DAVIS COASTAL CONSULTANTS

P.O. Box 185
Orewa
Phone 09 428 0040
021 627 193
Email coastal@daviscoastal.co.nz

Our Ref: 23028

28 March 2024

Mr Allan Fraser
Glen Isla Place
Waihi Beach

Dear Mr Fraser,

Memorandum – Location of Mean Highwater Springs Glen Isla Place, Waihi Beach

1.0 Introduction

In the context of investigating the provision of erosion control measures at Glen Isla Place, Waihi Beach, we have undertaken an analysis of the position of Mean High Water Springs (MHWS) at the site.

Mean High Water Springs (MHWS) is specified as the jurisdictional boundary between "Land" and the "Coastal Marine Area" (sea) in the Resource Management Act (RMA). The District Plan defines the Planning Rules and Consent requirements for Activities landward of this line. The Regional Coastal Plan has the same function seaward of this line.

Definition of this boundary was usefully explained by Professor J. Hannah of University of Otago to the Planning Tribunal (Falkner v Gisborne District Council Decision A82/94) as "*a two-stage process: determining the vertical height of the mean high water springs level, and then projecting that height on to the shore profile to determine the horizontal location of the mean high water springs contour.*"

The boundary can be envisaged as a flat plane at the level of MHWS intersecting with the sloping shoreline (Figure1). We have used this two-stage process to determine MHWS at the site.

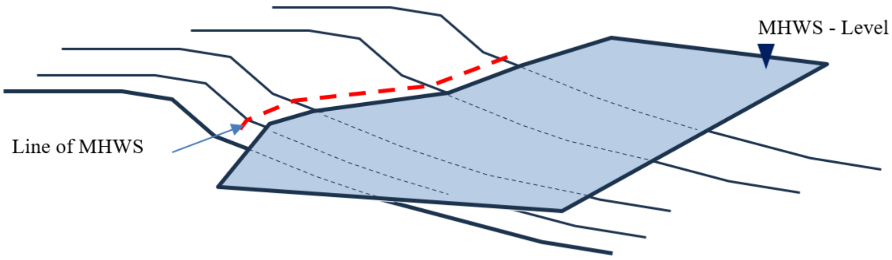


Figure 1 – Depiction of MHWS Calculation

2.0 Vertical Height of MHWS

MHWS is a statistic of the variable level of the high tide. It is typically interpreted as an average water level of spring tide.

There are multiple definitions of MHWS. A traditional maritime definition of MHWS (and MLWS) is provided by LINZ as *"The average of the levels of each pair of successive high waters, and of each pair of low waters, during that period of about 24 hours in each semi-lunation (approximately every 14 days), when the range of the tide is greatest (spring range)."* This definition was expected to be exceeded by approximately the 12% highest tides.

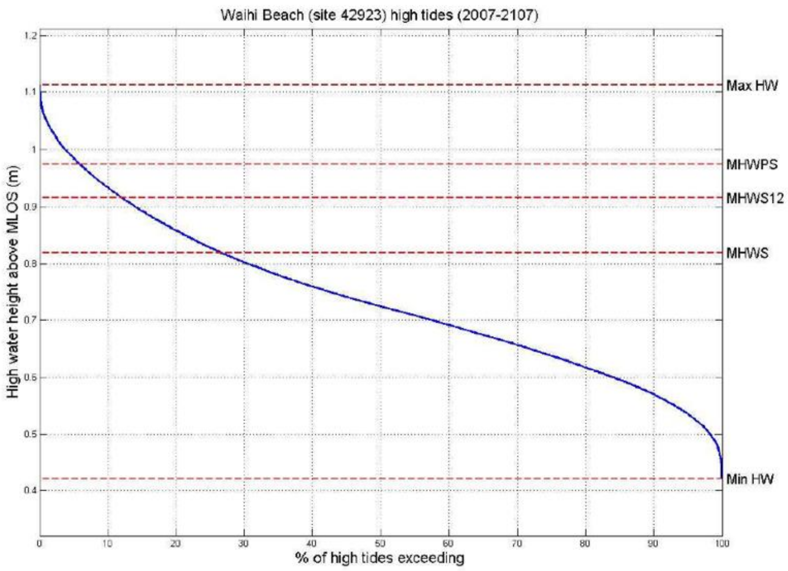
A mathematical algorithm (Equation 1) has often been used to calculate MHWS. It takes the primary harmonic Sun and Moon components of tide and combines the maxima of these to define high tide. In recent years, issues with this producing a representative MHWS in New Zealand, particularly in the upper South Island, led to inclusion of a third (N_2) harmonic component (Equation2). The N_2 component accounts for changes in tidal height due to the variation in distance between the moon and earth resulting from the elliptical lunar orbit. The component is at its maximum when the moon is at its closest point or perigee and the resulting tidal statistic often defined as the Perigean Mean High Water Spring (MHWSP).

$$MHWS = MLOS + A(M_2) + A(S_2) \qquad (1)$$

$$MHWSP = MLOS + A(M_2) + A(S_2) + A(N_2) \qquad (2)$$

With the advent of more sophisticated computer modelling and longer-term tidal monitoring to provide calibration, tidal exceedance curves have been developed. These curves show the frequency that all high tide levels occur. A figure for MHWS is then defined as level that only a given percentage of tides exceed. Typically, because of the traditional expectation that 12% of tides were greater than MHWS the height exceeded by 12% of tides is provided from the exceedance curve (MHWS12). The height exceeded by only 10% of high tides (MHWS10) is also another relatively common measure. NIWA have been at the forefront of this work in New Zealand and in 2006 provided a report for the Bay of Plenty Regional Council (BOPRC) detailing tidal calculation methods and modelling tidal levels in the Region. They produced an exceedance curve for Waihi Beach (Figure 2).

The exceedance curve for Waihi, reproduced from the 2006 report, shows the maximum tide is RL1.1 and all high tides are between RL 0.4 and RL1.1 The level of the traditionally defined MHWS is approximately RL 0.8 and the MHWSP is approximately RL1.2. (Table 1) These levels are all given relative to the "*Mean Level of the Sea (MLOS)*". They are set out in Table 1 below along with conversion to levels in respect to the Moturiki Vertical Datum 1953 (MVD1953). The Moturiki Datum is typically used in topographical survey data for the area.



High-tide exceedance curve for **Waihi Beach** relative to MLOS (which will vary). Annotation descriptors are given in the text abov

Figure 2 – High Tide Exceedance for Waihi Beach ex NIWA 2006

Statistic	**Level (m)** Relative to MLOS	**Level (m)** Relative to MVD1953
Maximum High tide	1.1	1.2
MHWS10	0.9 *(0.93)*	1.0
MHWS12	0.9 *(0.916)*	1.0
MHWS	0.8	0.9
Minimum High tide	0.4	0.5

Table 1 – Summary of High tide Statistics ex NIWA 2006

Both Case law and published reporting on tidal determination, highlight the need for pragmatism in determining MHWS. There is no correct or definitive value that can be specified. However, there is only a 300mm difference between a traditional value of MHWS and the maximum highest tide expected (excluding sea level rise). Between all the MHWS statistics quoted in the NIWA report there is less than a 200mm difference. This difference is largely theoretical and relevant primarily to the mathematical model.

On an open coast such as Waihi, tidal height is overlain by an active wave environment and the tide acts on a dynamic changing beach. In this context, the difference in level between the various definitions becomes less significant.

