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DOCUMENT DETAILS

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DOCUMENT TITLE	Cefas Report TR492 Hinkley Point Cardiff Grounds (LU110) post-disposal bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)			**EMPLOYER REVISION**	07
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REVISION HISTORY

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01	23/05/2019	Katie Musgrave	Coastal Processes Survey Scientist	Will Manning	Coastal Processes Scientist	Dean Foden	Hinkley Point Programme Lead
02	07/08/2019	Katie Musgrave	Coastal Processes Survey Scientist	Will Manning	Coastal Processes Scientist	Dean Foden	Hinkley Point Programme Lead
03	01/10/2019	Katie Musgrave	Coastal Processes Survey Scientist	Will Manning	Coastal Processes Scientist	Dean Foden	Hinkley Point Programme Lead
04	24/02/2020	Katie Musgrave	Coastal Processes Survey Scientist	Will Manning	Coastal Processes Scientist	Dean Foden	Hinkley Point Programme Lead
05	02/03/2020	Katie Musgrave	Coastal Processes Survey Scientist	Will Manning	Coastal Processes Scientist	Dean Foden	Hinkley Point Programme Lead
06	17/06/2020	Will Manning	Coastal Processes Scientist	Katie Musgrave	Coastal Processes Survey Scientist	Dean Foden	Hinkley Point Programme Lead
07	26/06/2020	Will Manning	Coastal Processes Scientist	Ralph Brayne	Senior Coastal Processes Survey Scientist	Dean Foden	Hinkley Point Programme Lead

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REVISION STATUS/SUMMARY OF CHANGES

Revision	Purpose	Amendment	By	Date
01	Initial submission to NNB GenCo		Cefas	23/05/2019
02	Update with further grab sample results	Inclusion of additional grab sample results (Tables 1, 2, 3 and Appendix F), NNB disposal volumes (Table 4) and grab sample photographs (Appendix E).	Cefas	07/08/2019
03	Update in response to comments from NNB GenCo	Minor formatting corrections and additional detail of Titan's Environmental Management Systems.	Cefas	01/10/2019
04	Update in response to NRW comments	Revision of Titan Report "CS0555_Cardiff Grounds Survey" section 7 and appendix B.	Cefas	24/02/2020
05	Update to formatting	Formatting update to pages 1 – 10.	Cefas	02/03/2020
06	Update in response to NRW comments	Update volume calculations and additional text under the heading "Residual Offset Analysis" on pages 7 – 16.	Cefas	17/06/2020
07	Update in response to comments from NNB GenCo	Minor formatting corrections.	Cefas	26/06/2020

BEEMS Technical Report	TR492
BEEMS Technical Report Title	Hinkley Point Cardiff Grounds (LU110) post-disposal bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)
Sub-Contract Report Original Title:	CS0555_Cardiff Grounds Survey_V4
Sub-Contractor	Titan Environmental Surveys Limited

Summary of Purpose & Value to BEEMS

Installation of the intake and outfall heads for the Hinkley Point C (HPC) nuclear power station, requires dredging works to prepare the seabed, and subsequent disposal of the dredged material. Consent to carry out this dredge was granted by the Marine Management Organisation in marine licence L/2013/00178/4, as amended (MMO, 2017). Permission to dispose of this material in disposal area LU110 (Cardiff Grounds) was granted by Natural Resources Wales in marine licence 12/45/MLv1 (NRW, 2018). To satisfy the conditions of marine licence 12/45/MLv1 (NRW 2018), pre- and post-disposal monitoring requirements were agreed with NRW and are detailed in BEEMS Technical Report TR429. To meet pre-disposal monitoring requirements, bathymetric and grab sampling surveys were conducted by Titan Environmental Surveys Ltd and reported in BEEMS Technical Report TR457.

To meet post-disposal requirements, bathymetric and grab sampling surveys were conducted by Titan Environmental Surveys Ltd between 3rd and 12th April 2019 and reported in survey report "CS0555_Cardiff Grounds Survey_V4". An additional grab sampling survey was undertaken by Cefas on 24th June 2019 to collect two samples (S7 and S12), as previous post-disposal samples were damaged in transit.

Grab samples were analysed for particle size distribution by the Cefas laboratory according to NMBAQC methodology (Mason, 2016). Data are presented (Table 1) and compared with pre-disposal results (Table 2 and Table 3). In comparison with the pre-disposal results, sites 1, 6, 7, and 11 were comprised of coarser sediment post-disposal, whilst sites 2, 3 and 4 were comprised of finer sediments. Sites 5 and 8 were sandier, with less gravel and fine sediment post-disposal, whilst sites 9, 10 and 12 showed minimal change.

Table 1: Summary of post-disposal particle size distributions for LU110. Samples acquired by Titan Environmental Surveys Ltd (see survey report "CS0555_Cardiff Grounds Survey_V2") and analysed by Cefas.

Sample Number	1	2	3	4	5	6	7	8	9	10	11	12
Sample Type	Trimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Unimodal, Extremely Poorly Sorted	Unimodal, Very Poorly Sorted	Unimodal, Moderately Sorted	Bimodal, Very Poorly Sorted	Polymodal, Extremely Poorly Sorted	Unimodal, Well Sorted	Unimodal, Well Sorted	Unimodal, Well Sorted	Unimodal, Well Sorted	Unimodal, Well Sorted
Textural Group	Slightly Gravelly Sandy Mud	Mud	Muddy Gravel	Slightly Gravelly Mud	Slightly Gravelly Sand	Muddy Sandy Gravel	Muddy Sandy Gravel	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand
Sediment Name	Slightly Fine Gravelly Medium Sandy Fine Silt	Medium Silt	Medium Silty Very Coarse Gravel	Slightly Fine Gravelly Mud	Slightly Very Fine Gravelly Medium Sand	Medium Silty Sandy Coarse Gravel	Medium Silty Sandy Coarse Gravel	Slightly Very Fine Gravelly Medium Sand	Slightly Very Fine Gravelly Medium Sand	Slightly Very Fine Gravelly Medium Sand	Slightly Very Fine Gravelly Medium Sand	Slightly Fine Gravelly Medium Sand
% Gravel	2.4	0.0	58.4	0.3	0.6	72.2	56.0	0.0	0.0	0.0	0.2	0.0
% Sand	17.9	3.2	4.7	4.5	94.8	17.4	27	100	100	100	99.8	100
% Mud	79.7	96.8	36.9	95.2	4.6	10.4	16.6	0.0	0.0	0.0	0.0	0.0
% V Coarse Gravel	0.0	0.0	31.6	0.0	0.0	21.5	5.4	0.0	0.0	0.0	0.0	0.0
% Coarse Gravel	0.0	0.0	23.3	0.0	0.0	33.7	24.1	0.0	0.0	0.0	0.0	0.0
% Medium Gravel	0.7	0.0	3.0	0.0	0.1	9.2	13.7	0.0	0.0	0.0	0.0	0.0
% Fine Gravel	0.9	0.0	0.3	0.1	0.1	4.4	4.6	0.0	0.0	0.0	0.0	0.0
% V Fine Gravel	0.8	0.0	0.2	0.1	0.4	3.4	8.2	0.0	0.0	0.0	0.1	0.0
% V Coarse Sand	0.8	0.0	0.3	0.2	0.4	2.3	7.6	0.1	0.0	0.0	0.2	0.0
% Coarse Sand	1.1	0.0	0.0	0.0	9.6	3.7	7.1	2.2	3.6	6.7	12.3	2.4
% Medium Sand	6.4	0.0	0.1	0.0	68.6	7.7	6.7	80.3	80.4	72.6	79.7	80.0
% Fine Sand	5.8	0.7	2.1	1.2	15.3	3.1	4.3	17.4	16.0	20.6	7.7	17.5
% V Fine Sand	3.8	2.5	2.3	3.1	0.9	0.7	1.8	0.0	0.0	0.0	0.0	0.0
% V Coarse Silt	6.0	5.8	3.1	5.1	0.4	0.9	1.9	0.0	0.0	0.0	0.0	0.0
% Coarse Silt	12.1	13.2	5.5	8.9	0.6	1.6	2.7	0.0	0.0	0.0	0.0	0.0
% Medium Silt	17.0	22.1	7.5	14.5	0.9	2.3	3.3	0.0	0.0	0.0	0.0	0.0
% Fine Silt	17.3	21.9	6.8	17.5	0.9	2.3	3.2	0.0	0.0	0.0	0.0	0.0
% V Fine Silt	10.6	13.8	4.8	15.1	0.6	1.4	2.1	0.0	0.0	0.0	0.0	0.0
% Clay	16.8	20.1	9.2	34.2	1.2	2.0	3.4	0.0	0.0	0.0	0.0	0.0

Table 2: Percentage change in each grain size fraction between pre- and post-disposal particle size distributions at the sampling sites.

	Sample number											
Percentage change	1	2	3	4	5	6	7	8	9	10	11	12
% Gravel	2.4	-32.4	-21.5	-35.6	-13.9	68.5	38.5	-0.2	0.0	0.0	0.1	0.0
% Sand	10.9	-14.5	-4.5	-0.6	40.5	8.3	-21.4	5.2	0.0	0.0	-0.1	0.0
% Mud	-13.2	46.9	26.0	36.3	-26.5	-76.8	-17.1	-5.0	0.0	0.0	0.0	0.0
% V Coarse Gravel	0.0	-25.1	-3.9	0.0	0.0	21.5	5.4	0.0	0.0	0.0	0.0	0.0
% Coarse Gravel	0.0	0.0	2.8	-15.2	0.0	33.7	17.7	0.0	0.0	0.0	0.0	0.0
% Medium Gravel	0.7	-2.8	-6.5	-14.2	-4.0	9.2	11.7	0.0	0.0	0.0	0.0	0.0
% Fine Gravel	0.9	-2.5	-11.3	-3.6	-5.6	2.9	0.5	0.0	0.0	0.0	0.0	0.0
% V Fine Gravel	0.7	-2.1	-2.7	-2.7	-4.3	1.2	3.2	-0.2	0.0	0.0	0.1	0.0
% V Coarse Sand	0.7	-3.1	-4.2	-1.5	-3.4	1.2	1.9	-1.2	0.0	0.0	0.2	0.0
% Coarse Sand	1.1	-1.8	-1.9	0.0	2.5	3.7	-3.1	-5.6	-6.6	6.7	3.2	-3.7
% Medium Sand	6.4	-6.3	-1.5	0.0	38.4	7.7	-11.2	17.2	1.1	10.5	-1.3	-1.6
% Fine Sand	3.9	-2.5	1.4	-0.5	4.6	0.1	-7.0	-4.3	5.5	-17.2	-2.3	5.3
% V Fine Sand	-1.3	-0.8	1.7	1.3	-1.6	-4.3	-2.0	-0.9	0.0	0.0	0.0	0.0
% V Coarse Silt	-2.2	1.9	2.2	1.4	-2.0	-6.4	-1.8	-0.5	0.0	0.0	0.0	0.0
% Coarse Silt	-2.4	6.2	3.9	1.9	-3.6	-10.7	-2.6	-0.6	0.0	0.0	0.0	0.0
% Medium Silt	-3.5	11.8	5.4	2.1	-5.0	-15.5	-3.1	-1.0	0.0	0.0	0.0	0.0
% Fine Silt	-2.5	11.7	4.9	4.7	-5.3	-15.4	-3.2	-1.1	0.0	0.0	0.0	0.0
% V Fine Silt	-2.1	6.3	3.2	6.0	-4.1	-11.6	-2.5	-0.7	0.0	0.0	0.0	0.0
% Clay	-0.7	9.0	6.4	20.1	-6.4	-17.3	-3.8	-1.1	0.0	0.0	0.0	0.0

Table 3: Comparison of pre- and post-disposal particle size characterisations at the sampling sites. Where changes are observed between pre- and post-disposal surveys, cells are shaded yellow

Sample No.	Sample type		Textural Group		Sediment Name	
	Pre-disposal	Post-disposal	Pre-disposal	Post-disposal	Pre-disposal	Post-disposal
1	Bimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Slightly Gravelly Mud	Slightly Gravelly Sandy Mud	Slightly Very Fine Gravelly Medium Silt	Slightly Fine Gravelly Medium Sandy Fine Silt
2	Polymodal, Extremely Poorly Sorted	Bimodal, Very Poorly Sorted	Muddy Gravel	Mud	Medium Silty Very Coarse Gravel	Medium Silt
3	Trimodal, Very Poorly Sorted	Unimodal, Extremely Poorly Sorted	Muddy Gravel	Muddy Gravel	Medium Silty Very Coarse Gravel	Medium Silty Very Coarse Gravel
4	Trimodal, Extremely Poorly Sorted	Unimodal, Very Poorly Sorted	Muddy Gravel	Slightly Gravelly Mud	Fine Silty Coarse Gravel	Slightly Fine Gravelly Mud
5	Trimodal, Very Poorly Sorted	Unimodal, Moderately Sorted	Gravelly Muddy Sand	Slightly Gravelly Sand	Fine Gravelly Fine Silty Medium Sand	Slightly Very Fine Gravelly Medium Sand
6	Unimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Slightly Gravelly Mud	Muddy Sandy Gravel	Slightly Very Fine Gravelly Medium Silt	Medium Silty Sandy Coarse Gravel
7	Polymodal, Extremely Poorly Sorted	Polymodal, Extremely Poorly Sorted	Gravelly Muddy Sand	Muddy Sandy Gravel	Coarse Gravelly Medium Silty Medium Sand	Medium Silty Sandy Coarse Gravel
8	Unimodal, Moderately Sorted	Unimodal, Well Sorted	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Very Fine Gravelly Medium Sand	Slightly Very Fine Gravelly Medium Sand
9	Unimodal, Well Sorted	Unimodal, Well Sorted	Sand	Slightly Gravelly Sand	Well Sorted Medium Sand	Slightly Very Fine Gravelly Medium Sand
10	Unimodal, Well Sorted	Unimodal, Well Sorted	Sand	Slightly Gravelly Sand	Well Sorted Medium Sand	Slightly Very Fine Gravelly Medium Sand
11	Unimodal, Well Sorted	Unimodal, Well Sorted	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Fine Gravelly Medium Sand	Slightly Very Fine Gravelly Medium Sand
12	Unimodal, Well Sorted	Unimodal, Well Sorted	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Very Fine Gravelly Medium Sand	Slightly Fine Gravelly Medium Sand

The sources, dates and volumes of material disposed at LU110 during the 12 months prior to the survey have also been collated by Cefas (Table 4). The volume disposed between the pre- and post-disposal surveys was 684,673 m^3.

*Table 4: Summary of material sources, dates and volumes disposed of at disposal site LU110 (Cardiff Grounds) during the 12 months prior to the post-disposal survey. * NOTE: ABP Barry use disposal site LU115 and has not disposed of any material in LU110 during this period.*

Material Source	Date of Disposal		Disposal Volume (m^3)
	Start	End	
ABP Barry*	n/a	n/a	0
ABP Cardiff	Apr-18	Apr-18	17,196
	May-18	May-18	75,812
	Jul-18	Jul-18	43,887
	Aug-18	Aug-18	36,845
	Sep-18	Sep-18	71,848
	Nov-18	Nov-18	125,473
	Dec-18	Dec-18	63,443
	Jan-19	Jan-19	34,420
	Mar-19	Mar-19	64,890
Cardiff Harbour Authority	07-Jul-18	14-Jul-18	73,272
	14-Jan-19	21-Jan-19	77,863
NNB GenCo	Sep-18	Sep-18	56,260
	Oct-18	Oct-18	36,472
Total			**777,681**
Total between pre- and post-disposal surveys (22-Jun-18 to 12-Apr-19)			684,673

The calculated net volume change, accretion, and erosion between surveys is summarised in Table 5 and Appendix B.6. It was noted that there was a small, consistent offset between the two surveys (as demonstrated by the transects shown in Appendix B.4 and Figure 8), indicating that a proportion of the calculated volumetric change can be attributed to survey artefact, rather than real topographic change. Titan state in section 7.2 of their report that survey results are within the swathe bathymetric equipment specifications used for the two surveys. The calculated volume change is therefore an overestimate of the true change, comprising mostly of offset (i.e., survey artefact) between the two surveys rather than disposal activity and/or natural processes, which is evident in the bathymetric change chart in Appendix B.5, and addressed further in the following section.

Table 5: Volumetric change calculations with Cardiff grounds disposal site.

Scenario	Net volume change above 12 m isochore (m^3)	Accretion or fill volume (m^3)	Erosion volume (m^3)
Post-disposal survey adjusted for +0.085 m antennae offset, as reported by Titan in Section 7.2 Appendix B.6 herein.	510,177	524,999	14,822
Post-disposal survey adjusted for remaining +0.24 m residual offset. (see section "Residual Offset Analysis" in this report for the method used to quantify this offset.	103	105,124	105,021

Residual Offset Analysis

Following discussions with NRW, the residual survey offset (which remained once Titan's report had been updated to remove the +0.085 m antenna offset) was further investigated by Cefas. For bathymetric surveys CS0534 (pre-disposal) and CS0555 (post-disposal), a histogram of the relative distributions of water depth was produced (bin size of 0.02 m) (Figure 1). The arithmetic mean of the water depths across Cardiff Grounds only (i.e., excluding the survey buffer) are -4.737 m and -4.496 m for CS0534 and CS0555 respectively. Direct comparison of these mean values results in a vertical offset between the surveys of 0.241 m.

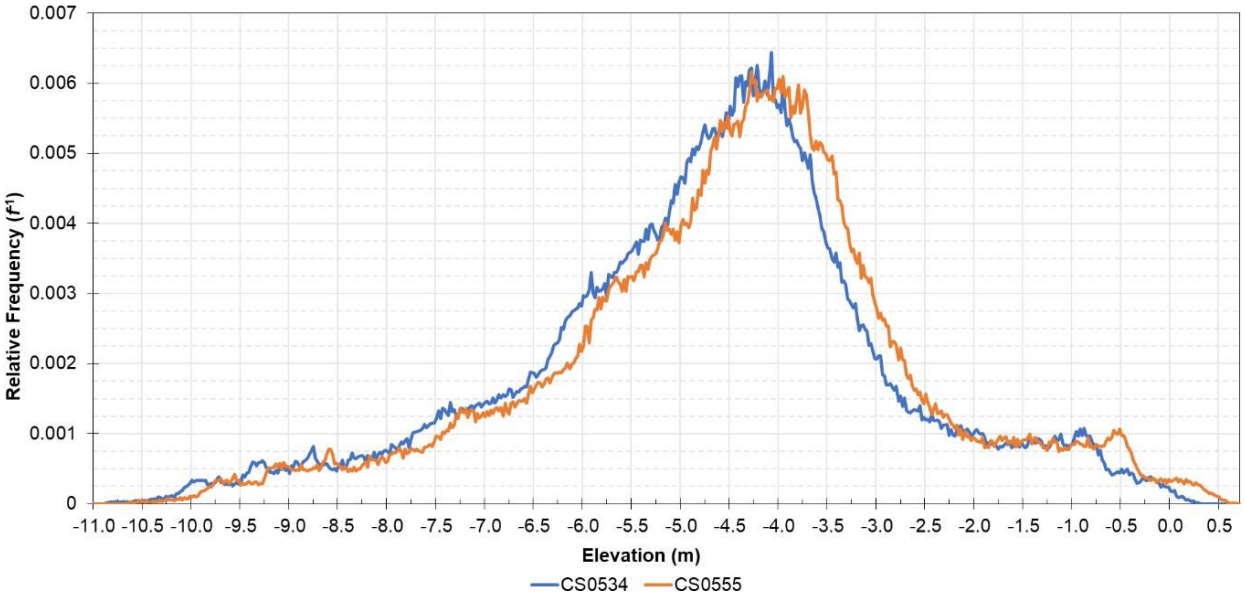

Figure 1: Cumulative water depth plot for the CS0534 (pre-disposal) and CS0555 (post-disposal) bathymetric surveys.

To further validate and demonstrate the vertical offset, a difference analysis was undertaken, assuming CS0534 to be vertically 'correct' and comparing it with survey CS0555 on a node by node basis. A histogram of the residual differences between the two bathymetric surveys is presented in Figure 2. The difference analysis again yields a residual mean value of +0.24 m (dashed black line (Figure 2)).

