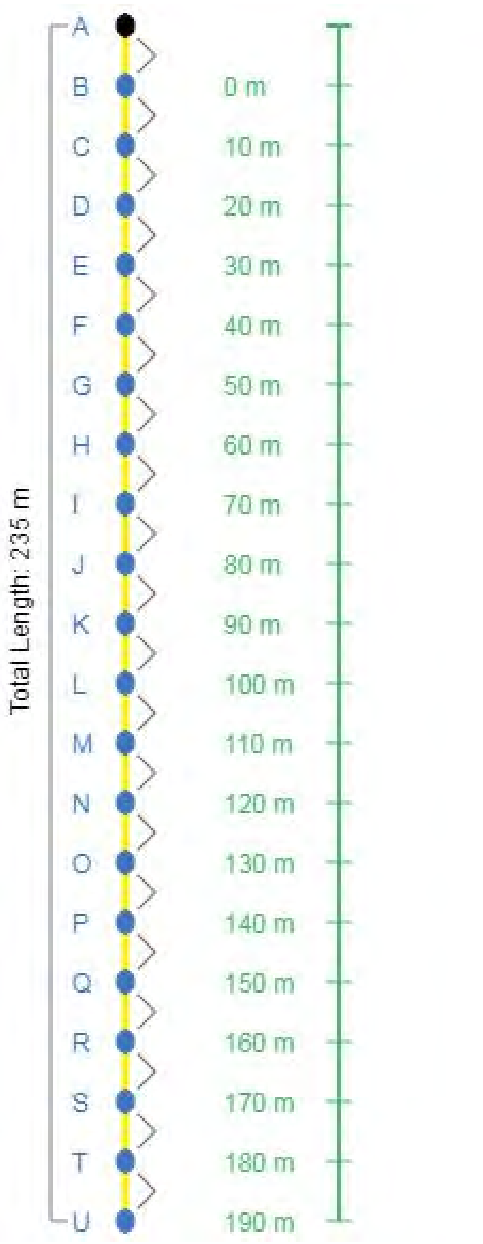
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	32.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 02-20-2018
Project: Hope Bay - South Dam	DTC Name: SD-HST-B1-KT
Quantity: 1	Serial Number(s): 3261

Client Notes:
Priority 3

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	45 m	yellow
Protection/Sensor 1	Straight	0 m	10 m	yellow
Sensor 2	Straight	10 m	10 m	yellow
Sensor 3	Straight	20 m	10 m	yellow
Sensor 4	Straight	30 m	10 m	yellow
Sensor 5	Straight	40 m	10 m	yellow
Sensor 6	Straight	50 m	10 m	yellow
Sensor 7	Straight	60 m	10 m	yellow
Sensor 8	Straight	70 m	10 m	yellow
Sensor 9	Straight	80 m	10 m	yellow
Sensor 10	Straight	90 m	10 m	yellow
Sensor 11	Straight	100 m	10 m	yellow
Sensor 12	Straight	110 m	10 m	yellow
Sensor 13	Straight	120 m	10 m	yellow
Sensor 14	Straight	130 m	10 m	yellow
Sensor 15	Straight	140 m	10 m	yellow
Sensor 16	Straight	150 m	10 m	yellow
Sensor 17	Straight	160 m	10 m	yellow
Sensor 18	Straight	170 m	10 m	yellow
Sensor 19	Straight	180 m	10 m	yellow
Sensor 20	End Mold	190 m	- m	-

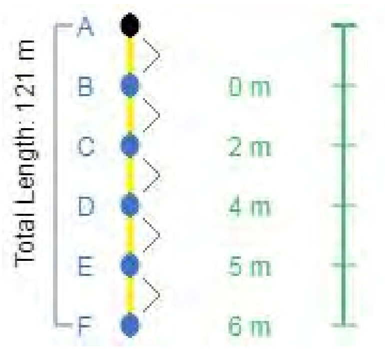


DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2		DTC Name: SD-HTS-065-US
Quantity: 1	Serial Number(s): 3263	

Client Notes:
Priority 1

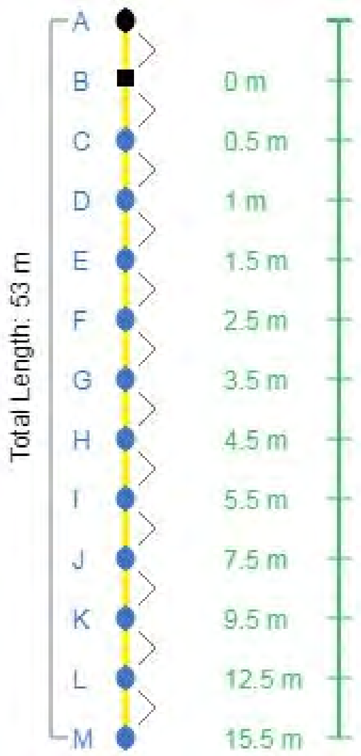
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	115 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	1 m	yellow
Sensor 4	Straight	5 m	1 m	yellow
Sensor 5	End Mold	6 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-VTS-155-DST and SD-VTS-240-DST
Quantity: 2	Serial Number(s): 3264, 3265

Client Notes:
Priority 3

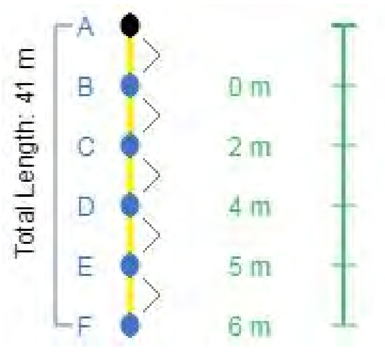
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	37.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Customer: SRK Consulting (Alaska)		Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2		DTC Name: SD-HTS-155-US and SD-HTS-460-US
Quantity: 2	Serial Number(s): 3266, 3267	

