

Hawaii National Marine Renewable Energy Center (HINMREC)

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Task 1: Management

Kāneʻohe Wave Energy Test Site: Remotely Operated Vehicle Survey

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KANEOHE WAVE ENERGY TEST SITE

**REMOTELY OPERATED VEHICLE SURVEY
OAHU, HI**

Febraruy, 2012



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1. INTRODUCTION

The area north of the Mokapu Peninsula, adjacent to Kaneohe Marine Corps Base Hawaii (MCBH), has been utilized by the U.S. Navy and Ocean Power Technologies, Inc. (OPT) for wave energy research since 2002. A prototype OPT PowerBuoy was recently retrieved from the 30 m water depth offshore of North Beach at the MCBH. The Hawaii National Marine Renewable Energy Center (HNMREC) at the University of Hawaii, under contract with Department of Energy, desires to expand the present test site to water depths of 100 m to allow for the testing of other wave energy devices.

Sea Engineering has been contracted by the HNMREC to conduct site investigations in support of the development of the expanded test site. This report presents the results of the Remotely Operated Vehicle (ROV) survey of the site. Remotely Operated Vehicles are camera equipped robotic vehicles controlled from the surface.

The project location is shown in Figure 1-1. An aerial image of the 4.4 km² proposed test site is shown in Figure 1-2. The test site is 1600 to 2000 m wide and extends approximately 2600 m offshore from the 30 m depth contour to the approximate 100 m depth contour.

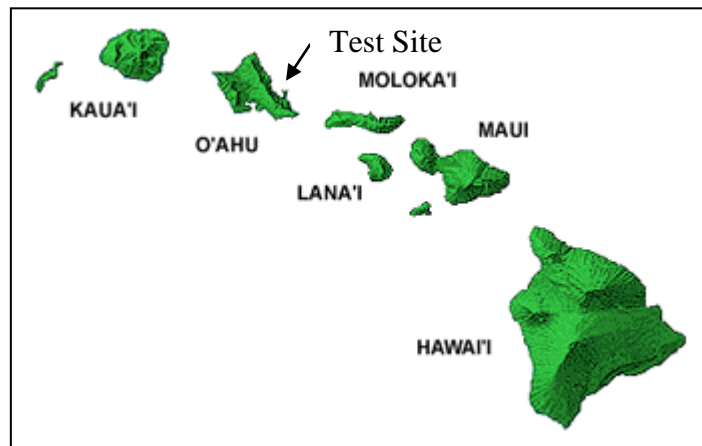


Figure 1-1. Project location.

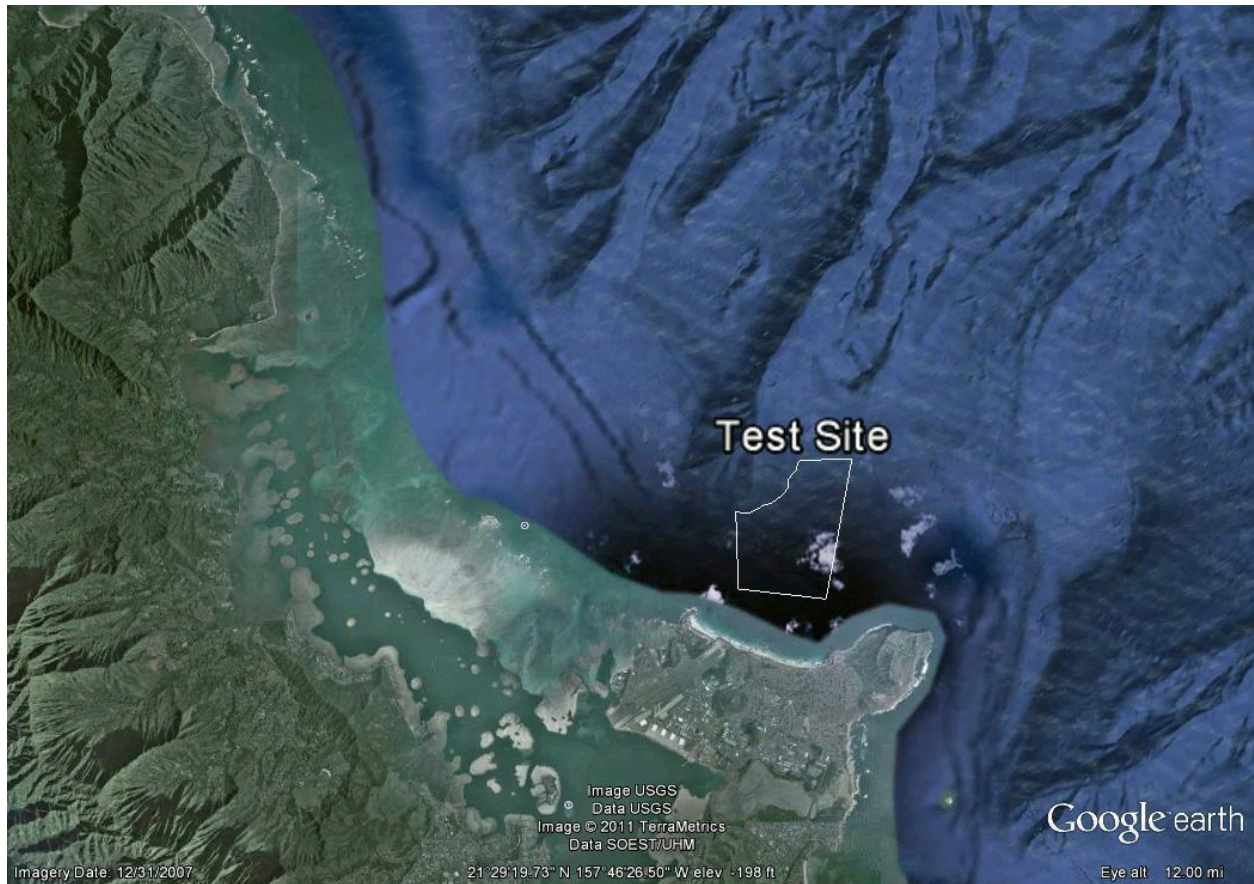


Figure 1-2. Aerial image of project site (from Google Earth).

2. METHODOLOGY

2.1 Survey Schedule

Sea Engineering conducted the ROV survey on January 12, 2012.

2.2 Units and Coordinate System

The project coordinate system is the Universal Transverse Mercator (UTM), Zone 4, meters.

2.3 Navigation and Positioning

A differential GPS (DGPS) receiver was used for horizontal positioning.

Hypack survey software was used for navigation of the survey vessel.

2.4 Remotely Operated Vehicle Methods

Remotely operated vehicles are camera and thruster equipped vehicles linked to a vessel with an umbilical control and electrical cable, and operated from the vessel to investigate the seafloor and underwater objects. They are used for a variety of underwater tasks ranging from underwater searches to plugging oil wells. They can be equipped with different equipment including manipulators, acoustic positioning systems, and multiple cameras.

For this survey, an Outland Technology Model 1000 ROV was utilized. This ROV is equipped with two forward facing cameras, a color and a black and white low light, which can rotate 360°; and one rear facing fixed camera. The forward facing color camera was used for the majority of this project with a small portion of the video done with the rear facing camera. All the camera displays are overlaid with a compass, depth indicator (indication in feet), date, and time. Sample images from the ROV are shown in Figure 2-1 and Figure 2-2. The crossbar, visible in the Figure 2-1 is fixed on the ROV and does not rotate with the camera. When the crossbar is visible in the bottom of the screen, the camera is looking straight ahead. The forward facing low light camera is black and white and was not used for this project.



Figure 2-1: Forward facing ROV camera



Figure 2-2: Rear facing camera, cable visible in upper left corner, ROV frame in bottom right.

The ROV was lowered down onto locations selected based on the results of the multibeam, sub-bottom, and side scan surveys.. The survey vessel would then drift with the wind and current. The ROV could also be towed short distances to survey a specific location on the bottom.



Figure 2-3 and Figure 2-4 present the ROV survey locations. The survey vessel position was recorded with differential GPS. ROV maneuverability was limited to a 50 ft radius around the survey vessel. The exact position of the ROV can be determined by time syncing the time on the ROV with the time and position recorded on the navigation computer. The location-time file is listed in Appendix I. Seventeen separate dives were conducted with the ROV.

The video from the ROV was recorded and is distributed on DVD.