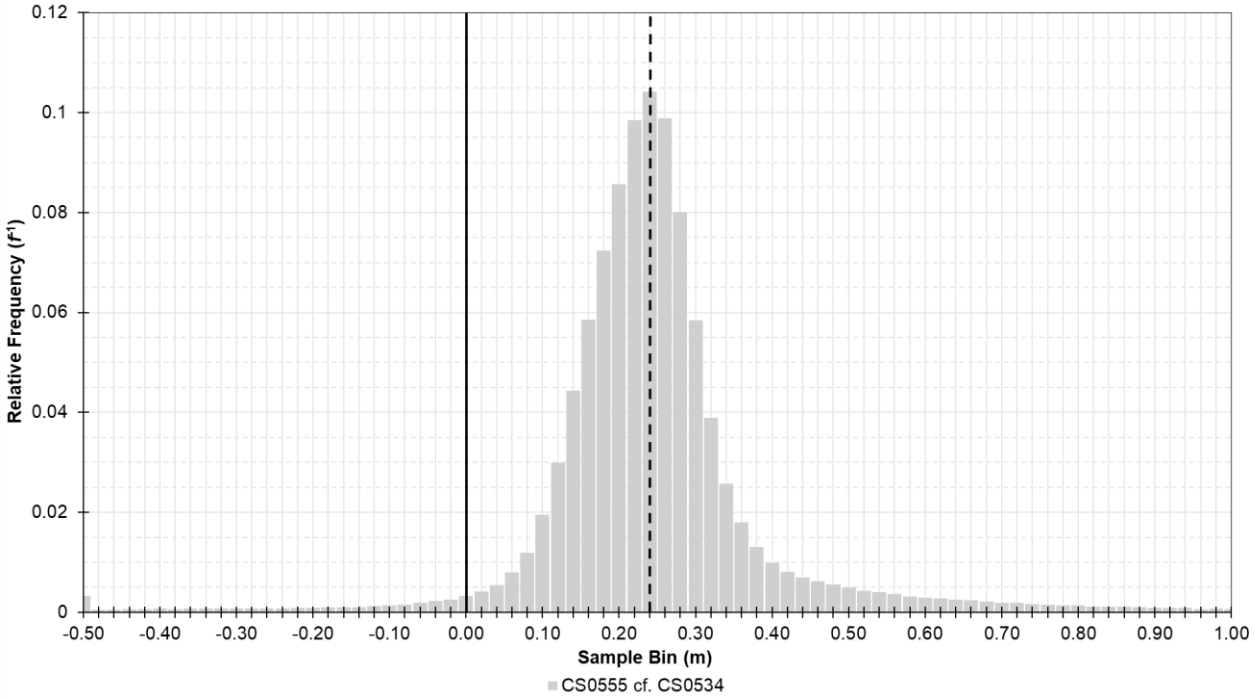

Figure 2: Histogram of residual differences, derived by subtracting CS0534 (pre-disposal) from CS0555 (post-disposal).

If the residual differences presented in Figure 2 were due to a real event (i.e., disposal activities and/or natural sediment processes, rather than survey artefact), the distribution of residuals and the residual mean value would be expected to vary, if the area over which they were calculated was changed (i.e., the residual offset would not be uniformly distributed across the site). To assess this, a gate filter was applied to survey CS0555 (post-disposal), such that it excluded areas where "real" changes were deemed to have occurred. "Real" changes were defined as any change greater than +0.50 m and less than 0.00 m (i.e., changes in the bed elevation about the offset of approximately +/- 0.25 m). The resultant "mask" (Figure 3) was used to repeat the above difference analysis (i.e., residual differences were calculated for areas highlighted green in Figure 3). Again, the difference analysis yields a residual mean value of 0.24 m (Figure 4Figure 4). The consistency between the results implies that the +0.24 m vertical offset is due to survey artefact, rather than any disposal activity and/or natural processes.

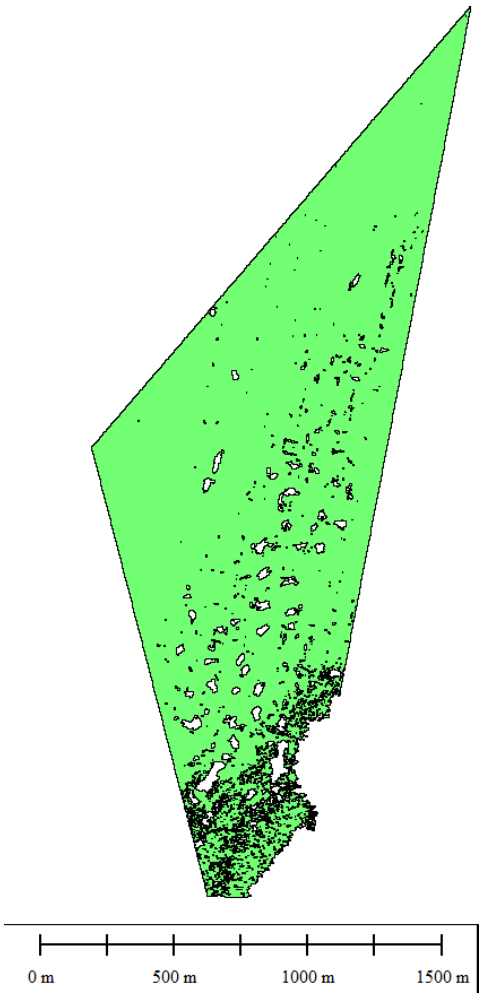

Figure 3: Areas within Cardiff Grounds where absolute changes in bed elevation between CS0534 (pre-disposal) and CS0555 (post-disposal) were less than |0.25 m| (green).

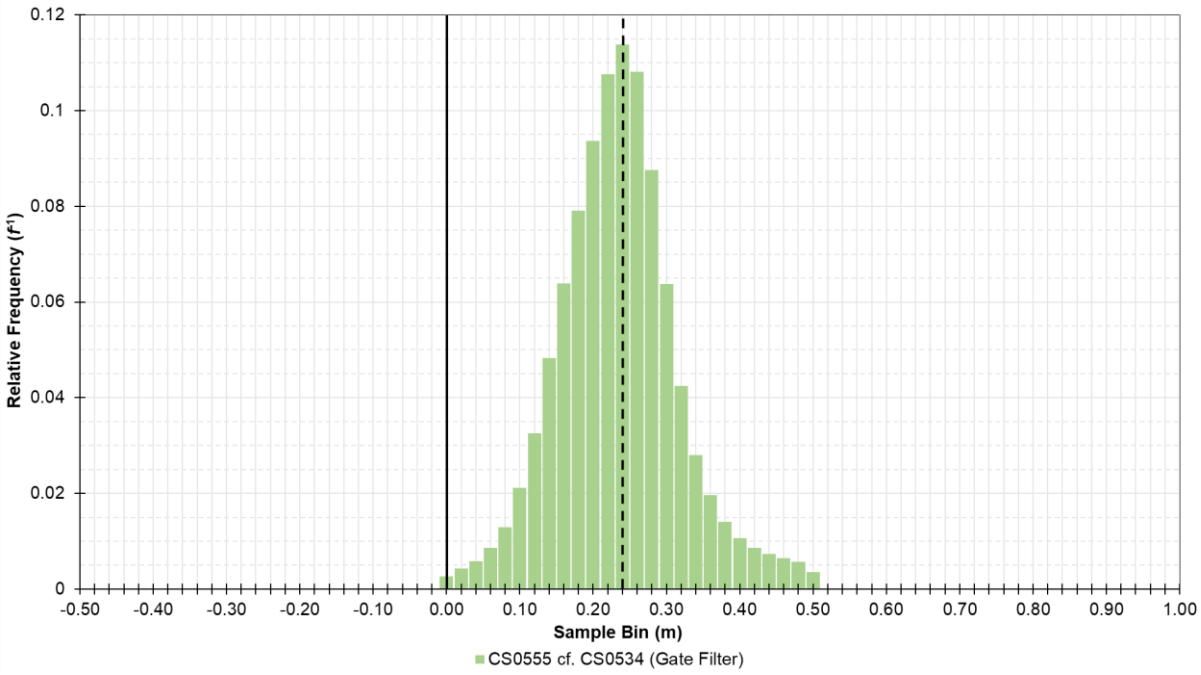

Figure 4: Histogram of residual differences, derived by subtracting CS0534 (pre disposal) from CS0555 (post-disposal), within areas where absolute changes in bed elevation between the surveys were less than |0.25 m| (Figure 3).

Applying this offset, a map of the difference analysis presented in Figure 2 is shown in Figure 5 (left panel), with an “adjusted” map for comparison, where a vertical offset of 0.24 m has been subtracted from survey CS0555 (right panel). The adjustment clearly shows the impact of the vertical offset and results in a map of erosion and accretion, which is more consistent with expected changes due to natural processes. Also, clearly visible are a number of accretion patterns, attributed to disposal events occurring during the period between the two bathymetric surveys (Table 4).

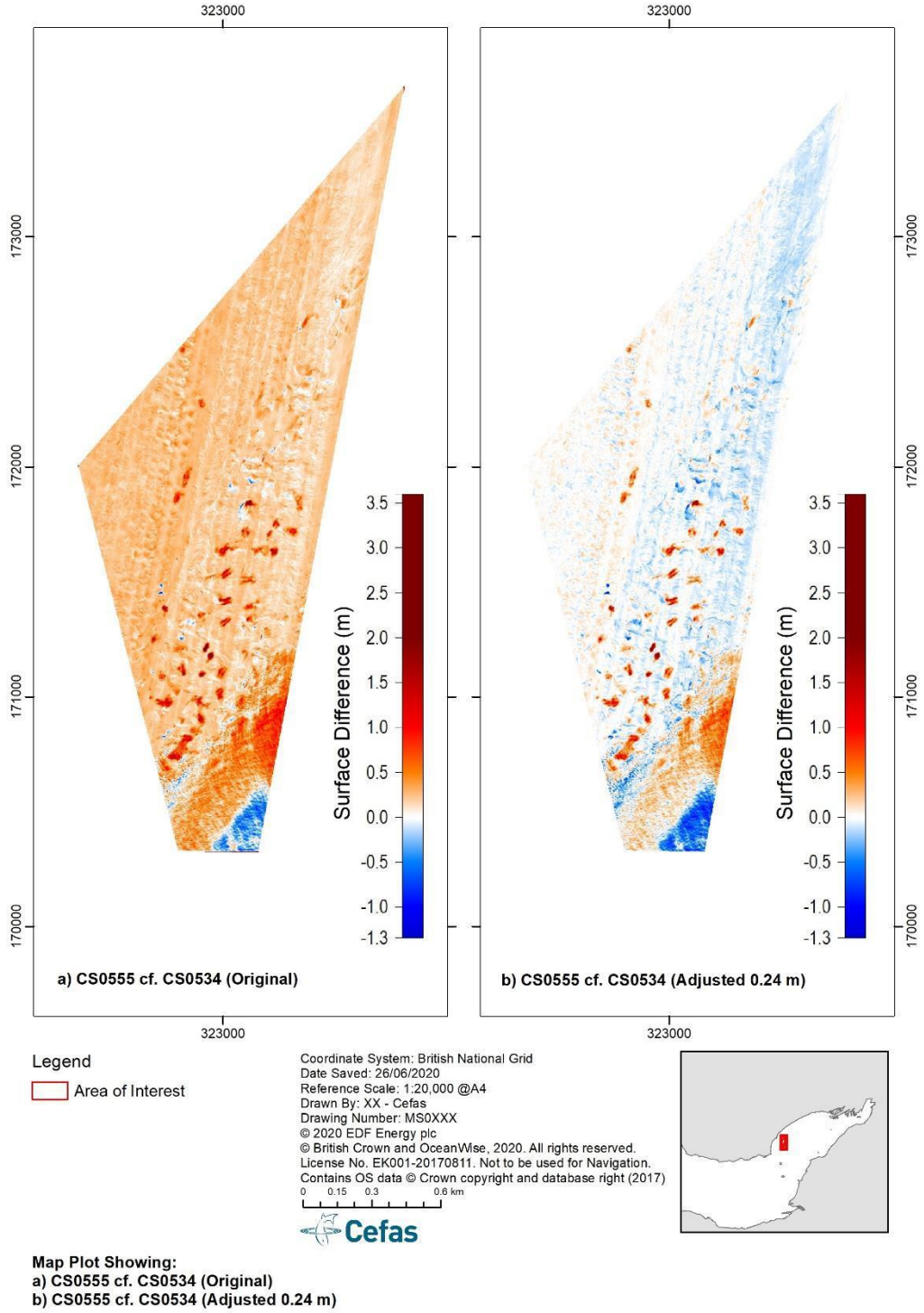

Figure 5: Map of residual differences across Cardiff Grounds, derived by subtracting CS0534 (pre disposal) from CS0555 (post-disposal), including both “unadjusted” (left panel) and “adjusted” (right panel).

These individual disposal events can be used to clearly identify changes in bed elevation (i.e., erosion or accretion) associated with “real” events and those attributed primarily to the offset. For example, Figure 6 (2D) and Figure 7 (3D) illustrate a series of four discrete disposal events along a transect (“Transect 01”), with each disposal identified as two parallel lines of deposited material (i.e., accretion), consistent with material being released through the hopper doors of a dredging vessel.

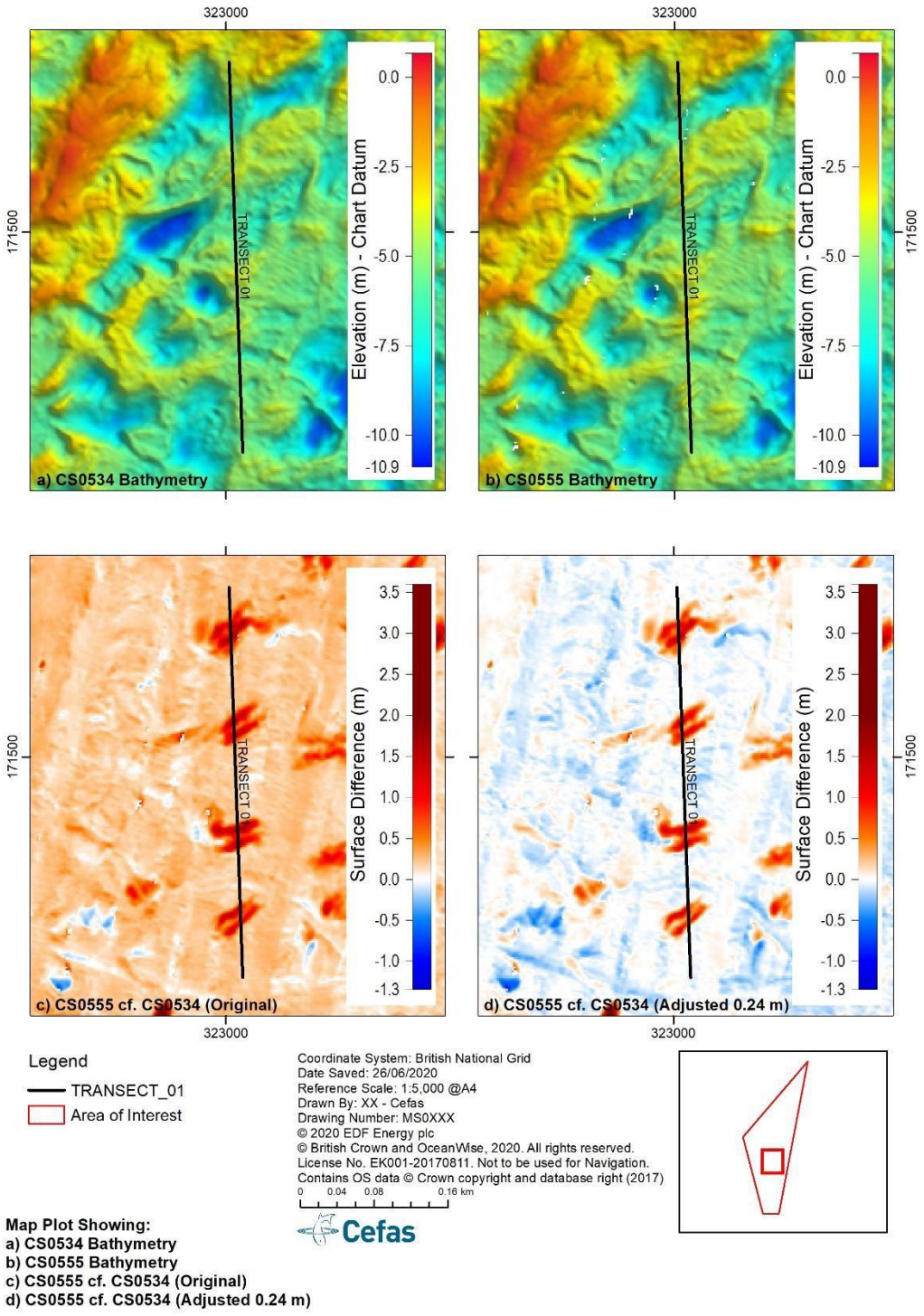

Figure 6: 2D Bathymetry results of each survey and a map of residual differences (“unadjusted” and “adjusted”) covering four discrete disposal events.

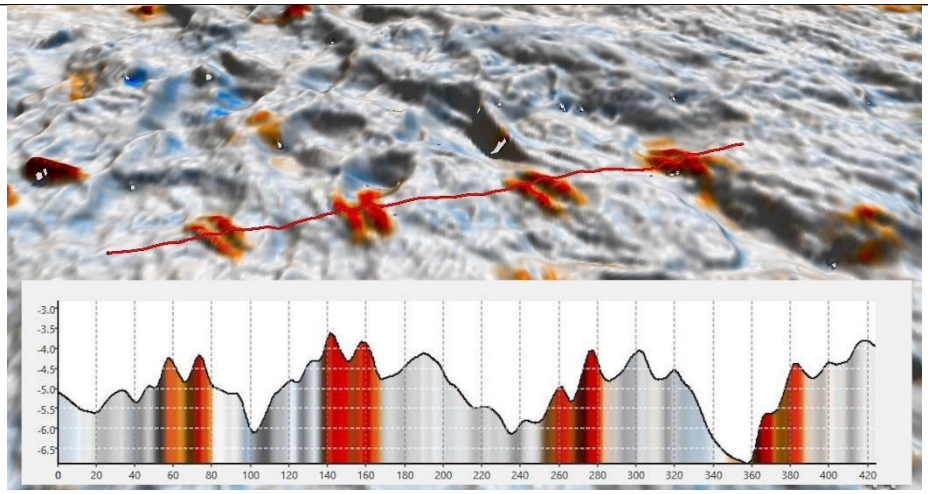

Figure 7: 3D map of residual differences ("adjusted") covering four discrete disposal events (the vertical scale is the same as Figure 6).

Elevation differences and bathymetry along "Transect 01" are presented in Figure 8. In the top panel, the elevation differences between the CS0534 (pre disposal) survey and the "unadjusted" (green line) and "adjusted" (orange line) CS0555 (post disposal) survey, clearly identify changes in the bed level associated with the four disposal events, whilst the 0.24 m offset is apparent in areas outside of these disposal events. In the bottom panel, the bathymetry of the CS0534 (pre disposal) (black line) survey and the "unadjusted" (blue line) and "adjusted" (red line) CS0555 (post disposal) survey along "Transect 01" is presented. Again, following subtraction of the 0.24 m offset, comparison of the CS0534 (pre disposal) (black line) survey and the "adjusted" (red line) CS0555 (post disposal) survey, clearly identifies the four disposal events whilst showing good agreement in areas where patterns of erosion and accretion would only be expected due to natural processes (i.e., there is no evidence of a disposal event).

