SCEILIG MHICHIL MONITORING SURVEY REPORT

June 2024

The Discovery Programme
Centre for Archaeology and Innovation Ireland

CONTENTS

1. Project Background

In September 2015, precise measurements were conducted at three locations around the Monastery on Sceilg Mhichíl , as illustrated in Figure 1. At these sites, marine bronze bolts were installed in both the bedrock and the built fabric of the structure fabric of the structure, establishing a local control network and monitoring points, respectively. The exact positions of these points are detailed in the report appendices. These survey points have been re-evaluated annually, except in September 2019 and September 2022 when surveys were cancelled due to adverse sea conditions and weather. Additionally, an interim set of readings was taken at Area 2 in May 2019 due to ongoing concerns regarding stability in that area.

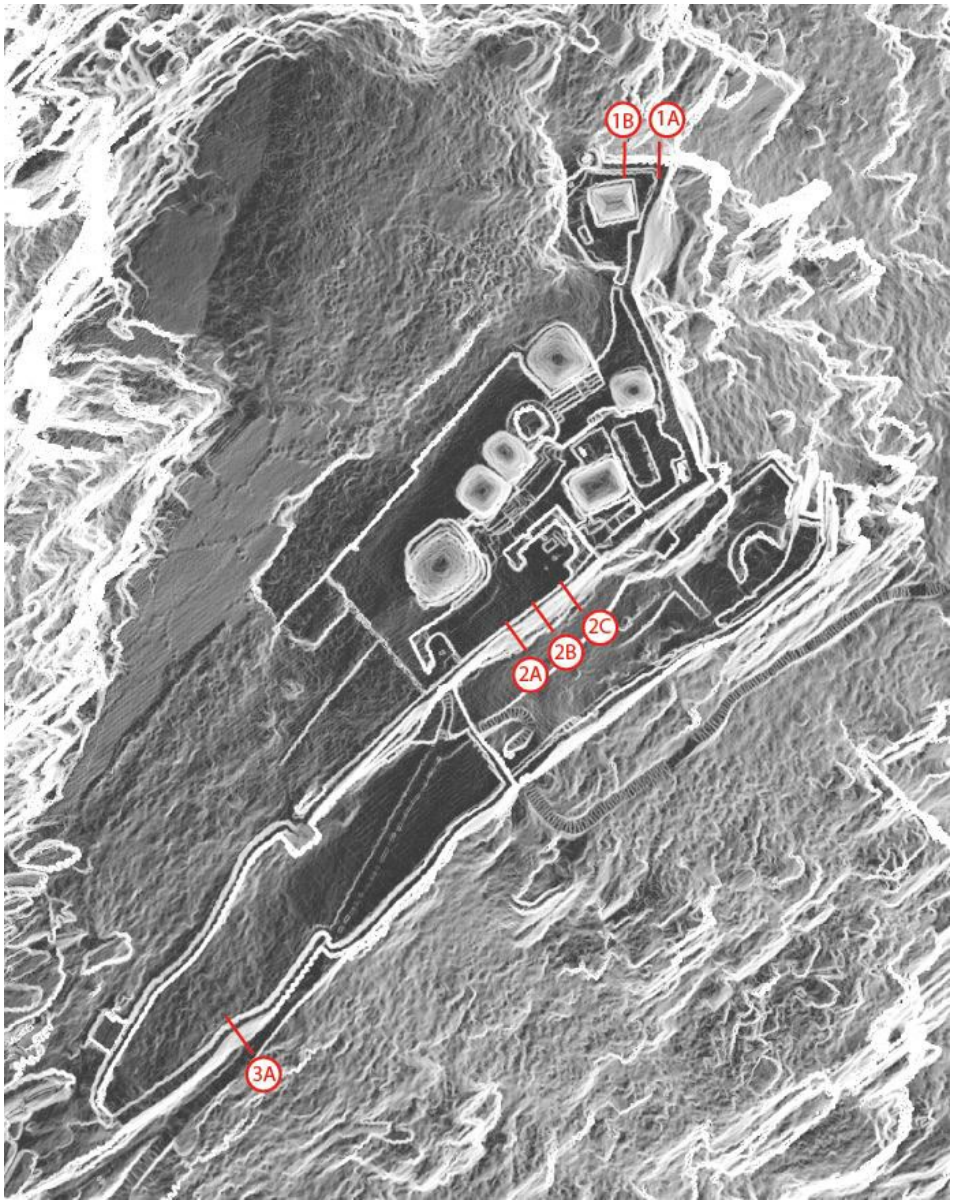


FIGURE 1 - INITIAL LOCATION OF THE MONITORING PROJECT

In July 2017, four additional locations were incorporated into the monitoring network on the South Peak of the island. These new locations are identified and numbered according to the instrument's position during observations, as shown in Figure 2. Since 2017, a total of seven areas have been monitored annually, subject to access. In 2018, four more lines of markers were added to Area 2, increasing the total network to 101 brass survey markers.

The monitoring surveys are conducted by the Discovery Programme on behalf of the OPW. This report presents the results of the latest survey conducted in June 2024, along with basic analysis of the results and the significance of vector changes over the course of the project.

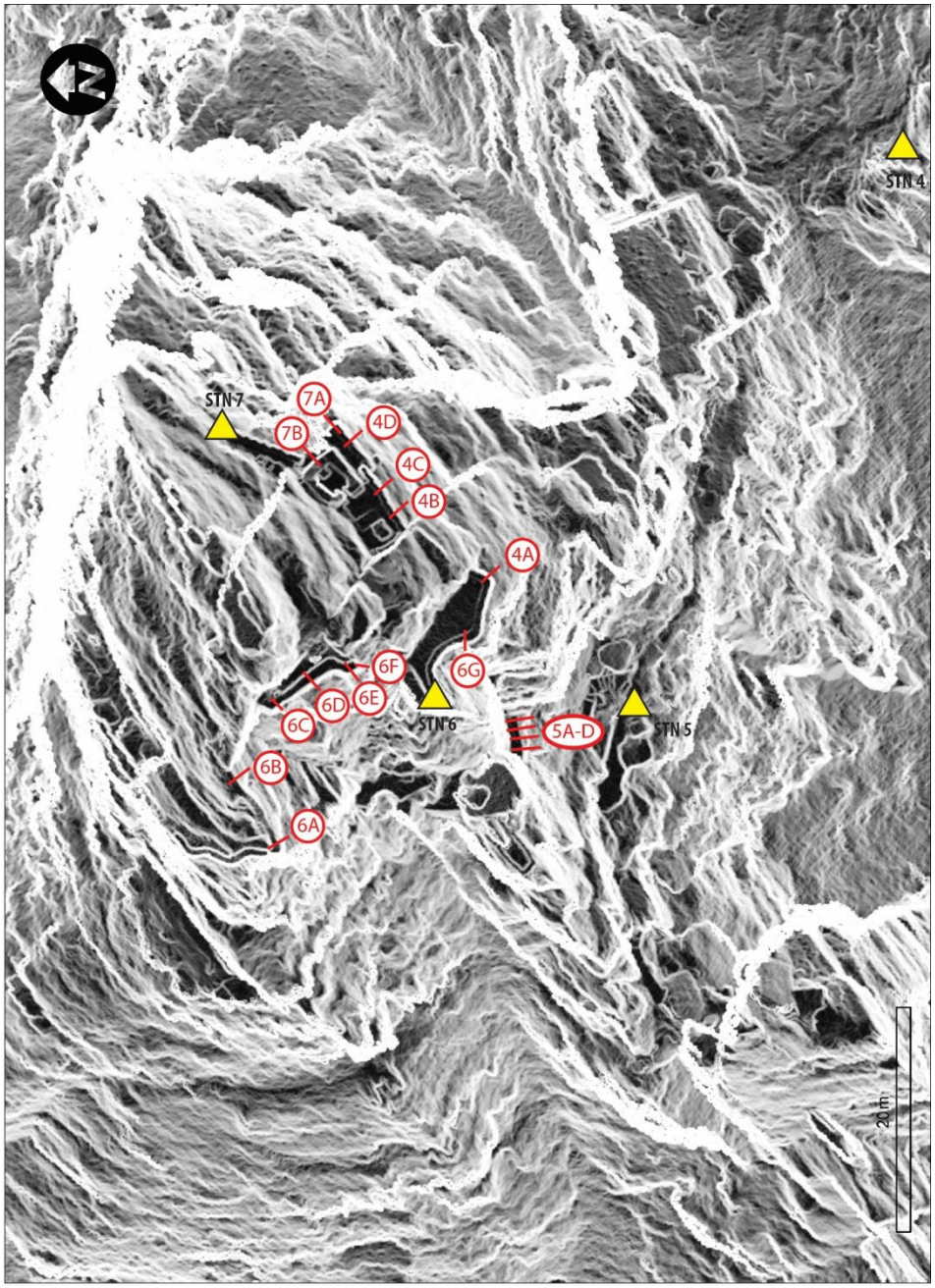


FIGURE 2 – 2017 MONITORING NETWORK

2. Equipment & Observations 2024

The observations took place in on the 16th, 17th and 18th June 2024. The instrument used was a Trimble VX total station, Figure 3, operated in standard DR (reflectorless mode) which has a manufacturer defined accuracy (RSME) of 2mm + 2ppm, set to average 5 readings per observation. The full specification of the instrument is available online:-*http://trl.trimble.com/docushare/dsweb/Get/Document-348124/022543-261G_TrimbleVX_DS_0613_LR.pdf*

FIGURE 3– VX TOTAL STATION

This was the same instrument has been used for the observations since 2015 and is subject to regular maintenance and calibration. It was most recently calibrated in August 2023

KOREC™

Certificate of Calibration

Customer DISCOVERY PROGRAMME
Instrument VX TOTAL STATION
Serial No. 93520011
Plant No.

We hereby certify that the above instrument has been calibrated to the manufacturer's specifications

Cert. No. DUB/022429
Date 17/08/2023
Signature
S. SMYTH

Trimble Authorized Distribution Partner

KOREC Group Ltd, Unit B7 Riverview Business Park, Nangor Road, Dublin 12, Ireland
T: 01 4564702, F: 01 4503786, W: www.korecgroup.com, VAT No. IE 8228469, Company No. 228469

FIGURE 4 - CALIBRATION CERTIFICATE

Two sets of observations, from independent resections were taken at each of the seven locations. Weather conditions were very good, with low wind and variable sunshine.

For each set of readings an average value is taken to establish a final set of coordinates for each monitoring survey marker.

The following sections present the June 2024 list of final coordinates for each area, and the calculated annual and overall vector differences. The overall vector shift is calculated by comparing the original coordinates (2015, 2017 or 2018 depending on when established) with the 2024 values. This is the critical value to consider as it indicates the overall stability, or otherwise of the survey markers.

Also included for each area is a comment on the significance of the survey data, and suggestions of appropriate survey actions.

3. Area 1 – Results

JUNE 2024 COORDS - AREA 1

POINT		X (m)	Y (m)	Z (m)
1-m-a-1		1495.303	1509.92	95.183
1-m-a-2		1495.347	1509.936	94.594
1-m-a-3		1495.378	1510.05	93.852
1-m-a-4		1495.428	1510.363	92.449
1-m-b-1		1497.838	1509.396	95.347
1-m-b-2		1497.78	1509.3	94.949
1-m-b-3		1497.794	1509.322	94.582
1-m-b-4		1497.884	1509.424	93.864

FIGURE 5 - TABLE OF AREA 1 FINAL COORDINATES, JUNE 2024

AREA 1 3D VECTOR SHIFTS – Annual & Cumulative

POINT	VECTOR SHIFT (2015 - 2016)	VECTOR SHIFT (2016 - 2017)	VECTOR SHIFT (2017 – 2018)	VECTOR SHIFT (2018 - 2020) Two years	VECTOR SHIFT (2020 - 2021)	VECTOR SHIFT (2021 – 2022)	VECTOR SHIFT (June 2022 – Sept 2024) 21 months	VECTOR SHIFT (2015 -2024) Nine years cumulative
1-m-a-1	0.001m	0.001m	0.001m	0.001m	0.004m	0.001m	0.001m	0.004m
1-m-a-2	0.001m	0.002m	0.010m	0.009m	0.002m	0.018m	0.014m	0.006m
1-m-a-3	0.001m	0.001m	0.003m	0.005m	0.001m	0.002m	0.003m	0.004m
1-m-a-4	0.001m	0.002m	0.002m	0.004m	0.002m	0.001m	0.002m	0.004m
1-m-b-1	0.000m	0.000m	0.001m	0.003m	0.001m	0.001m	0.000m	0.003m
1-m-b-2	0.000m	0.000m	0.001m	0.004m	0.001m	0.001m	0.000m	0.003m
1-m-b-3	0.004m	0.004m	0.002m	0.004m	0.002m	0.004m	0.005m	0.003m
1-m-b-4	0.001m	0.002m	0.001m	0.003m	0.001m	0.001m	0.000m	0.004m

FIGURE 6 - AREA 1, VECTOR SHIFT CALCULATED ANNUALLY AND THE OVERALL CUMULATIVE VECTOR CALCULATED FROM ORIGINAL TO LATEST POSITION. THIS IS NOT THE SUM OF THE ANNUAL SHIFTS AS MOVEMENT IS NOT NECESSARILY LINEAR

COMMENT

Area 1 continues to show a high level of stability and consistency of reading, see Figure 6. After 9 years of observations the average vector shift across the eight marker points is 3.9mm. Concerns in 2022 over higher than normal values from 1-m-a-4 have been resolved, and were most likely due to vegetation growth in 2022.

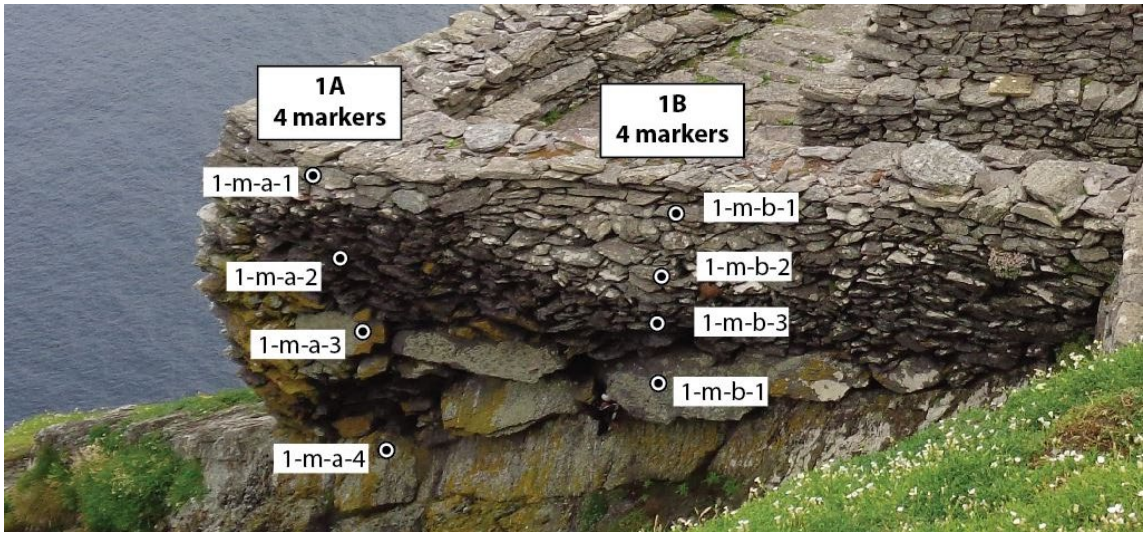


FIGURE 7 - SURVEY MARKER LOCATIONS, AREA 1

4. Area 2 - Results

JUNE 2024 COORDS - AREA 2

POINT	X (m)	Y (m)	Z (m)
2-m-a-1	2498.725	2508.703	105.2
2-m-a-2	2498.84	2509.514	106.583
2-m-a-3	2498.882	2510.096	108.008
2-m-a-4	2499.013	2510.656	109.506
2-m-b-1	2503.974	2508.898	104.288
2-m-b-2	2504.003	2509.566	105.836
2-m-b-3	2504.082	2510.198	106.986
2-m-b-4	2503.993	2510.602	107.874
2-m-b-5	2503.983	2510.948	109.158
2-m-c-1	2507.659	2509.696	104.015
2-m-c-2	2507.526	2510.137	105.111
2-m-c-3	2507.45	2510.716	106.613
2-m-c-4	2507.38	2510.94	107.652
2-m-c-5	2507.34	2511.121	108.256
2-m-d-1	2498.725	2508.703	105.2
2-m-d-2	2498.84	2509.514	106.583
2-m-d-3	2498.882	2510.096	108.008
2-m-d-4	2499.013	2510.656	109.506
2-m-d-5	2503.974	2508.898	104.288
2-m-d-6	2504.003	2509.566	105.836
2-m-e-1	2504.082	2510.198	106.986
2-m-e-2	2503.993	2510.602	107.874
2-m-e-3	2503.983	2510.948	109.158
2-m-f-1	2507.659	2509.696	104.015
2-m-f-2	2507.526	2510.137	105.111
2-m-f-3	2507.45	2510.716	106.613
2-m-f-4	2507.38	2510.94	107.652
2-m-g-1	2507.34	2511.121	108.256
2-m-g-2	2498.725	2508.703	105.2
2-m-g-3	2498.84	2509.514	106.583
2-m-g-4	2498.882	2510.096	108.008