For the purposes of defining MHWS for this matter we have adopted the value adopted by NIWA in their specialist report to BOPRC on this matter, which is exceeded by only approximately 10 % of tides. The adopted value by the NIWA report to one decimal place is RL1.0 MVD1953.

MHWS = RL1.0 MVD1953

This value has the benefit of being a contour that is readily and often plotted in a number of historic and contemporary studies and plans. It therefore provides a practicable and useable value. The contours on some topographical mapping, including the GIS mapping used by the BOPRC website, expresses contours and height in NZVD2016. Table 2 shows the offset of 0.3 between the data. Where the GIS shows a RL1.0 contour based on NZVD2016, the line of MHWS will be 0.3m above this.

	MVD1953	NZVD2016
MHWS	1.0	1.3
1.0 Contour on WBOPRC GIS	0.7	1.0

Table 2 – Comparison of RL1.0 in MVD and NZVD

3.0 Location of MHWS Line at Glen Isla Place

In order to locate the line of MHWS on site we must determine where the beach is at the level of RL1.0 or the location of the RL1.0 contour. This RL1.0 contour is the line MHWS.

However, the level of the beach varies due to many drivers on differing times scales. This includes diurnal tidal changes, seasonal and storm event changes as well as longer term changes from longer weather patterns. Changing weather patterns can be associated with El Nino/ La Nina cycles over many years and pan-decadal patterns have also been defined. In combination with these fluctuations, changes in the beach drivers such as a change in sediment supply, change in local control points (river outlets, headlands), sea level rise or man-made effects can also create changes in the beach profile.

Both Case law and published reporting on tidal determination, highlight the need for pragmatism in determining MHWS. There is no correct or definitive value that can be specified. The location chosen may depend on the accuracy required for the task at hand and practicable measures such as site features which provide some consistency in determining the jurisdictional boundary.

For the purposes of determining the jurisdictional planning boundary at this site, we have investigated the range of locations that the line of MHWS has been in over time and related this to the proposed location of any potential works. The over-arching philosophy is to maintain our works landward of any reasonable depiction of MHWS so that the work is firmly on Land and not within the Coastal Marine Area.

Waihi Beach has reasonable monitoring data for approximately 20 years, and a limited amount of older data going back over 30 years. This monitoring tends to show a generally stable beach, but this may be influenced by human interventions.

There are long term monitoring sites (Figure 3), CS49 and CS50, 400-600m each side of the site, that have 37-year and 34-year records, respectively. A set of three profiles at the Glen Isla site were monitored for 6 years between 2012 and 2018. This is understood to have been some short-term monitoring in relation to the drainage outlet of Three Mile Creek.

The data is mapped as beach cross sections or profiles, as Figure 4 and Attachment 1. From this record of profiles an envelope of profiles can be determined. This envelope provides a cross-section area of within which the beach profile has fluctuated. but also an area outside and landward of this which has always been above MHWS and therefore “Land” under the Resource Management Act. Activities in this area are subject to the District Plan and Sections 9 and 15 of the Act but not Section 12. For this area the District Council is the primary Planning Consent Authority.

Figure 3: Monitoring Locations

A useful tool in determining the location of MHWS over time is to map the “excursion” of the RL1.0m contour over time. This maps the horizontal distance from a fixed monitoring point to the RL1.0 contour. As more sand builds up on the beach and the beach builds seaward, the RL1.0 contour moves seaward. In times of storm erosion and beach retreat the beach lowers and the RL1.0 contour moves closer to the shore, landward.

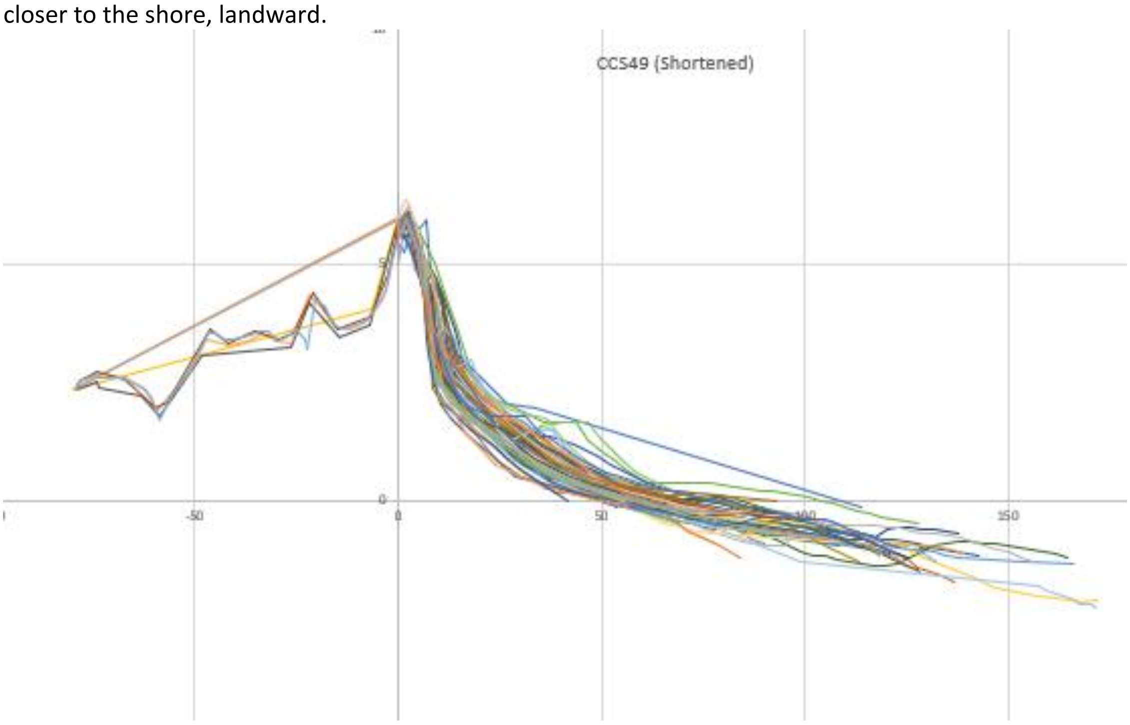


Figure 4: CS49 Profile Data

We mapped Excursions for all five profiles (Figures 5 and 6 and Attachment 1). As would be expected, there was greater variability and a greater range of excursion of the MHWS mark on the profiles that had been monitored over a longer time frame when compared to the profiles monitored for only six years. In order to determine the applicability of the wider range of movement to our site, which was adjacent to profiles only monitored over a short timeframe, all profiles were compared over similar 6-year timeframe to compare fluctuations at the sites.

Over the similar six-year period (2012-2018) the long-term monitoring sites (CS49 and CS50) behaved similarly to S1, S2 and S3. The range of excursion was 17m +/-1m at all profiles. Table 3 provides the maximum and minimum excursion information for the MHWS contour. Over the 6-year time period the minimum excursion was within 1m of that monitored over the 30year timeframe. The majority of the larger range of excursion in the longer record depicts a higher level of sand on the beach and a more seaward line of MHWS.

It was therefore extrapolated that S1-S3 would behave similarly to CS49 and CS50 over longer time frames and it was reasonable to assume the range of excursion documented at CS49 and CS50 would have been present at the site over that time. As the minimum excursion represents the" most eroded" of landward location of the beach although the 30-year period minimum was within 1m of the 6-year minimum, it was assumed that the long-term excursion was 2m further landward than the six-year figures.