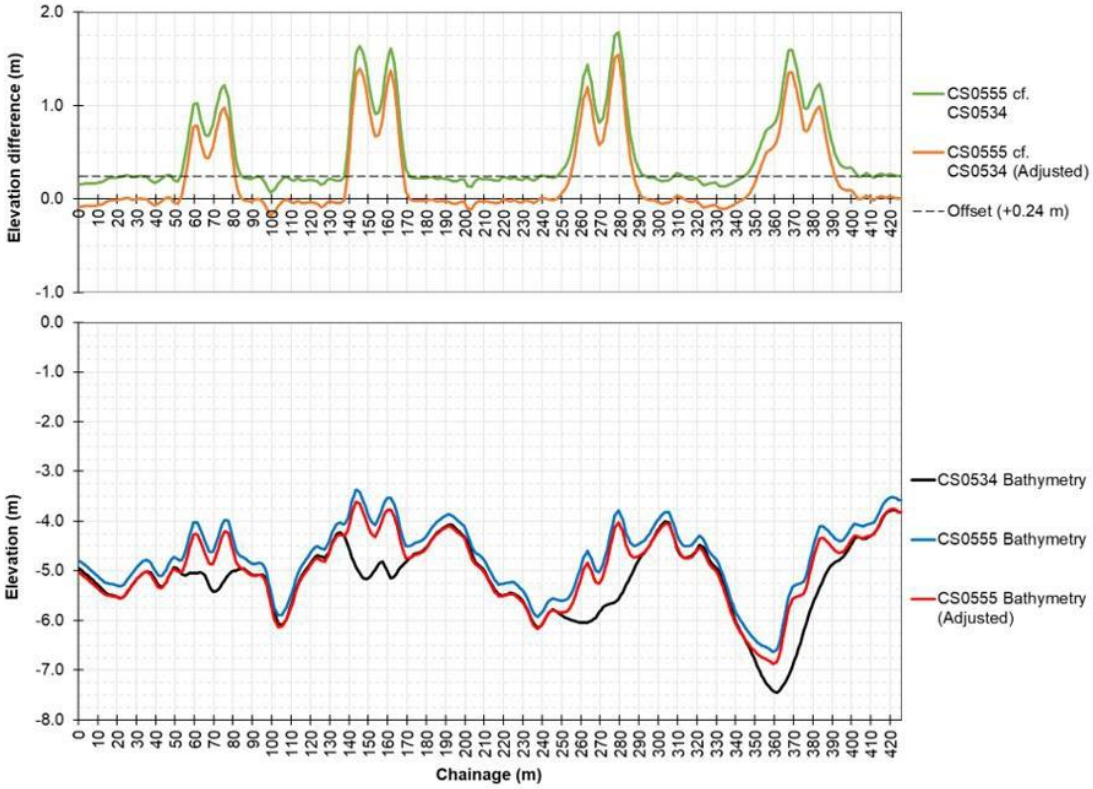

Figure 8: Bed level changes along "Transect 01" (shown in Figure 6 and Figure 7), including both "unadjusted" and "adjusted" elevations (chainage originates in the south of "Transect 01", progressing north).

This analysis clearly shows a systematic offset of 0.24 m between the pre- and post- disposal bathymetric surveys. Following subtraction of this offset, the resultant erosion and fill and resultant net volume change across Cardiff Grounds (Table 5). In summary, there has been a minor net increase in sediment volume of only 103 m^3 across the site between the pre- and post- disposal surveys, consistent with the understanding that this site is dispersive.

Changes to Scope of Works (SoW):

An extra grab sample, "Site 12", was surveyed in addition to the eleven sampling sites specified in BEEMS Technical Report TR429. See Figure 9 herein and Appendix F for further details.

Summary:

This Value-Added Statement (VAS) confirms that Cefas and Titan Environmental Surveys Ltd. have satisfactorily completed the agreed monitoring conditions of marine licence 12/45/MLv1 (NRW, 2018) (please refer to Table 6).

Table 6: Summary of the required and completed monitoring requirements.

	Agreed post-disposal reporting content (from BEEMS Technical Report TR429)	Location of content
1	Details of survey operations.	See survey report "CS0555_Cardiff Grounds Survey_V4", Appendix A and Appendix F.
2	A bathymetric chart of survey area.	See Appendix B.1. and B.2. within survey report "CS0555_Cardiff Grounds Survey_V4".
3	A chart showing changes in bathymetry detected since the pre-disposal survey	See Appendix B.5. within survey report "CS0555_Cardiff Grounds Survey_V4".
4	A volume/area plot of disposal site above a representative contour (e.g. 1m below chart datum).	See Appendix B.3. within survey report "CS0555_Cardiff Grounds Survey_V4".
5	A plot showing changes in volume/area detected since the pre-disposal survey	See Appendix B.5. and B.6. within survey report "CS0555_Cardiff Grounds Survey_V4".
6	Figures of three transects (one through the centre of the disposal site along a SW-NE axis and two perpendicular cross-transects in the centres of the northern and southern sectors) together with the previously surveyed transects for comparison.	See Appendix B.4. within survey report "CS0555_Cardiff Grounds Survey_V4".
7	A chart showing the locations of the transects.	See Appendix B.1. within survey report "CS0555_Cardiff Grounds Survey_V4".
8	A chart showing the locations of the grab sampling sites.	See Appendix B.1. within survey report "CS0555_Cardiff Grounds Survey_V4" and Figure 9 herein.
9	A table showing the coordinates of the grab sampling sites.	See Appendix C.1. and Appendix F within survey report "CS0555_Cardiff Grounds Survey_V4".
10	A table showing the results of the particle size analysis.	See Table 1, reported herein.
11	A comparison of the pre-disposal and post disposal particle size data	See

		Table 2 and Table 3, reported herein.
12	A table showing the volumes and dates of disposed material from other sources during the 12 months prior to the survey (as provided by ABP Cardiff, ABP Barry and Cardiff Harbour Authority (Cardiff CC)).	See Table 4, reported herein.

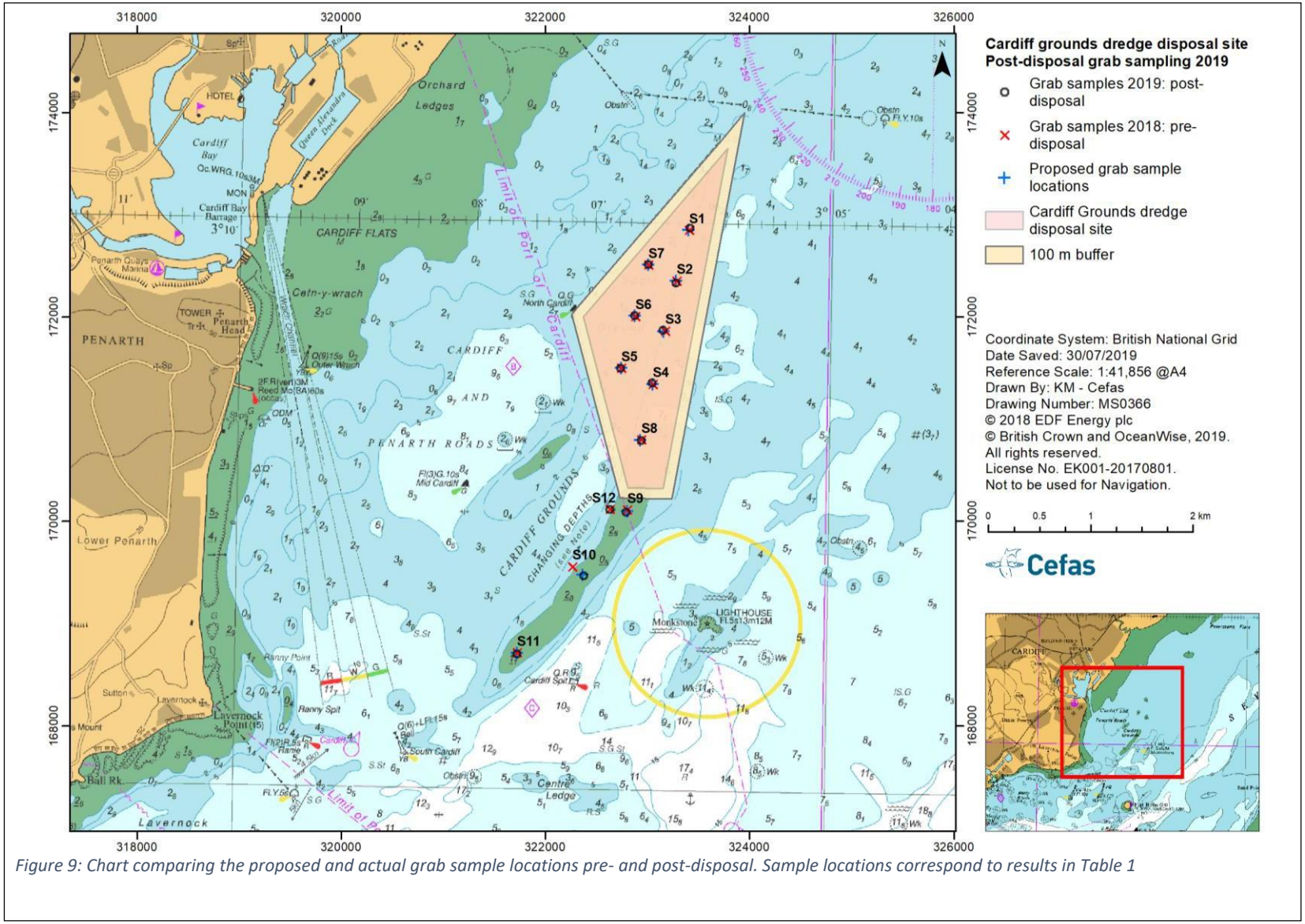

Figure 9: Chart comparing the proposed and actual grab sample locations pre- and post-disposal. Sample locations correspond to results in Table 1

References:

BEEMS Technical Report TR429. Hinkley Point C – Intake and outfall dredge disposal bathymetric survey plan. Cefas, Lowestoft.

BEEMS Technical Report TR457. Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1). Cefas, Lowestoft.

Marine Management Organisation (2017) Marine and Coastal Access Act 2009: Part 4, Marine Licence L/2013/00178/3 (as amended), case reference MLA/2012/00259/2.

Mason, C. (2016) NMBAQC's Best Practice Guidance. Particle Size Analysis (PSA) for Supporting Biological Analysis. National Marine Biological AQC Coordinating Committee, 77pp, First published 2011, updated January 2016.

Natural Resources Wales (2018) Marine and Coastal Access Act 2009: Part 4 – Marine Licencing, Marine Licence: 12/45/MLv1.

Revision	**01**	**02**	**03**	**04**	**05**	**06**	**07**
Author:	Katie Musgrave						
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Date of Evaluation:	23/05/2019	07/08/2019	01/10/2019	24/02/2020	02/03/2020	17/06/2020	26/06/2020

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A GARDLINE COMPANY

Client:
CEFAS

Project:
Cardiff Grounds Survey

Description
Bathymetry and Grab Sampling

Survey Date:
April 2019

Project Number:
CS0555

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1. Introduction

1.1 General

In April 2019 CEFAS commissioned Titan Environmental Surveys Ltd to conduct a post dumping bathymetric and grab sampling at the Cardiff Grounds Disposal Area (Area LU110). The site had recently been used for the disposal of materials dredged from an offshore development at Hinkley Point. A pre-disposal survey had previously been carried out by Titan at the site in July 2018 (Titan report CS0534).

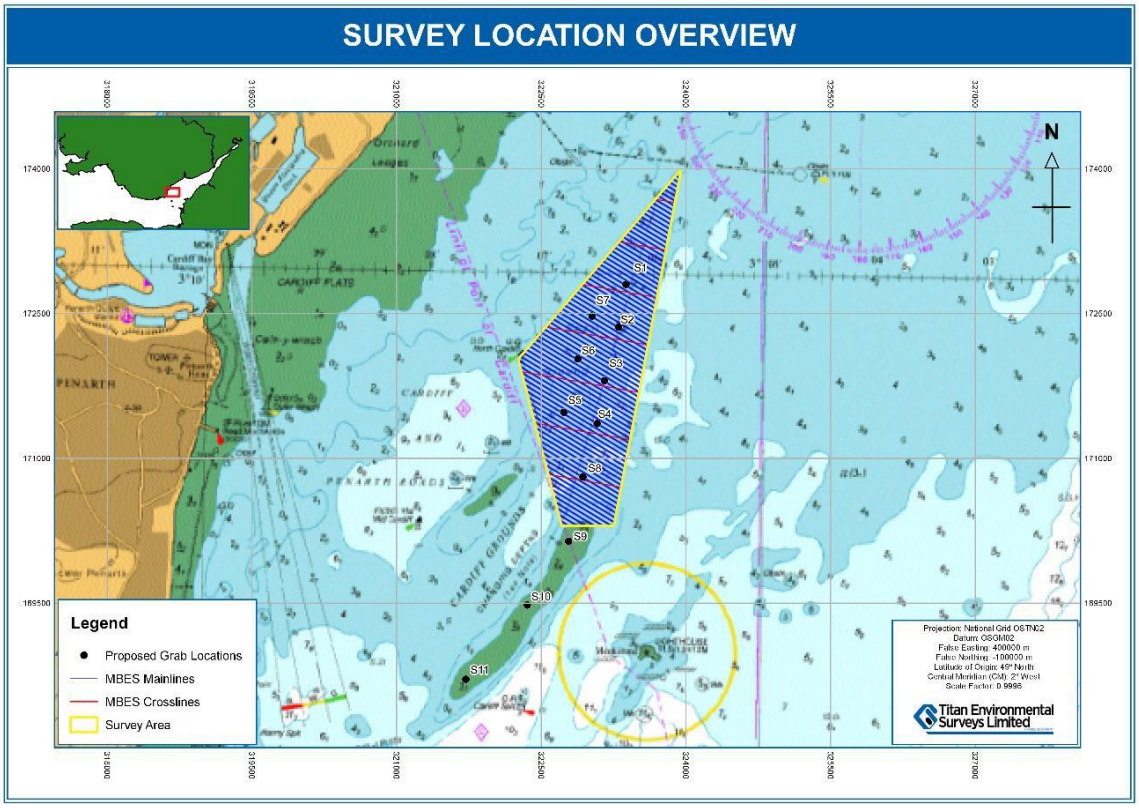


Figure 1.1 Survey Location

1.2 Scope of Work

The contract required the following objectives to be met:

- 100% multibeam bathymetry coverage with a maximum primary profile interval of 50m with cross lines at 500m
- Seabed grab samples to be collected for subsequent particle size analysis.

All raw data positioning was collected in WGS84 and transformed to OSGB36 during post processing. All co-ordinates provided in this report refer to OSGB36 and all depths relate to Chart Datum (CD).

Table 1.1 Cardiff Grounds (LU110) Survey Area

Point	Easting	Northing
1	323254	170303
2	322711	170302
3	322260	172027
4	323953	173998

(OSGB36)

The survey was carried out with primary survey profiles at 40m intervals, thus ensuring sufficient overlap of the outer swathe beams. Crosslines were run at 500m intervals. Eleven 0.5 litre Van Veen grab samples were collected and delivered to Cefas.

Table 1.2 Cardiff Grounds Grab Sample Locations

Grab Samples		
Site Number	**Easting (m)**	**Northing (m)**
1	323419	172867
2	323281	172331
3	323156	171870
4	323048	171352
5	322737	171495
6	322876	172010
7	323027	172530
8	322943	170791
9	322793	170085
10	322377	169466
11	321723	168701

(OSGB36)

1.3 Reporting

This report; CS0555_Cardiff Grounds Post Dump Survey_V4.0 details the field operations, instrumentation, data processing and presents the results of the survey.

Table 1.3 Project Deliverables

Item	Details	Location
1	Details of survey operations	Report CS0555_Cardiff Grounds Survey_V2
2	Bathymetry chart	Appendix B.1
3	A chart showing changes in bathymetry detected since the predisposal survey	Appendix B.5
4	A volume/area plot above a representative contour (e.g. 1m below chart datum)	Appendix B.3
5	A plot showing changes in volume/area detected since the predisposal survey	Appendix B.5
6	Figure of three transects (one through the centre of the disposal site along a SW – NE axis and two perpendicular cross-transects in the centre of the northern and southern sector)	Appendix B.4
7	Transect location charts	Appendix B.2
8	A chart showing the locations of the grab sampling sites	Appendix B.2
9	A table showing the coordinates of the grab sampling sites	Appendix C.1
10	A table showing the results of the particle size analysis **(N.B Requires results from CEFAS)**	Appendix C.3
11	A table showing the volumes and dates of disposal material from other sources during the 12 months prior to the survey and dates of disposal material from other sources during the 12 months prior to the survey (as provided by ABP Cardiff, ABP Barry and Cardiff Harbour Authority (Cardiff CC)) **(N.B Requires previous data to be supplied by CEFAS)**	Appendix C.4

2. Survey Operations

2.1 Personnel

Table 2.1 Key Titan Personnel

Key Personnel	
Project Manager	Chris Whitehouse
Lead Surveyor	Geraint O'Donovan

2.2 Vessel

The MV Titan Explorer (Figure 2.1) was used as the survey platform. The vessel's particulars are:

Length overall	:	9.7m
Beam	:	2.9m
Draught	:	0.8m
Engines	:	2 x 150bhp
Certification	:	MCA Category 2 (60 miles from safe haven)

An offset diagram showing the equipment arrangement has been provided in Appendix A.1

Figure 2.1 The MV Titan Explorer

2.3 Operations Summary

A summary of the principal survey activities is presented in Table 2.2. As the survey progressed, detailed Daily Progress Reports were produced and submitted to all parties concerned.

Table 2.2 Survey Activity Summary

Survey Day	Date	Activity
1	03/04/2019	Grab sampling and surveying
2	08/04/2019	Surveying
3	11/04/2019	Grab sampling and surveying
4	12/04/2019	Surveying

2.4 Health, Safety and Environment

2.4.1 Health and Safety

All work was carried out in accordance with Titan's Health and Safety Policy.

Prior to survey operations, all personnel joining the vessel were given a comprehensive safety briefing by the vessel skipper. This briefing included a detailed description of the survey work to be undertaken, all health and safety procedures aboard the vessel, and a demonstration of all safety equipment on board and its location.

Health and safety toolbox meetings were conducted and recorded to discuss specific issues associated with the vessel and the survey.

Any health and safety observations or incidents are recorded under the Gardline Group's safety framework. These are subsequently reviewed and assessed by a Titan director and Gardline's Health and Safety department. No observations were made during the project.

2.4.2 Environment

Titan recognises the importance of environmental issues. Consequently, great store has been laid upon the protection of the environment with regard to all our operations. In addition to our Health and Safety Organisation, environmental considerations are incorporated into our operations.

During this project:

- Field Staff complied with all relevant local, national and international environmental legislation, which impinge on survey activities.
- Environmental impact was reduced by the recycling of paper waste and printer cartridges; disposing of waste in a responsible manner; reducing energy use; encouraging the efficient use of our transport fleet to both optimise fuel consumption and minimise environmental emissions.

3. Reference Control

3.1 General

All times quoted in this report are in Coordinated Universal Time (UTC), all measurements are metric and all co-ordinates are referred to the OSGB36 horizontal datum. The bathymetry data has been reduced to Chart Datum (CD).

3.2 Horizontal Control

Primary positioning was achieved using an SPS852 operating in DGPS Mode. In addition, positioning of swathe data has been enhanced by post processing data via Trimble Business Centre (TBC) Software to improve positional and attitude data. Datum transformations from the WGS84 data, provided by the DGPS receivers were transferred OSGB36 using the OSTN02 grid transformation, (see Table 3.1). A Hemisphere Crescent VS110 DGPS was used as the secondary navigation system to provide real-time dynamic comparisons and quality control (QC) of the primary navigation.

Table 3.1 Project Geodetic Parameters

Navigation System Datum	**WGS84**	Semi-major axis	6378137
		Semi-minor axis	6356752.3141
		Flattening (1/f)	298.25722
Project Datum	**OSGB36: OSTN02 Transformation**	Semi-major axis	6377563.396
		Semi-minor axis	6356256.9100
		Flattening (1/f)	299.32498
Projection:			
	Projection type	OSGB36	
	Central Latitude	49°00.000'N	
	Central Longitude	2°00.000W	
	False easting	-100000	
	False northing	400000	
	Scale factor	0.9996012717	

3.3 Vertical Control

All bathymetry data has been reduced to Chart Datum using the UK Hydrographic Vertical Offshore Reference Frame (VORF) model.

4. Equipment Details and Methods

4.1 Survey Equipment Summary

Table 4.1 Navigation and Survey Equipment

Navigation and Survey Equipment Summary	
Integrated Navigation Software	Trimble HYDROPro
Primary Navigation	Trimble SPS 852
Secondary Navigation	Hemisphere Crescent VS110
Heading	Hemisphere Crescent VS110
Multibeam Echosounder	GeoAcoustics Geoswath Plus
Motion Sensor	TSS DMS-05
Sea Surface Sound Velocity Sensor	Valeport Miniature Sound Velocity Sensor
Water Column Sound Velocity Probe	Valeport Swift Sound Velocity Profiler

4.2 Integrated Navigation and Data Acquisition System: Trimble HYDROpro

Titan integrated navigation system is based on Trimble HYDROpro software operating on Windows. This is connected to the vessel's internal computer network via standard TCP/IP protocol. HYDROpro is used for the acquisition and logging of position, heading, bathymetry, positional control information, quality control information and updating of real-time data together with navigational displays. HYDROpro also has a Guidance Object creator tool which allows the user to create survey lines, routes or targets. Once combined with positioning, heading and velocity information the software can display the vessel's position, distance and track data on helmsman VDU for efficient vessel steering and guidance. When combined with high accuracy DGPS or RTK systems; HYDROpro can provide precise real time 3D positioning. All raw and computed data is time tagged to minimise real time system latency. All raw and computed data is stored in a single Microsoft Access database for efficient file management.