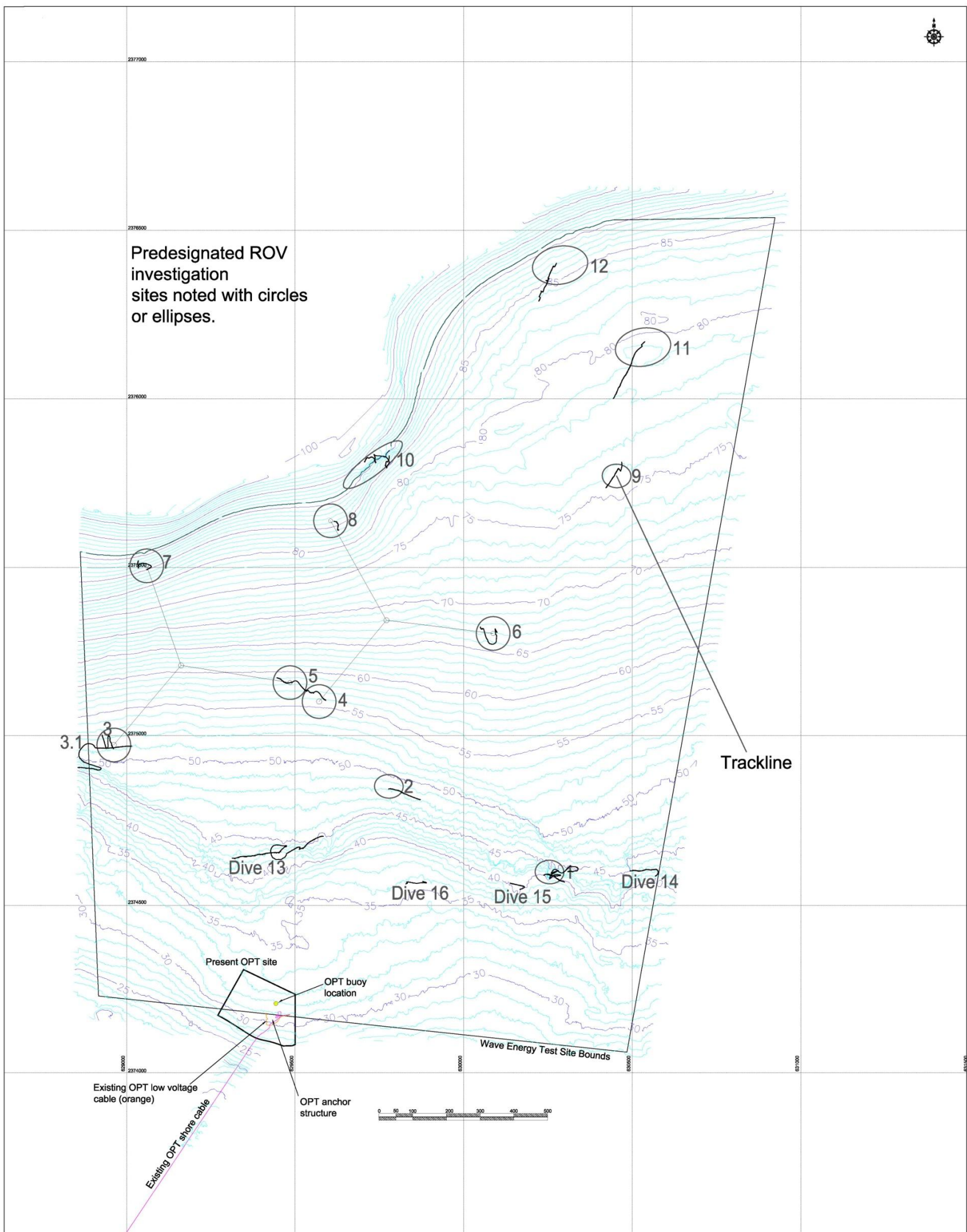


Figure 2-3. ROV survey track lines.

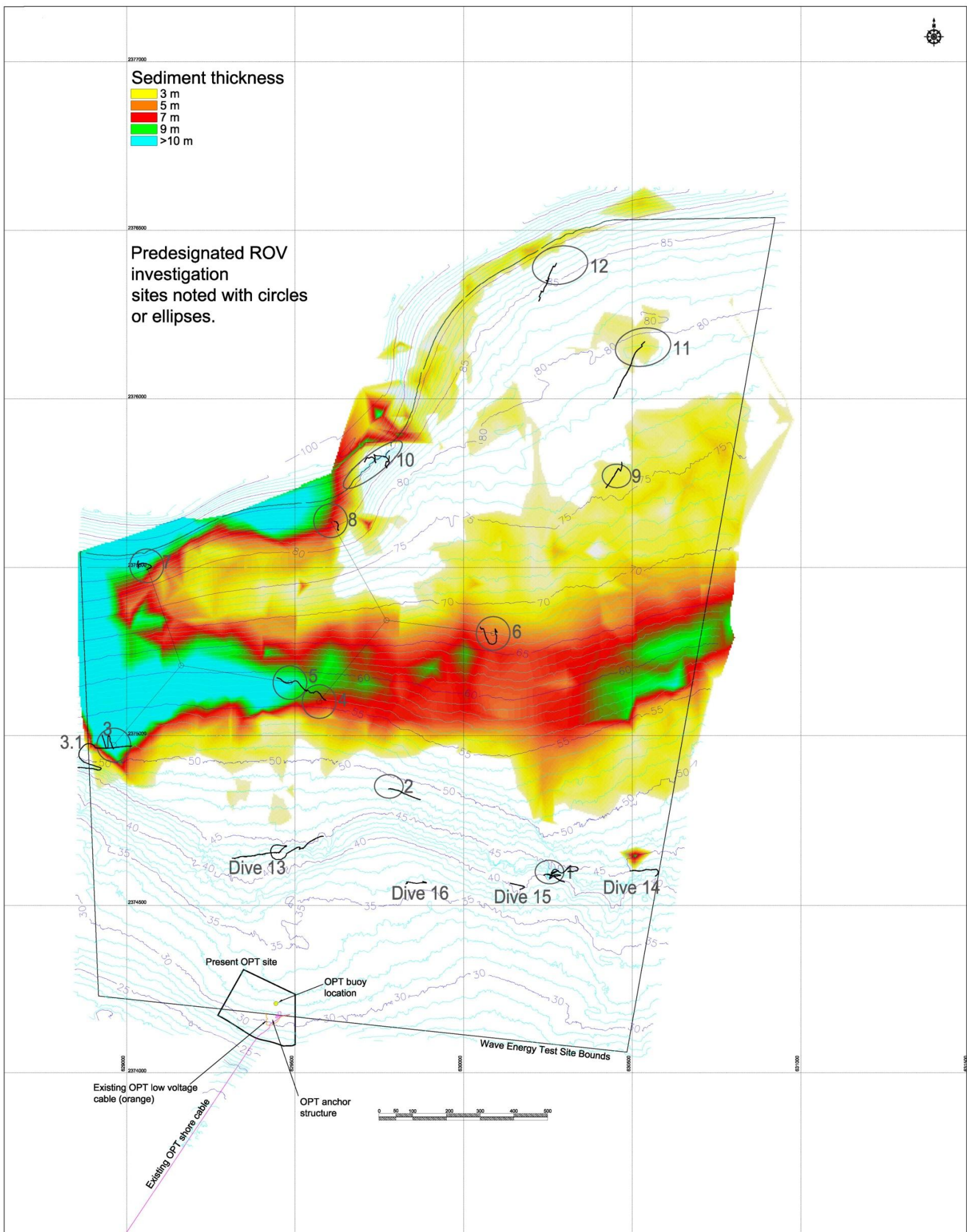


Figure 2-4: ROV survey track lines with colored sand thicknesses

3. SURVEY RESULTS

3.1 Remotely Operated Vehicle Survey

ROV dives are described below in the order in which they were conducted.

3.1.1 Site 1

The dive at Site 1 was conducted in the southeastern corner of the test area in water depths of 40-45 meters. Based on the previous surveys, this area was interpreted to be a steeply sloping, irregular, hard reef limestone bottom. The ROV video confirmed this interpretation. A relatively steep slope with undercut reef shelves and ledges was located. Scattered coral cover was noted in the area.