FIGURE 8 - TABLE OF AREA 2 FINAL COORDINATES, JUNE 2024

AREA 2 3D VECTOR SHIFTS – Annual & Cumulative

POINT	VECTOR SHIFT Sept 2015 – Sept 2016	VECTOR SHIFT Sept 2016 – Sept 2017	VECTOR SHIFT Sept 2017 – Sept 2018	VECTOR SHIFT (8months) Sept 2018 – May 2019	VECTOR SHIFT (16 months) May 2019 - Sept 2020	VECTOR SHIFT Sept 2020 – Sept 2021	VECTOR SHIFT Sept 2021 – Sept 2022	VECTOR SHIFT (21 months) Sept 2022 –June 2024	TOTAL SHIFT (Six years cumulative) Sept 2018 – June 2024	TOTAL SHIFT (Nine years cumulative) Sept 2015 – June 2024
2-m-a-1	0.006m	0.005m	0.003m	0.003m	0.010m	0.006m	0.004m	0.008m	0.029m	0.045m
2-m-a-2	0.005m	0.004m	0.006m	0.005m	0.010m	0.003m	0.004m	0.008m	0.030m	0.045m
2-m-a-3	0.004m	0.006m	0.007m	0.003m	0.010m	0.004m	0.004m	0.009m	0.032m	0.047m
2-m-a-4	0.006m	0.007m	0.007m	0.003m	0.013m	0.005m	0.004m	0.011m	0.038m	0.054m
2-m-b-1	0.006m	0.006m	0.010m	0.005m	0.015m	0.007m	0.003m	0.007m	0.030m	0.047m
2-m-b-2	0.004m	0.007m	0.004m	0.005m	0.009m	0.003m	0.004m	0.009m	0.031m	0.044m
2-m-b-3	0.004m	0.005m	0.008m	0.003m	0.010m	0.005m	0.002m	0.008m	0.030m	0.044m
2-m-b-4	0.006m	0.005m	0.006m	0.004m	0.008m	0.005m	0.004m	0.008m	0.030m	0.046m
2-m-b-5	0.005m	0.006m	0.005m	0.004m	0.007m	0.001m	0.003m	0.006m	0.027m	0.031m
2-m-c-1	0.002m	0.003m	0.003m	0.001m	0.007m	na	na	0.004m	0.014m	0.021m
2-m-c-2	0.002m	0.003m	0.003m	0.001m	0.006m	0.002m	0.001m	0.003m	0.005m	0.018m
2-m-c-3	0.004m	0.002m	0.004m	0.001m	0.008m	0.002m	0.003m	0.004m	0.017m	0.026m
2-m-c-4	0.003m	0.003m	0.004m	0.001m	0.007m	0.003m	0.002m	0.004m	0.019m	0.027m
2-m-c-5	0.001m	0.004m	0.004m	0.001m	0.008m	0.002m	0.002m	0.004m	0.017m	0.025m
2-m-d-1				0.003m	0.009m	0.003m	0.003m	0.006m	0.022m	na
2-m-d-2				0.002m	0.009m	0.004m	0.002m	0.007m	0.026m	na
2-m-d-3				0.004m	0.009m	0.002m	0.004m	0.007m	0.027m	na
2-m-d-4				0.020m	0.036m	0.007m	na	na	0.026m	na
2-m-d-5				0.004m	0.009m	0.032m	na	0.008m	0.027m	na
2-m-d-6				0.003m	0.010m	0.003m	0.004m	0.008m	0.027m	na
2-m-e-1				0.002m	0.004m	0.001m	0.000m	0.010m	0.015m	na
2-m-e-2				0.001m	0.003m	0.001m	0.001m	0.004m	0.006m	na
2-m-e-3				0.002m	0.004m	0.001m	0.000m	0.001m	0.003m	na
2-m-f-1				0.001m	0.004m	0.005m	0.000m	0.001m	0.003m	na
2-m-f-2				0.001m	0.005m	0.001m	0.002m	0.001m	0.005m	na
2-m-f-3				0.001m	0.004m	0.000m	0.006m	0.001m	0.004m	na
2-m-f-4				0.001m	0.005m	0.000m	0.000m	0.002m	0.005m	na
2-m-g-1				0.002m	0.005m	0.001m	0.000m	0.001m	0.003m	na
2-m-g-2				0.002m	0.005m	0.001m	0.001m	0.003m	0.005m	na
2-m-g-3				0.001m	0.003m	0.001m	0.001m	0.001m	0.006m	na
2-m-g-4				0.002m	0.004m	0.001m	0.000m	0.002m	0.006m	na

FIGURE 9- AREA 2, VECTOR SHIFT CALCULATED ANNUALLY, AND THE OVERALL CUMULATIVE VECTOR CALCULATED FROM ORIGINAL TO LATEST POSITION. THIS IS NOT THE SUM OF THE ANNUAL SHIFTS AS MOVEMENT IS NOT NECESSARILY LINEAR.

COMMENT

In Area 2, lines A, B, and C were part of the original network established in 2015. In 2018, lines D, E, F, and G were added to address significant vector shifts observed in the markers on lines A and B, which have been shifting by 5-10mm annually since the beginning of monitoring. By 2018, these shifts had accumulated to 15-20mm over three years, with a trend direction forward and downward.

FIGURE 10 -SURVEY MARKERS IN AREA 2

The 2024 survey observations were crucial for Area 2, which has exhibited the most significant movements. After missing the survey in September 2022, it was essential to assess how these movements had progressed. Unfortunately, the latest readings confirm the continued movement of markers in Lines A, B, and C, maintaining the downward and forward trend observed in previous years, with a similar magnitude within the margin of error. Over the nine-year monitoring period, markers in Line A show the largest movement, averaging 5.3 mm per year, followed by Line B at 4.7 mm per year, and Line C at 2.6 mm per year. Some markers have moved more than 5 cm since monitoring began in 2015.

Line D, established in 2018 to address concerns in Area 2, shows similar trends to Lines A and B, with an average annual movement of 4.3 mm per year. In 2022, some readings were compromised by vegetation growth, but this year, sightlines to the markers were cleared in advance of observation, ensuring reliable data.

Markers in the lower section of the wall, represented by Lines E, F, and G, are generally stable within the tolerance of the survey instrument and methodology. Only the movement of point 2-m-c-1 suggests potential issues, warranting an inspection next year.

Graphical Illustration

To illustrate the magnitude and characteristics of the movement, the change in position over time has been graphed in 3D for Lines A, B, C & D. These are generated with each survey marker in the Area given

the coordinate (0,0,0) as the start position, with the subsequent observations plotted as the (x,y,z) difference. In this way the magnitude and trend of each point can be evaluated and illustrated.
For each line a 3D isometric graph is followed by (x,z) and (y,z) graphs. These 2D graphs show the forward and lateral change against height.
Observations were taken in September each year except for 2019, when the May 2019 survey was the only one available, and 2024, surveyed in June. This needs to be considered when interpreting the graphs, The 2018-19 period is only 8 months, the 2019-20 period being 16 months and the 2022-24 period being 21 months.

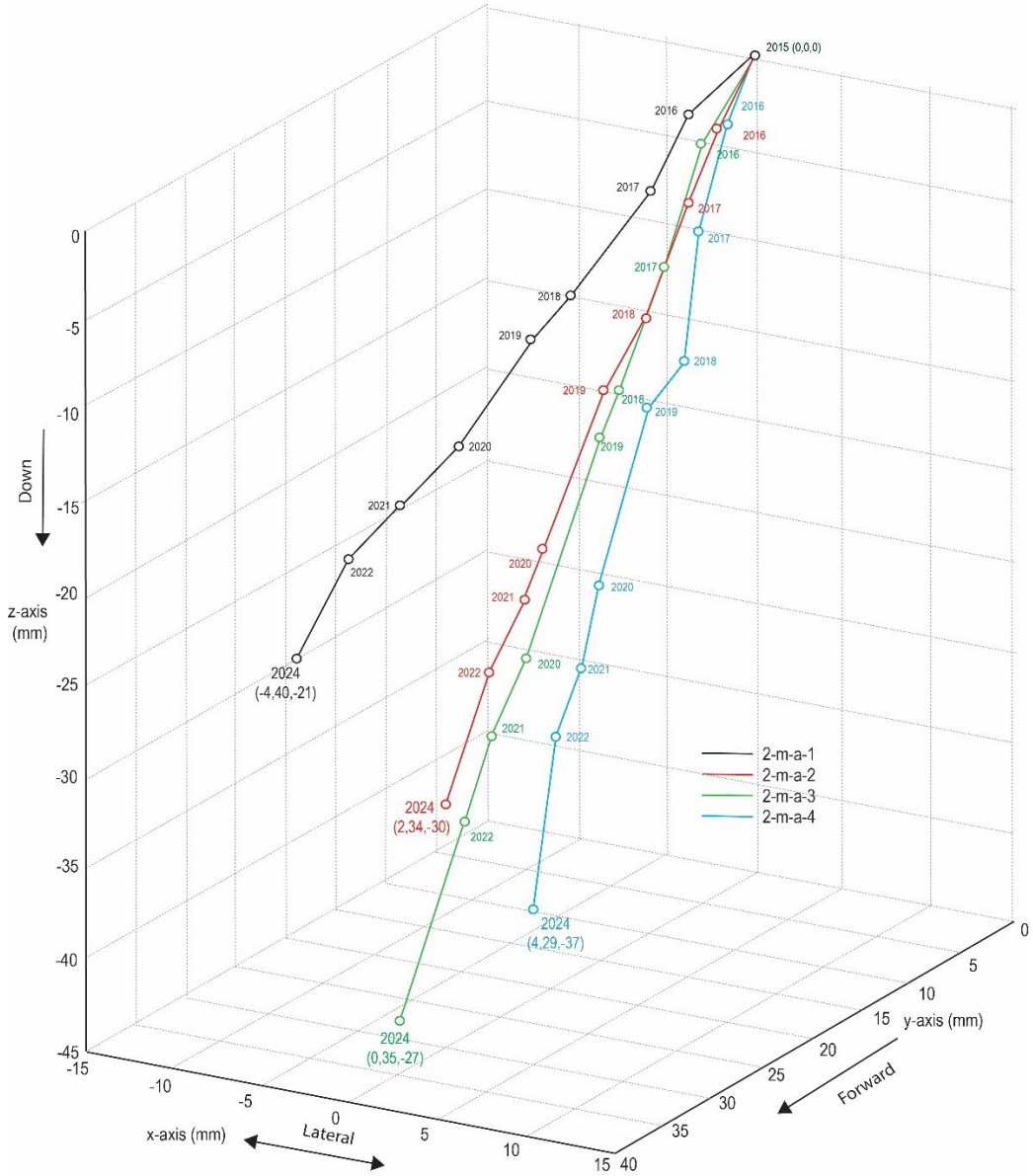
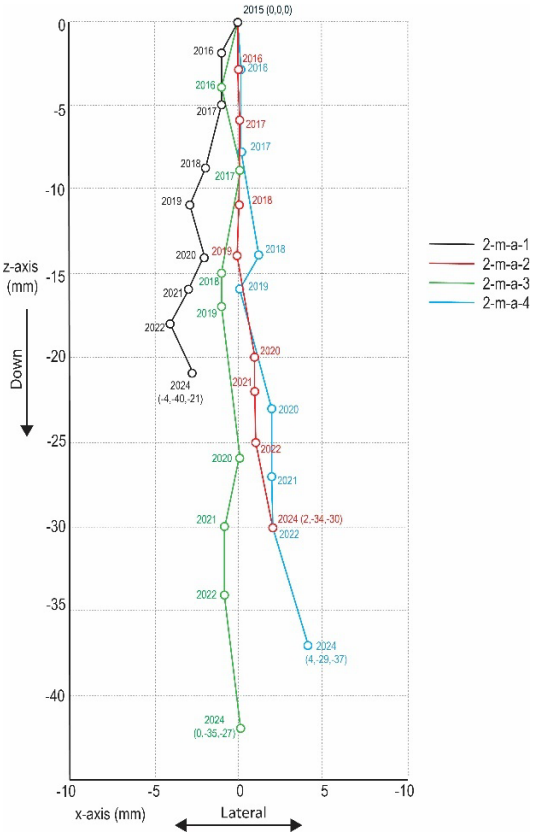