Titan uses HYDROpro's navigation options to convert positional data to the relevant datum, to input antenna/sensor offsets (relative to the vessel's common reference point), event triggering and graphical information display. HYDROpro was used to produced event marks at 20 second and positions at 5 metre intervals which were output to the RAW data collected in HYDROpro.

Following collection, the navigation data was edited and processed to produce a track chart for of each sensor to facilitate data interpretation.

4.3 Primary Navigation: Trimble SPS852 Dual Frequency DGPS

A Trimble SPS852 configured to receive DGPS was used as the primary navigation system. (See Table 4.2)

Table 4.2 Trimble SPS852: Specifications

Trimble SPS852	
Channel	72 Channel L1 C/A code
Horizontal Accuracy	0.25 m +1 ppm RMS (DGPS)
Vertical Accuracy	0.5 m +1 ppm RMS (DGPS)
Precise Heading	0.09° (2 m antenna spacing) 0.05° (10 m antenna spacing)
Initialization time	Typically <10 seconds >99%

4.3.1 Differential Mode (EGNOS)

The Trimble SPS852 system was configured to receive differential corrections from satellite transmissions. This uses Satellite Based Augmentation Systems (SBAS) and EGNOS, consisting of a network of ground reference stations and a number of geostationary satellites broadcasting GPS band signals. This provides corrections that increase the reliability, integrity and precision of the GPS solution.

4.4 Secondary Navigation: Hemisphere Crescent VS110 DGPS

A Hemisphere Crescent VS110 DGPS was used as the secondary navigation system. The system consists of two GPS antennae using a moving base station RTK technique. The system operates in either beacon or EGNOS mode. The system provided a real-time comparison of the primary navigation for QC purposes.

The specifications for the system are in Table 4.3.

Table 4.4.3 Hemisphere Crescent VS110 DGPS: Specifications

Hemisphere Crescent VS110	
Horizontal Accuracy	<0.60 m 95% confidence (DGPS)
Heading Accuracy	<0.30° RMS (0.5 m antenna separation) <0.15° RMS (1.0 m antenna separation) <0.10° RMS (2.0 m antenna separation)
Pitch/Roll Accuracy	<1.00° RMS (0.5 m antenna separation)

4.5 Heading: Hemisphere VS110 DGPS Compass

A Hemisphere Crescent VS110 Compass system was used as the primary heading system. The Hemisphere Crescent comprises of two GPS antennae that use a moving base station RTK technique to provide heading information. The specifications for the system are presented in Table 4.4.

Table 4.4.4 Hemisphere Crescent VS110 Compass: Specifications

Hemisphere Crescent VS110 (Heading)	
True Heading	0.03° with 2m baseline

4.6 Multibeam Echosounder: Geoswath Plus

A GeoSwath Plus system operating at 250kHz was used to collect MBES data. The instrument is capable of meeting IHO Special Order specifications of swathe width up to 6 times water depth. The system consisted of two transducers, a processing unit and an operating station. The transducers were transit mounted on a rigid 'v-plate' frame alongside a miniature sound velocity sensor (mini-SVS) and a miniature altimeter

During acquisition, the swathe data was displayed in real time to enable data quality and coverage to be monitored. The GeoSwath Plus system was interfaced to a GeoSwath 4 acquisition system that collected the data in a RAW format, together with navigation data, sea surface sound velocity and altitude data. (See Table 4.5).

Table 4.4.5 GeoSwath Plus MBES: Specifications

GeoSwath Plus MBES	
Frequency	250 kHz
Swathe Update Rate	30 swathes/sec
Resolution	0.003 m
Slant Range Resolution	0.05 m
Two way Beam Width	0.75° Azimuth

A TSS Dynamic Motion Sensor MRU unit was mounted directly over the MBES system to minimise lever arm correction offset. Heave, pitch and roll values were recorded within the MBES acquisition system and used in real-time to correct the swathe data. To improve dynamic performance, the unit was provided with position, heading and velocity data directly from the Hemisphere VS110 secondary positioning system.

4.6.1 Sea Surface Sound Velocity Sensor: Valeport Miniature Sound Velocity Sensor

A Valeport mini-SVS was mounted onto the bathymetry system to record continuous real-time sound velocity. The values from the sensor were applied directly into the bathymetry user interface. (See Table 4.6).

Table 4.6 Valeport Miniature Sound Velocity Sensor: Specifications

Valeport Miniature Sound Velocity Sensor	
Velocity Range	1400 ms^{-1} – 1600 ms^{-1}
Velocity Resolution	0.001 ms^{-1}

Velocity Accuracy	±0.06 ms^{-1}

4.6.2 Water Column Acoustic Velocity Sensor: Valeport SWiFT Sound Velocity Profiler

A Valeport SWiFT Sound Velocity Probe (Swift SVP) was deployed to record vertical sound velocity profiles throughout the water column and as a quality control against the transducer mounted mini-SVS. The unit was a self-recording/direct reading instrument, which allowed readings to be taken at 0.5m depth intervals. The data was downloaded as text files and uploaded into GeoSwath. (See Table Table 4.7).

Table 4.7 Valeport SWiFT Profiler: Specifications

Valeport SWiFT sound Velocity Profiler: Technical Specifications	
Velocity Range	1375 ms^{-1} – 1900 ms^{-1}
Velocity Resolution	0.001 ms^{-1}
Velocity Accuracy	±0.02 ms^{-1}
Pressure Range	10 or 20 Bar
Pressure Resolution	0.001% FS
Pressure Accuracy	±0.05% FS
Temperature Range	-5° to +35°C
Temperature Resolution	0.001°C
Temperature Accuracy	±0.01°C

4.7 Seabed Sampling: Van Veen Grab

Eleven 0.5 litre Van Veen grab samples were collected at specified sites across the disposal area. The samples were sealed onboard and subsequently delivered to CEFAS for particle size analysis.

The logs of the grab samples can be found in Appendix C.1

5. Calibration and Verification

5.1 Navigation Quality Control

5.1.1 Static Navigation Verification

A navigation calibration was carried out on 09/04/2019, whilst the vessel was alongside in Mermaid Quay Marina, Cardiff. GPS antenna positions were logged for approximately 1.5 hours enabling a comparison of the positions derived from the primary and secondary navigation systems. The positions derived from the two systems had an average difference in position of 0.36m in Easting and 0.62m in Northing, (see Figure 5.1). Further information can be found in Appendix A.2.

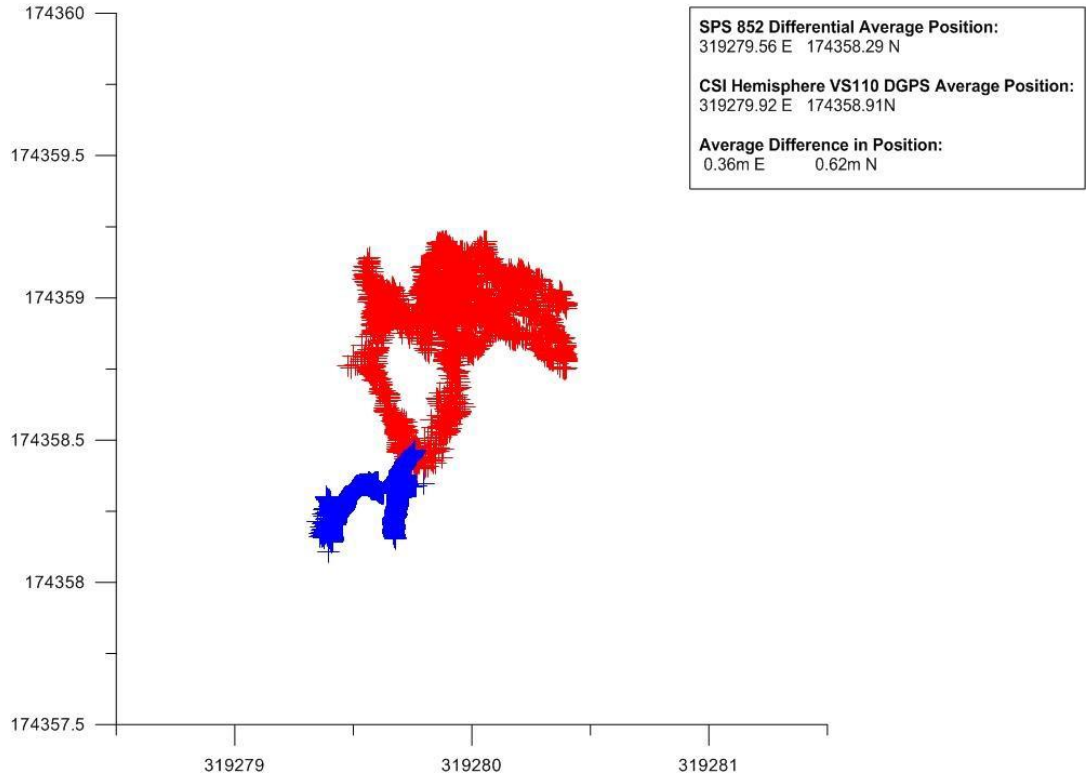


Figure 5.1 Navigation Static Verification Scatter Plot

5.1.2 Absolute Accuracy, Dynamic Verification

During the survey, comparisons were made between the primary and secondary navigation systems. Analysis produced average differences of 0.573m in easting and 0.685m in northing between the two systems confirming the accuracy of the primary navigation system.

Client: CEFAS
Project Title: Cardiff Grounds Survey
Titan Report Ref: CS0555 V4

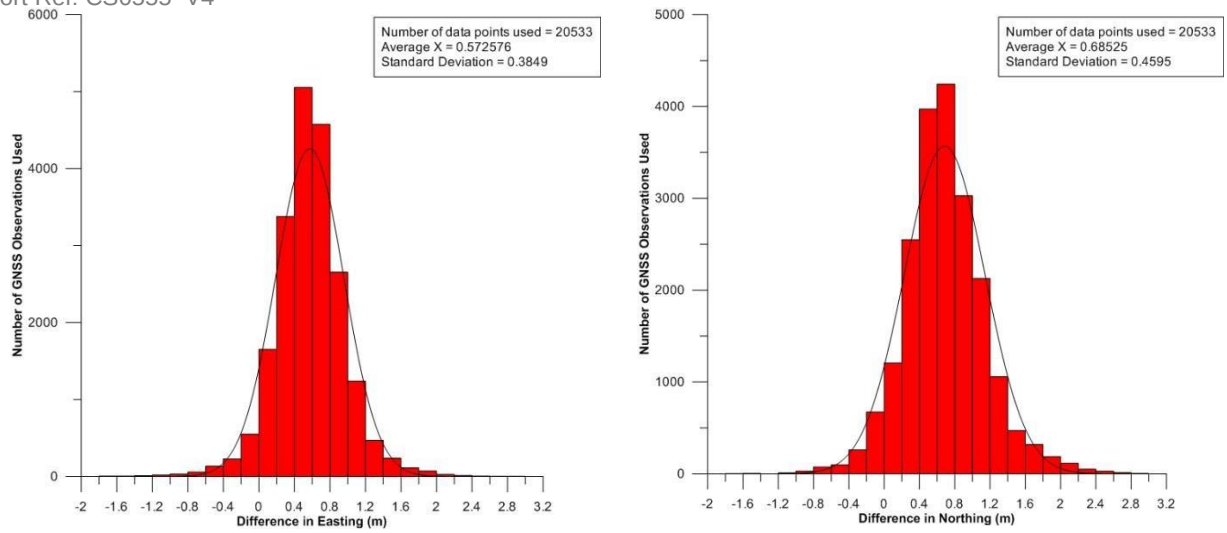


Figure 5.2 Comparison of Eastings and Northings between the Primary and Secondary Navigation Systems

Throughout the survey GPS quality figures were logged for each fix. These figures were processed and presented in tabulated form to enable positional verification. Sigma figures are generated for the North, East and Up axes. Each individual sigma display was a probability estimate of how close the actual position was to the GPS displayed position. Given the sigma values for a position fix, it is possible to construct an error ellipse; this is a graphical representation of the position fix, displaying the indicated GPS position at the centre of the ellipse with the relevant sigma error ellipse centred on this position (Figure 5.3). The 1-sigma error ellipse represented the probability that a position fix was within 68% of the indicated position and the two-sigma error ellipse represented the chance of a position fix being within 86.4% of the indicated position.

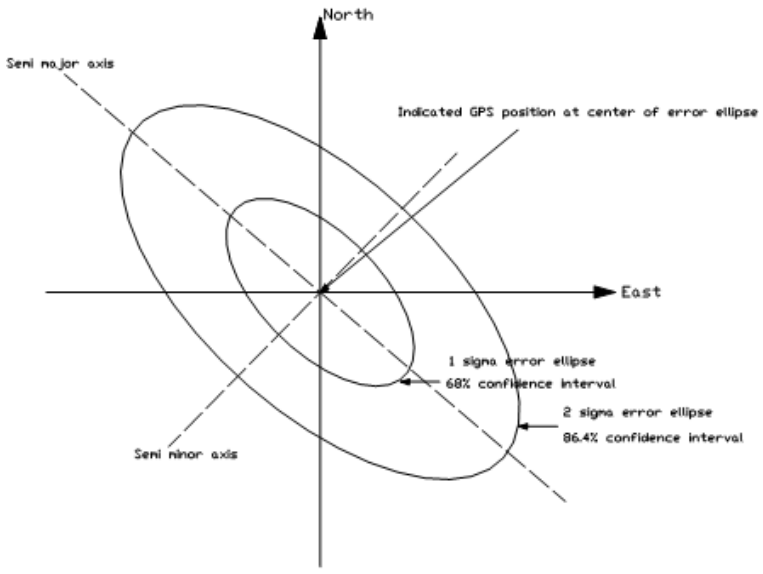


Figure 5.3 Schematic Diagram of a Two-Sigma Error Ellipse

Figure 5.4 below displays histograms of the Sigma East and Sigma North values recorded for the primary navigation during the survey. Average Sigma East and North values were recorded as 0.32m and 0.40m respectively.

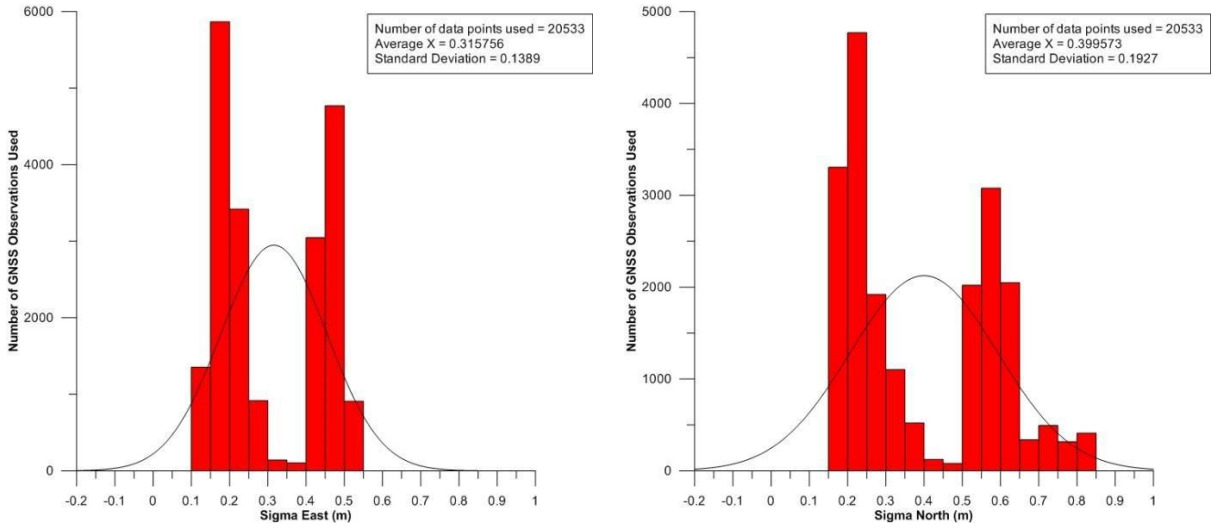


Figure 5.4 Primary Navigation, Sigma East and Sigma North.

5.1.3 Heading Verification

A heading calibration was conducted alongside the navigation calibration. This enabled a direct comparison of the primary heading system against the known heading of the berth, see Figure 5.5. Further information can be found Appendix A.3.

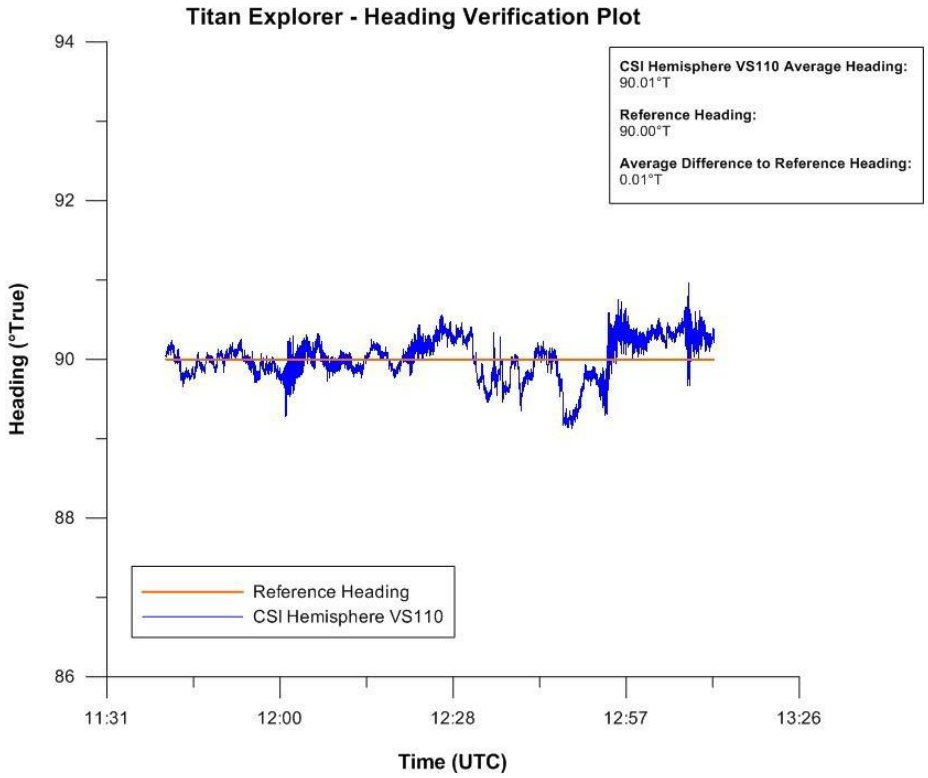


Figure 5.5 Heading Verification Plot

5.2 Swathe Calibration – Patch Test

A patch test was completed on 10/01/2019 to establish the correct motion sensor offset angles for the MBES system. The patch test consisted of the motion sensor offset values in the acquisition software being set to 0.00 and running the standard set of patch test lines. Latency was negated using a 1 PPS string from the primary navigation to ensure timings with the MBES system were synchronised to GPS time; thus, making the latency 0.00s.