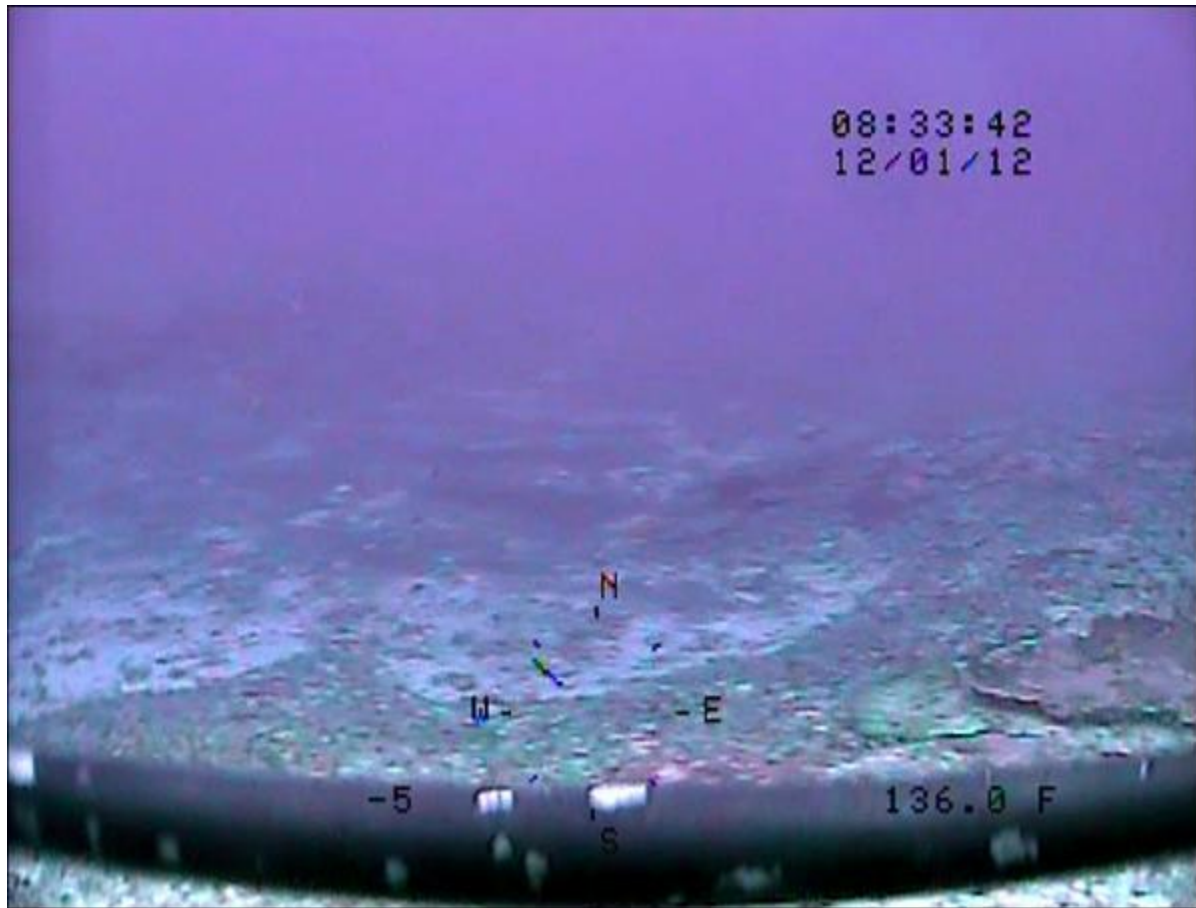


Figure 3-1: Image from Site 1



Figure 3-2: Ledge at Site 1

3.1.2 Site 2

Dive 2 was conducted seaward of the base of the 40-45m limestone escarpment, at a water depth of 48-50 meters in a gently sloping, hard bottom area. The bottom was confirmed to be limestone reef with thin sand cover, algae and isolated patches of coral.

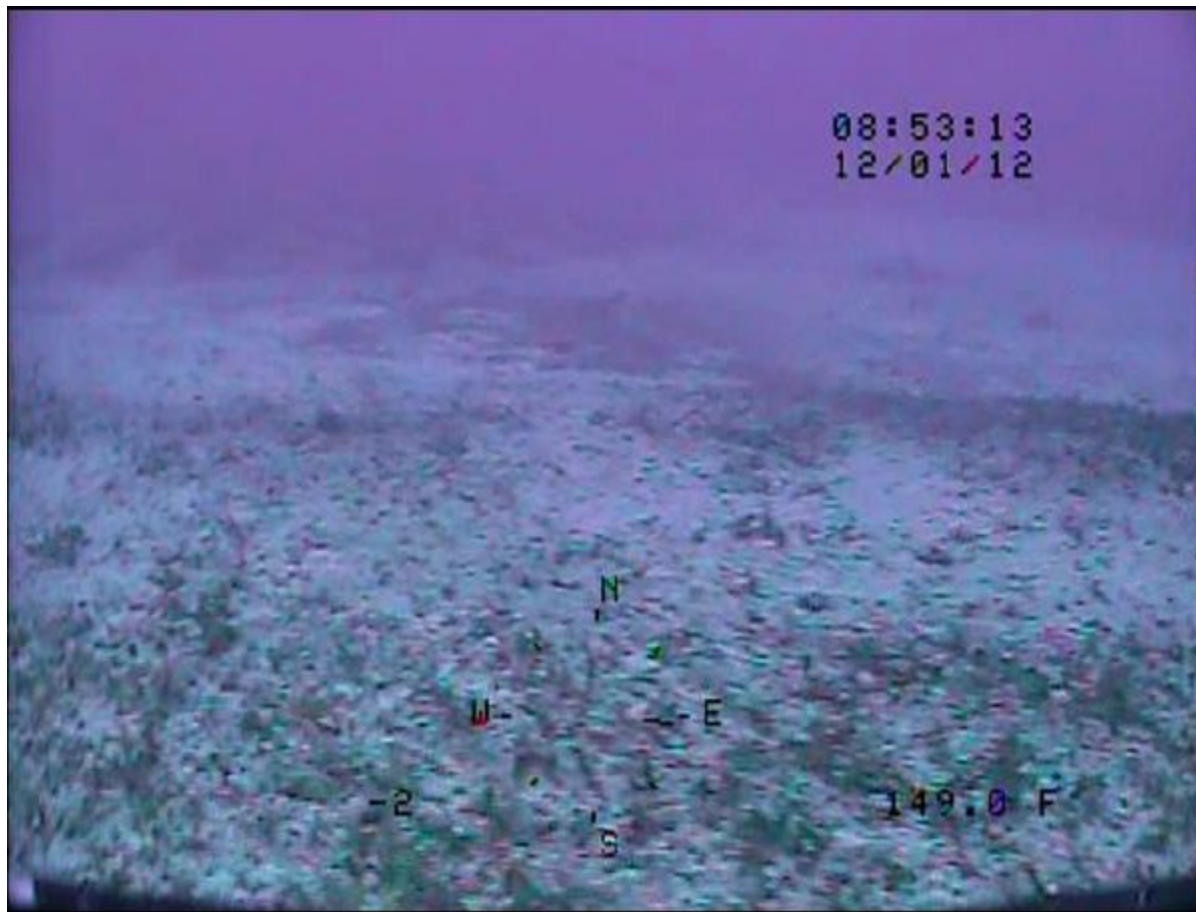


Figure 3-3: Hard bottom with thin layer of sand and algae, Site 2

3.1.3 Site 3.1

Site 3.1 was located at the west edge of the project area at the transition between the hard limestone bottom and sand. Figure 3-4 shows the hard bottom to the left of the image and sand extending seaward on the right side of the photograph.