FIGURE 11 - AREA 2, LINE A, 3D GRAPH OF X,Y,Z MOVEMENT OVER DURATION OF THE MONITORING SURVEY OF EACH SURVEY MARKER



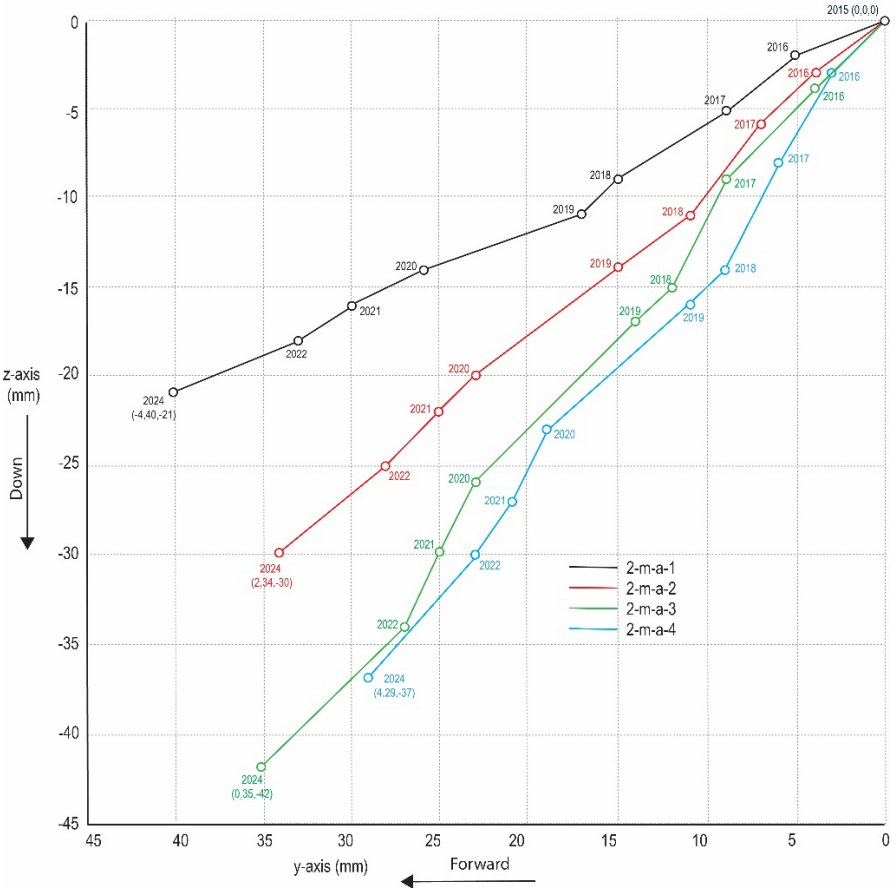


FIGURE 12 – AREA 2, LINE A, LATERAL AND FORWARD MOVEMENT 2D GRAPHS

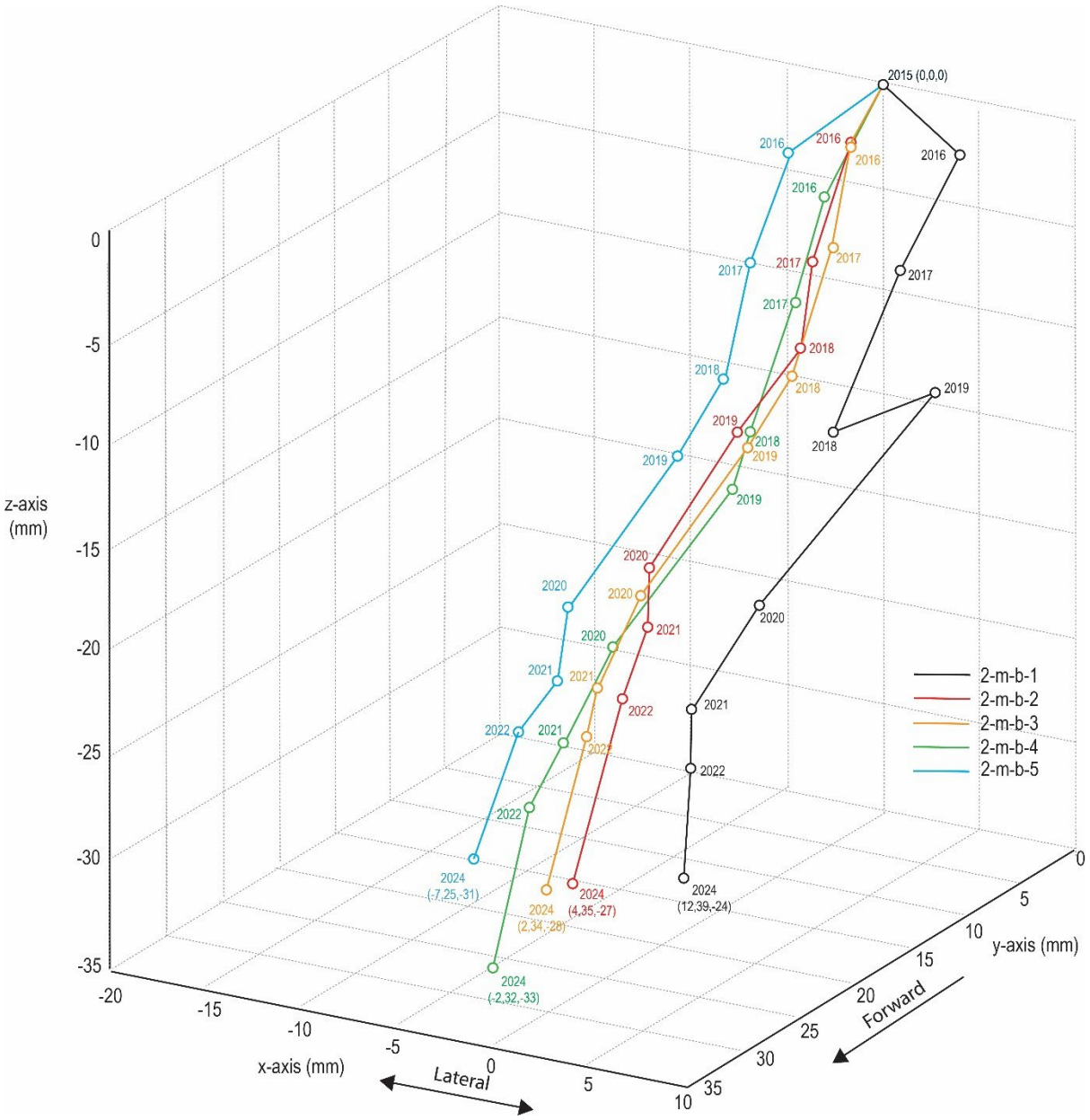


FIGURE 13- AREA 2, LINE B, 3D GRAPH OF X,Y,Z MOVEMENT OVER DURATION OF THE MONITORING SURVEY OF EACH SURVEY MARKER.

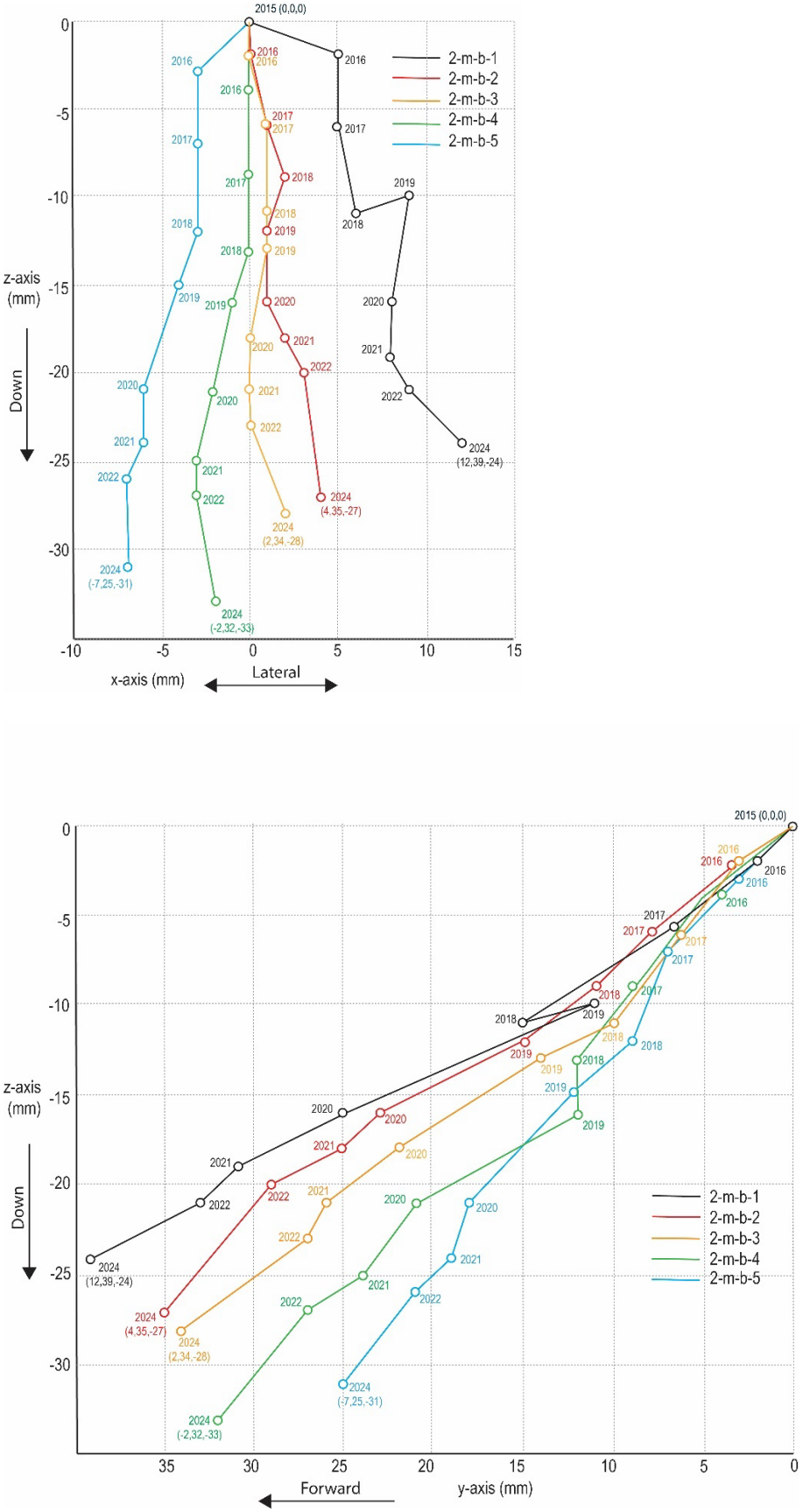


FIGURE 14 - AREA 2, LINE B, LATERAL AND FORWARD MOVEMENT 2D GRAPHS

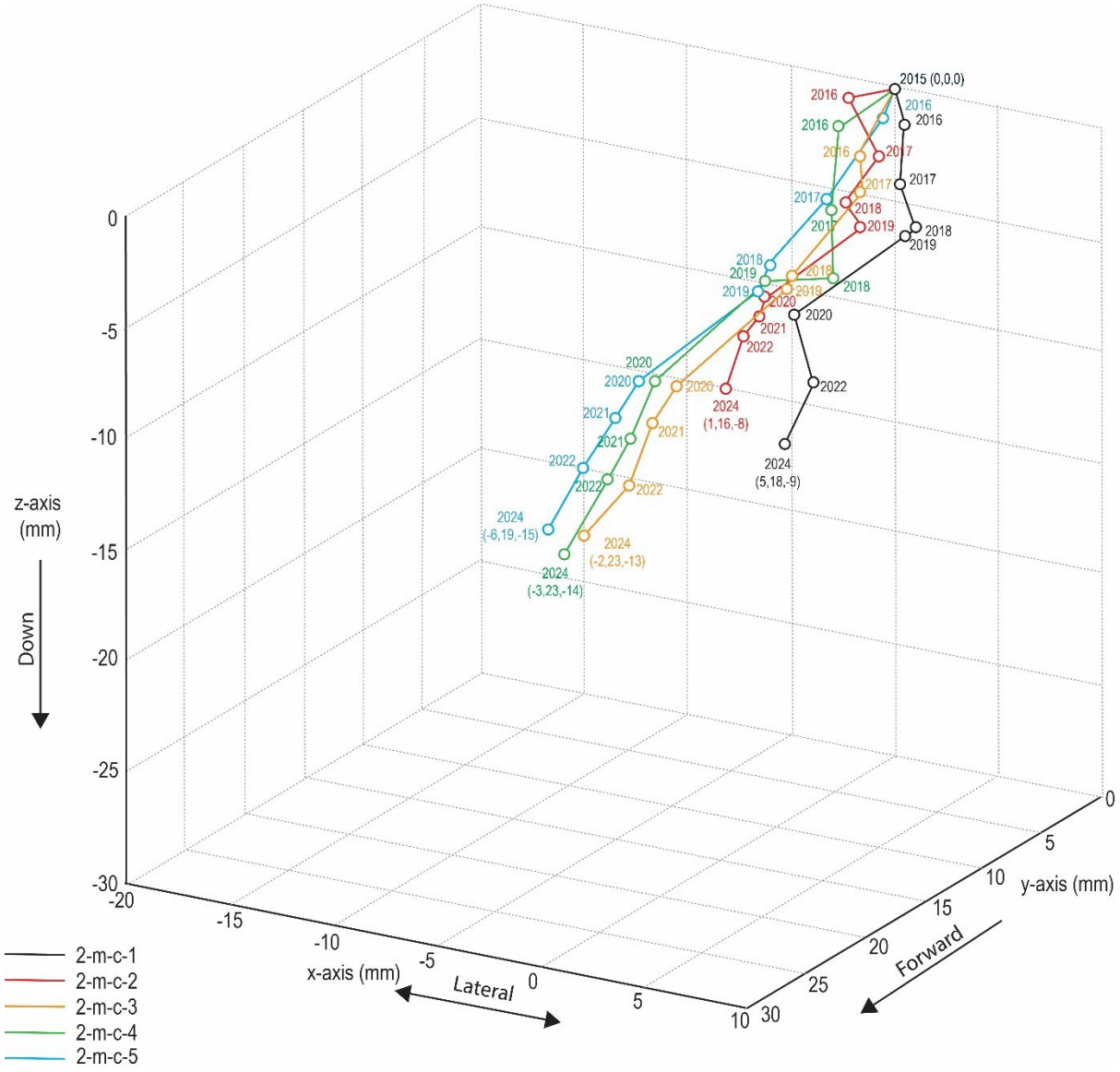


FIGURE 15 - AREA 2, LINE C, 3D GRAPH OF X,Y,Z MOVEMENT OVER DURATION OF THE MONITORING SURVEY OF EACH SURVEY MARKER.

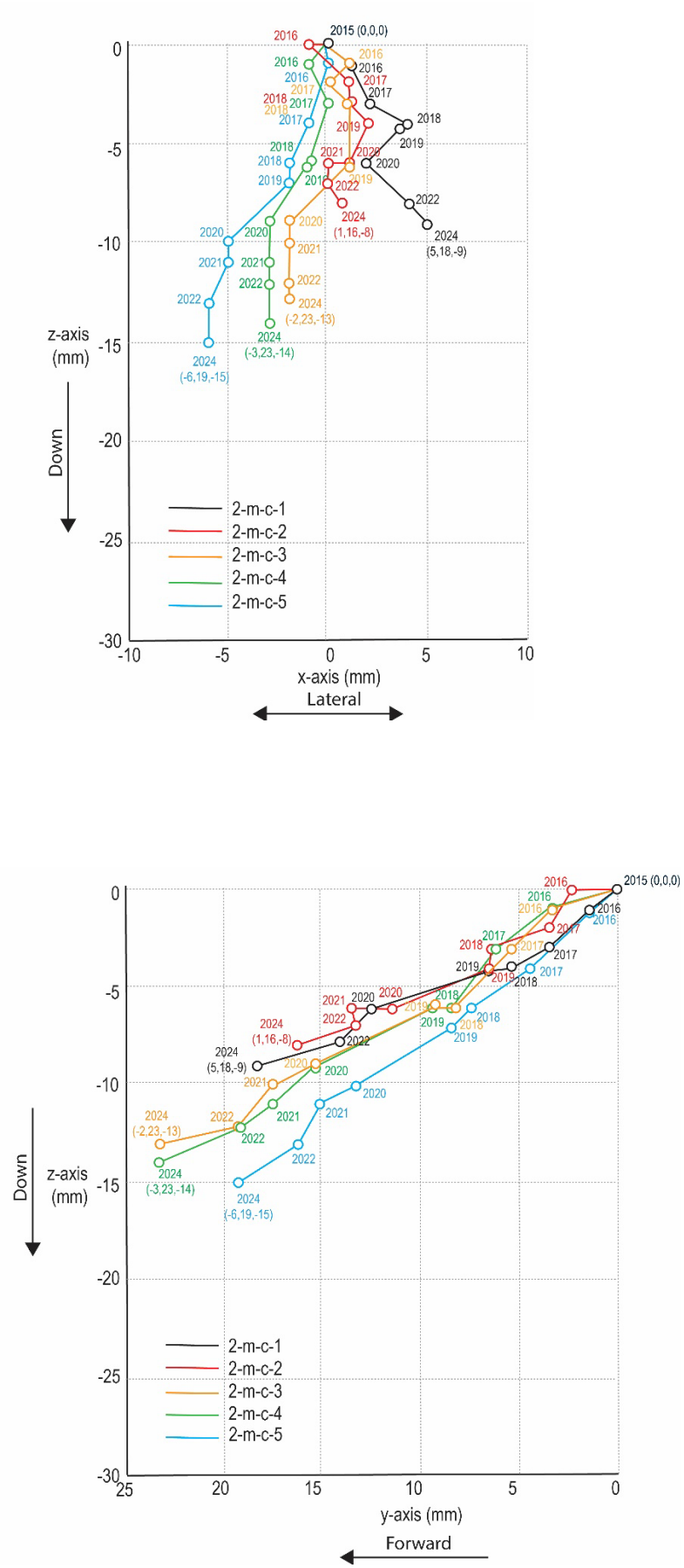


FIGURE 16 - AREA 2, LINE C, LATERAL AND FORWARD MOVEMENT 2D

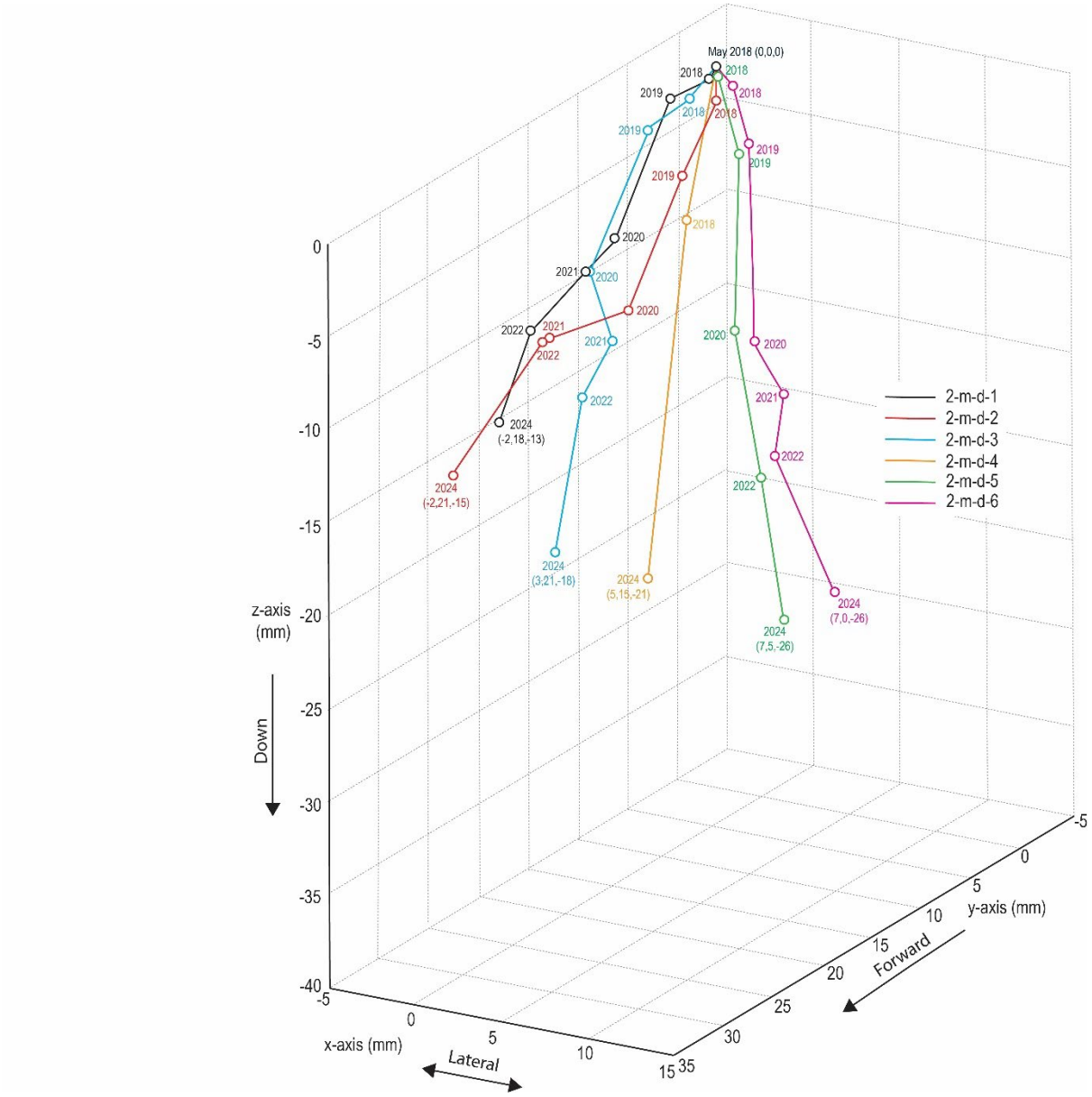


FIGURE 17- AREA 2, LINE D, 3D GRAPH OF X,Y,Z MOVEMENT OVER DURATION OF THE MONITORING SURVEY OF EACH SURVEY MARKER.