Table 5.1 Swathe Calibration Results

	Port	Starboard
Latency	0.00s	0.00s
Roll	+1.69	-1.14
Yaw	+3.35	+3.50
Pitch	+0.26	+0.17

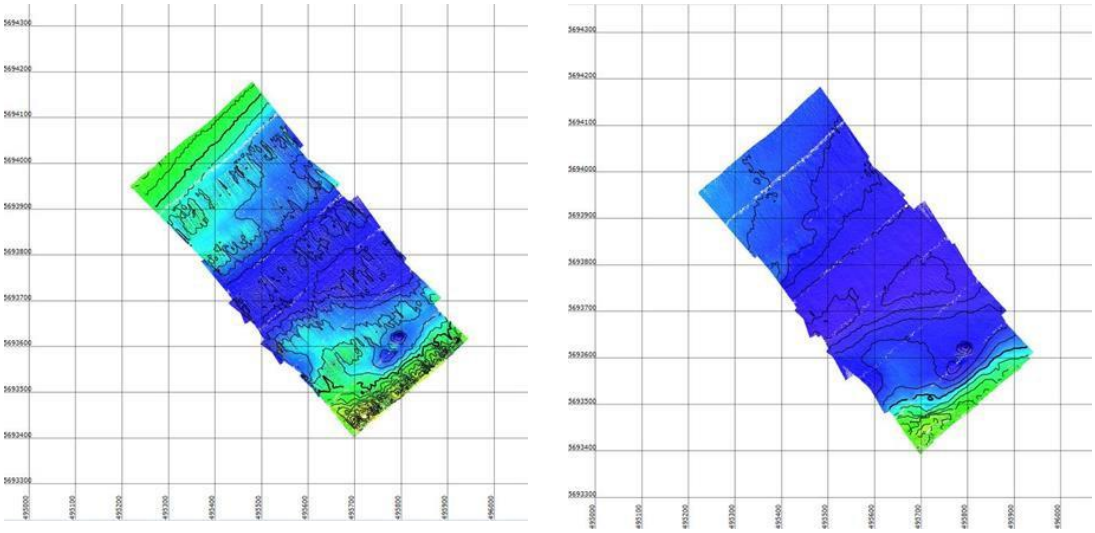


Figure 5.6 Pre and Post Roll Calibration Results

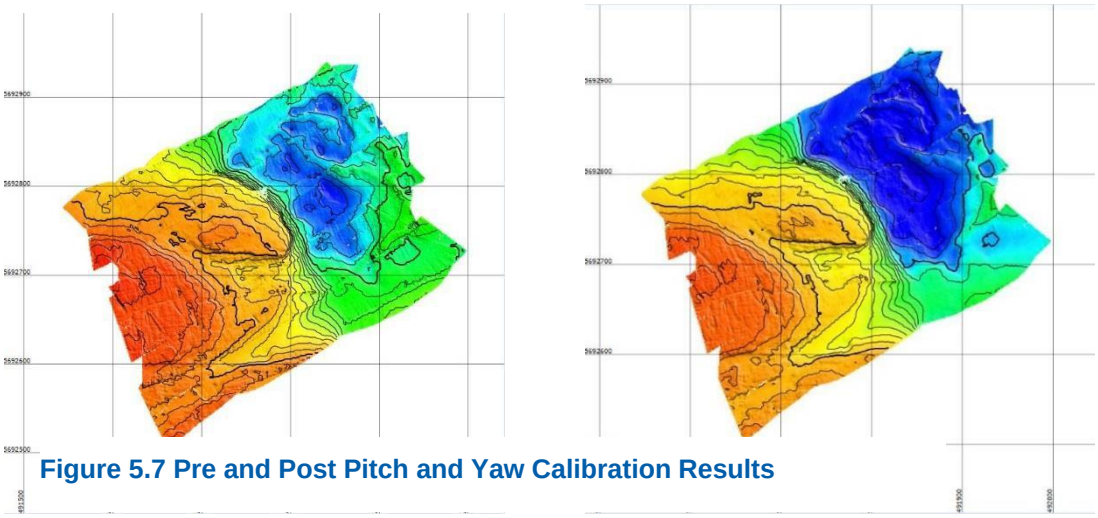


Figure 5.7 Pre and Post Pitch and Yaw Calibration Results

6. Data Processing

6.1 Post Processed Kinematic Tide: Trimble Business Centre Software

Observed tidal heights from the SPS system were processed using Trimble Business Centre software (TBC) to derive a PPK tide, which was later used to reduce bathymetry data to Chart Datum.

VRSNow Rinex Continuously Operating Reference Stations (CORS) data were downloaded for the Cardiff station.

TBC was used to combine the CORS data with the rover location in post-processing, providing accurate co-ordinates of the survey vessel at 1 second intervals. The derived GPS antenna elevation data was to OSTN02 and reduced to Chart Datum. Total station measurement was used to measure antenna height above the water surface.

Derived tidal elevations were smoothed using a spline smoothing routine within Turtle (Titan's proprietary tidal processing software). The tidal elevations were quality controlled through comparisons against predicted tides for Barry, Cardiff and Newport

6.2 Multibeam Bathymetry Processing; GeoSwath 4

A GeoSwath 4 (GS4) processing package was used to process the swathe bathymetry data. The package allowed data acquisition and storage, calibration, data cleaning processing and gridding for final exports. Within GS4, the RAW bathymetry data had all offsets applied, as well as calibration values for heave, pitch and roll. 1PPS time correction was applied to remove any latency in the system.

Corrections for variations in the propagation of sound in seawater (derived from the velocity profiles) were applied to the data during processing (Table 6.1).

Table 6.1 Sound Velocity Profile Statistics

Sound Velocity Profile Summary	
Mean Depth of Profile	10.6 m
Mean Sound Velocity	1461.4 ms^{-1}
Min Sound Velocity	1472.1 ms^{-1}
Max Sound Velocity	1477.9 ms^{-1}
Mean Surface Velocity	1475.5 ms^{-1}
Mean Max-Depth Velocity	1475.0 ms^{-1}

During processing a combination of amplitude, limits, along and across track filters were applied to the bathymetry data, allowing the production of an accurate final product. GS4 allows the user to apply spike removal, interpolation and smoothing filters to the gridded

product. The grid was then exported in. xyz and. grd format in the bin sizes required for charting.

Titan has a vigorous Quality Control and Quality Assurance process to ensure that at all stages of processing the correct steps have been taken and key information is recorded.

7. Results

7.1 PSA

At the time of writing, PSA results were not available for insertion into this report.

7.2 Volumes

After volumetric analysis undertaken by the client, Titan were requested to investigate a potential vertical offset between the 2018 and 2019 data sets. During the data review from both years a processing error of +8.5cm was found in the 2019 dataset. This was due to an incorrect antenna height used during the processing of the GPS tide. Consequently 8.5cm has been subtracted from the 2019 datasets; charts and volumes have been recalculated and updated.

Titan consider that during both surveys the swathe bathymetry systems onboard the Titan Endeavour (2018) and Titan Explorer (2019) operated within their manufactures specifications. Any remaining differences between the two surveys are within the equipment specification, due to natural environmental variation or from sediment accretion as part of spoil dumping.

The volume changes within disposal ground can be found in Appendix B.6

APPENDIX A

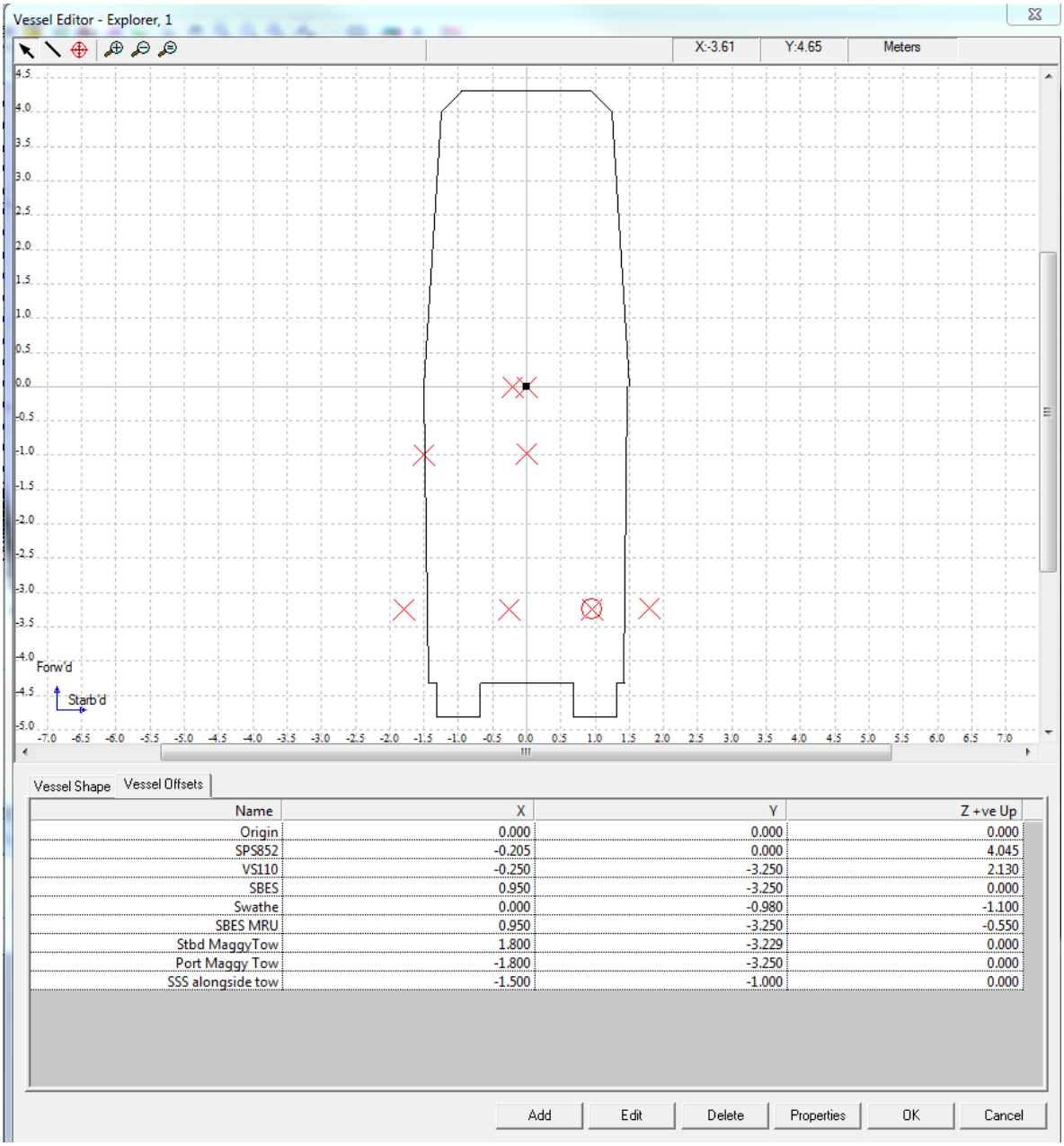
TITAN QUALITY ASSURANCE

A.1 MV TITAN EXPLORER VESSEL OFFSET DIAGRAM

TQA042 Vessel Offset Diagram

Client:	CEFAS	**Project Name:**	Cardiff Ground Post Dump Survey
Project Code:	CS0555	**Personnel:**	GOD ST CF
Vessel:	MV Titan Explorer		

Diagram:



Name	X	Y	Z +ve Up
Origin	0.000	0.000	0.000
SPS852	-0.205	0.000	4.045
VS110	-0.250	-3.250	2.130
SBES	0.950	-3.250	0.000
Swathe	0.000	-0.980	-1.100
SBES MRU	0.950	-3.250	-0.550
Stbd MaggyTow	1.800	-3.229	0.000
Port Maggy Tow	-1.800	-3.250	0.000
SSS alongside tow	-1.500	-1.000	0.000

A.2 NAVIGATION VERIFICATION

Titan Environmental Surveys Limited A GARDLINE COMPANY		**TQA017a Navigation Verification Form**	
Client:	CEFAS	**Project Name:**	Cardiff Grounds Survey
Project Code:	CS0555	**Personnel:**	GOD ST CF

Occupied Station:	MV Titan Explorer	**Station Code:**	TEx
Network Info:		**Date Occupied:**	09/04/2019
Datum:	OS National Grid (OSTN02)	**Ellipsoid:**	Airy 1830

Primary Equipment Used:			
Receiver:	Trimble SPS 852	**Differential Mode:**	DGPS
Frequency:	N/A	**Differential Station**	EGNOS

Secondary Equipment Used:			
Receiver:	CSI Hemisphere VS110	**Differential Mode:**	DGPS
Frequency:	N/A	**Differential Station**	EGNOS

Scatter Plot:

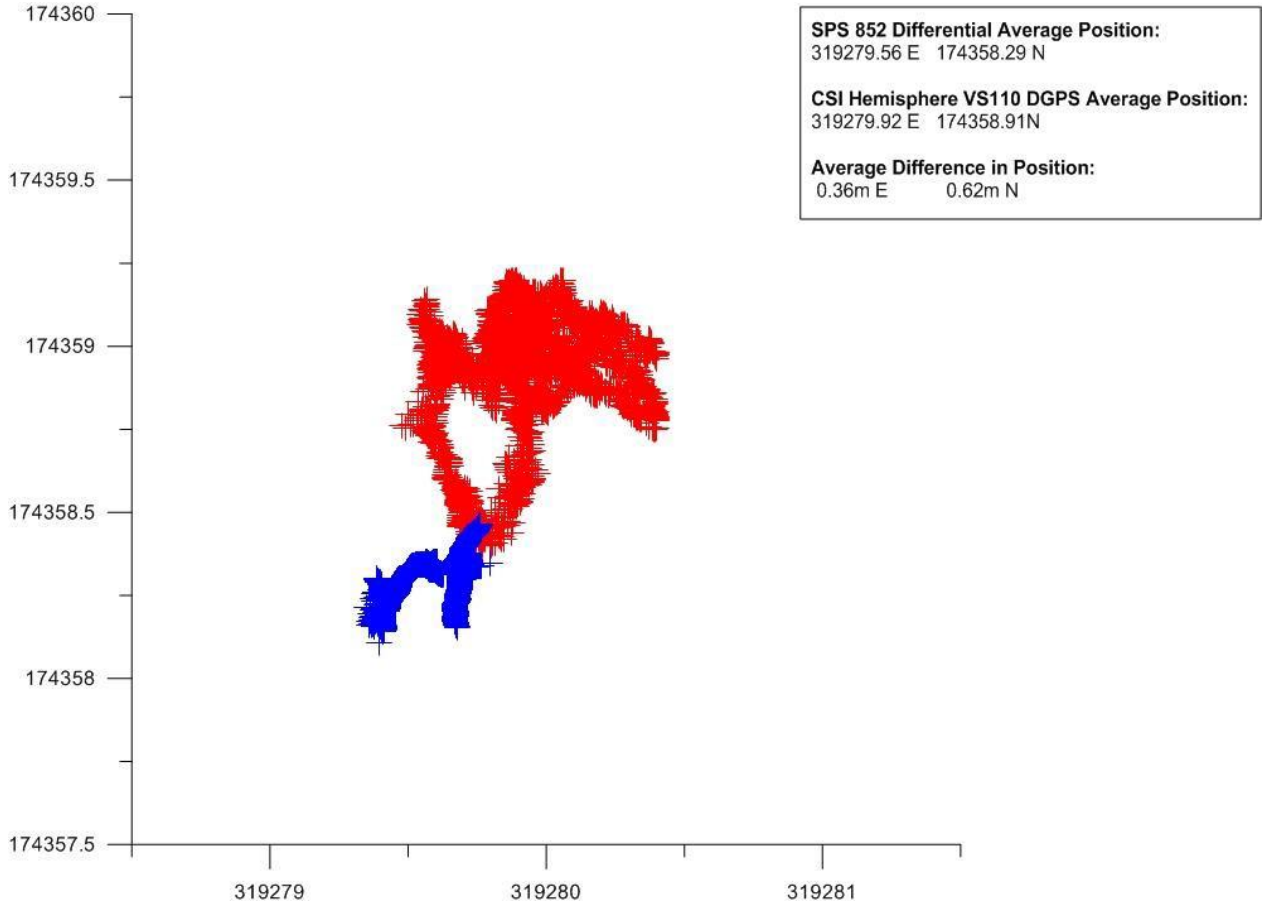


Figure 1: Comparison of Static Position between PosMV DGPS and CSI VS110 DGPS.

Histograms:

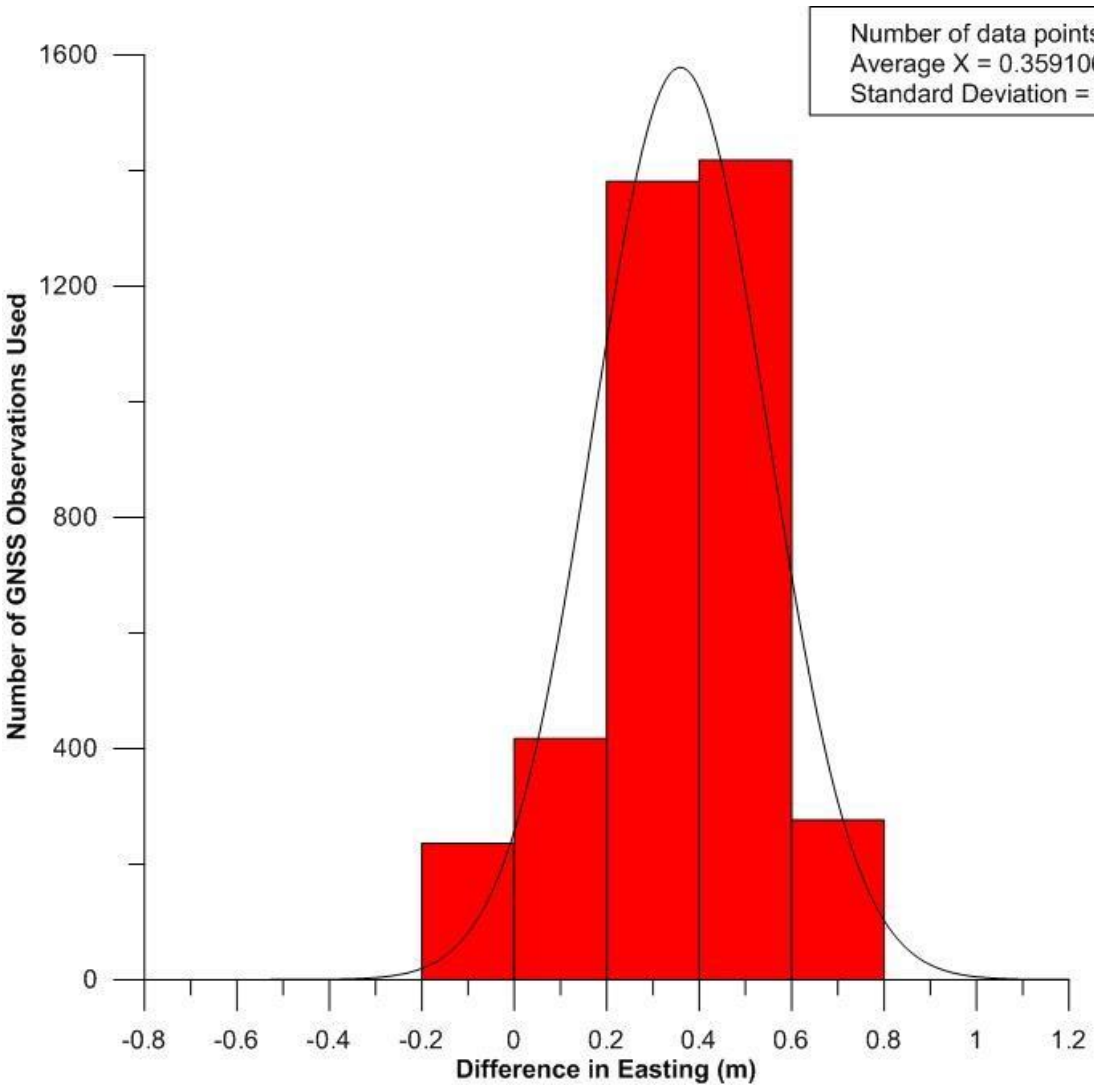


Figure 2: Comparison of Delta East

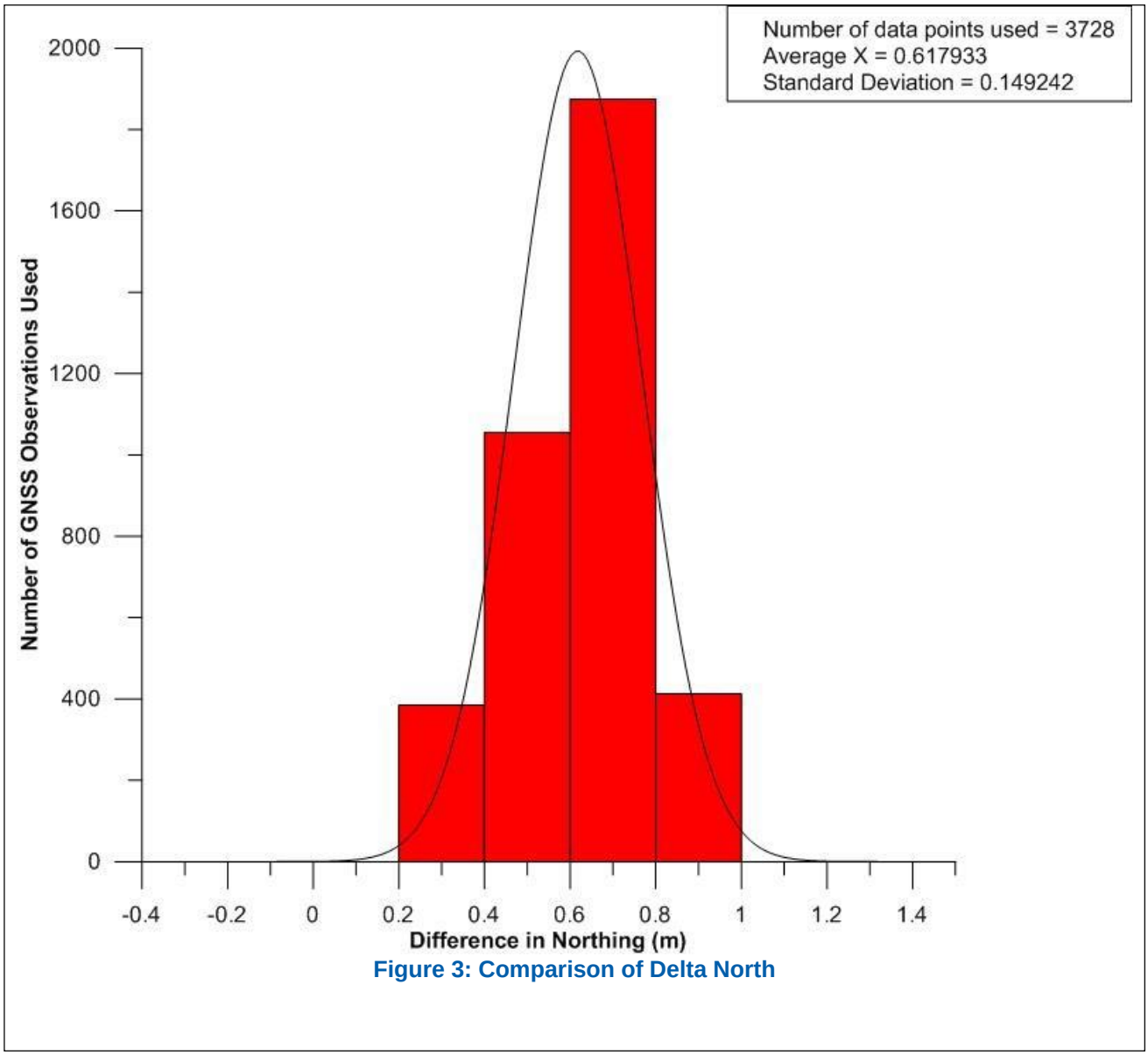


Figure 3: Comparison of Delta North

A.3 GYRO VERIFICATION

Titan Environmental Surveys Limited
A GARDLINE COMPANY

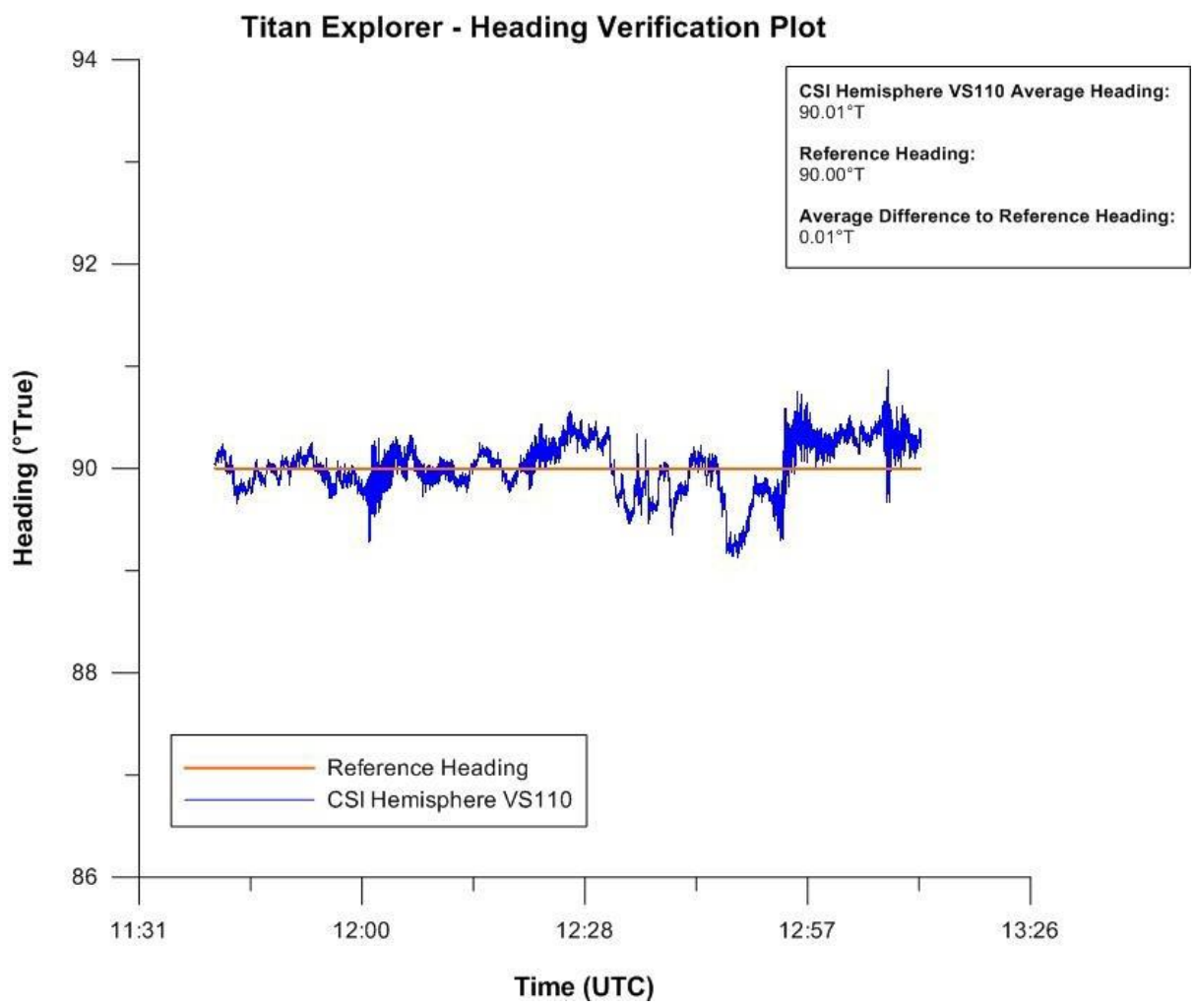
TQA038 Gyro Verification Form

Client:	CEFAS	**Project Name:**	Cardiff Grounds Post Dump Survey
Project Code:	CS055	**Personnel:**	GOD ST CF

Occupied Station:	MV Titan Explorer	**Station Code:**	TEx
Network Info:		**Date Occupied:**	09/04/2019
Datum:	OS National Grid (OSTN02)	**Ellipsoid:**	Airy 1830

Primary Equipment Used:	
Heading:	Hemisphere Crescent VS110

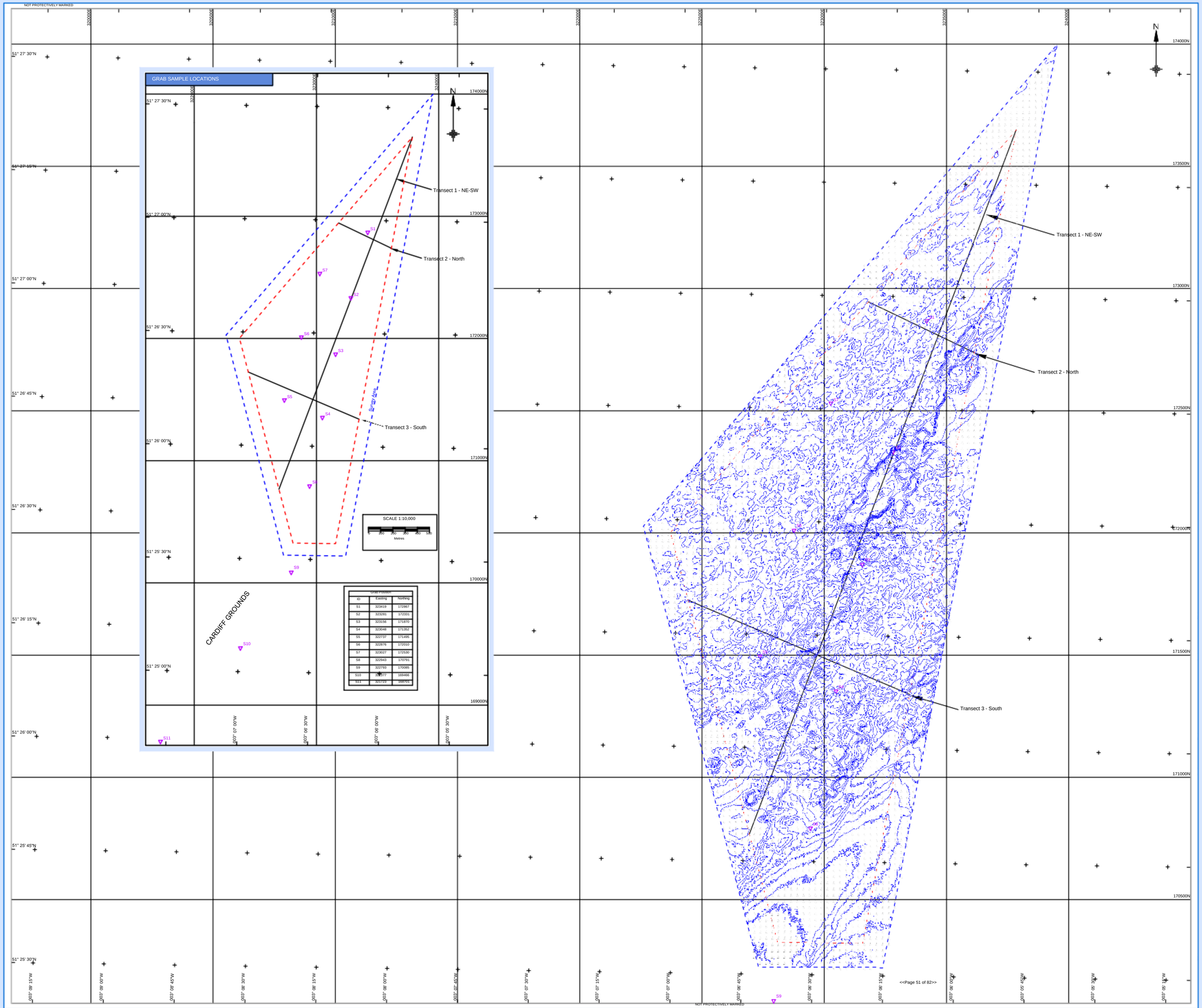
Time Series Plot:



APPENDIX B

CHARTS

B.1 BATHYMETRY



LEGEND

Revision 7

- Disposal Area - LU110
- Survey area (LU110 + 100m buffer)
- Grab sample
- Soundings in metres and decimetres reduced to Chart Datum (all depths are above CD)
- Isobaths at 1m intervals (CD)

NOTES

1. All Depths are reduced to Chart Datum (CD) using PPK tides and the Vertical Offset Reference Frame (VORF) model.
2. Contours generated using Fledermaus.
3. Following detailed analysis, bathymetry depths from 2019 have been increased by 8.5cm.
4. Survey area supplied by CEFAS. (tr429_hpc-intake-and-outfall-dredge-disposal-bathymetric-survey-plan-prel-v600.doc)

LU110 - Disposal Area

Point	Easting	Northing
A	322808	170326
B	322370	172002
C	323785	173649
D	323156	170321

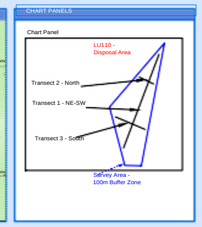
5. Transect co-ordinates below:

Transect Locations

Point	Start Easting	Start Northing	End Easting	End Northing
Transect 1 - NE-SW	322693	170766	323785	173649
Transect 2 - North	323181	172946	323614	172738
Transect 3 - South	322442	171725	323349	171340

GENERAL AREA

CHART PANELS



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM	: OSGB(36)	**PROJECTION**	: O.S. National Grid
ELLIPSOID	: AIRY	FALSE EASTING	: 400,000m
SEMI MAJOR AXIS	: 6377563.396	FALSE NORTHING	: -100,000m
INVERSE FLATTENING	: 299.325	LATITUDE OF ORIGIN	: 49° 00' 00.00" North
TRANSFORMATION	: WGS84-OSGB36 using OSTN02 Model	CENTRAL MERIDIAN (CM)	: 02° 00' 00.00" West
		SCALE FACTOR AT CM	: 0.99960127

SURVEY INFORMATION

SURVEY VESSEL	: MV TITAN EXPLORER
SURVEY DATE	: 03-APR-2019 TO 12-APR-2019
POSITIONING SYSTEM	: TRIMBLE SPS852 HEMISPHERE CRESCENT VS110
ECHO SOUNDER (MULTI-BEAM SYSTEM)	: GEOACOUSTICS GEOSWATH PLUS

SCALE (AO ORIGINAL)

MAIN CHART SCALE 1:5000

0 100 200 300 400 500 Metres

TITLE

Titan Environmental Surveys Limited
ORCHARD HOUSE, ENDEAVOUR PARK, WATERTON INDUSTRIAL ESTATE,
BRIDGEND, CF31 3BQ. TEL: +44 (0) 1656 673673

Cefas

CARDIFF GROUNDS
BATHYMETRY AND GRAB SAMPLING SURVEY

BATHYMETRY

APRIL 2019

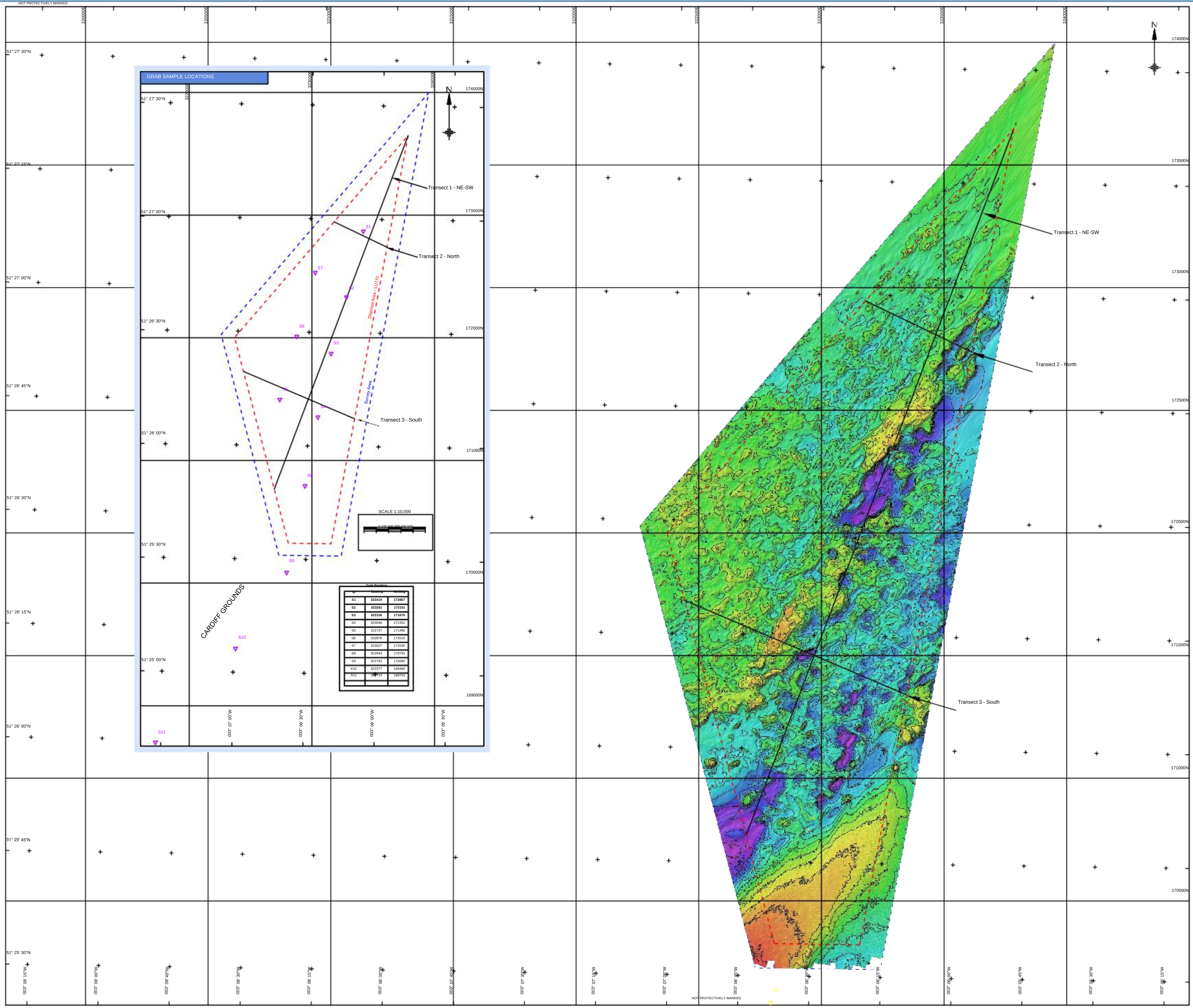
REVISIONS

REV	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	15-May-2019	FINAL	TES	CA	VG	VG
1	19-Feb-2020	Bathymetry adjustment	TES	CA	FD	FD

PROJECT REF. CS0555 **DRAWING REF.** CS0555A011 **APPENDIX NO.** **CHART NO.** 1 of 1

B.2 SEA BED RELIEF

HPC-DEV024-XX-000-RET-100119
Revision 7



Grab Position

ID	Easting	Northing
S1	**323419**	**172867**
S2	**323281**	**172331**
S3	**323156**	**171870**
S4	323048	171352
S5	322737	171495
S6	322876	172010
S7	323027	172530
S8	322943	170791
S9	322793	170085
S10	322377	169466
S11	321723	168701

LEGEND

- Disposal Area - LU110
- Survey area (LU110 + 100m buffer)
- Grab sample
- Isobaths at 1m intervals (CD)

Colour Palette (metres CD)

-2, 0, 2, 3, 5, 6, 8, 10

NOTES

1. Contours and image generated using Fledermaus.
2. Survey area supplied by CEFAS.
3. Following detailed analysis, bathymetry depths from 2019 have been increased by 8.5cm.
4. (tr429_hpc-intake-and-outfall-dredge-disposal-bathymetric-survey-plan-prel-v600.doc)

LU110 - Disposal Area

Point	Easting	Northing
A	322808	170326
B	322370	172002
C	323785	173649
D	323156	170321

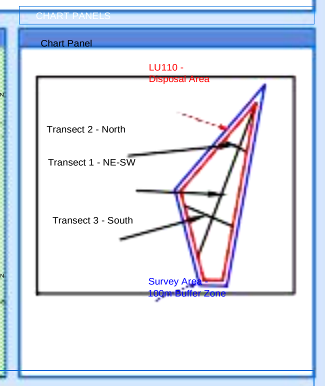
5. Transect co-ordinates below:

Transect Locations

Point	Start Easting	Start Northing	End Easting	End Northing
Transect 1 - NE-SW	322693	170766	323785	173649
Transect 2 - North	323181	172946	323614	172738
Transect 3 - South	322442	171725	323349	171340

GENERAL AREA

CHART PANELS



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM	OSGB(36)	**PROJECTION**	O.S. National Grid
ELLIPSOID	AIRY	FALSE EASTING	400,000m
SEMI MAJOR AXIS	6377563.396	FALSE NORTHING	-100,000m
INVERSE FLATTENING	299.325	LATITUDE OF ORIGIN	49° 00' 00.00" North
TRANSFORMATION	WGS84-OSGB36 using OSTN02 Model	CENTRAL MERIDIAN (CM)	02° 00' 00.00" West
		SCALE FACTOR AT CM	0.99960127

SURVEY INFORMATION

SURVEY VESSEL	MV TITAN EXPLORER
SURVEY DATE	03-APR-2019 TO 12-APR-2019
POSITIONING SYSTEM	TRIMBLE SPS852 HEMISPHERE CRESCENT VS110
ECHO SOUNDER (MULTI-BEAM SYSTEM)	GEOACOUSTICS GEOSWATH PLUS

SCALE (A0 ORIGINAL)

