# APPENDICES

# Appendix 1 – References

# REFERENCES


1. **Environment Agency Abu Dhabi.** *Greenhouse Gas Emissions in Abu Dhabi Projected to Stabilise Over Next Decade.* Abu Dhabi : EAD, 2019.

2. **Envrionment Agency - Abu Dhabi.** *Greenhouse Gas Inventory and Projections for Abu Dhabi Emirate - Executive Summary of the Third Cycle.* Abu Dhabi : EAD, 2019.

3. **MacDonald, Mott.** *Environmental Screening Report.* 2020.

4. —. *Gap Analysis Report .* March 2021. Ref. AD41-90.0 27-26-G-25301_Rev.02.

5. —. *Ecosystem Services Assessment.* April 2021. Ref. AD41-90.0 27-26-G-25302_Rev.02.

6. —. *Dredging Management Plan Framework.* May 2021. Ref. AD41-90.0 27-26-G-25303_Rev.02.

7. —. *Hydrodynamic and Sediment Dispersion Modelling.* May 2021. Ref. AD41-90.0 27-26-G-25304_Rev.02.

8. **Mott MacDonald.** *Critical Habitat Assessment.* May 2021. Ref. AD41-90.0 27-26-G-25305_Rev.05.

9. **MacDonald, Mott.** *Framework Biodiversity Action Plan.* May 2021. Ref. AD41-90.0 27-26-G-25306_Rev.02.

10. —. *Framework Compensation Plan .* May 2020. Ref. AD41-90.0 27-26-G-25307_Rev.02.

11. —. *Marine Impact Assessment.* June 2021. Ref. AD41-90.0 27-26-G-25308_Rev.02.

12. **Nautica.** *Mirfa Landfall Terrestrial Ecology Report.* September 2021. Ref. N684-0621-MIR-1.1.

13. —. *Shuweihat Landfall Terrestrial Ecology Report.* September 2021. Ref. N684-0621-SHU-1.1.

14. —. *Das Island Landfall Terrestrial Ecology Report .* September 2021. Ref. N684-0821-DAS-1.1.

15. **Fugro.** *Environmental Baseline Survey Results Report Route 1 Rev 04.* 2020. Ref: AD41-457-G-24202-04.

16. —. *Environmental Baseline Survey Results Report Route 2 Rev 04.* 2020. Ref: AD41-457-G-24203-02.

17. —. *Weather Report – Statistical Report Eastern Route (Route 1) Location North .* 2020. Ref: AD41-457-G-24210-04 OMU037-Eastern Route 1 Location North.

18. —. *Weather Report – Statistical Report Eastern Route (Route 1) Location South.* 2020. Ref: AD41-457-G-24219-01 OMU037-Eastern Route 1 Location South.

19. —. *Environmental Baseline Survey Results Report – Route 1 E-0395-Document Rev 4.* 2020. Ref: AD41-457-G-24202 (OEU021-Vol 1 Route 1.

20. —. *Environmental Baseline Survey Results Report – Route 2 E-0395-Lightning Project Rev 02.* 2020a. Ref: AD41-457-G-24203 (OEU021-VO2-Route 2.

21. —. *Geophysical Survey Report – Cable Route 1A from Mirfa Landfall to Lower Zakum Island G Rev 02 .* 2020c. Ref: AD41-457-G-24197 (MRU093-V02-Route-1A.

22. —. *Weather Report – Statistical Report Eastern Route (Route 1) Location North A .* 2020d. Ref: AD41-457-G-24210 Northern Location Rev 04.

23. —. *Weather Report – Statistical Report Eastern Route (Route 1) Location South.* 2020e. Ref: AD41-457-G-24219 Southern Location Rev 01.

24. —. *Weather Report – Statistical Report Eastern Route (Route 2) Location North.* 2020f. Ref: AD41-457-G-24209.

25. —. *Weather Report – Statistical Report Eastern Route (Route 2) Location South.* 2020g. Ref: AD41-457-G-24218 Southern Location Rev01.

26. —. *Geophysical Survey Report – Cable Route 1-A from Mirfa to Landfall to Lower Zakum Island G.* 2020h. Ref: AD41-457-G-24197 (MRU093-V02-Route11A) Rev02.

27. —. *Geophysical Survey Report – Cable Route 1B from Mirfa to Landfall to Lower Zakum Island G .* 2020i. Ref: AD41-457-G-24197 (MRU093-V02-Route-1B) Rev02.

28. —. *Geophysical Survey Report – Cable Route 2 from Shuweihat to Landfall to Das .* 2020j. Ref: AD41-457-G-24199-01 (MRU093-V04-Route-2.

29. —. *Geophysical Survey Report – Cable Route 2A from Shuweihat to Landfall to Das .* 2020k. Ref: AD41-457-G-24200-01 MRU093-V06-Route-2B.

30. —. *Geophysical Survey Report – Cable Route 2B from Shuweihat to Landfall to Das .* 2020. Ref: AD41-457-G-24201-01 (MRU093-V06-Route-2B).

31. **Bechtel.** *Environmental Impact Assessment (EIA) Offshore.* s.l. : ADNOC-BEchtel, 2020. GH0000-40-STU-9034.

32. **Consultants, Blue Sea Environmental.** *Environmental Baseline Study, ADMA-OPCO's isting acilities – Zakum Oil Field .* 2011. OP/04-001/ZK-EBS/029.

33. **Creocean.** *Project Das Island Environmental Baseline Study - Final Report March 2009.* 2009. 1-07092-E.

34. **Mott MacDonald.** *Project Lightning Baseline Gap Analysis .* 2021.

35. **Dhabi, Environment Agency Abu.** *Towards Integrated Waste Management in Abu Dhabi.* Abu Dhabi : EAD and CWM, 2013.

36. ***Vision 2021 United Arab Emirates.* [Online] July 13, 2021. https://www.vision2021.ae/en.**

**37. Council, Abu Dhabi Urban Planning. *Plan Abu Dhabi 2030 - Urban Structure Framework Plan.* Abu Dhabi : ADUPC, 2007.**

**38. Environment Agency Abu Dhabi. *Recommended STandards for Treated Wastewater Reuse and Discharge to Land in Abu Dhabi Emirate.* s.l. : EAD, 2017. EAD-EQ-PR-TR-05.**

**39. The United Nations Educational, Scientific and Cultural Organisation . Marawah Biosphere Reserve, United Arab Emirates. *UNESCO.* [Online] UNESCO, February 2019. [Cited: April 30, 2022.] https://en.unesco.org/biosphere/arab-states/marawah?msclkid=c8bdb760d01311ecacf8527fc707f454.**

**40. Abdessalaam, T.Z. Al. Marine Enviroment Conservation and Management Programs in the Emirate of Abu Dhabi - Environment Agency Abu Dhabi. *IUCN.* [Online] Unknown. [Cited: April 30, 2022.] https://www.iucn.org/sites/dev/files/import/downloads/uae_marine_environment_programs.pdf.**

**41. Nautica Environmental Associates. *ADNOC Lightning Project - Das Island Landfall Terrestrial Ecology Survey Report.* 2021.**

**42. . *ADNOC Lightning Project - Das Island Terrestrial Ecology Survey Report.* 2021.**

**43. Abu Dhabi Ports. Al Dhafra Region Ports. *adports.* [Online] 2021. [Cited: May 17, 2022.] https://www.adports.ae/core-business/ports-terminals/ports/community-ports/al-dhafra-region-ports/#:~:text=Located%20125%20km%20from%20Abu%20Dhabi%20city%2C%20Al,local%20fishing%20industry%20and%20community%20in%20the%20Emirate..**

44. MarineTraffic. *MarineTraffic.* [Online] [Cited: May 16, 2022.] https://www.marinetraffic.com/en/ais/home/centerx:53.0/centery:24.7/zoom:9.

45. Mirfa International Power & Water Company. Summary of Environmental and Social Impact Study. *Mirfa International Power & Water Company.* [Online] Mirfa International Power & Water Company, 2018. [Cited: February 4, 2022.] http://www.mipco.ae/esia/.

46. Emirates Water & Electricity Co. Al Shuweihat Power and Water Complex. *Al Shuweihat Power and Water Complex.* [Online] Emirates Water & Electricity Co., 2021. [Cited: February 04, 2022.] https://www.ewec.ae/en/power-plants/shuweihat.

47. Shuweihat Asia Power Company. Shuweihat Asia Power Company - Project Details. *Shuweihat Asia Power Company.* [Online] SAPCO, 2011-2022. [Cited: February 4, 2022.] http://www.sapco.ae/Project.html.

48. Mott MacDonald. *Project Lightning Environmental Screening Report.* s.l. : Mott MacDonald, 2020.

49. Consortium, Samsung C&T Corporation & Jan De Nul. *Work Method Statement Trenching and Backfilling Works (TSHD Methodology Update.* 2022. JDN2688.MES.81.01.e.01.

50. Prysmian Group. *Method Statement – Submarine Cable Installation.* April. PPL20035-IE-MW-003-01.

51. Group, JDN. *Rock Installation Method Statement.* 2022. JDN.MES.83.01.

52. . *Lay – CLV (Cable Laying Vessel) – Isaac Newton.* 2019. JDN.MS.84.02.13.

53. . *Post-Lay Jet Trenching – UTV1200.* 2020. JDN.MS.84.03.01 .

54. Environment Agency Abu Dhabi. Air Quality Monitoring System - Ruwais Air Quality Monitoring System. *Environment Agency Abu Dhabi .* [Online] 2022. [Cited: February 07, 2022.] https://www.adairquality.ae/#Station.

55. *An Introduction to the Climate of the United Arab Emirates.* B, Boer. 35: 3-16, s.l. : Journal of Arid Environments, 1997.

56. *Die Wärmezonen der Erde, nach der Dauer der heissen, gemässigten und kalten Zeit und nach der Wirkung der Wärme auf die organische Welt betrachtet. Köppen, Wladimir. 3, 1884.* s.l. : Meteorologische Zeitschrift, Vol. 20, pp. 351-360.

57. National Oceanic and Atmospheric Administration. *Climate Normals for Abu Dhabi.*

58. Meteorology, National Centre for. Climate Yearly Report. [Online] April 22, 2022. https://www.ncm.ae/services/climate-reports-yearly?lang=en.

59. al., T.B.M.J. Ouarda et. *Probability distributions of wind speed in the UAE.* s.l. : Elsevier, 2015.

60. Environment Agency Abu Dhabi. Air Quality Annial Summary Report 2020. [Online] https://www.ead.gov.ae/-/media/Project/EAD/EAD/Documents/Resources/Air-Quality-Annual-Summary-Report-2020---English.pdf.

61. Institute of Air Quality Management. *Guidance on the assessment of dust from demolition and construction.* 2014.

62. *IAQM Guidance on the assessment of dust from demolition and construction .* al., Holman et. London : Institue of Air Quality Management , 2014.

63. Fugro. *Environmental Baseline Results Report - Route 1.* 2020.

64. . *Environmental Baseline Results Report - Route 2.* 2020.

65. . *Environmental Baseline Results Report - Route 1.* 2020.

66. Sondergaard, M. Redox Potential. *Encyclopedia of Inland Waters.* University of Aarhus, Denmark : Academic Press, 2009.

67. Sondergaard, M. Redox Potential. *Organic Compounds.* Denmark : Academic Press, 2009, pp. 852-859.

68. Dzombak, David A, et al. Anthropogenic Cyanide in the Marine Environment. *Cyanide in Water and Soil.* 2005, pp. 209-224.

69. *Microbiologically Induced Corrosion of UNS N04400 in Seawater.* Gouda, V K, et al. 1, 1993, Corrosion Engineering, Vol. 9, pp. 63-73.

70. EAD. *Standards and Limits for Pollution to Air and Marine Environments Occupational Exposure Pesticides and Chemical Use.* Abu Dhabi : s.n. Techincal Guidance Document TG-003R.

71. *Ambient Marine Water and Sediments Specifications.* 2017, Abu Dhabi QCC.

72. *Improvement of Global Ocean Tide Models in Shallow Water Regions.* Yongcum Cheng, Ole Baltazar Andersen. Lisbon : s.n., 2010. Ocean Surface Topography Science Team Meeting.

73. *The NCEP Climate Forecast System Reanalysis.* Saha et al, S. 2010, Bulletin of the American Meteorological Society, Vol. 97, pp. 1015 - 1057.

74. UKHO. *British Admiralty Chart 3715.* s.l. : Admiralty Charts & Publications, 2017.

75. Global Environmental Modelling Systems. *Grange Resources, Albany Port Authority, Port Development, Oceanographic Studies and Dredging Program Simulation Studies.* Albany : CSIRO, 2007.

76. Fugro. *E-0395 Lightning Project, Geotechnical Factual Report - Common Corridor (Route-2, Route-2A & route-2B) Between Shuweihat and Das Island.* 2020.

77. Williams, S.J. *Surfical Sediment Character of the Louyisiana offshore Continental Shelf Region.* s.l. : US Geological Survey, 2007.

78. United States Environmental Protection Agency. *Profile of the Water Transportation Industry.* Washington DC : EPA, 1997.

79. Dhabi, Environment Agency - Abu. *Abu Dhabi State of Environment Report .* Abu Dhabi : EAD, 2017.

80. Dhabi, Statistics Centre - Abu. *Statistical Yearbook of Abu Dhabi .* Abu Dhabi : Statistics Centre - Abu Dhabi , 2020.

81. Statistics Centre Abu Dhabi. *Waste Statistics in Abu Dhabi Emirates.* Abu Dhabi : Statistic Centre Abu Dhabi, July 2020.

82. *UAE Vision 2021.* [Online] [Cited: January 4, 2018.] https://www.vision2021.ae/en.

83. EAD. *Abu Dhabi State of Environment Report 2017.* 2017.

84. Nautica Environmental Associates . *ADNOC Lightning Project - Shuweihat Landfall Terrestrial Ecology Survey Report.* 2021.

85. Nautica Environmental Associates. *ADNOC Lightning Project - Mirfa Landfall Terrestrial Ecology Survey Report.* 2021.

86. Shahid, S. A., Abdelfattah, M.A. and Arshad, K.R. *Soil survey for the coastline of Abu Dhabi Emirate. .* s.l. : Environmental Research and Wildlife Development Agency, Abu Dhabi, UAE. ERWDA Internal Report, 2004.

87. USDA. *Soil taxonomy. A basic system of soil classification for making and interpreting soil surveys .* s.l. : USDA Agriculture Handbook No. 436. U.S. Government Print Office, Washington, DC, 1999.

88. World Wildlife Fund. *Arabian Peninsula: Oman and United Arab Emirates.* s.l. : National Geographic Society, 2001.

89. Meteorology, National Center of. *Seismic Department.* Abu Dhabi : Ministry of Presidential Affairs, 2021.

90. EAD. Environmental Atlas. [Online] [Cited: 02 19, 2018.] www.environmentalatlas.ae/cartography/geographicInheritance/earthquakesSeismicEventsAndTectonicPlateBoundaries.

91. Government of Dubai - Dubai Municipality. Seismicity of United Arab Emirates. [Online] [Cited: 02 19, 2018.] www.seismo.geodesy.ae/seismicity.aspx.

92. John, D.M. & George, J.D. *The Marine Life of Abu Dhabi - A Report for the Abu Dhabi Company for Onshore Oil Operations.* London : The Natural History Museum, 2001.

93. Al Dhaheri, S.S., Al Cibahi, A., Javed, S., GRandcourt, E., Bin Kulaib, R., & Al Mazrouei, S. *Abu Dhabi State of Environment Report.* Abu Dhabi : Biodiversity, Environment Agency Abu Dhabi, 2017.

94. *Anthropogenic and natural sources of anbient noise in the ocean.* Hildenbrand, J.A. 2009, Marine Ecology Progress Series, Vol. 395, pp. 5-20.

95. Rako- ospi , i olina and icci lin, arta. Underwater oise So rces and Effects on Marine Life. *World Seas: An Environmental Evaluation.* s.l. : Academic Press, 2019, pp. 367-389.

96. *Good Practice Guide for Underwater Measurement, National Measurement Office, Marine Scotland, The Crown Estate.* Robinson, S.P., Lepper, P. A. and Hazelwood, R.A. 2014, NPL Good Practice Guide No. 133, Vols. ISSN: 1368-6550.

97. Carey, W. M. and Evans, R. B. *Ocean Ambient Noise: Measurements and Theory.* s.l. : Springer, 2011.

98. *Sounds of Indo-Pacific humpback dolphins (Sousa chinensis) in west Hong Kong: a preliminary description.* PQ, Sims, et al. 1, 2012, The Journal of the Acoustical Society of America, Vol. 131, pp. 48-53.

99. *Marine Mammal Noise Exposure Criteria: updated scientific recommendations for residual hearing effects.* JJ, Southall BL: Finneran, et al. 2, 2019, Aquatic Mammals, Vol. 45.

100. 2015 - 2022 OSPAR Commission. Underwater Noise. *OSPAR Commission.* [Online] www.ospar.org/work-areas/eiha/noise.

101. Underground, Weather. [Online] TWC Product and Technology, 2014. [Cited: May 2, 2022.] https://www.wunderground.com/history/daily/ae/abu-dhabi/OMAA/date/2022-4-7.

102. Wunderground. [Online] [Cited: May 20, 2022.] wunderground.com.

103. Tides4Fishing. [Online] 2022. [Cited: May 2, 2022.] https://tides4fishing.com/ae/united-arab-emirates/abu-dhabi.

104. *Abu Dhabi Emirate Habitat Classification and Protection Guideline.* Al Dhaheri, S., Javed, S., Alzahlawi, N., Binkulaib.R., Cowie,W., Grandcourt, E. and Kabshawi, M. 2017, Environment Agency Abu-Dhabi (EAD).

105. Javed, S., et al. *The Abu Dhabi Red List of Species: An assessment of the conservation status of mammals, birds, reptiles, invertebrates and plants in Abu Dhabi Emirate.* Abu Dhabi, UAE : Environment Agency - Abu Dhabi, Provita and IUCN Species Survival Commission, 2020.

106. IUCN. The IUCN Red List of Threatened Species. Version 2021-3. [Online] 2022. [Cited: April 30, 2022.] <https://www.iucnredlist.org>.

107. *Environmental factors affecting benthic infaunal communities of the Western Arabian Gulf.* Coles, Stephen and McCain, John. 29, 1990, Marine Environmental Research.

108. *Limits on carbon sequestration in arid blue carbon ecosystems.* Schile, L., et al. 27, 2016, Ecological Applications.

109. *Eutrophication in shallow coastal bays and lagoons: The role of plants in the coastal filter.* Glathery, K. J., Sundback, K. and Anderson, I. C. 2007, Marine Ecology Progress Series.

110. EAD. *Marine Habitat Classification.* Abu Dhabi, UAE : Environment Agency Abu Dhabi (EAD), 2011.

111. *Seagrass habitats in the Arabian Gulf: distribution, tolerance thresholds and threats.* Erftemeijer, Paul and Shuail, Dawood. 15, 2012, Aquatic Ecosystem Health and Mangement.

112. Nasser H. *Chapter 12: Marine Ecosystem Diversity in the Arabian Gulf: Threats and Conservation in Biodiversity.* s.l. : The Dynamic Balanace of the Planet, 2014.

113. *Growth of seagrass Halophila ovalis at dugong trails compared to existing within-patch variation in a Thailand intertidal flat.* Nakaoka, Masahiro and Aioi, Keiko. 184, 1999, Marine Ecology Progress Series.

114. EAD. *Abu Dhabi Fisheries and Aquaculture Bulletin.* 2017.

115. Jabado, Rima W., et al. *The Conservation Status of Sharks, Rays, and Chimaeras in the Arabian Sea and Adjacent Waters.* Abu Dhabi, UAE : Environment Agency - Abu Dhabi (EAD) and IUCN Species Survival Commission Shark Specialist Group, 2017.

116. *Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects.* BL, Southall, et al. 2, 2019, Aquatic Mammals, Vol. 45.

117. Richardson, W J, et al. *Marine Mammals and Noise.* s.l. : Academic press, 2013.

118. *Dugong (Dugong dugon) vocalization patterns recorded by automatic underwater sound monitoring systems.* Ichikawa, K, et al. 3, 2006, The Journal of the Acoustical Society of America, Vol. 119, pp. 3726-3722.

119. *Biosonar, hearing and noise effect on the Indo-Pacific humpback dolphins (Sousa chinensis) In: Proceedings of Meetings on Acoustics 4ENAL.* Li, S and Wang, D. 1, 2016, Acoustical Society of America, Vol. 27.

120. *The cumulative impact of annual coral bleaching can turn some coral species winners into losers.* Grottoli, A. G., Warrier, M. E. and Levas, S. J. 20, 2014, Global Change Biology.

121. *Functional roles of sponges.* Bell, James. 79, 2010, Estuarine Coastal and Shelf Science.

122. *The distribution, abundance and group dynamics of Indian Ocean humpback dolphins (Sousa plumbea) in the Emirate of Abu Dhabi (UAE).* Lopez, B. D., et al. 2017, Journal of the Maine Biological Association of the United Kingdom.

123. EAD. MOCCAE and EAD Launch Programme to Save UAE's Severely Overexploited Fisheries. Abu Dhabi : EAD Press Centre, 2016.

124. Al Dhaheri S., Javid S., Alzahlawi N., Binkulaid R., Cowie W., Grandcourt E. and Kabshawi M. *Abu Dhabi Emirate Habitat Classification & Protection Guideline.* Abu Dhabi : Environment Agency - Abu Dhabi, 2017.

125. *Environmental impacts of dredging on seagrasses: A review.* Erftemeijer, Paul L. A> and Robin Lewis, Roy R. 2006, Marine Pollution Bulletin, Vol. 52, pp. 1553-1572.

126. *Chronic light reduction reduces overall resilience to additional shading stress in the seagrass Halophila ovalis.* Yaakub, S. M., Chen, E., Bouma, T. J., Erftemeijer, P. L. A., & Todd, P. A. 2, 2014, Marine Pollution Bulletin, Vol. 83, pp. 467-474.

127. *Environmental monitoring and management of reclamation works clost to sensitive habitats.* Doorn-Groen, S. M. and Foster, T. M. 2007. PROCEEDINGS OF THE EIGHTEENTH WORLD DREDGING CONGRESS (WODCON XVIII).

128. *Environmental Monitoring and Management Close to Sensitive Habitats.* Doorn-Groen, Stephanie M. 2007, Terra et Aqua, p. 8.

129. *Environmental impacts of dredging and other sediment disturbances on corals: A review.* Erftemeijer, Paul L.A., et al. 2012, Marine Pollution Bulletin, pp. 1737–1765.

130. *Assessing the impacts of sediments from dredging on corals.* Jones, Ross, et al. 2016, Marine Pollution Bulletin, pp. 9-29.

131. *Chronic Exposure of Corals to Fine Sediments: Lethal and Sub-Lethal Impacts.* Flores F., Hoogenboom M., Smith L., Cooper T., Abrego D., Negri A. 5, 2012, PLOIS One, Vol. 7.

132. *Responses of coral reefs and reef organisms to sedimenations.* S., Rogers C. 1990, Marine Ecology Progress Series, Vol. 62, pp. 185-202.

133. *Coral reproduction in the worlds warmest reefs; Southern Persian Gulf (Dubai, United Arab Emirates).* Baiman A. G., Baird A. H., Cavalcante G. H. 2, 2011, Coral Reefs, Vol. 30, pp. 405-413.

134. Chevron Australia Pty Ltd. *Final Environmental Impact Statement/Response to Submission on the Environmental Review and Management Programme for the Proposed Gorgon Project.* 2006.

135. Thomson F., McCully S., Wood D., Pace F., White P. *A generic investigation into noise profiles of marine dredging in relation to the acoustic sensitivity of the marine fauna in UK waters with particular emphasis on addregate dredging: Phase 1 Scoping and review of key issues.* Southamton : Cefas, 2009.

136. *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations.* al., Southall et. 4, 2008, Aquatic Mammals, Vol. 33, pp. 273-275.

137. Finneran J., Jenkins K. *Criteria and Thresholds for US Navy Acoustic and Explosive Effects Analysis (Phase III).* s.l. : US Navy, 2017.

138. Blue Planet Marine. *Survey - Monitoring Aquatic Ambient Noise and the Associated Pressure Impacts in Port Curtis and Port Alma.* 2013.

139. *Collisions between ships and whales.* W., Laist D. 1, 2001, Marine Mammal Science, Vol. 17, pp. 35-75.

140. H., Marsh. *Dugong Status Reports and Action Plans for Countries and Territories.* s.l. : UNEP, 1992.

141. PAME. *Arctic Marine Shipping Assessment 2009 Report.* s.l. : PAME, 2009.

142. *A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions.* Taormina, Bastien, et al. 2018, Renewable and Sustainable Energy Reviews, Vol. 96, pp. 380-391.

143. Exponent. *Submarine Cable DC Magnetic Field in Lake Champlain and Marine Assessment.* Bowie, MD : Exponent, Inc., 2014.

**144. Al Dhaheri, S., et al. *Abu Dhabi Emirate Habitat Classification and Protection Guideline.* Abu-Dhabi. : Environment Agency Abu-Dhabi, 2017.**

**145. Treweek, J. *Ecological impact assessment.* 1st. Oxford : Blackwell Science, 1999.**

**146. Institute of Ecology and Environmental Management. *Guidelines for ecological impact assessment in the United Kingdom.* s.l. : Institute of Ecology and Environmental Management (IEEM), 2006.**

**147. Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Synthesis.* Washington : Island Press, 2005.**

**148. *Guidelines for ecological evaluation and impact assessment. Ecology & Environmental Management In Practice.* Regini, K. 29, 2000, Bulletin of the Institute of Ecology and Environmental Management, pp. 1–7.**

**149. Regini, K. *Guidelines for ecological impact assessment: Amended pilot.* s.l. : Institute of Ecology and Environmental Management (IEEM), 2002.**

**. Canadian Environmental ssessment gency. C m lative effects assessment practitioners' g ide. [Online] 2014. [Cited: January 17, 2020.] http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=43952694-1&offset=1&toc=show.**

**151. *Implementing ecological compensation in New Zealand: Stakeholder perspectives and a way forward.* Brown, M. A., et al. 1, 2013, Journal of the Royal Society of New Zealand, Vol. 44, pp. 34–47.**

**152. Business and Biodiversity Offsets Programme. Biodiversity offset design handbook. Washington, D.C: BBOP. [Online] 2009. [Cited: January 17, 2020.] http://www.forest-trends.org/documents/files/doc_3126.pdf.**

**153. *Limits on carbon sequestration in arid blue carbon ecosystems.* Shile, L.M., Kauffman, J.B., Crooks, S., Fourqurean, J.W., Glavan, J., and Megonigal, J.P. 3, Maryland : Ecological Society of America, 2017, Vol. 27.**

**154. Agency, Central Intelligence. The World Factbook - UAE Economy. *The World Factbook.* [Online] 2021. [Cited: August 5, 2021.] https://www.cia.gov/the-world-factbook/countries/united-arab-emirates/#economy.**

**155. Economy, United Arab Emirates Ministry of. *The Annual Economic Report 2020 28th Edition.* Abu Dhabi : s.n., 2020.**

**156. Oxford Business Group. *Dubai Covid-19 Recovery Roadmap.* Oxford : Oxford Business Group, 2021.**

**157. Dhabi, Department of Culture and Tourism - Abu. *Annual Report - Tourism .* Abu Dhabi : ADCT, 2019, Volume 2.**

**158. EAD. *Environmentalatlas.ae.* [Online] [Cited: June 5th, 2022.] https://www.environmentalatlas.ae/cartography/seaToSummit/commercialFisheriesFishLandingsBySite.**

**159. Seek, Sea -. Sea - Seek - Ebook Sailling Guide - Arabian Gulf . *Sea - Seek.* [Online] July 2021. [Cited: 2021 15, July .]**

**160. Society, Abu Dhabi Islands Archaeological. *Abu Dhabi - 8 Million Years Ago Late Miocene Fossils from the Western Region.* Abu Dhabi : ADIAS, 2005.**

**161. EAD. *Enviroportal.* [Online] [Cited: June 06, 2022.] https://enviroportal.ead.ae/map/.**

**162. Task Force on Climate-Related Financial Disclosures. *Recommendations of the Task Force on Climate-related Financial Disclosures.* s.l. : TFCD, 2017.**

**163. Christensen, J.H., K. Krishna Kumar, E. Aldrian, S.-I. An, I.F.A. Cavalcanti, M. de Castro, W. Dong, P. Goswami, A. Hall, J.K. Kanyanga, A. Kitoh, J. Kossin, N.-C. Lau, J. Renwick, D.B. Stephenson, S.-P. Xie and T. Zhou. *Climate Phenomena and their Relevance for Future Regional Climate Change. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* 2013.**

**164. *Modelling Current and Future Climate Change in the UAE using Various GCMs in MarksimGCM.* Al Blooshi, L.S, Alyan, S, Joshua, J.N and Ksiksi, T.S. Al Ain : The Open Atmospheric Science Journal, 2019, Vol. 13. 0.2174/1874282301913010056.**

**165. *A Roadmap for Policy-Relevant Sea-Level Rish Research in the United Arab Emirates.* Melville-Rea, H., Eayrs, C., Anwahi, N., Burt, J.A, Holland, D., Samara, F., Paparella, F., Al Mushidi, A.H., Al-Shehhi, M.R., and Holland, D.M. 2296-7745, Abu Dhabi : Frontiers in Marine Science, 2021, Vol. 8.**

**166. United Arab Emirates Ministry of Climate Change and Enivronment. *National Climate Change Plan of the United Arab Emirates 2017-2050.* Abu Dhabi : United Arab Emirates Ministry of Climate Change and Enivronment, 2017.**

**167. Environmental Agency in Abu Dhabi . *Technical Guidance for Environmental Impact Assessment .* Abu Dhabi : s.n., 2014.**

**168. Abu Dhabi Occupational Safety and Health System Center (OSHAD). *Abu Dhabi Occupational Safety and Health System Framework (OSHAD-SF), Technical Guideline, Process of Risk Management.* July 2016. Version 3.0.**

**169. Agriculture, International Centre for Biosaline. *Soil Survey for the Emirate of Abu Dhabi - Project Brief.* Abu Dhabi : ICBA, 2015.**

**170. Envrionment Agency Abu Dhabi. *Marine and coastal environments of Abu Dhabi Emirate.* 2008.**

**171. (n.d.), A Chiffings. *Arabian Seas, 1st Ed.***

**172. Mott MacDonald. *Project Lightning Ecosystem Services Assessment .* 2021. AD41-90.0/27/26-G-25302 Rev. 02.**

**173. *Work Method Statement Trenching and Backfilling Works (JDN2688.MES.81.01.e.00).* s.l. : Samsung C&T Corporation & Jan De Nul Consortium,, January 2022.**

**174. Consortium, Samsung C&T Corporation & Jan De Nul. *Work Method Statement Trenching and Backfilling Works (JDN2688.MES.81.01.e.00).* January 2022.**

**175. . *Work Method Statement Trenching and Backfilling Works (JDN2688.MES.81.01.e.00).* January 2022.**

**176. MacDonald, Mott. *Hydrodynamic and Sediment Dispersion Modelling.* May 2021. Ref. AD41-90.0 27-26-G-25304_Rev.02.**

**177. Nautica. *Das Island Landfall Terrestrial Ecology Report.* September 2021. Ref. N684-0821-DAS-1.1.**

**178. Fugro. *Geophysical Survey Report – Cable Route 1B from Mirfa to Landfall to Lower Zakum Island G.* 2020i. Ref: AD41-457-G-24197 (MRU093-V02-Route-1B) Rev02.**

**179. . *Geophysical, Geotechnical and Environamental Baseline Surveys for Subsea Cable Routes.* Abu Dhabi : FUgro, 2020.**

**180. *Numerical Limitations of Hydraulic Models.* Chanson, L. and H., Toombes. Brisbane : s.n., 2011. IAHR World Congress - Balance and Uncertainty.**

**181. Wilmott, C. J. *Some comments on the evaluation of model performance.* Delaware : Centre for Climatic Research, University of Delaware, 1982.**

**182. *Evaluation of Costal Area Modelling Systems at an Estury Mouth.* Sutherland, J., Walstra, D., Chesher, T., Van Rijn, L., and Southgate, J. 2003, Coastal Engineering: An International Journal for Coastal Harbour and Offshore Engineering, Vol. 51, pp. 119-142.**

**183. Tides 4 Fishing. [Online] [Cited: 05 20, 2022.] tides4fishing.com.**

# Appendix 2 – Information on the Current Condition of the Environment (Methodology, Data and Results)

Anthesis

# Appendix 2.1 – WKC Hydrodynamic Modelling Report

# Project Lightning

## Hydrodynamic & Sediment Plume Dispersion Report

**Prepared for: Anthesis**

**Ref.: J21071_R_XX**

**Date: 16/05/2022**

# Report Approval & Revision Record

| | |
|---|---|
| **Project:** | Project Lightning |
| **Document Title:** | Hydrodynamic & Sediment Plume Dispersion Report |
| **Client:** | Anthesis |
| **Report Number:** | J21071_R_XX |

| Rev | Date | Prepared | Reviewed | Approved |
|---|---|---|---|---|
| A | 30/04/2022 | Gregory Ashcroft<br>Partner | Donald Afan<br>Principal Consultant | Gregory Ashcroft<br>Partner |
| 01 | 16/05/2022 | Ravel Barnard<br>Environmental Consultant | Gregory Ashcroft<br>Partner | Gregory Ashcroft<br>Partner |

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# Acronyms

| | |
|---|---|
| 2D | Two-dimensional |
| 3D | Three-dimensional |
| °C | Degrees Celsius |
| ADCP | Acoustic Doppler Current Profiler |
| CSD | Cutter Suction Dredger |
| E | Efficiency Coefficient |
| (E) | Exchange Coefficient |
| EAD | Environmental Agency Abu Dhabi |
| FM | Flow Model |
| HD | Hydrodynamic |
| IOA | Index of Agreement |
| km | kilometre |
| m | metre |
| $m^3/s$ | cubic metres per second |
| MAE | Mean Absolute Error |
| ARMAE | Adjusted Relative Mean Absolute Error |
| RMAE | Relative Absolute Mean Error |
| QCC | Quality Conformity Council |
| RMSE | Root Mean Square Error |
| TG-13 | Technical Guidance for Hydrodynamic Modelling |
| TR/AD | Transport Module/Advection Dispersion |
| UAE | United Arab Emirates |
| US EPA | United States Environmental Protection Agency |
| UKHO | United Kingdom Hydrographic Office |
| WKC | WKC Environment Consultancy |

# 1 Introduction

## 1.1 Background

WKC Environment Consultancy (WKC) has been contracted by Anthesis to undertake a hydrodynamic modelling sediment plume dispersion assessment as part of the Environmental Impact Assessment (EIA) for the proposed Project Lightning power utilities venture (the “Project”) located in Abu Dhabi, United Arab Emirates (UAE).