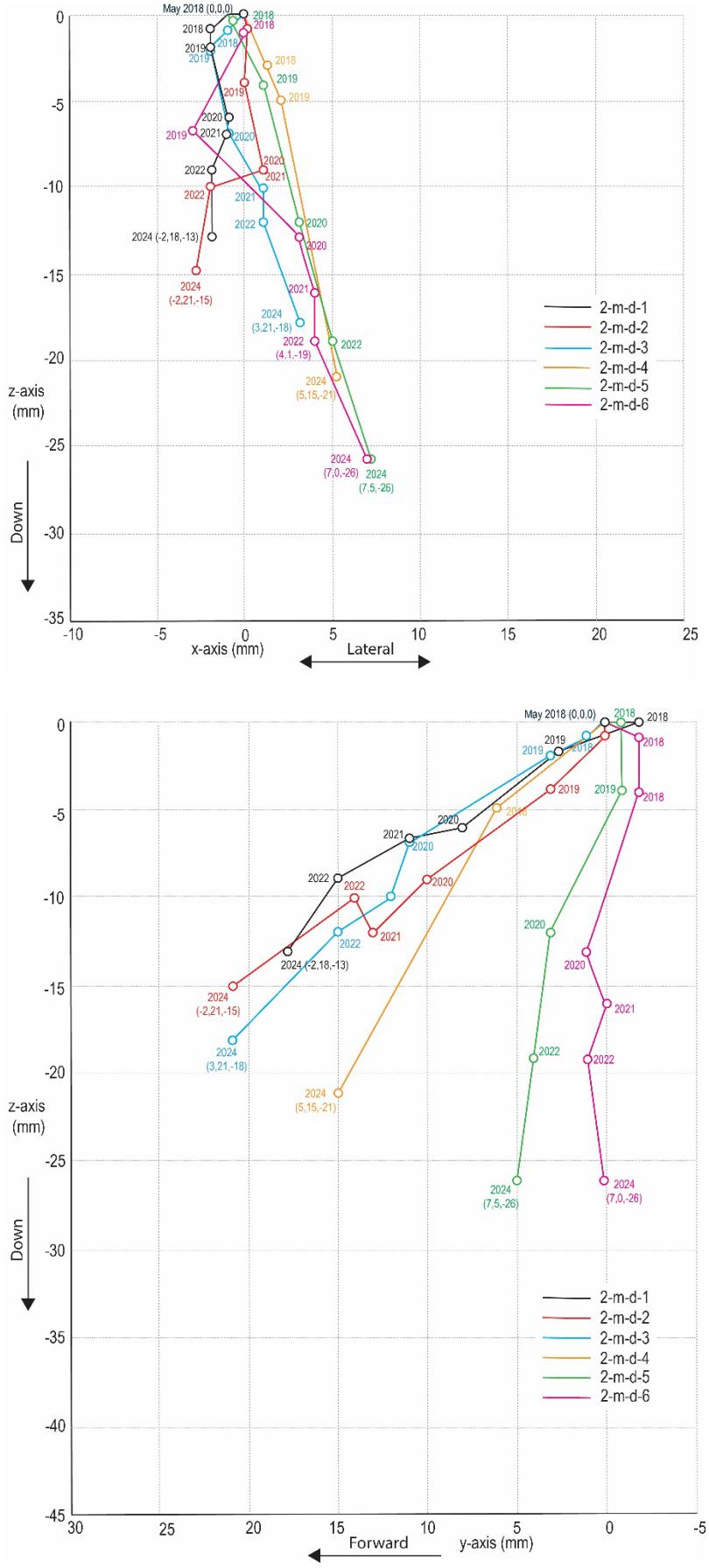


FIGURE 18 - AREA 2, LINE D, LATERAL AND FORWARD MOVEMENT 2D

5. Area 3 Results

JUNE 2024 COORDS - AREA 3

POINT	X (m)	Y (m)	Z (m)
3-m-a-1	3500.039	3502.912	101.412
3-m-a-2	3500.174	3503.339	102.274
3-m-a-3	3500.27	3503.621	102.917
3-m-a-4	3500.366	3504.13	104.024

FIGURE 19 - TABLE OF AREA 3 FINAL COORDINATES, JUNE 2024

AREA 3 3D VECTOR SHIFTS – Annual & Cumulative

POINT	**VECTOR SHIFT (2015 - 2016)**	**VECTOR SHIFT (2016 - 2017)**	**VECTOR SHIFT (2017 – 2018)**	**VECTOR SHIFT (2018 - 2020) Two years**	**VECTOR SHIFT (2020 – 2021)**	**VECTOR SHIFT (2021 - 2022)**	**VECTOR SHIFT (21 months) Sept 2022 –June 2024**	**VECTOR SHIFT (2015 -2024) Nine-years cumulative**
3-m-a-1	0.002m	0.001m	0.001m	0.003m	0.000m	0.001m	0.001m	0.002m
3-m-a-2	0.000m	0.001m	0.001m	0.003m	0.000m	0.004m	0.005m	0.002m
3-m-a-3	0.004m	0.000m	0.001m	0.003m	0.002m	0.002m	0.001m	0.005m
3-m-a-4	0.003m	0.001m	0.003m	0.007m	0.002m	0.002m	0.002m	0.009m

FIGURE 20 - AREA 3, ANNUAL VECTOR SHIFT, AND THE OVERALL CUMULATIVE VECTOR CALCULATED FROM ORIGINAL TO LATEST POSITION. THIS IS NOT THE SUM OF THE ANNUAL SHIFTS AS MOVEMENT IS NOT NECESSARILY LINEAR.

COMMENT

Reading 3-m-a-4 slightly above tolerance, but in general cumulative vector shifts over 9 years are small indicating general stability.

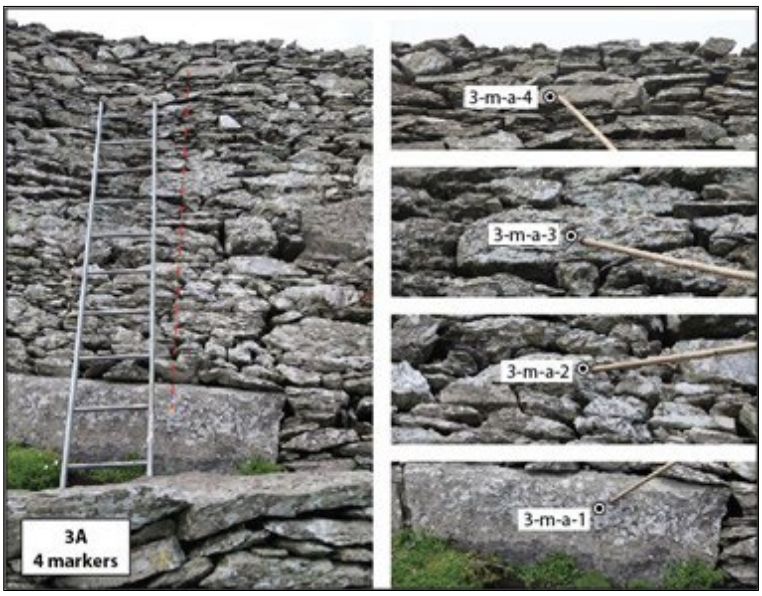


FIGURE 21- SURVEY MARKERS IN AREA 3

6. Area 4 Results

JUNE 2024 COORDS - AREA 4

POINT	X (m)	Y (m)	Z (m)
4-m-a-1	4533.268	4546.02	141.03
4-m-a-2	4533.218	4546.118	141.684
4-m-a-3	4533.313	4546.118	142.12
4-m-b-1	4542.385	4539.617	142.314
4-m-b-2	4542.6	4539.704	142.73
4-m-b-3	4542.693	4539.752	143.048
4-m-b-4	4542.723	4539.812	143.393
4-m-c-1	4543.368	4537.936	141.664
4-m-c-2	4543.814	4538.098	142.29
4-m-c-3	4544.078	4538.292	142.948
4-m-c-4	4544.126	4538.272	143.29
4-m-d-1	4546.25	4535.02	140.986
4-m-d-2	4546.316	4535.088	141.542
4-m-d-3	4546.302	4535.172	141.887

FIGURE 22 - TABLE OF AREA 4 FINAL COORDINATES, SEPTEMBER 2022

AREA 4 VECTOR SHIFTS – Annual & Cumulative

POINT	**VECTOR SHIFT (2017 -2018)**	**VECTOR SHIFT (2018 - 2020) Two years**	**VECTOR SHIFT (2020 - 2021)**	**VECTOR SHIFT (2021 - 2022**	**VECTOR SHIFT (21 months) Sept 2022 –June 2024**	**VECTOR SHIFT (2017-2024) Seven years cumulative**
4-m-a-1	0.003m	0.003m	0.008m	0.001m	0.004m	0.014m
4-m-a-2	0.002m	0.012m	0.003m	0.002m	0.002m	0.018m
4-m-a-3	0.003m	0.007m	0.003m	0.001m	0.003m	0.013m
4-m-b-1	0.005m	0.048m	0.110m	n/a	n/a	0.028m
4-m-b-2	0.004m	0.012m	0.005m	0.001m	n/a	n/a
4-m-b-3	0.003m	0.003m	0.002m	0.001m	0.004m	0.005m
4-m-b-4	0.002m	0.002m	0.004m	0.002m	0.002m	0.004m
4-m-c-1	0.002m	0.014m	0.013m	0.005m	0.016m	0.018m
4-m-c-2	0.003m	0.018m	0.013m	0.002m	n/a	n/a
4-m-c-3	0.002m	0.005m	0.002m	0.002m	0.003m	0.005m
4-m-c-4	0.003m	0.005m	0.001m	0.002m	0.005m	0.007m
4-m-d-1	0.002m	0.005m	0.001m	0.002m	0.003m	0.007m
4-m-d-2	0.004m	0.006m	0.003m	0.000m	0.002m	0.007m
4-m-d-3	0.002m	0.005m	0.005	0.002m	0.003m	0.005m

FIGURE 23 - AREA 4, ANNUAL VECTOR SHIFT, AND THE OVERALL CUMULATIVE VECTOR CALCULATED FROM ORIGINAL TO LATEST POSITION. THIS IS NOT THE SUM OF THE ANNUAL SHIFTS AS MOVEMENT IS NOT NECESSARILY LINEAR. READINGS AFFECTED BY VEGETATION GROWTH OBSCURING MARKERS 4-M-B-1 & 4-M-C-1

COMMENT

Area 4 monitoring markers are located on the south and southwest-facing walls of the terraces high on the South Peak, with observations taken from a resection position to the south, above Christ's Saddle. As noted in previous reports, this requires observations over longer distances (70-80m) and at acute angles (45°), which is the only feasible solution for these challenging locations. Consequently, slightly larger values might be expected due to potential sighting errors. These errors are compounded by poor weather conditions, such as low cloud, mist, or bright sunlight causing shimmer or haze.

The 2024 survey results indicate significant movements in two markers since 2022. Marker 4-m-b-1 continues to show abnormal values, likely due to vegetation interference, similar to the values for 4-m-c-1, which was intermittently obscured by vegetation during observation. These markers require rope access to clear survey sightlines and should be evaluated for inclusion in future surveys.

More notably, for the first time, there is an indication of a significant movement trend developing over the seven-year observation period in Area 4. This downward and forward trend appears to be restricted to Line A, with cumulative values of 13-18mm, though it remains modest.

4-m-a-1, 4-m-a-2, 4-m-a-3, from bottom

4-m-b-1, 4-m-b-2, 4-m-b-3, 4-m-b-4 from bottom

4-m-c-1, 4-m-c-2, 4-m-c-3, 4-m-c-4 from bottom

4-m-d-1, 4-m-d-2, 4-m-d-3, from bottom

FIGURE 24 - SURVEY MARKERS IN AREA 4

7. Area 5 Results

JUNE 2024 COORDS - AREA 5

POINT	EAST	NORTH	ELEVATION
5-m-a-1	5505.184	5508.873	107.788
5-m-a-2	5505.182	5509.284	108.429
5-m-b-1	5505.626	5507.542	107.114
5-m-b-2	5505.909	5507.822	107.564
5-m-b-3	5505.807	5507.734	107.772
5-m-b-4	5506.074	5507.983	108.36
5-m-c-1	5506.269	5506.68	106.749
5-m-c-2	5506.62	5506.98	107.698
5-m-c-3	5506.751	5507.186	108.333
5-m-d-1	n/a	n/a	n/a
5-m-d-2	5506.784	5506.02	106.762
5-m-d-3	5506.848	5506.013	107.3
5-m-d-4	5506.956	5506.176	107.82

FIGURE 25 - TABLE OF AREA 5 FINAL COORDINATES, JUNE 2024

AREA 5 3D VECTOR SHIFTS – Annual & Cumulative

POINT	**VECTOR SHIFT (2017 -2018)**	**VECTOR SHIFT (2018 - 2020) Two years**	**VECTOR SHIFT (2020 - 2021)**	**VECTOR SHIFT (2021 - 2022)**	**VECTOR SHIFT (21 months) Sept 2022 – June 2024**	**VECTOR SHIFT (2017-2024) Seven years cumulative**
5-m-a-1	0.001m	0.005m	0.001m	0.002m	0.003m	0.007m
5-m-a-2	0.001m	0.003m	0.001m	0.000m	0.001m	0.006m
5-m-b-1	0.001m	0.009m	0.005m	0.005m	0.005m	0.016m
5-m-b-2	0.000m	0.003m	0.002m	0.001m	0.002m	0.006m
5-m-b-3	0.001m	0.005m	0.001m	0.001m	0.002m	0.008m
5-m-b-4	0.008m	0.019m	0.011m	0.003m	0.008m	0.012m
5-m-c-1	0.001m	0.004m	0.001m	0.001m	0.001m	0.006m
5-m-c-2	0.004m	0.006m	0.001m	0.002m	0.002m	0.007m
5-m-c-3	0.007m	0.008m	0.000m	0.000m	0.008m	0.002m
5-m-d-1	0.003m	0.003m	0.002m	0.001m	0.002m	0.005m
5-m-d-2	0.001m	0.003m	0.001m	0.000m	0.001m	0.005m
5-m-d-3	0.001m	0.003m	0.001m	0.000m	0.001m	0.005m
5-m-d-4	0.002m	n/a	n/a	0.000m	0.003m	0.009m

FIGURE 26 - AREA 5, ANNUAL VECTOR SHIFT, AND THE OVERALL CUMULATIVE VECTOR CALCULATED FROM ORIGINAL TO LATEST POSITION. THIS IS NOT THE SUM OF THE ANNUAL SHIFTS AS MOVEMENT IS NOT NECESSARILY LINEAR

COMMENT

The 2024 observations show good consistency with the previous years, and the low cumulative vector change over the seven year (2017-2024) indicate general stability in Area 5. Some minor shifts may have been associated with vegetation or movement of stones as this area is adjacent to the routeway to the south peak via the eye of the needle.