Client Notes:
Priority 1

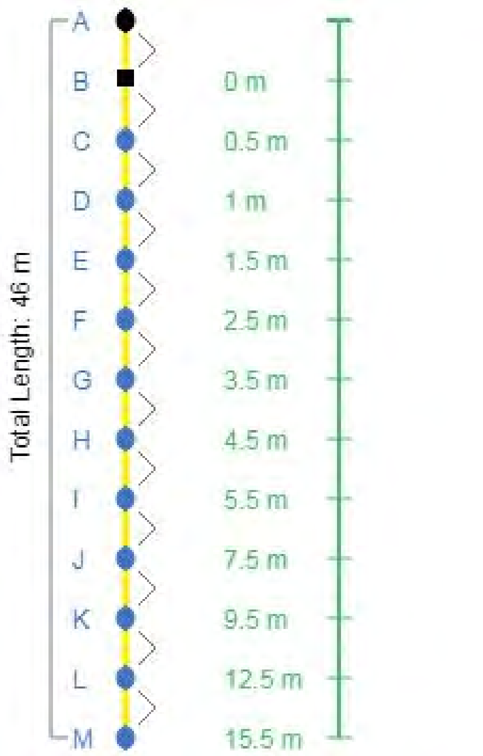
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	35 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	1 m	yellow
Sensor 4	Straight	5 m	1 m	yellow
Sensor 5	End Mold	6 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-VTS-240-UST
Quantity: 1	Serial Number(s): 3268

Client Notes:
Priority 2

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	30.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-

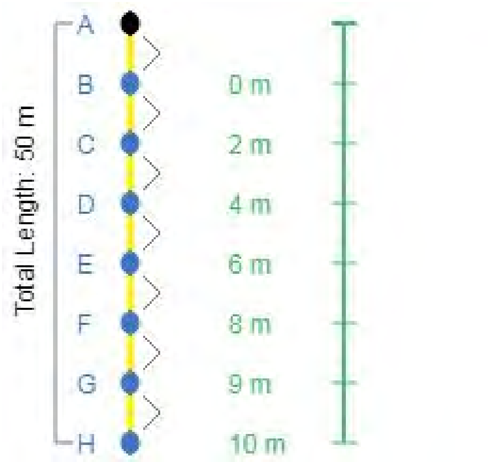


DTC Order Sheet

Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-HTS-240-US
Quantity: 1	Serial Number(s): 3269

Client Notes:
Priority 1

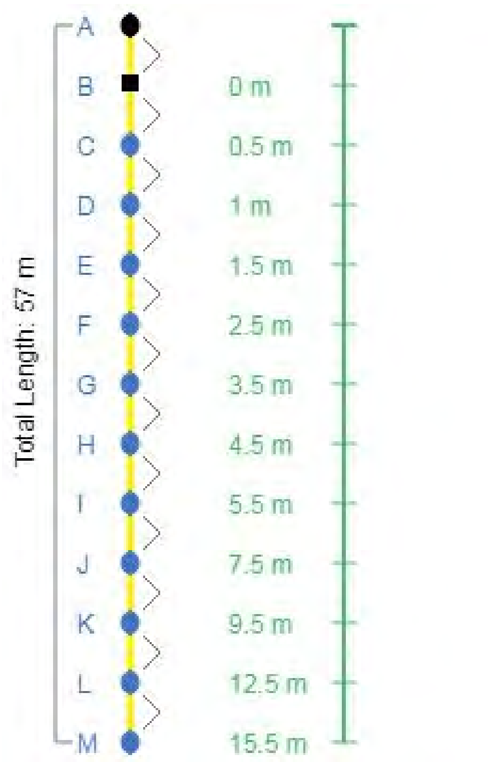
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	40 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	2 m	yellow
Sensor 4	Straight	6 m	2 m	yellow
Sensor 5	Straight	8 m	1 m	yellow
Sensor 6	Straight	9 m	1 m	yellow
Sensor 7	End Mold	10 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-VTS-365-UST
Quantity: 1	Serial Number(s): 3270

Client Notes:
Priority 2

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	41.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-

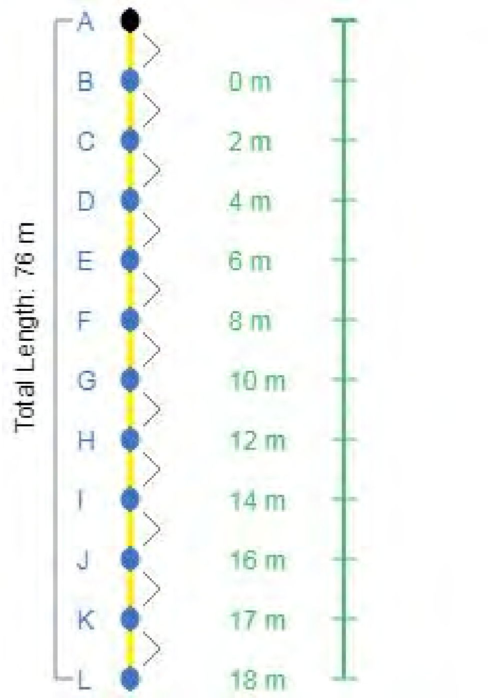


DTC Order Sheet

Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-HTS-365-US
Quantity: 1	Serial Number(s): 3271

Client Notes:
Priority 1

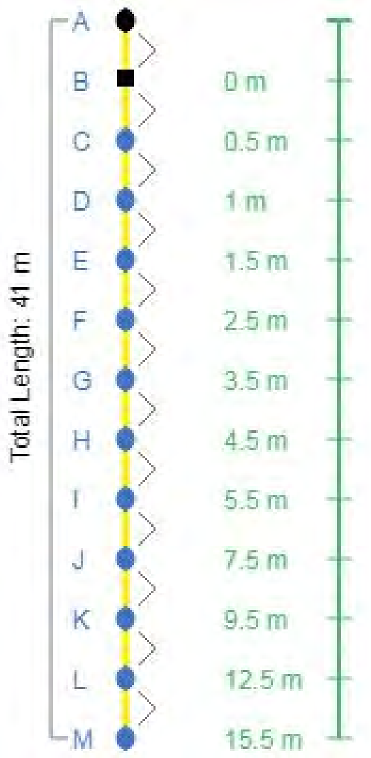
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	58 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	2 m	yellow
Sensor 4	Straight	6 m	2 m	yellow
Sensor 5	Straight	8 m	2 m	yellow
Sensor 6	Straight	10 m	2 m	yellow
Sensor 7	Straight	12 m	2 m	yellow
Sensor 8	Straight	14 m	2 m	yellow
Sensor 9	Straight	16 m	1 m	yellow
Sensor 10	Straight	17 m	1 m	yellow
Sensor 11	End Mold	18 m	- m	-



Customer: SRK Consulting (Alaska)	Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-VTS-155-UST, SD-VTS-460-UST
Quantity: 2	Serial Number(s): 3272, 3273