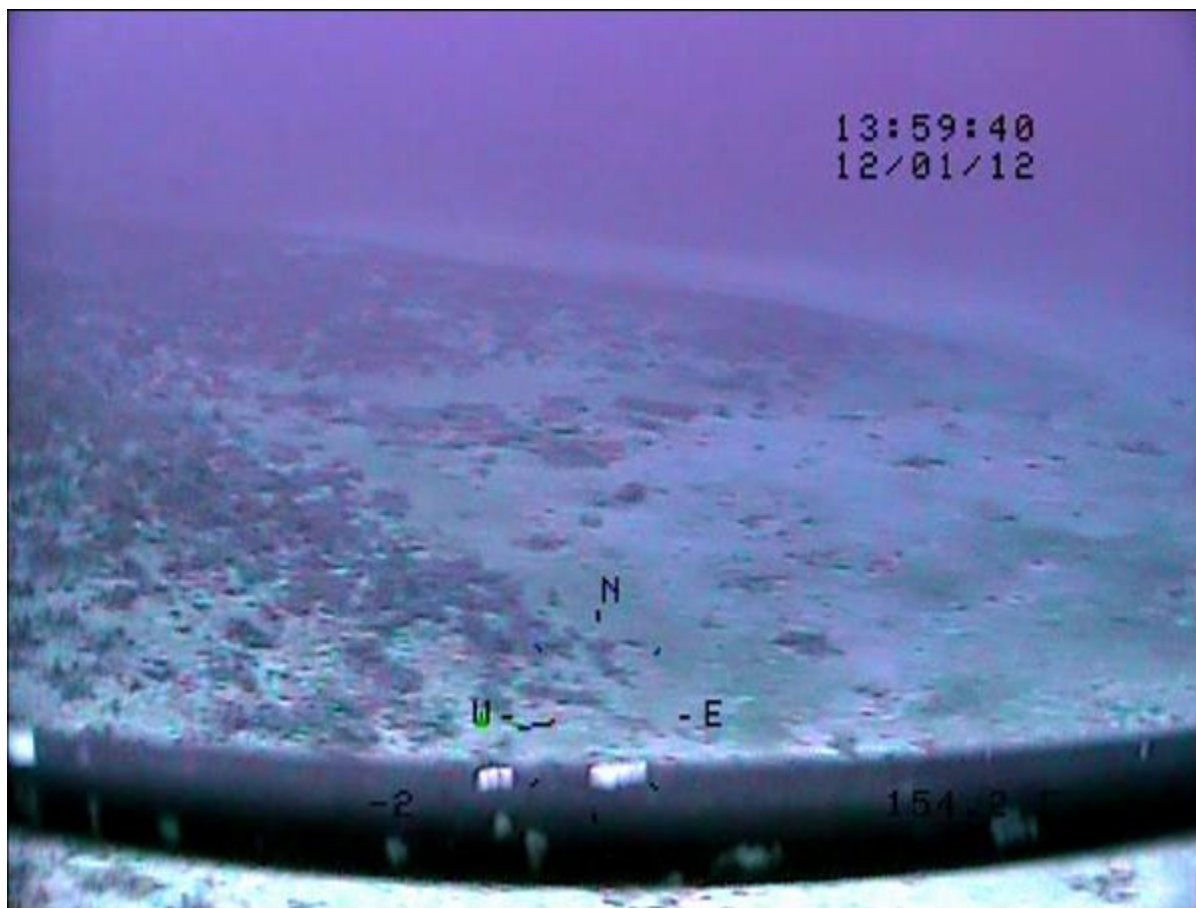


Figure 3-4: Transition from reef limestone bottom with algae (left side of photograph) to thick sandy bottom (right) at Site 3.1 (second dive at site 3)

3.1.4 Site 3,5,4,6,7,8

The dives at Sites 3-8 were conducted on the proposed anchor sites in the test area in water depths varying from 51 to 86 meters. The sites were located in areas where sand thickness was estimated to be greater than 5 meters. The ROV survey confirmed that the bottom was sandy with scattered patches of algae.

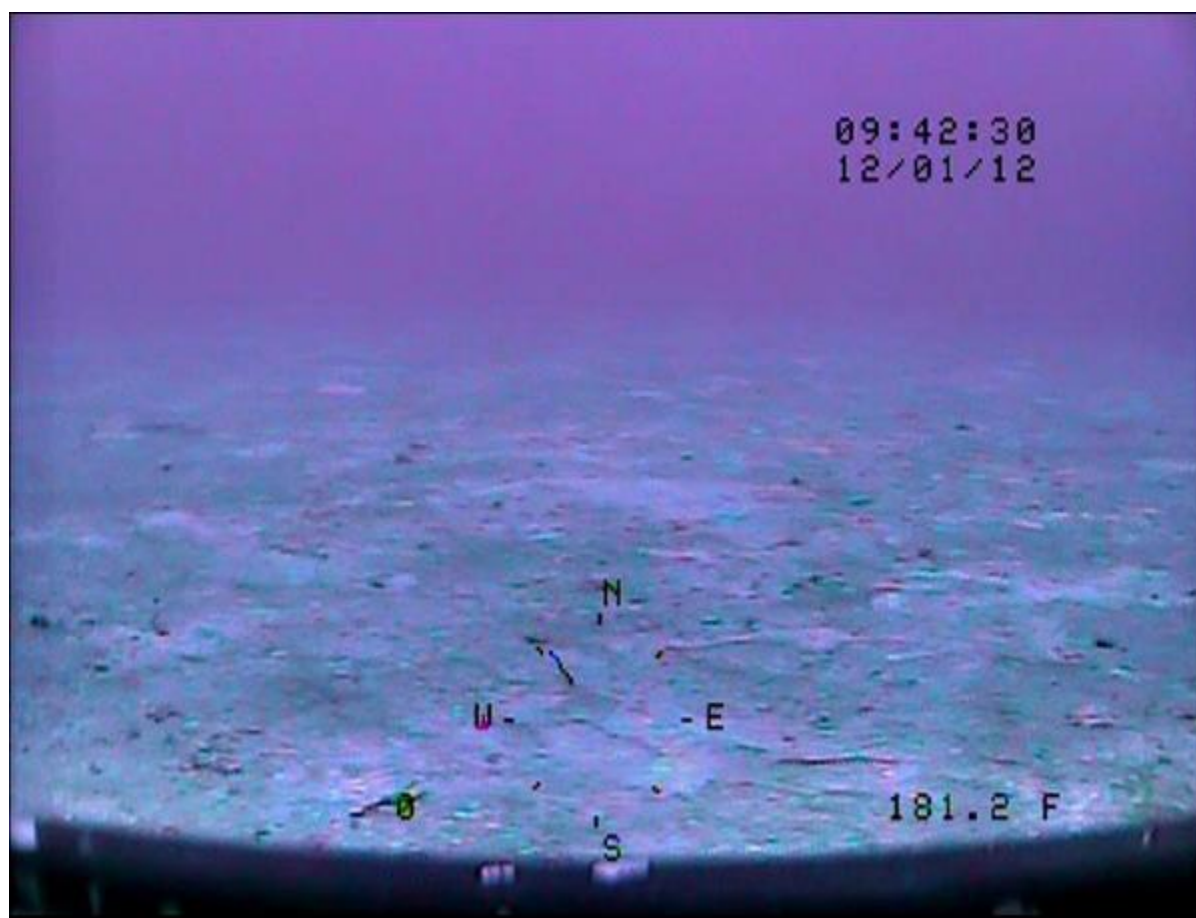


Figure 3-5: Sand at Site 4



Figure 3-6: Algae in sand depression, Site 8

3.1.5 Site 10

Site 10 was located at a water depth of 90 meters at an area with a 2-3 meter escarpment noted on the multibeam survey and irregular relief noted in the side scan survey. The ROV video indicated revealed a rock ledge with 2 to 3 meter vertical wall and irregular indentations. Large schools of fish were present in the area.

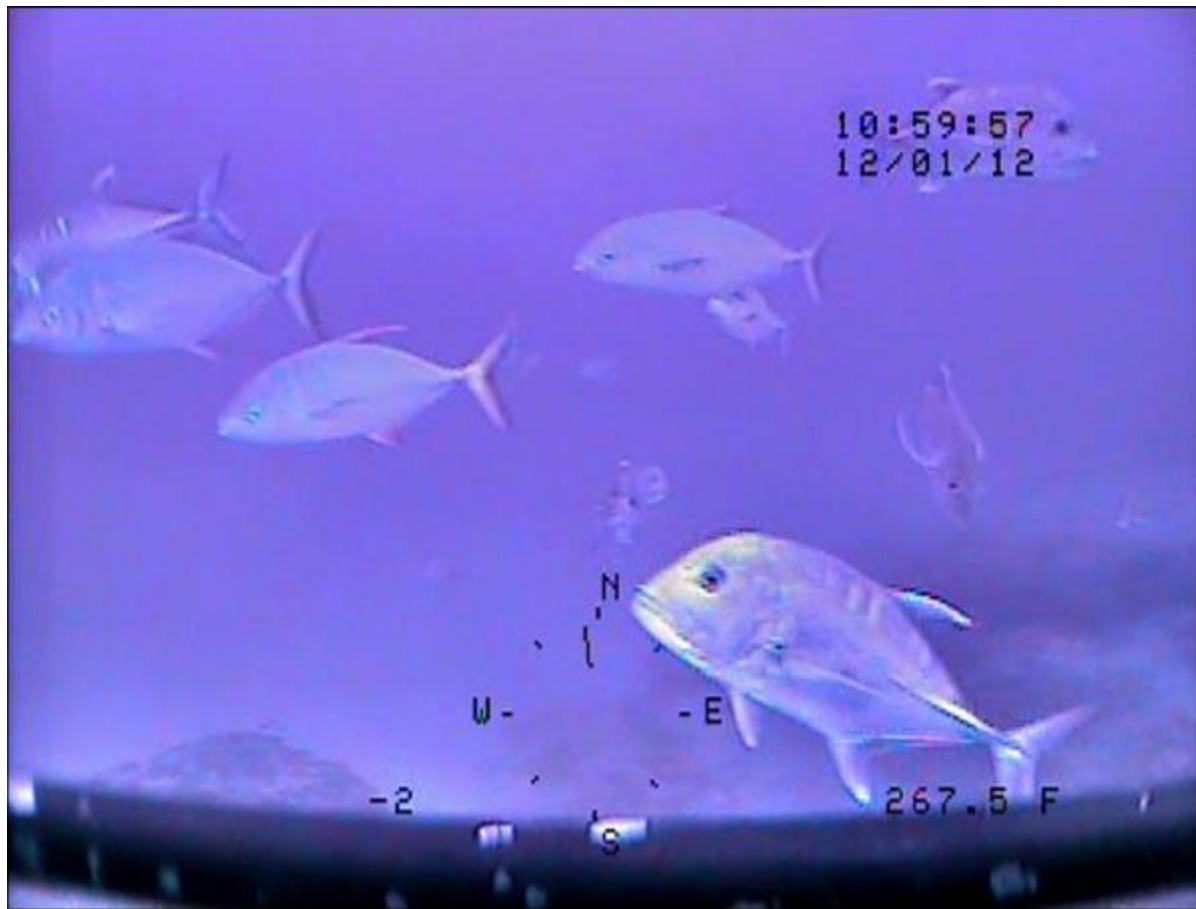


Figure 3-7: Fish at Site 10



Figure 3-8: Rock ledge at Site 10

3.1.6 Site 12

The ROV dive at Site 12 was conducted at a water depth of 87 meters along the northern edge of the test area. This area was relatively featureless in the bathymetry and side scan surveys and the sub-bottom survey did not indicate significant sand. The ROV video indicated that the bottom consisted of coarse cobbles, scattered algae and scattered thin sand.