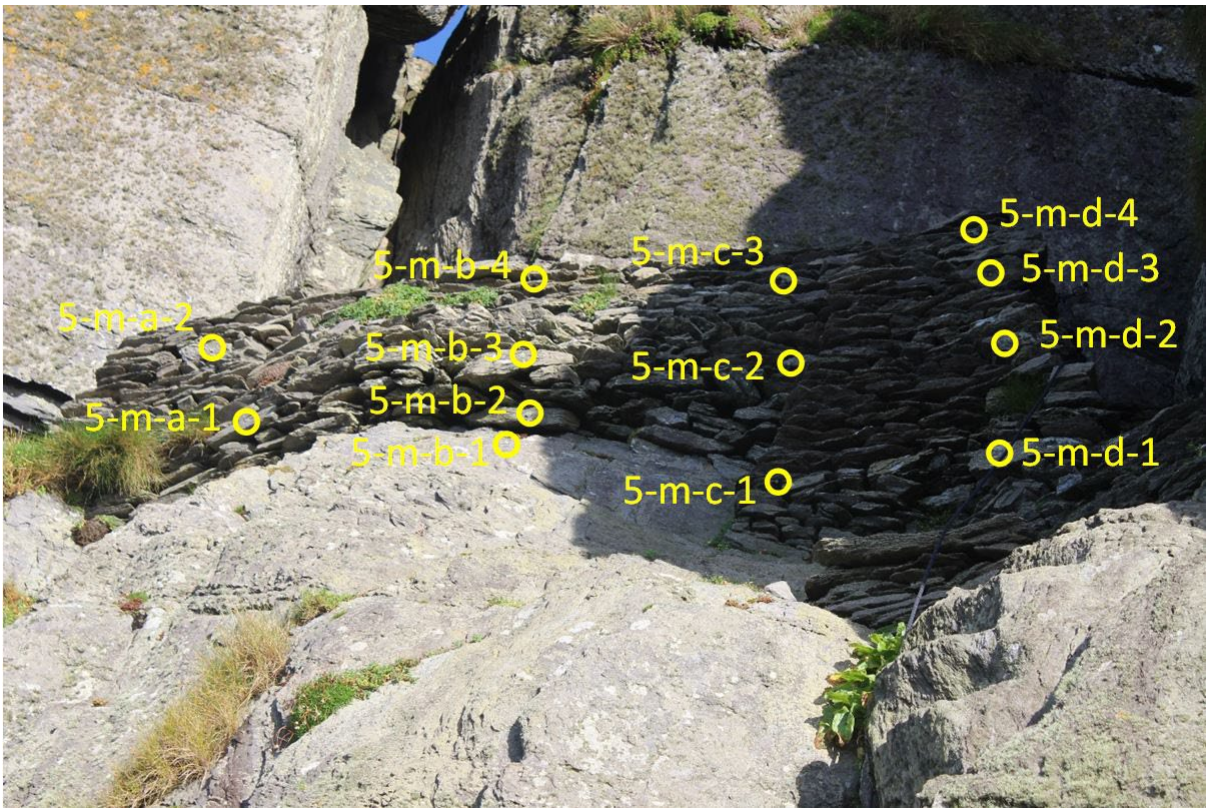


FIGURE 27 - SURVEY MARKERS IN AREA 5

8. Area 6 Results

JUNE 2024 COORDS - AREA 6

POINT	X (m)	Y (m)	Z (m)
6-m-a-1	6499.126	6517.84	101.052
6-m-a-2	6499.182	6517.82	101.506
6-m-a-3	6499.147	6517.836	102.058
6-m-a-4	6499.193	6517.904	102.59
6-m-b-1	6504.432	6516.678	104.414
6-m-b-2	6504.362	6516.8	105.107
6-m-b-3	6504.549	6516.898	105.669
6-m-c-1	6507.325	6509.213	103.886
6-m-c-2	6507.863	6509.882	104.484
6-m-c-3	6507.944	6509.785	104.842
6-m-c-4	6508.001	6509.862	105.245
6-m-d-1	6507.283	6506.216	103.592
6-m-d-2	6507.354	6506.322	103.876
6-m-d-3	6507.375	6506.288	104.398
6-m-e-1	6505.571	6503.285	103.403
6-m-e-2	6505.669	6503.196	103.838
6-m-e-3	6505.752	6503.148	104.42
6-m-f-1	6504.807	6502.071	102.695
6-m-f-2	6505.436	6502.682	103.487
6-m-f-3	6505.475	6502.578	103.884
6-m-f-4	6505.59	6502.521	104.488
6-m-g-1	6500.625	6494.16	96.959
6-m-g-2	6500.65	6494.068	97.169
6-m-g-3	6500.775	6494.188	97.578

FIGURE 28 - TABLE OF AREA 6 FINAL COORDINATES, JUNE 2024

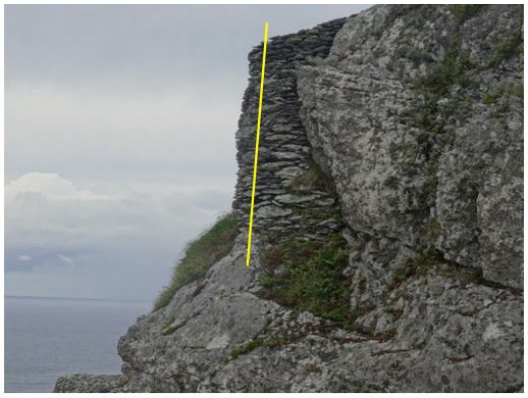
AREA 6 3D VECTOR SHIFTS – Annual & Cumulative

POINT	VECTOR SHIFT (2017 -2018)	VECTOR SHIFT (2018 - 2020) Two years	VECTOR SHIFT (2020 - 2021)	VECTOR SHIFT (2021 - 2022)	VECTOR SHIFT (21 months) Sept 2022 – June 2024	VECTOR SHIFT (2017 - 2024) Seven years cumulative
6-m-a-1	0.003m	0.003m	0.002m	0.001m	0.001m	0.003m
6-m-a-2	0.003m	0.004m	0.002m	0.002m	0.001m	0.004m
6-m-a-3	0.001m	0.004m	0.001m	0.001m	0.002m	0.006m
6-m-a-4	0.002m	0.008m	0.003m	0.002m	0.000m	0.007m
6-m-b-1	0.001m	0.004m	0.002m	0.004m	0.004m	0.006m
6-m-b-2	0.001m	0.005m	0.001m	0.001m	0.001m	0.005m
6-m-b-3	0.001m	0.005m	0.001m	0.002m	0.001m	0.005m
6-m-c-1	0.002m	0.013m	0.008m	0.021m	0.002m	0.001m
6-m-c-2	0.001m	0.018m	0.004m	0.008m	0.001m	0.008m
6-m-c-3	0.001m	0.003m	0.001m	0.003m	0.002m	0.004m
6-m-c-4	0.002m	0.003m	0.001m	0.002m	0.002m	0.004m
6-m-d-1	0.001m	n/a	n/a	n/a	n/a	0.004m
6-m-d-2	0.001m	0.002m	0.003m	0.002m	0.002m	0.001m
6-m-d-3	0.001m	0.003m	0.001m	0.001m	0.001m	0.001m
6-m-e-1	0.001m	0.015m	0.014m	0.005m	0.005m	0.000m
6-m-e-2	0.001m	0.024m	0.019m	0.002m	0.008m	0.011m
6-m-e-3	0.002m	0.004m	0.001m	0.002m	0.001m	0.006m
6-m-f-1	0.002m	0.002m	0.003m	0.001m	0.001m	0.001m
6-m-f-2	0.004m	0.005m	0.010m	n/a	n/a	0.009m
6-m-f-3	0.003m	0.002m	n/a	n/a	0.001m	0.004m
6-m-f-4	0.005m	0.009m	0.001m	0.002m	0.002m	0.008m
6-m-g-1	0.002m	0.001m	0.001m	0.002m	0.002m	0.001m
6-m-g-2	0.002m	0.001m	0.003m	0.001m	0.001m	0.003m
6-m-g-3	0.004m	0.001m	0.002m	0.001m	0.001m	0.001m

FIGURE 29 - AREA 6, ANNUAL VECTOR SHIFT, AND THE OVERALL CUMULATIVE VECTOR CALCULATED FROM ORIGINAL TO LATEST POSITION. THIS IS NOT THE SUM OF THE ANNUAL SHIFTS AS MOVEMENT IS NOT NECESSARILY LINEAR.

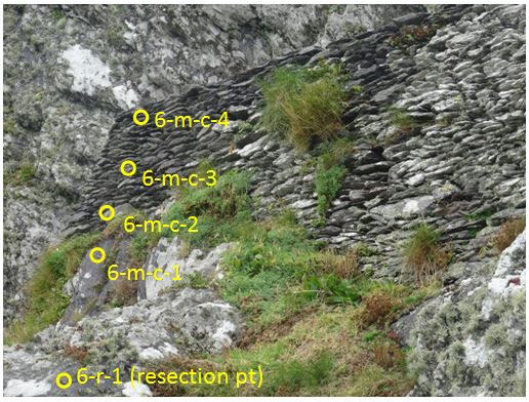
COMMENT

The vector shifts measured at Area 6 over the 2017-2024 seven-year observation period are generally within tolerance and continue to indicate no significant change. Sightlines were cleared in advance of the survey, returning a reading for all the markers in the area for the first time since the monitoring began.



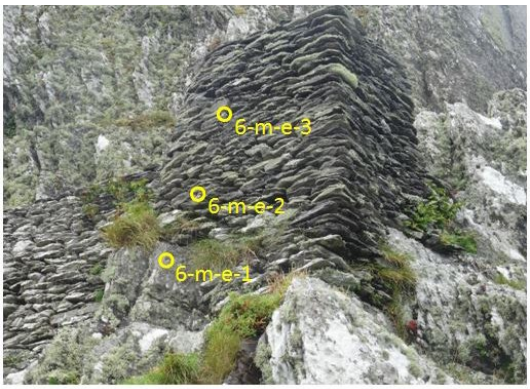
6-m-a-1, 6-m-a-2, 6-m-a-3, 6-m-a-4 from bottom

6-m-b-1, 6-m-b-2, 6-m-b-3 from bottom

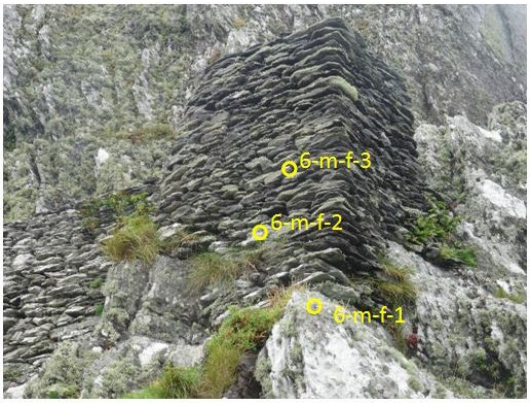


6-m-c-1, 6-m-c-2, 6-m-c-3, 6-m-c-4

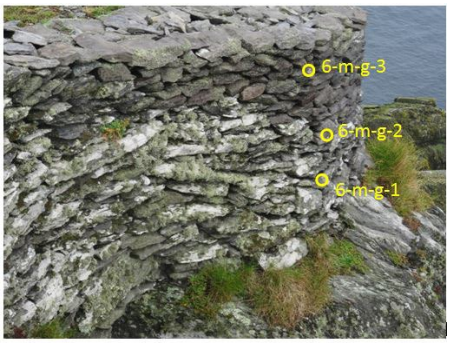
6-m-d-1, 6-m-d-2, 6-m-d-3



6-m-e-1, 6-m-e-2, 6-m-e-3



6-m-f-1, 6-m-f-2, 6-m-f-3



6-m-g-1, 6-m-g-2, 6-m-g-3

FIGURE 26 - SURVEY MARKERS IN AREA 6

9. Area 7 results

JUNE 2024 COORDS - AREA 7

POINT	EAST	NORTH	ELEVATION
7-m-a-1	7507.500	7503.246	96.440
7-m-a-2	7507.474	7503.244	96.660
7-m-a-3	7507.437	7503.215	96.985
7-m-a-4	7507.446	7503.142	97.279
7-m-b-1	7506.812	7500.076	98.284
7-m-b-2	7506.801	7500.051	98.442

FIGURE 27- TABLE OF AREA 7 FINAL COORDINATES, JUNE 2024

AREA 7 VECTOR SHIFTS – Annual & Cumulative

POINT	VECTOR SHIFT (2017 -2018)	VECTOR SHIFT (2018-2020) Two years	VECTOR SHIFT (2020 - 2021)	VECTOR SHIFT (2021 - 2022)	VECTOR SHIFT (21 months) Sept 2022 – June 2024	VECTOR SHIFT (2017-2024) Seven years cumulative
7-m-a-1	0.002m	0.003m	0.005m	0.001m	0.004m	0.005m
7-m-a-2	0.002m	0.002m	0.001m	0.002m	0.002m	0.004m
7-m-a-3	0.002m	0.003m	0.006m	0.001m	0.003m	0.004m
7-m-a-4	0.002m	0.001m	0.001m	0.001m	0.002m	0.002m
7-m-b-1	0.002m	0.001m	0.001m	0.000m	0.002m	0.001m
7-m-b-2	0.004m	0.002m	0.001m	0.000m	0.001m	0.002m

FIGURE 28 - AREA 7, ANNUAL VECTOR SHIFT, AND THE OVERALL CUMULATIVE VECTOR CALCULATED FROM ORIGINAL TO LATEST POSITION. THIS IS NOT THE SUM OF THE ANNUAL SHIFTS AS MOVEMENT IS NOT NECESSARILY LINEAR.

COMMENT

The 2024 survey results show that all Area 7 markers are within tolerance over the seven-year 2017-2024 period.

7-m-a-1, 7-m-a-2, 7-m-a-3, 7-m-a-4

7-m-b-1, 7-m-b-2

FIGURE 29 - SURVEY MARKERS IN AREA 7

10. Conclusions

Area 2, the retaining wall below St Michael's Church, still presents the largest vector shifts, and subsequently the greatest concern. As in previous years the results should be considered by the OPW engineers alongside other scientific evidence when considering appropriate responses.

To create a more detailed record of the wall additional survey data in the form of terrestrial laser scanning and photogrammetric imagery was captured. The laser scan data will be compared with similar data from 2015 and the resulting deformation model should help understand the dynamics of the wall over time. The photogrammetric model will add texture and reveal the different phases of conservation work which have taken place to date. This analysis will be presented in a separate auxiliary report to follow.

Finally, vegetation growth, identified as an issue last year remains a significant problem, particularly on the South Peak. Inspection of all network points in advance of the survey would be good practice and increase confidence in the survey data.