Client Notes:
Priority 2

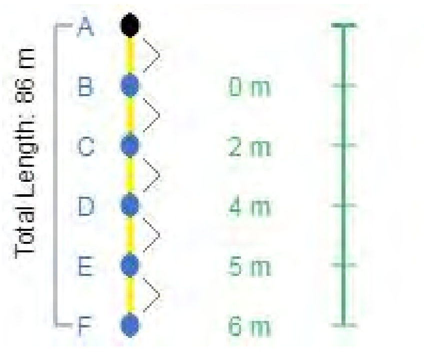
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	25.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



DTC Order Sheet

Customer: SRK Consulting (Alaska)		Date Generated: 03-14-2018
Project: Hope Bay - South Dam - Order 2		DTC Name: SD-HTS-510-US
Quantity: 1	Serial Number(s): 3274	

Client Notes:
Priority 1



Component	**Mold**	**Position**	**Section**	**Cable**
XLR	XLR Mold	-	80 m	yellow
Protection/Sensor 1	Straight	0 m	2 m	yellow
Sensor 2	Straight	2 m	2 m	yellow
Sensor 3	Straight	4 m	1 m	yellow
Sensor 4	Straight	5 m	1 m	yellow
Sensor 5	End Mold	6 m	- m	-

Customer: SRK Consulting (Alaska)		Date Generated: 03-16-2018
Project: Hope Bay - South Dam - Order 2		DTC Name: Extensions for SD-VTS-065-KTC, 510-KTC
Quantity: 2	Serial Number(s): 3277, 3278	

Client Notes:
The "zero marker" on the end of this extension represents the opposite gender XLR connector.

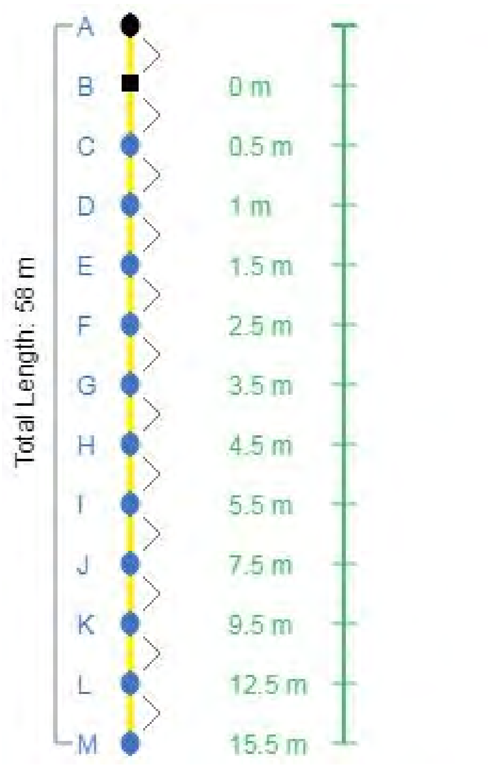
Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	90 m	yellow
Zero Marker	None	0 m	- m	-

DTC Order Sheet

Customer: SRK Consulting (Alaska)	Date Generated: 03-16-2018
Project: Hope Bay - South Dam - Order 2	DTC Name: SD-VTS-365-DST, SD-VTS-460-DST
Quantity: 2	Serial Number(s): 3275, 3276

Client Notes:
Priority 3

Component	Mold	Position	Section	Cable
XLR	XLR Mold	-	42.5 m	yellow
Zero Marker	None	0 m	0.5 m	yellow
Protection/Sensor 1	Straight	0.5 m	0.5 m	yellow
Sensor 2	Straight	1 m	0.5 m	yellow
Sensor 3	Straight	1.5 m	1 m	yellow
Sensor 4	Straight	2.5 m	1 m	yellow
Sensor 5	Straight	3.5 m	1 m	yellow
Sensor 6	Straight	4.5 m	1 m	yellow
Sensor 7	Straight	5.5 m	2 m	yellow
Sensor 8	Straight	7.5 m	2 m	yellow
Sensor 9	Straight	9.5 m	3 m	yellow
Sensor 10	Straight	12.5 m	3 m	yellow
Sensor 11	End Mold	15.5 m	- m	-



Appendix B4 – GTC Calibration Certificates

DTC Calibration Certificate
SRK - Hope Bay Phase 1

This certificate verifies and displays the results of calibration for the digital temperature cables with serial numbers **3187 to 3201**. **3188** had repair work started but was then superseded by replacement cable **3201**. The values are shown in the tables below.

Offset values are a result of BeadedStream's rigorous calibration process where each offset is determined with measurement in a **0.000 °C ice bath** confirmed with our NIST traceable secondary reference platinum RTD (Resistance temperature detector).

When temperature readings are taken with a D405 Datalogger or NetGate (Ethernet Bridge), the offset values are first subtracted from the raw temperature and then are driven to **+/- 0.1 °C accuracy** using BeadedStream's proprietary characteristic error curve correction algorithm.

Sensor	Sensor ID	Offset
	Serial 3187	
1	E6 00 00 07 12 68 2F 28	0.250
2	BC 00 00 08 40 A4 88 28	1.000
3	94 00 00 08 40 4C 14 28	0.438
4	2B 00 00 08 40 EA 8C 28	0.375
5	A3 00 00 08 40 A4 EC 28	0.875
6	66 00 00 08 40 B6 02 28	0.938
7	2F 00 00 08 41 31 A2 28	0.438
8	65 00 00 08 41 06 62 28	0.250
9	37 00 00 08 40 C5 F2 28	0.438
10	29 00 00 08 41 4C B6 28	0.375
11	78 00 00 08 41 30 C1 28	0.375
12	2C 00 00 08 41 06 F9 28	0.375
13	45 00 00 08 40 9D 55 28	1.000
14	DE 00 00 08 40 6B 5D 28	0.438
15	15 00 00 08 41 36 03 28	0.375
	Serial 3189	
1	29 00 00 07 12 09 21 28	0.375
2	B2 00 00 08 40 4C 08 28	0.500

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **January 24th 2018***
*Cable 3201 calibrated and added and certificate completed by **Paul Harren** (Project Manager) on **February 1st 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