MAIN CHART SCALE 1:5000

0 100 200 300 400 500 Metres

Titan Environmental Surveys Limited

Cefas

CARDIFF GROUNDS
BATHYMETRY AND GRAB SAMPLING SURVEY

SEABED RELIEF

APRIL 2019

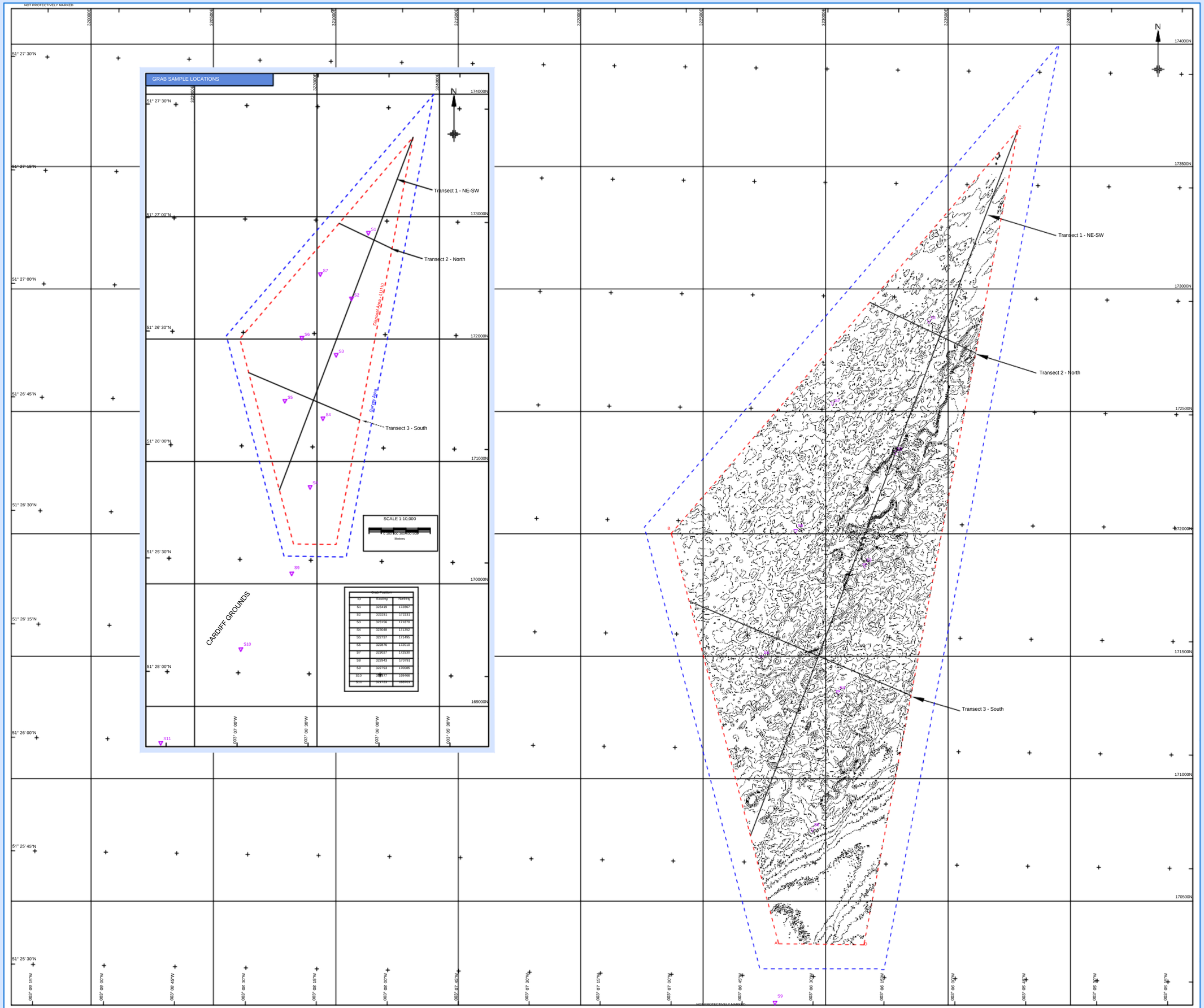
REVISION

REV	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	15-May-2019	FINAL	TES	CA	VG	VG
1	19-Feb-2020	Bathymetry adjustment	TES	CA	FD	FD
				B.2		

PROJECT REF. CS0555 | **DRAWING REF.** CS0555A021 | **APPENDIX NO.** | **CHART NO.** 1 of 1

B.3 ISOCHORES ABOVE 12M ISOBATH

HPC-DEV024-XX-000-RET-100119
Revision 7



NOT PROTECTIVELY MARKED

LEGEND

- Disposal Area - LU110
- Survey area (LU110 + 100m buffer)
- Grab sample
- Isochores at 1m intervals (from seabed to 12m CD isobath)

NOTES

1. Contours and image generated using Fledermaus.
3. Following detailed analysis, bathymetry depths from 2019 have been increased by 8.5cm.
4. Survey area supplied by CEFAS. (tr429_hpc-intake-and-outfall-dredge-disposal-bathymetric-survey-plan-prel-v600.doc)

LU110 - Disposal Area

Point	Easting	Northing
A	322808	170326
B	322370	172002
C	323785	173649
D	323156	170321

5. Transect co-ordinates below:

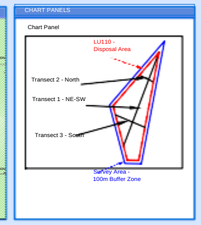
Transect Locations

Point	Start Easting	Start Northing	End Easting	End Northing
Transect 1 - NE-SW	322693	170766	323785	173649
Transect 2 - North	323181	172946	323614	172738
Transect 3 - South	322442	171725	323349	171340

6. **This chart presents isochores (true vertical thickness contours) between the seabed and the level of the 12m CD isobath. The volume above this level is 15,963,953m³. The deepest depth encountered during the survey was 10.7m CD.**

GENERAL AREA

CHART PANELS



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM	OSGB(36)	**PROJECTION**	O.S. National Grid
ELLIPSOID	AIRY	FALSE EASTING	400,000m
SEMI MAJOR AXIS	6377563.396	FALSE NORTHING	-100,000m
INVERSE FLATTENING	299.325	LATITUDE OF ORIGIN	49° 00' 00.00" North
TRANSFORMATION	WGS84-OSGB36 using OSTN02 Model	CENTRAL MERIDIAN (CM)	02° 00' 00.00" West
		SCALE FACTOR AT CM	0.99960127

SURVEY INFORMATION

SURVEY VESSEL	MV TITAN EXPLORER
SURVEY DATE	03-APR-2019 TO 12-APR-2019
POSITIONING SYSTEM	TRIMBLE SPS852 HEMISPHERE CRESCENT VS110
ECHO SOUNDER (MULTI-BEAM SYSTEM)	GEOACOUSTICS GEOSWATH PLUS

SCALE (AO ORIGINAL)

MAIN CHART SCALE 1:5000

0 100 200 300 400 500 Metres

TITLE

Titan Environmental Surveys Limited
ORCHARD HOUSE, MARC ENTERPRISE, MARCROSS INDUSTRIAL ESTATE, BRIDGEND, CF31 3BQ. TEL: +44 (0) 1656 673673

Cefas

CARDIFF GROUNDS
BATHYMETRY AND GRAB SAMPLING SURVEY

ISOCHORES ABOVE 12M ISOBATH

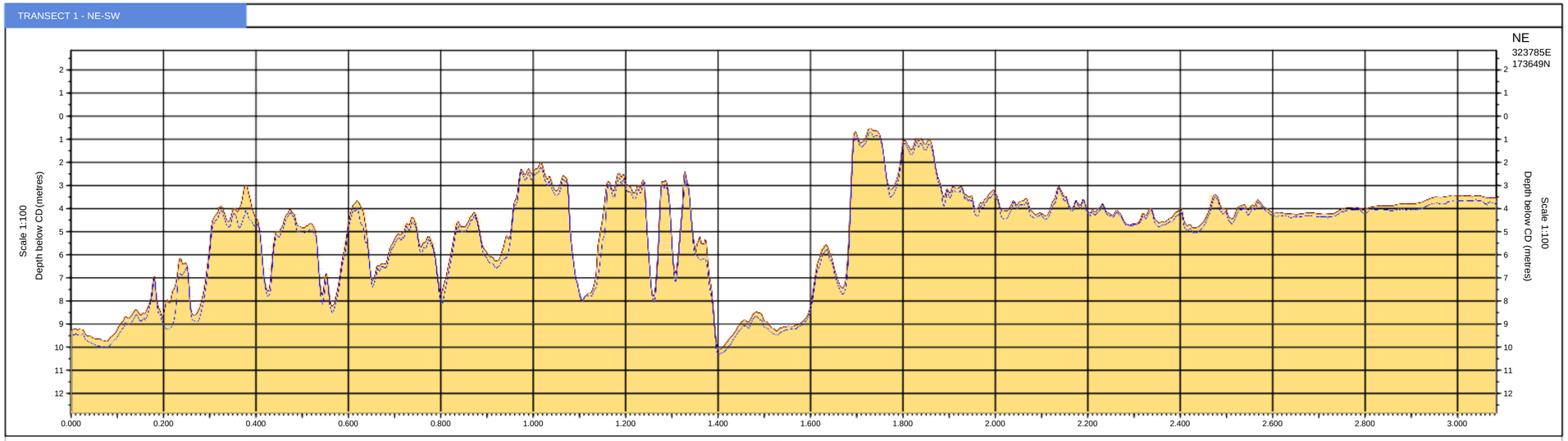
APRIL 2019

REV	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	15-May-2019	FINAL	TES	CA	VG	VG
1	19-Feb-2020	Bathymetry adjustment	TES	CA	FD	FD

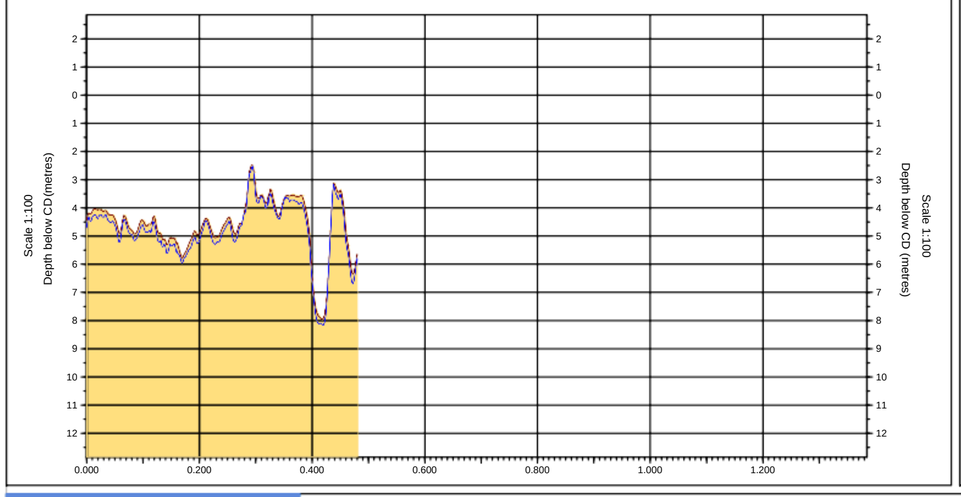
PROJECT REF. CS0555 **DRAWING REF.** CS0555A031 **APPENDIX NO.** B.3 **CHART NO.** 1 of 1

B.4 BATHYMETRY TRANSECTS

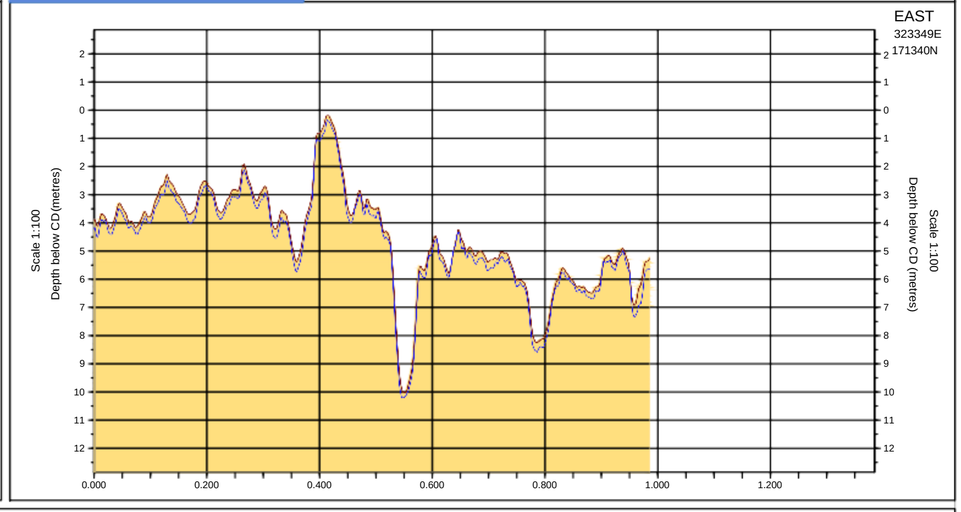
TRANSECT 1 - NE-SW



TRANSECT 2 - NORTH



TRANSECT 3 - SOUTH



LEGEND

General

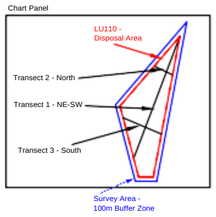
- Seabed profile to Chart Datum - 2019 (Titan CS0555)
- Seabed profile to Chart Datum - 2018 (Titan CS0534)

NOTES

1. All Depths are reduced to Chart Datum (CD) using PPK tides and the Vertical Offset Reference Frame (VORF) model.
2. The longitudinal profile has been produced from the bathymetry DTM produced in 2018 and 2019.
3. Following detailed analysis, the depths from the 2019 transects have been increased by 8.5cm.

GENERAL AREA

CHART KEY



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM	: OSGB(36)	**PROJECTION**	: O.S. National Grid
ELLIPSOID	: AIRY	FALSE EASTING	: 400,000m
SEMI MAJOR AXIS	: 6377563.396	FALSE NORTHING	: -100,000m
INVERSE FLATTENING	: 299.325	LATITUDE OF ORIGIN	: 49° 00' 00.00" North
TRANSFORMATION	: WGS84-OSGB36 using OSTN02 Model	CENTRAL MERIDIAN (CM)	: 02° 00' 00.00" West
		SCALE FACTOR AT CM	: 0.99960127

SURVEY INFORMATION

SURVEY VESSEL	: MV TITAN EXPLORER
SURVEY DATE	: 03-APR-2019 TO 12-APR-2019
POSITIONING SYSTEM	: TRIMBLE SPS852 HEMISPHERE CRESCENT VS110
ECHO SOUNDER (MULTI-BEAM SYSTEM)	: GEOACOUSTICS GEOSWATH PLUS

SCALE (A1 ORIGINAL)

HORIZONTAL SCALE 1:5000

0 100 200 300 400 500 Metres

TITLE

Titan Environmental Surveys Limited
ORION HOUSE, PARC CRESCENT, WATERTON INDUSTRIAL ESTATE,
BRIDGEND, CF31 3BQ. TEL: +44 (0) 1656673673

Cefas

CARDIFF GROUNDS
BATHYMETRY AND GRAB SAMPLING SURVEY

BATHYMETRY TRANSECTS

APRIL 2019

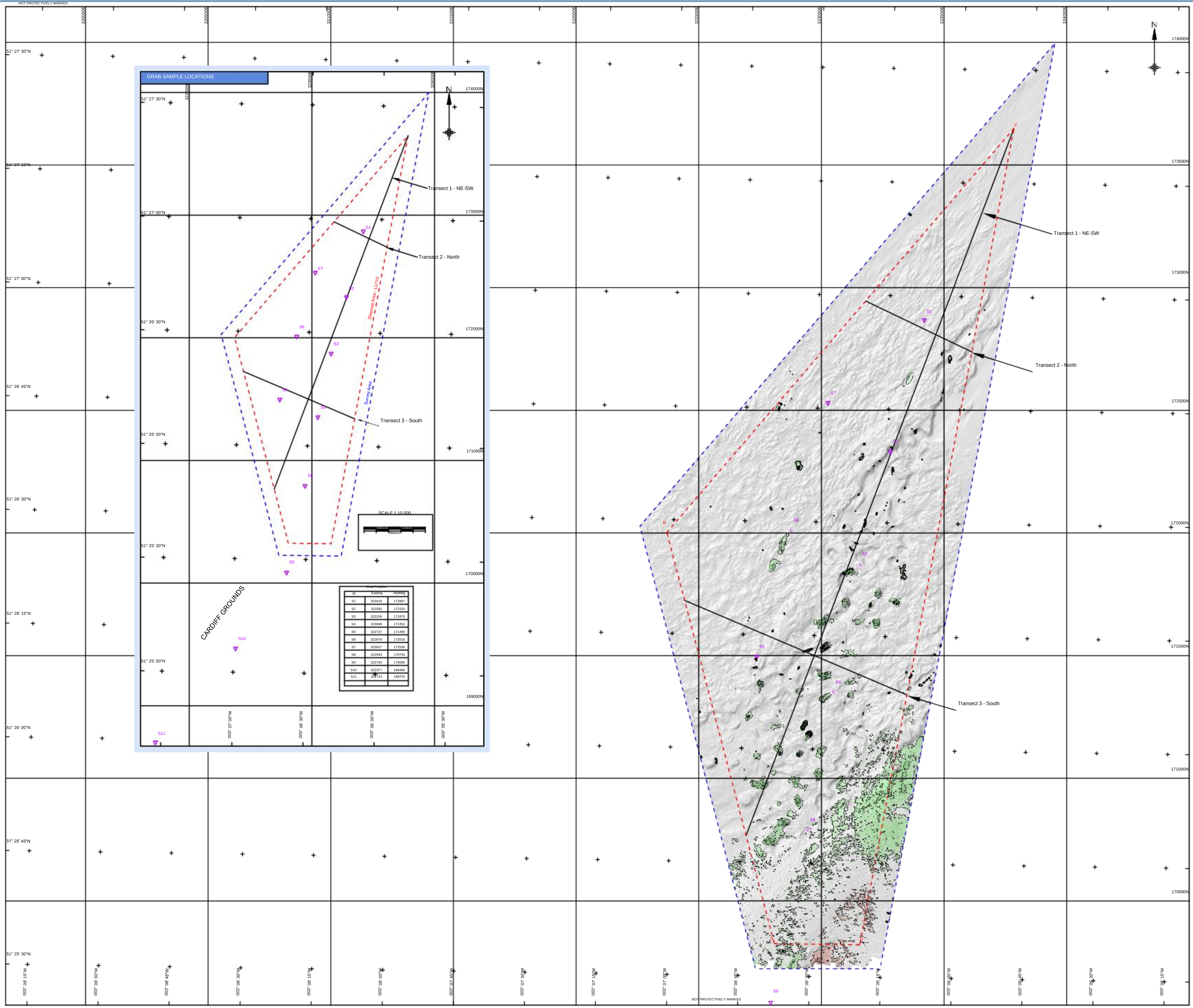
REVISION

REV	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	15-MAY-2019	FINAL	TES	CA	VG	VG
1	17-MAY-2019	Transects from 2018 included. This chart supersedes CS0555B010.	TES	CA	VG	VG
2	17-FEB-2020	2019 bathymetry adjustment. This chart supersedes CS0555B011.	TES	CA	FD	FD

REPORT REF. CS0555 | **DRAWING REF.** CS0555B012 | **APPENDIX NO.** B.4 | **CHART NO.** 1 of 1

B.5 BATHYMETRY 2018 - 2019

NOT PROTECTIVELY MARKED



Grab Position

ID	Easting	Northing
S1	323419	172867
S2	323281	172331
S3	323156	171870
S4	323048	171352
S5	322737	171495
S6	322876	172010
S7	323027	172530
S8	322943	170791
S9	322793	170085
S10	322377	169466
S11	321723	168701

LEGEND

- Disposal Area - LU110
- Survey area (LU110 + 100m buffer)
- Grab sample
- Contours showing depth variation between surveys (metres)
- Areas of deposition
- Areas of erosion

NOTES

1. Seabed relief topography image generated using Fledermaus from 2019 survey data.
2. Depth variation contours and shading generated in Fledemaus from 2018 and 2019 data, commence at ±0.5m then incrementing at 0.5m intervals.
3. Following detailed analysis, bathymetry depths from 2019 have been increased by 8.5cm.
4. Survey area supplied by CEFAS (tr429_hpc-intake-and-outfall-dredge-disposal-bathymetric-survey-plan-prel-v600.doc)

LU110 - Disposal Area

Point	Easting	Northing
A	322808	170326
B	322370	172002
C	323785	173649
D	323156	170321

5. Transect co-ordinates below:

Transect Locations

Point	Start Easting	Start Northing	End Easting	End Northing
Transect 1 - NE-SW	322693	170766	323785	173649
Transect 2 - North	323181	172946	323614	172738
Transect 3 - South	322442	171725	323349	171340

6.