This width of excursion was then mapped in Plan onto the beach seaward of Glen Isla as the area in which MHWS has been located over the last 30-35 years. (Figure 7 Attachment 2)

It is assumed that work landward of this area, and so landward of MHWS for the last 30 years is therefore outside the Coastal Marine Area and under the Jurisdiction of the District Plan and Terrestrial Consent Authority, Western BOPDC

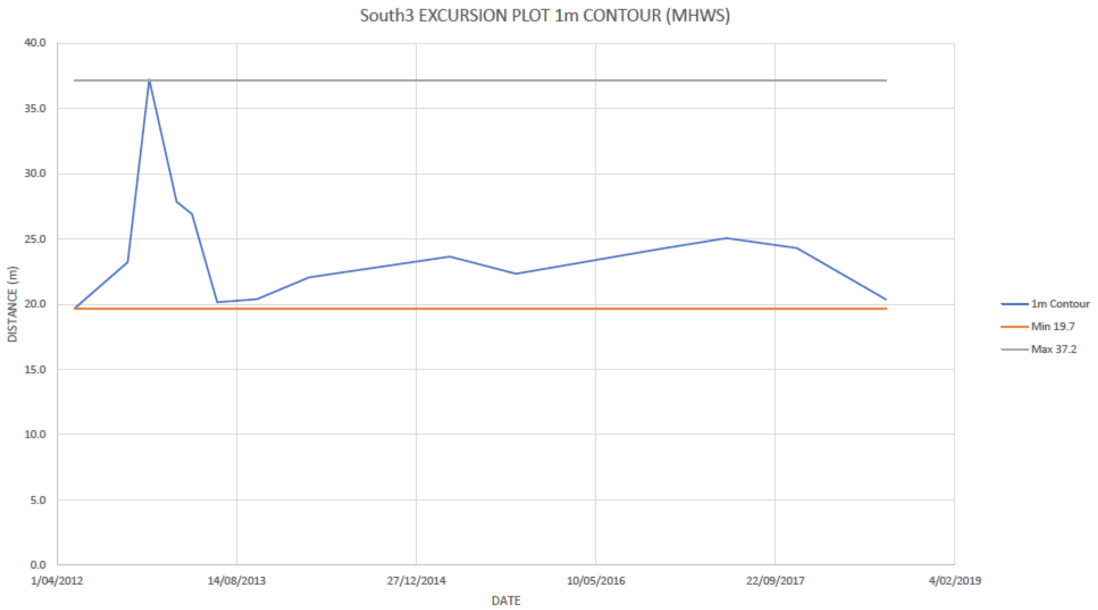


Figure 5 – Excursion of RL1.0m contour (MHWS) 2012-2019 Glen Isla Place

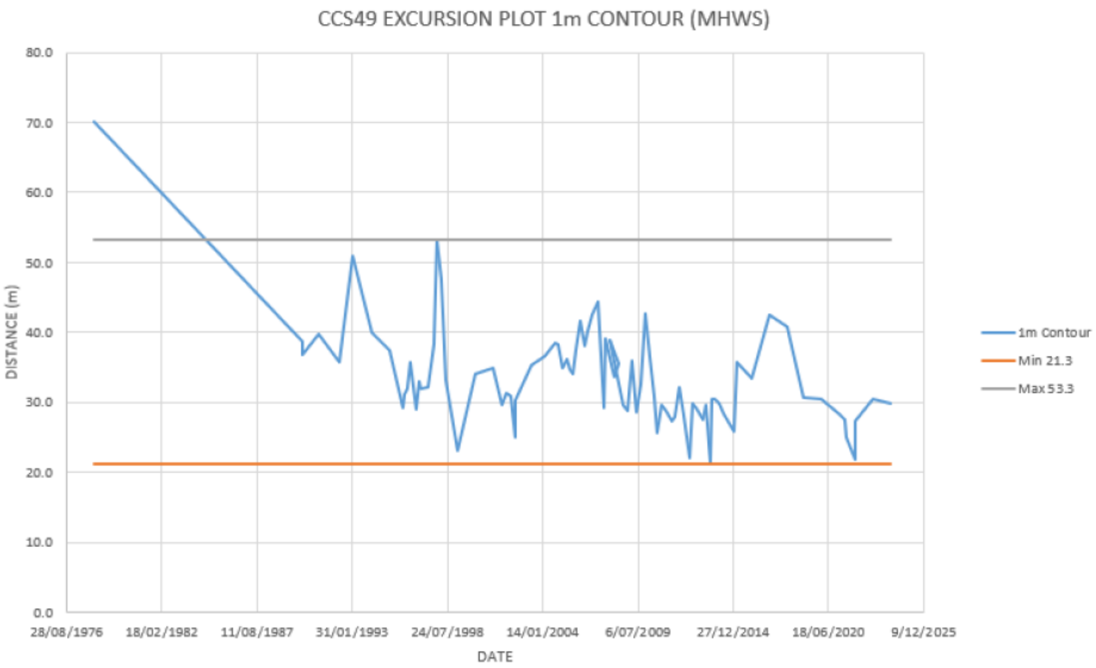


Figure 6 – Excursion of RL1.0m contour (MHWS) 1987-2024 CS49

MONITORING PROFILE EXCURSION RANGE - FULL PERIOD						
Profile	**Duration**			**Excursion**		**Range**
			years	min	max	m
CS49	1987 -	2024	37	21	53	32
CS50	1990 -	2024	34	47	71	24
N	2012 -	2018	6	15	33	17
S1	2012 -	2018	6	46	62	16
S2	2012 -	2018	6	25	43	18
S3	2012 -	2018	6	20	37	17

MONITORING PROFILE EXCURSION RANGE- 2012-2018						
Profile	**Duration**			**Excursion**		**Range**
			years	min	max	m
CS49	2012 -	2018	6	21	33	17
CS50	2012 -	2018	6	48	67	19
N	2012 -	2018	6	15	33	17
S1	2012 -	2018	6	46	62	16
S2	2012 -	2018	6	25	43	18
S3	2012 -	2018	6	20	37	17

Table 3 – Excursion Range of MHWS

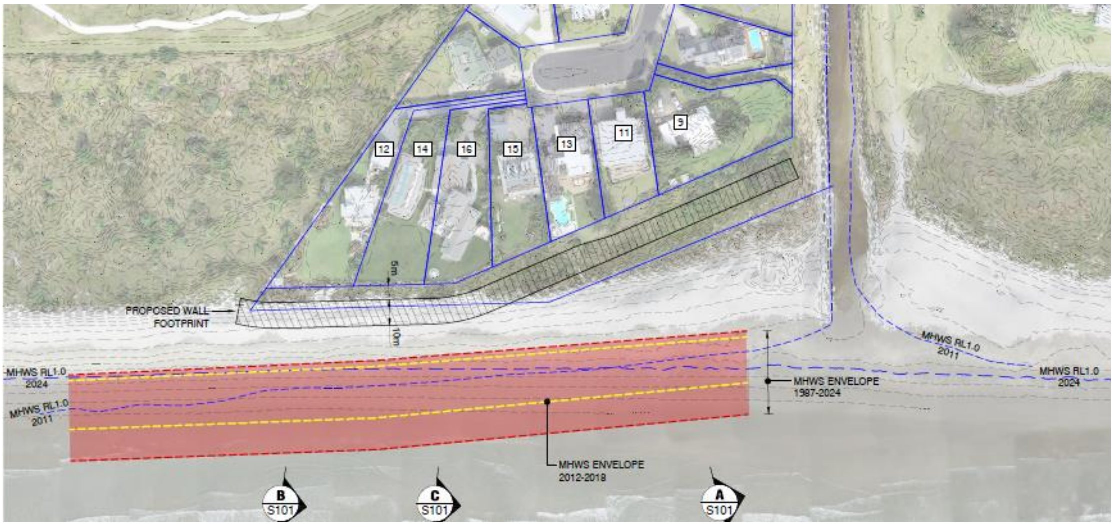


Figure 7 – Plan Showing Historic Range of MHWS 30+ years

4.0 Sea Level Rise

The location of MHWS is likely to migrate landward with rising levels due to Climate Change. Accepted theory is that as the water level increases the average location of the shoreline is likely to also migrate shoreward.