3	F1 00 00 08 40 6B 88 28	0.438
4	EE 00 00 08 40 5D 38 28	1.000
5	D1 00 00 08 40 8F F4 28	0.375
6	52 00 00 08 41 22 0C 28	0.438
7	98 00 00 08 41 38 D6 28	0.438
8	C0 00 00 08 3F F1 41 28	0.563
9	BD 00 00 08 41 49 D1 28	0.313
10	E0 00 00 08 40 A5 31 28	1.000
11	87 00 00 08 40 64 D9 28	0.750
12	05 00 00 08 41 30 CD 28	0.438
13	3A 00 00 08 40 64 23 28	0.813
14	EE 00 00 08 40 64 6B 28	1.000
15	EF 00 00 08 41 36 1B 28	0.313
	Serial 3190	
1	65 00 00 07 12 67 9A 28	0.188
2	A5 00 00 08 40 5D B0 28	0.938
3	38 00 00 08 41 22 28 28	0.250
4	DB 00 00 08 40 19 58 28	0.875
5	CA 00 00 08 40 64 64 28	0.938
6	D5 00 00 08 3F CD 54 28	0.313
7	76 00 00 08 40 11 F2 28	0.563
8	55 00 00 08 40 92 4A 28	0.500
9	59 00 00 08 40 64 CE 28	1.000
10	F4 00 00 08 40 8F 7E 28	0.125
11	65 00 00 08 41 22 0D 28	0.375
12	3B 00 00 08 3F B0 D3 28	0.875
	Serial 3191	
1	A0 00 00 07 12 7A F3 28	0.250
2	70 00 00 08 41 49 C8 28	0.625
3	D5 00 00 08 41 22 18 28	0.313
4	E4 00 00 08 40 64 34 28	0.875
5	6E 00 00 08 40 38 FC 28	0.750
6	AC 00 00 08 3F FD FC 28	0.313
7	C6 00 00 08 3F B1 62 28	1.125

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **January 24th 2018***
*Cable 3201 calibrated and added and certificate completed by **Paul Harren** (Project Manager) on **February 1st 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

11	CE 00 00 08 40 19 63 28	1.000
12	B0 00 00 08 41 38 B3 28	0.500
	Serial 3197	
1	B0 00 00 07 12 08 CD 28	0.438
2	2E 00 00 08 3F D1 EC 28	0.375
3	57 00 00 08 40 EB 1C 28	0.438
4	4B 00 00 08 40 59 72 28	0.250
5	53 00 00 08 40 7A 86 28	1.125
6	F7 00 00 08 3F B1 56 28	0.938
7	3A 00 00 08 40 EA 91 28	0.438
8	03 00 00 08 40 8F 89 28	0.500
9	F6 00 00 08 40 A4 85 28	0.938
10	25 00 00 08 40 8F 95 28	0.375
11	41 00 00 08 40 11 F3 28	0.438
12	89 00 00 08 41 38 CB 28	0.375
13	79 00 00 08 40 90 3B 28	0.063
	Serial 3198	
1	2F 00 00 07 12 09 14 28	0.250
2	66 00 00 08 40 D9 98 28	0.375
3	32 00 00 08 40 7A 78 28	0.875
4	47 00 00 08 40 A5 0C 28	1.000
5	3E 00 00 08 40 9D 6C 28	0.813
6	E7 00 00 08 40 A5 81 28	1.000
7	2C 00 00 08 40 72 51 28	0.250
8	72 00 00 08 3F CD 69 28	0.500
9	4A 00 00 08 40 57 69 28	0.438
10	97 00 00 08 41 22 59 28	0.375
11	AC 00 00 08 40 FE 75 28	0.563
12	53 00 00 08 40 D6 0D 28	0.375
13	2C 00 00 08 40 D1 5D 28	0.938
	Serial 3199	
1	29 00 00 07 12 AF 50 28	0.188
2	9C 00 00 08 40 D9 80 28	0.188
3	43 00 00 08 40 9D 60 28	0.938

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **January 24th 2018***
*Cable 3201 calibrated and added and certificate completed by **Paul Harren** (Project Manager) on **February 1st 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

DTC Calibration Certificate
SRK - Hope Bay South Dam

This certificate verifies and displays the results of calibration for the digital temperature cables with serial numbers **3251 to 3261**. The values are shown in the tables below.

Offset values are a result of BeadedStream's rigorous calibration process where each offset is determined with measurement in a **0.000 °C ice bath** confirmed with our NIST traceable secondary reference platinum RTD (Resistance temperature detector).

When temperature readings are taken with a D405 Datalogger, NetGate, or Recite, the offset values are first subtracted from the raw temperature and then are driven to **+/- 0.1 °C accuracy** using BeadedStream's proprietary characteristic error curve correction algorithm.

Sensor	Sensor ID	Offset
	Serial 3251	
1	B2 00 00 07 11 F6 10 28	0.250
2	EA 00 00 07 12 11 00 28	0.188
3	C3 00 00 07 12 46 30 28	0.375
4	21 00 00 07 12 42 98 28	0.250
5	37 00 00 07 12 46 51 28	0.125
6	43 00 00 07 12 60 C9 28	0.250
7	A7 00 00 07 12 27 69 28	0.250
8	CF 00 00 07 12 24 75 28	0.375
9	35 00 00 07 12 7B 75 28	0.250
10	88 00 00 07 12 9E C3 28	0.188
11	73 00 00 07 12 51 E3 28	0.250
	Serial 3252	
1	54 00 00 07 12 09 2D 28	0.313
2	C5 00 00 07 12 1C 60 28	0.250
3	C8 00 00 07 12 AD 38 28	0.125
4	7D 00 00 07 12 19 44 28	0.250
5	84 00 00 07 12 9D 82 28	0.188
6	D3 00 00 07 12 6F 72 28	0.250
7	23 00 00 07 12 01 B6 28	0.250