The project will be developed in the AL Dhafra region of Abu Dhabi and consists of two sub-sea transmission cables running from onshore power supply stations at Mirfa and Shuweihat to the offshore locations of Lower Zakum and Das Island respectively as illustrated below in Figure 1-1 for Route 2 and Figure 1-2 for Route 1.

This report presents the results of the hydrodynamic modelling and sediment plume dispersion modelling associated with dredging activities.  The assessment has been conducted to determine the potential environmental impacts to the marine environment.

**Figure 1-1 - Project Location / Modelling Domain – Route 2**

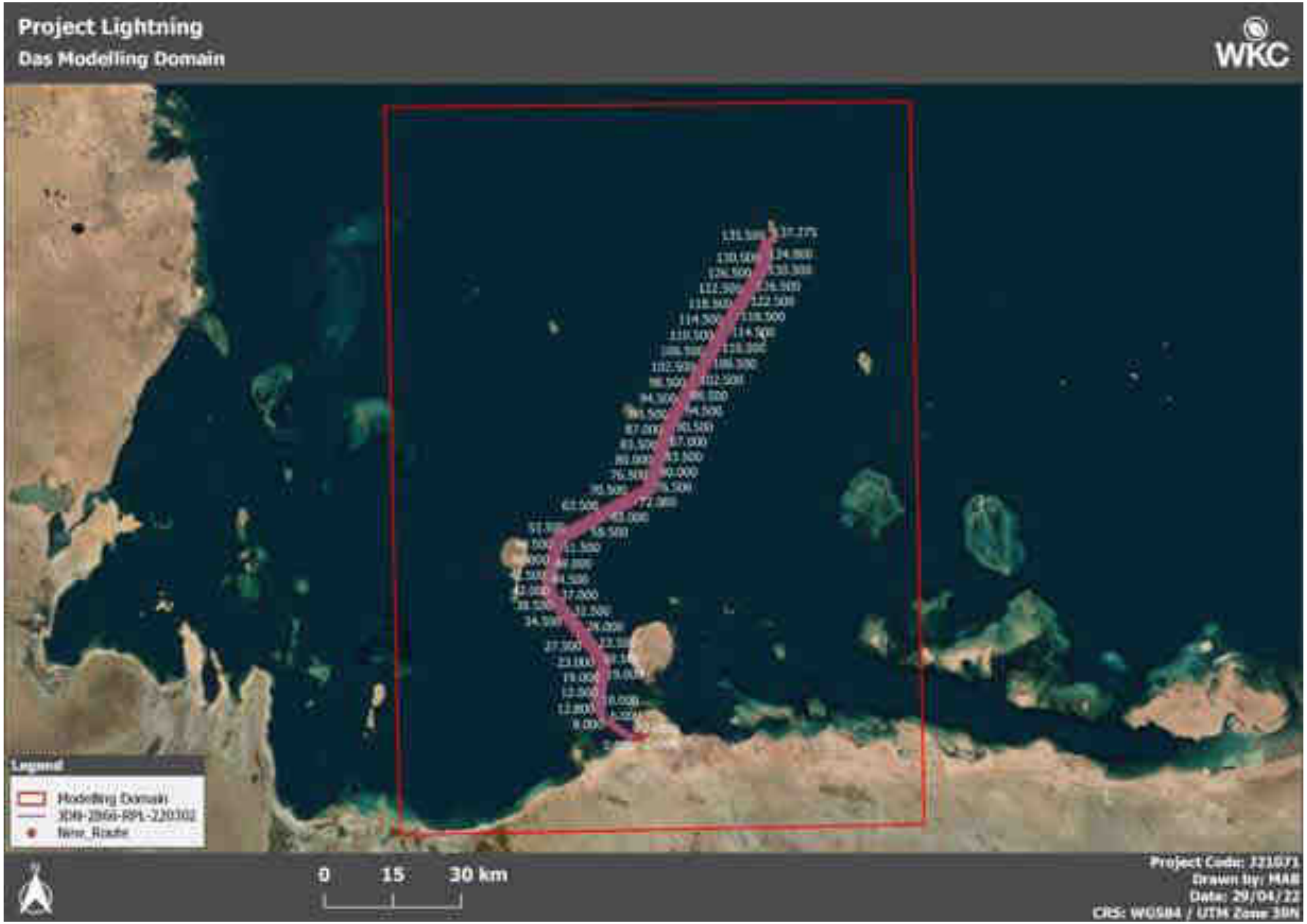
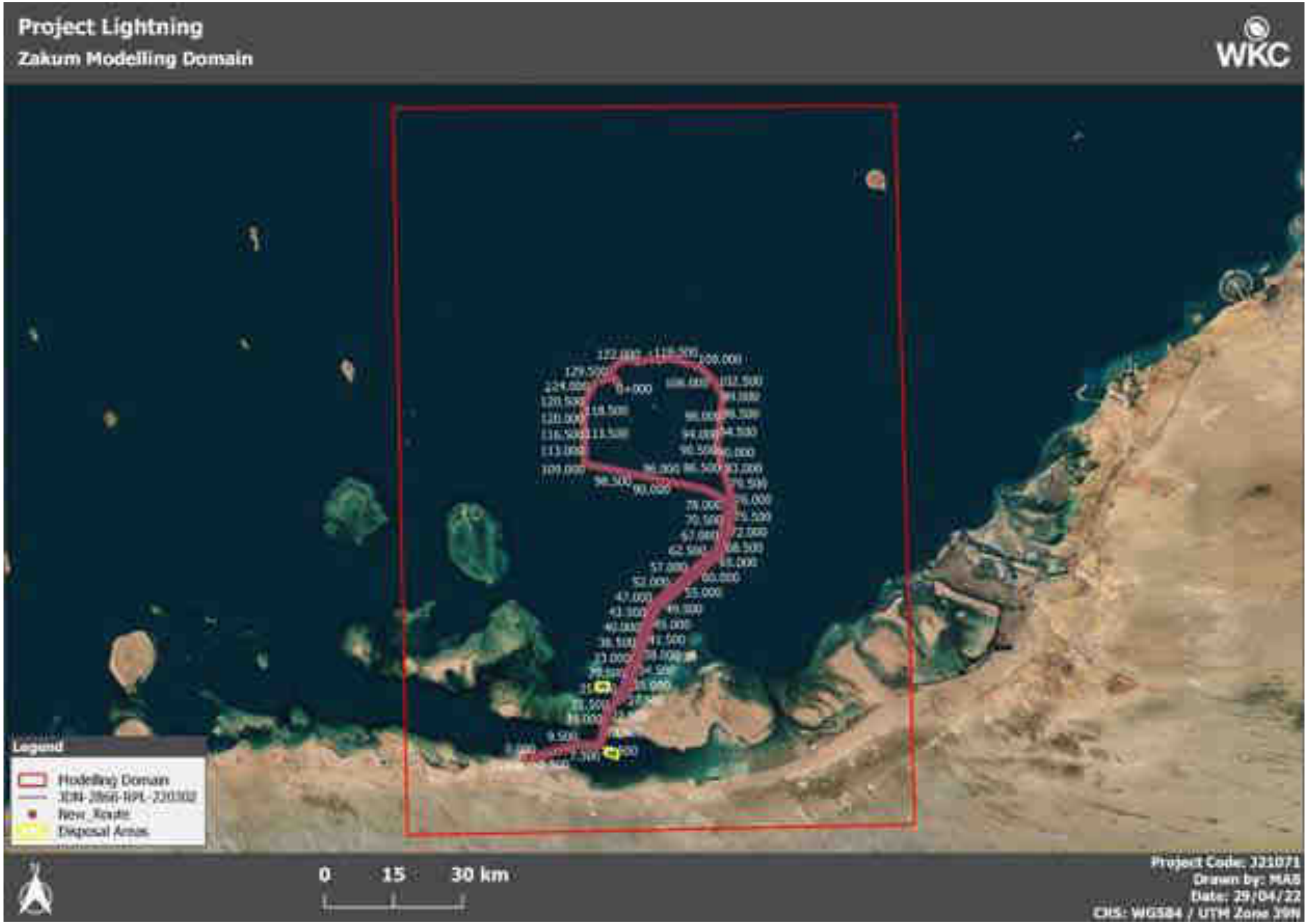


**Figure 1-2 - Project Location / Modelling Domain – Route 1**



## 1.2 Study Objectives

The objective of the study is to determine whether increased suspended sediment concentration during dredging activities and the associated deposition of fine sediment may cause adverse impacts to the marine environment. These objectives can be summarised as follows:

- Simulation of hydrodynamics to feed into subsequent sediment dispersion simulations; and
- Simulations to determine the suspended sediment plume dispersion and deposition of sediment associated with dredging activities.

# 2 Project Standards

This section provides a summary of regulations and technical guidelines for hydrodynamic modelling studies within the Abu Dhabi Emirate. These include UAE Federal Guidance, which may be of relevance for comparative purposes. Where UAE or Abu Dhabi specific criteria are unavailable, reference has been made to widely accepted international guidance, including relevant guidelines, protocols and standards that will be applicable to the Project.

## 2.1 Technical Guidance (TG13) for Hydrodynamic Modelling

The Environment Agency of Abu Dhabi (EAD) issued a technical guidance document which provides general guidance for conduction hydrodynamic modelling studies and are listed as follows [1]:

- Model selection;
- General model requirements, and
- Reporting structure.

## 2.2 Technical Guidance (TG12) for Dredging and Reclamation

The Environment Agency of Abu Dhabi (EAD) issued a technical guidance document which provides general guidance for conduction hydrodynamic modelling studies and are listed as follows [2]

- Dredging and reclamation recommended practices.

## 2.3 Regulation for Protection of Maritime Environment

### 2.3.1 UAE Federal Regulations

Discharges to the marine environment are regulated under the 'Regulation for the Protection of Maritime Environment', UAE Cabinet [3]. The principle requirements of Chapter 3 of this regulation, pertaining to this scope of works, are as follows:

- No discharge of plastic materials including but not limited to, synthetic rope, synthetic fishing nets, plastic bags;
- No discharge of garbage including products, ceramics, glass and bottles, wood, lining and packing materials; and,

- If food leftovers generated from marine vessels, rigs, barges, manned platforms, or installation, are to be disposed of into marine environment, the discharge location should be as far as possible from land, but not less than 12 nautical miles from the nearest shoreline.

In accordance with the Council of Ministers' Decision No 37 – 2001 – Protection of the Marine Environment, the following non-degradable pollutants / Illegal compounds are not to be discharged into marine environment:

**Table 2-1 - UAE Federal Discharge Banned Substances [4]**

| | |
|---|---|
| Organ phosphorus Pesticides | Polychlorinated Biphenyls |
| Dimethoate | PCBs |
| Malathion | Aroclor |
| Organochlorine Pesticides | Tetrachlorobiphenyl |
| Aldrin | Trichlorobiphenyl |
| Dieldrino | Polynuclear Aromatic Hydrocarbons (PAH) |
| DDT | Benzo (a) pyrene and Naphthalene |
| Chloridane | Naphthalene |
| Eldrin | |

Note that this assessment does not pertain to discharges of any kind. Therefore, the Federal Regulations are not considered further within this assessment.

The full text of the Regulation should be referred to for further details.

### 2.3.2 Municipality Regulations and Guidelines

Quality standards for ambient marine water are provided by Abu Dhabi Quality and Conformity Council (QCC) for the maximum allowable concentrations for ambient marine water (Table 2-2) and maximum allowable concentrations for ambient marine sediments (Table 2-3) [5].

**Table 2-2 - Abu Dhabi QCC Maximum Allowable Concentrations for Ambient Marine Water**

| Parameter | Unit | General Use Areas | Marine Protected Use Areas |
|---|---|---|---|
| Cadmium | µg/l | 0.7 | 0.3 |
| Chromium | µg/l | 0.2 | 0.2 |
| Copper | µg/l | 3.0 | 3.0 |
| Lead | µg/l | 2.2 | 2.2 |
| Mercury | µg/l | 0.1 | 0.1 |

| | | | |
|---|---|---|---|
| Nickel | µg/l | 7.0 | 3.0 |
| Zinc | µg/l | 15.0 | 15.0 |
| Total Petroleum Hydrocarbons (TPH) | µg/l | 7.0 | 7.0 |
| Total Polychlorinated Biphenyls (PCBs) | µg/l | 0.03 | 0.03 |
| Chlorophyll (a) | µg/l | 1.0 | 0.7 |
| DO* | mg/l | 4.0 | 4.0 |
| Enterococci | CFU or MPN/100ml | 35.0 | 35.0 |
| *** Minimum allowable concentration** | | | |

**Table 2-3 - Abu Dhabi QCC Maximum Allowable Concentrations for Ambient Marine Sediments**

| Parameter | Unit | General Use Area |
|---|---|---|
| Arsenic | mg/kg | 7 |
| Cadmium | mg/kg | 0.7 |
| Chromium | mg/kg | 52 |
| Copper | mg/kg | 20 |
| Lead | mg/kg | 30 |
| Mercury | mg/kg | 0.2 |
| Nickle | mg/kg | 16 |
| Zinc | mg/kg | 125 |
| Total Polychlorinated Biphenyls (PCBs) | µg/l | 22 |
| Total Polycyclic Aromatic Hydrocarbons (PAHs) | mg/kg | 1.7 |

Environmental specifications for land-based-liquid discharges to marine environment are provided by Abu Dhabi Quality and Conformity Council (QCC) below (Table 2-4) [6].

**Table 2-4 - Maximum allowable concentrations of discharges to marine at point of discharge**

| Parameter | Symbol | Unit | Limit |
|---|---|---|---|
| Total Suspended Solids | TSS | mg/l | 50 |

| Parameter | Symbol | Unit | Limit |
|---|---|---|---|
| pH | - | pH Unit | 6.0-9.0 |
| Temperature | - | °C | ±5 from ambient |
| Turbidity | - | NTU | 75 |
| Ammonia (as Nitrogen) | $NH_3$-N | mg/l | 2.0 |
| Nitrate (as Nitrogen) | $NO_3$-N | mg/l | 30.0 |
| Free Residual Chlorine | $Cl_2$ | mg/l | 0.5 |
| Cyanide | CN | mg/l | 0.05 |
| Dissolved Oxygen | DO | mg/l | ≥ 3.0 |
| Fluoride | F | mg/l | 10 |
| Sulphide | $S^-$ | mg/l | 0.1 |

## 2.4 Environment Agency Abu Dhabi Ambient Water Quality Objectives

The Environment Agency Abu Dhabi (EAD) previously developed standards and limits for marine environments prior to the implementation of QCC standards [7]. These are presented in Table 2-5, and will be adopted as guidance values where allowable ambient concentrations are not provided within the QCC standards.

**Table 2-5 - Recommended Ambient Marine Water Quality Standards for Abu Dhabi**

| Parameter | | Proposed Maximum Limits | Units |
|---|---|---|---|
| **I Physical Indicators** | | | |
| 1 | Floating Particles/Floatable/debris | Nil | mg/m2 |
| 2 | Temperature (change) | ±3 | °C of background temperature |
| 3 | Turbidity | 10 | NTU |
| | Transparency / Clarity | ≥10 | meter of Secchi Depth |
| 4 | Salinity | <5 | % of background concentration |
| 5 | BOD5 | 5 | mg/L (5day at 20°C annual average) |
| 6 | Odour | Not objectionable | - |

| Parameter | | Proposed Maximum Limits | Units |
|---|---|---|---|
| 7 | Colour | No change from background | - |
| **II Chemical Indicators** | | | |
| 8 | Ammonia (Free as N) or<br>Ammonia (NH3-N) | 0.004 | mg/L |
| 9 | Arsenic (As) | 0.005 | mg/L |
| 10 | Cadmium (Cd) | 0.001 | mg/L |
| 11 | Chlorine Residual (Cl2) | 0.01 | mg/L |
| 12 | Chromium (Cr) | 0.01 | mg/L |
| 13 | Copper (Cu) | 0.01 | mg/L |
| 14 | Cyanide (Cn) | 0.004 | mg/L |
| 15 | Lead (Pb) | 0.01 | mg/L |
| 16 | Mercury (Hg) | - | - |
| 17 | Oil and Grease | Not visible | - |
| 18 | Petroleum Hydrocarbons | 5 | ppm or mg/L |
| 19 | Dissolved Oxygen (DO) | >4 | mg/L |
| 20 | Total Suspended Solids (TSS) | <33 | mg/L |
| 21 | Si-SiO3 | 890 | microgram/L |
| 22 | pH | 6.5 – 8.5 | mg/L |
| 23 | Phenols | 0.001 | mg/L |
| 24 | Phosphorous Total as (P) | 0.001 | mg/L |
| | Phosphate (PO4) | 34 | microgram/L |
| 25 | Sulphides (S) | 0.004 | mg/L |
| 26 | Total Organic Carbon (TOC) | 2.5 | mg/L |
| 27 | Zinc (Zn) | 0.01 | mg/L |
| 28 | Nickel (Ni) | 20 | microgram/L |
| 29 | Iron (Fe) | 0.3 | mg/L |

| Parameter | | Proposed Maximum Limits | Units |
|---|---|---|---|
| 30 | Vanadium (V) | 9.4 | microgram/L |
| 31 | Nitrate (as NO3) | 95 | microgram/L |
| 32 | Nitrite (as NO2) | 34 | microgram/L |
| **III Biological Indicators** | | | |
| 33 | Total Coliform | 70 | MPN/100mL |

## 2.5 Total Suspended Solids (TSS) Criteria Selection

As listed by EAD Ambient Water Quality Objectives (AWO’s), the most relevant parameter for sediment plume assessments is Total Suspended Solids (TSS) concentrations that should not exceed 33 mg/l (0.033 kg/$m^3$) considering the more recent QCC guidance do not provide an allowable ambient concentration for turbidity or related parameters. The guidelines however do not stipulate frequencies of exceedance or mixing zone dimensions and were not passed as law however they do provide more stringent criteria to allow for a conservative assessment.

# 3 Modelling Systems

The modelling study has been carried out utilising the MIKE software package (developed by DHI). The MIKE software package is a powerful and versatile tool for simulating physical, chemical, biological and ecological processes in coastal and marine areas. The package utilises multiple modules for various simulation, prediction and forecast applications; the modules utilised within this scope of works are summarised further below.

## 3.1 MIKE Hydrodynamic Flow Model

The MIKE Hydrodynamic (HD) Flow Model (FM) is a numerical modelling system for the simulation of water level variations and their associated flows. The model is able to run, in both two-dimensional (2D) and three-dimensional (3D) modes, using multiple simulation engines, including single grid, multiple grid and flexible mesh application. The MIKE HD FM modules are the 'base' module for the software suite, the outputs of which are used as input for various other modules of differing applications.

The MIKE21 FM HD module is system for simulating 2D free-surface flows. MIKE21 is applicable for the simulation of hydraulic environments, such as lakes, estuaries, bays, coastal areas and seas, where the significance of vertical stratification can be discounted.

The 3D, baroclinic module MIKE3 FM HD, is a general non-hydrostatic numerical modelling system which simulates unsteady, 3D flows in fluids when presented with the bathymetry and other relevant ambient conditions (e.g. bed resistance, wind forcing, hydrographic boundary conditions, and atmospheric influence). MIKE3 FM HD is applicable to areas where stratification cannot be discounted, or where simulation requires the assessment of effluent with a positive or negative density differential. The fully baroclinic nature of the module enables density currents caused by this differential density to be simulated accurately, in conjunction with other dispersal effects associated tide and wind driven flows and atmospheric effects (such as surface cooling).

The software also incorporates near-field simulations which can accurately simulate the 'jet' phase of an effluent discharge (where the effluent momentum influences trajectory and mixing behaviour). These near-field simulations are linked within the MIKE3 FM HD module, enabling the influence of ambient currents on 'jet' behaviour to be simulated at the same temporal and spatial resolution as the hydrodynamic model.

Additional scientific documentation on MIKE HD FM can be provided on request.

## 3.2 MIKE Mud Transport

The MIKE Mud Transport (MT) module describes erosion, transport and deposition of mud or sand mixtures under the action of currents and waves. MIKE MT takes into account current and wave (where applicable) forcing, material sliding, salt-flocculation, detailed settling processes, seabed description and continuous morphological update of the seabed, whilst simulation the dispersion and deposition of sediment particulates.

The MIKE MT module varies sediment settling velocities according to salinity, wave, current speed, particle size distribution (PSD) and bed morphology. Bed erosion can be either non-uniform (i.e. erosion of soft or partly consolidated bed), or uniform (i.e. erosion of a dense and consolidated bed).

Application of the MIKE MT module include sediment transport studies, dredge turbidity simulations and sediment deposition studies for harbours, canals, rivers and navigational corridors.

Additional scientific documentation on MIKE MT can be provided on request.

# 4 Hydrodynamic Modelling Flushing and Dredging Methodology

## 4.1 Overview

In order to assess suspended sediment dispersion during trenching, dredging and backfilling activities, and comparison to relevant water quality criteria, the MIKE21 HD FM and MIKE21 MT modules were utilised. The hydrodynamic results from the MIKE21 HD FM module have been used to 'drive' the subsequent dredge induced sediment plumes using the MT module.

The hydrodynamics of the area were simulated for a baseline case and used for validation/calibration purposes, by comparison to measured ADCP data at four locations (2 each along Rout1 & 2).

Hydrodynamics are simulated concurrently with the plume simulations to take into account bed changes associated with dredging, trenching, disposal and backfilling activities.

## 4.2 Hydrodynamic Modelling

### 4.2.1 Overview

The hydrodynamics of the project area were simulated utilising the MIKE21 HD FM model, driven by meteorological data from CFSR and tidal constituent amplitude and phase predictions sourced from the DTU10 global ocean tide model from the Technical University of Denmark. [8] An overview of the hydrodynamic modelling approach is presented in Table 4-1.

**Table 4-1 - Summary of Hydrodynamic Modelling Approach**

| **Task** | Hydrodynamic Modelling |
|---|---|
| **Model** | MIKE21 HD FM & MIKE21 HD TR/AD |
| **Model Features** | 2-dimensional<br>Horizontal and depth averaged vertical plane |
| **Tidal Data** | DTU10 global ocean tide model at ≈ 0.125° resolution [8]. |
| **Meteorological Data** | NCEP supported CFSR data at ≈0.2° spatial and hourly temporal resolution. [9] |
| **Period Modelled** | A single scenario (baseline) was simulated for calibration and validation purposes, a further two, final scenarios were simulated concurrently with sediment dispersion to take into account real-time physical seabed changes associated with construction works.<br>These scenarios were simulated for separate modelling domains covering the Cable Routes 1 & 2. |
| **Bathymetry** | Simulations were conducted utilising bathymetric data provided from the client as well as from a digitized admiralty chart 3715 (obtained from MIKE C-Map). [10] |
| **Model Verification** | Verification was conducted against ADCP current and prognostic tidal gauge height data. |
| **Resolution** | Flexible mesh, variable element size from a maximum area of 750,000 $m^2$ (equivalent to approx. 1.7km horizonal resolution) to an area of 1400 $m^2$ (equivalent to approx. 37 m horizontal resolution). |

### 4.2.2 Model Grids and Bathymetry

Bathymetry within the project area was obtained from a number of sources in order to accurately portray the physical environment within the modelling domain. The sources of data utilised, in the order that they were used, are summarised below:

- Digitised British Admiralty Bathymetric Charts 3715 [10] sourced from C-MAP;
- Bathymetry survey data of the project area was provided by the client [11]; and
- Archived WKC bathymetric and topographical survey data around the project area.

The coverage and resolution of the modelling domain were decided based on knowledge of the project area, and the outcomes of a numerous modelling iterations carried out during the validation/calibration process (Section 5.1.4). The entire model includes all Abu Dhabi waters and the hydrodynamic simulation testing was conducted whereby the mesh size is varied in order to ensure model stability. Once the model is proved to be stable, the mesh size is reduced to conclude if accuracy is improved by reducing each size. Following guidelines set forth by DHI on scaling between mesh transitions, a growth factor of 3 was used. The final modelling domain mesh and bathymetry are provided below in Figure 4-1 and Figure 4-2 for Cable Route 2 Modelling Domain and Figure 4-5 and Figure 4-6 for Cable Route 1 modelling domain.

