

## Analysis of the storm event (18/03/2020-19/03/2021) along with the impact on Burnham-on-Sea (BURN4a) and Sand Bay (7eSANB1)

### 1.0 Introduction

This report briefly identifies the hydrodynamic forcing between the 7<sup>th</sup> and 14<sup>th</sup> of March and the resultant morphological impact identified by a post storm survey undertaken at Burnham-on-Sea (7dBURN2, 7dBURN3, 7dBURN4-A and 7dBURN4-B) on the 19<sup>th</sup> of March and Sand Bay (7eSANB1) on the 18<sup>th</sup> of March. All hydrodynamic and meteorological data has been obtained from the Weston Bay directional wave rider (DWR) buoy (Location: 51° 21.13' N 003° 01.23' W) and shore station.

### 2.0 Hydrodynamics

Between the 9<sup>th</sup> and 14<sup>th</sup> of March, the Weston Bay DWR recorded an average significant wave height ( $H_s$ ) of 0.76, over double that of the March average recorded from 2009 to 2019 (Table 1). The peak direction of the incoming swell recorded for the study period (250°) was also considerably further westward than the March average (217°) (Table 1).

Table 1 - Hydrodynamic statistics averaged from the Weston Bay DWR. Indicating significant wave height ( $H_s$ ), maximum wave height ( $H_{Max}$ ), peak wave period ( $T_p$ ), mean wave period ( $T_z$ ) and wave direction ( $Dir$ ) for the study period and averaged across March from 2009-2019.

	$H_s$	$H_{Max}$	$T_p$	$T_z$	$Dir$ (°)
Spring Tide Period 09/03 to 14/03	0.76	1.21	5.19	3.68	254.00
Average for March 2009-2019	0.36	0.72	4.90	3.20	217

Despite the significantly higher  $H_s$  and more westerly wave direction, the storm threshold was not surpassed throughout the study period (Fig.1). Despite this, considerable morphodynamic change and structural damage was observed at both survey units as discussed in section 3.0. However, the study period of relative high energy fell amongst the spring tide window, with several peaks in swell energy combining with several spring high tide events in excess of 13.5 m between the 9<sup>th</sup> and 14<sup>th</sup> March (Fig.1).

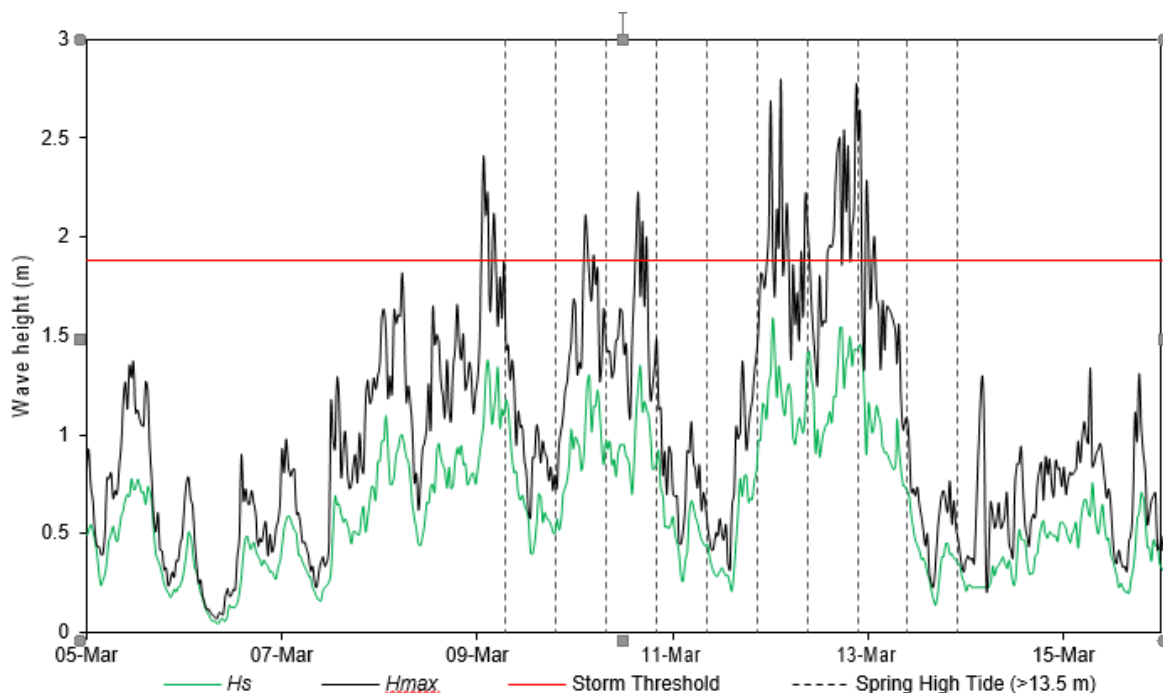


Figure 1 - Plot showing significant wave height ( $H_s$ ) and maximum wave height ( $H_{MAX}$ ) for Weston Bay DWR between the 5<sup>th</sup> and 15<sup>th</sup> of March. The storm threshold (1.88 m) is shown in red with vertical dashed black lines representing spring high tide events >13.5 m.

### 3.0 Morphological Impact Analysis

Profile comparison between the most recent spring interim and the post storm surveys along with the cross sectional area analysis is taken from data captured between the extent of the master profiles indicated in the profile charts (Appendix 1 and 3) for each profile.

#### 3.1 Burnham-on-Sea

A total of 17 profiles were surveyed across four survey units on the 19<sup>th</sup> March 2020 (App.5). When comparing the

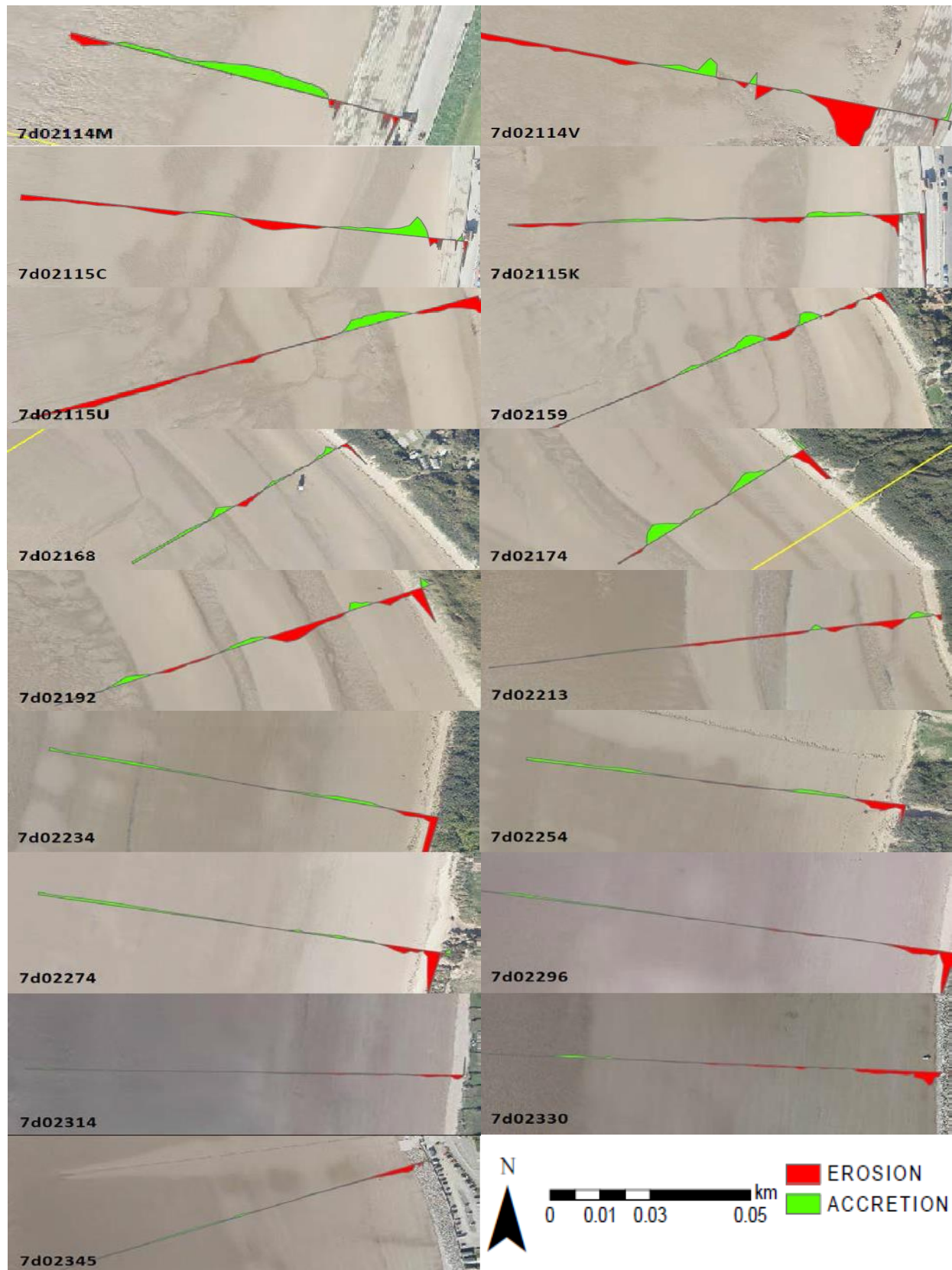


Figure 2 - Plot indicating the Burnham post storm profiles from North (top) to South (bottom) along with an exaggerated overlay depicting where there has been erosion (red) and accretion (green) across each of the profiles since the previous interim survey (27<sup>th</sup> January 2020).

post storm survey data to that of the most recent interim (undertaken on the 27<sup>th</sup> January 2020), there is a common trend representing erosion at the upper beach face and beach toe with resultant deposition occurring across the low tide terrace for the majority of profiles (Fig.2 and App.1).

All surveyed Burnham profiles indicated a reduction in cross-sectional area (CSA) in the range of 0.2 to 27.3 m<sup>2</sup> when comparing the post storm survey to that of the most recent interim, with the exception of profiles 7d02159, 7d02168 and 7d02174 which all showed minor relative accretion (App.2). The two profiles which lost the most CSA were 7d02174 (-23.8 m<sup>2</sup> or 3.3% loss) and 7d02192 (-27.3 m<sup>2</sup> or 3.9% loss), these are found to the North of those three profiles which gained CSA and have a shore orientation of 246° and 248° respectively (App.2). It can thus be theorised that there has been some localised longshore transport from profile 7d02254 in a southerly direction as a result of the predominantly westerly swell direction (Table 1) since the last interim.

Despite erosion observed across the majority of profiles, the total CSA of all Burnham profiles was only 78 m<sup>2</sup> less than that of the spring interim survey (Fig.3) equating to a loss of <1% in area. The overall state of CSA for the Burnham profiles as a whole indicates an accretion rate of 61.6 m<sup>2</sup> y<sup>-1</sup> since the programme began surveying in 2007 (Fig.3).