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

8	2A 00 00 07 12 2B 8E 28	0.250
9	DD 00 00 07 12 9A CE 28	0.313
10	6D 00 00 07 11 FD 61 28	0.188
11	22 00 00 07 12 77 F1 28	0.250
	Serial 3253	
1	60 00 00 07 12 A0 4C 28	0.313
2	1C 00 00 07 11 E3 10 28	0.313
3	46 00 00 07 12 49 B0 28	0.063
4	8F 00 00 07 12 A3 44 28	0.313
5	C8 00 00 07 11 F8 32 28	0.250
6	16 00 00 07 11 F3 C6 28	0.313
7	52 00 00 07 12 3D FE 28	0.375
8	B0 00 00 07 12 42 21 28	0.250
9	B1 00 00 07 12 01 99 28	0.313
10	91 00 00 07 12 42 8D 28	0.188
11	8C 00 00 07 12 96 2D 28	0.188
	Serial 3254	
1	20 00 00 07 12 A1 07 28	0.313
2	26 00 00 07 12 78 50 28	0.250
3	4B 00 00 07 11 FC 64 28	0.250
4	9E 00 00 07 12 64 2C 28	0.188
5	35 00 00 07 12 74 F2 28	0.125
6	5C 00 00 07 12 5E B1 28	0.313
7	5B 00 00 07 12 10 89 28	0.188
8	18 00 00 07 12 49 03 28	0.063
9	D3 00 00 07 12 AC 63 28	0.188
10	DE 00 00 07 12 78 5B 28	0.188
11	07 00 00 07 12 2C 07 28	0.188
	Serial 3255	
1	41 00 00 07 12 6A 20 28	0.250
2	17 00 00 07 12 4E B0 28	0.250
3	6A 00 00 07 12 78 68 28	0.125
4	36 00 00 07 11 F0 C4 28	0.250
5	1B 00 00 07 12 48 8C 28	0.188

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

6	53 00 00 07 12 2D F2 28	0.313
7	81 00 00 07 12 45 5A 28	0.313
8	34 00 00 07 12 2A 76 28	0.375
9	CC 00 00 07 12 60 91 28	0.188
10	4A 00 00 07 12 19 45 28	0.250
11	96 00 00 07 12 27 5D 28	0.125
	Serial 3256	
1	94 00 00 07 12 93 84 28	0.250
2	55 00 00 07 11 EC 0C 28	0.188
3	61 00 00 07 11 E3 1C 28	0.188
4	C8 00 00 07 12 A7 C2 28	0.125
5	35 00 00 07 12 42 26 28	0.250
6	92 00 00 07 12 33 96 28	0.250
7	A2 00 00 07 12 00 8E 28	0.125
8	D5 00 00 07 12 8C 5D 28	0.125
9	56 00 00 07 12 0C 43 28	0.125
10	03 00 00 07 12 5A E3 28	0.188
11	0F 00 00 07 12 50 73 28	0.188
	Serial 3257	
1	B4 00 00 07 12 91 9F 28	0.063
2	E8 00 00 07 12 AC 08 28	0.125
3	11 00 00 07 12 90 A8 28	0.188
4	C6 00 00 07 12 AC 58 28	0.250
5	37 00 00 07 12 14 FC 28	0.313
6	78 00 00 07 12 A2 AA 28	0.313
7	82 00 00 07 11 E8 B6 28	0.313
8	19 00 00 07 12 A7 29 28	0.250
9	2F 00 00 07 12 78 99 28	0.250
10	24 00 00 07 11 F8 87 28	0.313
11	95 00 00 07 12 08 47 28	0.188
	Serial 3258	
1	27 00 00 07 12 7A E7 28	0.313
2	F3 00 00 07 11 F9 40 28	0.188
3	25 00 00 07 12 38 D0 28	0.000

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

4	05 00 00 07 12 77 68 28	0.313
5	94 00 00 07 12 2B E2 28	0.313
6	0D 00 00 07 11 F1 B6 28	0.313
7	3D 00 00 07 12 00 4E 28	0.438
8	5D 00 00 07 12 15 C1 28	0.313
9	78 00 00 07 12 0A 45 28	0.250
10	62 00 00 07 11 EC 0D 28	0.313
11	E9 00 00 07 12 33 AF 28	0.250
	Serial 3259	
1	20 00 00 07 11 E9 31 28	0.313
2	64 00 00 07 12 98 20 28	0.250
3	28 00 00 07 12 2A 84 28	0.188
4	70 00 00 07 12 9A AC 28	0.250
5	2A 00 00 07 12 36 B2 28	0.313
6	E0 00 00 07 12 0D 7A 28	0.313
7	42 00 00 07 12 16 8E 28	0.250
8	03 00 00 07 12 08 4E 28	0.250
9	AD 00 00 07 12 3E 6E 28	0.313
10	27 00 00 07 12 00 89 28	0.188
11	B9 00 00 07 12 A8 23 28	0.313
	Serial 3260	
1	BB 00 00 07 12 9D CF 28	0.313
2	DB 00 00 07 11 FC 58 28	0.250
3	86 00 00 07 12 45 EA 28	0.250
4	57 00 00 07 11 ED 06 28	0.188
5	58 00 00 07 11 F0 C6 28	0.250
6	85 00 00 07 12 01 0E 28	0.250
7	8A 00 00 07 12 97 01 28	0.375
8	5A 00 00 07 11 F0 D5 28	0.313
9	04 00 00 07 12 4B C3 28	0.563
10	8B 00 00 07 12 01 77 28	0.250
11	94 00 00 07 11 FD EF 28	0.438
	Serial 3261	
1	A6 00 00 07 12 39 FB 28	0.250

*Calibrations performed by **Lindsey Bohnert** (Tech Ops Associate) on **March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

2	27 00 00 07 12 01 90 28	0.313
3	FD 00 00 07 12 A7 D0 28	0.563
4	22 00 00 07 12 55 C8 28	0.563
5	7B 00 00 07 12 2A D8 28	0.500
6	53 00 00 07 11 E9 44 28	0.375
7	63 00 00 07 11 F1 B4 28	0.563
8	F7 00 00 07 12 2E 72 28	0.688
9	F3 00 00 07 11 FB 72 28	0.500
10	51 00 00 07 12 4B AA 28	0.563
11	AA 00 00 07 12 A7 AA 28	0.250
12	94 00 00 07 12 42 2E 28	0.375
13	68 00 00 07 12 10 AE 28	0.313
14	B7 00 00 07 12 45 DE 28	0.438
15	6F 00 00 07 12 17 51 28	0.438
16	36 00 00 07 12 79 D1 28	0.125
17	26 00 00 07 12 01 15 28	0.313
18	12 00 00 07 12 08 53 28	0.375
19	1D 00 00 07 11 ED 0B 28	0.375
20	BF 00 00 07 12 44 8B 28	0.375

Calibrations performed by ***Lindsey Bohnert*** *(Tech Ops Associate) on* ***March 2nd 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

DTC Calibration Certificate
SRK - Hope Bay South Dam Order 2

This certificate verifies and displays the results of calibration for the digital temperature cables with serial numbers **3263 to 3276**. The values are shown in the tables below.