**Figure 4-1 –Cable Route 2 – Modelling Domain Bathymetry and Domain Variable Mesh**

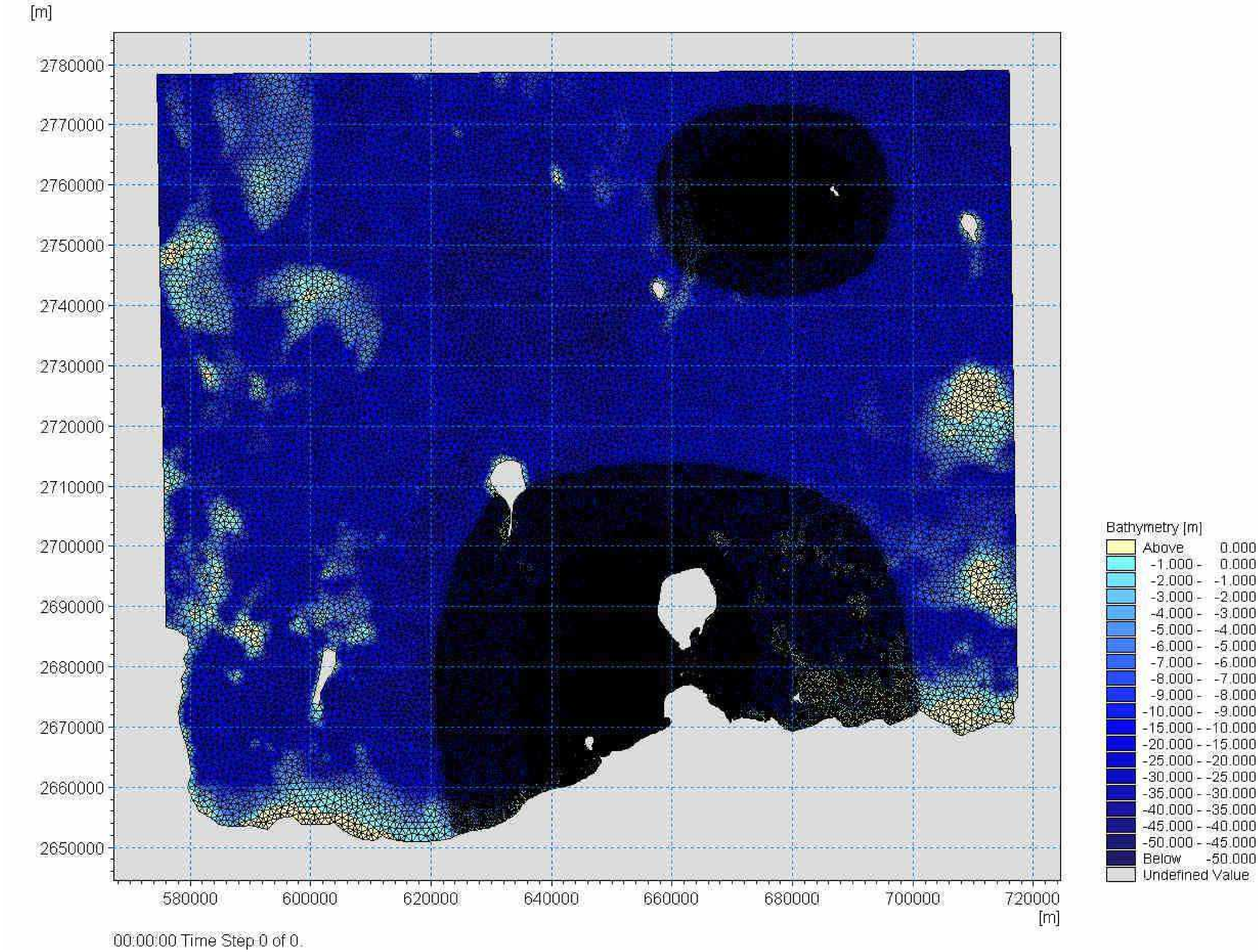


**Figure 4-2 –Cable Route 2 – Modelling Domain Bathymetry and ADCP Location**

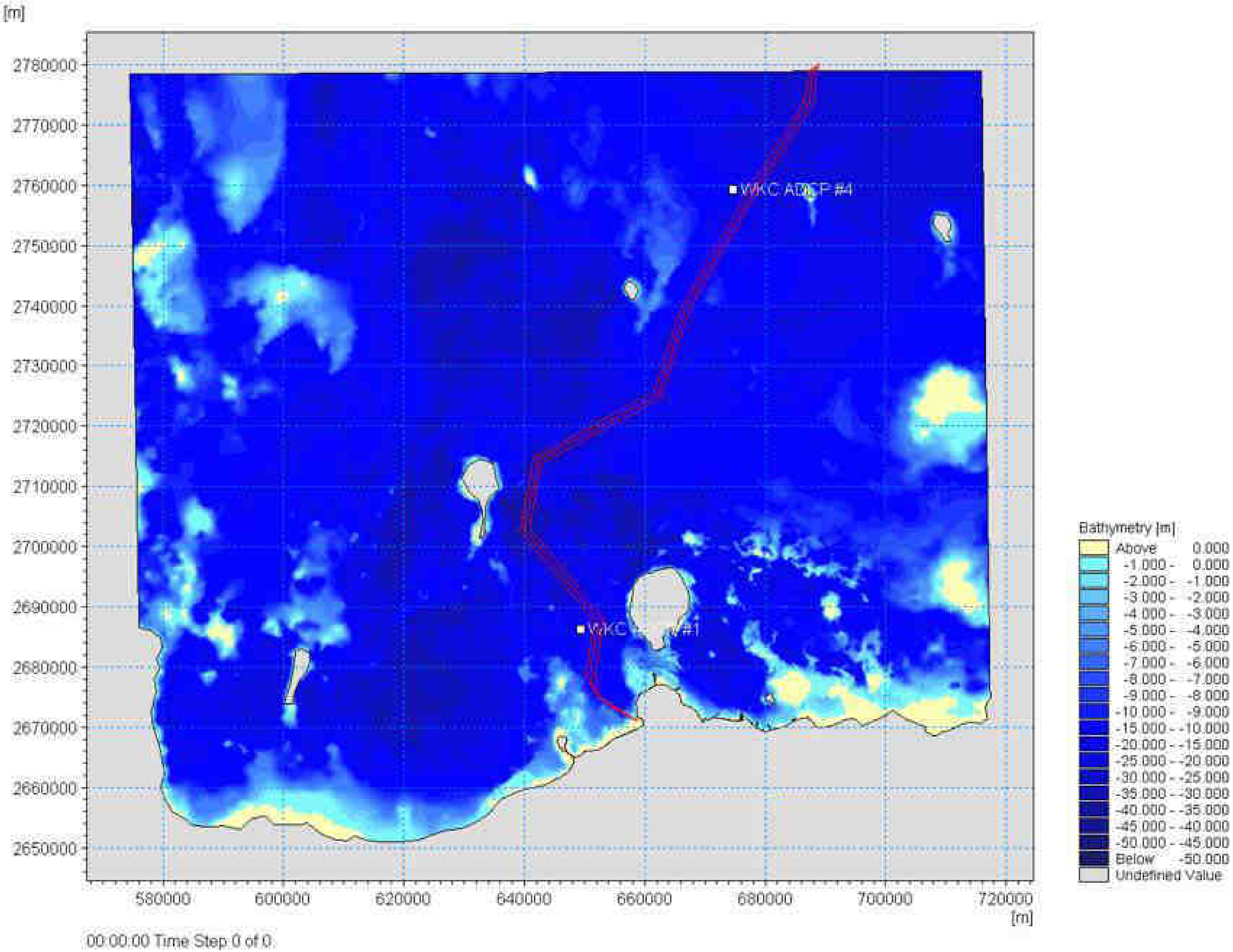


**Figure 4-3 –Cable Route 2 – Local Bathymetry and Domain Variable Mesh**

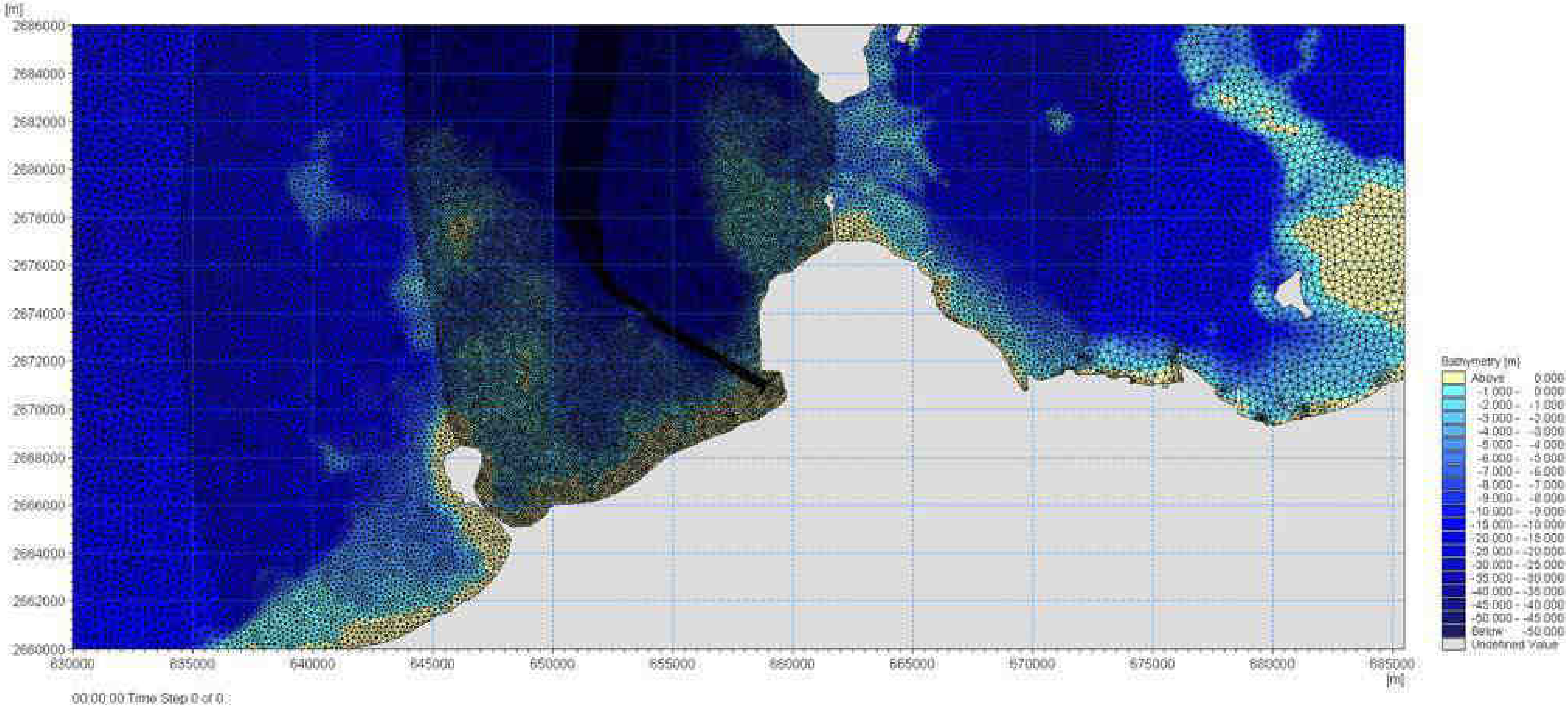


Figure 4-4 - Cable Route 2 - Local Bathymetry and Cable Route

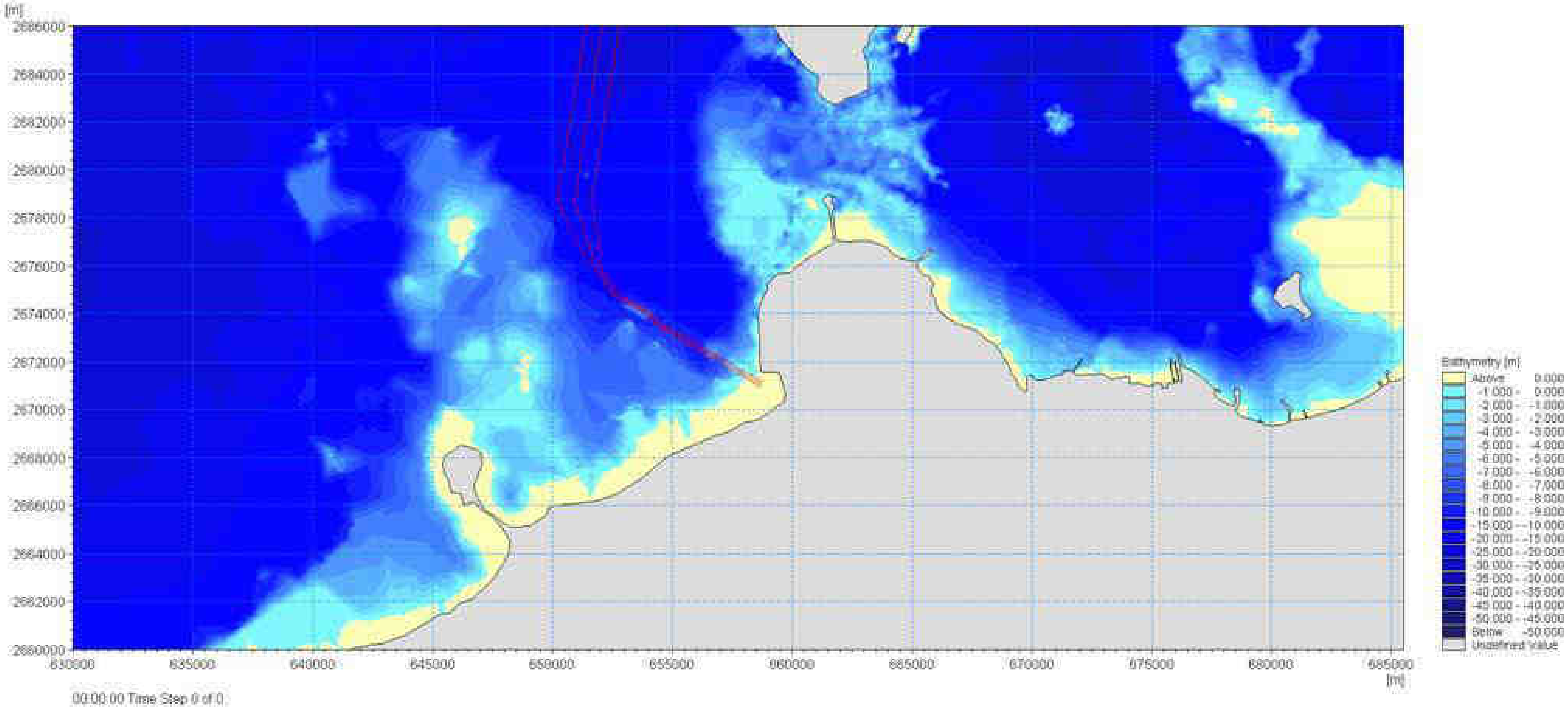


**Figure 4-5 - Cable Route 1 - Modelling Domain Bathymetry and Domain Variable Mesh**

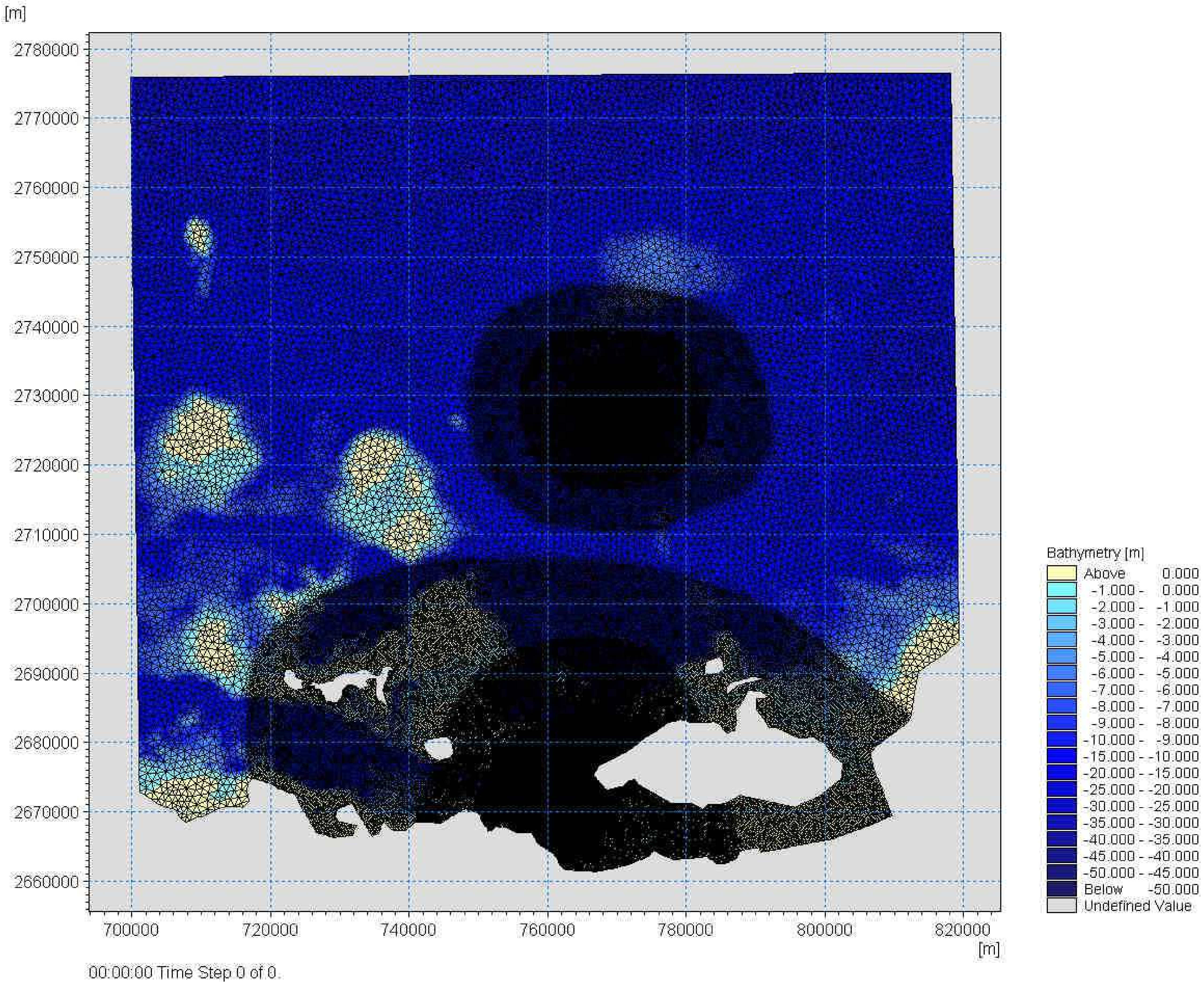


**Figure 4-6 - Cable Route 1 - Modelling Domain Bathymetry and ADCP Location**

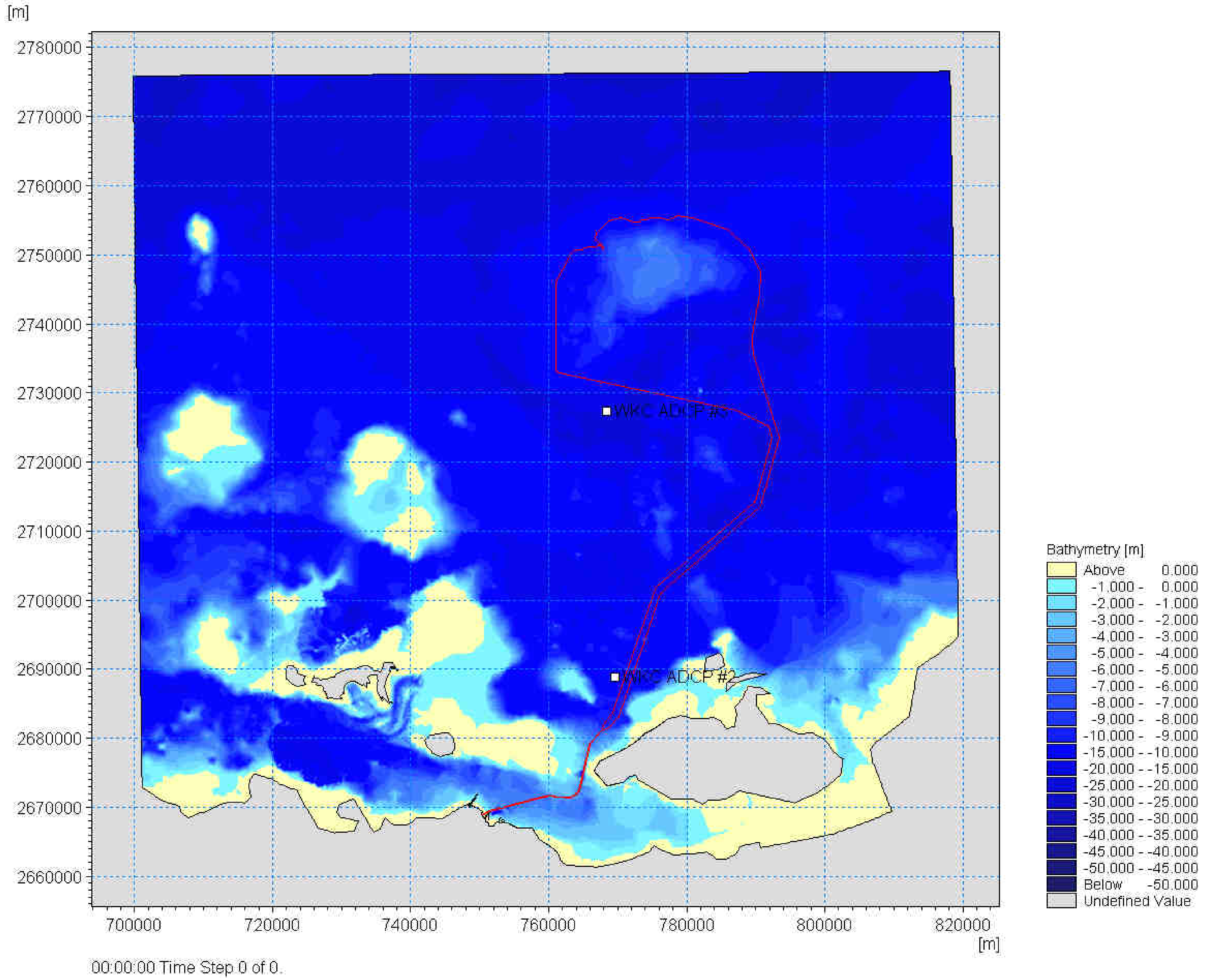


**Figure 4-7 - Cable Route 1 - Local Bathymetry and Domain Variable Mesh**

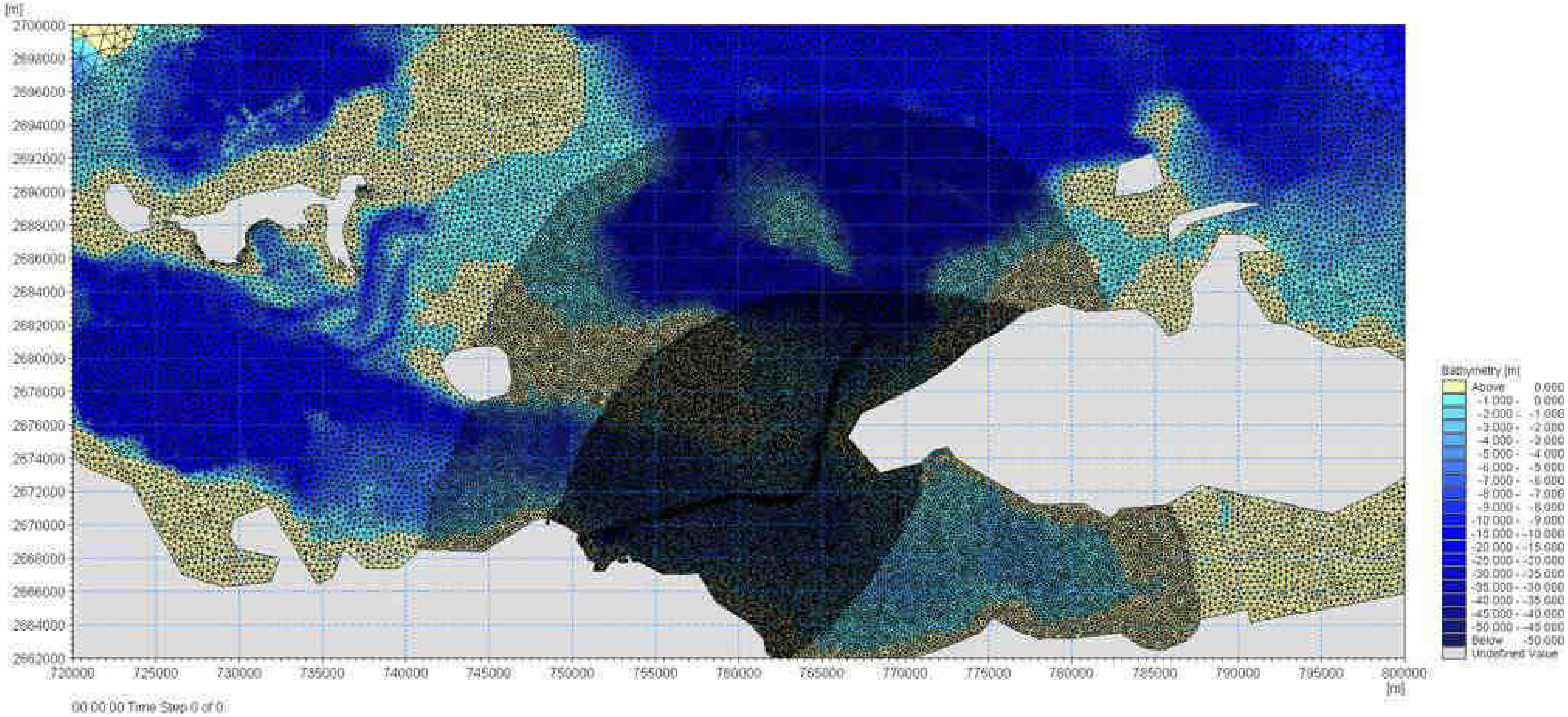
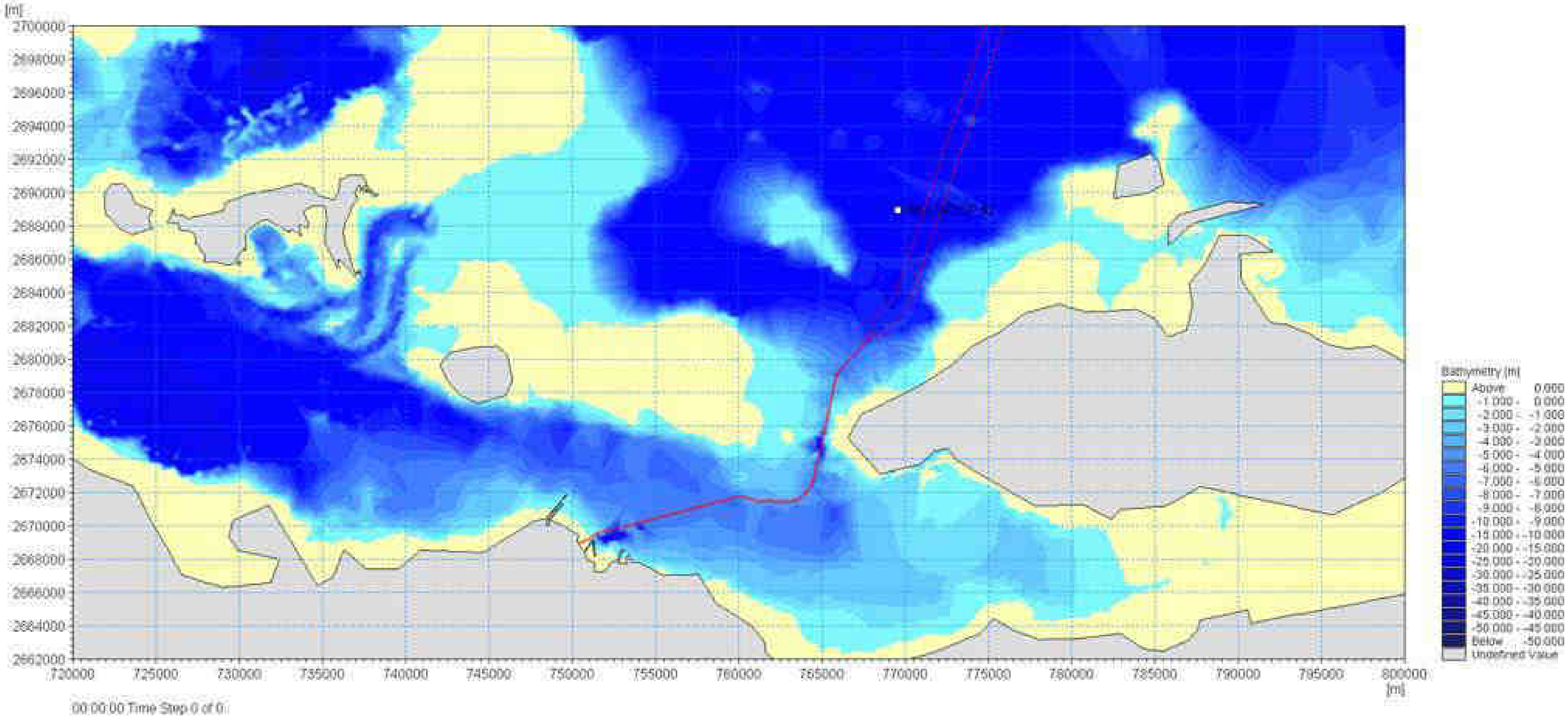


Figure 4-8 - Cable Route 1 - Local Bathymetry and Cable Route



### 4.2.3 Winds

Winds was purchased to cover the simulated period which coincided with the ADCP deployment period (2020 & 2021). This wind data is reanalysed forecast data from the CFSR [9]. The CFSR routinely operates a suit of numerical weather prediction models at a range of spatial and temporal resolutions. The data utilised within this study is gridded data set at a spatial resolution of approximately 0.2°, and a temporal resolution of 1 hour.

### 4.2.4 Tides

In order to accurately simulate the propagation of the tides to the project area within the modelling domain, tidal boundary conditions were sourced using the DTU10 global ocean tide model from the Technical University of Denmark [8].

The amplitude and phase of the two dominant tidal constituents, the principal lunar semidiurnal ($M_2$) and the principal solar semidiurnal ($S_2$) constituents for the DTU10 global ocean tide model are presented within Figure 4-9 and Figure 4-10 for reference purposes.

The data is pre-processed in order to be recognised by MIKE and provides the user with 2D model boundary data at each open water boundary in order to allow MIKE21 HD FM to simulate the tidal and current variations within the project domain. These open water boundaries are illustrated in Figure 4-2.

**Figure 4-9 - Amplitude and Phase of Principal Lunar Semidiurnal Constituent**

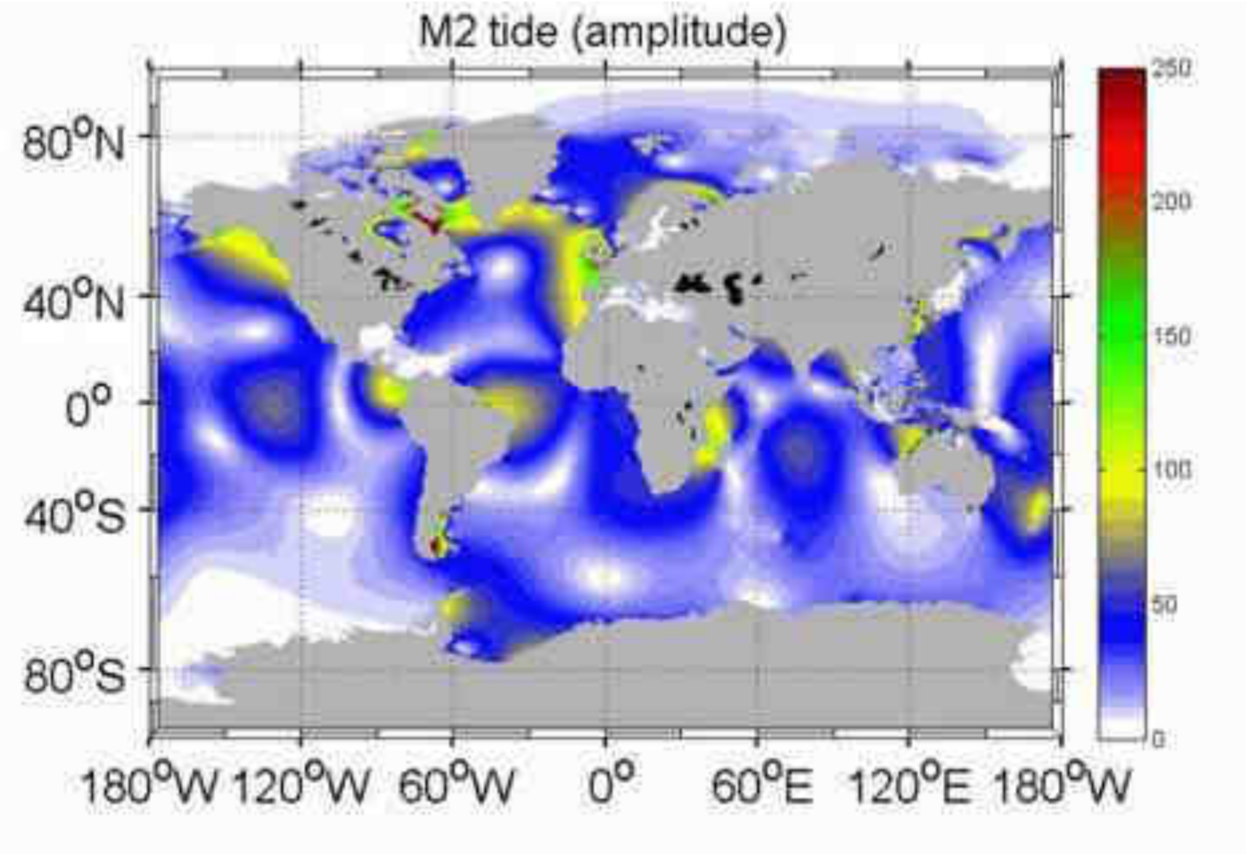
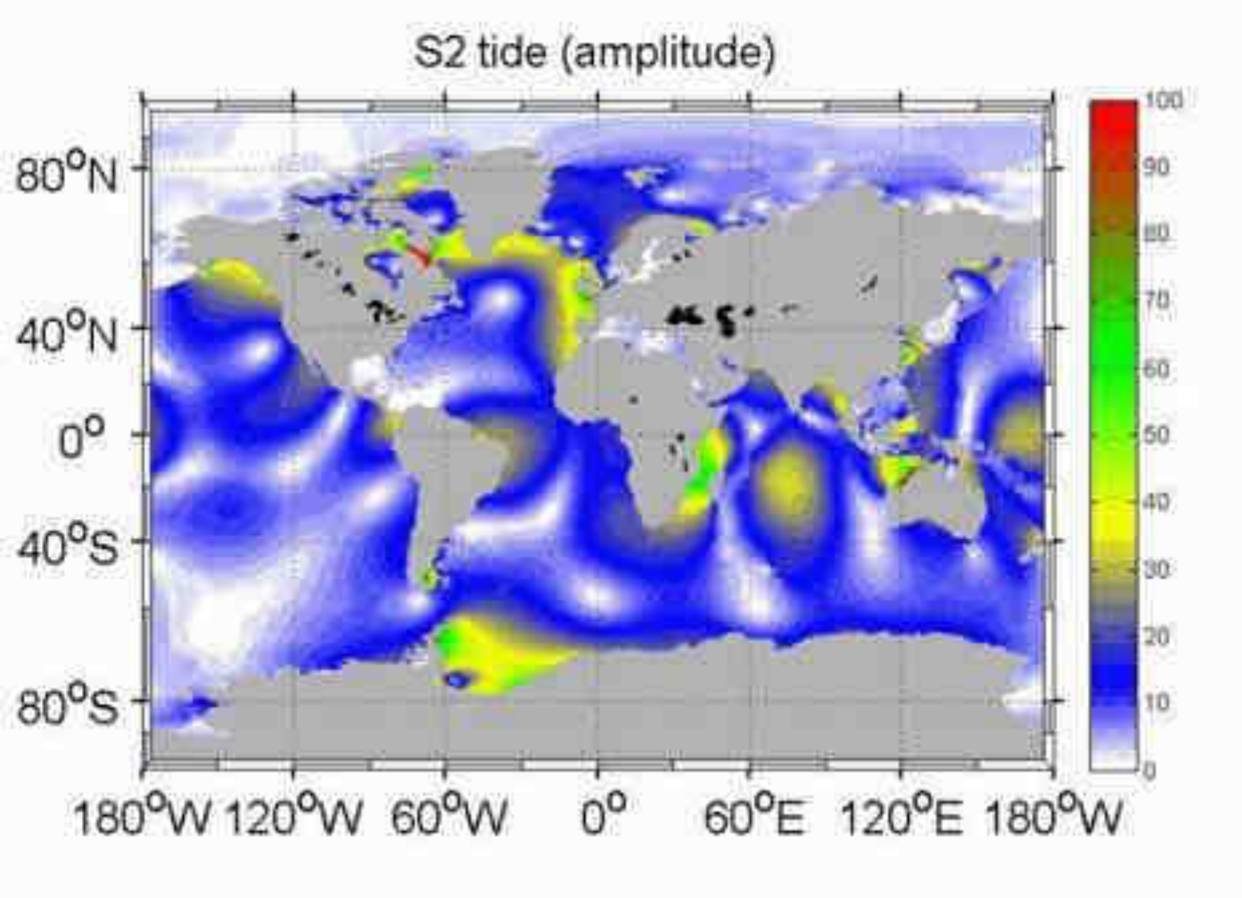


**Figure 4-10 - Amplitude and Phase of Principal Solar Semidiurnal Constituent**




## 4.3 Dredging Simulations

### 4.3.1 Overview

Dredge plume modelling predicts the physical behaviour of dredged sediments released into the water column, based on the results of the hydrodynamic modelling undertaken using MIKE HD FM module. The characteristics of the released sediment, the timing and location of releases by the dredging plan and the equipment used for dredging and soil disposal.

The dredge plume model requires a range of key inputs including engineering, geotechnical, meteorological, and oceanographic components. These inputs feed into the simulation process which uses data developed by the MIKE HD FM module to drive the dispersion of the particles released into the water column during dredging operations, whereas the behaviour and settling characteristics of the particles are determined by the parameters set in the MIKE MT FM module.

The basic methodology for the simulation of the dredging programme was as follows:

In the MIKE HD FM Module:

- Incorporate detailed bathymetry and topography data of the project region;
- Establish bathymetric grids covering the dredging region and surrounding coastlines;
- Extract meteorological data from CFSR global atmospheric forecast model for the region.

In the MIKE MT FM Module:

- Input Particle Size Distribution Data for the seabed materials which are to be dredged;
- Develop the dredge logs, for input to the dredging simulation model, which define the fine detail of the method of executing the dredging plan from detailed information provided by the client;

In post-processing:

- Analyse output from simulation(s) to provide data for initial impact assessment studies;
- Derive exceedance statistics for TSS from MIKE MT FM output, and
- Derive bed load depths for material originating from the dredging process.

The focus of this study is to determine the levels of turbidity and sedimentation likely to be experienced in the nearby waters deriving from dredging activities associated with the project.

### 4.3.2 Dredging Equipment and Method

The dredging methodology for the Project Lightning Project consists of multiple stages. The basic stages are summarised below:

1. Dredging/trenching of the Cable Trench;
2. Laying of the Cable; and
3. Backfilling the Cable Trench.

The cables will lie within trenches for the nearshore areas whereas in the offshore areas, the cables will be post-lay trenched when encountering soft sand or laid on the bottom and covered with rock when encountering hard sand. Therefore, the marine modelling studies focused on the nearshore areas due to the significant construction activities

The cable will only lie within a trench for areas near shore, or within shallow areas. The equipment used for the dredging/trenching and backfilling will be dependent on the depth of the area which requires work. The most shallow sections will be worked using amphibious 'starfish' dredgers (Figure 4-11), the intermediate areas will be worked using backhoe dredgers (BHD) (Figure 4-12), and the deeper areas will be worked using trailer suction hopper dredgers (TSHD) (Figure 4-13). At deeper areas where concerns regarding weathering or damage due to anchor drops is not a concern, the cable will be laid directly on the seabed, and no trenching will be required.