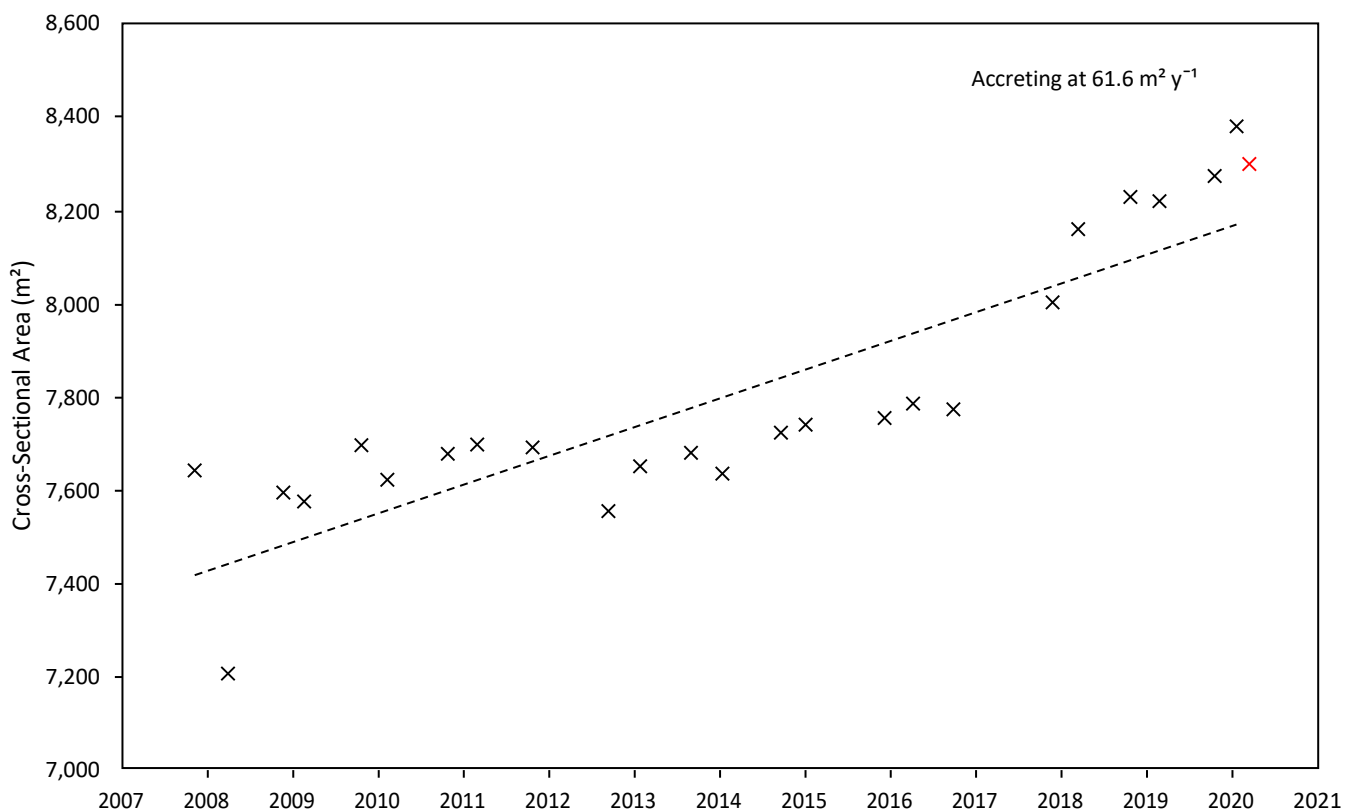


Figure 3 – Plot indicating the accumulated CSA for all post storm profiles at Burnham for every interim and baseline survey since the programme began. The red cross indicates the most recent post storm survey.

Despite the minimal impact in terms of sediment lost from the profile indications, there was still considerable damage caused at the upper beach face and dune toe as alluded to in figure 2. This can be shown from images captured during the post storm survey (Fig.4). Profiles which showed considerable loss at the upper beach since the last interim included 7d02174, 7d02234 and 7d02296 which saw a 4 m, 5 m and 4 m retreat of the beach face (Fig.2 & App.1.). Additionally, profiles 7d02159, 7d02169 7d02192 and 7d02274 saw a 2 m, 3 m, 6 m and 2 m retreat of the beach toe respectively (Fig.2 & App.1.).

The damage and loss of sediment from the upper beach face observed for the majority of post storm profiles indicates the impact of the spring high tide events tied in with a relatively high wave energy period.





Figure 4 - Images captured during the post storm survey at Burnham indicating the damage at the upper beach face to dune systems and beach entrances between profiles 7d002159 and 7d002274.

### 3.2 Sand Bay

Five post storm profiles were surveyed on the 18<sup>th</sup> March 2020 (App.5) for the survey unit SANB1. When comparing

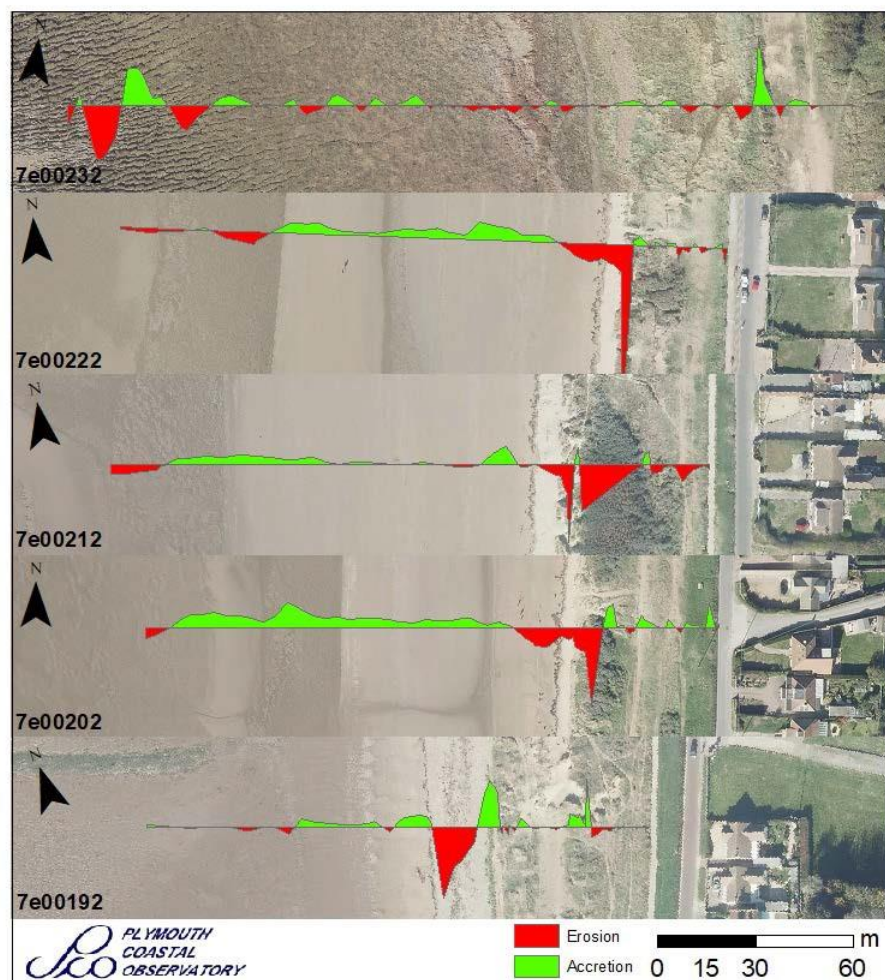


Figure 5 - Plot indicating the Sand Bay post storm profiles from North (top) to South (bottom) along with an exaggerated overlay depicting where there has been erosion (red) and accretion (green) across each of the profiles since the previous spring interim survey (6<sup>th</sup> January 2020).

the post storm survey data to that of the recent spring interim (6<sup>th</sup> January 2020) all displayed a similar trend to that of the Burnham profiles. The primary loss in CSA was observed at the upper beach face and dune toe with accretion observed across the low-tide platform (Fig.5, App.3) this is with the exception of profile 7e00232 where the predominant loss was observed at the seaward extent of the saltmarsh indicating the natural defence offered by the habitat.

Despite the apparent loss of CSA from the upper beach face, only two of the profiles indicated a loss of sediment area since the spring interim with profile 7e00202 displaying the largest change losing a mere 3 m<sup>2</sup> equating to a 1% loss in area with the remaining profiles showing <0.4% change (App.4).

Similarly to the Burnham survey units, when combining all post storm profiles it can be deduced that Sand Bay has been accreting at an estimated 18.6 m<sup>2</sup> y<sup>-1</sup> since the beginning of the programme (Fig.6). The post storm survey profiles suggested a loss of only 1 m<sup>2</sup> when compared to that of the spring interim, equating to a change of 0.05% (Fig.6).

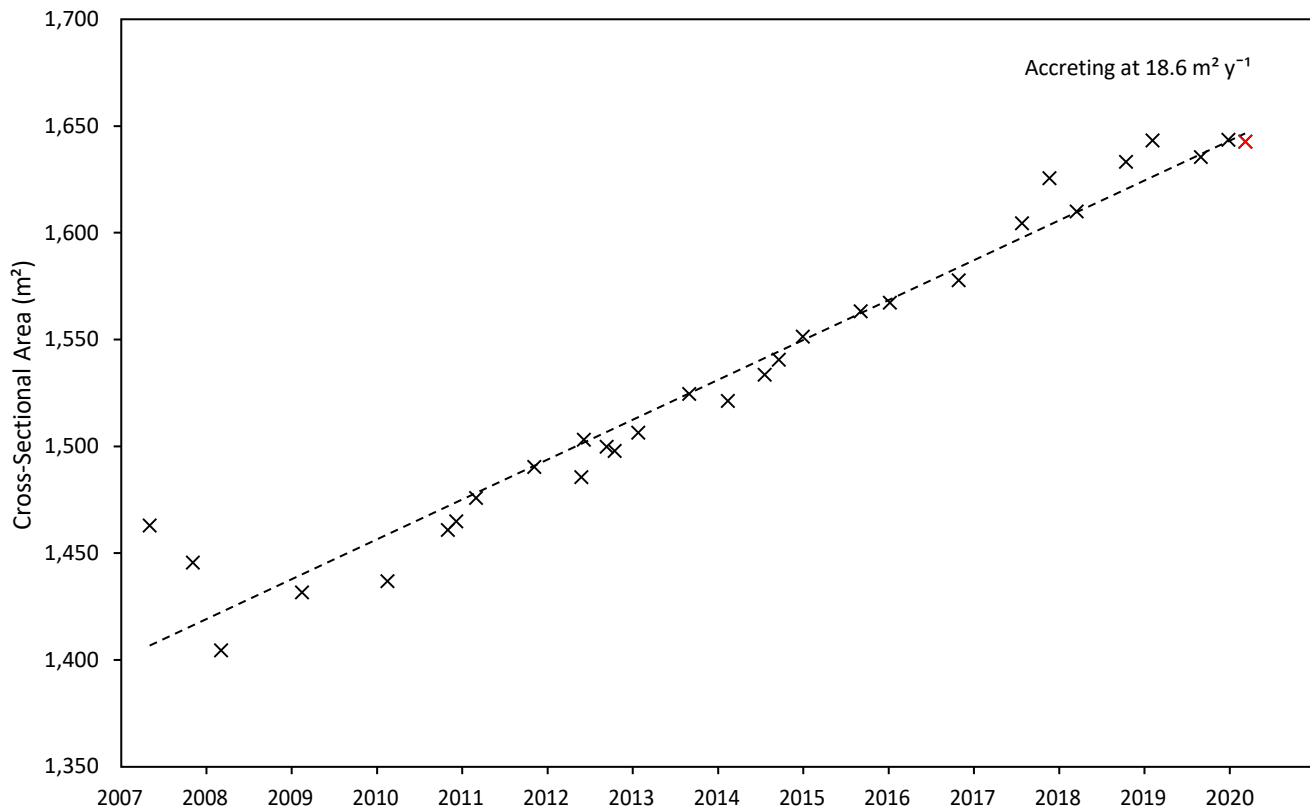


Figure 6 – Plot indicating the accumulated CSA for all post storm profiles at Sand Bay for every interim and baseline survey since the programme began. The red cross indicates the most recent post storm survey.