Figure 3-9: Cobbles, thin sand and scattered algae, Site 12

3.1.7 Site 11

Site 11 was located within the Barchan dune area identified in the multibeam and side scan surveys at a water depth of approximately 75 meters. During this dive, the ROV recorded video along a 200 meter transect extending from the northeast to southwest. During the transect, the ROV rises up one side of a large, 1 to 2 meter high mound of sand, and then down the other side. The sand comprising the Barchan feature is coated with algae, suggesting that the feature was formed in the past, and active sand transport is not presently occurring. At the base and between the Barchan features, the bottom contained small sand ripples or waves about 1 foot apart with pebbles and algae lining the troughs.



Figure 3-10: Edge of a Barchan feature at Site 11. Barchan sand is visible in the foreground. Sand ripples with pebbles and algae in the trough are visible beyond the Barchan.

3.1.8 Site 9

Site 9 is located at a water depth of 76 meters in a relatively flat area at the seaward margin of the thick sand deposit. The transition to the area of thicker sand is evident on the video. The ROV video clearly shows the transition from an area with thin sand cover and sand ripples, to the thick sand deposit to the southeast.

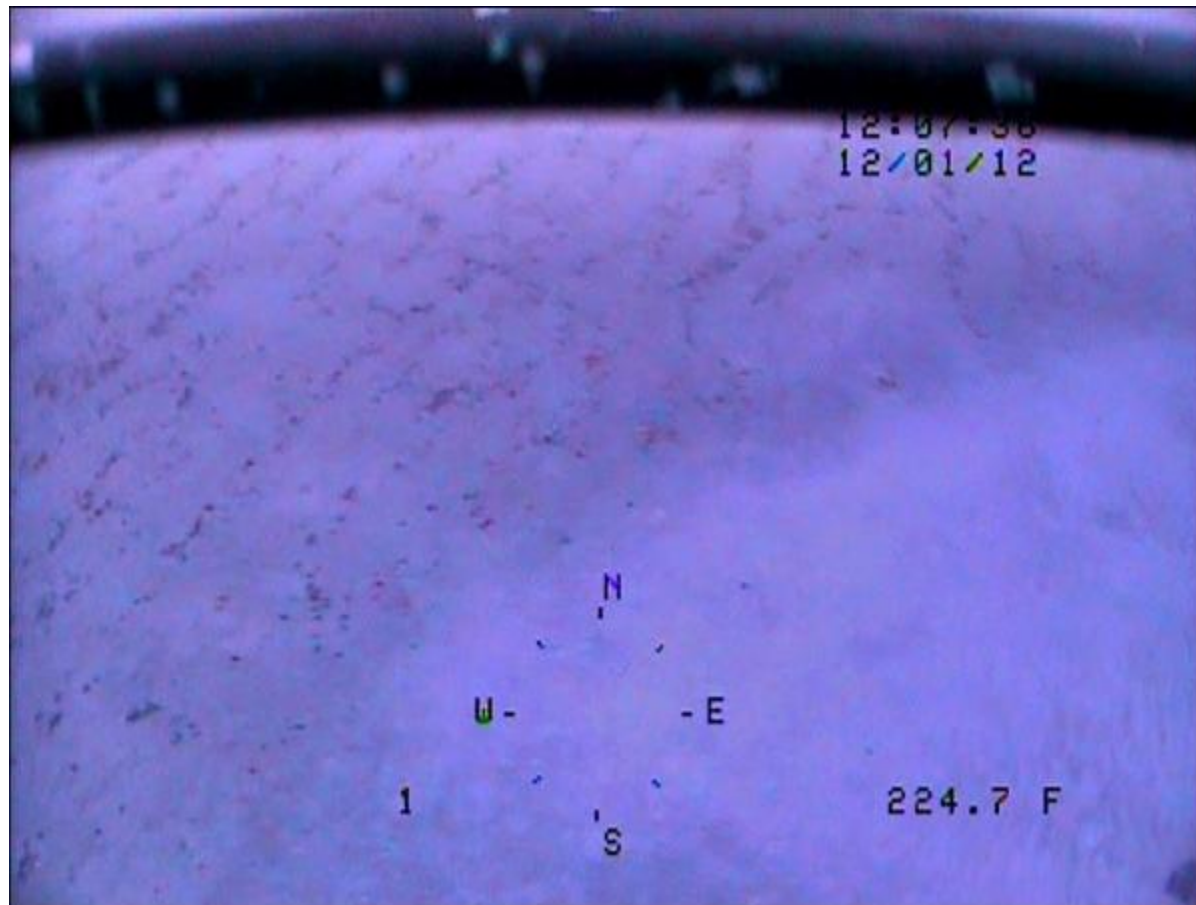


Figure 3-11: Transition from thin, rippled sand with cobbles (upper left) to thick sand (lower right) at Site 9.

3.1.9 Site 13

Dive 13 was conducted at a water depth of 42 to 45 meters, in an area noted on the side scan survey to have hard bottom and irregular relief. The ROV survey revealed hard bottom, with 1-2 meter relief and a spur and groove morphology. Sand was visible in the grooves while the spurs were barren, hard bottom with some algae.

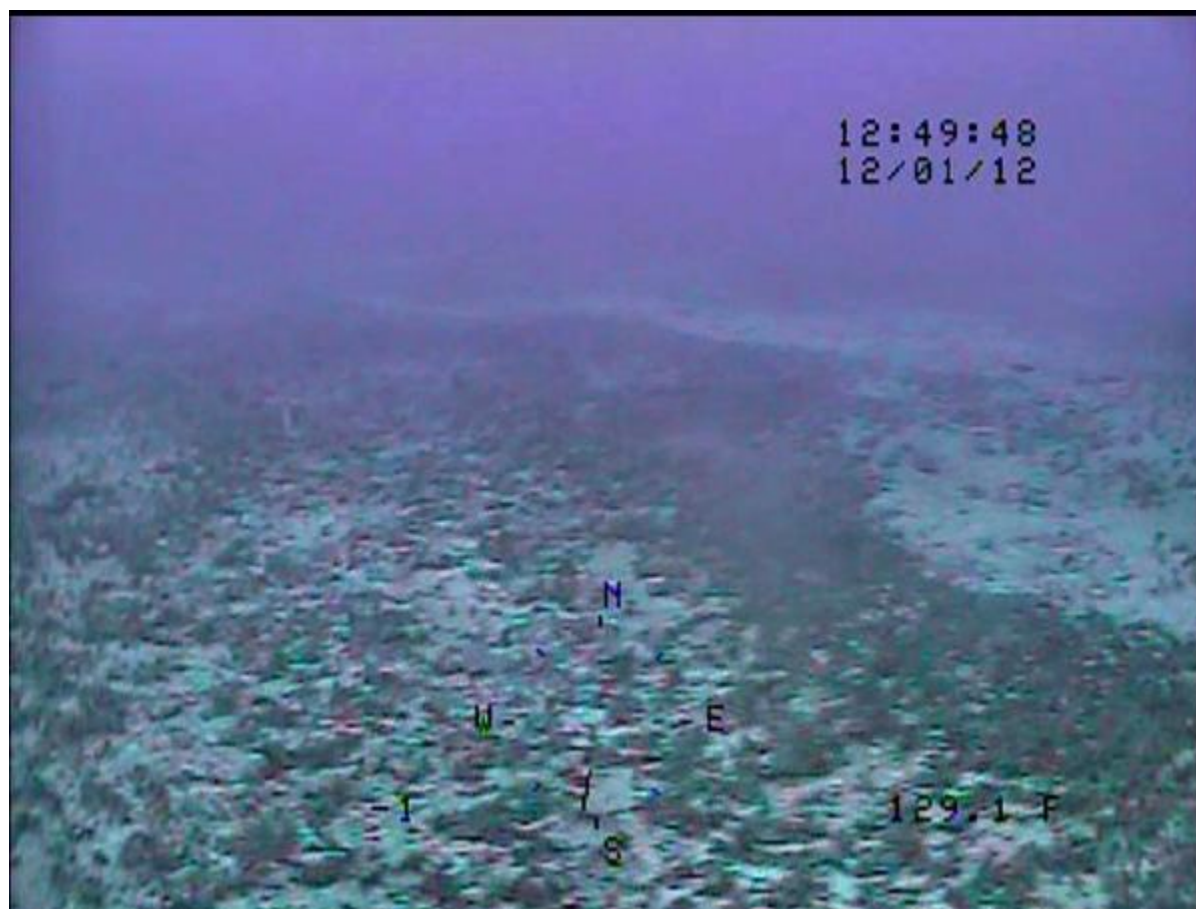


Figure 3-12: Hard bottom with thin sand and algae cover, Dive 13

3.1.10 Site 14

Dive 14 was conducted at the east edge of the project site on the 40 to 45 meter escarpment noted in the bathymetry and side scan surveys. The bottom consisted of reef limestone with extensive algae cover and occasional 1-meter high ledges.