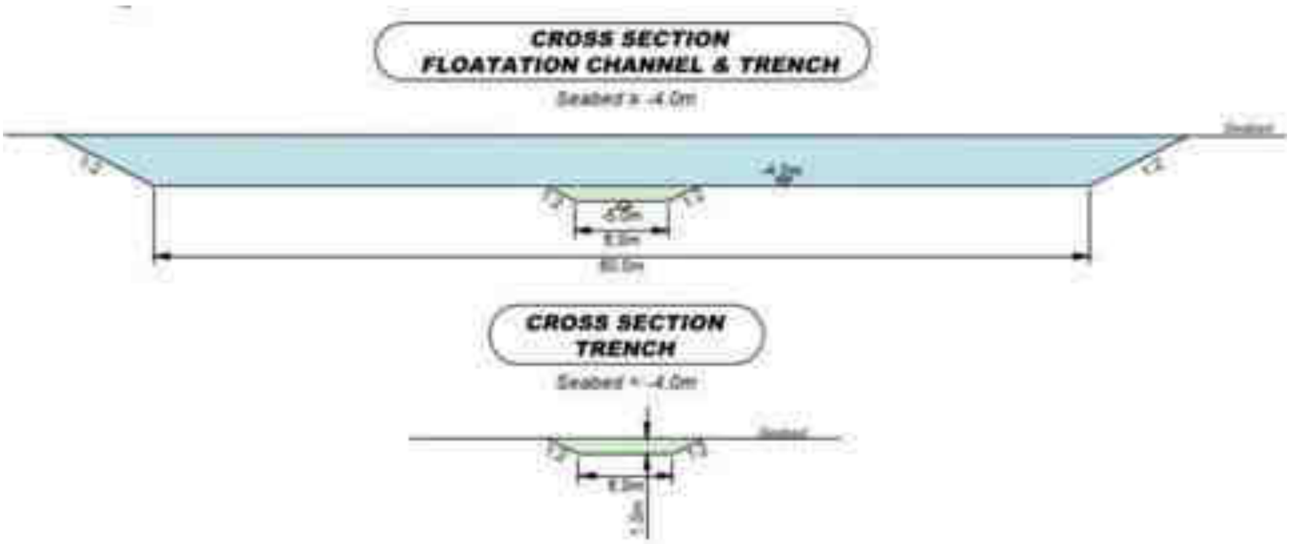
## Figure 4-11 - Starfish Trencher

## Figure 4-12 - Backhoe Dredger

**Figure 4-13 - Trailer Suction Hopper Dredger**

Once the trenching has been completed, the cable will be laid within the trench and any side cast material will be backfilled, burying the cable. The method to lay the cable will be dependent on proximity to land, with nearshore areas using a float out method, and areas further offshore using a cable lay vessel. The trenching activities are complicated to a degree along the Cable Route 1, where the area is too shallow to allow access to the cable lay vessel. Within these areas, a navigation channel, sufficient for the cable lay barge will need to be cut in order to allow access, significantly increasing the scale of works within these areas. An indication of the access channel/ floatation trench dimensions are indicated within Figure 4-14, along with the standard dimensions of the relatively small trench required for the cable only.

**Figure 4-14 - Dredging Cross Sections**




Material along the majority of the trenched route will be side cast and reserved to fill the trench once cable laying has been completed. However, the material dredged from the access/floatation channel, cannot be replaced due to concerns regarding future assess requirements for maintenance. This excess material, highlighted in blue within Figure 4-14 will need to be disposed of offshore. The locations of these disposal areas is included within Figure 4-16

Table 4-2 presents a summary of the trenching and backfilling works, with Figure 4-15 and Figure 4-16 illustrating Cable Routes 2 & 1 respectively, providing an indication of the waypoint markers summarised within the schedule table.

Note all turbidity producing task items, including dredge volume, cutting rate, disposal rate and backfilling have been included within the simulations.

**Table 4-2 - Trenching and Backfilling Schedule – Cable Routes 1 & 2**

| Task | Estimated days | Equipment | Volume | Start Date | End Date |
|---|---|---|---|---|---|
| Zakum - Trenching Navigation channel (Campaign 1) | 37 days | | 59,767 m³ | 01-Nov-23 | 07-Dec-23 |
| Trench 1 // 18.010 - 18.500 | 3.3 | BHD | 1,650 m³ | 01-Nov-23 | 04-Nov-23 |
| Trench 1 // 18.500 - 18.700 | 24.0 | BHD | 18,190 m³ | 01-Nov-23 | 25-Nov-23 |
| Trench 1 // 18.800 - 20.000 | 10.6 | BHD | 33,884 m³ | 25-Nov-23 | 05-Dec-23 |
| Trench 1 // 20.000 - 20.200 | 1.9 | BHD | 6,043 m³ | 05-Dec-23 | 07-Dec-23 |
| Zakum - Hammering scope (Campaign 1) | 41 days | | 18,175 m³ | 04-Nov-23 | 15-Dec-23 |
| Trench 1a // 18.010 - 18.800 | 13.1 | BHD | 5,751 m³ | 04-Nov-23 | 17-Nov-23 |
| Trench 1a // 20.280 - 21.100 | 7.6 | BHD | 3,337 m³ | 30-Nov-23 | 08-Dec-23 |
| Trench 1b // 18.010 - 18.800 | 13.1 | BHD | 5,751 m³ | 17-Nov-23 | 30-Nov-23 |
| Trench 1b // 20.280 - 21.100 | 7.6 | BHD | 3,337 m³ | 08-Dec-23 | 15-Dec-23 |
| Zakum - Trenching scope ZAKUM (Campaign 2) | 116 days | | 503,346 m³ | 17-Dec-23 | 12-Apr-24 |
| Trench 1a // 0.000 - 1.020 | 9.9 | Starfish | 7,498 m³ | 17-Jan-24 | 27-Jan-24 |
| Trench 1a // 1.020 - 1.510 | 2.3 | BHD | 3,567 m³ | 17-Dec-23 | 20-Dec-23 |
| Trench 1a // 1.510 - 10.000 | 5.7 | TSHD | 105,955 m³ | 06-Jan-24 | 12-Jan-24 |
| Trench 1a_bis // 10.000 bis - 15.630 bis | 38.0 | BHD | 40,986 m³ | 20-Dec-23 | 27-Jan-24 |
| Trench 1a // 15.000 - 17.500 | 1.7 | TSHD | 31,200 m³ | 18-Jan-24 | 19-Jan-24 |
| Trench 1a // 17.500 - 17.610 | 0.3 | BHD | 801 m³ | 21-Jan-24 | 22-Jan-24 |
| Trench 1a // 17.610 - 18.010 | 0.3 | TSHD | 4,992 m³ | 21-Jan-24 | 22-Jan-24 |
| Trench 1a // 18.800 - 20.280 | 4.7 | BHD | 10,774 m³ | 22-Jan-24 | 27-Jan-24 |
| Trench 1a // 21.100 - 25.310 | 2.8 | TSHD | 52,541 m³ | 24-Jan-24 | 27-Jan-24 |
| Trench 1b // 0.000 - 1.220 | 11.8 | Starfish | 8,954 m³ | 31-Mar-24 | 12-Apr-24 |

| Task | Estimated days | Equipment | Volume | Start Date | End Date |
|---|---|---|---|---|---|
| Trench 1b // 1.220 - 1.400 | 0.9 | BHD | 1,310 m³ | 10-Apr-24 | 11-Apr-24 |
| Trench 1b // 1.400 - 10.000 | 5.7 | TSHD | 107,328 m³ | 12-Jan-24 | 18-Jan-24 |
| Trench 1b_bis // 10.000bis - 15.641bis | 38.1 | BHD | 41,066 m³ | 03-Mar-24 | 10-Apr-24 |
| Trench 1b // 15.000 - 18.010 | 2.0 | TSHD | 37,565 m³ | 19-Jan-24 | 21-Jan-24 |
| Trench 1b // 18.800 - 20.280 | 4.7 | BHD | 10,744 m³ | 15-Mar-24 | 19-Mar-24 |
| Trench 1b // 21.100 - 24.150 | 2.0 | TSHD | 38,064 m³ | 22-Jan-24 | 24-Jan-24 |
| Zakum - Cable installation schedule | | | | | |
| Cable installation 1a | 7.0 | Cable | | 01-Feb-24 | 08-Feb-24 |
| Cable installation 1b | 7.0 | Cable | | 17-Apr-24 | 24-Apr-24 |
| Zakum - Backfiling Zakum (Campaign 2) | 129 days | | 788,229 m³ | 11-Feb-24 | 18-Jun-24 |
| Backfill 1a // 0.000 - 1.020 | 9.9 | Starfish | 7,498 m³ | 11-Feb-24 | 20-Feb-24 |
| Backfill 1a // 1.020 - 1.500 | 2.0 | BHD | 3,675 m³ | 11-Feb-24 | 12-Feb-24 |
| Backfill 1a // 1.500 - 10.000 | 26.1 | TSHD | 176,592 m³ | 11-Feb-24 | 08-Mar-24 |
| Backfill 1a // 10.000bis - 15.63bis - bis route | 27.9 | BHD | 45,040 m³ | 12-Feb-24 | 11-Mar-24 |
| Backfill 1a // 15.000 - 17.500 | 7.7 | TSHD | 52,000 m³ | 08-Mar-24 | 15-Mar-24 |
| Backfill 1a // 17.500 - 17.610 Single float | 1.0 | BHD | 825 m³ | 11-Feb-24 | 12-Feb-24 |
| Backfill 1a // 17.610 - 18.010 | 1.2 | TSHD | 8,320 m³ | 15-Mar-24 | 17-Mar-24 |
| Backfill 1a // 18.010 - 20.280 Combined float 1a + 1b | 20.7 | BHD | 17,025 m³ | 12-Feb-24 | 03-Mar-24 |
| Backfill 1a // 20.280 - 21.100 | 3.3 | BHD | 6,150 m³ | 11-Mar-24 | 15-Mar-24 |
| Backfill 1a // 21.100 - 25.310 | 12.9 | TSHD | 87,568 m³ | 17-Mar-24 | 29-Mar-24 |
| Backfill 1b // 0.000 - 1.220 | 11.8 | Starfish | 8,954 m³ | 27-Apr-24 | 08-May-24 |
| Backfill 1b // 1.220 - 1.400 | 0.7 | BHD | 1,350 m³ | 27-Apr-24 | 27-Apr-24 |
| Backfill 1b // 1.400 - 10.000 | 26.4 | TSHD | 178,880 m³ | 27-Apr-24 | 23-May-24 |

| Task | Estimated days | Equipment | Volume | Start Date | End Date |
|---|---|---|---|---|---|
| Backfill 1b // 10.000bis - 15.461bis - bis route | 27.9 | BHD | 45,128 m³ | 27-Apr-24 | 25-May-24 |
| Backfill 1b // 15.000 - 18.010 | 9.3 | TSHD | 62,608 m³ | 23-May-24 | 01-Jun-24 |
| Backfill 1b // 18.010 - 20.280 | 20.7 | BHD | 17,025 m³ | 25-May-24 | 15-Jun-24 |
| Backfill 1b // 20.280 - 21.100 | 3.3 | BHD | 6,150 m³ | 15-Jun-24 | 18-Jun-24 |
| Backfill 1b // 21.100 - 25.310 | 9.4 | TSHD | 63,440 m³ | 01-Jun-24 | 11-Jun-24 |
| Das - Trenching scope (Campaign 2) | 143 days | | 159,081 m³ | 29-Jun-24 | 19-Oct-24 |
| Trench 2 // -0.850 - 1.440 | 30.5 | Starfish | 17,791 m³ | 29-Jun-24 | 30-Jul-24 |
| Trench 2 // 1.440 - 2.750 | 15.3 | BHD | 6,708 m³ | 14-Jul-24 | 30-Jul-24 |
| Trench 2 // 2.750 - 5.030 | 1.5 | TSHD | 28,454 m³ | 28-Jul-24 | 30-Jul-24 |
| Trench 2a // -0.850 - 1.440 | 28.2 | Starfish | 16,448 m³ | 11-Aug-24 | 09-Sep-24 |
| Trench 2a // 1.440 - 2.750 | 18.3 | BHD | 8,051 m³ | 19-Aug-24 | 06-Sep-24 |
| Trench 2a // 2.750 - 5.030 | 1.5 | TSHD | 28,454 m³ | 21-Aug-24 | 22-Aug-24 |
| Trench 2b // -0.850 - 1.440 | 30.9 | Starfish | 18,013 m³ | 18-Sep-24 | 19-Oct-24 |
| Trench 2b // 1.440 - 2.750 | 15.3 | BHD | 6,708 m³ | 29-Sep-24 | 15-Oct-24 |
| Trench 2b // 2.750 - 5.030 | 1.5 | TSHD | 28,454 m³ | 01-Oct-24 | 02-Oct-24 |
| Das - Backfilling scope (Campaign 2) | 106 days | | 223,923 m³ | 14-Aug-24 | 26-Nov-24 |
| Backfill 2 // -0.850 - 1.440 | 23.4 | Starfish | 17,791 m³ | 14-Aug-24 | 06-Sep-24 |
| Backfill 2 // 1.440 - 2.750 | 5.3 | BHD | 9,825 m³ | 14-Aug-24 | 19-Aug-24 |
| Backfill 2 // 2.750 - 5.030 | 7.0 | TSHD | 47,424 m³ | 14-Aug-24 | 21-Aug-24 |
| Backfill 2a // -0.850 - 1.340 | 21.6 | Starfish | 16,448 m³ | 24-Sep-24 | 15-Oct-24 |
| Backfill 2a // 1.340 - 2.750 | 5.7 | BHD | 10,575 m³ | 24-Sep-24 | 29-Sep-24 |
| Backfill 2a // 2.750 - 5.030 | 7.0 | TSHD | 47,424 m³ | 24-Sep-24 | 01-Oct-24 |
| Backfill 2b // -0.850 - 1.550 | 23.7 | Starfish | 18,013 m³ | 03-Nov-24 | 26-Nov-24 |
| Backfill 2b // 1.550 - 2.750 | 4.9 | BHD | 9,000 m³ | 03-Nov-24 | 07-Nov-24 |

| Task | Estimated days | Equipment | Volume | Start Date | End Date |
|---|---|---|---|---|---|
| Backfill 2b // 2.750 - 5.030 | 7.0 | TSHD | 47,424 m³ | 03-Nov-24 | 10-Nov-24 |
| Das - Cable installation schedule | | | | | |
| Cable installation 2 | 10.0 | Cable | | 04-Aug-24 | 14-Aug-24 |
| Cable installation 2a | 10.0 | Cable | | 14-Sep-24 | 24-Sep-24 |
| Cable installation 2b | 10.0 | Cable | | 24-Oct-24 | 03-Nov-24 |

## Figure 4-15 –Waypoint Markers for Route 2

Figure 4-16 – Waypoint Markers and Disposal Areas for Route 1

### 4.3.3 Particle Size Distributions and Settling Velocities

The formation of sediment plumes is largely associated with the finer fraction of material. It is therefore necessary to understand the relative distribution of material, particularly that smaller than 100 microns (1 micron = $10^{-6}$ m).

The particle settling velocity values were based on analyses of sand and silt by CSIRO Australia data from previous dredging programs using a sedigraph, shown below in Table 4-3 [12]. Sodium hexametaphosphate was used by CSIRO as the medium through which the measured particles fall. The data was later corrected to consider the difference in the settling velocities in sea water and with consideration of drag resulting in a terminal velocity in seawater.

**Table 4-3 - Particle Size Distribution and Settling Velocities**

<table>
<tr><th></th><th>Size (micron)</th><th>Settling Rate (mm/s)</th><th>Group</th><th>Descriptor</th></tr>
<tr><td rowspan="15">Particle Size Distribution</td><td>2000</td><td>3156.000</td><td rowspan="4">8</td><td rowspan="4">Coarse Sand</td></tr>
<tr><td>1000</td><td>789.000</td></tr>
<tr><td>600</td><td>284.200</td></tr>
<tr><td>400</td><td>126.300</td></tr>
<tr><td>250</td><td>49.300</td><td rowspan="2">7</td><td rowspan="2">Fine Sand</td></tr>
<tr><td>150</td><td>17.760</td></tr>
<tr><td>100</td><td>7.890</td><td rowspan="2">6</td><td rowspan="2">Very Fine Sand</td></tr>
<tr><td>80</td><td>5.050</td></tr>
<tr><td>60</td><td>2.842</td><td rowspan="2">5</td><td rowspan="2">Coarse Silt</td></tr>
<tr><td>40</td><td>1.262</td></tr>
<tr><td>20</td><td>0.316</td><td>4</td><td>Medium Silt</td></tr>
<tr><td>10</td><td>0.079</td><td rowspan="2">3</td><td rowspan="2">Very Fine Silt</td></tr>
<tr><td>5</td><td>0.020</td></tr>
<tr><td>2</td><td>0.003</td><td>2</td><td>Medium Clay</td></tr>
<tr><td>1</td><td>0.001</td><td>1</td><td>Very Fine Clay</td></tr>
</table>

For the purposes of this modelling study, the material was divided into 8 groups based on the PSD information from a geotechnical surveys [13] and the Wentworth Grain Size Chart, developed by the United States Geological Survey [16].

The geotechnical surveys indicated that a variety of sediment types along the route of the trenching area, ranging from very silty sand (>20% silt content) to sandy gravel (<5% silt content). Sand and silt fractions of the potentially resuspended sediment were simulated. Considering that the Gravel category would consist of particles with a diameter of more than 2mm, these particles will not contribute to the overall sediment suspension due to dredging was not included in the model.

Due to the vast majority of sediment in the area consisting of Sand, this category was divided into 3 different classifications, namely Coarse Sand, Fine Sand and Very Fine Sand with particles size ranges as indicated in Table 4-4. Silt fractions were also broken down into three fractions, and clay broken into two fractions, considering these fractions are likely to settle more slowly and contribute disproportionally to water turbidity.

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**Table 4-4 - Particle Size Distribution and Settling Velocities of Simulated Sediment Fractions**

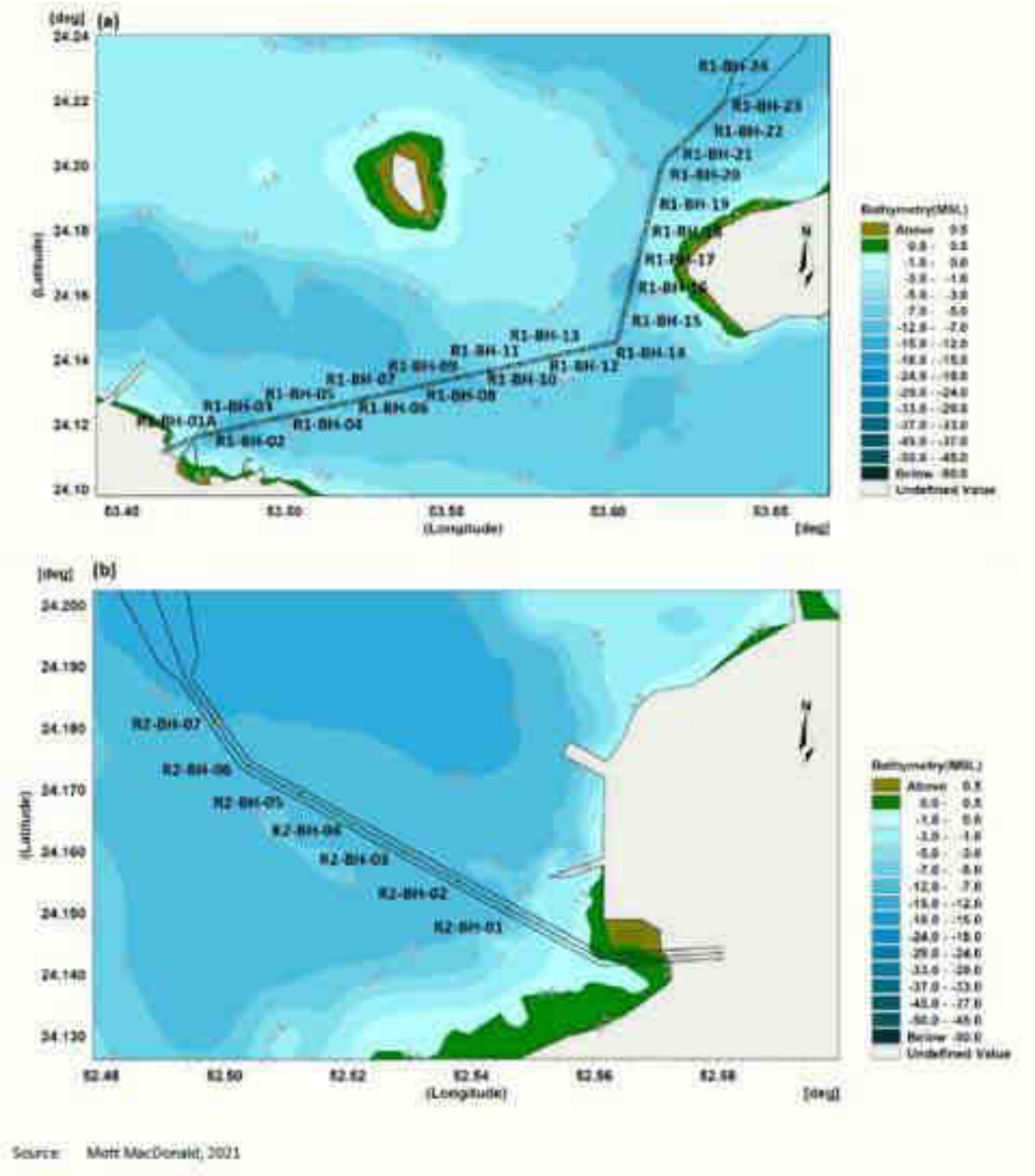
| | Size (micron) | Settling Rate (mm/s) | Group | Descriptor |
|---|---|---|---|---|
| Particle Size Distribution | >400 | 789.000 | 8 | Coarse Sand |
| | 150-400 | 25.0 (Estimated) | 7 | Fine Sand |
| | 80-150 | 6.470 | 6 | Very Fine Sand |
| | 40-80 | 2.052 | 5 | Coarse Silt |
| | 20-40 | 0.316 | 4 | Medium Silt |
| | 5-20 | 0.049 | 3 | Very Fine Silt |
| | 2-5 | 0.003 | 2 | Medium Clay |
| | <2 | 0.001 | 1 | Very Fine Clay |

The characteristics of the sediment within the dredged areas was defined utilising a number of boreholes from the geotechnical surveys [13], with the appropriate borehole characteristics being selected based on proximity. Table 4-5 presents the location, and characteristics of these boreholes, with Figure 4-17 presenting the location of these boreholes along the proposed Cable Routes 1 & 2.

**Table 4-5 - Relevant Borehole Summary**

| Borehole Ref | Coordinates East (m) | Coordinates North (m) | Water Depth (m) | Borehole Depth (m) | % Silt | % Sand | %Gravel |
|---|---|---|---|---|---|---|---|
| Route 2 | | | | | | | |
| BH-01 | 657092 | 2671534 | 3.9 | 2.9 | 21 | 73 | 6 |
| BH02 | 656228 | 2672038 | 8.4 | 3.5 | 6 | 69 | 25 |
| BH-03 | 655363 | 2672542 | 7.9 | 3.5 | 20 | 74 | 6 |
| Route 1 | | | | | | | |
| BH-01 | 751802 | 2609184 | 8.8 | 3.3 | 12 | 84 | 4 |
| BH-04 | 752763 | 2669443 | 10.3 | 3.2 | 33 | 64 | 3 |
| BH-14 | 764371 | 2675509 | 5.2 | 3.3 | 20 | 75 | 5 |
| BH-15 | 764665 | 2673464 | 6.3 | 3.4 | 5 | 67 | 28 |
| BH-17 | 765082 | 2673418 | 7.7 | 3.0 | 17 | 79 | 4 |
| BH-21 | 766221 | 2679183 | 6.0 | 3.0 | 5 | 30 | 65 |

**Figure 4-17 - Borehole Location – Routes 1&2**



## 4.3.4 Dredging Simulations

The dredge programme was simulated by MIKE MT FM to predict the behaviour of particles released into the water column, driven by 3D currents from MIKE HD FM, the dredge log and particle size distributions at each time step.

The dredge modelling predicted the X-Y-Z coordinates of all particles throughout the full simulation and the results were stored on a 10-minute timestep. These results were then analysed to determine the distribution of TSS developed over the total simulation, as well as the maximum depth-averaged concentrations which were attained over the entire dredge programme.

## 4.4 Assumptions and Limitations

The movement of the coastal ocean is controlled by the principles of mass, energy and momentum conservation. Numerical hydrodynamic modelling attempts to solve complex flow situations using empirical approximations and derivations of these principles. All numerical models make approximations to solve these principles and therefore have inherent limitations [14].

In addition to these inherent limitations, numerical modelling requires that input data be selected which itself has inherent limitations, and where input data is unavailable educated assumptions must be made. The following section highlights the limitations of the input data and assumptions which have been selected. Note, these assumptions and limitations do not invalidate the conclusions of the modelling study and the best-known source of data available within the confines of the project scope of work have been selected where possible.

The modelling assessment has been carried out utilising the most accurate data available at this time, however a number of assumptions/calculations were used to fill data gaps. Where selected methodologies or data gaps limit the assessment, these are summarised below:

### 4.4.1 Hydrodynamic Modelling

- The bathymetric data collected was a combination of bathymetry points obtained through digitisation of historic navigation charts, bathymetric (both physical survey data and Satellite Derived (SDB) data) obtained from the client, as well as relevant archived WKC bathymetric data surrounding the project area. Bathymetry obtained from the navigational charts were used for most of the surrounding areas within the modelling domain whilst the accurate survey data was used specifically around the area of interest. The ocean floor is a dynamic and constantly changing environment, therefore it is possible that for certain bathymetric data used, some variation between modelled bathymetry and actual bathymetry may exist. It is however not expected that this variation is significant enough to change the outcomes of this assessment.

### 4.4.2 Dredging Simulations

- Dredging simulations were carried out based on the methodology supplied by the contractor with estimated dredge rates, volumes and spill rates supplied by the dredging contractor. There is likely to be minor variations in theses agreed values during the actual dredging operations.

- The dredge modelling relies on the best available meteorological and bathymetric information and information concerning the proposed dredging methodology and material to be dredged. All these inputs can be subject to error and so where there was potential uncertainty in model parameters, conservative values were chosen such that the model would tend to overestimate the impact.

# 5 Hydrodynamic Modelling Flushing and Dredging Results

## 5.1 Hydrodynamic Modelling

### 5.1.1 Overview

In order to provide simulation data which captured a full spring/neap tidal cycle and achieved steady state equilibrium, validation simulations were conducted from 18/02/22 to 10/03/22 to coincide with the deployment of the four ADCPs for validation purposes. Separate simulations were conducted for Cable Route 2 area cable route 1 area, with the modelling domain boundary provided within Figure 1-1 and Figure 1-2 respectively.

Table 5-1 provides a summary of the ADCP data and tidal stations used for model calibration and validation with the locations of the ADCPs shown in Figure 4-2 and Figure 4-6.

**Table 5-1 - Overview of Client ADCP Data and Tidal Station Location**

| | | Period | | Location (UTM) | |
|---|---|---|---|---|---|
| ADCP | Interval | Start | End | Easting | Northing |
| ADCP #1 | 20 Min | 20/02/2022 13:00:00 | 09/03/2022 11:40:00 | 674643 | 2759342 |
| ADCP #2 | 20 Min | 19/02/2022 12:00:00 | 10/03/2022 11:20:00 | 649411 | 2686217 |
| ADCP #3 | 20 Min | 19/02/2022 10:20:00 | 10/03/2022 09:40:00 | 769562 | 2688942 |
| ADCP #4 | 20 Min | 20/02/2022 10:00:00 | 09/03/2022 09:20:00 | 768330 | 2727302 |
| Mubarraz | 10 Min | - | - | 740621 | 2706173 |
| Sir Bani Yas | 10 Min | - | - | 667407 | 2692103 |

For the analysis of the proposed sediment dispersion during trenching and backfilling operations, the planned dates (November 2023 to November 2024) and durations of each construction activities for Cable Routes 1&2 was used, with the exception that the simulations were run within 2021 and 2022 in order that representative meteorological data was available to force the simulations. Simulation periods for the assessment scenarios are summarised below:

- Cable Route 2 29/06/21 – 01/12/21 10 minute time-step
- Cable Route 1 01/11/20 – 01/07/21 10 minute time-step

### 5.1.2 Mesh Sensitivity Analysis

The model used for the project was based on an existing baseline hydrodynamic modelling mesh developed for the Ruwais area with the boundaries being extended east and west for the Cable Routes 1 & 2 respectively.

The two models (Cable Routes 1 & 2) were calibrated (maximum current speeds) against two ADCP's (that were recently deployed along each of the routes) as well as prognostic tidal data and is illustrated in Figure 4-2 and Figure 4-6.

The opportunity was taken at this stage to reanalyse the mesh sensitivity to resolution.

The first three revisions of each mesh were purely focused on ensuring emphasis was placed in properly defining any coastline differences as per updated satellite imagery dated the 31st of December 2020. The mesh resolution is relatively course (maximum element size of 1,500,000 $m^2$ for Rev 1 at the ADCP locations) and gradually reduced whilst testing the overall simulation stability of the initial mesh structures. Mesh revision 2 (element size of 150,000 $m^2$ at the ADCP locations) proved to be stable enough for the first round of calibration checks were performed utilising the two sets of ADCP data for each route.

The mesh elements were then further reduced for Mesh 3 and again further reduced for Mesh 4. The progression of the mesh element sizes is presented in Table 5-2 and illustrates how mesh convergence is reached between Mesh No.2 and the Mesh No. 4 (Final Mesh) with slight decreases in correlation between observed and simulated current characteristics.

The overall resolution of the mesh is variable, however the sensitivity analysis was conducted at areas of the ADCP locations. The intention of the sensitivity analysis is to determine whether any increase in resolution (which reduces simulation time significantly) would result in a significant increase in model accuracy. The goal in these assessments is to maintain a reasonable run time using available computing power, whilst retaining accuracy fit for purpose in environmental assessment.

A maximum fine resolution of approximately 37m horizontal resolution was maintained, as any further improvement in validation was small and not sufficient to justify proportionally increased run-times considering the objectives of the model set-up.

**Table 5-2 - Mesh Sensitivity Test of Existing MIKE21 HD FM for Ocean Characteristics**

| Mesh No. | 2 | 3 | 4(Final) |
|---|---|---|---|
| Smallest Element Size (Approx. Horizontal Resolution) | 1000m | 100m | 37m |
| Parameter | IOA | IOA | IOA |
| Ideal Score | 1 | 1 | 1 |
| ADCP1 – Avg Current Speed | 0.82 | 0.78 | 0.77 |
| ADCP1 – Avg Current Direction | 0.84 | 0.81 | 0.81 |
| ADCP2 – Avg Current Speed | 0.82 | 0.83 | 0.79 |
| ADCP2 – Avg Current Direction | 0.6 | 0.57 | 0.56 |
| ADCP3 – Avg Current Speed | 0.84 | 0.88 | 0.87 |
| ADCP3 – Avg Current Direction | 0.88 | 0.86 | 0.84 |
| ADCP4 – Avg Current Speed | 0.89 | 0.91 | 0.90 |
| ADCP4 – Avg Current Direction | 0.87 | 0.90 | 0.89 |

### 5.1.3 Hydrodynamic Currents

Currents speeds within the two areas of interest are variable both within the domain and between Cable Route 1 & 2 domains. Currents within both the areas of interest are complicated by nearby islands and shoals creating both restricted channels with high current speeds and sheltered areas with limited tide or wind driven currents.

The tides are generally of a mixed diurnal and semi-diurnal nature. The current velocities within the project area are largely driven by the flood and ebb tidal events with some influence from wind effects (due to the predominant north-westerly wind direction).

The area of landfall with the Abu Dhabi mainland for Cable Route 2 area is sheltered by both the Jebel Dhana headland and Sir Bani Yas Island. Current speeds are high through the narrow channel that separates Sir Bani Yas Island from the Abu Dhabi mainland, however currents on either side of the Jebel Dhana headland are sheltered during both the flood and ebb tide, and are generally below 0.1m/s.

Current speeds within the nearshore area of Cable Route 1 are generally higher during both the flood and ebb tide, and are largely tidal driven due to some sheltering from wind affects from islands and shoals offshore. The currents are generally in the east to west orientation following the lay of the mainland coast with the channel that separates the mainland from both Marawah and Abu al Abyad Islands. The cable route turns towards the north and exploits and existing channel between tidal shoals, where an existing navigation channel has been dredged. Currents supplying and emptying the nearshore areas during the flood and ebb tide respectively are particularly strong through this channel, frequently exceeding 1.0 m/s.

Figure 5-1 and Figure 5-2 present a typical ebb tide at both Cable Routes 2 and Cable Routes 1 respectively whereas Figure 5-3 and Figure 5-4 present the flood tide.