Offset values are a result of BeadedStream's rigorous calibration process where each offset is determined with measurement in a **0.000 °C ice bath** confirmed with our NIST traceable secondary reference platinum RTD (Resistance temperature detector).

When temperature readings are taken with a D405 Datalogger, NetGate, or Recite, the offset values are first subtracted from the raw temperature and then are driven to **+/- 0.1 °C accuracy** using BeadedStream's proprietary characteristic error curve correction algorithm.

Sensor	Sensor ID	Offset
	Serial 3263	
1	9D 00 00 07 12 7F D0 28	0.188
2	92 00 00 07 11 F3 44 28	0.375
3	E7 00 00 07 12 39 2C 28	0.125
4	04 00 00 07 12 29 EC 28	0.188
5	DE 00 00 07 11 F6 01 28	0.250
	Serial 3264	
1	5D 00 00 07 11 E9 3D 28	0.188
2	36 00 00 07 11 F8 0C 28	0.313
3	CF 00 00 07 11 F8 82 28	0.313
4	D8 00 00 07 12 AF 92 28	0.313
5	B4 00 00 07 12 2A D2 28	0.188
6	23 00 00 07 12 5A CA 28	0.250
7	1F 00 00 07 11 EC 01 28	0.063
8	4C 00 00 07 12 87 4B 28	0.188
9	00 00 00 07 11 F3 6B 28	0.188
10	AD 00 00 07 12 0D C7 28	0.250
11	2E 00 00 07 12 7B 37 28	0.188
	Serial 3265	

*Calibrations performed by **Lindsey Bohnert and Trevor Sprague** (Tech Ops Associates) on **April 7th 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

1	0B 00 00 07 12 32 7A 28	0.063
2	38 00 00 07 12 9C E4 28	0.250
3	37 00 00 07 11 F5 3C 28	0.313
4	C7 00 00 07 12 61 52 28	-0.063
5	42 00 00 07 12 87 32 28	0.125
6	F3 00 00 07 11 F3 BA 28	0.375
7	C9 00 00 07 12 2A DE 28	-0.063
8	4C 00 00 07 12 10 A1 28	0.125
9	6F 00 00 07 12 0E 09 28	0.125
10	AE 00 00 07 12 A8 0B 28	0.250
11	AD 00 00 07 12 8D EB 28	0.250
	Serial 3266	
1	7B 00 00 07 12 7F 3A 28	0.313
2	8E 00 00 07 12 4B 38 28	0.188
3	0F 00 00 07 12 75 05 28	0.188
4	39 00 00 07 12 14 85 28	0.125
5	5D 00 00 07 12 46 75 28	0.125
	Serial 3267	
1	CB 00 00 07 11 E9 34 28	0.250
2	46 00 00 07 12 3D 40 28	0.125
3	DB 00 00 07 12 91 18 28	0.438
4	2A 00 00 07 12 2D D8 28	0.125
5	DC 00 00 07 12 02 26 28	0.250
	Serial 3268	
1	87 00 00 07 12 08 CC 28	0.313
2	19 00 00 07 12 64 38 28	0.188
3	FF 00 00 07 12 A8 44 28	0.125
4	9A 00 00 07 12 64 0A 28	0.313
5	C5 00 00 07 12 87 26 28	0.063
6	17 00 00 07 11 F6 3E 28	0.188
7	95 00 00 07 12 3C A1 28	0.438
8	E5 00 00 07 11 EC 19 28	0.250
9	65 00 00 07 11 F5 E5 28	0.125
10	6A 00 00 07 12 33 9D 28	0.125

Calibrations performed by ***Lindsey Bohnert and Trevor Sprague*** *(Tech Ops Associates) on* ***April 7th 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

11	C6 00 00 07 12 32 63 28	0.125
	Serial 3269	
1	6E 00 00 07 12 93 9C 28	0.188
2	F5 00 00 07 11 FC 08 28	0.250
3	09 00 00 07 12 3B B8 28	0.188
4	4B 00 00 07 11 F4 AC 28	0.313
5	EA 00 00 07 12 17 56 28	0.125
6	5F 00 00 07 12 AC AD 28	0.000
7	CE 00 00 07 11 FC 63 28	0.188
	Serial 3270	
1	18 00 00 07 12 09 15 28	0.313
2	8C 00 00 07 12 2D 60 28	0.438
3	10 00 00 07 12 4A 64 28	0.250
4	44 00 00 07 12 2B 8C 28	0.063
5	3F 00 00 07 12 A6 2C 28	0.250
6	2B 00 00 07 12 75 0A 28	0.188
7	24 00 00 07 12 10 96 28	0.188
8	BD 00 00 07 12 04 8E 28	0.188
9	55 00 00 07 12 74 89 28	0.250
10	BB 00 00 07 12 A5 85 28	0.250
11	DF 00 00 07 12 85 D3 28	0.125
	Serial 3271	
1	2B 00 00 07 12 AF 43 28	0.375
2	52 00 00 07 12 01 D0 28	0.438
3	FC 00 00 07 12 81 08 28	0.313
4	16 00 00 07 12 5A D8 28	0.125
5	86 00 00 07 12 5A E4 28	0.125
6	3F 00 00 07 12 7B 2A 28	0.125
7	7E 00 00 07 11 ED E6 28	0.375
8	2D 00 00 07 11 F8 4E 28	0.125
9	71 00 00 07 12 3D 41 28	0.250
10	4B 00 00 07 12 2A 69 28	0.250
11	7C 00 00 07 12 91 25 28	0.063
	Serial 3272	

*Calibrations performed by **Lindsey Bohnert and Trevor Sprague** (Tech Ops Associates) on **April 7th 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