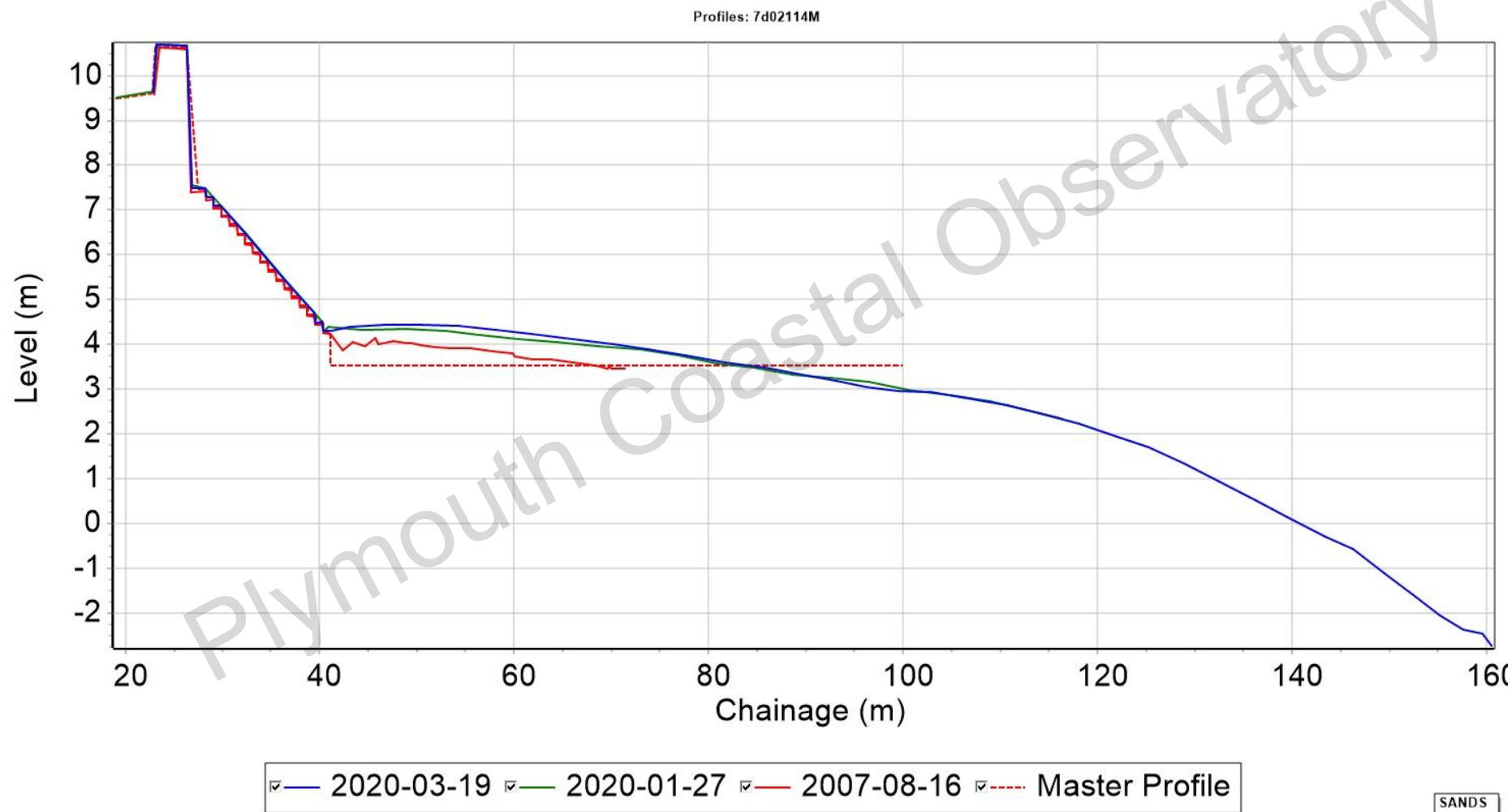
Again, despite the minimal impact on the CSA for all surveyed profiles, there was still damage recorded at the upper beach face as identified in the images captured during the post storm survey (Fig.7). Cutting back of the beach face was observed for profiles 7e00192, 7e00212 and 7e00222 (Fig.7, App.3). Damage to the sea defence south of profile 7e00192 was observed with a hole forming along the transect of the interim profile 7e00190 (Fig.7). Geotextile was also uncovered to the south of profile 7e00212, which has not been recorded by the surveyor since 2016 (Fig.7).



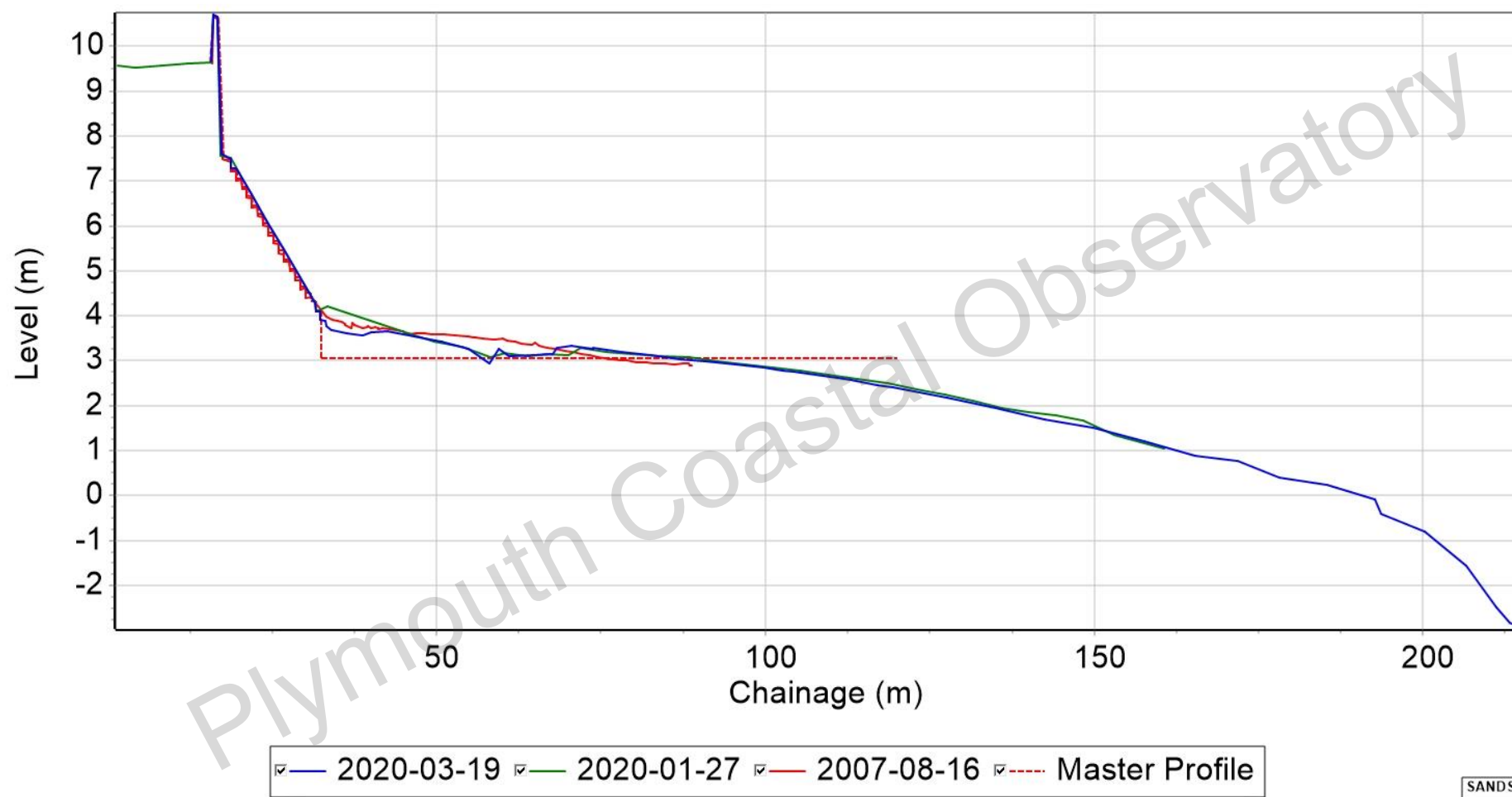


*Figure 7 - Images taken from the post storm survey at Sand Bay. Top from left to right: Hole in the sea defence, cutting back of the upper beach step and more damage to the sea defence all south of profile 7e00192. Bottom from left to right: Beach debris and cutting back of the dune face, cutting back of the upper beach step and unveiled geotextile all between profile 7e00202 and 7e00212.*

**Appendix 1** – Profile charts for all post storm profiles surveyed at Burnham survey units showing the baseline survey (red), the most recent spring interim (green) survey and the post storm survey (blue).