**Figure 5-1 - Cable Route 2 - Typical Ebb Tide Currents**

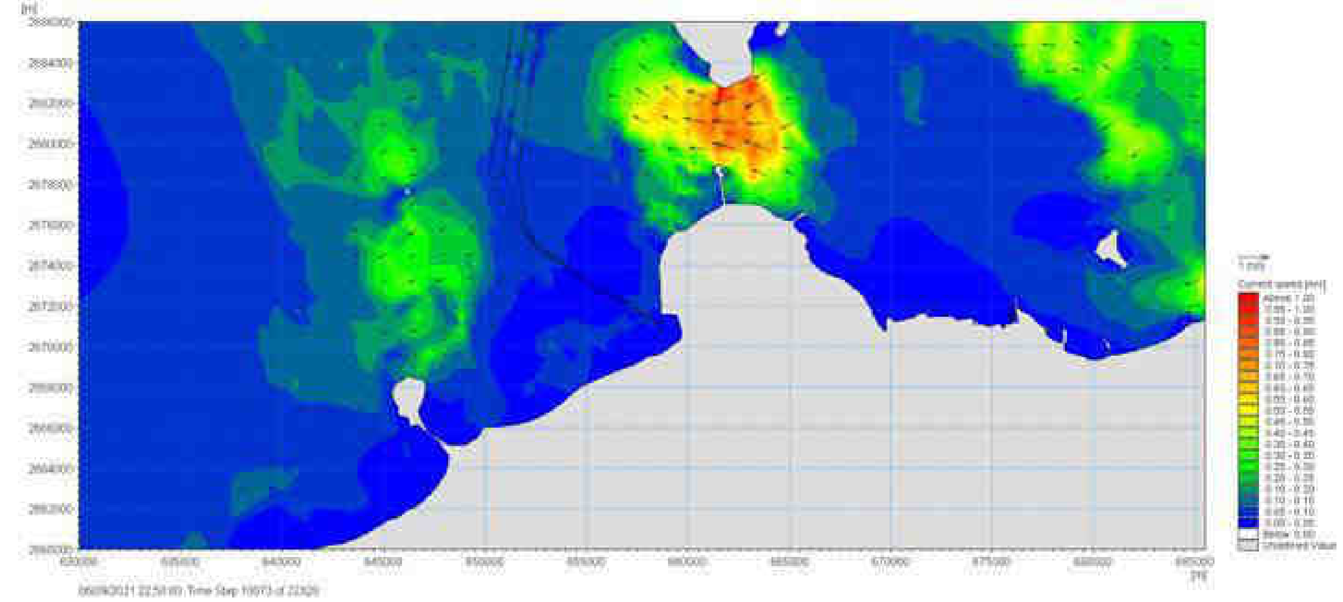


**Figure 5-2 - Cable Route 1 - Typical Ebb Tide Currents**

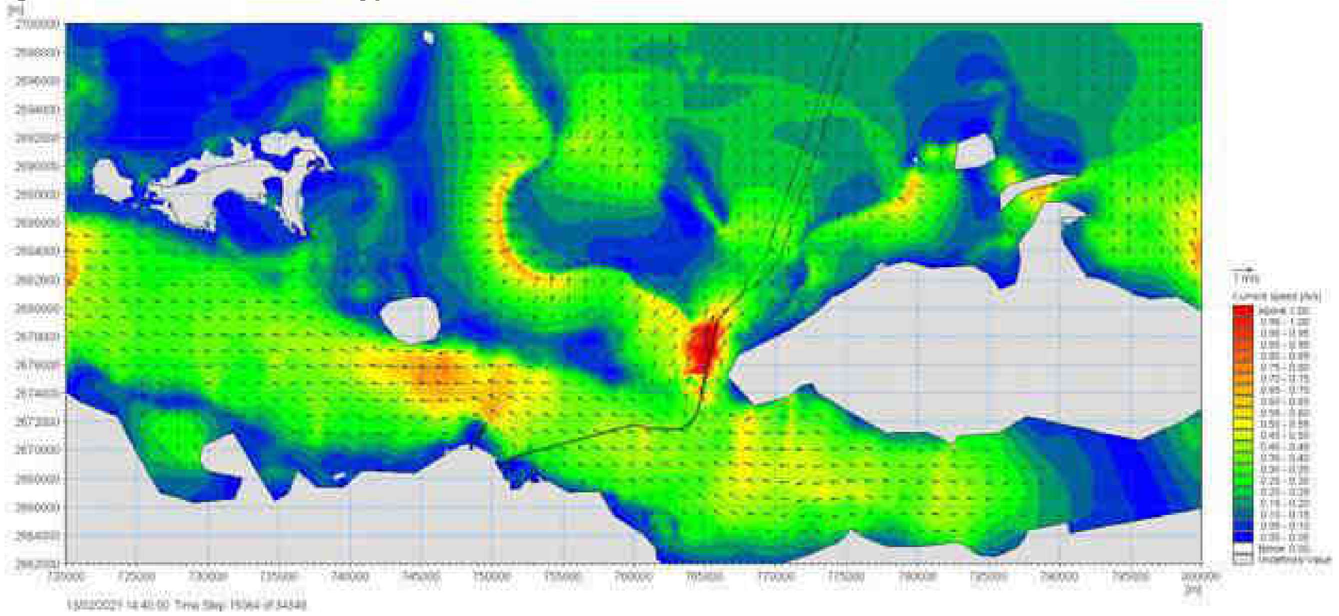


**Figure 5-3 - Cable Route 2 - Typical Flood Tide Currents**

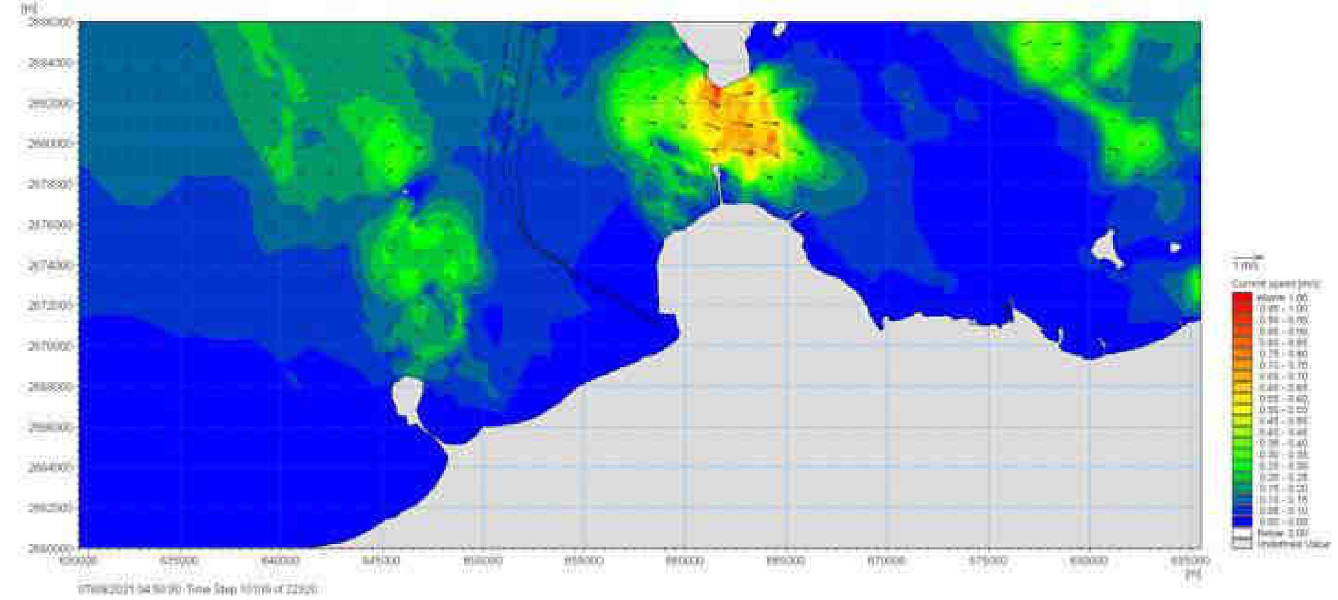
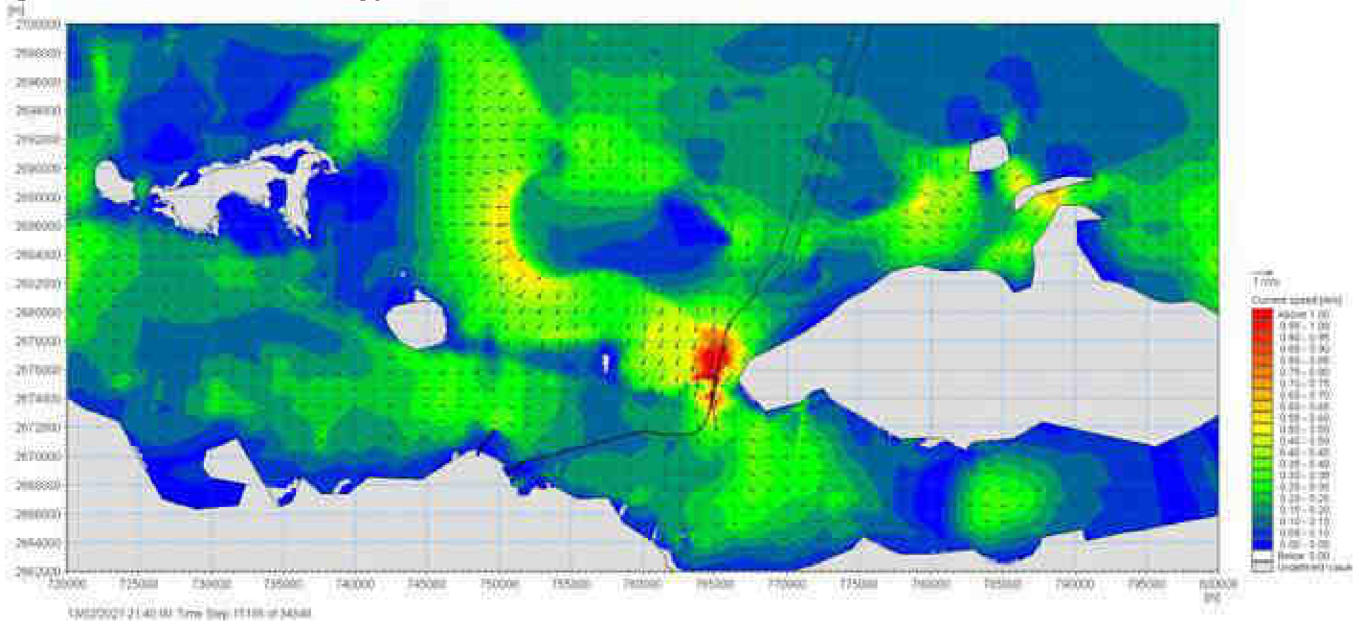


**Figure 5-4 - Cable Route 1 - Typical Flood tide Currents**



### 5.1.4 Verification of Tide and Current Predictions

The tidal currents and gauge heights utilised within the assessment were simulated to coincide with the period for which the ADCP's were deployed to allow direct comparison. The location of the ADCP's can be seen in Figure 4-2 and Figure 4-6 and verification of the accuracy of the currents in the region of interest was possible due to measured current speeds and direction observed at these locations. The hydrodynamics of the simulated model were calibrated using the measured current speed and direction data collected from four ADCPs, two along each of the proposed cable routes 1 & 2.

A comparison between the simulated (depth averaged current speeds and directions) and observed mid-column current speeds and directions at the location of the ADCP deployments was conducted. Mid-Column ADCP speeds and directions were chosen to equalise the potential opposing influence of seabed an sea surface friction.

Additionally, a comparison of simulated and prognostic gauge height (water level) data at both Sir Bani Yas and Mubarraz Island was conducted. The correlation between simulated and observed prognostic water levels at both Sir Bani Yas and Mubarraz Island are shown in Figure 5-5 and Figure 5-6 respectively. The correlation between simulated and observed current speeds and current directions at the four ADCP locations are provided within Figure 5-7 to Figure 5-18. Observed and simulated current roses are illustrated in Figure 5-19 to Figure 5-26.

These figures provide a graphical representation of how accurately MIKE21 HD FM is simulating the ocean physics when compared to measured ADCP data in the form of time series plots as well as current rose plots.

Note: Considering the locations of the areas where both ADCP's were deployed, the mid-column data bin was used for the observed data due to this bin layer being less influenced by bed and wind friction (which are depth averaged within the 2D simulations).

To statistically analyse model performance, the Index of Agreement (IOA) is calculated through comparison between observed (ADCP data) and simulated model data and is compared to the semantic scale presented in Table 5-3 with explanation of the various metrics and indices given in the text that follows. Furthermore, the Relative Mean Absolute Error (RMAE) and an Adjusted Relative Mean Absolute Error (ARMAE) was used to analyse the model performance using the semantic scaled presented in Table 5-4 with the ARMAE scores also included in Table 5-5.

**Table 5-3 - Indices of Agreement Score Qualifications [15]**

| Range | Qualification |
|---|---|
| 0.9 < x < 1.0 | Excellent |
| 0.8 < x < 0.9 | Very Good |
| 0.6 < x < 0.8 | Good |
| 0.5 < x < 0.6 | Reasonable |
| 0.3 < x < 0.5 | Poor |
| x < 0.3 | Bad |

**Table 5-4 - ARMAE Score Qualifications [18]**

| Range | Qualification |
|---|---|
| x < 0.2 | Excellent |
| 0.2 < x < 0.4 | Good |
| 0.4 < x < 0.7 | Reasonable |
| 0.7 < x < 1 | Poor |
| x > 1 | Bad |

Presented below, Table 5-5 illustrates the mean absolute error (MAE) root-mean-square error (RMSE), the coefficient of efficiency (E), the IOA, RMAE and ARMAE, for Gauge heights, Current Speeds and Current Directions, along with the ideal score for each test.

The RMSE can be described as the standard deviation of the difference for predicted and observed pairing at the ADCP location. The RMSE is a quadratic scoring rule which measures the average magnitude of the error. The RMSE is a good measure of model performance, but since large errors are weighted heavily, its value can be distorted. The MAE is a measure of comparison similar to the RMSE but puts less emphasis on the largest errors. RMSE and MAE are equal to the unit of the values being analysed.

E can range from negative infinity to 1 with larger values indicating a better fit. E measures the one to one relationship between the observed and simulated values and hence is sensitive to bias and proportional effects.

The IOA [15] can take a value between 0 and 1, with 1 indicating perfect agreement. The IOA is the ratio of the total RMSE to the sum of two differences, the difference between each prediction and the observed mean, and the difference between each observation and the observed mean. Therefore, the IOA is a measure of the match between departure of each prediction from the observed mean and the departure of each observation from the observed mean.

From the statistical analysis of the simulated and observed water heights, the simulated tidal variations show an excellent correlation to the prognostic tidal data for the 2020 data period and is illustrated in Figure 5-5 and Figure 5-6 below.

Model performance statistics can be used to calibrate and/or validate hydrodynamic models in an objective way. One statistical method used to analyse the performance is to evaluate the RMAE [16].

$$RMAE = \frac{<|Y - X|>}{<X>}$$

Where:

$$<|X|> = \frac{1}{N}\sum_{n=1}^{N}|x_n|$$

$$<|Y|> = \frac{1}{N}\sum_{n=1}^{N}|y_n|$$

However, a RMAE value of zero implies a perfect match between predictions and observations, which in practice can never be achieved as the RMAE includes contributions from the measurement error. A way of reducing the influence of the observational errors is to introduce an Observational Error (OE) component and subtract this from each absolute error, thus defining an Adjusted RMAE.

$$ARMAE = \frac{<|Y - X| - OE>}{<X>}$$

OE depends on a number of things such as water clarity/turbidity, correct and proper installation of the equipment as well as inherent device accuracy factors. In a previous study, an average observational error for current speeds is 0.05 m/s was considered but for conservative purposes and based on past experience, an observational error of 0.015 m/s was considered for currents in this assessment [16].

**Table 5-5 - Statistical Performance of MIKE21 HD FM for Ocean Characteristics**

| | MAE | RMSE | E | ARMAE | IOA |
|---|---|---|---|---|---|
| Ideal Score | 0 | 0 | 1 | 0 | 1 |
| Sir Bani Yas - Prognostic Gauge Heights | 0.0725 | 0.0938 | 0.9108 | - | 0.9799 |
| Mubarraz - Prognostic Gauge Heights | 0.0827 | 0.1009 | 0.9164 | - | 0.9810 |
| ADCP1 – Avg Current Speed | 0.0378 | 0.0481 | -0.044 | 0.050 | 0.7753 |
| ADCP1 – Avg Current Direction | 0.6754 | 1.4686 | 0.3132 | - | 0.8120 |
| ADCP1 – Mid Column U-Velocity Component | 0.0442 | 0.0535 | 0.4512 | 0.095 | 0.8999 |
| ADCP1 – Mid Column V-Velocity Component | 0.0299 | 0.0380 | 0.7580 | 0.094 | 0.9507 |
| ADCP2 -Avg Current Speed | 0.0368 | 0.0456 | -0.3474 | 0.050 | 0.7915 |
| ADCP2 – Avg Current Direction | 1.5945 | 2.611 | -1.1898 | - | 0.5649 |
| ADCP2 – Mid Column U-Velocity Component | 0.0376 | 0.0466 | -0.0812 | 0.154 | 0.7245 |
| ADCP2 – Mid Column V-Velocity Component | 0.0445 | 0.0544 | 0.5991 | 0.098 | 0.9304 |
| ADCP3 – Avg Current Speed | 0.0379 | 0.0482 | 0.5386 | 0.041 | 0.8725 |
| ADCP3 – Avg Current Direction | 0.5672 | 1.2939 | 0.4243 | - | 0.8493 |
| ADCP3 – Mid Column U-Velocity Component | 0.0585 | 0.0727 | 0.7572 | 0.079 | 0.9443 |
| ADCP3 – Mid Column V-Velocity Component | 0.0487 | 0.0595 | 0.5766 | 0.103 | 0.8950 |
| ADCP4 – Avg Current Speed | 0.0430 | 0.0546 | 0.5719 | 0.046 | 0.9059 |
| ADCP4 – Avg Current Direction | 0.4808 | 1.1251 | 0.5801 | - | 0.8911 |
| ADCP4 – Mid Column U-Velocity Component | 0.0456 | 0.0561 | 0.8458 | 0.078 | 0.9676 |
| ADCP4 – Mid Column V-Velocity Component | 0.0589 | 0.0757 | 0.7786 | 0.091 | 0.9490 |

Visual comparison of graphical observed and simulated results indicated that the validation of both the modelling domains (see Figure 4-1 and Figure 4-5) can be considered excellent. Statistical comparison of the observed and simulated data shows that validation is very good to excellent. A single metric analysed returned ‘good’ validation, that being the current direction at ADCP #2, however note that both the u-component and v-component validation is considered to be very good or excellent.