Robert Shaw

The Discovery Programme

July 2024

Appendix I - Resection Networks

Area 1

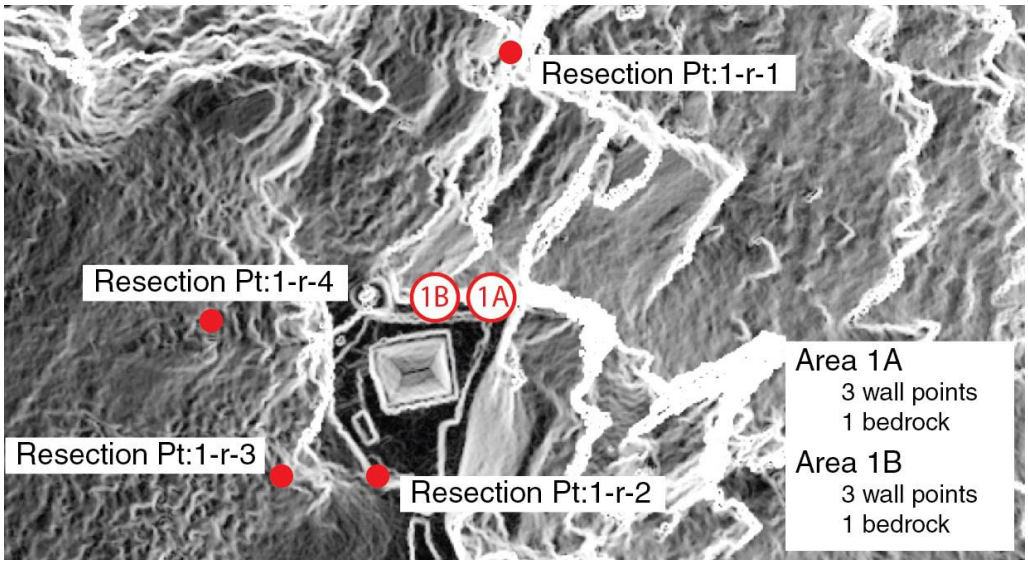


FIGURE I - PLAN LOCATING RESECTION CONTROL NETWORK FOR AREA 1

FIGURE I - PHOTOS TO IDENTIFY AREAS 1 RESECTION MARKERS

Area 2

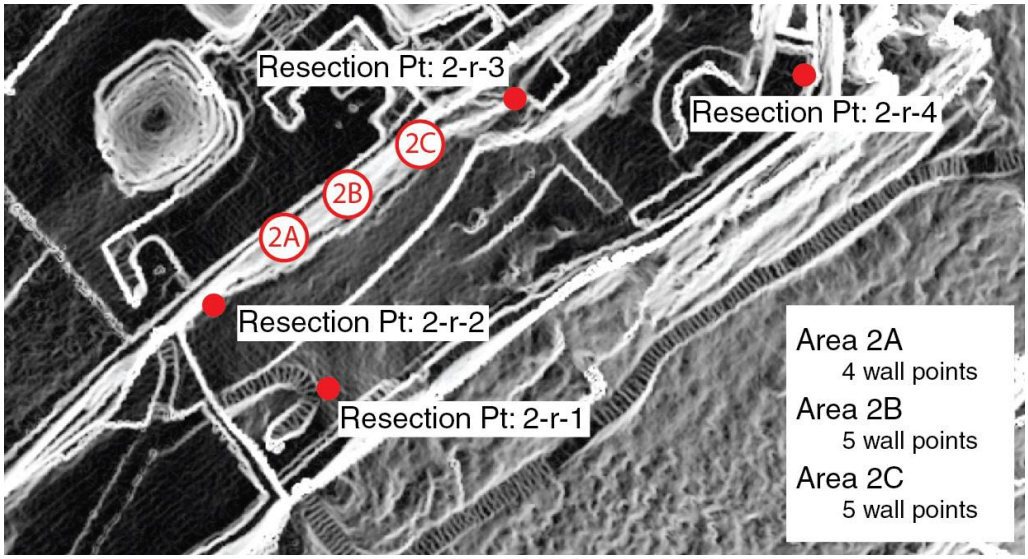


FIGURE II - PLAN LOCATING RESECTION CONTROL NETWORK FOR AREA 2

FIGURE III - PHOTOS TO IDENTIFY AREAS 2 RESECTION MARKERS

Area 3

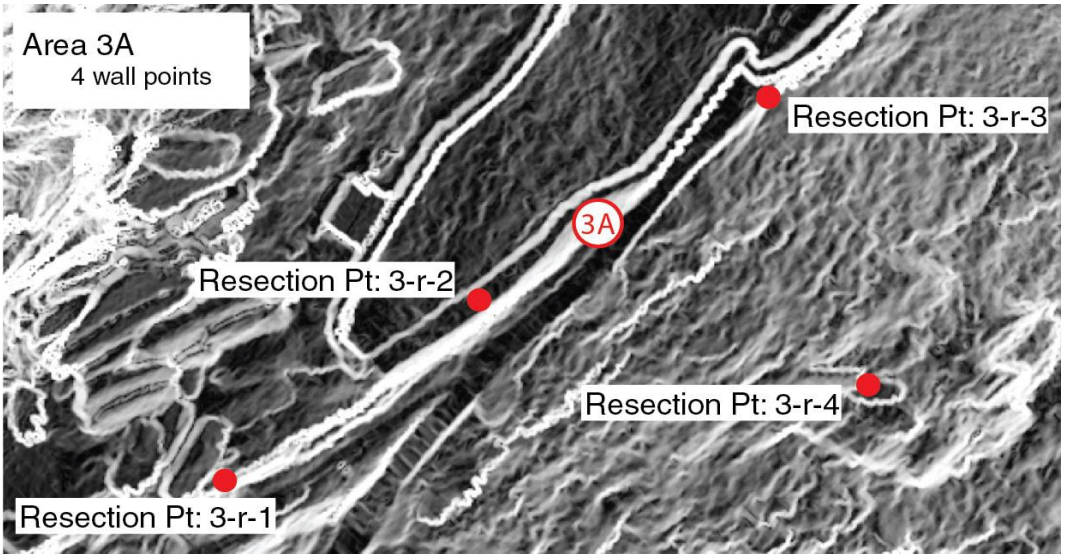


FIGURE IV - PLAN LOCATING RESECTION CONTROL NETWORK FOR AREA 3

FIGURE V - PHOTOS TO IDENTIFY AREAS 3 RESECTION MARKERS

Area 4

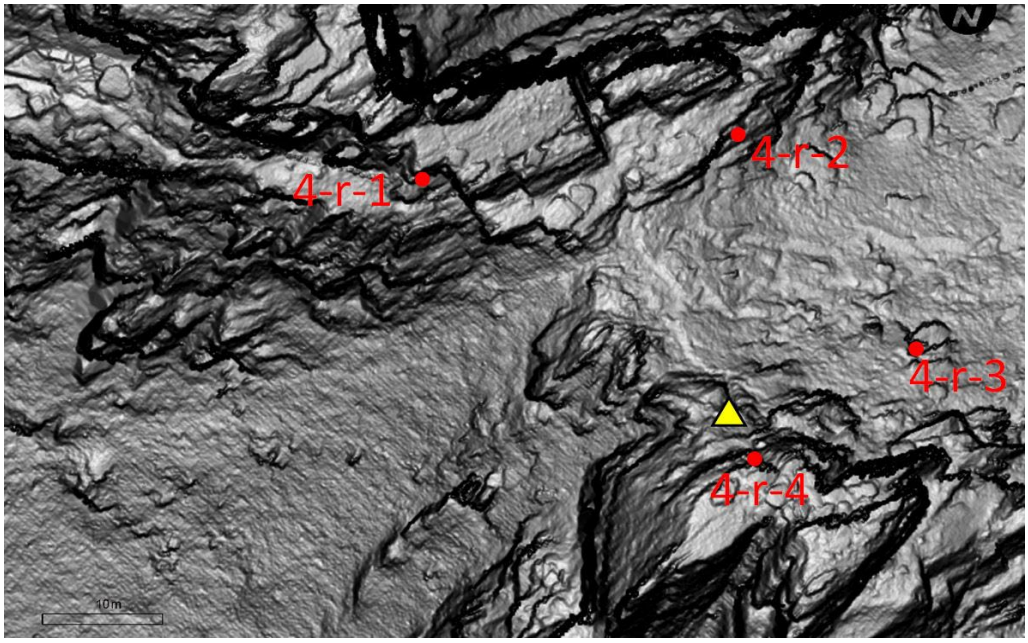


FIGURE VI - PLAN LOCATING RESECTION CONTROL NETWORK FOR AREA 4

FIGURE VII PHOTOS TO IDENTIFY AREAS 4 RESECTION MARKERS

Area 5

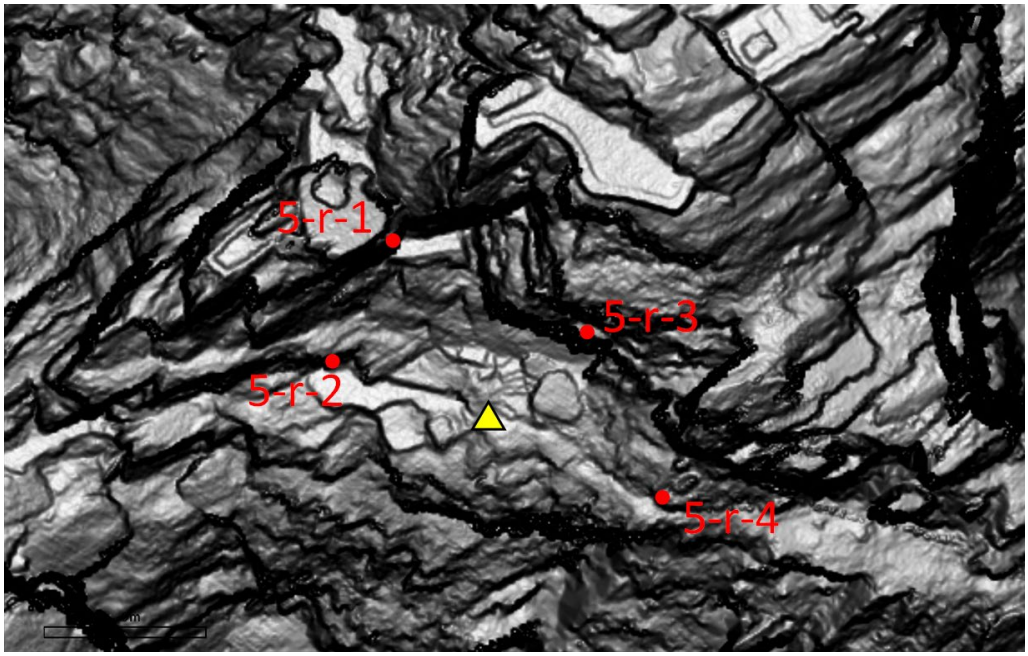


FIGURE VIII - PLAN LOCATING RESECTION CONTROL NETWORK FOR AREA 5

FIGURE IX - PHOTOS TO IDENTIFY AREAS 5 RESECTION MARKERS

Area 6

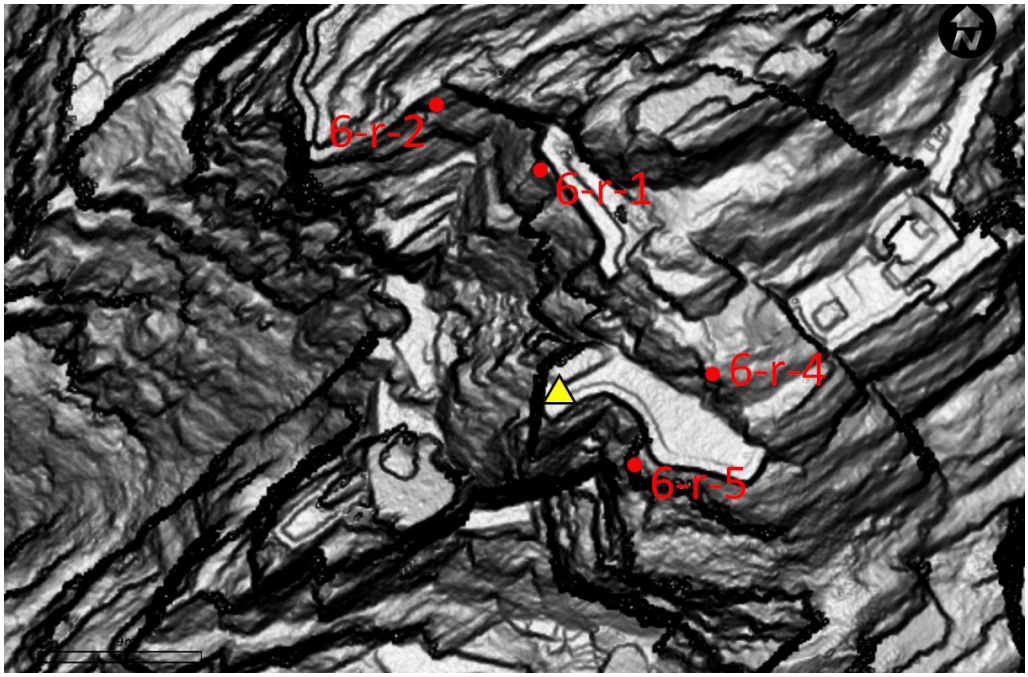


FIGURE X PLAN LOCATING RESECTION CONTROL NETWORK FOR AREA 6

FIGURE XI - PHOTOS TO IDENTIFY AREAS 6 RESECTION MARKERS

Area 7

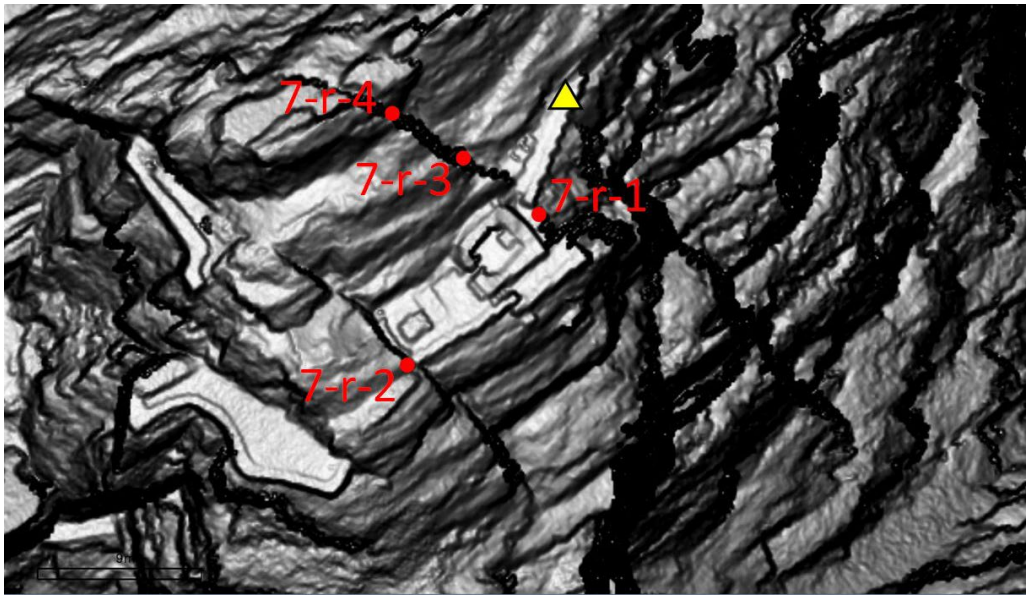


FIGURE XII - PLAN LOCATING RESECTION CONTROL NETWORK FOR AREA 6

7-r-3 (approx.)

7-r-4

7-r-1

7-r-2

FIGURE XIII - PHOTOS TO IDENTIFY AREAS 7 RESECTION MARKERS

Appendix II - Resection Point Coordinate Lists

Area 1

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
1-r-1	1493.380	1490.603	101.814
1-r-2	1503.874	1518.655	96.169
1-r-3	1508.541	1517.604	99.624
1-r-4	1511.401	1508.181	105.085

Area 2

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
2-r-1	2495.86	2500.888	102.184
2-r-2	2494.024	2509.697	106.525
2-r-3	2509.455	2510.428	105.374
2-r-4	2529.449	2501.391	97.352

Area 3

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
3-r-1	3471.063	3509.188	103.28
3-r-2	3493.696	3503.877	101.411
3-r-3	3516.941	3499.897	98.889
3-r-4	3503.643	3484.744	88.498

Area 4

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
4-r-1	4515.563	4523.675	103.916
4-r-2	4522.681	4500.303	90.815
4-r-3	4508.317	4487.155	88.061
4-r-4	4496.091	4498.067	102.521

Area 5

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
5-r-1	5505.584	5509.863	110.1
5-r-2	5492.348	5515.485	98.521
5-r-3	5507.077	5497.315	102.117
5-r-4	5501.321	5490.037	98.23

Area 6

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
6-r-1	6505.561	6507.147	102.375
6-r-2	6505.737	6515.834	104.464
6-r-4	6505.355	6493.549	99.289
6-r-5	6500.437	6493.73	96.62

Area 7

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
7-r-1	7506.146	7500.693	97.826
7-r-2	7515.189	7494.625	100.349
7-r-3	7504.306	7497.76	99.985
7-r-4	7503.356	7493.865	104.055

Appendix III - Annual Monitoring Point Coordinate Lists from previous surveys (2015 – 2022)

2015

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
1-m-a-1	1495.302	1509.924	95.182
1-m-a-2	1495.351	1509.933	94.597
1-m-a-3	1495.377	1510.053	93.85
1-m-a-4	1495.426	1510.366	92.447
1-m-b-1	1497.838	1509.399	95.346
1-m-b-2	1497.78	1509.303	94.948
1-m-b-3	1497.795	1509.325	94.582
1-m-b-4	1497.884	1509.427	93.862
2-m-a-1	2498.728	2508.743	105.221
2-m-a-2	2498.838	2509.548	106.613
2-m-a-3	2498.878	2510.125	108.045
2-m-a-4	2499.013	2510.691	109.548
2-m-b-1	2503.962	2508.937	104.312
2-m-b-2	2503.999	2509.601	105.863
2-m-b-3	2504.08	2510.232	107.014
2-m-b-4	2503.995	2510.634	107.907
2-m-b-5	2503.99	2510.973	109.189
2-m-c-1	2507.654	2509.714	104.024
2-m-c-2	2507.525	2510.153	105.119
2-m-c-3	2507.452	2510.739	106.626
2-m-c-4	2507.383	2510.963	107.666
2-m-c-5	2507.346	2511.14	108.271
3-m-a-1	3500.04	3502.913	101.414
3-m-a-2	3500.175	3503.338	102.276
3-m-a-3	3500.269	3503.617	102.92
3-m-a-4	3500.365	3504.123	104.029