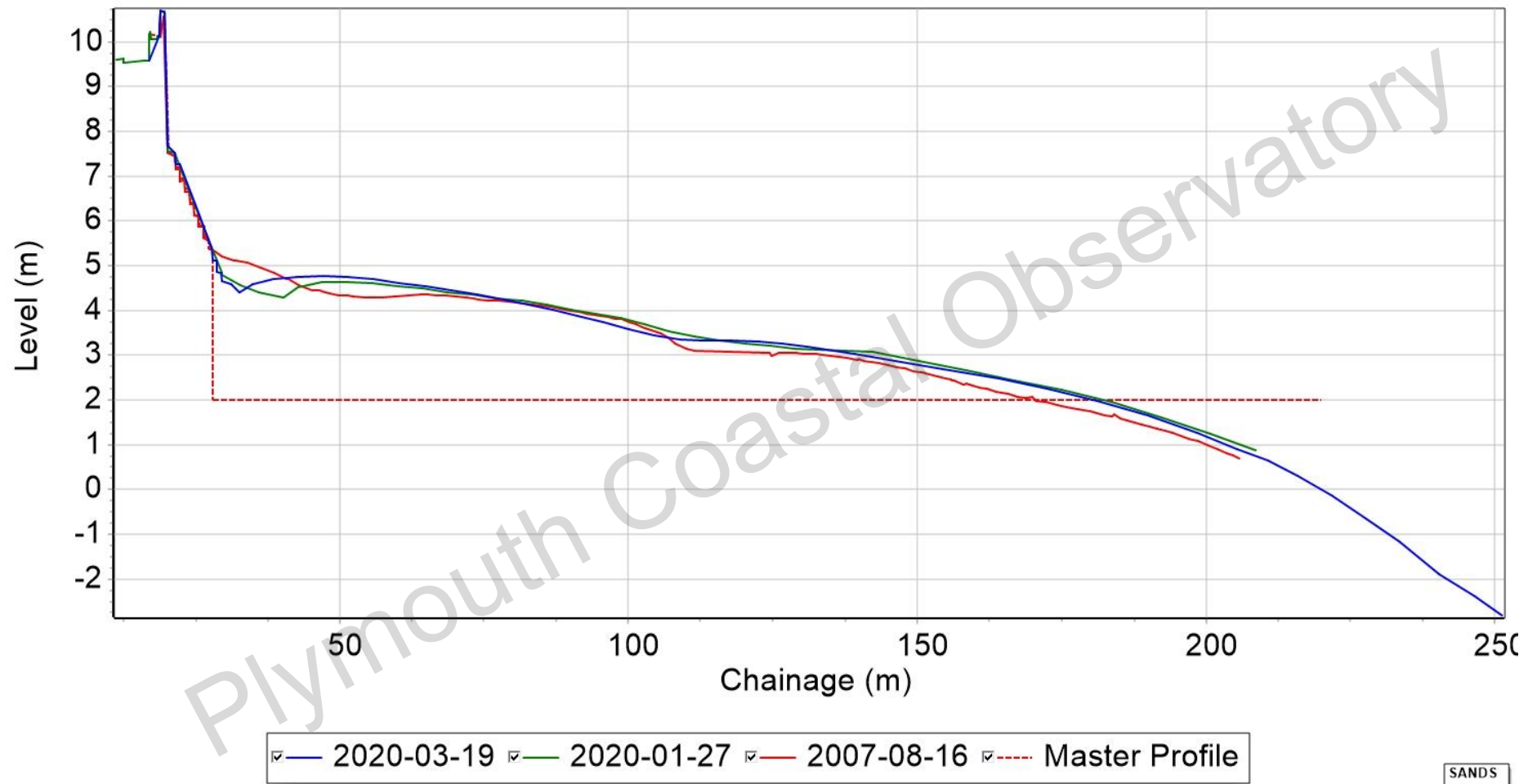


Profiles: 7d02114V





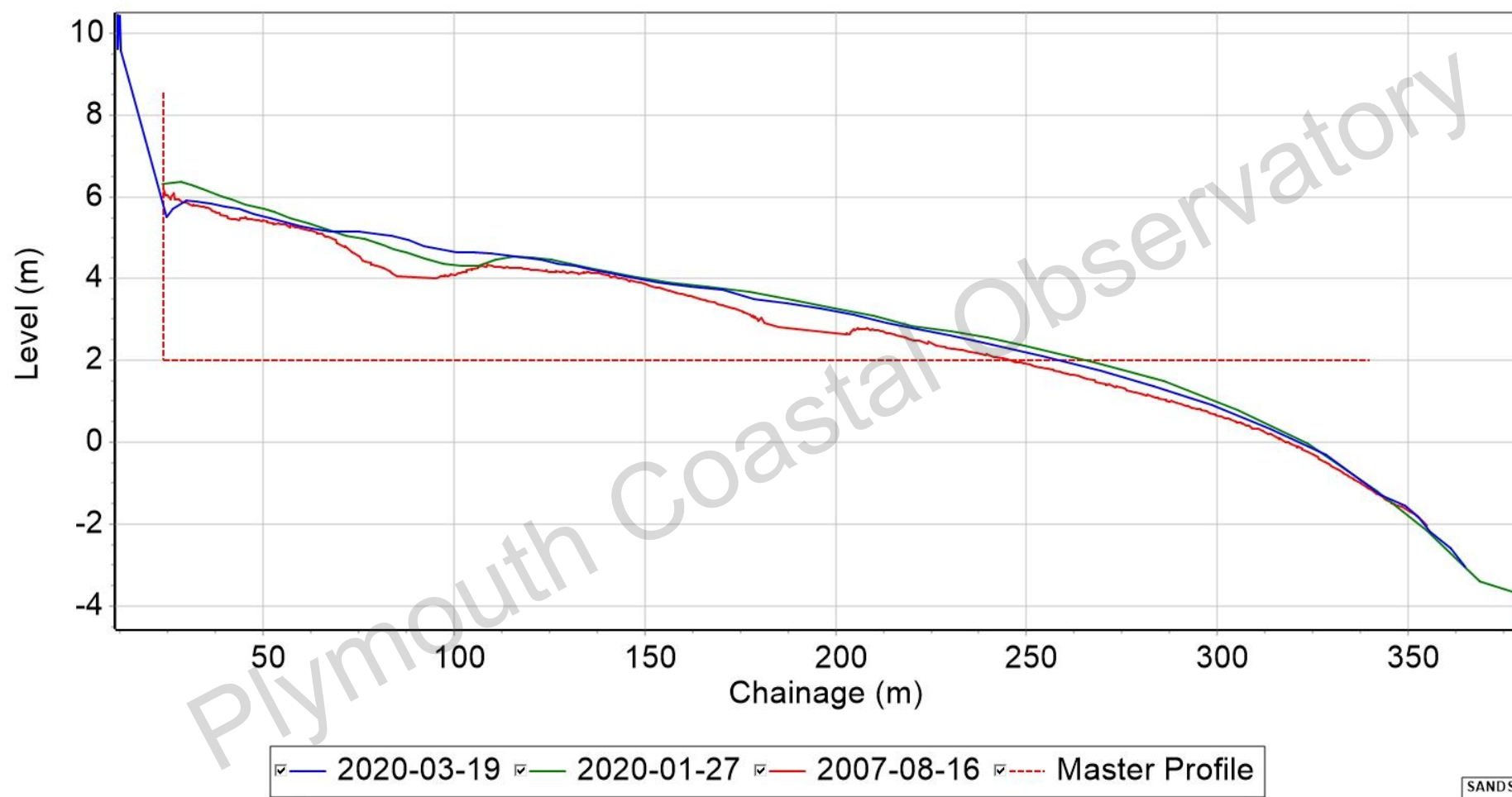
Profiles: 7d02115C

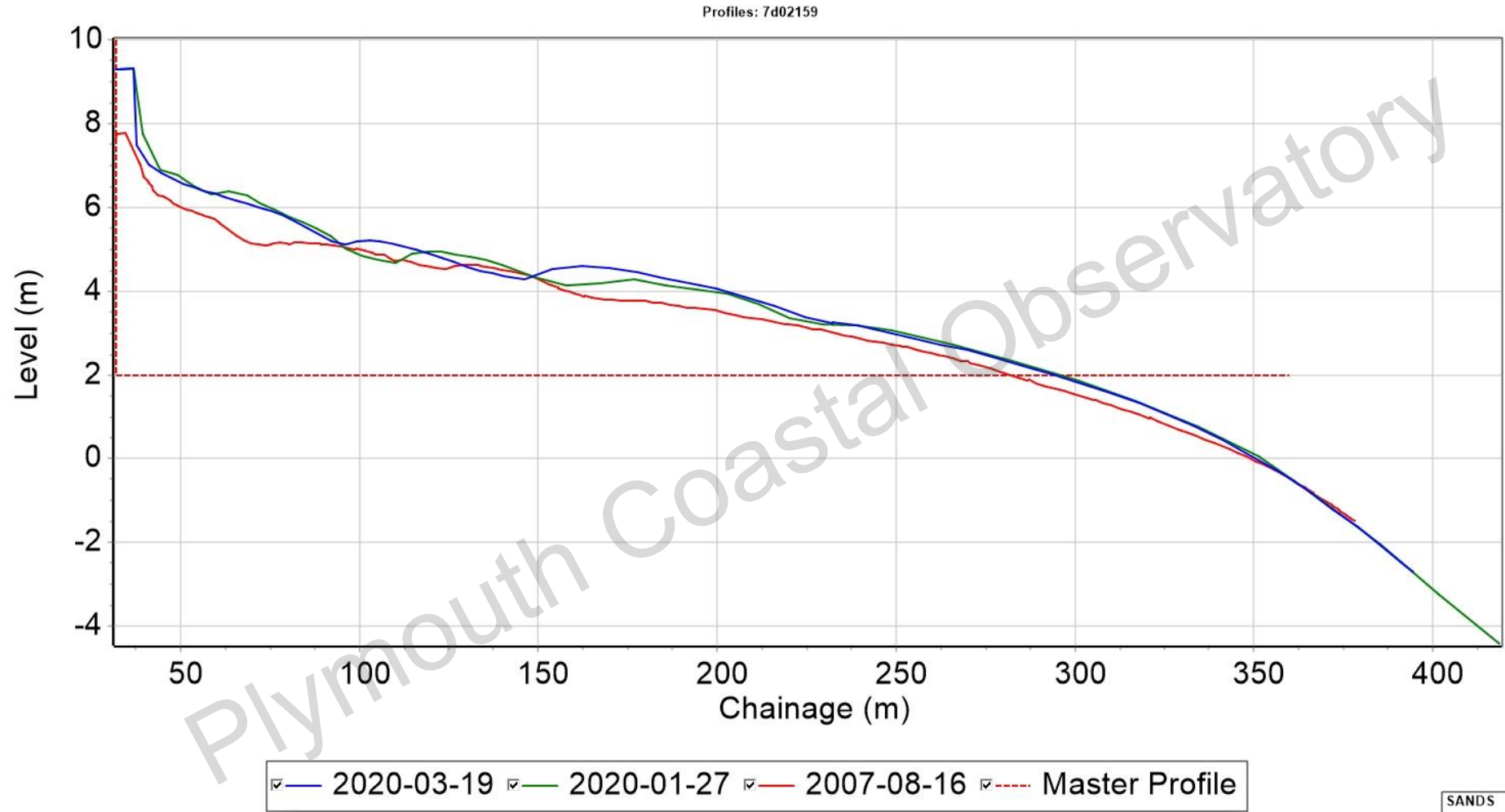


Profiles: 7d02115K



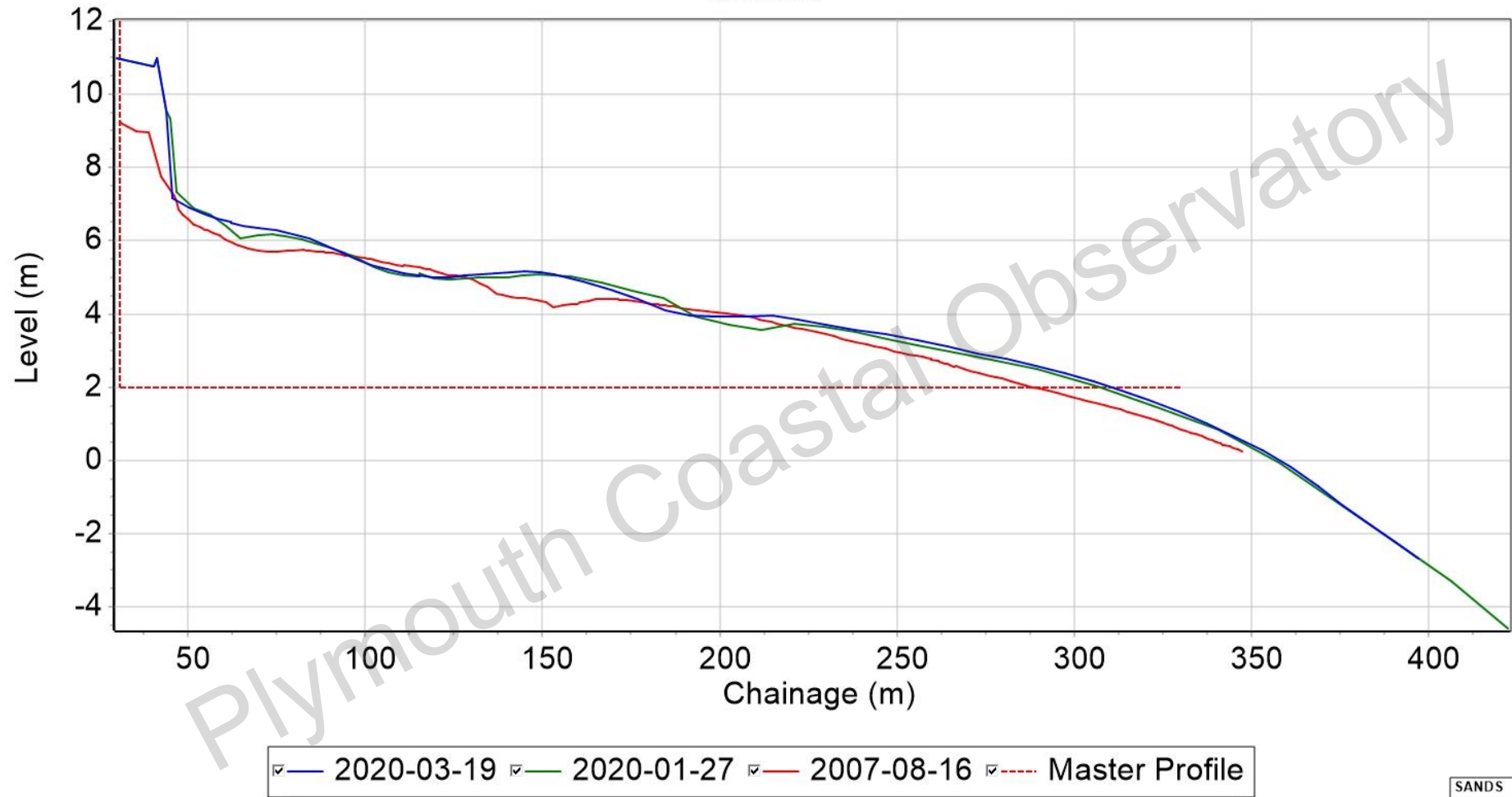
Profiles: 7d02115U







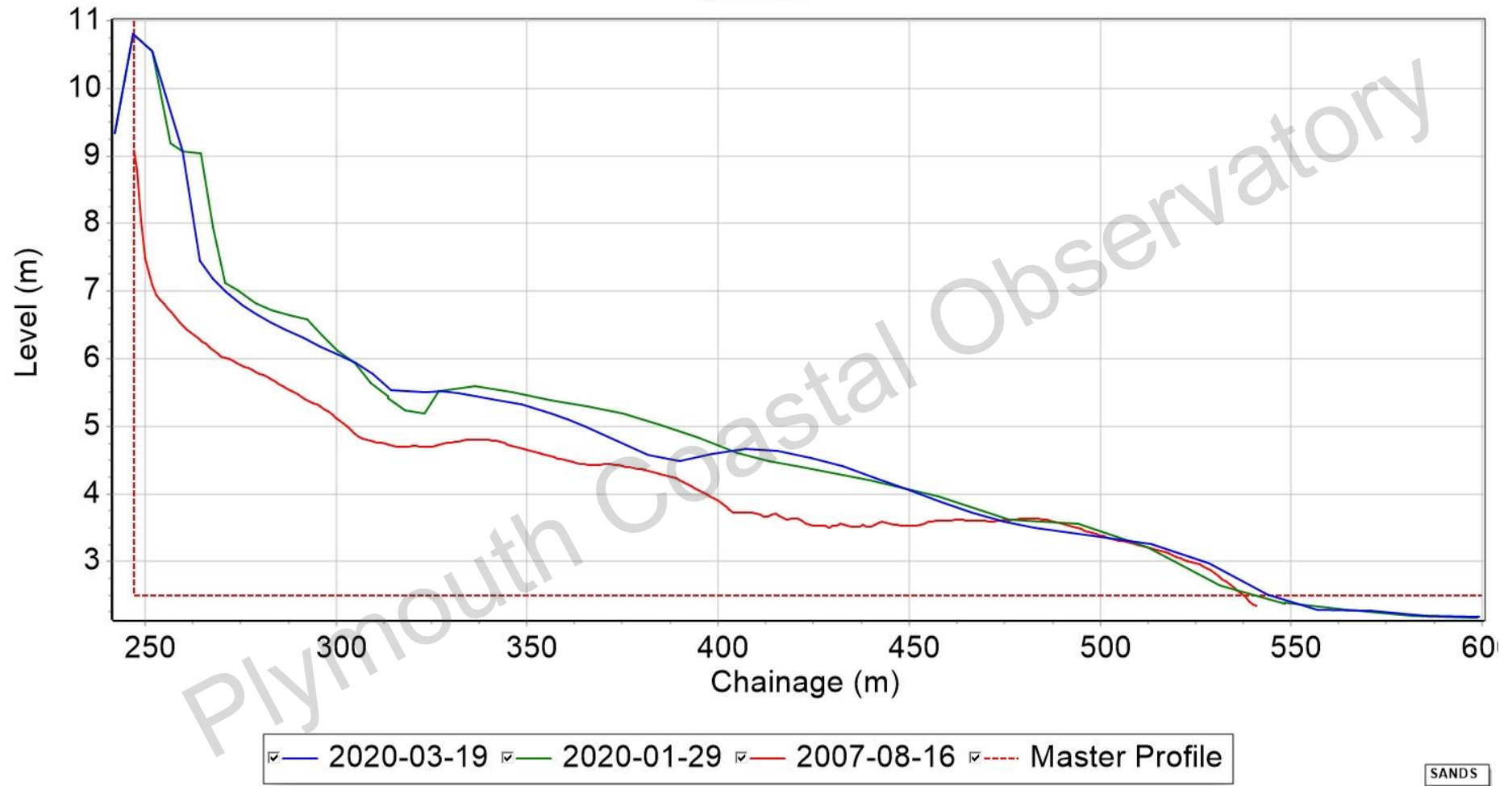
Profiles: 7d02168



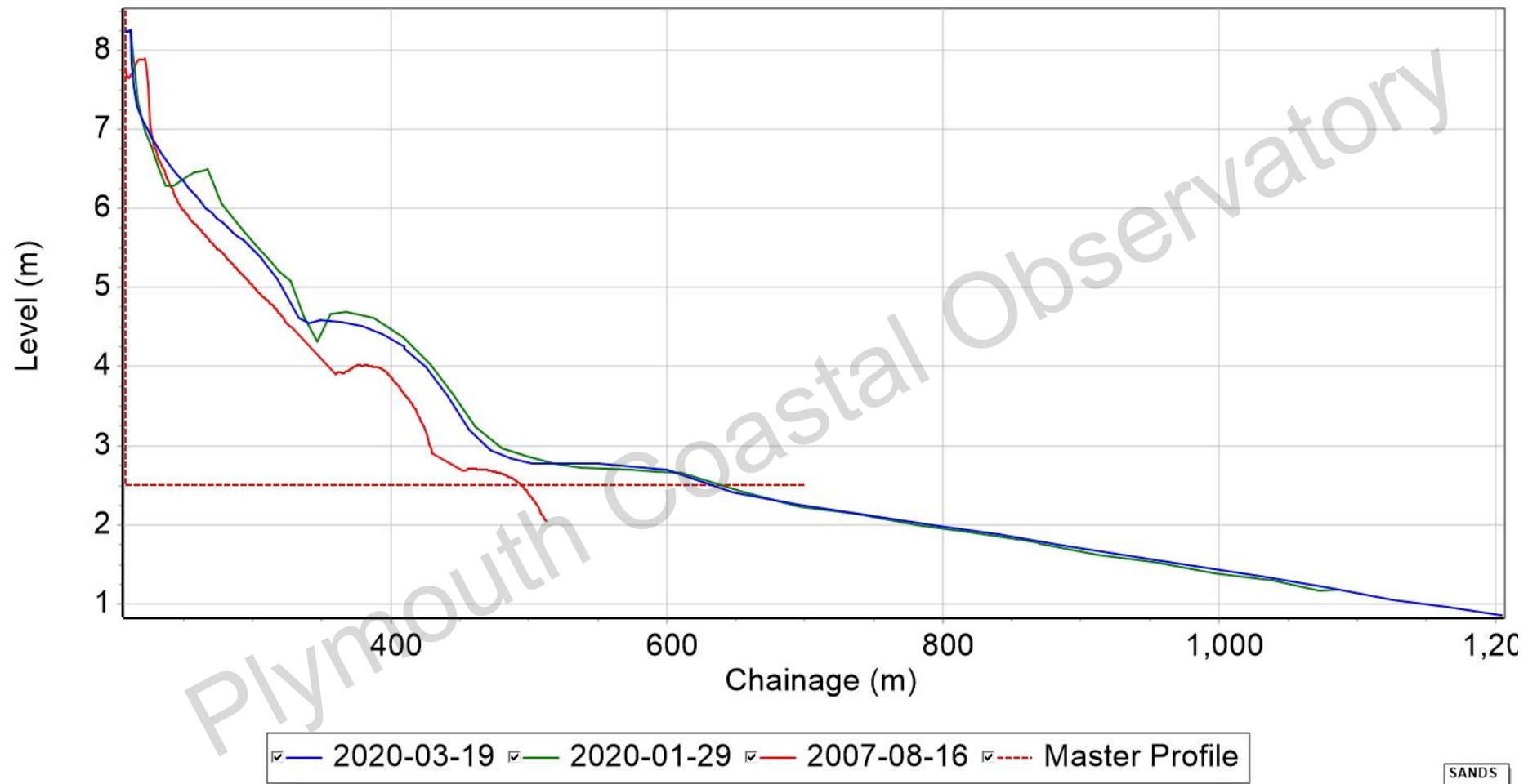
Profiles: 7d02174



Profiles: 7d02192



Profiles: 7d02213

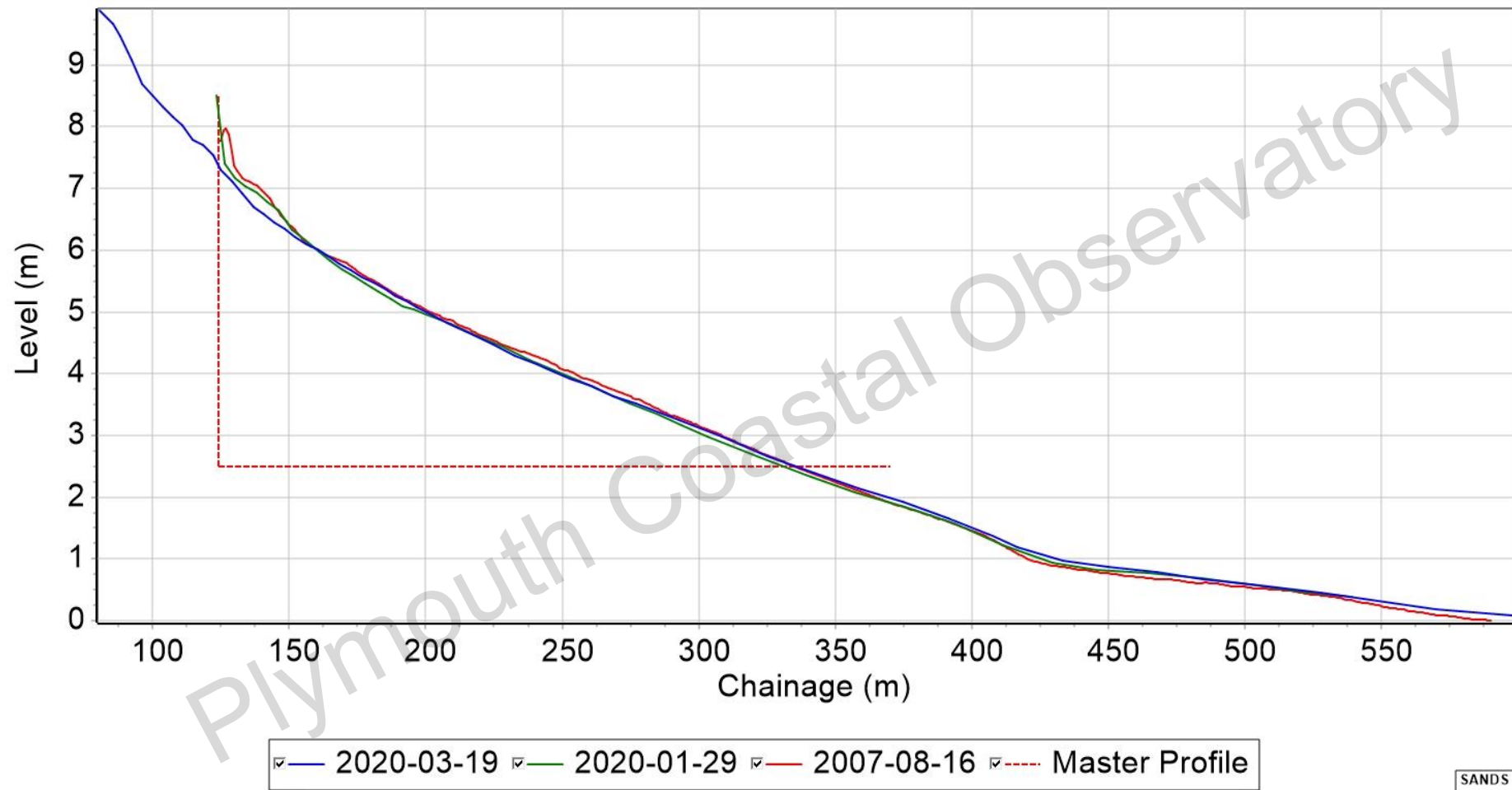




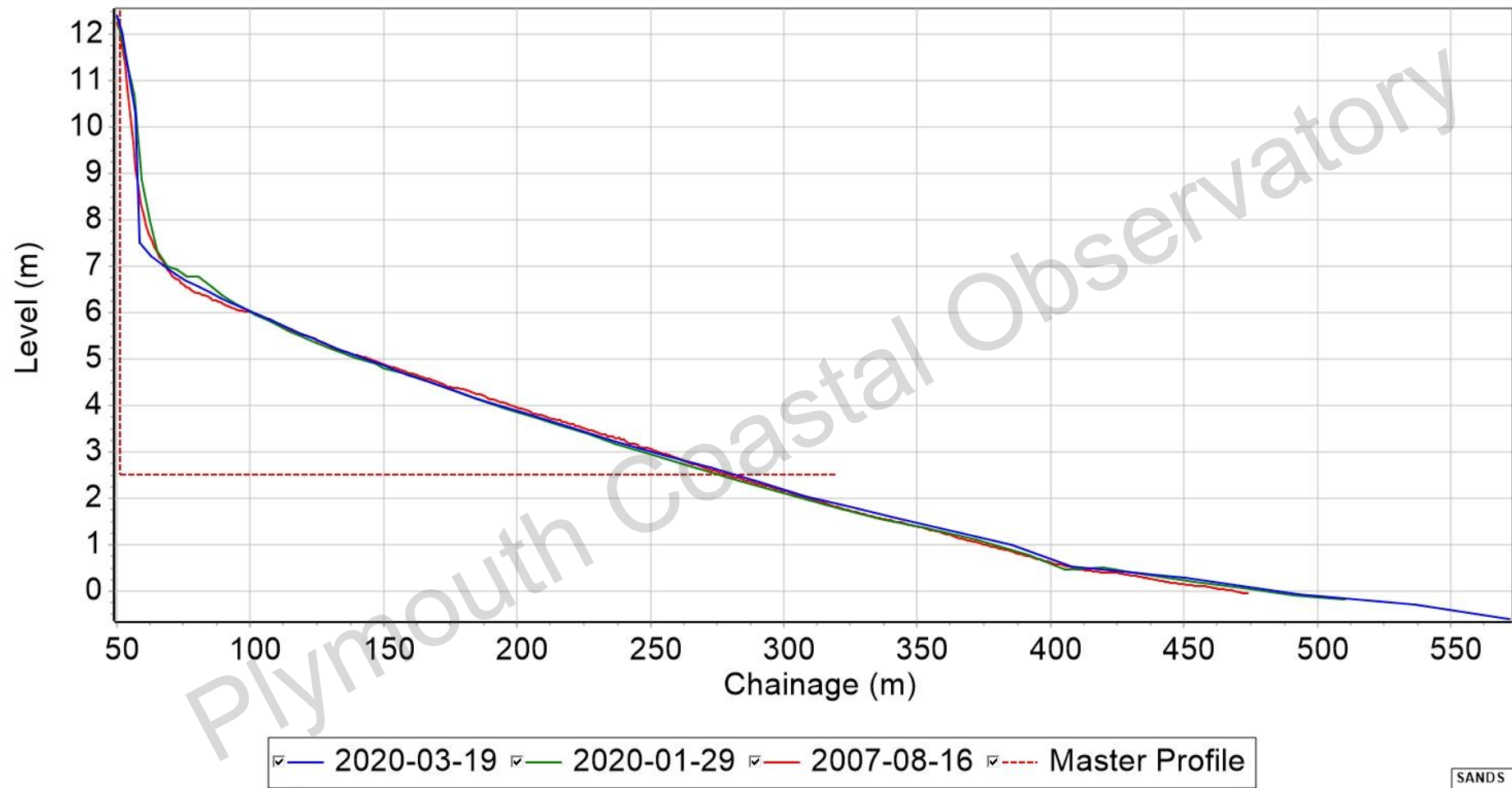
Profiles: 7d02234



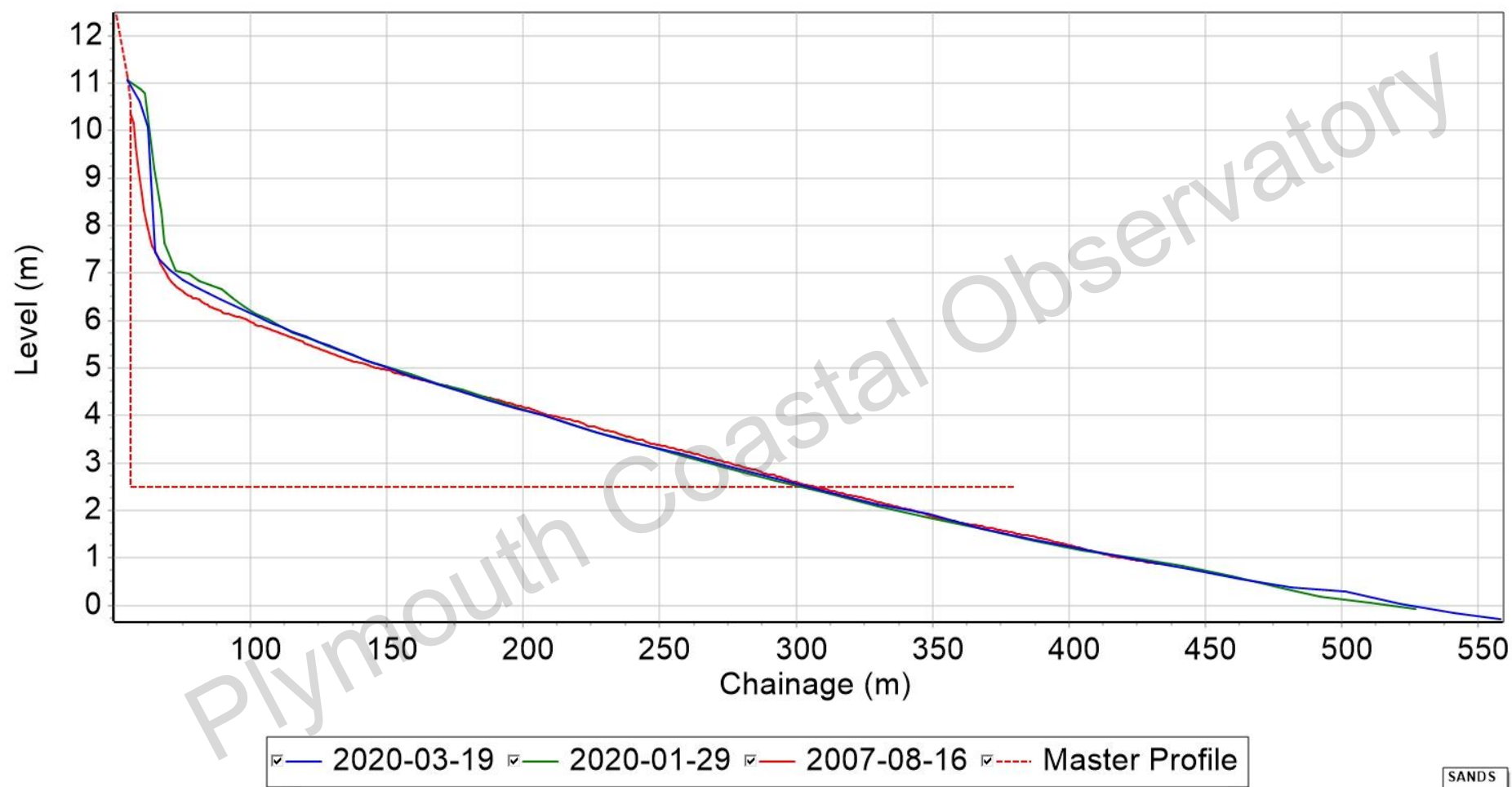
Profiles: 7d02254



Profiles: 7d02274

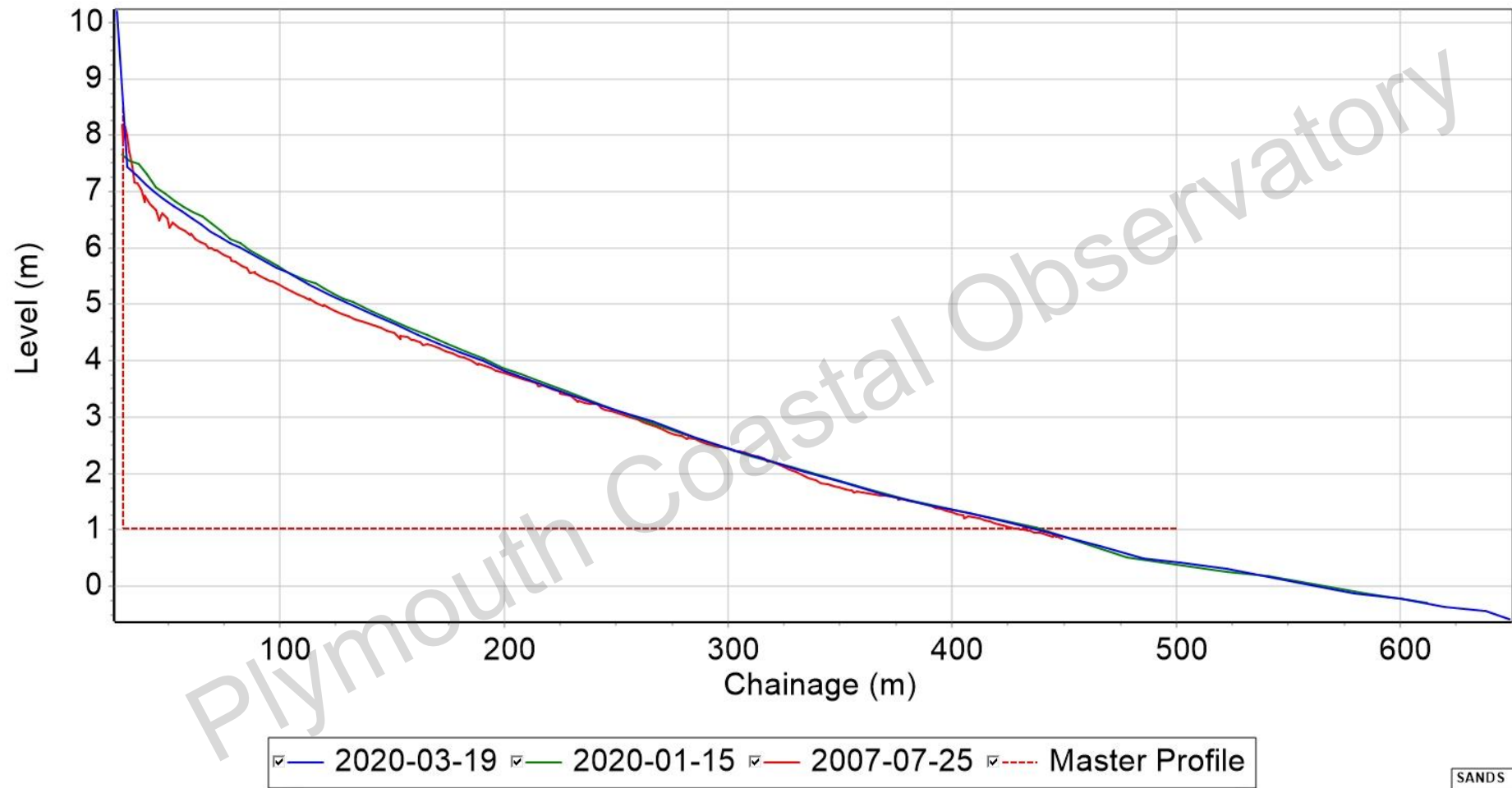


Profiles: 7d02296





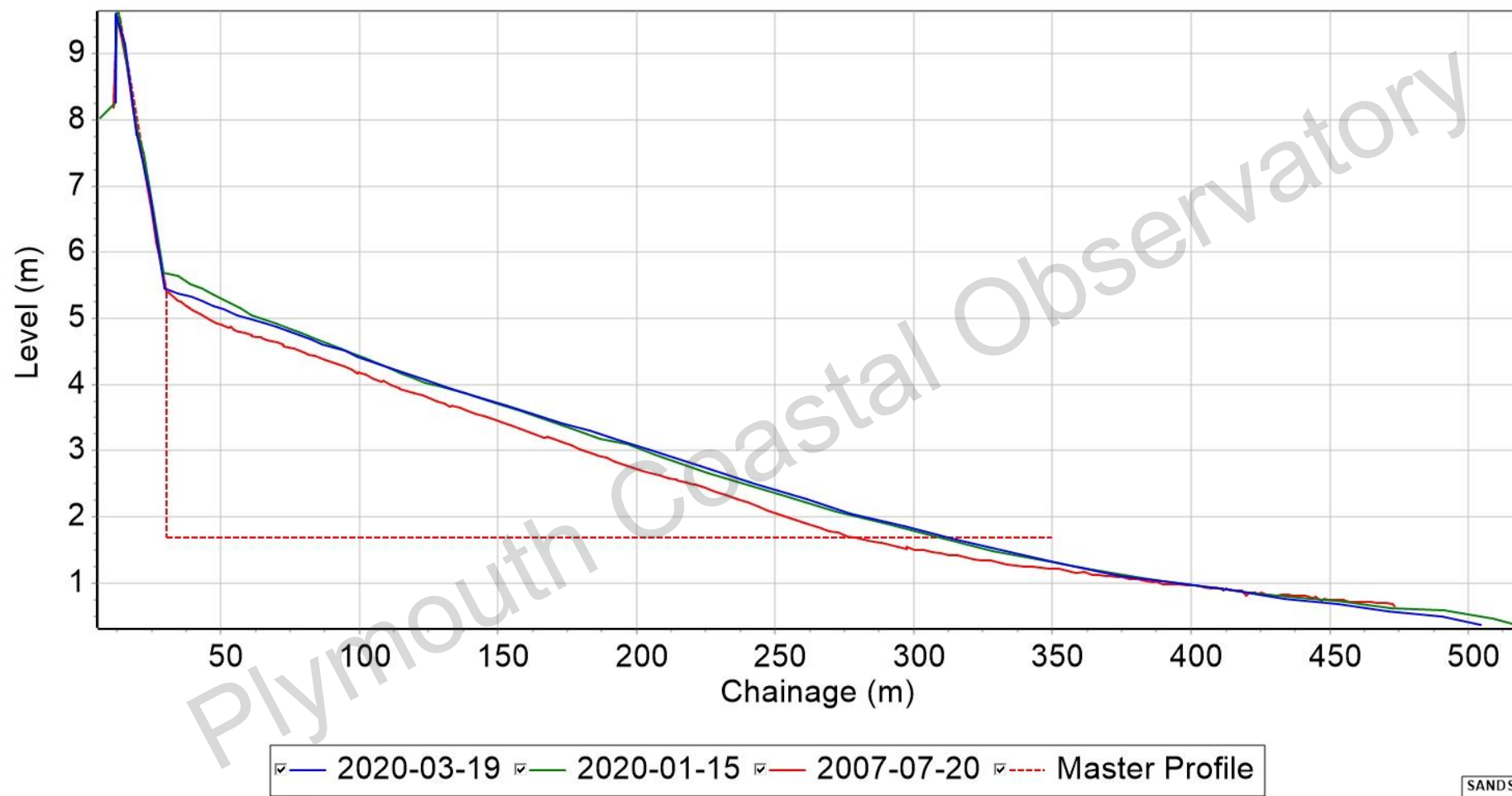
Profiles: 7d02314



Profiles: 7d02330



Profiles: 7d02345



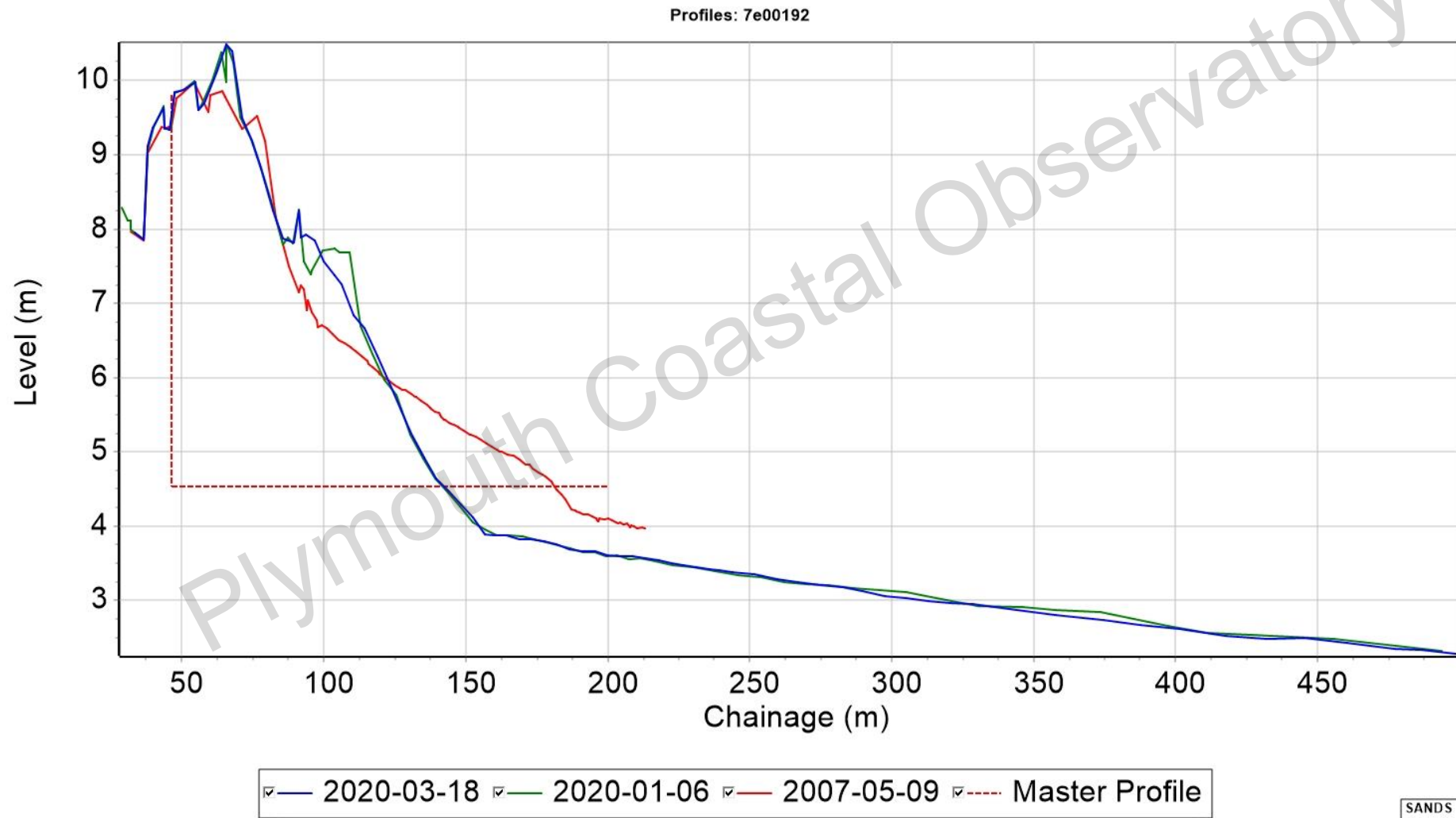
**Appendix 2** – CSA values for all post-storm profiles at Burnham survey units for each interim and baseline survey, including the post storm survey undertaken in March.

*Table 2 – CSA values (m<sup>2</sup>) for each Burnham post storm profile for every interim and baseline survey including the most recent post storm survey since the beginning of the programme.*