This is at odds with the longer-term processes such that estuaries tend to infill and barrier bar beaches tend to migrate seaward over long-term sea-level rise. Again, the quantum of sea level rise is relevant. Within a typical design time frame (50Y) sea-level rise is likely to be in the order of 0.5m and shoreward translation of 5m for a 1:10 Beach. This will be insufficient to make the proposed works within the CMA. We therefore consider that the structure is within an area of District Council Jurisdiction for construction of any erosion protection.

5.0 Conclusion

The location of MHWS has been considered on the site in order to determine Consent requirements of any proposal to address erosion issues for the properties on Glen Ilsa Place, Waihi. A level of pragmatism and judgement is required when determining the location of MHWS.

In this case, a detailed study and modelling of the height of MHWS has been undertaken by NIWA in 2006 and adopted by the Regional Council. The height of MHWS at Waihi Beach provided by that report and adopted for this exercise is RL1.0 (MVD53).

We have utilised the monitoring data of beach level over a period of over 30 years and plotted where this line of MHWS would have been due to beach fluctuation over that time. A median or mean location would seem a reasonable representation of MHWS at the site. However, we have adopted the most landward position that MHWS has been within that 30 year+ period and ensured all proposed work is outside this line.

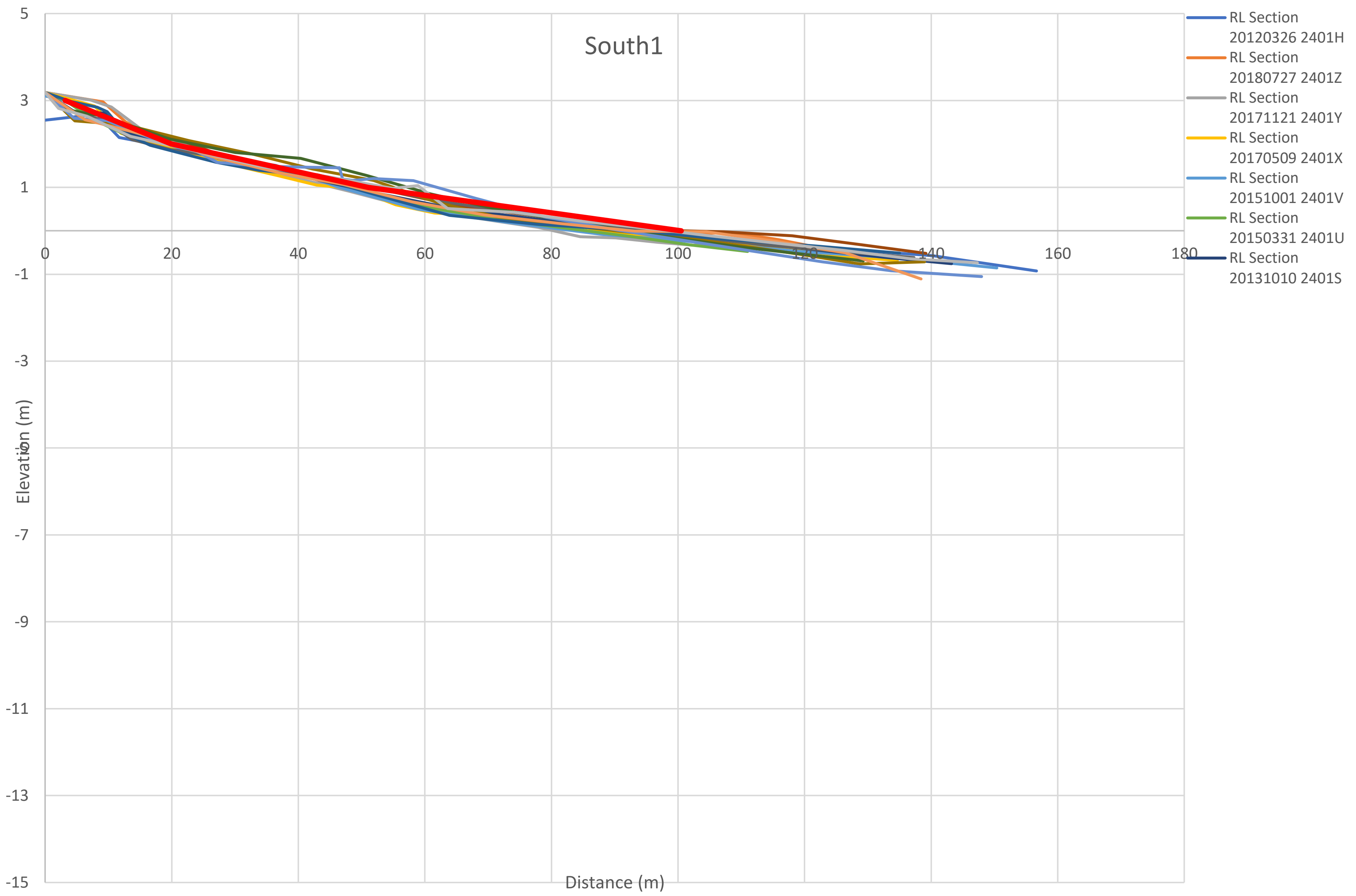
All coastal protection measures considered will be located landward of this MHWS mark. As such, any infringements by any structures will be under the jurisdiction of the WBOPDC and the District Plan.