2016

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
1-m-a-1	1495.302	1509.923	95.182
1-m-a-2	1495.35	1509.933	94.597
1-m-a-3	1495.376	1510.053	93.85
1-m-a-4	1495.426	1510.366	92.446
1-m-b-1	1497.838	1509.399	95.346
1-m-b-2	1497.78	1509.303	94.948
1-m-b-3	1497.795	1509.321	94.584
1-m-b-4	1497.883	1509.427	93.862
2-m-a-1	2498.727	2508.738	105.219
2-m-a-2	2498.838	2509.544	106.61
2-m-a-3	2498.878	2510.122	108.042
2-m-a-4	2499.012	2510.687	109.544
2-m-b-1	2503.967	2508.935	104.31
2-m-b-2	2503.999	2509.598	105.861

2-m-b-3	2504.08	2510.229	107.012
2-m-b-4	2503.995	2510.629	107.903
2-m-b-5	2503.987	2510.97	109.186
2-m-c-1	2507.655	2509.713	104.023
2-m-c-2	2507.524	2510.151	105.119
2-m-c-3	2507.452	2510.735	106.624
2-m-c-4	2507.382	2510.96	107.665
2-m-c-5	2507.346	2511.139	108.27
3-m-a-1	3500.041	3502.914	101.413
3-m-a-2	3500.175	3503.338	102.276
3-m-a-3	3500.269	3503.621	102.921
3-m-a-4	3500.366	3504.126	104.03

2017

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
1-m-a-1	1495.302	1509.924	95.182
1-m-a-2	1495.351	1509.932	94.598
1-m-a-3	1495.377	1510.054	93.85
1-m-a-4	1495.427	1510.365	92.447
1-m-b-1	1497.838	1509.399	95.346
1-m-b-2	1497.78	1509.303	94.948
1-m-b-3	1497.795	1509.324	94.582
1-m-b-4	1497.885	1509.427	93.862
2-m-a-1	2498.727	2508.734	105.216
2-m-a-2	2498.838	2509.541	106.607
2-m-a-3	2498.878	2510.119	108.037
2-m-a-4	2499.013	2510.682	109.539
2-m-b-1	2503.967	2508.93	104.306
2-m-b-2	2504	2509.593	105.857
2-m-b-3	2504.081	2510.226	107.008
2-m-b-4	2503.995	2510.626	107.899
2-m-b-5	2503.987	2510.966	109.182
2-m-c-1	2507.656	2509.711	104.021
2-m-c-2	2507.526	2510.15	105.117
2-m-c-3	2507.453	2510.734	106.623
2-m-c-4	2507.383	2510.958	107.663
2-m-c-5	2507.345	2511.136	108.267
3-m-a-1	3500.041	3502.914	101.414
3-m-a-2	3500.175	3503.339	102.276
3-m-a-3	3500.269	3503.621	102.921
3-m-a-4	3500.367	3504.127	104.03
4-m-a-1	4533.276	4546.03	141.04
4-m-a-2	4533.228	4546.132	141.694
4-m-a-3	4533.32	4546.128	142.129
4-m-b-1	4542.404	4539.635	142.335
4-m-b-2	4542.659	4539.757	142.788
4-m-b-3	4542.696	4539.753	143.051

4-m-b-4	4542.724	4539.814	143.395
4-m-c-1	4543.359	4537.924	141.652
4-m-c-2	4544.076	4538.323	142.539
4-m-c-3	4544.081	4538.296	142.95
4-m-c-4	4544.129	4538.275	143.294
4-m-d-1	4546.254	4535.025	140.991
4-m-d-2	4546.319	4535.093	141.545
4-m-d-3	4546.305	4535.176	141.891
5-m-a-1	5505.187	5508.877	107.791
5-m-a-2	5505.185	5509.288	108.433
5-m-b-1	5505.632	5507.551	107.121
5-m-b-2	5505.913	5507.826	107.567
5-m-b-3	5505.812	5507.74	107.775
5-m-b-4	5506.077	5507.986	108.361
5-m-c-1	5506.273	5506.682	106.75
5-m-c-2	5506.621	5506.983	107.7
5-m-c-3	5506.747	5507.184	108.325
5-m-d-1	5506.787	5506.025	106.764
5-m-d-2	5506.851	5506.018	107.303
5-m-d-3	5506.959	5506.18	107.823
5-m-d-4	5507.106	5506.39	108.269
6-m-a-1	6499.125	6517.846	101.052
6-m-a-2	6499.181	6517.827	101.507
6-m-a-3	6499.146	6517.842	102.06
6-m-a-4	6499.195	6517.906	102.595
6-m-b-1	6504.433	6516.684	104.414
6-m-b-2	6504.363	6516.803	105.108
6-m-b-3	6504.55	6516.902	105.671
6-m-c-1	6507.326	6509.215	103.885
6-m-c-2	6507.869	6509.885	104.487
6-m-c-3	6507.948	6509.787	104.844
6-m-c-4	6508.002	6509.862	105.247
6-m-d-1	6507.285	6506.218	103.594
6-m-d-2	6507.354	6506.323	103.876
6-m-d-3	6507.375	6506.289	104.399
6-m-e-1	6505.57	6503.284	103.403
6-m-e-2	6505.676	6503.199	103.844
6-m-e-3	6505.755	6503.146	104.423
6-m-f-1	6504.805	6502.07	102.694
6-m-f-2	6505.44	6502.683	103.489
6-m-f-3	6505.475	6502.577	103.885
6-m-f-4	6505.594	6502.523	104.492
6-m-g-1	6500.625	6494.162	96.961
6-m-g-2	6500.65	6494.067	97.169
6-m-g-3	6500.774	6494.192	97.58
7-m-a-1	7507.507	7503.244	96.44
7-m-a-2	7507.479	7503.242	96.661

7-m-a-3	7507.44	7503.212	96.987
7-m-a-4	7507.448	7503.141	97.281
7-m-b-1	7506.815	7500.075	98.283
7-m-b-2	7506.803	7500.05	98.442

2018 May

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
2-m-a-1	2498.726	2508.729	105.213
2-m-a-2	2498.838	2509.537	106.603
2-m-a-3	2498.878	2510.116	108.033
2-m-a-4	2499.012	2510.68	109.536
2-m-b-1	2503.968	2508.924	104.302
2-m-b-2	2504.001	2509.591	105.854
2-m-b-3	2504.081	2510.222	107.004
2-m-b-4	2503.994	2510.623	107.896
2-m-b-5	2503.987	2510.965	109.179
2-m-c-1	2507.658	2509.709	104.02
2-m-c-2	2507.525	2510.147	105.116
2-m-c-3	2507.452	2510.731	106.621
2-m-c-4	2507.383	2510.956	107.661
2-m-c-5	2507.345	2511.134	108.266
2-m-d-1	2496.603	2509.199	105.649
2-m-d-2	2496.53	2509.633	106.56
2-m-d-3	2496.511	2509.851	107.48
2-m-d-4	2496.533	2510.237	108.437
2-m-d-5	2496.505	2510.705	109.221
2-m-d-6	2496.508	2510.757	109.768
2-m-e-1	2498.442	2505.064	102.071
2-m-e-2	2498.396	2505.086	102.597
2-m-e-3	2498.5	2505.143	103.002
2-m-f-1	2504.122	2505.93	101.108
2-m-f-2	2504.166	2505.983	101.609
2-m-f-3	2504.196	2506.031	101.942
2-m-f-4	2504.169	2506.062	102.627
2-m-g-1	2508.152	2507.049	100.875
2-m-g-2	2508.137	2507.128	101.497
2-m-g-3	2508.179	2507.169	101.998
2-m-g-4	2508.202	2507.244	102.465

2018 July

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
2-m-a-1	2498.726	2508.729	105.212
2-m-a-2	2498.838	2509.536	106.602
2-m-a-3	2498.879	2510.115	108.032
2-m-a-4	2499.013	2510.679	109.534

2-m-b-1	2503.969	2508.924	104.302
2-m-b-2	2504.001	2509.59	105.854
2-m-b-3	2504.082	2510.221	107.004
2-m-b-4	2503.995	2510.622	107.895
2-m-b-5	2503.988	2510.964	109.178
2-m-c-1	2507.658	2509.708	104.02
2-m-c-2	2507.527	2510.147	105.116
2-m-c-3	2507.453	2510.731	106.621
2-m-c-4	2507.383	2510.955	107.661
2-m-c-5	2507.343	2511.132	108.264
2-m-d-1	2496.602	2509.2	105.649
2-m-d-2	2496.529	2509.633	106.561
2-m-d-3	2496.511	2509.851	107.479
2-m-d-4	2496.534	2510.236	108.436
2-m-d-5	2496.505	2510.706	109.221
2-m-d-6	2496.508	2510.758	109.768
2-m-e-1	2498.442	2505.064	102.071
2-m-e-2	2498.396	2505.086	102.597
2-m-e-3	2498.5	2505.143	103.002
2-m-f-1	2504.123	2505.93	101.108
2-m-f-2	2504.165	2505.983	101.609
2-m-f-3	2504.195	2506.029	101.942
2-m-f-4	2504.17	2506.062	102.627
2-m-g-1	2508.152	2507.051	100.875
2-m-g-2	2508.136	2507.126	101.497
2-m-g-3	2508.178	2507.168	101.998
2-m-g-4	2508.201	2507.243	102.464

2018 September

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
1-m-a-1	1495.301	1509.924	95.181
1-m-a-2	1495.345	1509.938	94.592
1-m-a-3	1495.375	1510.055	93.848
1-m-a-4	1495.426	1510.366	92.446
1-m-b-1	1497.838	1509.399	95.345
1-m-b-2	1497.78	1509.302	94.948
1-m-b-3	1497.794	1509.322	94.582
1-m-b-4	1497.884	1509.427	93.861
2-m-a-1	2498.726	2508.728	105.212
2-m-a-2	2498.838	2509.537	106.602
2-m-a-3	2498.879	2510.116	108.031
2-m-a-4	2499.012	2510.679	109.533
2-m-b-1	2503.968	2508.922	104.301
2-m-b-2	2504.001	2509.59	105.854
2-m-b-3	2504.081	2510.22	107.003
2-m-b-4	2503.995	2510.622	107.894
2-m-b-5	2503.987	2510.964	109.177

2-m-c-1	2507.658	2509.709	104.02
2-m-c-2	2507.526	2510.147	105.116
2-m-c-3	2507.452	2510.731	106.62
2-m-c-4	2507.383	2510.955	107.66
2-m-c-5	2507.344	2511.133	108.265
2-m-d-1	2496.602	2509.201	105.649
2-m-d-2	2496.529	2509.632	106.559
2-m-d-3	2496.511	2509.851	107.479
2-m-d-4	2496.535	2510.231	108.432
2-m-d-5	2496.505	2510.706	109.221
2-m-d-6	2496.508	2510.759	109.767
2-m-e-1	2498.443	2505.063	102.071
2-m-e-2	2498.396	2505.085	102.597
2-m-e-3	2498.5	2505.142	103.001
2-m-f-1	2504.122	2505.93	101.108
2-m-f-2	2504.164	2505.983	101.609
2-m-f-3	2504.195	2506.03	101.941
2-m-f-4	2504.169	2506.061	102.627
2-m-g-1	2508.151	2507.052	100.875
2-m-g-2	2508.135	2507.127	101.497
2-m-g-3	2508.176	2507.167	101.998
2-m-g-4	2508.199	2507.242	102.464
3-m-a-1	3500.04	3502.914	101.414
3-m-a-2	3500.174	3503.34	102.276
3-m-a-3	3500.269	3503.622	102.921
3-m-a-4	3500.367	3504.13	104.031
4-m-a-1	4533.276	4546.029	141.037
4-m-a-2	4533.227	4546.131	141.692
4-m-a-3	4533.32	4546.127	142.126
4-m-b-1	4542.401	4539.633	142.331
4-m-b-2	4542.661	4539.76	142.787
4-m-b-3	4542.698	4539.752	143.049
4-m-b-4	4542.726	4539.814	143.394
4-m-c-1	4543.358	4537.923	141.651
4-m-c-2	4544.079	4538.323	142.539
4-m-c-3	4544.082	4538.295	142.949
4-m-c-4	4544.132	4538.274	143.293
4-m-d-1	4546.255	4535.024	140.989
4-m-d-2	4546.322	4535.092	141.543
4-m-d-3	4546.306	4535.175	141.889
5-m-a-1	5505.187	5508.878	107.792
5-m-a-2	5505.185	5509.287	108.433
5-m-b-1	5505.633	5507.551	107.12
5-m-b-2	5505.913	5507.826	107.567
5-m-b-3	5505.812	5507.739	107.775
5-m-b-4	5506.081	5507.991	108.366
5-m-c-1	5506.274	5506.683	106.75

5-m-c-2	5506.624	5506.985	107.701
5-m-c-3	5506.751	5507.187	108.33
5-m-d-1	5506.789	5506.025	106.766
5-m-d-2	5506.851	5506.017	107.302
5-m-d-3	5506.959	5506.179	107.823
5-m-d-4	5507.108	5506.391	108.269
6-m-a-1	6499.125	6517.843	101.052
6-m-a-2	6499.181	6517.824	101.506
6-m-a-3	6499.146	6517.842	102.059
6-m-a-4	6499.196	6517.907	102.596
6-m-b-1	6504.432	6516.684	104.415
6-m-b-2	6504.363	6516.804	105.109
6-m-b-3	6504.55	6516.902	105.672
6-m-c-1	6507.325	6509.214	103.886
6-m-c-2	6507.87	6509.885	104.487
6-m-c-3	6507.947	6509.786	104.844
6-m-c-4	6508.003	6509.864	105.248
6-m-d-1	6507.285	6506.219	103.593
6-m-d-2	6507.353	6506.323	103.877
6-m-d-3	6507.376	6506.289	104.399
6-m-e-1	6505.571	6503.285	103.403
6-m-e-2	6505.677	6503.2	103.844
6-m-e-3	6505.757	6503.146	104.423
6-m-f-1	6504.807	6502.07	102.694
6-m-f-2	6505.443	6502.685	103.491
6-m-f-3	6505.478	6502.578	103.886
6-m-f-4	6505.598	6502.524	104.494
6-m-g-1	6500.626	6494.16	96.96
6-m-g-2	6500.651	6494.065	97.168
6-m-g-3	6500.775	6494.189	97.578
7-m-a-1	7507.505	7503.245	96.44
7-m-a-2	7507.477	7503.242	96.661
7-m-a-3	7507.438	7503.212	96.988
7-m-a-4	7507.446	7503.141	97.281
7-m-b-1	7506.813	7500.075	98.284
7-m-b-2	7506.799	7500.05	98.443

2019 May

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
2-m-a-1	2498.725	2508.726	105.21
2-m-a-2	2498.838	2509.533	106.599
2-m-a-3	2498.878	2510.114	108.029
2-m-a-4	2499.012	2510.677	109.531
2-m-b-1	2503.971	2508.926	104.302
2-m-b-2	2504.001	2509.586	105.851

2-m-b-3	2504.081	2510.218	107.001
2-m-b-4	2503.994	2510.62	107.891
2-m-b-5	2503.986	2510.961	109.174
2-m-c-1	2507.658	2509.708	104.02
2-m-c-2	2507.527	2510.147	105.115
2-m-c-3	2507.452	2510.73	106.62
2-m-c-4	2507.382	2510.954	107.66
2-m-c-5	2507.344	2511.132	108.264
2-m-d-1	2496.601	2509.198	105.648
2-m-d-2	2496.528	2509.63	106.558
2-m-d-3	2496.511	2509.848	107.476
2-m-d-4	2496.542	2510.216	108.42
2-m-d-5	2496.506	2510.706	109.217
2-m-d-6	2496.509	2510.759	109.764
2-m-e-1	2498.442	2505.064	102.072
2-m-e-2	2498.396	2505.086	102.597
2-m-e-3	2498.499	2505.143	103.002
2-m-f-1	2504.123	2505.931	101.108
2-m-f-2	2504.165	2505.983	101.61
2-m-f-3	2504.195	2506.031	101.942
2-m-f-4	2504.169	2506.061	102.628
2-m-g-1	2508.152	2507.053	100.876
2-m-g-2	2508.136	2507.128	101.498
2-m-g-3	2508.177	2507.167	101.999
2-m-g-4	2508.2	2507.243	102.465