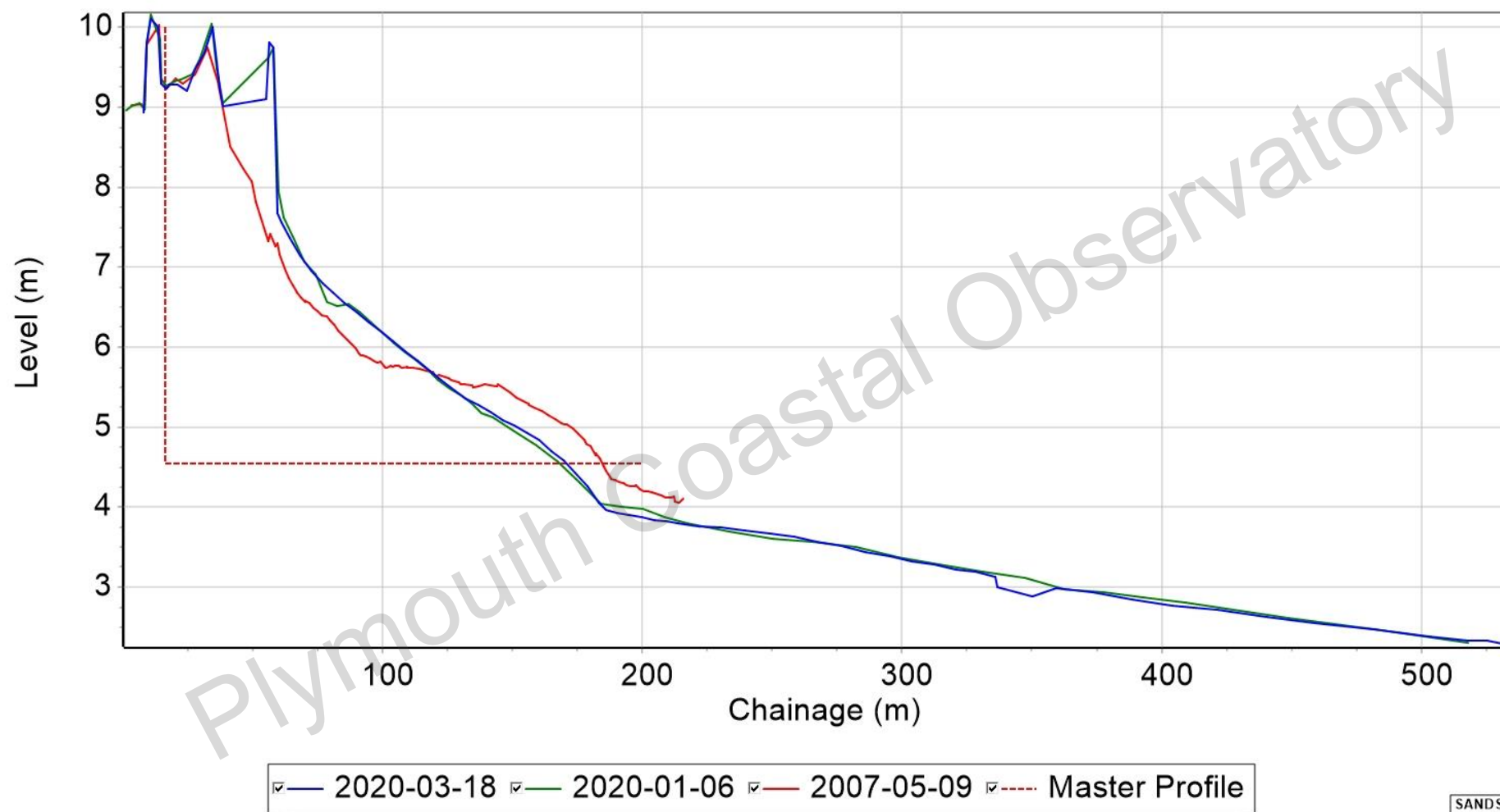
Location	11/07	03/08	11/08	02/09	10/09	02/10	10/10	03/11	10/11	09/12	01/13	09/13	01/14	09/14	01/15	12/15	04/16	10/16	12/17	03/18	10/18	03/19	10/19	01/20	03/20
7d02114M	14.2	6.7	13.9	14.2	15.7	13.5	13.4	10.3	19.5	17.7	22.2	19.7	21.0	31.0	28.2	16.5	22.0	21.0	31.7	21.3	20.5	18.3	16.5	24.2	27.5
7d02114V	29.3	23.0	25.8	27.9	31.0	31.8	32.4	26.1	31.3	30.2	28.9	31.7	24.3	30.5	28.2	27.6	21.9	15.3	17.6	19.0	24.5	19.1	25.2	19.4	16.0
7d02115C	250.5	247.2	250.9	251.0	249.6	250.8	252.4	235.7	262.0	254.0	254.0	256.0	243.6	245.8	237.5	245.1	247.5	249.6	261.0	258.5	256.2	243.9	245.2	248.8	247.5
7d02115K	239.1	207.7	222.8	223.5	215.6	212.1	219.2	220.7	225.0	223.6	225.8	231.2	216.9	231.6	227.1	227.4	224.8	221.6	233.4	246.4	247.2	247.2	247.8	250.0	246.3
7d02115U	451.8	421.1	448.2	448.3	450.5	452.9	450.9	457.3	458.3	450.1	431.2	469.1	451.9	456.3	447.7	476.5	467.7	466.7	490.2	482.1	490.6	499.1	496.0	500.5	489.4