Overall Volume Change - m³	
Total	510,177
erosion (- ve	14,822
accretion (+ve)	524,999

GENERAL AREA

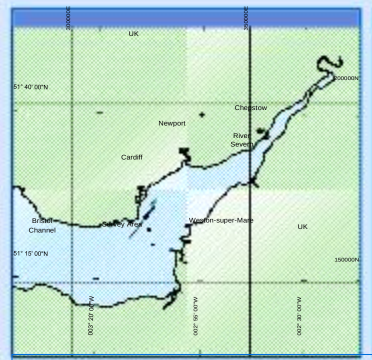
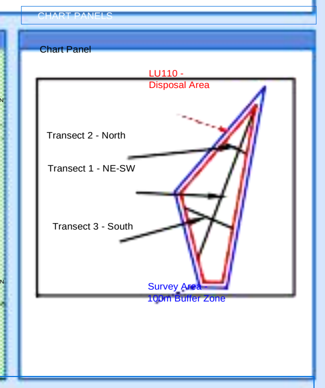


CHART PANELS



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM : OSGB(36)
ELLIPSOID : AIRY
SEMI MAJOR AXIS : 6377563.396
INVERSE FLATTENING : 299.325
TRANSFORMATION : WGS84-OSGB36 using OSTN02 Model

PROJECTION : O.S. National Grid
FALSE EASTING : 400,000m
FALSE NORTHING : -100,000m
LATITUDE OF ORIGIN : 49° 00' 00.00" North
CENTRAL MERIDIAN (CM) : 02° 00' 00.00" West
SCALE FACTOR AT CM : 0.99960127

SURVEY INFORMATION

SURVEY VESSEL : MV TITAN EXPLORER
SURVEY DATE : 03-APR-2019 TO 12-APR-2019
POSITIONING SYSTEM : TRIMBLE SPS852
HEMISPHERE CRESCENT VS110
ECHO SOUNDER (MULTI-BEAM SYSTEM) : GEOACOUSTICS GEOSWATH PLUS

SCALE (A0 ORIGINAL)

MAIN CHART SCALE 1:5000

0 100 200 300 400 500 Metres

TITLE

Titan Environmental Surveys Limited
ORION HOUSE, PARC CRESCENT, WATERTON INDUSTRIAL ESTATE,
BRIDGEND, CF31 3BQ. TEL: +44 (0) 1656 673673

Cefas

CARDIFF GROUNDS
BATHYMETRY AND GRAB SAMPLING SURVEY

DEPTH VARIATION

JUNE 2018 - APRIL 2019

REVISION

REV	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	17-May-2019	FINAL	TES	CA	VG	VG
1	17-May-2019	Volumes included	TES	CA	VG	VG
2	17-Feb-2020	2019 bathymetry adjustment.	TES	CA	FD	FD
				B.5		

PROJECT REF. CS0555 | **DRAWING REF.** CS0555A042 | **APPENDIX NO.** | **CHART NO.** 1 of 1

NOT PROTECTIVELY MARKED

B.6 VOLUME CHANGES

Type of change	Volume (m^3)
Total amount of material added above the 12m isochore	510,177
Fill	524,999
Erosion	14,822

APPENDIX C

SEDIMENT SAMPLING

C.1 GRAB SAMPLING LOGS

Titan Environmental Surveys Limited
A GARDLINE COMPANY

TQA003
Grab Sample Log

Client: CEFAS	Project: Cardiff Grounds	Job No: CS0554	Notes / Diagrams:
Vessel: Titan Explorer	Date: 03 / 04 / 2019	Personnel: ST GOD CF	
DataBase: 093_03042019_TEx		Sheet: 1 of	
Nav System: OSTN02	Sea State: Smooth	Grab Type: Van Veen	
Spheroid Projection:	Time HW/LW (UTC): LW 1205 HW 1817	Other Tests:	

Site No.	Fix No	Time (UTC)	Easting/ Latitude	Northing/ Longitude	Depth (m)	Photo ID	Grab Sample Description	Other Tests			Comments
S1	3	12:05	323419	172867	3.5	20190403_S1_A1_TEx	M				
S7	6	12:19	323023	172525	4.3	20190403_S7_A1_TEx	Mg				
S7	9	12:23	323013	172519	5.5	20190403_S7_A2_TEx	Mg				
S7	12	12:26	323027	172530	6.4	20190403_S7_A3_TEx	Mg				
S6	18	12:44	322892	172027	11.3	20190403_S6_A2_TEx	Mp				
S6	21	12:46	322875	172020	12.1	20190403_S6_A3_TEx	R				
S6	27	12:52	322876	172010	6.8	20190403_S6_A5_TEx	Mp				
S3	37	13:03	323170	171870	4.5	20190403_S3_A2_TEx	Pm				
S3	40	13:05	323168	171877	4.9	20190403_S3_A3_TEx	Pm				
S3	43	13:06	323163	171878	4.6	20190403_S3_A4_TEx	Pm				
S3	46	13:10	323156	171870	4.9	20190403_S3_A5_TEx	Pm				
S4	60	13:26	323057	171352	8.02	20190403_S4_A5_TEx	P				
S5	69	13:42	322734	171507	6.2	20190403_S5_A3_TEx	Pm				
S5	74	13:46	322737	171495	6.6	20190403_S5_A5_TEx	S				
S8	77	13:57	322943	170791	9.8	20190403_S8_A1_TEx	S				
Date: 11/04/2019 Time: HW/LW (UTC): HW 1028 LW 1625 DataBase: 101_11042019_TEx											
S9	2839	11:40	322793	1700850	10.49	20190411_S9_A4_TEx	S				
S10	2844	11:59	322355	169460	9.3	20190411_S10_A2_TEx	S				

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TQA003
Grab Sample Log

Client: CEFAS
Project: Cardiff Grounds
Job No: CS0554
Notes / Diagrams:
Vessel: Titan Explorer
Date: 03 / 04 / 2019
Personnel: ST GOD CF
DataBase: 093_03042019_Tex
Sheet: 2 of
Nav System: OSTN02
Sea State: Smooth
Grab Type: Van Veen
Spheroid Projection:
Time HW/LW (UTC): LW 1205 HW 1817
Other Tests:

Site No.	Fix No	Time (UTC)	Easting/ Latitude	Northing/ Longitude	Depth (m)	Photo ID	Grab Sample Description	Other Tests			Comments
S11	2851	12:14	321723	168701	8	20190411_S11_A2_TEx	S				
S10	2854	12:28	322377	169466	9.5	20190411_S10_A3_TEx	S				
Date: 12/04/2019 Time: HW/LW (UTC): HW 11:17 LW 17:15 DataBase: 102_12042019_TEx											
S2	3388	11:50	323281	172331	16.0	20190412_S2_A6_Tex	C				
S4_9	3996	13:25	323048	171352	12.5	20190411_S4_A9_Tex	C				

C.2 PARTICLE SIZE ANALYSIS RESULTS

TBC

C.3 VOLUMES OF DISPOSAL MATERIAL

TBC

APPENDIX D

DELIVERED DATA

Grabs : 21 grab sample photos
: 11 0.5kg grab samples
: Grab Sample Log

Swathe : CS0555_Cardiff_Grounds_2m_OSGB36.txt
: CS0555_Cardiff_Grounds_25m_OSGB36.txt

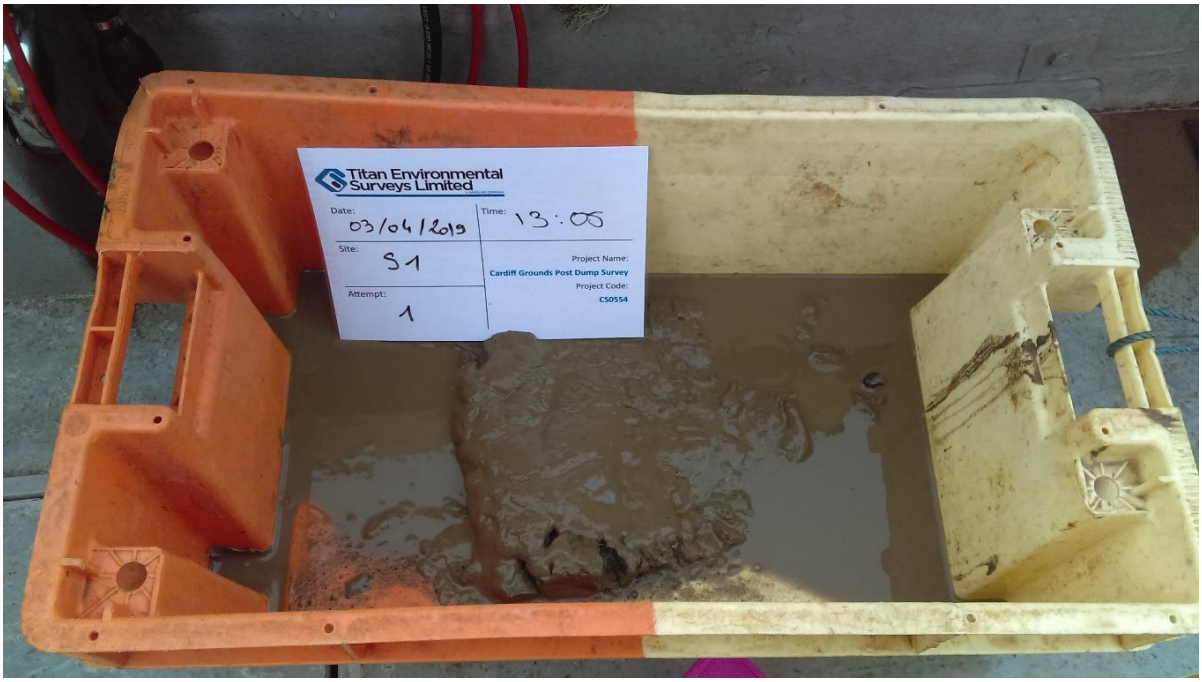
Report : CS0555_Cardiff Grounds Post Dump Survey_V4

Charts / Dwg
: Ref. CS0555A011_Bathymetry (.pdf) Scale 1:5,000
: Ref. CS0555A021_SBR (.pdf) Scale 1:5,000
: Ref. CS0555A031_IsochoresAbove12mCD (.pdf) Scale 1:5,000
: Ref: CS0555B012_Transects (.pdf) Scale 1:5,000
: Ref: CS0555A042_Bathy2018-2019 (.pdf) Scale 1:5,000
: Ref: Volume Changes

APPENDIX E

GRAB SAMPLE PHOTOGRAPHS

Client: CEFAS
Project Title: Cardiff Grounds Survey
Titan Report Ref: CS0555_V4




Titan Environmental Surveys Limited
Date: 03/04/2019
Time: 13:05
Site: S3
Attempt: 3
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554

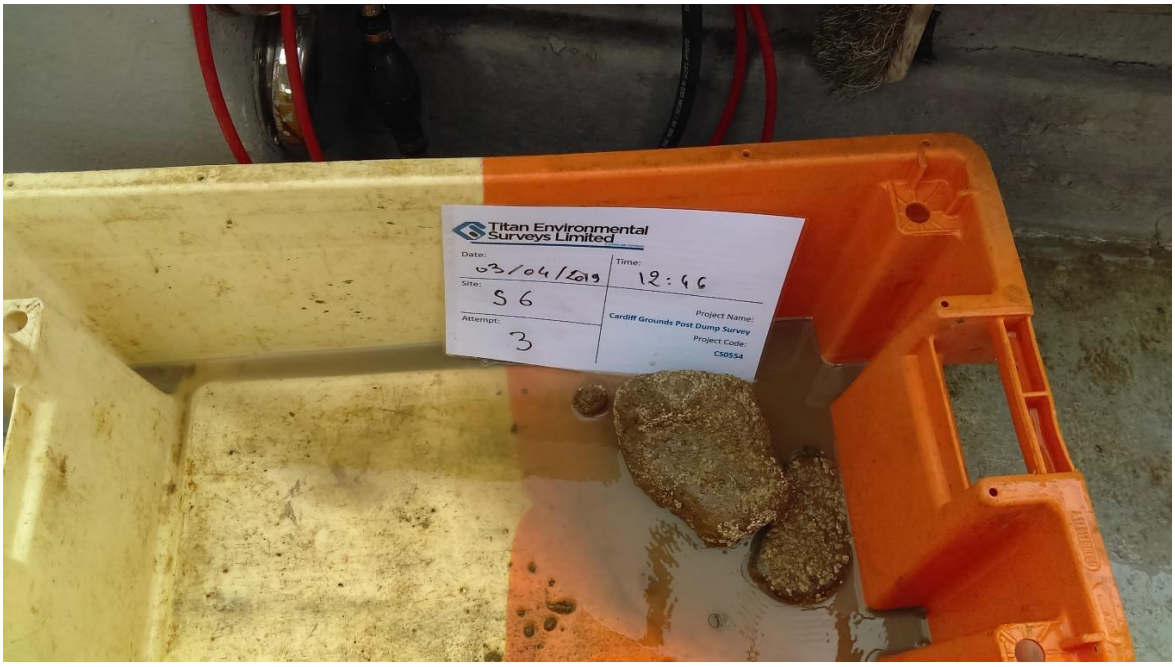

Titan Environmental Surveys Limited
Date: 03/04/2019
Time: 13:06
Site: S3
Attempt: 4
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554


Titan Environmental Surveys Limited
Date: 03/04/2019
Time: 13:10
Site: S3
Attempt: 5
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554

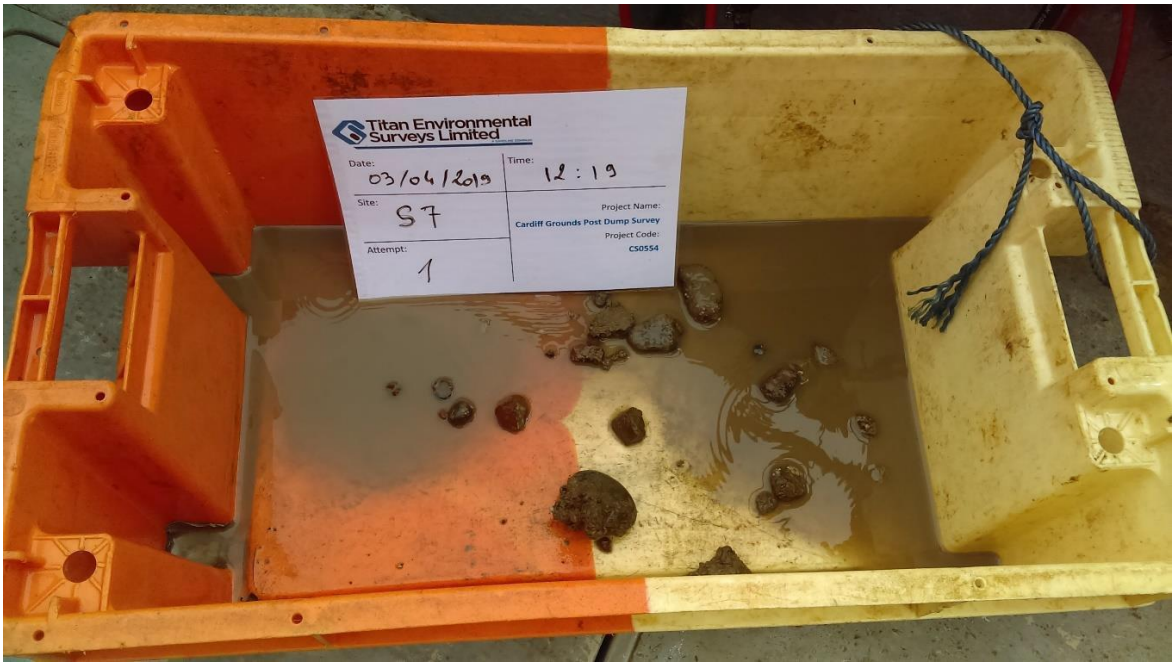

Titan Environmental Surveys Limited
Date: 03/04/2019
Time: 13:26
Site: S4
Attempt: 5
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554

Client: CEFAS
Project Title: Cardiff Grounds Survey
Titan Report Ref: CS0555_V4

Client: CEFAS
Project Title: Cardiff Grounds Survey
Titan Report Ref: CS0555_V4



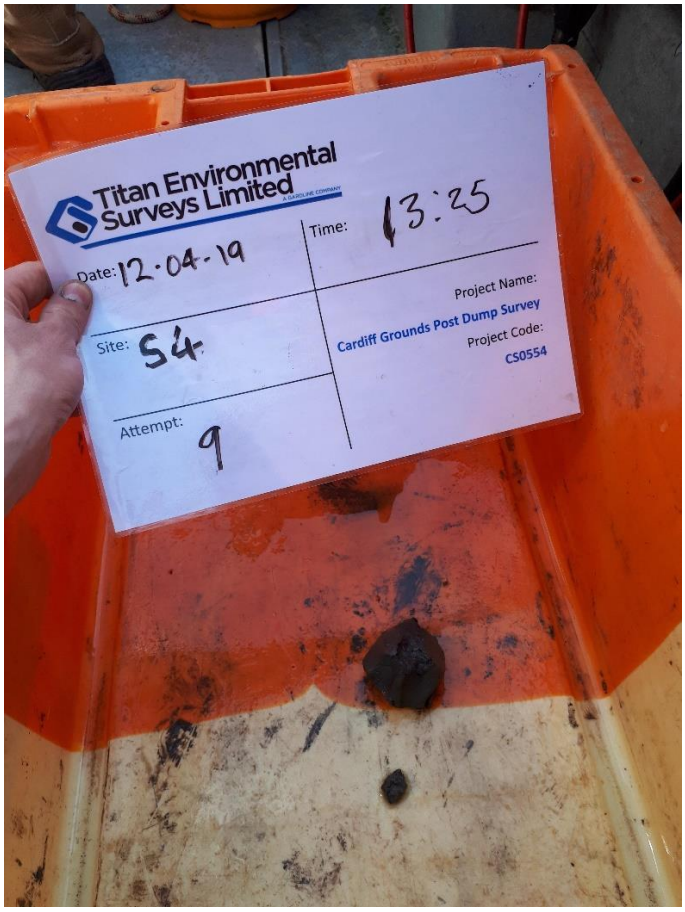
Client: CEFAS
Project Title: Cardiff Grounds Survey
Titan Report Ref: CS0555_V4




Titan Environmental Surveys Limited
Date: 03/04/2019
Time: 12:23
Site: S7
Attempt: 2
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554


Titan Environmental Surveys Limited
Date: 03/04/2019
Time: 12:26
Site: S7
Attempt: 3
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554


Titan Environmental Surveys Limited
Date: 03/09/2019
Time: 13:57
Site: S8
Attempt: 1
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554


Titan Environmental Surveys Limited
Date: 12-04-19
Time: 13:25
Site: S4
Attempt: 9
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554


Titan Environmental Surveys Limited
Date: 11·04·19
Time: 11:40
Site: S9
Attempt: 4
Project Name:
Cardiff Grounds Post Dump Survey
Project Code:
CS0554


Titan Environmental Surveys Limited
Date: 11·04·19
Time: 11.59
Site: S10
Attempt: 2
Project Name:
Cardiff Grounds Post Dump Survey
Project Code:
CS0554


Titan Environmental Surveys Limited
Date: 11-04-19
Time: 12:28
Site: S10
Attempt: 3
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554


Titan Environmental Surveys Limited
Date: 11/04/2019
Time: 12:14
Site: S11
Attempt: 2
Project Name: Cardiff Grounds Post Dump Survey
Project Code: CS0554


Titan Environmental Surveys Limited
Date: 12-04-19
Time: 11:50
Site: S2
Attempt: 6
Project Name:
Cardiff Grounds Post Dump Survey
Project Code:
CS0554

APPENDIX F: ADDITIONAL GRAB SAMPLE SURVEY

Scope: Two additional grab samples were required to fulfil requirements under the monitoring plan BEEMS Technical Report TR457.

Date: 24th June 2019.

Operations: Cefas conducted grab sampling operations from Ecospan's RV Coastal Surveyor, 7.9 m twin engine Sea Cheetah catamaran, an MCA Category 3 workboat (Figure 1). Survey works were supported by Marine Science Services (MSS).

Figure 1: Ecospan RV Coastal Surveyor

Sampling: Two additional grab samples were collected from Cardiff Grounds at the locations specified in Table 1. The grab sample from station S12 was collected with a 0.1 m^3 day grab. The grab sample from station S7 was collected with a Van Veen grab, as the day grab was unsuccessful due to the presence of coarse material.

Table 1: Grab sample locations

Sample station	MSS sample reference	Latitude (DD)	Longitude (DD)	Easting (m) OSGB36	Northing (m) OSGB36
S7	2a	51.446350	-3.109217	323011	172513
S12	1a	51.424751	-3.114117	322634	170116

Results: Upon survey completion, samples were transported to the Cefas Lowestoft sedimentology laboratory for particle size analysis (PSA). Upon completion of analysis, results will be reported to NNB GenCo in accordance with monitoring requirements. Photographs of the grab samples taken during the survey are shown in Figure 2.

Figure 2: S7 sample (top panel) and S12 sample (bottom panel) collected 24th June 2019. Note that unfortunately camera issues led to blur in the S7 photograph.