**Figure 5-5 – Sir Bani Yas - Tidal Gauge Height Comparison - Simulated vs Observed**

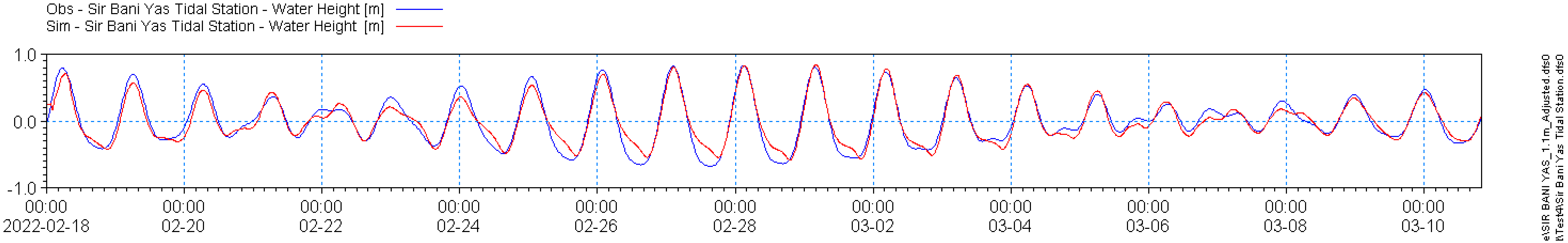



**Figure 5-6 - Mubarraz Island - Tidal Gauge Height Comparison - Simulated vs Observed**

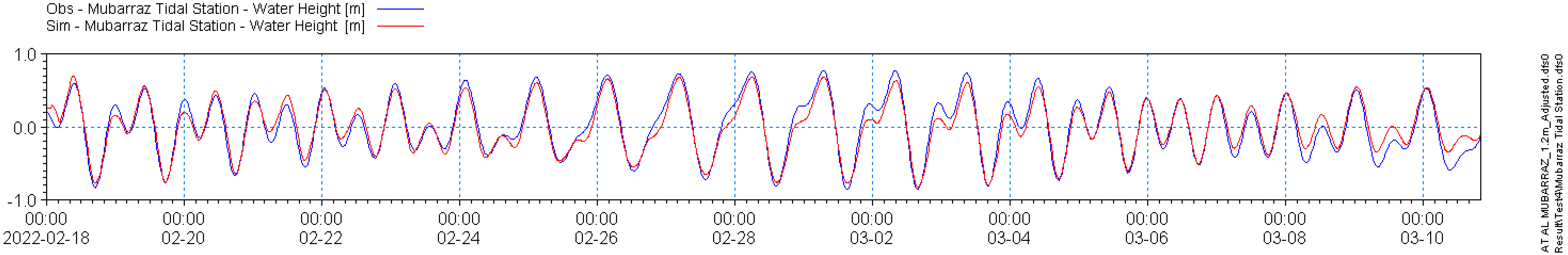


Figure 5-7 – ADCP #1 Current Speed Comparison - Simulated vs Observed

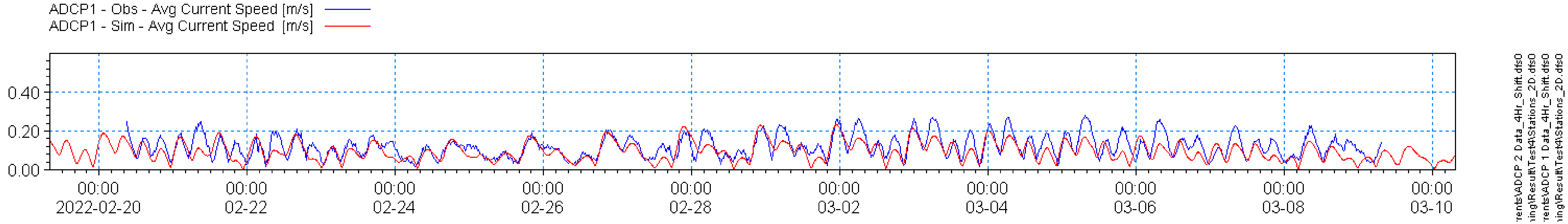



Figure 5-8 - ADCP #1 U-Component Comparison - Simulated vs Observed

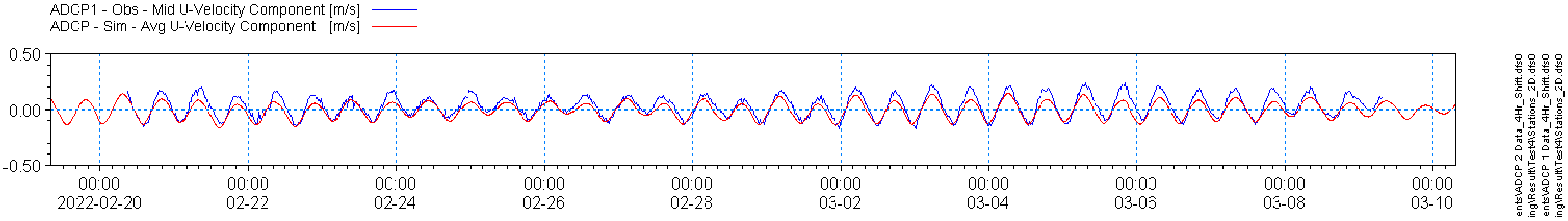



Figure 5-9 - ADCP #1 V-Component Comparison - Simulated vs Observed

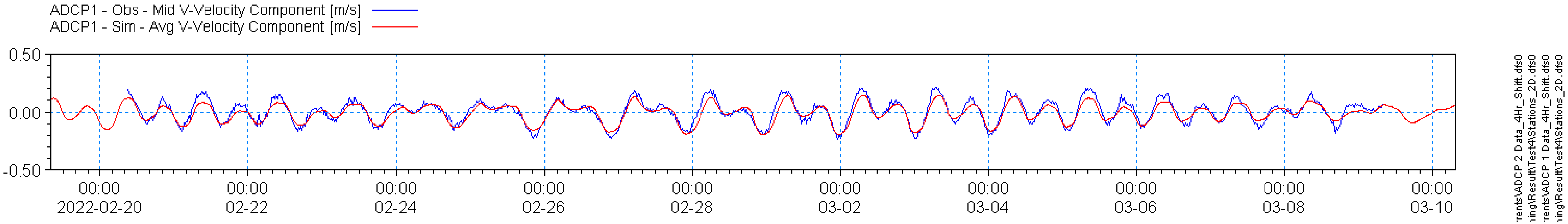


**Figure 5-10 – ADCP #2 Current Speed Comparison - Simulated vs Observed**

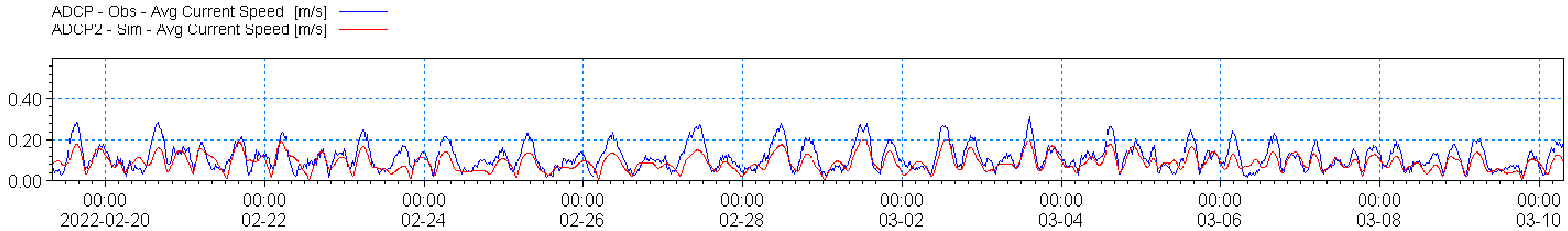



**Figure 5-11 - ADCP #2 U-Component Comparison - Simulated vs Observed**

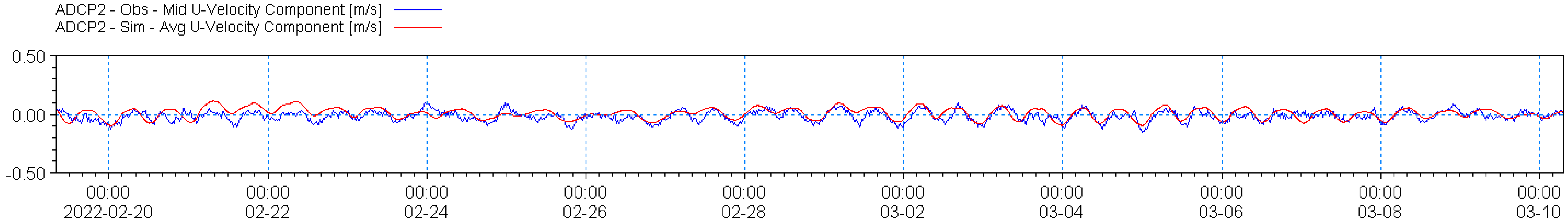



**Figure 5-12 - ADCP #2 V-Component Comparison - Simulated vs Observed**

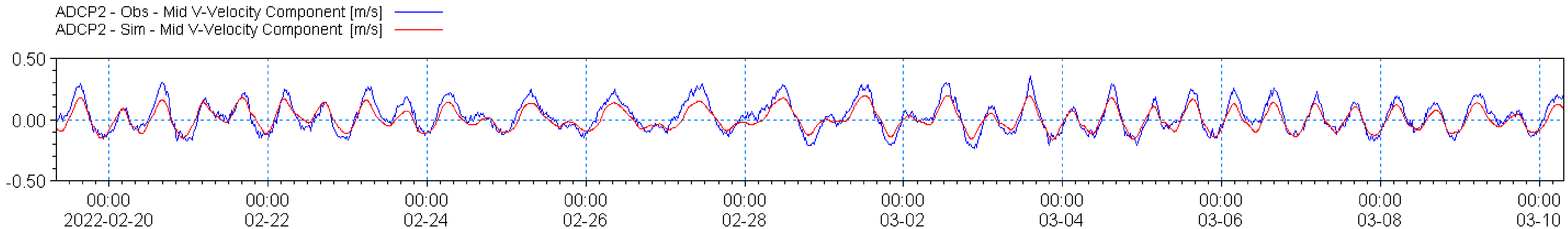


**Figure 5-13 – ADCP #3 Current Speed Comparison - Simulated vs Observed**

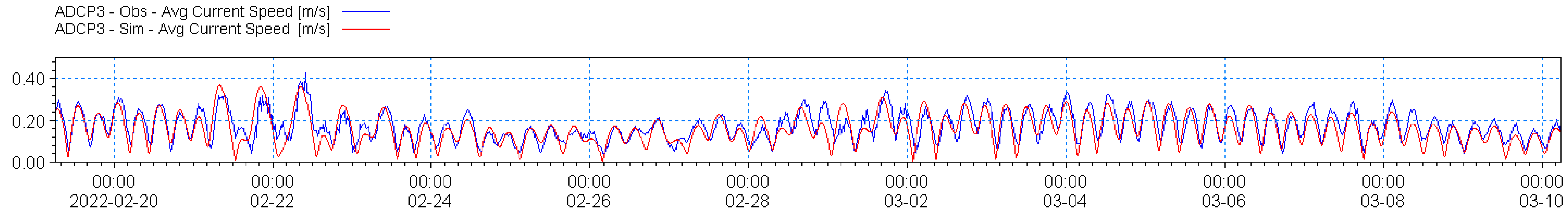



**Figure 5-14 - ADCP #3 U-Component Comparison - Simulated vs Observed**

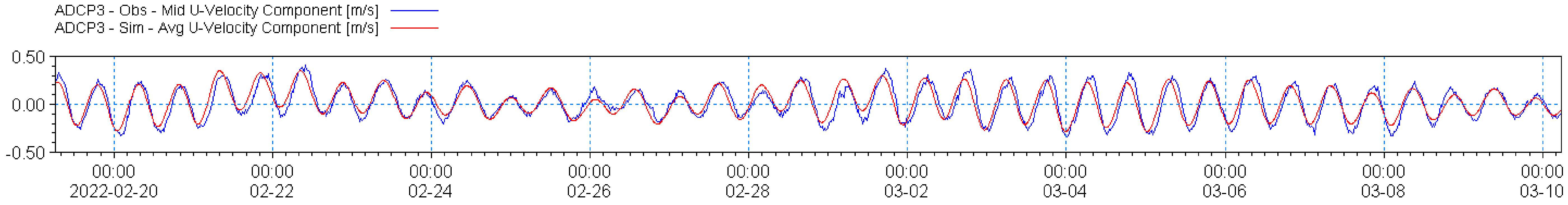



**Figure 5-15 - ADCP #3 V-Component Comparison - Simulated vs Observed**

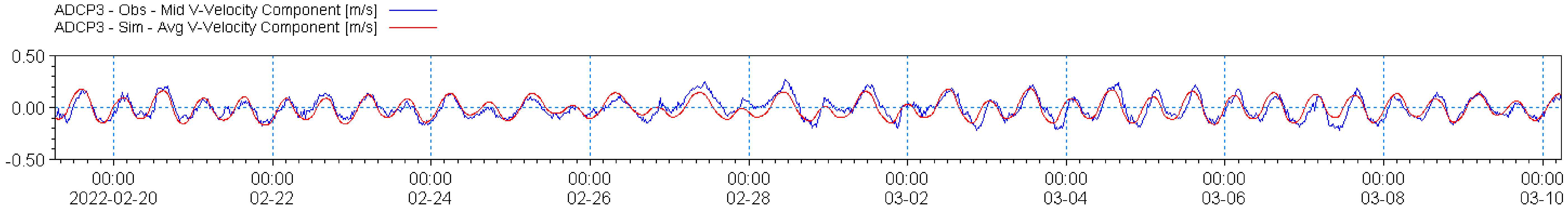


Figure 5-16 – ADCP #4 Current Speed Comparison - Simulated vs Observed

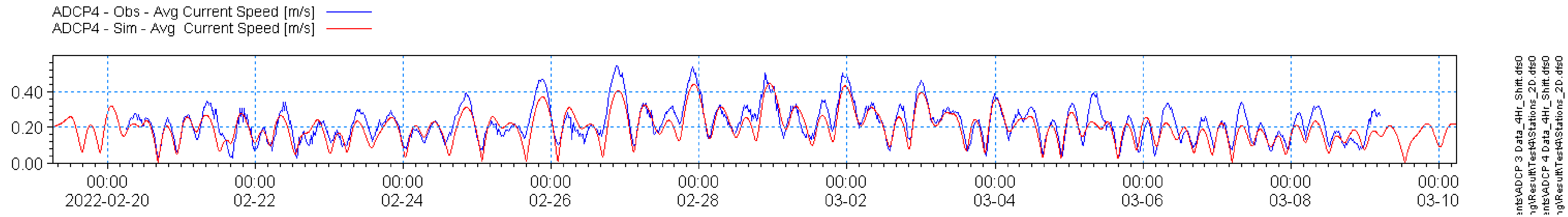



Figure 5-17 - ADCP #4 U-Component Comparison - Simulated vs Observed

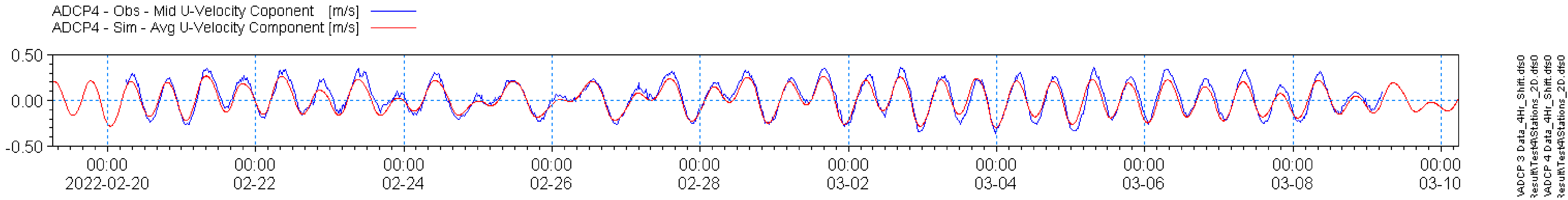



Figure 5-18 - ADCP #4 V-Component Comparison - Simulated vs Observed

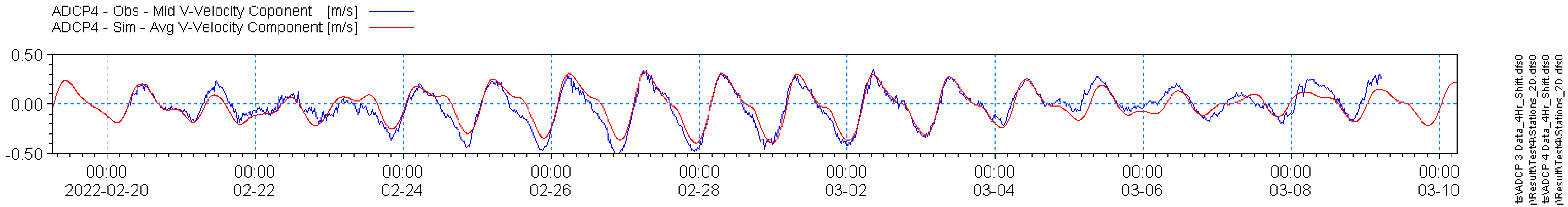


**Figure 5-19 - ADCP#1 - Observed (ADCP) Current Rose**

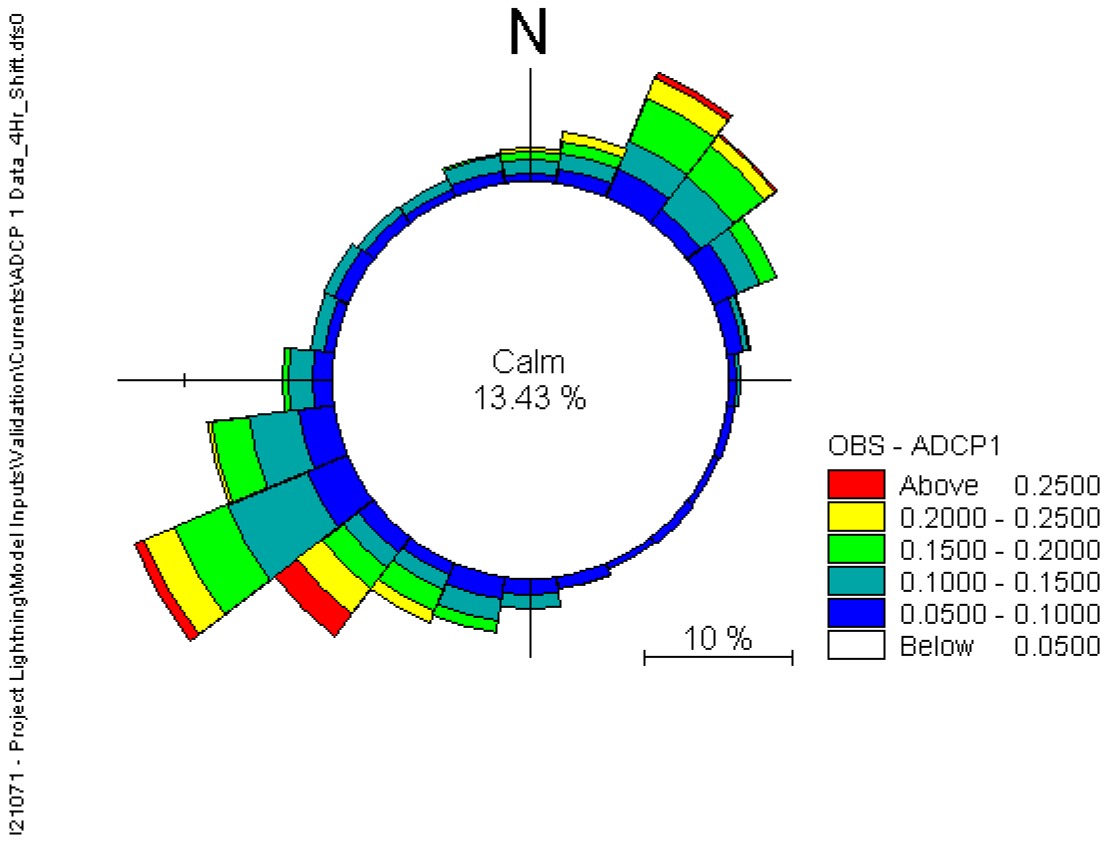



**Figure 5-20 - ADCP #1 - Simulated Current Rose**

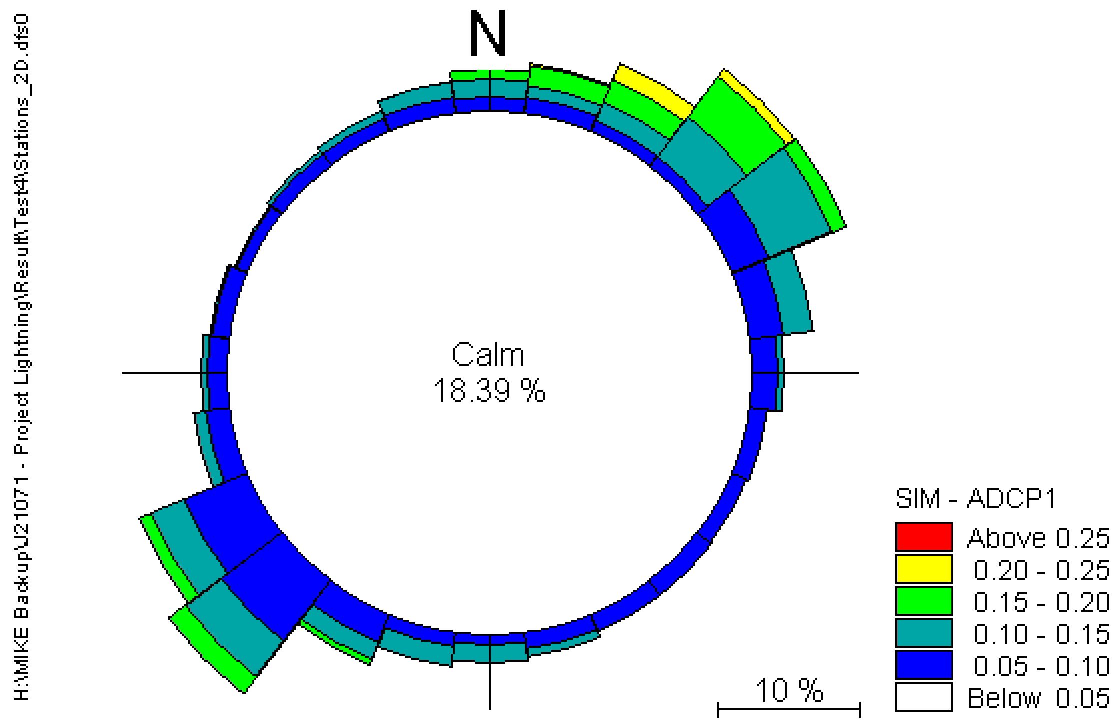



**Figure 5-21 - ADCP #2 Observed (ADCP) Current Rose**

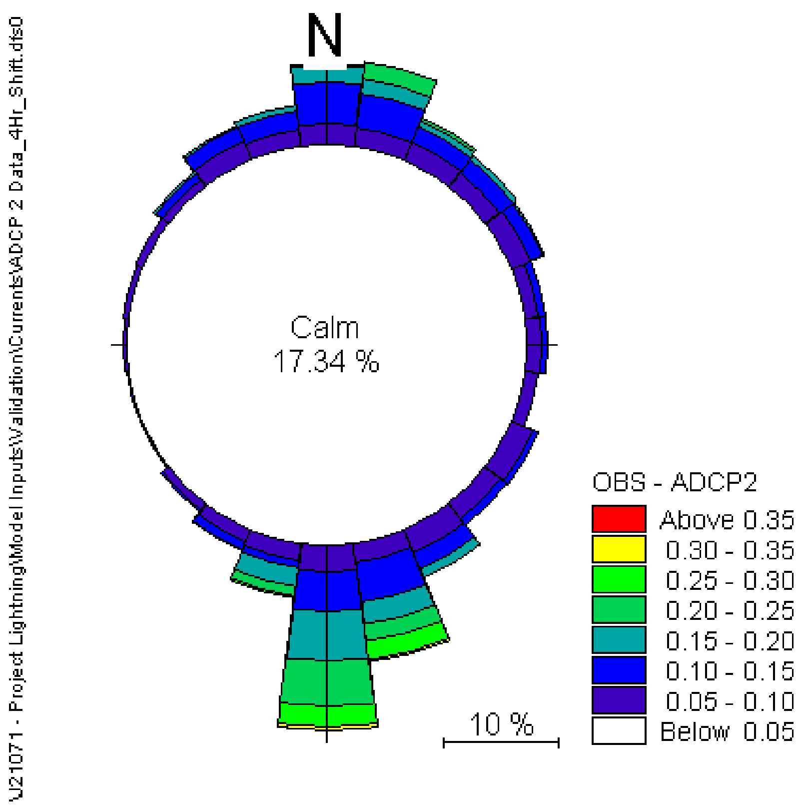



**Figure 5-22 - ADCP #2 Simulated Current Rose**

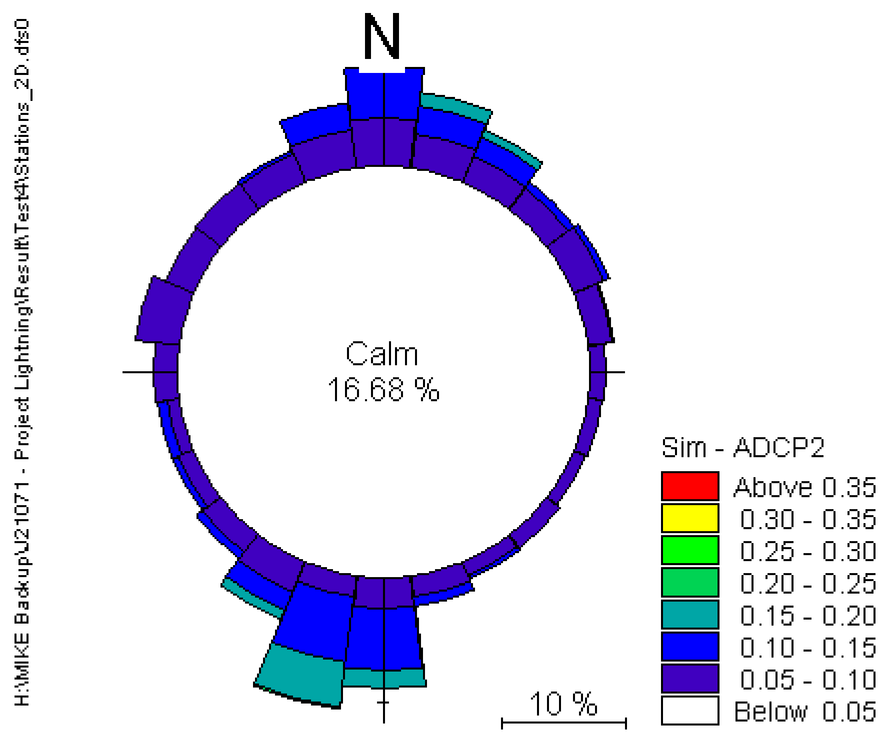


**Figure 5-23 - ADCP #3 Observed (ADCP) Current Rose**

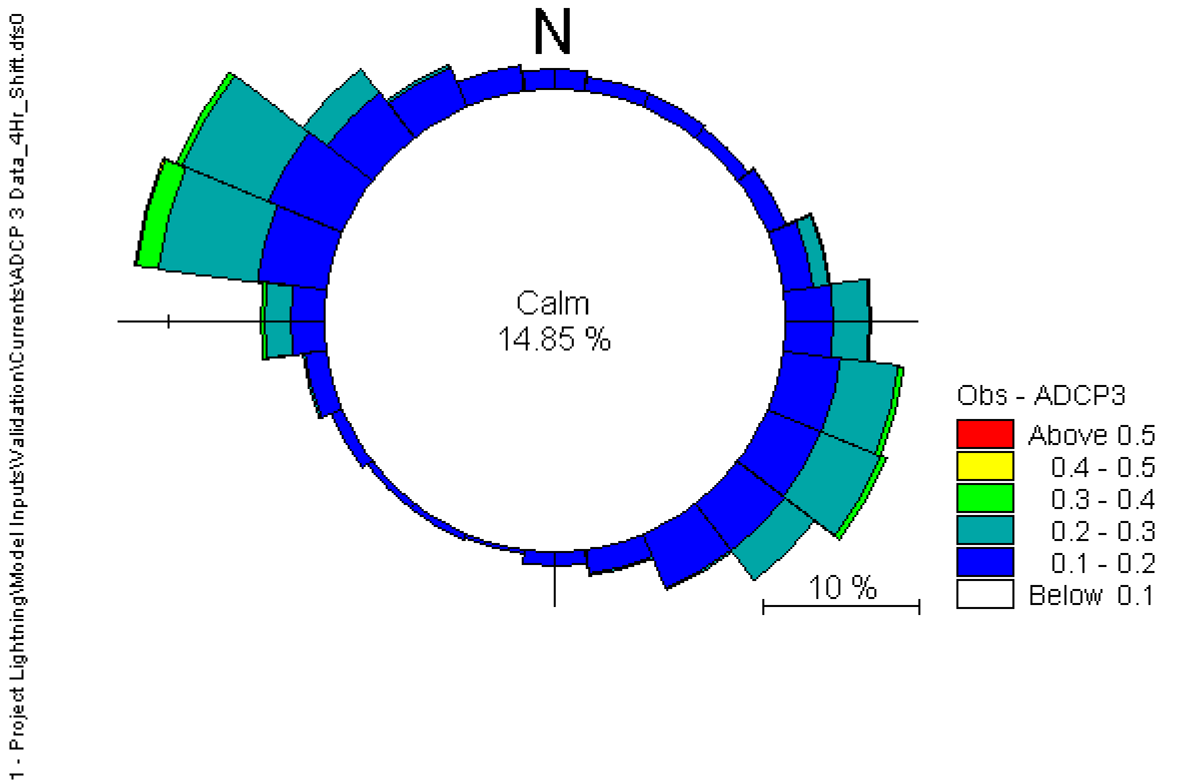



**Figure 5-24 - ADCP #3 Simulated Current Rose**

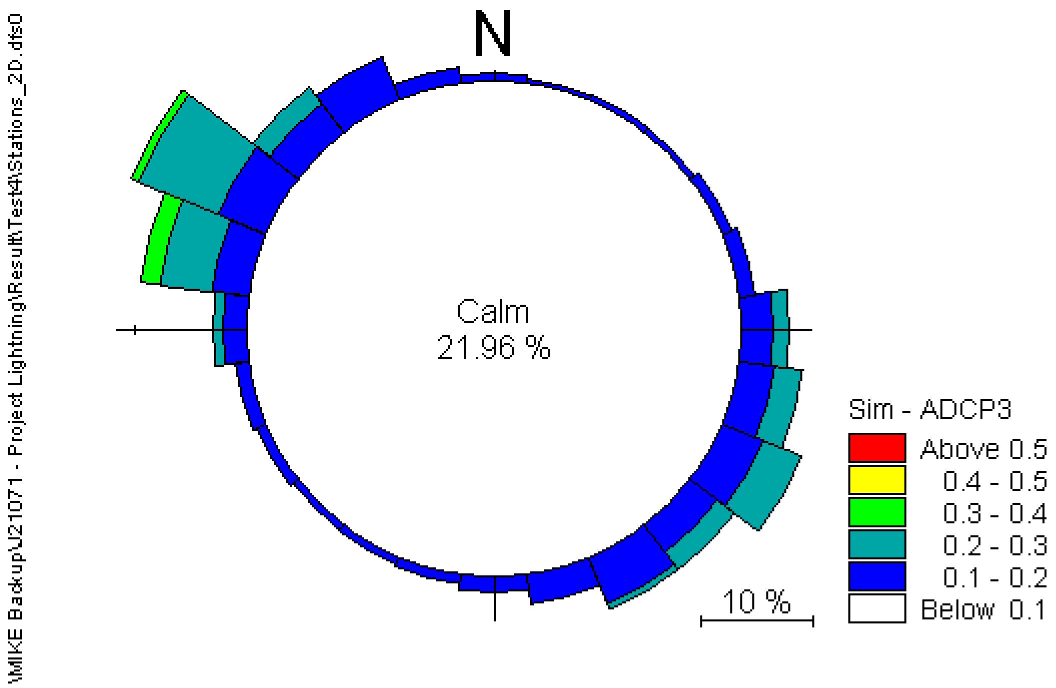



**Figure 5-25 - ADCP #4 Observed (ADCP) Current Rose**

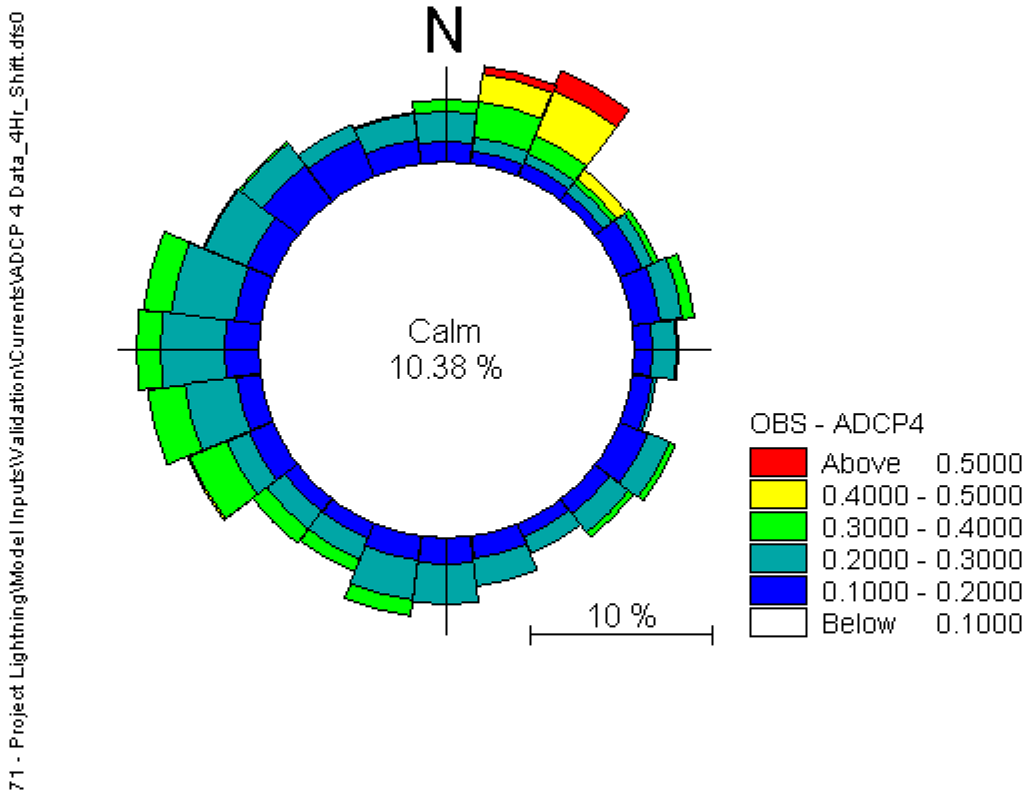
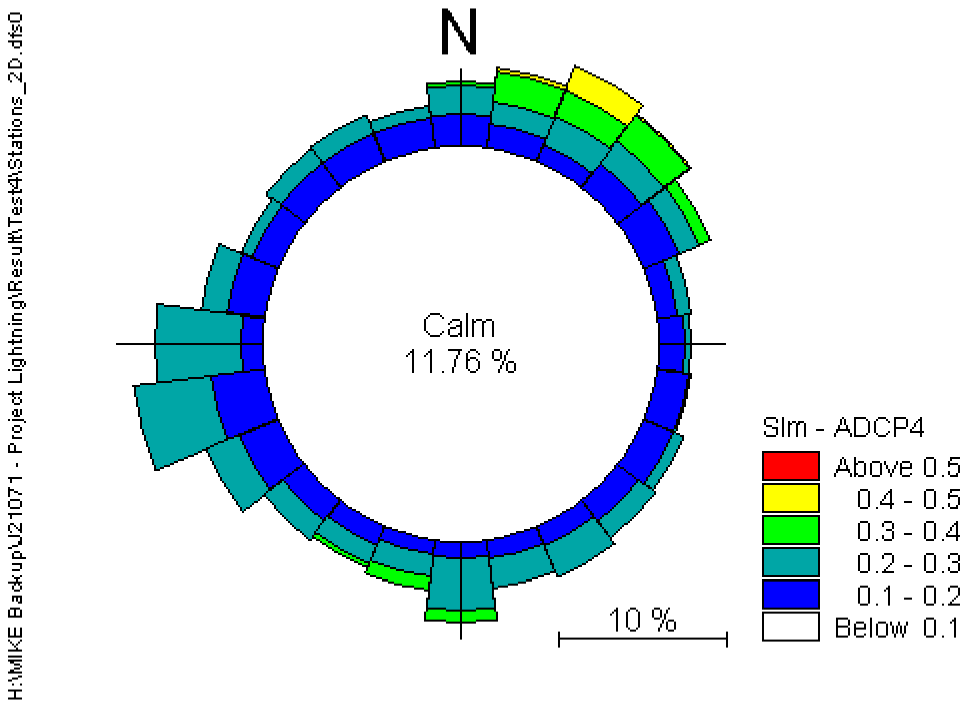



**Figure 5-26 - ADCP #4 Simulated Current Rose**



### 5.1.5 Area of Interest Variation

***Cable Route 2***

Currents within the area of interest, where dredging and backfilling will occur, are largely tidal in nature. However, currents within the area are complicated by the presence of Sir Bani Yas island, and the Jebel Dhana headland. Whereas normally the currents would be orientated east to west along the coastline of Abu Dhabi, these two feature create a shadow effect within the area of interest, instead the tides pass through the narrow channel between the mainland and Sir Bani Yas Island.

Average currents speeds within the area where trenching and backfilling will occur are below 0.05 m/s, with maximum current speeds rarely exceeding 0.3 m/s. It is anticipated that this area of relatively low currents speeds will limit dispersion of any sediment suspended into the water column, which although may reduce the area of impact, will result in less efficient dilution of TSS concentrations within this area.

***Cable Route 1***

The area of interest containing the proposed trenched areas along the proposed Cable Route 1 is partially separated from the open Gulf by various islands and shoals, which complicates and restricts tidal flows within this area. In general, the tidal currents move along the coastline in an east to west direction but are deflected by various shoals and islands.

Average current speeds along the majority of the trenched route are approximately 0.2 m/s reaching a maximum of 0.4 – 0.5 m/s. A small gap in the shielding influence of the islands and shoals lies immediately west of Abu al Abyad Island, although shallow, a small access channel has been historically dredged here. This gap allows the flood and ebb to move in a north and south direction, however the restriction here results in average current speeds of up to 0.7 m/s and maximum currents speeds of over 1.5 m/s.

Figure 5-27 and Figure 5-28 present the mean and maximum current speeds respectively for the area of interest surrounding the proposed Cable Route 2 trenching area, whereas Figure 5-29 and Figure 5-30 present the same for the area of interest along the proposed Cable Route 1.

Results of the simulation in video format for both the pre-development and post-development scenarios are provided in Appendix A.

**Figure 5-27 –Cable Route 2 AOI - Mean Current Speeds**

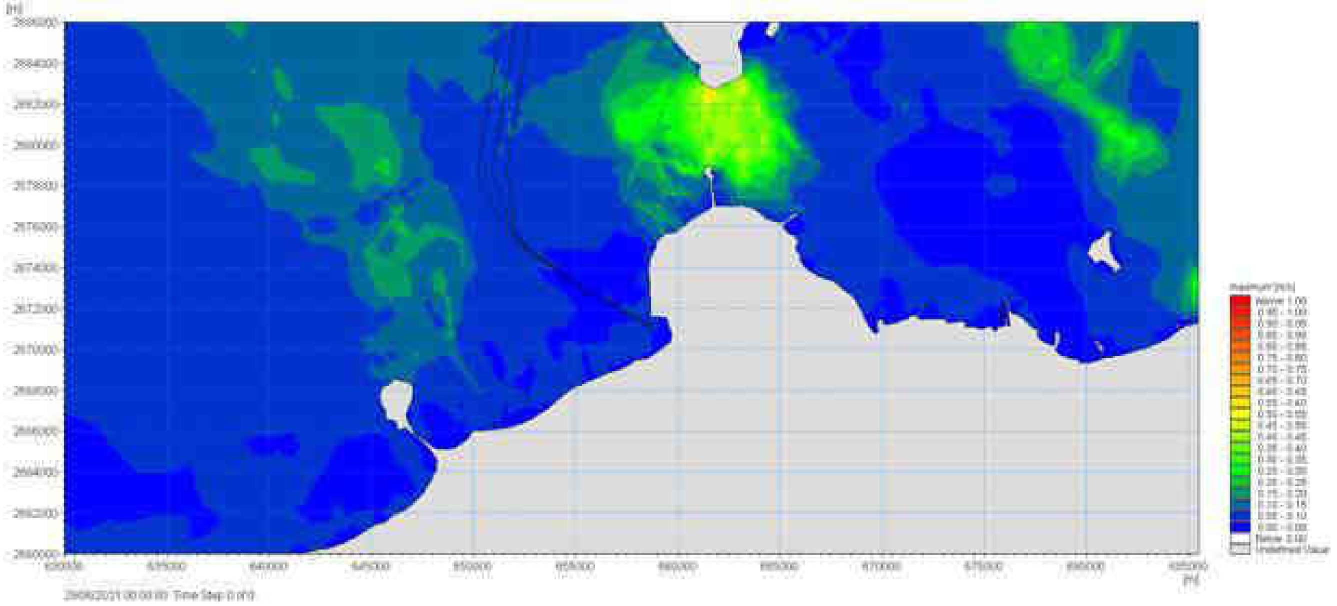


**Figure 5-28 - Cable Route 2 AOI - Max Current Speeds**

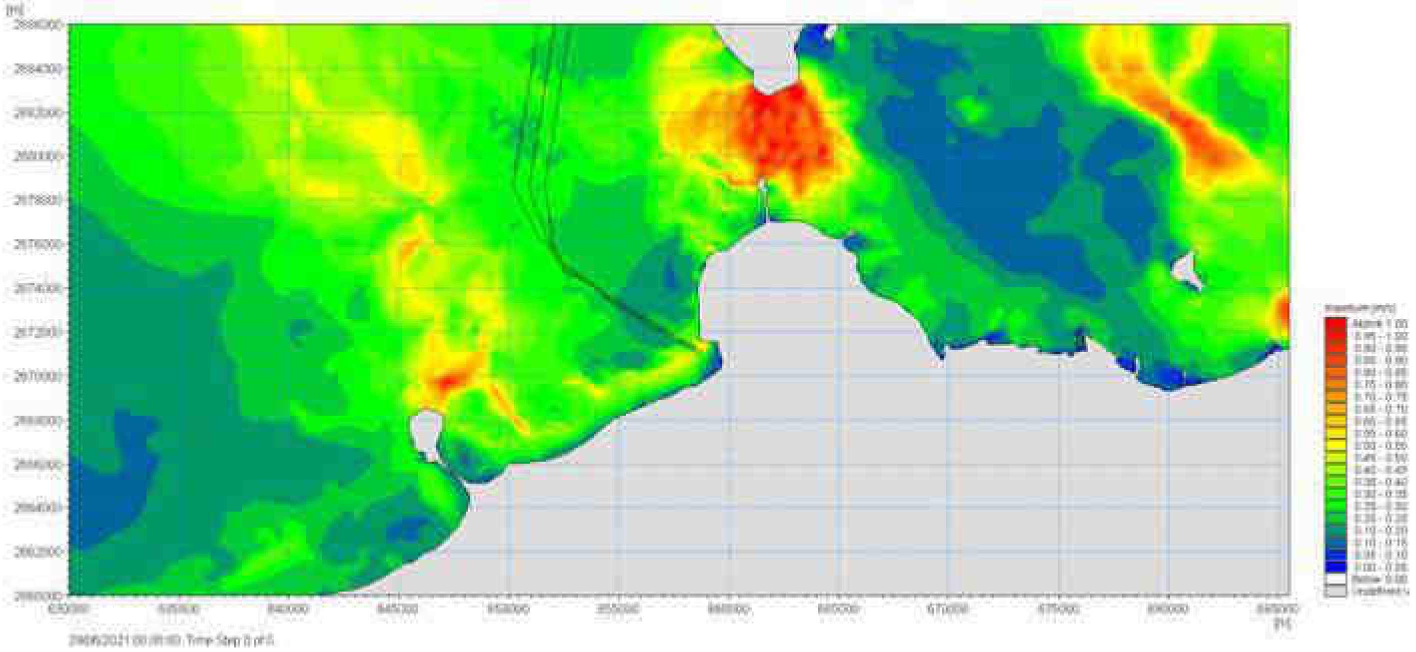


**Figure 5-29 – Cable Route 1 AOI - Mean Current Speeds**

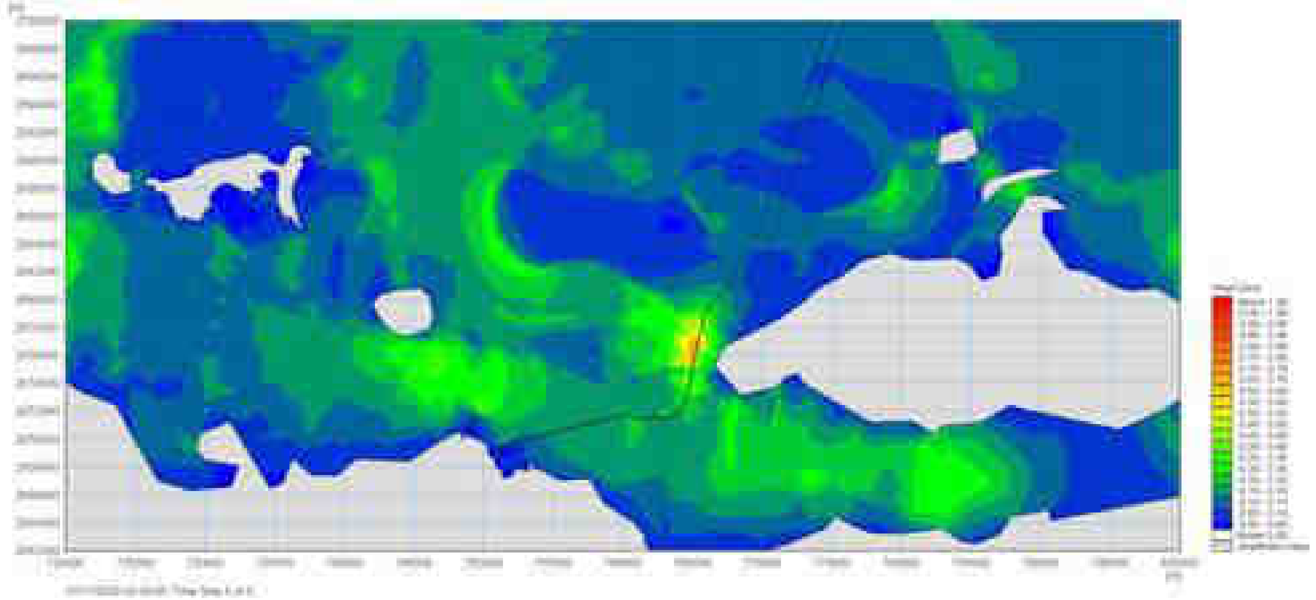
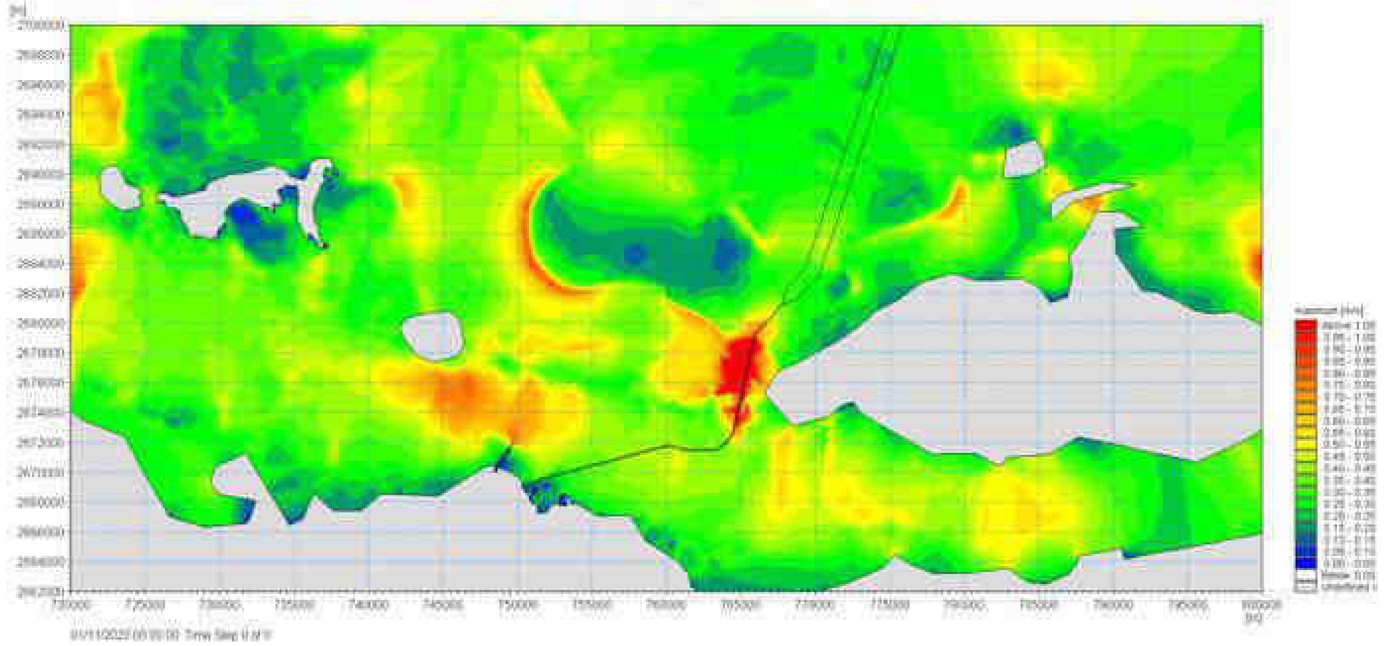


**Figure 5-30 – Cable Route 1 AOI - Max Current Speeds**



## 5.2 Dredging Assessment

Two dredging scenarios were simulated within separate domains to take into account proposed trenching, backfilling and dumping methods for the proposed cable routes 1 & 2. These simulations was conducted to predict turbidity concentrations and deposition patterns during the dredging activities that are proposed for the channel as discussed in Section 4.3.2.