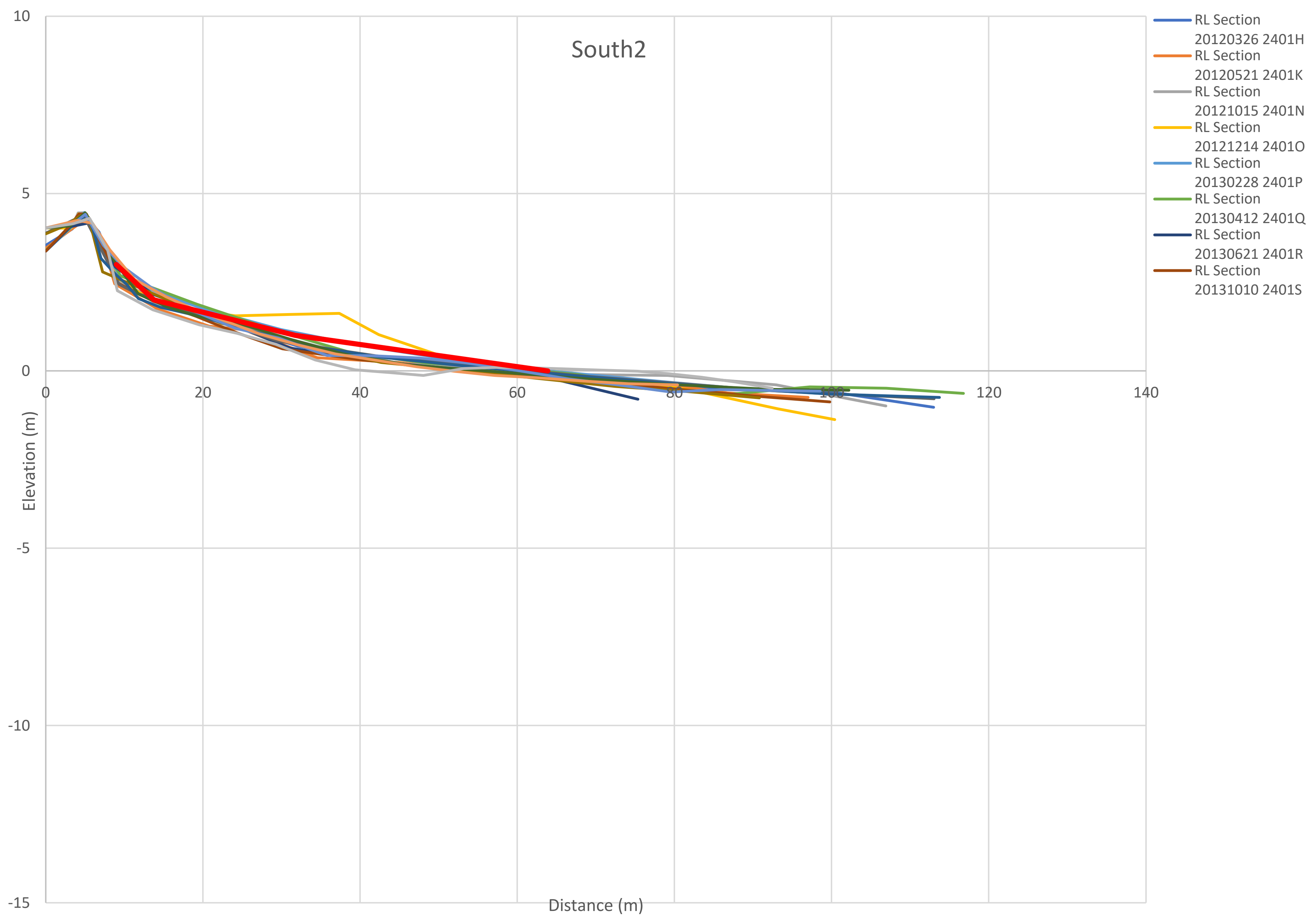
Yours sincerely,

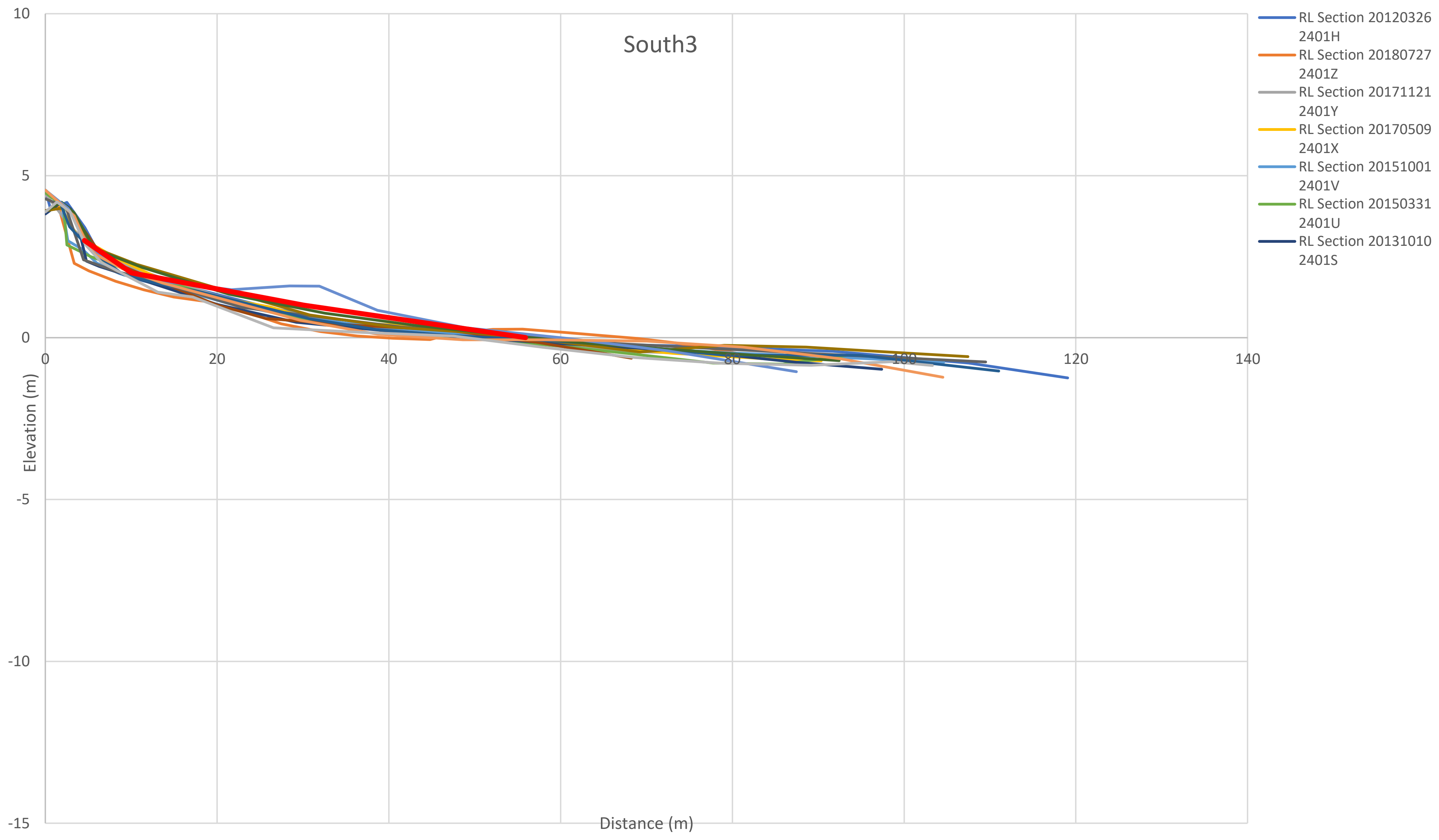
Craig Davis
BE, CPEng, IntPE(NZ), CMENZ

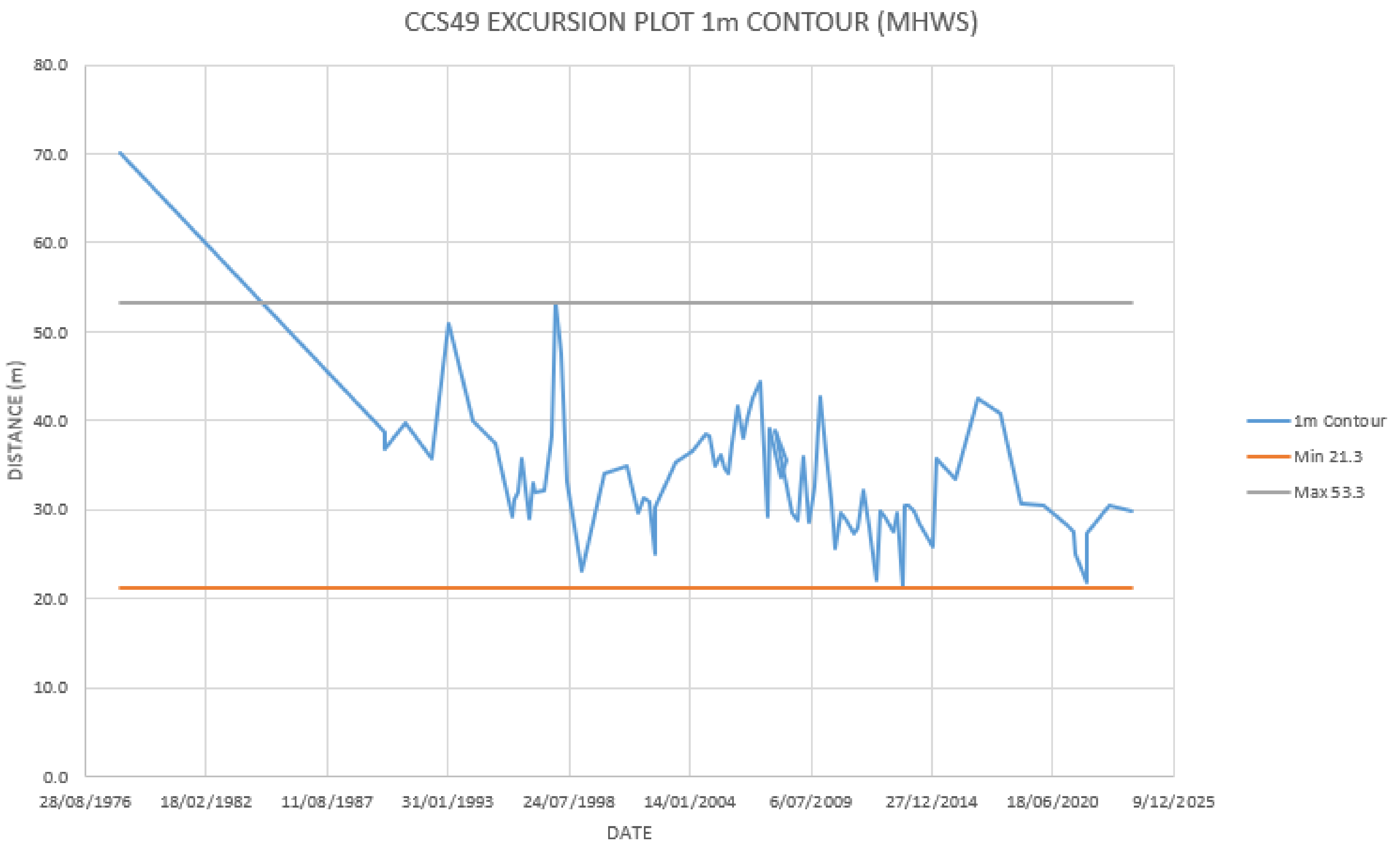
ATTACHMENT A

Monitoring Profiles and Excursion Data Plots

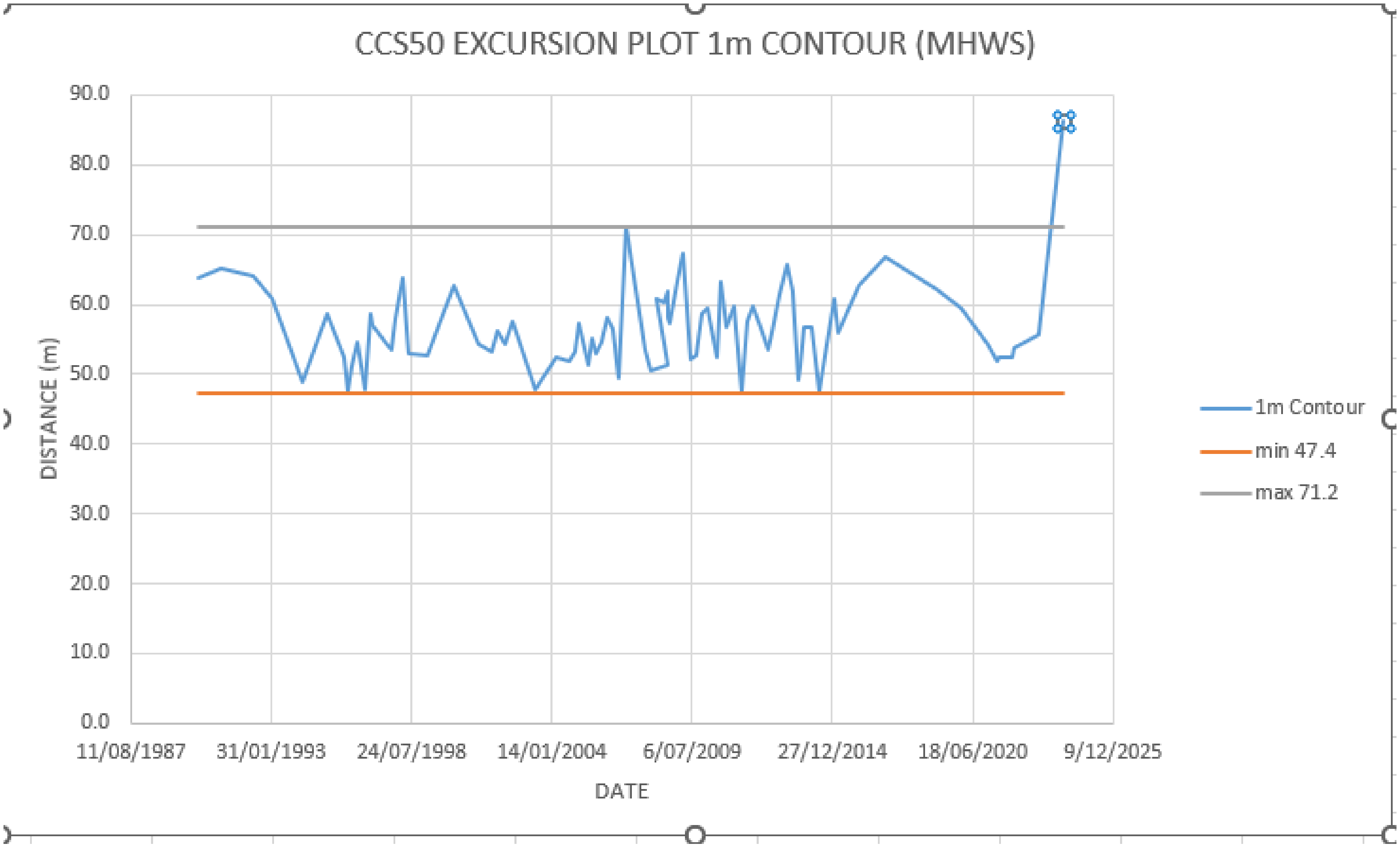

South1
Elevation (m)
Distance (m)
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
0
20
40
60
80
100
120
140
160
180
RL Section 20120326 2401H
RL Section 20180727 2401Z
RL Section 20171121 2401Y
RL Section 20170509 2401X
RL Section 20151001 2401V
RL Section 20150331 2401U
RL Section 20131010 2401S