1	ED 00 00 07 11 F0 70 28	0.125
2	98 00 00 07 12 9D 70 28	0.125
3	22 00 00 07 12 02 18 28	0.250
4	ED 00 00 07 11 F8 B8 28	0.375
5	56 00 00 07 12 AC 64 28	0.313
6	4D 00 00 07 12 01 B4 28	0.125
7	5B 00 00 07 12 1B 6A 28	0.313
8	4C 00 00 07 12 02 1A 28	0.188
9	BA 00 00 07 12 99 2E 28	0.313
10	5C 00 00 07 12 01 A9 28	0.125
11	F7 00 00 07 12 6F 7D 28	0.125
	Serial 3273	
1	98 00 00 07 12 AF C0 28	0.188
2	BF 00 00 07 12 9C F0 28	0.250
3	B1 00 00 07 11 F8 18 28	0.250
4	AB 00 00 07 12 16 98 28	0.125
5	D6 00 00 07 12 2C EC 28	0.250
6	54 00 00 07 12 A1 C2 28	0.188
7	CE 00 00 07 12 85 CE 28	0.250
8	B8 00 00 07 12 95 91 28	0.188
9	54 00 00 07 12 2E 69 28	0.125
10	D5 00 00 07 11 F4 E9 28	0.250
11	26 00 00 07 12 2E 99 28	0.250
	Serial 3274	
1	7B 00 00 07 12 90 8C 28	0.250
2	EA 00 00 07 12 4A 7C 28	0.125
3	0F 00 00 07 12 59 A2 28	0.188
4	4B 00 00 07 12 5D B2 28	0.000
5	B6 00 00 07 11 F6 36 28	0.188
	Serial 3275	
1	41 00 00 07 11 E8 D6 28	0.250
2	FB 00 00 07 12 60 90 28	0.188
3	AA 00 00 07 12 6F 58 28	0.125
4	9F 00 00 07 12 04 B4 28	0.313

*Calibrations performed by **Lindsey Bohnert and Trevor Sprague** (Tech Ops Associates) on **April 7th 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

5	E6 00 00 07 12 23 DA 28	0.250
6	49 00 00 07 12 A2 9E 28	0.188
7	92 00 00 07 12 02 0D 28	0.250
8	54 00 00 07 12 18 BD 28	0.250
9	31 00 00 07 11 FF F3 28	0.375
10	6C 00 00 07 12 1B 6B 28	0.063
11	AD 00 00 07 11 FD 97 28	0.313
	Serial 3276	
1	54 00 00 07 12 8B 33 28	0.125
2	09 00 00 07 12 75 30 28	0.188
3	CC 00 00 07 11 FC 70 28	0.438
4	12 00 00 07 12 9A C4 28	0.188
5	D5 00 00 07 12 01 C4 28	0.250
6	CD 00 00 07 12 2E 9C 28	0.250
7	23 00 00 07 11 EC DA 28	0.313
8	E4 00 00 07 12 00 E9 28	0.125
9	75 00 00 07 11 EC 25 28	0.250
10	30 00 00 07 11 EB 9B 28	0.188
11	69 00 00 07 12 52 0F 28	0.188

*Calibrations performed by **Lindsey Bohnert and Trevor Sprague** (Tech Ops Associates) on **April 7th 2018***

Questions? Email us at contact@beadedstream.com or call 844-488-4880

Appendix C - Suggested Guidelines for Surveying at the North Dam

Appendix D - South Dam Visual Inspection / Checklist Form

Hope Bay - South Dam
Visual Inspection Form

Frequency: Weekly or as specified by EOR

Date:	
Inspected By:	
Conditions:	(ie. snow on ground, clear)

Visual Inspection:

This weekly visual inspection (walk over) report is a means to track the condition on the **South Dam**, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam (Overall)		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Downstream Side of Dam (Overall)		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	No
Crest of Dam (Overall)		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Tailings Beach on the Upstream Side of the Dam		
Is ponded water on the upstream side further than 100 meters from the dam? (Beach length of 100 meters or greater, no water ponding or pooling near the dam etc.) * Use shoreline markers indicating 100 meters from the crest for visual reference*	Yes	No
Active Tailings Discharge Spigot		
Indicate the active discharge spigot location (Spigot ID or identify with a Spigot ID and ● using Figure 2 as a guide)		
Settlement Instrumentation (on crest and downstream side)		
Any visible concerns? (significantly rusted or otherwise damaged, etc.)	Yes	No
Thermistors and Dataloggers		
Any visible concerns? (cables frayed, disconnected or damaged, boxes cracked, etc.)	Yes	No
Water at the Toe of the Downstream Side of the Dam		
Is water visible on the downstream side of the dam?	Yes	No
Is the water visibly flowing?	Yes	No
Walk over inspection of the downstream toe complete? (May to November)		
Inspector should walk the length of the downstream toe inspecting for seepage or slumping once most of the snow has melted (May to November)	Yes	No
If you answered yes to any of the questions above, or made other observations, please provide details and photos. Observations can be sketched on the figure provided below. NOTES: If water flow near the dam toe been noted estimate the flow and report to the Environmental Supervisor: High/Medium/Low: Estimate a flow rate if possible:		

Photos:

Please collect the following photos:

- Photo from the crest looking W along the dam crest (Station 0+30) ☐
- Photo from the crest looking SW over the downstream toe along the dam (Station 2+00) ☐
- Photo from the crest looking W over the tailings beach (Station 2+00) ☐
- Photo from the crest looking NE over the tailings beach (Station 4+20) ☐
- Photo from the crest looking E over the downstream toe along the dam (Station 4+20) ☐
- Photo from west end looking E along the dam crest (Station 5+20) ☐