The results were analysed to determine the mean concentration and predicted maximum Total Suspended Solids (TSS) concentration in $kg/m^3$ exceeded 5% of the time (otherwise known as the $95^{th}$ percentile) across the region as well as the total deposition/sedimentation depth/thickness resulting from the dredging activities. The statistics were conducted over the entire dredging period (approximately 5 months for Cable Route 2 and 8 months for Cable Route 1).

The mean and $95^{th}$ percentile concentrations are presented for Route 2 in Figure 5-31 and Figure 5-32 and for Route 1 within Figure 5-33 and Figure 5-34.

Suspended sediment concentrations within the trenching area of the Cable Route 1 are, on average, anticipated to meet ambient water quality objectives (33 mg/l), however within a minority of conditions (i.e. <5% of the time) the area exceeding the ambient water quality objective is predicted to spread over 5 km to the south-west. Suspended sediment generation rate within this area is relatively limited due to the small volume being trenched and backfilled, and the relatively small size of the equipment conducting the work. The sediment being dredged within the area is also relatively high in silt content, increasing the potential for suspended sediment to remain suspended within the water column for longer period of time before settling on the seabed. Low current speeds within the area of interest greatly reduce suspended sediment dispersion and dilution. The shadow created by the Jebel Dhana headland creates a relatively slack area where sediment dispersion is not optimal.

The potential for suspended sediment generation within Cable Route 2 trenching area is greater than that for Cable Route 2, due to the longer length of cable route that requires trenching, and the requirement to dredge a navigation/floating channel to allow access of the cable lay vessel, and the use of two disposal areas. Although sediment generation is larger, current speeds are generally significantly higher in this area, particularly within the shallow areas which require substantial dredging for the navigation/floating channels. The higher currents aid dispersion in two ways, first they will generally increase the dilution rate of any dispersed sediment, but also by ensuring that the sediment being dredge is of a larger particle size due to natural erosion processes. Mean TSS concentrations, when averaged throughout the entire 8 month programme, are anticipated to be below AWQOs, however for a minority of the time (<5%) an areas of approximately 5-10 $km^2$ may exceed AWQOs within the proximity of the dredging of the navigation/floatation channel.

The trenching and backfilling involved within the construction programme for both Cable Routes 1 & 2, are sparsely spread both temporally (occurring over 5 months and 8 months respectively) and spatially (consisting of a very narrow (Figure 4-14) dredge cross section over a long overall length). Due to this sparsity in activities, the statistical analysis of concentrations (e.g. mean and $95^{th}$ percentile) may be considered too optimistic when looking at the potential for significant exceedance in AWQOs. Therefore Figure 5-35 and Figure 5-36 present the area within which a certain number of days are expected to exceed AWQOs. Exceedances within the AOI for Cable Route 2 are expected to occur for over two weeks, whereas within Cable Route 1 AOI, exceedance is generally limited to less than one week, likely due to the faster mixing processes associated with higher current speeds.

In the immediate areas surrounding the dredging activities, high dropout rates of course material (coarse and medium sand particles) are predicted and is likely to cause deposition in the vicinity near the dredger.

However, although a large volume of the dredged material is relatively course, certain areas do contain fine fractions which may spread further afield and deposit on sensitive habitats.

The deposition depth associated with the dredging activities along Cable Route 2 are presented within Figure 5-37. Although sediment within the area does contain a fair fraction of silt, the limited currents speeds within the area general restrict dispersion of suspended sediment, therefore deposition depth is generally limited to < 1mm, with the area of deposition greater than 1 mm extending over approximately 2 $km^2$.

Depositions associated with the trenching and navigation/floating channel within Cable Route 1 AOI is generally larger. This is likely due to the larger volume of work, the fact that disposal areas will be used, and the higher current speeds increasing dispersion. The area where deposition is predicted to be greater than 1 mm is anticipated to cover approximate 40 $km^2$, whereas the area where deposition is anticipated greater than 5 mm is anticipated to cover approximately 15 $km^2$.

Video output of the dredging activities are included in Appendix B.

**Figure 5-31 –Cable Route 2 – Mean TSS Concentration**

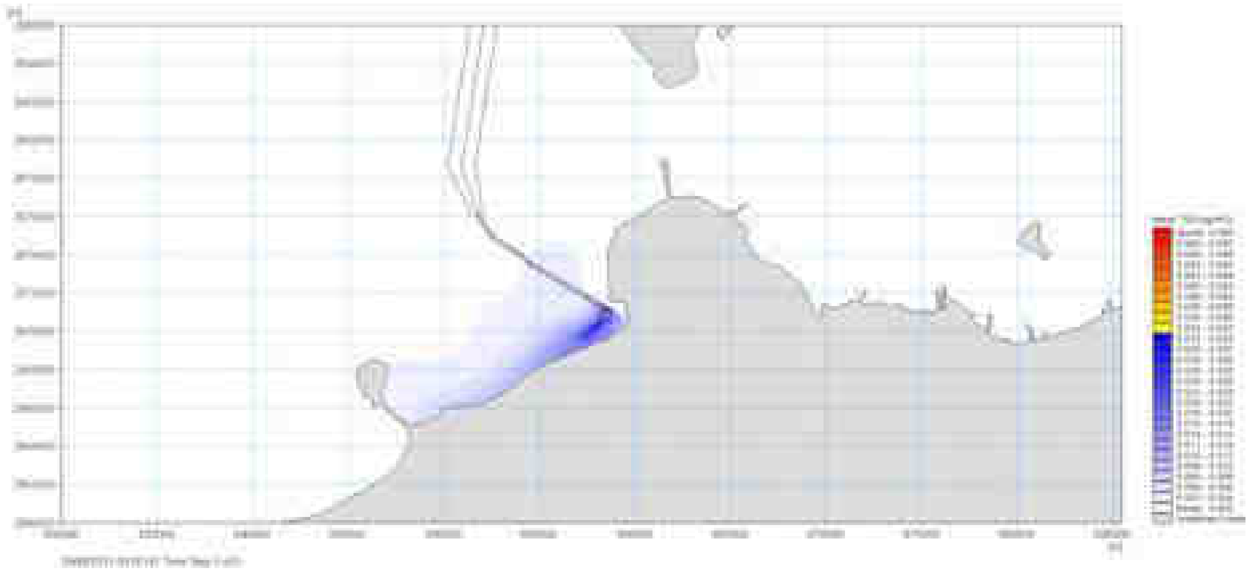


**Figure 5-32 – Cable Route 2 - 95th Percentile TSS Concentration**

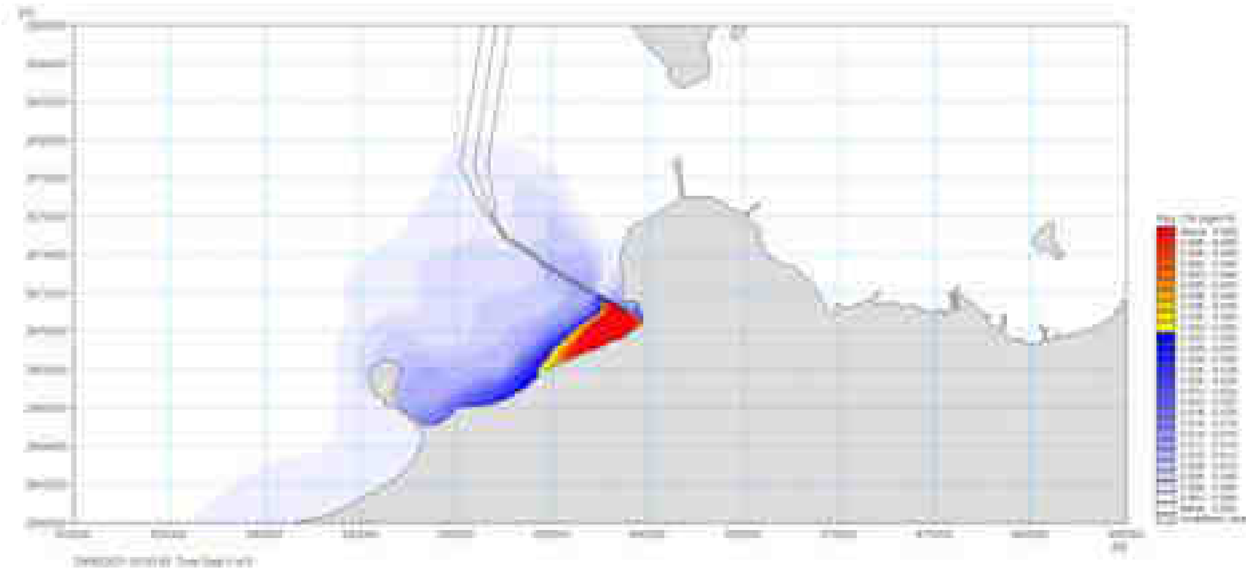


**Figure 5-33 – Cable Route 1 – Mean TSS Concentration**

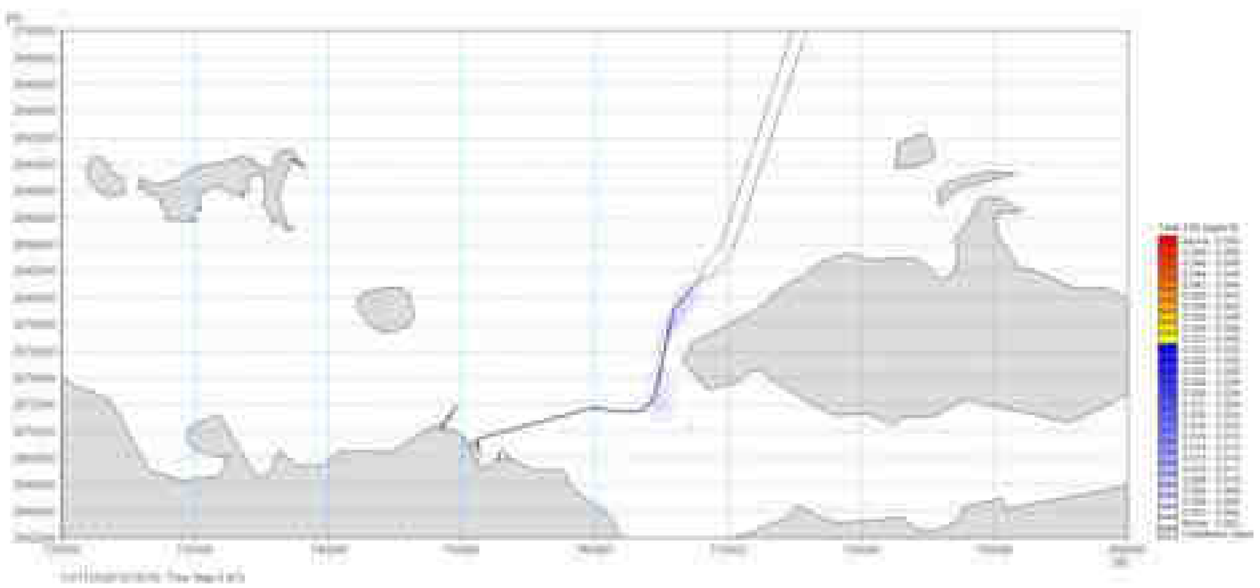


**Figure 5-34 – Cable Route 1 – 95th Percentile TSS Concentration**

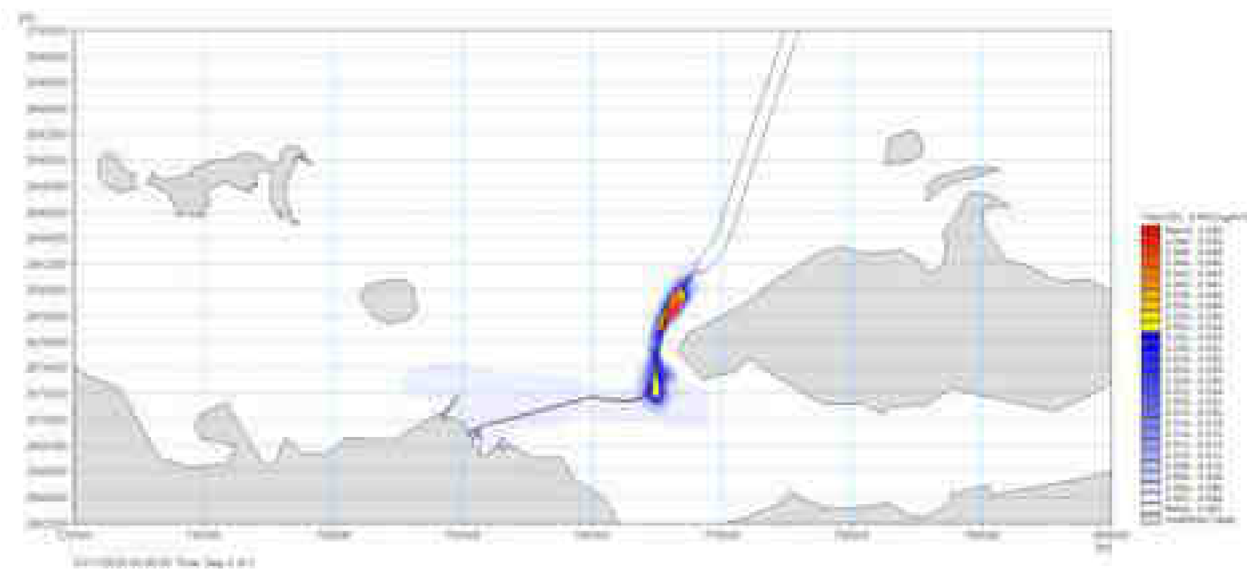


**Figure 5-35 – Cable Route 2 – Days Exceeding TSS AWQO (33 mg/l)**

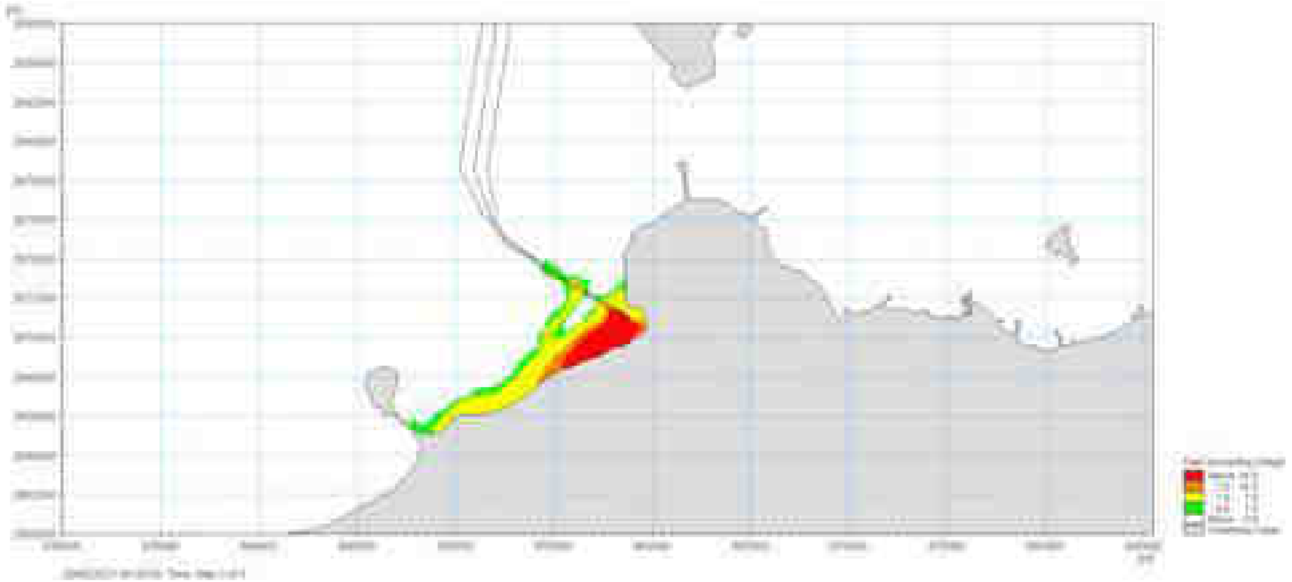


**Figure 5-36 – Cable Route 1 – Days Exceeding TSS AWQO (33mg/l)**

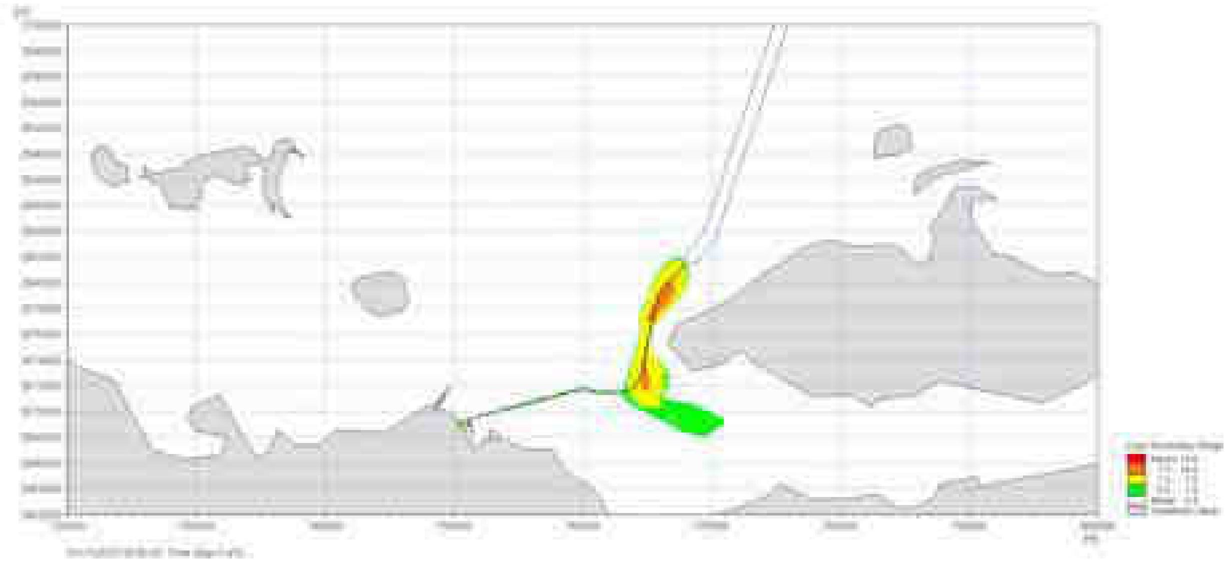


**Figure 5-37 - Cable Route 2 - Cumulative Deposition Depth**

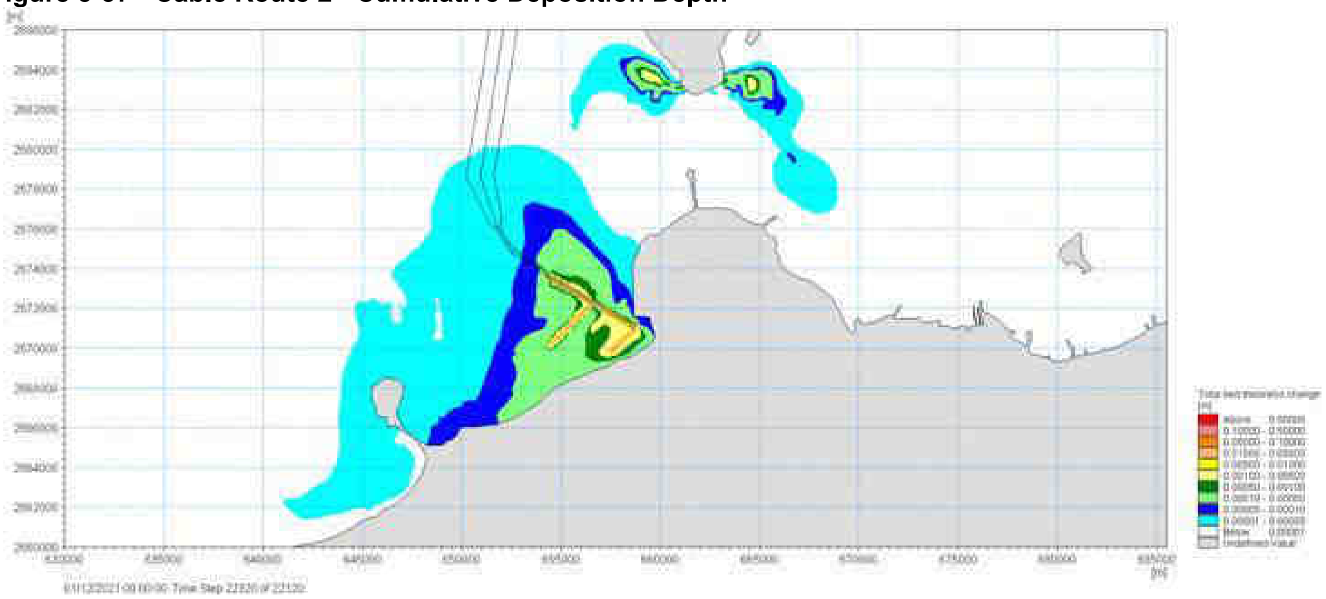
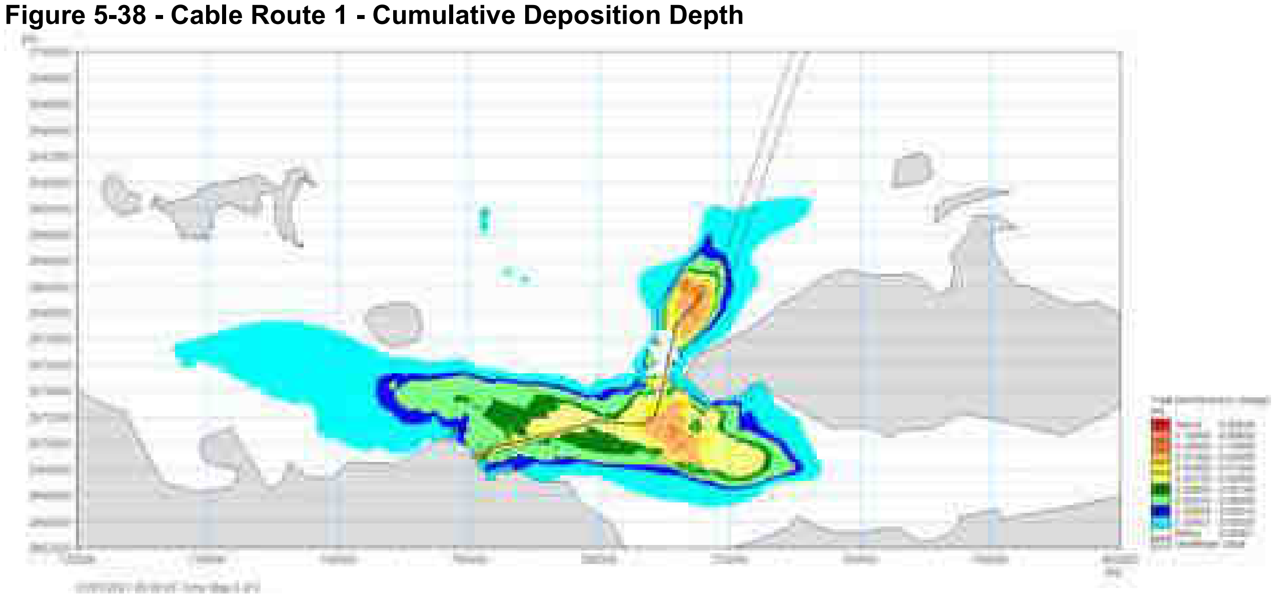


**Figure 5-38 - Cable Route 1 - Cumulative Deposition Depth**



# 6 Summary and Conclusions

## 6.1 Overview

WKC Environment Consultancy (WKC) has been contracted by Anthesis to undertake a hydrodynamic modelling sediment plume dispersion assessment as part of the Environmental Impact Assessment (EIA) for the proposed Project Lightning power utilities venture (the "Project") located in Abu Dhabi, United Arab Emirates (UAE).

The objective of the study is to determine whether increased suspended sediment concentration during dredging activities and the associated deposition of fine sediment may cause adverse impacts to the marine environment.

## 6.2 Hydrodynamics

The hydrodynamics of the project area were simulated utilising the MIKE21 HD FM model, driven by meteorological data from CFSR and tidal constituent amplitude and phase predictions sourced from the DTU10 global ocean tide model from the Technical University of Denmark.

Currents speeds within the two areas of interest are variable both within the domain and between Cable Routes 1 & 2 domains, being generally higher at the Cable Route 1 location. Currents within both the areas of interest are complicated by nearby islands and shoals creating both restricted channels with high current speeds and sheltered areas with limited tide or wind driven currents.

The tides are generally of a mixed diurnal and semi-diurnal nature. The current velocities within the project area are largely driven by the flood and ebb tidal events with some influence from wind effects (due to the predominant north-westerly wind direction).

Validation was conducted again data obtained at four locations using ADCPs. Validation of the hydrodynamics was considered to be very good to excellent.

## 6.3 Dredging Assessment

Two dredging scenarios were simulated within separate domains to take into account proposed trenching, backfilling and dumping methods for the proposed cable 1 & 2. These simulations were conducted to predict turbidity concentrations and deposition patterns during the dredging activities that are proposed for the cable routes.

Suspended sediment concentrations within the trenching area of Cable Route 2 are, on average (over 5 months), anticipated to meet ambient water quality objectives (33 mg/l), however within a minority of conditions (i.e. <5% of the time) the area exceeding the ambient water quality objective is predicted to spread over 5 km to the south-west. Mean TSS concentrations within Cable Route 1 area of interest, when averaged throughout the entire 8-month programme, are anticipated to be below AWQOs, however for a minority of the time (<5%) an area of approximately 5-10 $km^2$ may exceed AWQOs within the proximity of the dredging of the navigation/floatation channel.

The deposition depth associated with the dredging activities along Cable Route 2 is generally limited to < 1mm, with the area of deposition greater than 1 mm extending over approximately 2 $km^2$. Depositions associated with the trenching and navigation/floating channel within Cable Route 1 area of interest is predicted to be greater than 1 mm cover approximately 40 $km^2$, whereas the area where deposition is anticipated greater than 5 mm is anticipated to cover approximately 15 $km^2$.

## 6.4 Recommendations

It is recommended that silt curtains are employed as this will help limit any sediment transport away from the dredged areas and will help mitigate and impacts brought about by the dispersion of the sediment plumes on the water quality and any ecological receptors in the area. Silt curtains are an effective method in significantly reducing the transportation of fine sediment during dredging and reclamation activities.

It is further recommended that real time WQ (turbidity) monitoring take place during dredging activities as a further mitigation measure whereby dredging would be stopped once TSS levels are exceeded during dredging operations.

# 7 References

[1] E. Environemnt Agency Abu Dhabi, “Technical Guidance for Hydrodynamic Modelling,” EAD, Abu Dhabi.

[2] E. Environment Agency Abu Dhabi, “Technical Guidance for Dredging and Reclamation,” EAD, Abu Dhabi.

[3] “Council of Ministers Decree No. 37 of 2001 - Regulation for the Protection of the Maritime Environment,” UAE Cabinet, 2001.

[4] “Council of Ministers Decree No. 23 of 2001 - Concerning the protection of ports, shore, and maritime territory from oil pollution incidents,” UAE Cabinet, 2001.

[5] QCC, “Ambient Marine Water and Sediments Specifications,” **Abu Dhabi QCC,** 2017.

[6] QCC, “Environment Specifications for Land Based Liquid Discharges to Marine Environment,” **Abu Dhabi QCC,** 2017.

[7] “Technical Guidance Document for Standards and Limits for Pollution ato Air and Marine Environments, Occupational Exposure, Pesticides and Chemical Use,” Environment Agency Abu Dhabi, Abu Dhabi, 2014.

[8] O. B. A. Yongcum Cheng, “Improvement of Global Ocean Tide Models in Shallow Water Regions,” in **Ocean Surface Topography Science Team Meeting**, Lisbon, 2010.

[9] S. Saha et al, “The NCEP Climate Forecast System Reanalysis,” **Bulletin of the American Meteorological Society,** vol. 97, pp. 1015 - 1057, 2010.

[10] UKHO, “British Admiralty Chart 3715,” Admiralty Charts & Publications, 2017.

[11] Fugro, “Geophysical, Geotechnical and Environamental Baseline Surveys for Subsea Cable Routes,” FUgro, Abu Dhabi, 2020.

[12] Global Environmental Modelling Systems, “Grange Resources, Albany Port Authority, Port Development, Oceanographic Studies and Dredging Program Simulation Studies,” CSIRO, Albany, 2007.

[13] Fugro, “E-0395 Lightning Project, Geotechnical Factual Report - Common Corridor (Route-2, Route-2A & route-2B) Between Shuweihat and Das Island,” 2020.

[14] L. Chanson and T. H., “Numerical Limitations of Hydraulic Models,” in **IAHR World Congress - Balance and Uncertainty**, Brisbane, 2011.

[15] C. J. Wilmott, “Some comments on the evaluation of model performance,” Centre for Climatic Research, University of Delaware, Delaware, 1982.

[16] J. W. D. C. T. V. R. L. a. S. J. Sutherland, “Evaluation of Costal Area Modelling Systems at an Estury Mouth,” **Coastal Engineering: An International Journal for Coastal Harbour and Offshore Engineering,** vol. 51, pp. 119-142, 2003.

# Appendix A - Hydrodynamic Modelling Results

# Appendix B - Dredging Results

# Appendix 2.2 – Nautica Environmental Baseline Surveys

Anthesis

*Appendix 2.2.1 – Mirfa Landfall Terrestrial Ecology Survey Report*

MOTT MACDONALD

# ADNOC Lightning Project
# Mirfa Landfall
# Terrestrial Ecology Survey Report

NEA Reference: N684-0621-MIR-1.1 dated September 2021

NAUTICA Environmental Associates LLC

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|---|---|
| Cover: | White-eared Bulbuls, *Phycnonotus leucotis*. |
| Credits: | Plates ©NEA, unless otherwise credited. |

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## 1.0 Background and Survey Conduct

### 1.1 Background

Mott MacDonald (MM), on behalf of the Abu Dhabi National Oil Company (ADNOC), has commissioned Nautica Environmental Associates LLC (NEA), an Abu Dhabi based environmental consultancy, to conduct environmental surveys at three landfall locations for the ADNOC Lightning Project, namely Mirfa, Shuweihat and Das Island.

This document relates to the field elements conducted at Mirfa and provides the results from the survey undertaken at that location.

### 1.2 Survey Scope and Conduct

#### 1.2.1 Scope

The scope included evaluations of the following, along landfall pipeline footprints, as shown in Figure 1:

- Evaluation of habitats and associated species.
- Ambient noise measurements, over weekend and week-day periods.
- Soil and groundwater sampling and analysis to evaluate possible contamination.

#### 1.2.2 Conduct

The field elements were conducted over 6 days, between 04 and 31 May 2021, at Mirfa, as shown in Table 1. A minimum of two NEA staff were on-site, supported by NEA 4x4 vehicle.

Surveys were conducted using a combination of walkover and vehicle drive throughs of the site location, deploying camera traps and noise meters, and undertaking soil sampling, where deemed appropriate.

Additionally, at certain locations within the Plot, in order to provide additional photographic records of habitat and general conditions, cardinal point photographs were taken (North, South, East and West). Camera traps were deployed for a minimum of one overnight period (≥12 hours).

Table 1 provides an overview of site visits and activities undertaken by NEA specialists during the ecological survey. Figure 1 shows a map of the survey area with camera trap and noise meter locations. Figure 2 shows a habitat map of the area (see Annex A for records). Figure 3 shows cardinal point locations where photographic documentation of the area from fixed locations has been taken and provided in Annex

C. Figure 4 shows locations of points of interest (waypoints), detailed in Table 2 and discussed in subsequent sections. Figure 5 shows the track map of NEA staff movements across the area.

In the current circumstances, COVID-19 mitigation involved NEA field scientists wearing full eye and nose/mouth masks, with gloves, when travelling to/from and when on-site (Plate 1).