7d02159	577.6	562.1	581.0	580.7	584.8	582.0	590.7	594.4	591.1	588.7	591.1	604.8	599.5	610.4	611.7	603.2	621.0	613.2	602.2	647.1	637.1	637.3	634.1	641.0	646.7
7d02168	699.5	673.3	707.4	702.9	709.0	693.5	658.9	675.7	671.0	645.8	633.6	657.5	607.9	628.9	657.2	660.8	647.4	624.0	629.4	742.6	751.6	754.0	755.3	757.9	771.6
7d02174	283.5	264.0	268.4	264.8	269.2	267.0	271.6	270.4	282.7	247.9	256.3	242.7	265.0	273.4	278.7	253.1	268.0	266.8	274.6	321.6	322.0	321.3	327.0	329.3	346.0
7d02192	546.9	530.5	573.6	574.0	602.4	599.2	604.2	657.0	610.9	622.4	617.6	597.4	607.4	631.5	654.1	667.7	688.6	732.4	751.3	740.5	748.1	716.1	743.4	742.5	718.7
7d02213	569.6	516.7	545.2	543.5	573.6	559.8	563.1	573.0	548.1	534.5	576.5	564.0	580.3	557.7	556.2	572.0	579.7	598.3	644.1	627.0	658.4	677.3	708.4	730.8	703.5
7d02234	497.4	475.2	501.2	490.6	493.6	493.9	485.8	477.6	473.2	465.9	470.5	467.7	473.9	466.1	468.2	468.6	453.3	429.5	448.3	462.2	477.4	470.4	475.2	483.8	481.0