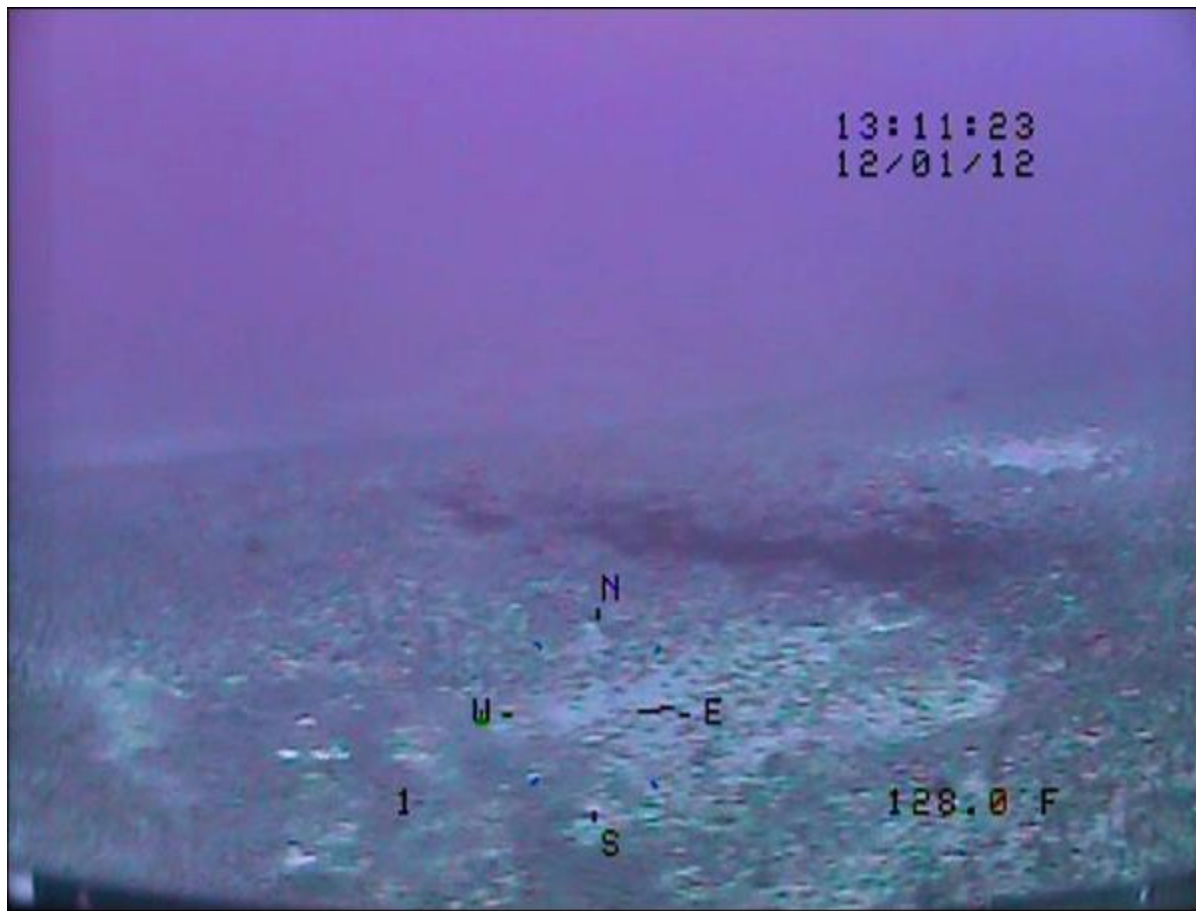


Figure 3-13: Reef ledge along Dive 14

3.1.11 Site 15

Site 15 was located at a water depth of 40 meters along the top of the 40 to 45 meter escarpment. The ROV revealed reef limestone with irregular relief and scattered, small live coral heads.

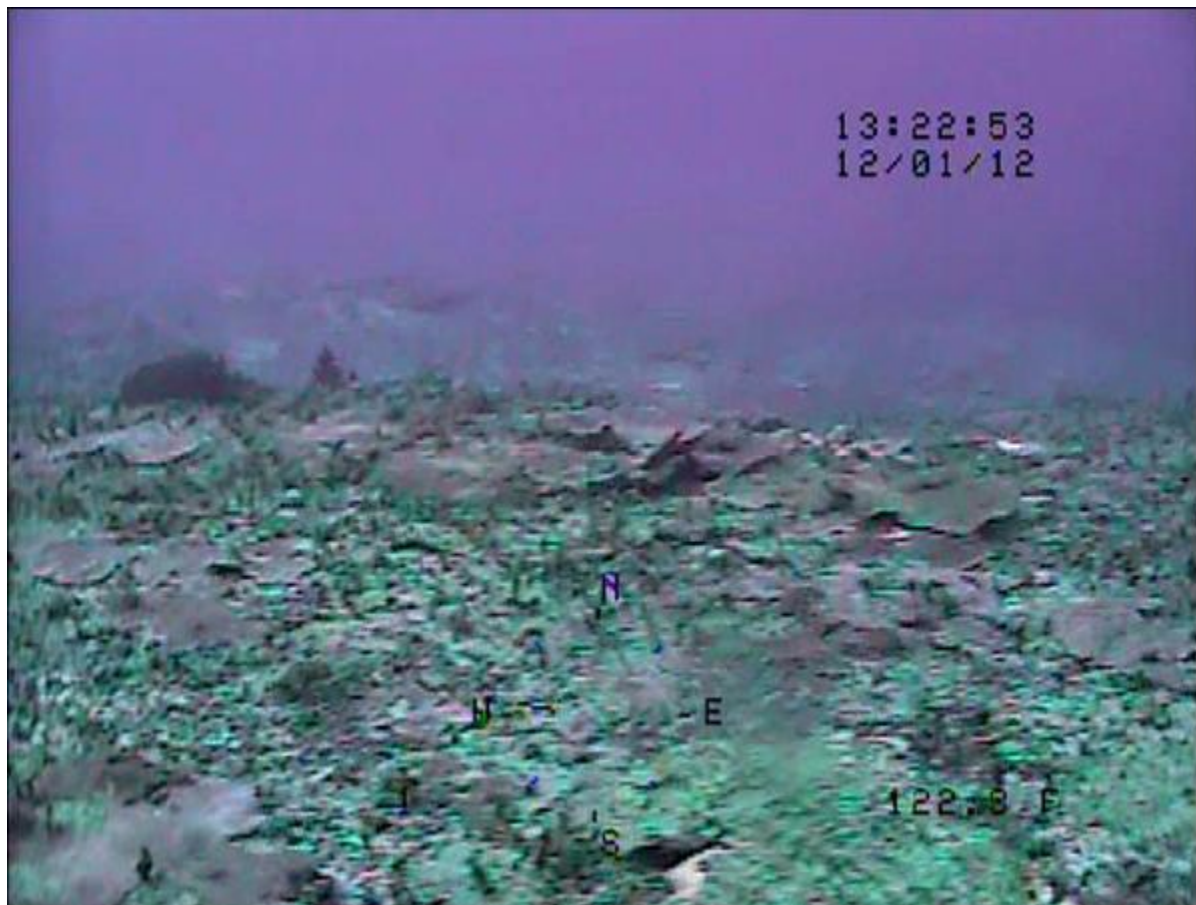


Figure 3-14: Reef limestone and scattered live coral at Site 15

3.1.12 Site 16

Site 16 was located at a water depth of 36 meters in a gently sloping area close to the existing OPT anchor area. Previous surveys suggested this was relatively featureless hard bottom with scattered thin sand. The ROV video survey confirmed this interpretation, showing relatively flat, featureless reef limestone bottom, with widely scattered small coral heads.