2020 September

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
1-m-a-1	1495.301	1509.923	95.182
1-m-a-2	1495.348	1509.933	94.596
1-m-a-3	1495.377	1510.051	93.851
1-m-a-4	1495.427	1510.363	92.449
1-m-b-1	1497.838	1509.396	95.347
1-m-b-2	1497.78	1509.3	94.949
1-m-b-3	1497.794	1509.319	94.584
1-m-b-4	1497.884	1509.424	93.864
2-m-a-1	2498.726	2508.717	105.207
2-m-a-2	2498.839	2509.525	106.593
2-m-a-3	2498.88	2510.106	108.022
2-m-a-4	2499.013	2510.668	109.522
2-m-b-1	2503.97	2508.912	104.296
2-m-b-2	2504.001	2509.578	105.847
2-m-b-3	2504.08	2510.21	106.996
2-m-b-4	2503.993	2510.613	107.886
2-m-b-5	2503.984	2510.955	109.168
2-m-c-1	2507.656	2509.702	104.018

2-m-c-2	2507.525	2510.142	105.113
2-m-c-3	2507.45	2510.724	106.617
2-m-c-4	2507.38	2510.948	107.657
2-m-c-5	2507.341	2511.127	108.261
2-m-d-1	2496.602	2509.191	105.643
2-m-d-2	2496.529	2509.622	106.553
2-m-d-3	2496.513	2509.841	107.471
2-m-d-4	2496.553	2510.189	108.398
2-m-d-5	2496.508	2510.702	109.209
2-m-d-6	2496.511	2510.756	109.755
2-m-e-1	2498.444	2505.061	102.072
2-m-e-2	2498.397	2505.083	102.597
2-m-e-3	2498.501	2505.14	103.002
2-m-f-1	2504.121	2505.928	101.109
2-m-f-2	2504.162	2505.979	101.61
2-m-f-3	2504.193	2506.027	101.942
2-m-f-4	2504.166	2506.057	102.627
2-m-g-1	2508.155	2507.05	100.874
2-m-g-2	2508.143	2507.129	101.497
2-m-g-3	2508.177	2507.164	101.998
2-m-g-4	2508.201	2507.24	102.464
3-m-a-1	3500.04	3502.912	101.412
3-m-a-2	3500.175	3503.338	102.274
3-m-a-3	3500.269	3503.62	102.918
3-m-a-4	3500.366	3504.127	104.025
4-m-a-1	4533.275	4546.028	141.034
4-m-a-2	4533.221	4546.123	141.686
4-m-a-3	4533.316	4546.122	142.124
4-m-b-1	4542.375	4539.605	142.302
4-m-b-2	4542.655	4539.752	142.781
4-m-b-3	4542.695	4539.751	143.049
4-m-b-4	4542.724	4539.813	143.395
4-m-c-1	4543.368	4537.929	141.659
4-m-c-2	4544.067	4538.313	142.529
4-m-c-3	4544.08	4538.291	142.947
4-m-c-4	4544.129	4538.271	143.291
4-m-d-1	4546.251	4535.021	140.988
4-m-d-2	4546.318	4535.089	141.54
4-m-d-3	4546.302	4535.174	141.887
5-m-a-1	5505.185	5508.874	107.789
5-m-a-2	5505.183	5509.285	108.431
5-m-b-1	5505.628	5507.545	107.116
5-m-b-2	5505.911	5507.824	107.565
5-m-b-3	5505.809	5507.736	107.773
5-m-b-4	5506.072	5507.979	108.355
5-m-c-1	5506.271	5506.68	106.749
5-m-c-2	5506.62	5506.981	107.698

5-m-c-3	5506.748	5507.183	108.326
5-m-d-1	5506.784	5506.021	106.762
5-m-d-2	5506.849	5506.015	107.301
5-m-d-3	5506.957	5506.177	107.821
5-m-d-4	na	na	na
6-m-a-1	6499.125	6517.84	101.051
6-m-a-2	6499.181	6517.82	101.505
6-m-a-3	6499.146	6517.837	102.058
6-m-a-4	6499.194	6517.9	102.592
6-m-b-1	6504.432	6516.68	104.413
6-m-b-2	6504.362	6516.8	105.107
6-m-b-3	6504.549	6516.898	105.669
6-m-c-1	6507.318	6509.205	103.88
6-m-c-2	6507.858	6509.873	104.48
6-m-c-3	6507.945	6509.785	104.842
6-m-c-4	6508.001	6509.862	105.245
6-m-d-1	na	na	na
6-m-d-2	6507.353	6506.322	103.875
6-m-d-3	6507.374	6506.287	104.398
6-m-e-1	6505.56	6503.278	103.396
6-m-e-2	6505.66	6503.189	103.831
6-m-e-3	6505.754	6503.146	104.421
6-m-f-1	6504.805	6502.069	102.694
6-m-f-2	6505.439	6502.683	103.488
6-m-f-3	6505.476	6502.578	103.885
6-m-f-4	6505.591	6502.522	104.488
6-m-g-1	6500.626	6494.16	96.959
6-m-g-2	6500.651	6494.065	97.168
6-m-g-3	6500.775	6494.19	97.578
7-m-a-1	7507.502	7503.245	96.44
7-m-a-2	7507.475	7503.242	96.662
7-m-a-3	7507.435	7503.213	96.988
7-m-a-4	7507.445	7503.141	97.281
7-m-b-1	7506.813	7500.076	98.284
7-m-b-2	7506.801	7500.051	98.442

2021 September

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
1-m-a-1	1495.303	1509.92	95.183
1-m-a-2	1495.35	1509.934	94.596
1-m-a-3	1495.378	1510.052	93.851
1-m-a-4	1495.428	1510.364	92.448
1-m-b-1	1497.839	1509.396	95.347
1-m-b-2	1497.781	1509.3	94.949
1-m-b-3	1497.796	1509.319	94.585
1-m-b-4	1497.885	1509.424	93.864

2-m-a-1	2498.725	2508.713	105.205
2-m-a-2	2498.839	2509.523	106.591
2-m-a-3	2498.88	2510.104	108.018
2-m-a-4	2499.012	2510.666	109.518
2-m-b-1	2503.97	2508.906	104.293
2-m-b-2	2504.002	2509.576	105.845
2-m-b-3	2504.08	2510.206	106.993
2-m-b-4	2503.992	2510.61	107.882
2-m-b-5	2503.984	2510.954	109.165
2-m-c-1	n/a	n/a	n/a
2-m-c-2	2507.526	2510.14	105.113
2-m-c-3	2507.45	2510.722	106.616
2-m-c-4	2507.38	2510.946	107.655
2-m-c-5	2507.341	2511.125	108.26
2-m-d-1	2496.602	2509.188	105.642
2-m-d-2	2496.528	2509.62	106.55
2-m-d-3	2496.512	2509.839	107.47
2-m-d-4	2496.556	2510.184	108.394
2-m-d-5	2496.519	2510.68	109.188
2-m-d-6	2496.512	2510.757	109.752
2-m-e-1	2498.444	2505.06	102.072
2-m-e-2	2498.397	2505.084	102.598
2-m-e-3	2498.5	2505.142	103.002
2-m-f-1	2504.123	2505.933	101.109
2-m-f-2	2504.162	2505.98	101.61
2-m-f-3	2504.193	2506.027	101.942
2-m-f-4	2504.166	2506.057	102.627
2-m-g-1	2508.156	2507.05	100.875
2-m-g-2	2508.144	2507.13	101.497
2-m-g-3	2508.178	2507.165	101.998
2-m-g-4	2508.202	2507.24	102.464
3-m-a-1	3500.04	3502.912	101.412
3-m-a-2	3500.175	3503.338	102.274
3-m-a-3	3500.27	3503.622	102.918
3-m-a-4	3500.367	3504.128	104.026
4-m-a-1	4533.272	4546.021	141.032
4-m-a-2	4533.22	4546.12	141.685
4-m-a-3	4533.316	4546.12	142.122
4-m-b-1	4542.312	4539.543	142.236
4-m-b-2	4542.658	4539.754	142.784
4-m-b-3	4542.696	4539.749	143.048
4-m-b-4	4542.724	4539.81	143.392
4-m-c-1	4543.36	4537.921	141.653
4-m-c-2	4544.076	4538.32	142.536
4-m-c-3	4544.079	4538.289	142.946
4-m-c-4	4544.128	4538.27	143.292
4-m-d-1	4546.252	4535.02	140.987

4-m-d-2	4546.318	4535.087	141.542
4-m-d-3	4546.304	4535.17	141.888
5-m-a-1	5505.184	5508.874	107.788
5-m-a-2	5505.182	5509.284	108.43
5-m-b-1	5505.626	5507.542	107.113
5-m-b-2	5505.91	5507.822	107.565
5-m-b-3	5505.809	5507.736	107.772
5-m-b-4	5506.077	5507.986	108.362
5-m-c-1	5506.27	5506.679	106.749
5-m-c-2	5506.62	5506.98	107.698
5-m-c-3	5506.748	5507.183	108.326
5-m-d-1	5506.785	5506.021	106.763
5-m-d-2	5506.785	5506.021	106.763
5-m-d-3	5506.849	5506.014	107.3
5-m-d-4	5506.957	5506.176	107.821
6-m-a-1	6499.126	6517.842	101.051
6-m-a-2	6499.182	6517.819	101.506
6-m-a-3	6499.147	6517.838	102.058
6-m-a-4	6499.195	6517.903	102.591
6-m-b-1	6504.433	6516.678	104.414
6-m-b-2	6504.363	6516.8	105.107
6-m-b-3	6504.55	6516.898	105.669
6-m-c-1	6507.314	6509.198	103.878
6-m-c-2	6507.86	6509.876	104.482
6-m-c-3	6507.946	6509.784	104.843
6-m-c-4	6508.002	6509.862	105.246
6-m-d-1	na	na	na
6-m-d-2	6507.351	6506.32	103.875
6-m-d-3	6507.375	6506.287	104.398
6-m-e-1	6505.571	6503.284	103.403
6-m-e-2	6505.676	6503.199	103.842
6-m-e-3	6505.754	6503.147	104.422
6-m-f-1	6504.807	6502.071	102.695
6-m-f-2	6505.447	6502.686`	103.494
6-m-f-3	na	na	na
6-m-f-4	6505.59	6502.521	104.488
6-m-g-1	6500.625	6494.16	96.959
6-m-g-2	6500.65	6494.068	97.168
6-m-g-3	6500.774	6494.188	97.578
7-m-a-1	7507.498	7503.244	96.442
7-m-a-2	7507.476	7503.243	96.661
7-m-a-3	7507.44	7503.215	96.986
7-m-a-4	7507.445	7503.142	97.28
7-m-b-1	7506.814	7500.076	98.284
7-m-b-2	7506.802	7500.051	98.442

2022 September

POINT	X COORD(m)	Y COORD (m)	Z COORD (m)
1-m-a-1	1495.302	1509.921	95.183
1-m-a-2	1495.336	1509.942	94.588
1-m-a-3	1495.376	1510.052	93.85
1-m-a-4	1495.427	1510.364	92.448
1-m-b-1	1497.838	1509.396	95.347
1-m-b-2	1497.78	1509.3	94.949
1-m-b-3	1497.792	1509.318	94.584
1-m-b-4	1497.884	1509.424	93.864
2-m-a-1	2498.724	2508.71	105.203
2-m-a-2	2498.839	2509.52	106.588
2-m-a-3	2498.88	2510.102	108.015
2-m-a-4	2499.012	2510.664	109.514
2-m-b-1	2503.971	2508.904	104.291
2-m-b-2	2504.002	2509.572	105.843
2-m-b-3	2504.08	2510.205	106.991
2-m-b-4	2503.992	2510.607	107.88
2-m-b-5	2503.983	2510.952	109.163
2-m-c-1	2507.658	2509.7	104.016
2-m-c-2	2507.525	2510.14	105.112
2-m-c-3	2507.45	2510.72	106.614
2-m-c-4	2507.38	2510.944	107.654
2-m-c-5	2507.34	2511.124	108.258
2-m-d-1	2496.6	2509.186	105.64
2-m-d-2	2496.527	2509.618	106.549
2-m-d-3	2496.512	2509.836	107.467
2-m-d-4	n/a	n/a	n/a
2-m-d-5	2496.51	2510.702	109.202
2-m-d-6	2496.512	2510.758	109.748
2-m-e-1	2498.444	2505.06	102.072
2-m-e-2	2498.396	2505.084	102.598
2-m-e-3	2498.5	2505.14	103.002
2-m-f-1	2504.12	2505.928	101.109
2-m-f-2	2504.162	2505.98	101.61
2-m-f-3	2504.193	2506.028	101.942
2-m-f-4	2504.166	2506.057	102.627
2-m-g-1	2508.156	2507.05	100.875
2-m-g-2	2508.144	2507.13	101.496
2-m-g-3	2508.178	2507.164	101.998
2-m-g-4	2508.202	2507.24	102.464
3-m-a-1	3500.039	3502.913	101.412
3-m-a-2	3500.175	3503.334	102.274
3-m-a-3	3500.269	3503.62	102.917
3-m-a-4	3500.366	3504.128	104.024

4-m-a-1	4533.271	4546.021	141.032
4-m-a-2	4533.22	4546.118	141.685
4-m-a-3	4533.315	4546.12	142.122
4-m-b-1	n/a	n/a	n/a
4-m-b-2	4542.658	4539.755	142.784
4-m-b-3	4542.696	4539.75	143.048
4-m-b-4	4542.725	4539.811	143.394
4-m-c-1	4543.364	4537.924	141.655
4-m-c-2	4544.077	4538.318	142.537
4-m-c-3	4544.08	4538.29	142.948
4-m-c-4	4544.129	4538.269	143.292
4-m-d-1	4546.252	4535.018	140.987
4-m-d-2	4546.318	4535.087	141.542
4-m-d-3	4546.304	4535.17	141.886
5-m-a-1	5505.184	5508.875	107.79
5-m-a-2	5505.182	5509.284	108.43
5-m-b-1	5505.628	5507.546	107.116
5-m-b-2	5505.91	5507.823	107.566
5-m-b-3	5505.808	5507.736	107.773
5-m-b-4	5506.078	5507.988	108.364
5-m-c-1	5506.27	5506.68	106.75
5-m-c-2	5506.62	5506.982	107.699
5-m-c-3	5506.748	5507.183	108.326
5-m-d-1	5506.785	5506.021	106.763
5-m-d-2	5506.785	5506.021	106.764
5-m-d-3	5506.849	5506.014	107.3
5-m-d-4	5506.957	5506.176	107.821
6-m-a-1	6499.126	6517.841	101.052
6-m-a-2	6499.181	6517.821	101.506
6-m-a-3	6499.146	6517.838	102.058
6-m-a-4	6499.193	6517.904	102.59
6-m-b-1	6504.432	6516.682	104.414
6-m-b-2	6504.362	6516.801	105.108
6-m-b-3	6504.548	6516.898	105.669
6-m-c-1	6507.324	6509.215	103.886
6-m-c-2	6507.863	6509.883	104.485
6-m-c-3	6507.945	6509.787	104.843
6-m-c-4	6508.001	6509.864	105.246
6-m-d-1	na	na	na
6-m-d-2	6507.352	6506.322	103.876
6-m-d-3	6507.374	6506.288	104.398
6-m-e-1	6505.567	6503.283	103.401
6-m-e-2	6505.674	6503.2	103.842
6-m-e-3	6505.753	6503.148	104.42
6-m-f-1	6504.807	6502.07	102.694

6-m-f-2	na	na	na
6-m-f-3	6505.476	6502.578	103.885
6-m-f-4	6505.588	6502.522	104.487
6-m-g-1	6500.626	6494.162	96.96
6-m-g-2	6500.651	6494.068	97.169
6-m-g-3	6500.775	6494.189	97.579
7-m-a-1	7507.497	7503.244	96.442
7-m-a-2	7507.474	7503.243	96.662
7-m-a-3	7507.44	7503.215	96.985
7-m-a-4	7507.444	7503.142	97.28
7-m-b-1	7506.814	7500.076	98.284
7-m-b-2	7506.802	7500.051	98.442

Appendix IV - Available resources

All the original survey files (trimble .job format) are available on request
The coordinate lists are available as excel spreadsheets or .csv files.

All previous reports are available as pdf documents