7d02254	464.6	438.3	454.9	448.5	455.2	456.3	461.6	455.6	451.5	408.2	455.6	450.8	448.7	445.5	444.9	428.3	419.9	421.8	431.2	432.3	433.5	424.1	426.6	430.4	429.5
7d02274	526.3	498.0	526.0	512.9	530.8	526.5	534.2	531.9	535.5	531.3	530.6	534.9	530.1	531.9	529.4	517.5	522.0	524.7	534.8	533.0	525.7	528.3	531.0	530.5	527.4
7d02296	535.9	495.5	531.6	528.0	544.4	539.4	550.8	549.3	556.4	554.6	555.8	559.8	551.6	556.6	556.9	549.5	552.9	552.3	563.9	557.2	528.8	559.6	563.4	564.2	550.8
7d02314	1006	958	1003	1024	1024	1003	1026	1012	1019	1023	1030	1026	1028	1034	1032	1039	1036	1031	1054	1047	1066	1068	1050	1067	1052
7d02330	526.4	489.9	517.1	517.2	523.3	515.7	525.9	527.2	525.3	514.8	524.9	525.1	527.1	533.4	526.0	532.6	532.7	526.4	539.0	530.0	544.8	543.0	537.7	553.9	542.2
7d02345	420.9	399.8	420.4	421.3	421.4	421.8	434.2	421.2	428.1	439.3	444.5	438.9	454.8	455.8	454.3	466.9	478.7	476.0	494.0	490.3	498.8	496.1	490.8	504.5	504.3
Total Area (m <sup>2</sup> )	7639	7207	7592	7573	7694	7619	7675	7695	7689	7552	7649	7677	7632	7721	7738	7752	7783	7771	8000	8158	8231	8223	8274	8379	8301