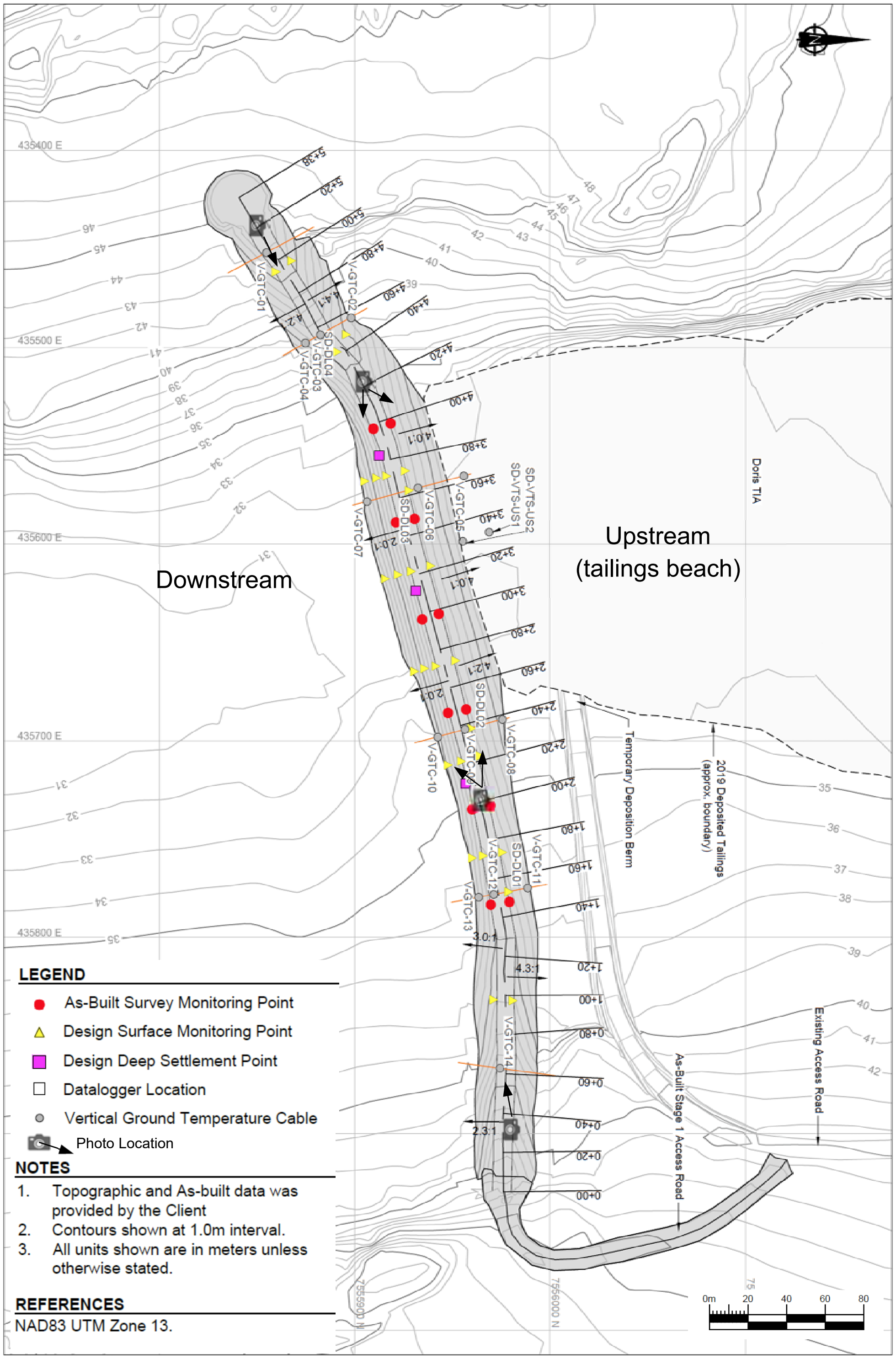


Figure 1: Plan view and recommended locations for walkover photographs

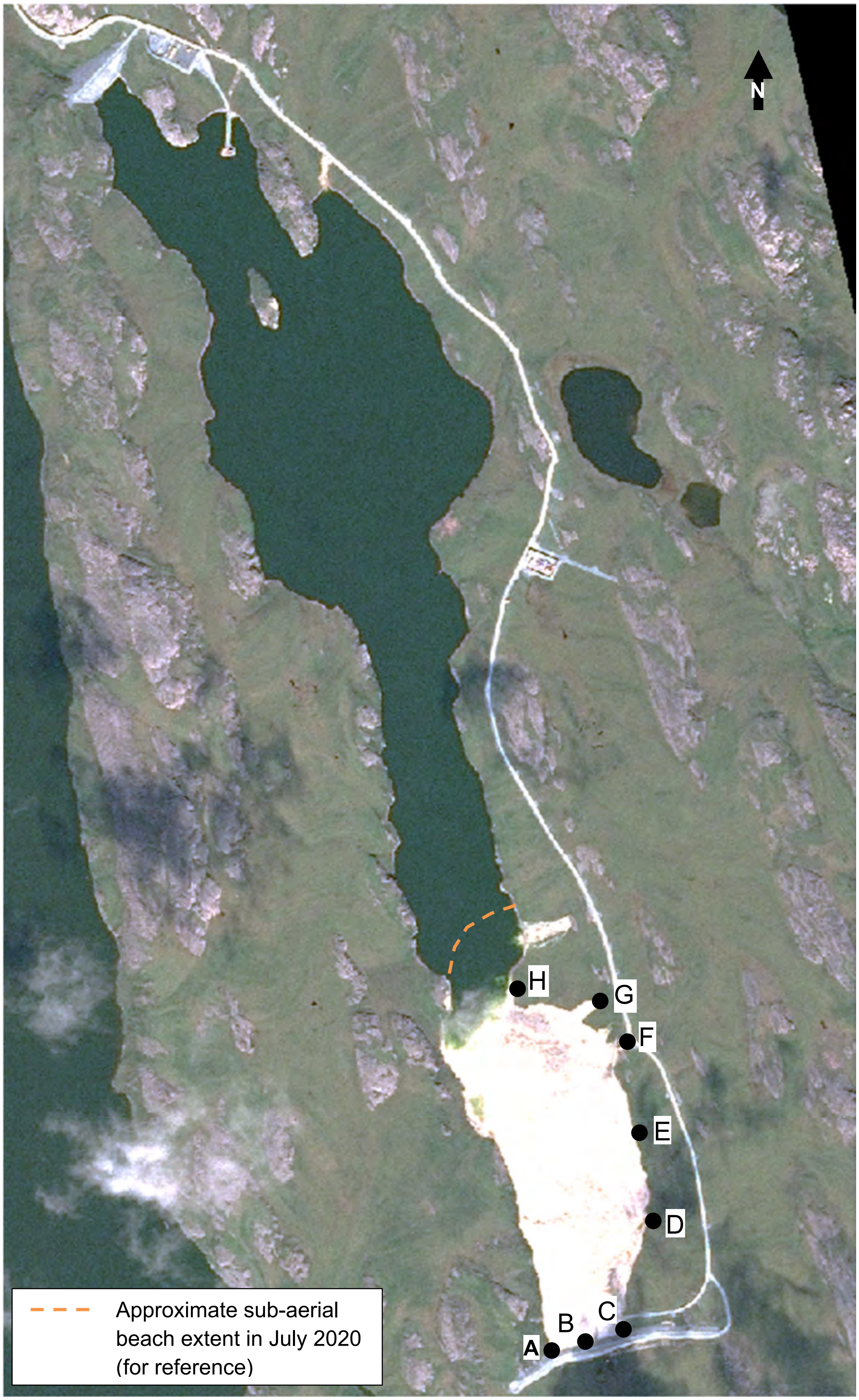


Figure 2: Spigot locations