South2
Elevation (m)
Distance (m)
10
5
0
-5
-10
-15
0
20
40
60
80
100
120
140
RL Section 20120326 2401H
RL Section 20120521 2401K
RL Section 20121015 2401N
RL Section 20121214 2401O
RL Section 20130228 2401P
RL Section 20130412 2401Q
RL Section 20130621 2401R
RL Section 20131010 2401S

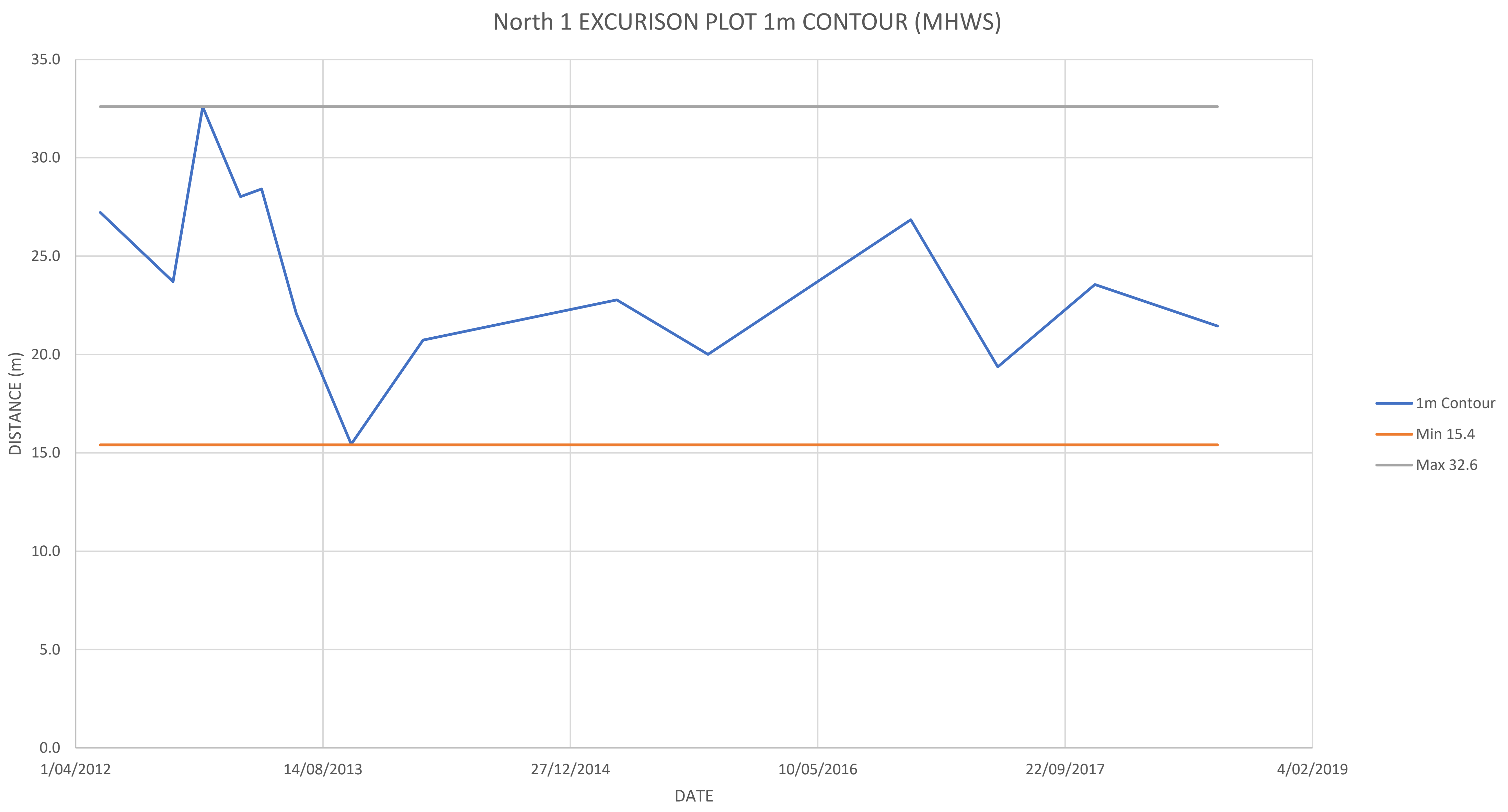

South3
Elevation (m)
Distance (m)
10
5
0
-5
-10
-15
0
20
40
60
80
100
120
140
RL Section 20120326 2401H
RL Section 20180727 2401Z
RL Section 20171121 2401Y
RL Section 20170509 2401X
RL Section 20151001 2401V
RL Section 20150331 2401U
RL Section 20131010 2401S