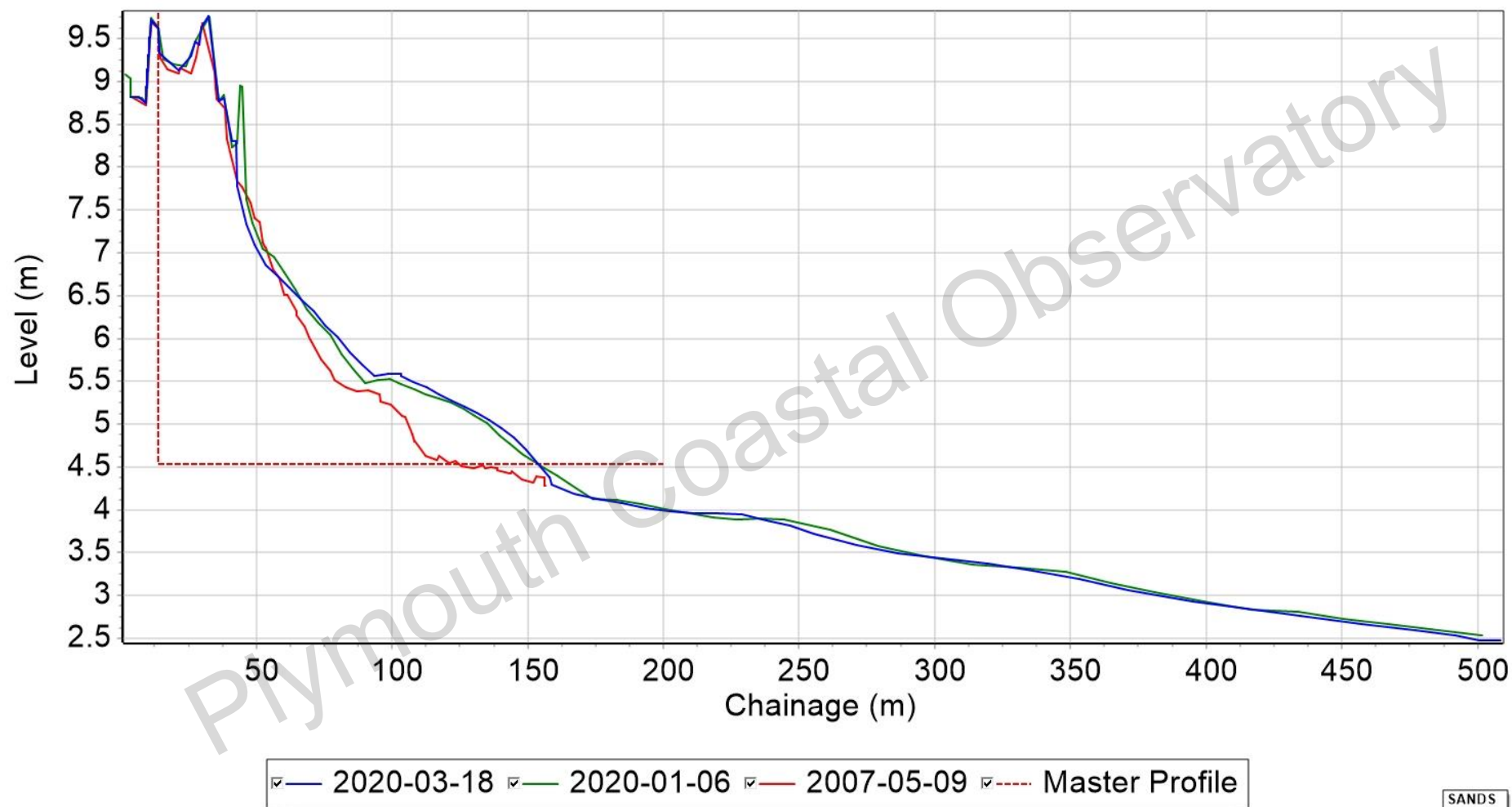
**Appendix 3** - Profile Charts for all post-storm profiles surveyed at Sand Bay showing the baseline survey (red), the most recent spring interim (green) survey and the post storm survey (blue).



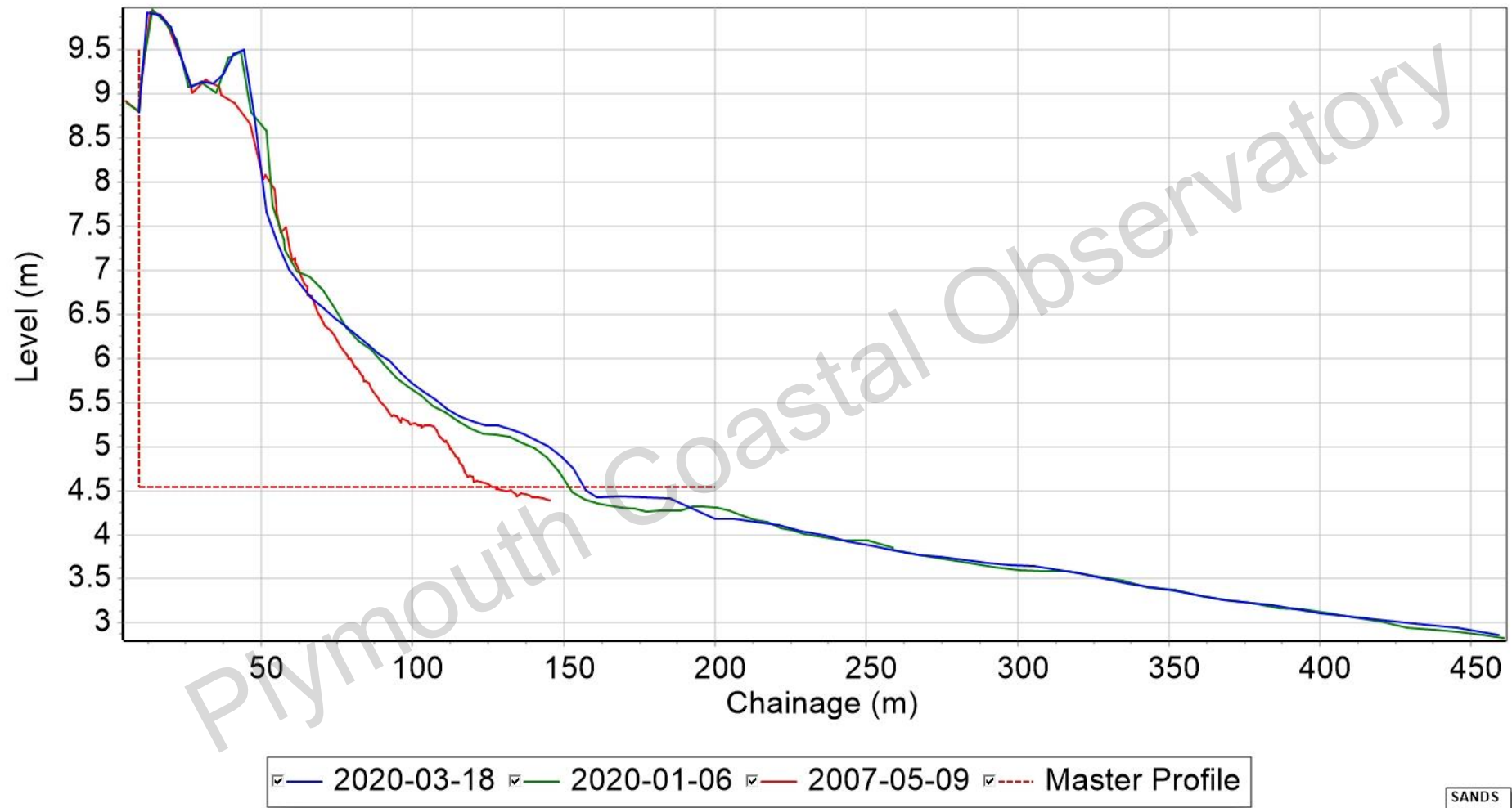
Profiles: 7e00202



Profiles: 7e00212



Profiles: 7e00222



Profiles: 7e00232





**Appendix 4** - CSA values for all post-storm profiles at Sand Bay for each interim and baseline survey, including the post storm survey undertaken in March.

*Table 3 - CSA values (m<sup>2</sup>) for each Sand Bay post storm profile for every interim and baseline survey including the most recent post storm survey since the beginning of the programme.*

Location	11/07	03/08	02/09	02/10	11/10	12/10	03/11	11/11	05/12	06/12	09/12	10/12	01/13	09/13	02/14	09/14	01/15	09/15	01/16	11/16	08/17	11/17	03/18	10/18	02/19	09/19	01/20	03/20
7e00192	303.6	294.7	293.7	300.4	305.1	306.2	307.9	307.4	305.5	305.2	306.0	305.5	307.7	312.2	309.8	310.6	309.6	312.5	312.9	310.1	318.1	316.2	310.0	314.9	309.8	309.7	307.7	306.6
7e00202	318.1	308.6	317.6	311.0	319.0	317.7	326.0	327.6	323.7	325.7	322.6	322.0	326.1	331.2	326.6	330.3	329.7	336.1	335.2	336.8	350.2	352.5	347.5	355.0	359.1	352.9	355.0	351.3
7e00212	222.2	213.5	219.7	217.3	221.7	220.7	226.8	237.9	237.6	238.3	235.3	233.7	233.0	237.1	243.2	245.6	250.1	248.1	246.9	251.2	254.5	257.5	260.9	268.6	269.8	264.4	270.1	270.4
7e00222	285.2	279.1	285.0	287.7	288.5	287.1	288.7	289.6	288.8	291.1	291.4	292.9	294.7	294.1	293.2	297.5	300.2	303.5	309.2	314.2	317.2	325.2	324.2	326.1	326.8	330.0	329.5	331.8
7e00232	316.6	308.6	315.5	320.4	326.5	333.2	326.5	327.9	330.0	342.8	344.7	343.8	344.9	350.1	348.5	356.7	361.8	363.0	363.0	365.5	364.3	374.3	367.5	368.5	377.8	378.4	381.3	382.5
Total Area (m <sup>2</sup> )	1446	1405	1432	1437	1461	1465	1476	1490	1486	1503	1500	1498	1506	1525	1521	1541	1551	1563	1567	1578	1604	1626	1610	1633	1643	1635	1643	1643

Appendix 5 – Map indicating the post storm profiles surveyed in this report for Burnham survey units and Sand Bay.



Figure 8 – Map indicating the location and name of the post storm profiles surveyed at Burnham survey units and Sand Bay for the purpose of this report.