Figure 3-15: Scattered coral heads on hard bottom overlain with sand and algae

3.2 Summary

The video survey of the Wave Energy Test Site area confirmed the interpretations of the side scan, sub-bottom, and bathymetric surveys. Reef limestone is present from the southern edge of the test area to the approximate 50 meter contour. Between the 30 to 40 meter water depths, the bottom is gently sloping, relatively featureless, reef limestone with scattered small coral heads and thin sand patches. An escarpment from 40 to 45 meter water depths contains the greatest relief in the project site, with vertical ledges and pockets of live coral growth. A band of sand, 5 to 12 meters thick extends across site at water depths of 55 to 65 meters; the sand thins to 2 to 3 meters from 65 to 75 meter water depths, and minimal sand exists offshore of the 75 meter contour in the northeastern portion of the test area.



APPENDIX 1: TIMESTAMP LOCATION REFERENCE

Site	Time	Easting	Northing	Site	Time	Easting	Northing	Site	Time	Easting	Northing
1	8:23:00	630309	2374598	3	9:14:30	628951	2374993	5	9:27:00	629459	2375167
1	8:23:30	630314	2374598	3	9:15:00	628951	2374990	5	9:27:30	629460	2375164
1	8:25:00	630328	2374599	3	9:15:30	628951	2374986	5	9:28:30	629463	2375162
1	8:26:30	630315	2374613	3	9:16:00	628952	2374983	5	9:29:00	629465	2375161
1	8:28:00	630260	2374593	3	9:16:30	628955	2374978	5	9:29:30	629467	2375160
1	8:29:30	630278	2374599	3	9:17:00	628955	2374974	5	9:30:00	629469	2375158
1	8:31:00	630266	2374585	3	9:17:30	628956	2374972	5	9:30:30	629471	2375158
1	8:32:30	630280	2374588	3	9:18:00	628958	2374968	5	9:31:00	629473	2375157
1	8:34:00	630279	2374584	3	9:18:30	628958	2374965	5	9:31:30	629476	2375156
1	8:35:30	630249	2374590	3	9:19:00	628960	2374963	5	9:32:30	629480	2375157
1	8:37:00	630261	2374587	3	9:19:30	628961	2374962	5	9:33:00	629482	2375157
1	8:38:30	630268	2374584	3.1	13:44:30	629008	2374969	4	9:38:00	629539	2375134
1	8:40:00	630274	2374578	3.1	13:45:00	629001	2374969	4	9:38:30	629543	2375129
1	8:41:30	630282	2374573	3.1	13:45:30	628995	2374968	4	9:39:00	629544	2375129
1	8:43:00	630291	2374570	3.1	13:46:00	628990	2374968	4	9:39:30	629546	2375128
2	8:48:30	629782	2374843	3.1	13:46:30	628984	2374967	4	9:40:00	629546	2375128
2	8:49:00	629787	2374843	3.1	13:47:00	628978	2374967	4	9:40:30	629548	2375128
2	8:49:30	629791	2374842	3.1	13:47:30	628970	2374966	4	9:41:00	629548	2375127
2	8:50:00	629795	2374840	3.1	13:48:00	628964	2374965	4	9:41:30	629549	2375128
2	8:50:30	629801	2374840	3.1	13:48:30	628957	2374964	4	9:42:00	629550	2375128
2	8:51:00	629806	2374838	3.1	13:49:00	628950	2374964	4	9:42:30	629551	2375128
2	8:51:30	629811	2374836	3.1	13:49:30	628944	2374963	4	9:43:00	629553	2375128
2	8:52:00	629816	2374834	3.1	13:50:00	628938	2374963	4	9:43:30	629554	2375127
2	8:52:30	629820	2374831	3.1	13:50:30	628932	2374963	4	9:44:00	629554	2375127
2	8:53:00	629826	2374828	3.1	13:51:00	628926	2374964	4	9:44:30	629555	2375127
2	8:53:30	629831	2374826	3.1	13:51:30	628919	2374963	4	9:45:00	629555	2375126
2	8:54:00	629836	2374823	3.1	13:52:00	628912	2374964	4	9:45:30	629560	2375131
2	8:54:30	629843	2374821	3.1	13:52:30	628905	2374968	4	9:46:00	629575	2375122
2	8:55:00	629848	2374819	3.1	13:53:00	628881	2374975	4	9:46:30	629580	2375114
2	8:55:30	629856	2374816	3.1	13:53:30	628859	2374950	4	9:47:00	629583	2375111
2	8:56:00	629862	2374814	3.1	13:54:00	628872	2374924	4	9:47:30	629585	2375109
2	8:56:30	629868	2374812	3.1	13:54:30	628907	2374910	4	9:48:00	629586	2375107
3	9:05:30	628928	2375002	3.1	13:55:00	628923	2374906	4	9:48:30	629588	2375107
3	9:06:00	628928	2375000	3.1	13:55:30	628924	2374902	4	9:49:00	629589	2375107
3	9:06:30	628929	2374998	3.1	13:56:00	628921	2374900	4	9:49:30	629590	2375107
3	9:07:00	628930	2374993	3.1	13:56:30	628915	2374899	4	9:50:00	629590	2375107
3	9:07:30	628931	2374990	3.1	13:57:00	628910	2374900	4	9:50:30	629591	2375106
3	9:08:00	628932	2374987	3.1	13:57:30	628904	2374902	6	9:58:00	630050	2375323
3	9:08:30	628933	2374984	3.1	13:58:00	628899	2374903	6	9:58:30	630050	2375322
3	9:09:00	628934	2374980	3.1	13:58:30	628891	2374903	6	9:59:00	630050	2375321
3	9:09:30	628935	2374976	3.1	13:59:00	628887	2374904	6	9:59:30	630051	2375319
3	9:10:00	628936	2374971	3.1	13:59:30	628879	2374905	6	10:00:00	630052	2375318
3	9:10:30	628938	2374968	3.1	14:00:00	628874	2374906	6	10:00:30	630052	2375317
3	9:11:00	628939	2374965	3.1	14:00:30	628868	2374906	6	10:01:00	630054	2375316
3	9:11:30	628945	2374969	3.1	14:01:00	628862	2374906	6	10:01:30	630054	2375317
3	9:12:00	628944	2374993	3.1	14:01:30	628856	2374906	6	10:02:00	630056	2375319
3	9:12:30	628946	2374999	5	9:25:00	629449	2375171	6	10:02:30	630058	2375318
3	9:13:00	628949	2374999	5	9:25:30	629452	2375170	6	10:03:00	630059	2375317
3	9:13:30	628949	2374999	5	9:26:00	629454	2375170	6	10:03:30	630062	2375309
3	9:14:00	628950	2374996	5	9:26:30	629457	2375168	6	10:04:00	630067	2375292