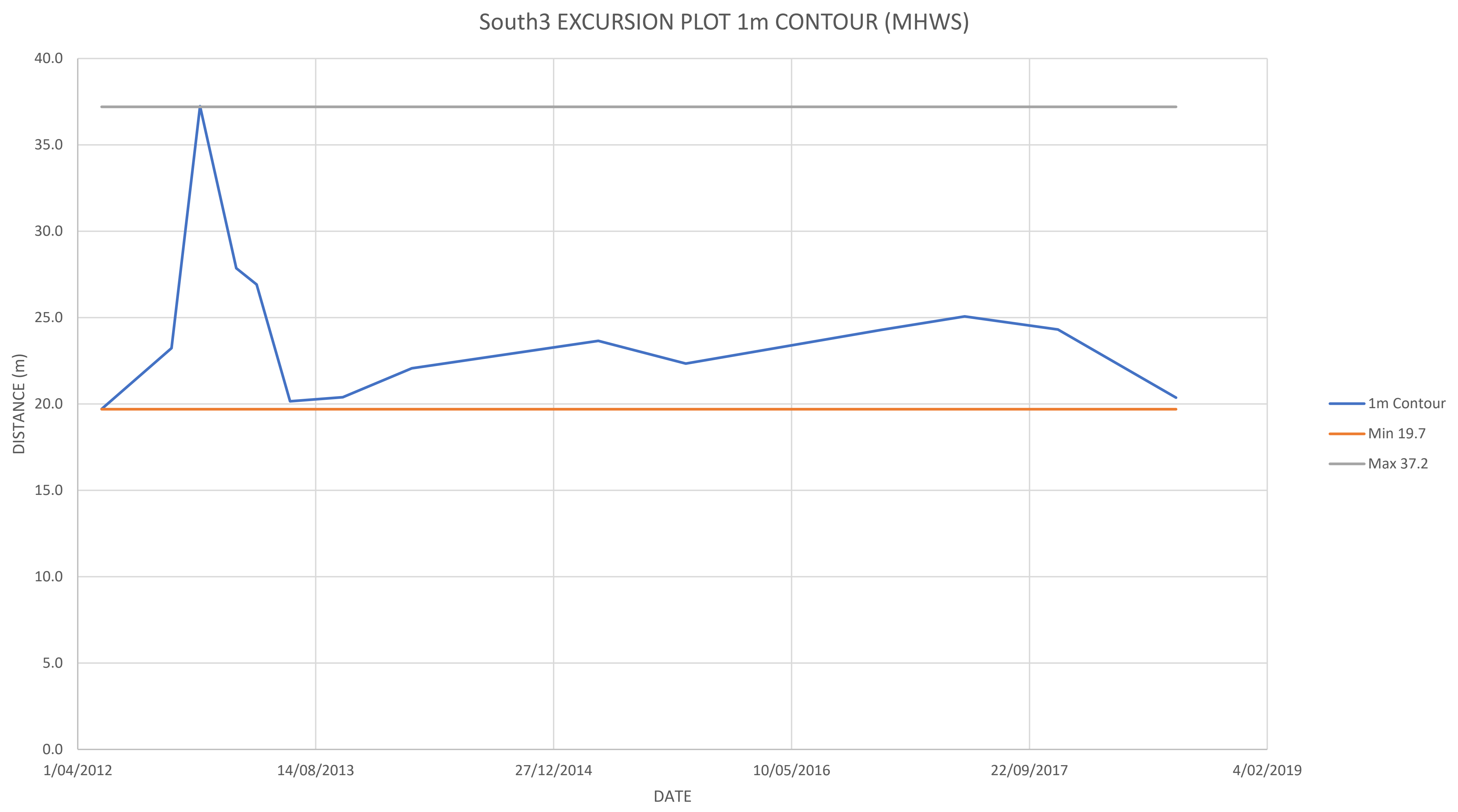


CCS49 EXCURSION PLOT 1m CONTOUR (MHWS)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
DISTANCE (m)
28/08/1976
18/02/1982
11/08/1987
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
9/12/2025
DATE
1m Contour
Min 21.3
Max 53.3



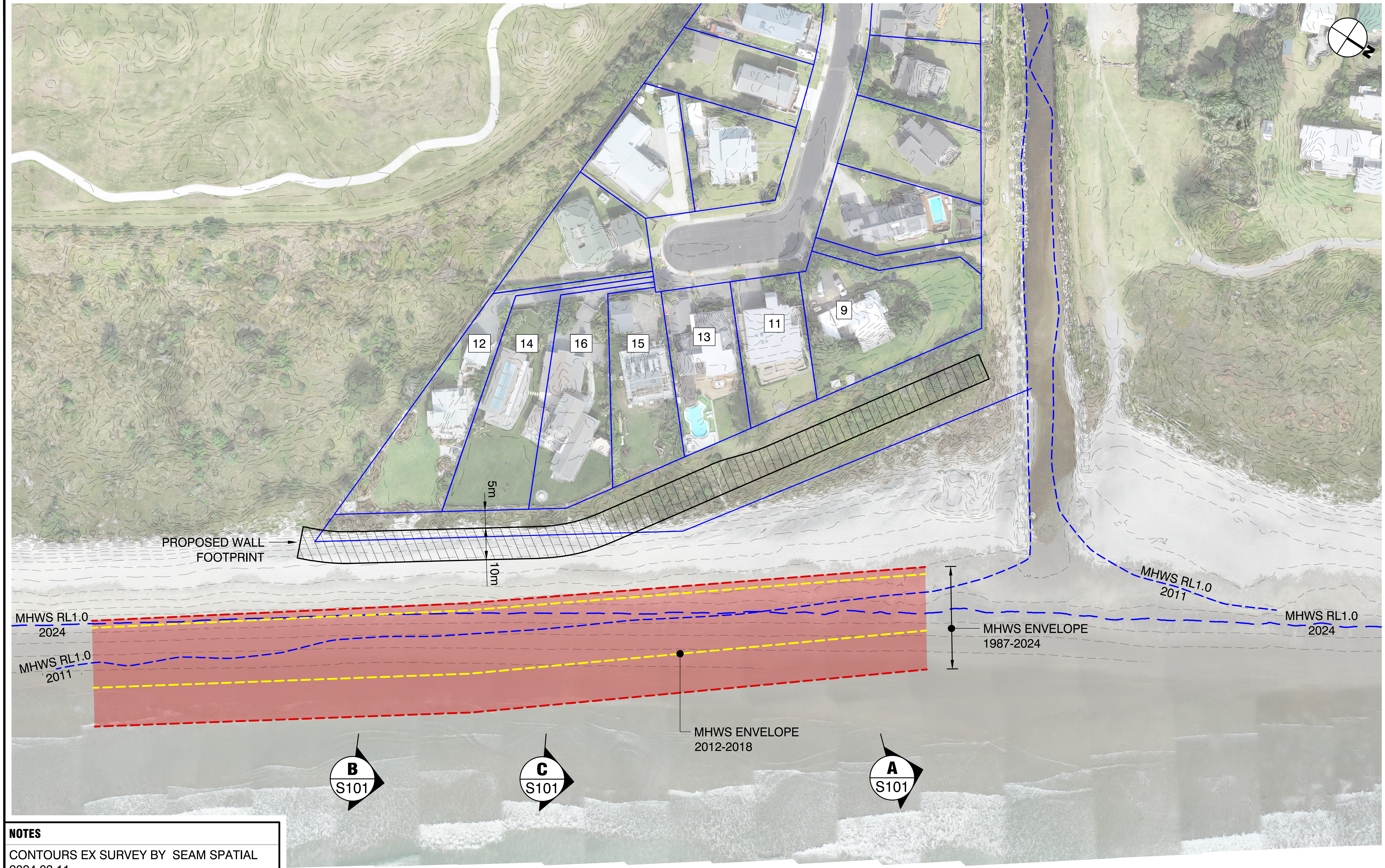
CCS50 EXCURSION PLOT 1m CONTOUR (MHWS)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
DISTANCE (m)
11/08/1987
31/01/1993
24/07/1998
14/01/2004
6/07/2009
27/12/2014
18/06/2020
9/12/2025
DATE
1m Contour
min 47.4
max 71.2


North 1 EXCURISON PLOT 1m CONTOUR (MHWS)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
DISTANCE (m)
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
DATE
1m Contour
Min 15.4
Max 32.6


South3 EXCURSION PLOT 1m CONTOUR (MHWS)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
DISTANCE (m)
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
DATE
1m Contour
Min 19.7
Max 37.2

ATTACHMENT B

Site Plan Showing Historic Extent of MHWS over 30+ years



NOTES

CONTOURS EX SURVEY BY SEAM SPATIAL 2024.03.11

No.	REVISION DETAILS	DATE
-	PRELIMINARY ISSUE	03.04.2024

DESIGN: DAVIS COASTAL CONSULTANTS
SURVEY: SEAM SPATIAL
DRAWN: JMA
CHECKED: -
DATE: APRIL 2024
SCALE 1:1000 @ A3
CAD FILE: 23028-01 Glen Isla Place Waihi

NOT FOR CONSTRUCTION

JOB TITLE:

GLEN ISLA EROSION PROTECTION OPTIONS

DAVIS COASTAL CONSULTANTS

COASTAL MANAGEMENT AND ENGINEERING
P.O. Box 185
Orewa

Phone: 09 428 0040
Mobile: 021 627 193
Email: coastal@daviscoastal.co.nz

DRAWING TITLE:
PROPOSED WALL LAYOUT

FILE NO: 23028
SHT NO: S100
REV: -

SERIES: PRELIMINARY

Z:\Projects\23028 Glen Isla Place Waihi\Drawings\Dwg\23028-01 Preliminary\23028-01 Glen Isla Place Waihi