Site	Time	Easting	Northing	Site	Time	Easting	Northing	Site	Time	Easting	Northing
6	10:04:30	630070	2375286	8	10:48:00	629627	2375611	12	11:30:00	630252	2376362
6	10:05:00	630077	2375273	8	10:48:30	629628	2375610	12	11:30:30	630253	2376357
6	10:05:30	630097	2375283	8	10:49:00	629629	2375610	12	11:31:00	630250	2376351
6	10:06:00	630093	2375315	8	10:49:30	629629	2375610	12	11:31:30	630248	2376345
6	10:06:30	630095	2375316	8	10:50:00	629628	2375611	12	11:32:00	630246	2376340
6	10:07:00	630096	2375313	10	10:55:30	629779	2375827	12	11:32:30	630244	2376335
6	10:07:30	630098	2375309	10	10:56:00	629779	2375823	12	11:33:00	630240	2376330
6	10:08:00	630098	2375308	10	10:56:30	629777	2375818	12	11:33:30	630239	2376326
7	10:18:30	629035	2375518	10	10:57:00	629775	2375812	12	11:34:00	630237	2376321
7	10:19:00	629034	2375518	10	10:57:30	629770	2375811	12	11:34:30	630235	2376317
7	10:19:30	629034	2375517	10	10:58:00	629769	2375806	12	11:35:00	630230	2376316
7	10:20:00	629034	2375515	10	10:58:30	629769	2375805	12	11:35:30	630228	2376311
7	10:20:30	629033	2375513	10	10:59:00	629768	2375803	12	11:36:00	630226	2376306
7	10:21:00	629033	2375512	10	10:59:30	629768	2375802	12	11:36:30	630227	2376298
7	10:21:30	629034	2375510	10	11:00:00	629769	2375801	12	11:37:00	630225	2376294
7	10:22:00	629033	2375509	10	11:00:30	629771	2375798	11	11:52:00	630484	2376076
7	10:22:30	629034	2375508	10	11:01:00	629771	2375798	11	11:52:30	630482	2376071
7	10:23:00	629034	2375506	10	11:01:30	629771	2375797	11	11:53:00	630478	2376067
7	10:23:30	629034	2375503	10	11:02:00	629771	2375797	11	11:53:30	630475	2376062
7	10:24:00	629035	2375500	10	11:02:30	629772	2375797	11	11:54:00	630472	2376058
7	10:24:30	629035	2375499	10	11:03:00	629771	2375796	11	11:54:30	630470	2376054
7	10:25:00	629035	2375498	10	11:03:30	629774	2375803	11	11:55:00	630468	2376048
7	10:25:30	629035	2375499	10	11:04:00	629773	2375824	11	11:55:30	630466	2376044
7	10:26:00	629045	2375512	10	11:04:30	629743	2375831	11	11:56:00	630464	2376038
7	10:26:30	629065	2375508	10	11:05:00	629735	2375834	11	11:56:30	630461	2376034
7	10:27:00	629072	2375505	10	11:05:30	629735	2375832	11	11:57:00	630458	2376029
7	10:27:30	629073	2375503	10	11:06:00	629736	2375830	11	11:57:30	630456	2376024
7	10:28:00	629072	2375500	10	11:06:30	629737	2375828	11	11:58:00	630454	2376020
7	10:28:30	629071	2375499	10	11:07:00	629738	2375826	11	11:58:30	630452	2376017
7	10:29:00	629068	2375498	10	11:07:30	629738	2375825	11	11:59:00	630450	2376011
7	10:29:30	629066	2375496	10	11:08:00	629737	2375823	11	11:59:30	630447	2376005
7	10:30:00	629064	2375495	10	11:08:30	629736	2375821	9	12:03:30	630469	2375805
7	10:30:30	629063	2375494	10	11:09:00	629736	2375818	9	12:04:00	630469	2375794
7	10:31:00	629062	2375494	10	11:09:30	629736	2375817	9	12:04:30	630466	2375788
7	10:31:30	629060	2375493	10	11:10:00	629736	2375815	9	12:05:00	630461	2375791
8	10:39:30	629616	2375637	10	11:10:30	629740	2375811	9	12:05:30	630459	2375793
8	10:40:00	629620	2375635	10	11:11:00	629737	2375817	9	12:06:00	630458	2375791
8	10:40:30	629622	2375635	10	11:11:30	629731	2375826	9	12:06:30	630456	2375789
8	10:41:00	629623	2375634	10	11:12:00	629726	2375828	9	12:07:00	630454	2375784
8	10:41:30	629624	2375634	10	11:12:30	629722	2375825	9	12:07:30	630453	2375782
8	10:42:00	629624	2375633	10	11:13:00	629714	2375825	9	12:08:00	630450	2375778
8	10:42:30	629625	2375631	10	11:13:30	629711	2375822	9	12:08:30	630448	2375774
8	10:43:00	629626	2375629	10	11:14:00	629709	2375818	9	12:09:00	630446	2375769
8	10:43:30	629628	2375628	10	11:14:30	629707	2375815	9	12:09:30	630442	2375766
8	10:44:00	629628	2375626	10	11:15:00	629706	2375813	9	12:10:00	630441	2375762
8	10:44:30	629628	2375624	12	11:26:30	630274	2376399	9	12:10:30	630437	2375758
8	10:45:00	629628	2375623	12	11:27:00	630272	2376394	9	12:11:00	630435	2375753
8	10:45:30	629627	2375621	12	11:27:30	630266	2376393	9	12:11:30	630433	2375750
8	10:46:00	629627	2375618	12	11:28:00	630263	2376387	9	12:12:00	630430	2375747
8	10:46:30	629627	2375615	12	11:28:30	630260	2376381	9	12:12:30	630427	2375743
8	10:47:00	629626	2375613	12	11:29:00	630257	2376374	9	12:13:00	630425	2375740
8	10:47:30	629626	2375611	12	11:29:30	630255	2376367	13	12:24:30	629571	2374700



Site	Time	Easting	Northing	Site	Time	Easting	Northing	Site	Time	Easting	Northing
13	12:25:00	629563	2374697	13	12:51:00	629362	2374643	16	13:35:30	629847	2374565
13	12:25:30	629557	2374693	13	12:51:30	629356	2374643	16	13:36:00	629836	2374566
13	12:26:00	629555	2374692	13	12:52:00	629350	2374643	16	13:36:30	629832	2374566
13	12:26:30	629558	2374693	13	12:52:30	629345	2374642	16	13:37:00	629832	2374563
13	12:27:00	629556	2374692	13	12:53:00	629340	2374643				
13	12:27:30	629552	2374691	13	12:53:30	629335	2374641				
13	12:28:00	629548	2374689	13	12:54:00	629330	2374639				
13	12:28:30	629545	2374687	13	12:54:30	629323	2374638				
13	12:29:00	629541	2374684	13	12:55:00	629317	2374637				
13	12:29:30	629537	2374681	14	13:04:30	630573	2374587				
13	12:30:00	629534	2374677	14	13:05:00	630577	2374593				
13	12:30:30	629531	2374674	14	13:05:30	630577	2374598				
13	12:31:00	629528	2374671	14	13:06:00	630575	2374601				
13	12:31:30	629524	2374667	14	13:06:30	630572	2374603				
13	12:32:00	629523	2374668	14	13:07:00	630569	2374604				
13	12:32:30	629521	2374667	14	13:07:30	630566	2374603				
13	12:33:00	629519	2374666	14	13:08:00	630562	2374604				
13	12:33:30	629516	2374665	14	13:08:30	630559	2374603				
13	12:34:00	629512	2374665	14	13:09:00	630554	2374602				
13	12:34:30	629515	2374669	14	13:09:30	630550	2374603				
13	12:35:00	629513	2374671	14	13:10:00	630546	2374603				
13	12:35:30	629509	2374670	14	13:10:30	630542	2374604				
13	12:36:00	629505	2374668	14	13:11:00	630538	2374603				
13	12:36:30	629500	2374665	14	13:11:30	630534	2374602				
13	12:37:00	629495	2374663	14	13:12:00	630530	2374600				
13	12:37:30	629491	2374660	14	13:12:30	630525	2374600				
13	12:38:00	629486	2374658	14	13:13:00	630520	2374599				
13	12:38:30	629482	2374656	14	13:13:30	630515	2374600				
13	12:39:00	629478	2374652	14	13:14:00	630511	2374600				
13	12:39:30	629471	2374642	14	13:14:30	630507	2374601				
13	12:40:00	629437	2374637	14	13:15:00	630503	2374601				
13	12:40:30	629428	2374664	14	13:15:30	630499	2374600				
13	12:41:00	629449	2374676	14	13:16:00	630495	2374600				
13	12:41:30	629475	2374673	15	13:21:30	630167	2374544				
13	12:42:00	629465	2374667	15	13:22:00	630177	2374549				
13	12:42:30	629458	2374660	15	13:22:30	630181	2374552				
13	12:43:00	629454	2374654	15	13:23:00	630178	2374554				
13	12:43:30	629448	2374654	15	13:23:30	630174	2374555				
13	12:44:00	629443	2374654	15	13:24:00	630169	2374556				
13	12:44:30	629437	2374654	15	13:24:30	630164	2374557				
13	12:45:00	629431	2374654	15	13:25:00	630160	2374558				
13	12:45:30	629426	2374653	15	13:25:30	630155	2374559				
13	12:46:00	629420	2374652	15	13:26:00	630150	2374560				
13	12:46:30	629415	2374652	15	13:26:30	630146	2374562				
13	12:47:00	629410	2374650	15	13:27:00	630141	2374562				
13	12:47:30	629404	2374649	16	13:32:00	629883	2374567				
13	12:48:00	629398	2374648	16	13:32:30	629889	2374565				
13	12:48:30	629392	2374648	16	13:33:00	629889	2374564				
13	12:49:00	629386	2374647	16	13:33:30	629886	2374564				
13	12:49:30	629381	2374644	16	13:34:00	629881	2374565				
13	12:50:00	629374	2374644	16	13:34:30	629876	2374564				
13	12:50:30	629369	2374644	16	13:35:00	629865	2374563				

APPENDIX 2: GEOGRAPHIC POSITION OF ANCHOR LOCATIONS

ID	Latitude	Longitude	Depth (m)
8	21 28.717 N	157 44.939 W	86
7	21 28.647 N	157 45.255 W	86
6	21 28.534 N	157 44.661 W	67
5	21 28.457 N	157 45.011 W	58
4	21 28.426 N	157 44.961 W	56
3	21 28.359 N	157 45.314 W	51