Table 1: Survey Field Visits

| Day | Date | Survey Activity | NEA Staff |
|---|---|---|---|
| 1 | 19.05.2021 | Survey planning and Preparation | RP, AM, PM, BC |
| 2 | 20.05.2021 | Survey walkover & Trap/Meter deployment | RP, AM, PM |
| 3 | 21.05.2021 | Survey walkover | RP, AM, PM |
| 4 | 22.05.2021 | Trap retrieval | RP, AM, PM |
| 5 | 24.05.2021 | Noise Monitoring | RP, AM |
| 6 | 31.05.2021 | Noise Monitoring | RP, AM |

Table Key: RP = Ross Pappin / AM = Aneeta Mathew / PM = Paulo Mendoza / BC = Bonnie Corneta

Plate 1: NEA Environmental Technician using soil augur on site wearing PPE

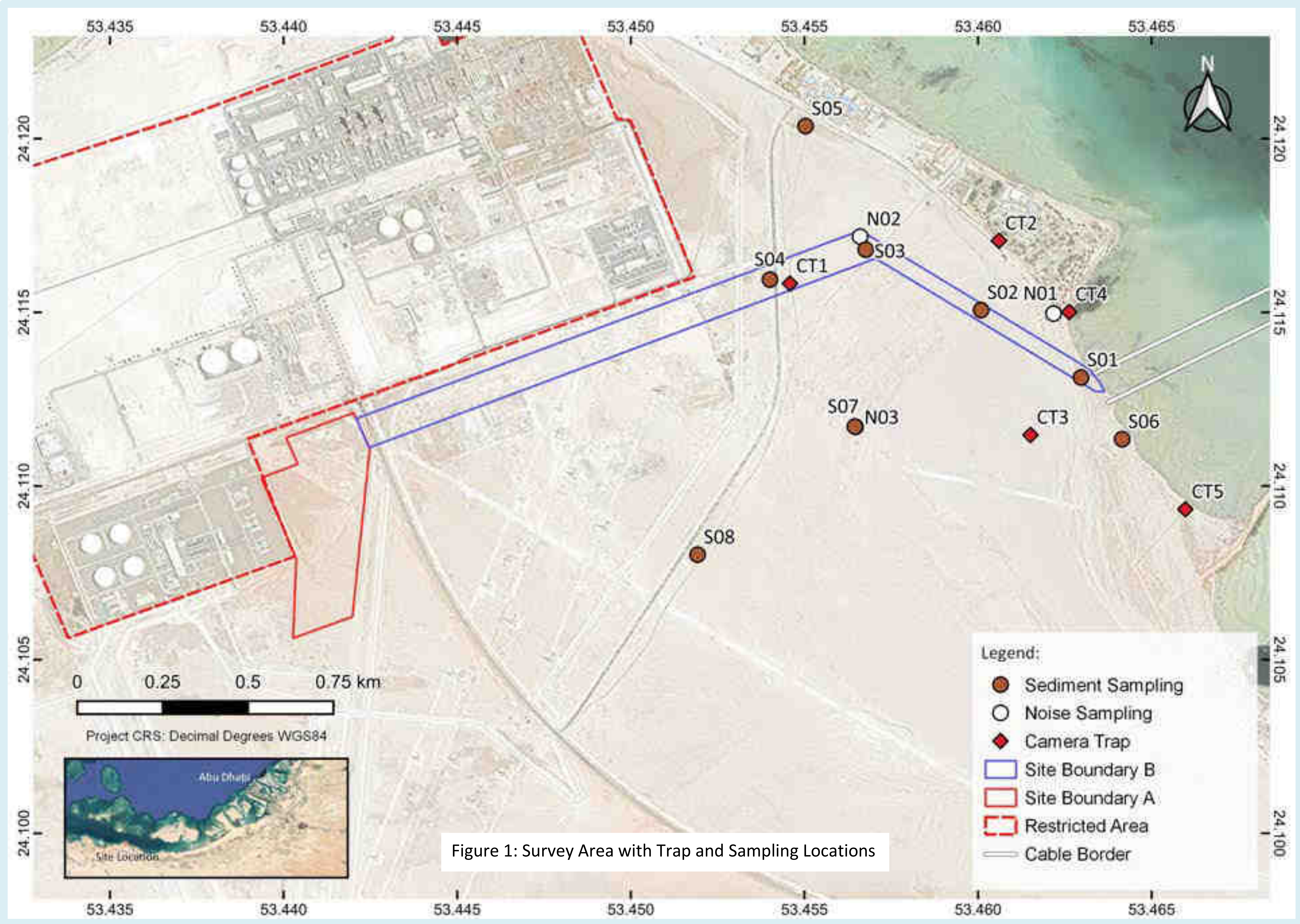

Figure 1: Survey Area with Trap and Sampling Locations

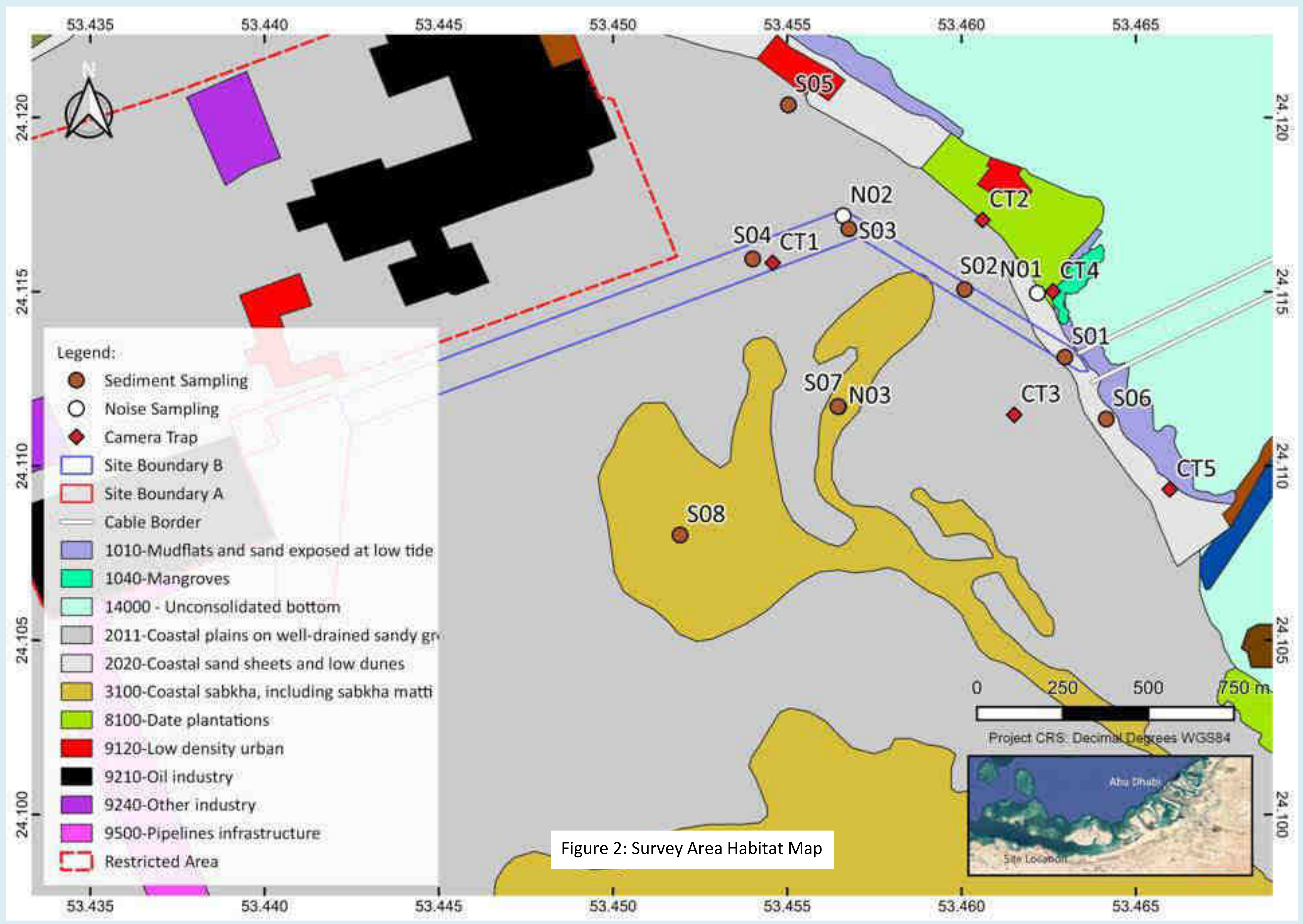


Figure 2: Survey Area Habitat Map

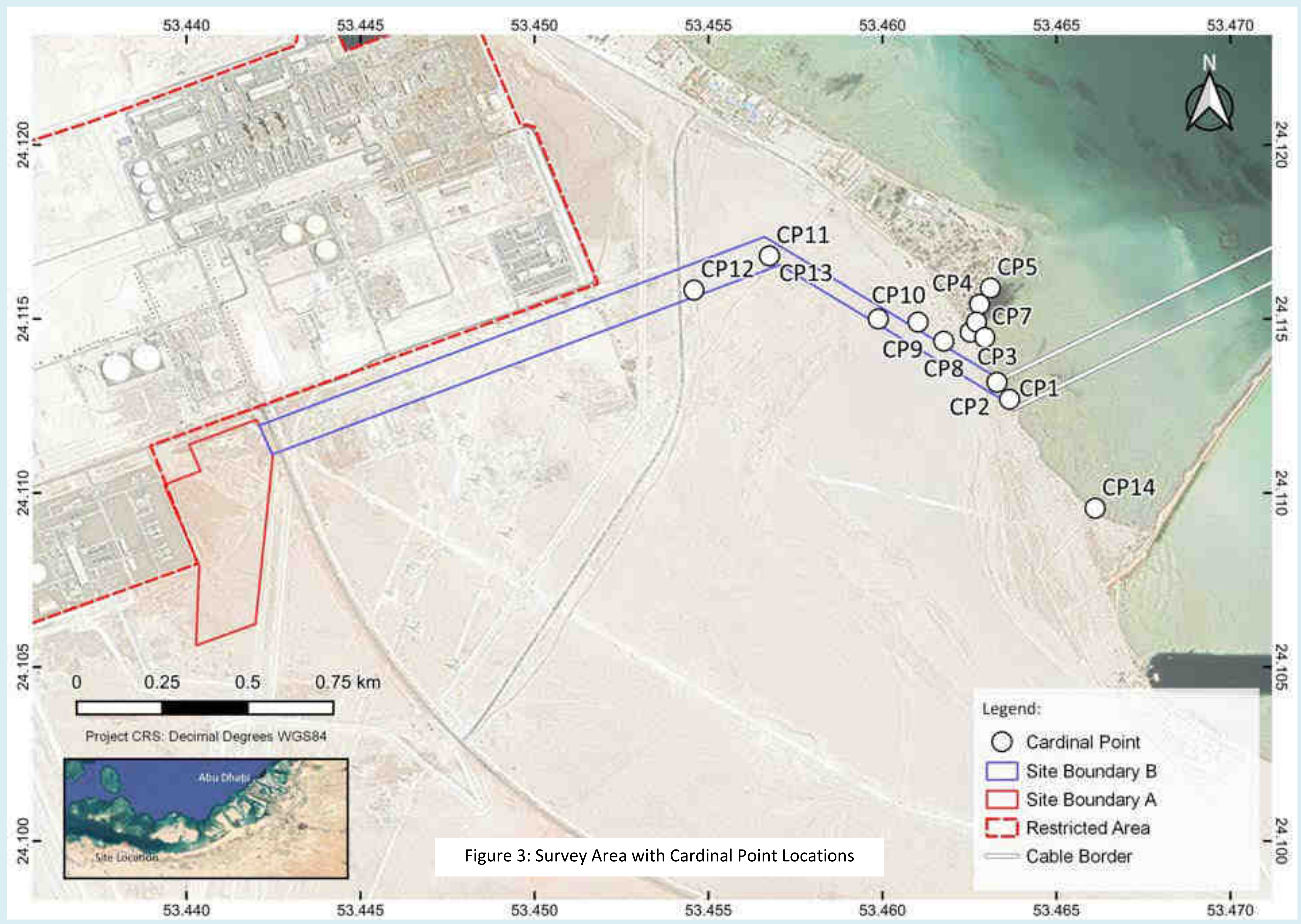


Figure 3: Survey Area with Cardinal Point Locations


Figure 4: Survey Area with Points of Interest

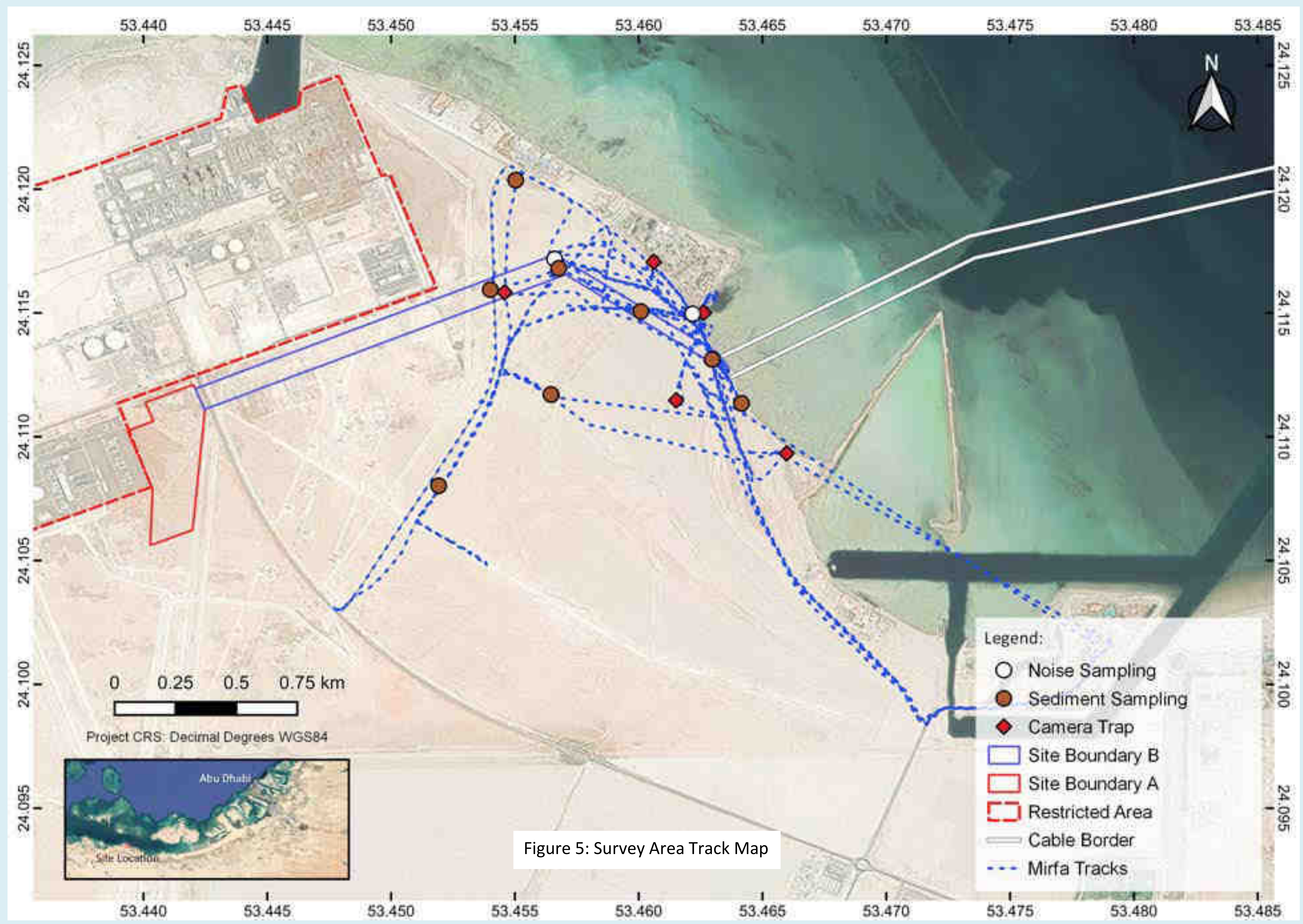


Figure 5: Survey Area Track Map

| Table 2: Mirfa Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude (N) | Longitude (E) | Notes |
| N01 | Noise Sampling | 21/05/2021 | 06:46 | 15min | 24.114964 | 53.46217196 | NA |
| N02 | Noise Sampling | 21/05/2021 | 07:48 | 15min | 24.11718101 | 53.45660102 | NA |
| N03 | Noise Sampling | 21/05/2021 | 08:13 | 15min | 24.11170201 | 53.456468 | NA |
| S01 | Sediment Sampling | 20/05/2021 | 15:20 | NA | 24.113124 | 53.46296397 | NA |
| S02 | Sediment Sampling | 20/05/2021 | 16:35 | NA | 24.115064 | 53.46008504 | NA |
| S03 | Sediment Sampling | 20/05/2021 | 16:55 | NA | 24.116805 | 53.45676304 | NA |
| S04 | Sediment Sampling | 20/05/2021 | 17:25 | NA | 24.115942 | 53.45400397 | NA |
| S05 | Sediment Sampling | 21/05/2021 | 18:36 | NA | 24.12036102 | 53.45502899 | NA |
| S06 | Sediment Sampling | 21/05/2021 | 11:53 | NA | 24.11134796 | 53.464148 | NA |
| S07 | Sediment Sampling | 21/05/2021 | 16:57 | NA | 24.11170998 | 53.45644997 | NA |
| S08 | Sediment Sampling | 21/05/2021 | 18:12 | NA | 24.10802202 | 53.45192098 | NA |
| CP1 | Cardinal Point | 21/05/2021 | 10:21 | NA | 24.11269 | 53.46365 | NA |
| CP2 | Cardinal Point | 21/05/2021 | 10:27 | NA | 24.11318 | 53.46329 | NA |
| CP3 | Cardinal Point | 21/05/2021 | 10:38 | NA | 24.11462 | 53.46252 | NA |
| CP4 | Cardinal Point | 21/05/2021 | 10:47 | NA | 24.11542 | 53.46279 | NA |

| Table 2: Mirfa Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude (N) | Longitude (E) | Notes |
| CP5 | Cardinal Point | 21/05/2021 | 11:00 | NA | 24.11589 | 53.4631 | NA |
| CP6 | Cardinal Point | 21/05/2021 | 11:08 | NA | 24.11491 | 53.4627 | NA |
| CP7 | Cardinal Point | 21/05/2021 | 11:12 | NA | 24.11447 | 53.46294 | NA |
| CP8 | Cardinal Point | 21/05/2021 | 12:12 | NA | 24.11436 | 53.46176 | NA |
| CP9 | Cardinal Point | 21/05/2021 | 12:18 | NA | 24.11491 | 53.46102 | NA |
| CP10 | Cardinal Point | 21/05/2021 | 12:19 | NA | 24.115 | 53.45988 | NA |
| CP11 | Cardinal Point | 21/05/2021 | 12:26 | NA | 24.11681 | 53.45675 | NA |
| CP12 | Cardinal Point | 21/05/2021 | 12:28 | NA | 24.11583 | 53.45458 | NA |
| CP13 | Cardinal Point | 21/05/2021 | 20:29 | NA | 24.11681 | 53.45675 | NA |
| CP14 | Cardinal Point | 22/05/2021 | 09:21 | NA | 24.10956 | 53.46611 | NA |
| CT1 | Camera Trap | 21/05/2021 | 20:54 | 12hrs | 24.11583 | 53.45458 | Arabian Red Fox & Feral Cat |
| CT2 | Camera Trap | 21/05/2021 | 21:01 | 12hrs | 24.11706 | 53.4606 | Nothing captured |
| CT3 | Camera Trap | 21/05/2021 | 21:07 | 12hrs | 24.11147 | 53.46151 | Cheesman's Gerbil |
| CT4 | Camera Trap | 21/05/2021 | 21:18 | 12hrs | 24.11501 | 53.46262 | Arabian Red Fox & Feral Cat |
| CT5 | Camera Trap | 21/05/2021 | 21:26 | 12hrs | 24.10933 | 53.46597 | Nothing captured |

| Table 2: Mirfa Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude (N) | Longitude (E) | Notes |
| WPT1 | Handheld GPS | 21/05/2021 | 10:20 | NA | 24.11266 | 53.46355 | Western Reef Heron |
| WPT2 | Handheld GPS | 21/05/2021 | 10:20 | NA | 24.11264 | 53.46371 | Kentish Plover × 6 |
| WPT3 | Handheld GPS | 21/05/2021 | 10:21 | NA | 24.11269 | 53.46365 | Cardinal Point 1 |
| WPT4 | Handheld GPS | 21/05/2021 | 10:23 | NA | 24.11279 | 53.46353 | Arabian Red Fox tracks |
| WPT5 | Handheld GPS | 21/05/2021 | 10:25 | NA | 24.11288 | 53.46344 | Cat tracks |
| WPT6 | Handheld GPS | 21/05/2021 | 10:26 | NA | 24.11287 | 53.46347 | Fox scats |
| WPT7 | Handheld GPS | 21/05/2021 | 10:27 | NA | 24.113 | 53.46337 | Large bird tracks (Grey Francolin?) |
| WPT8 | Handheld GPS | 21/05/2021 | 10:27 | NA | 24.11318 | 53.46329 | Cardinal Point 2 |
| WPT9 | Handheld GPS | 21/05/2021 | 10:30 | NA | 24.11335 | 53.46308 | Trash |
| WPT10 | Handheld GPS | 21/05/2021 | 10:33 | NA | 24.11294 | 53.46315 | Small bird tracks (House Sparrow?) |
| WPT11 | Handheld GPS | 21/05/2021 | 10:37 | NA | 24.11411 | 53.46258 | Lesser Sand Plover × 2 |
| WPT12 | Handheld GPS | 21/05/2021 | 10:38 | NA | 24.11462 | 53.46249 | Kentish Plover × 2 |
| WPT13 | Handheld GPS | 21/05/2021 | 10:38 | NA | 24.11462 | 53.46252 | Cardinal Point 3 |
| WPT14 | Handheld GPS | 21/05/2021 | 10:45 | NA | 24.11547 | 53.46272 | Eurasian Collared Dove |
| WPT15 | Handheld GPS | 21/05/2021 | 10:47 | NA | 24.11542 | 53.46279 | Cardinal Point 4 |

| Table 2: Mirfa Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude (N) | Longitude (E) | Notes |
| WPT 16 | Handheld GPS | 21/05/2021 | 10:53 | NA | 24.11551 | 53.46303 | House Sparrow × 6 |
| WPT17 | Handheld GPS | 21/05/2021 | 10:58 | NA | 24.11564 | 53.46309 | Asian Dwarf Honey Bee × 100+ |
| WPT18 | Handheld GPS | 21/05/2021 | 11:00 | NA | 24.11589 | 53.4631 | Cardinal Point 5 |
| WPT19 | Handheld GPS | 21/05/2021 | 11:01 | NA | 24.11555 | 53.46298 | White- eared Bulbul |
| WPT20 | Handheld GPS | 21/05/2021 | 11:02 | NA | 24.11553 | 53.46302 | Bean Caper |
| WPT21 | Handheld GPS | 21/05/2021 | 11:03 | NA | 24.11558 | 53.46305 | Greater Hoopoe-lark |
| WPT22 | Handheld GPS | 21/05/2021 | 11:06 | NA | 24.11506 | 53.46275 | Mottled Crab |
| WPT23 | Handheld GPS | 21/05/2021 | 11:08 | NA | 24.11491 | 53.4627 | Cardinal Point 6 |
| WPT24 | Handheld GPS | 21/05/2021 | 11:12 | NA | 24.11447 | 53.46294 | Cardinal Point 7 |
| WPT25 | Handheld GPS | 21/05/2021 | 11:14 | NA | 24.11415 | 53.46285 | House Sparrow × 4 |
| WPT26 | Handheld GPS | 21/05/2021 | 12:05 | NA | 24.11355 | 53.4628 | Common Greenshank |
| WPT27 | Handheld GPS | 21/05/2021 | 12:12 | NA | 24.11436 | 53.46176 | Cardinal Point 8 |
| WPT28 | Handheld GPS | 21/05/2021 | 12:18 | NA | 24.11491 | 53.46102 | Cardinal Point 9 |
| WPT29 | Handheld GPS | 21/05/2021 | 12:19 | NA | 24.115 | 53.45988 | Cardinal Point 10 |
| WPT30 | Handheld GPS | 21/05/2021 | 12:22 | NA | 24.11501 | 53.45984 | Pile of debris |

| Table 2: Mirfa Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude (N) | Longitude (E) | Notes |
| WPT31 | Handheld GPS | 21/05/2021 | 12:24 | NA | 24.11618 | 53.4582 | Pile of debris |
| WPT32 | Handheld GPS | 21/05/2021 | 12:26 | NA | 24.11681 | 53.45675 | Cardinal Point 11 |
| WPT33 | Handheld GPS | 21/05/2021 | 12:28 | NA | 24.11583 | 53.45458 | Cardinal Point 12 |
| WPT34 | Handheld GPS | 21/05/2021 | 20:26 | NA | 24.11514 | 53.46073 | Arabian Toad-headed Agama |
| WPT35 | Handheld GPS | 21/05/2021 | 20:27 | NA | 24.11493 | 53.46139 | White-eared Bulbul |
| WPT36 | Handheld GPS | 21/05/2021 | 20:29 | NA | 24.1144 | 53.46255 | Cardinal Point 13 |
| WPT37 | Camera Trap | 21/05/2021 | 20:54 | 12hrs | 24.11581 | 53.46291 | Camera Trap 1 |
| WPT38 | Camera Trap | 21/05/2021 | 21:01 | 12hrs | 24.11706 | 53.4606 | Camera Trap 2 |
| WPT39 | Camera Trap | 21/05/2021 | 21:07 | 12hrs | 24.11147 | 53.46151 | Camera Trap 3 |
| WPT41 | Handheld GPS | 21/05/2021 | 21:10 | NA | 24.11147 | 53.4615 | Cheesman's Gerbil Burrow |
| WPT42 | Camera Trap | 21/05/2021 | 21:18 | 12hrs | 24.11501 | 53.46262 | Camera Trap 4 |
| WPT43 | Camera Trap | 21/05/2021 | 21:26 | 12hrs | 24.10933 | 53.46597 | Camera Trap 5 |
| WPT44 | Handheld GPS | 22/05/2021 | 09:21 | NA | 24.10956 | 53.46611 | Cardinal Point 14 |
| WPT45 | Handheld GPS | 22/05/2021 | 09:55 | NA | 24.11503 | 53.46206 | *Heliotropium kotschyi* |
| WPT46 | Handheld GPS | 22/05/2021 | 10:03 | NA | 24.11367 | 53.46282 | Eurasian Curlew |

| Table 2: Mirfa Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude (N) | Longitude (E) | Notes |
| WPT47 | Handheld GPS | 22/05/2021 | 10:05 | NA | 24.11271 | 53.46354 | Kentish Plover × 3 |
| WPT48 | Handheld GPS | 22/05/2021 | 10:15 | NA | 24.11526 | 53.46259 | Laughing Dove |
| WPT49 | Handheld GPS | 24/05/2021 | 19:33 | NA | 24.11494 | 53.46224 | Grey Francolin × 3 |
| WPT50 | Handheld GPS | 31/05/2021 | 07:04 | NA | 24.11597 | 53.46015 | Red-wattled Lapwing nest (Eggs × 4) |
| WPT51 | Handheld GPS | 31/05/2021 | 09:28 | NA | 24.11478 | 53.46227 | Osprey |

Table Key:

NA = Not Applicable

CT = Camera Trap

CP = Cardinal Point

ID = Site ID

min = Minute(s)

Lat + Long in Decimal Degrees WGS84

WPT = Waypoint

## 2.0 Methodology

### 2.1 Noise Measurements

Baseline noise measurements were carried out at three sites at the Mirfa location and included both weekday and weekend measurement periods. Measurements at each site were carried out for 15-minutes and repeated for day and night-time (total of four measurements per site). Surveys were undertaken in parallel with ongoing ecological surveys of the location.

Measurements were collected using a bench and field-calibrated Rion NL-52 integrating Class 1 (IEC 61672-2002) sound level meter, with data stored on the device's internal memory as well as on detailed field-sheets. Measurement locations were chosen to minimise reflective phenomena or interruptive weather conditions in accordance with ISO1996-1:2016.

Reported parameters included maximum and average noise levels as well identification of specific sound events where feasible and were reflective of the characteristics of the ambient noise environment and nature of the project.

- Measurements Overview:
    - 15-minutes each site (day/night/weekday/weekend).
    - Total 1 hour per site.
    - Total 3 hours at location.
- Parameters:
    - $L_{Aeq}$, $L_{AMax}$, $L_{A10}$, $L_{A50}$, $L_{A90}$.

Plate 2: Noise meter deployed on location

## 2.2 Soil and Groundwater Inspection and Analysis

A visual survey of the surface for any signs of contamination was conducted in parallel with ecological and noise survey data collections at the location.

Where visible contamination was identified, a GPS waypoint will be collected. For large areas, a tracked path was walked around the edge, using the GPS tracklog to map the extent of contamination.

All identified instances were reported with accompanying geo-referenced photographs.

8 soil samples were collected by hand augur along the cable corridor (see Figure 1) and analysed at an ENAS accredited laboratory. Data is provided in Annex B.

No groundwater samples were collected, as there were no sources within or near to the survey footprint.

Plate 3: NEA scientist using soil augur on location (NEA File Photo)

## 2.3 Ecology Survey Methodology

Field activities involved day-time drive-over and walkabouts in selected areas, with one overnight trapping effort involving deployment of Bushnell camera traps (Plate 3) at selected locations. Figure 1 details trap and photo locations.

Bushnell camera traps were deployed at locations considered potentially suitable for mammal and/or reptile activity, such as near burrows or in areas of particularly dense vegetation and/or visible track activity.

Binoculars were also used to help find and identify bird species within the area and where possible, high-definition pictures were taken and have been used in this report, where deemed appropriate.

All photos displayed in this report were taken on location unless otherwise stated (NEA File Photo).

Plate 4: Recording gecko tracks in sand

Plates 5 & 6:  Camera Trap deployed on location (top); domestic cat recorded on location (bottom)

## 3.0 Survey Results

### 3.1 Noise Measurement Analysis

A baseline survey was conducted in the area of the proposed landfall, including three separate locations, with four fifteen-minute measurements each, representative of residential noise receptors, such as those to the north of the alignment. The locations of the noise measurement station (N01-N03) are shown in Figure 1.

The combined measurement period at each location was 1 hour, representing weekday, weeknight, weekend day and weekend night time periods. The aim of the noise measurements is to provide an indication of existing ambient conditions as well as to identify any significant anthropogenic noise sources which may affect any subsequent assessments of noise. Measurements were collected using a bench- and field-calibrated Rion NL-52 integrating Class 1 (IEC 61672-2002) sound level meter (SLM) with data stored on the device's internal memory as well as on detailed field-sheets. The SLM and microphone were field calibrated before and after each measurement to detect and account for any drift in the measured noise levels. Measurement locations were chosen to minimise reflective phenomena or interruptive weather conditions in accordance with ISO1996-1:2016.

#### 3.1.1 Noise Measurement Locations

The Mirfa landfall area would currently be classified as 'residential with light traffic' (day and night-time noise limits of 50 dBA and 40 dBA respectively). The completion of the landfall infrastructure would expectedly result in these areas being reclassified as 'heavy industry' (limits of 70 dBA and 60 dBA respectively), however the infrastructure itself would not likely add to the ambient noise environment and as such, all ambient noise levels have been assessed against the more stringent residential limits for day and night-time periods of 50 dBA and 40 dBA, respectively.

#### 3.1.2 Noise Result and Analysis

A breakdown of measured noise metrics for the measurement sites at the Mirfa landfall is provided in Tables 3, 4 and 5 overleaf.

Only two of the noise measurements exceeded the statutory noise limit for the given period. These were the weeknight noise level at N02 and the weekday period at N03, each exceeding the ambient limit by less than 2 dBA. There is no obvious cause for the increased noise level in either case. Overall, the noise climate of the landfall area is relatively undisturbed by anthropogenic noise. Further, the site is sufficiently removed from the nearest noise sensitive receptor that any increase in noise levels as a result of Project activities are unlikely to affect the overall ambient noise environment in a way which may cause significant impact to residential properties.

| Table 3: Noise measurement metrics for Mirfa Landfall, site N01 | | | | | |
|---|---|---|---|---|---|
| Site | | N01 | | | |
| Period | | Week Day | Week Night | Weekend D | Weekend N |
| $L_{Aeq}$ | dBA | 48.9 | 34.3 | 40.4 | 36.2 |
| $L_{max}$ | dBA | 66.2 | 49.2 | 53.3 | 52 |
| $L_{10}$ | dBA | 52.8 | 35.9 | 43.3 | 37.1 |
| $L_{50}$ | dBA | 47.9 | 33.8 | 39.4 | 36.0 |
| $L_{90}$ | dBA | 43.0 | 33.0 | 36.0 | 35.0 |
| Environmental Conditions | | | | | |
| Average Windspeed | m/s | 1.95 | 1.23 | 3.51 | 0.76 |
| Max Windspeed | m/s | 4.47 | 2.17 | 5.11 | 2.31 |
| Average Temp | °C | 35.6 | 25.2 | 37.4 | 32.3 |
| Average Humidity | % | 64.8 | 91.5 | 40.8 | 75.3 |
| Table Key: | | | | | |
| | Exceeds the relevant ambient noise limit of 50 dBA (daytime) or 40 dBA (night-time) | | | | |
| D = Day / N = Night / dBA = Decibels / m/s = Metres per Second / °C = Degrees Centigrade / % = Percentage | | | | | |

| Table 4: Noise measurement metrics for Mirfa Landfall, site N02 | | | | | |
|---|---|---|---|---|---|
| Site | | N02 | | | |
| Period | | Week Day | Week Night | Weekend D | Weekend N |
| $L_{Aeq}$ | dBA | 36.6 | 41.6 | 36.7 | 31.7 |
| $L_{max}$ | dBA | 46.4 | 49.9 | 47.8 | 53.6 |
| $L_{10}$ | dBA | 37.9 | 42.4 | 39.4 | 32.6 |
| $L_{50}$ | dBA | 36.4 | 41.5 | 36.0 | 30.3 |
| $L_{90}$ | dBA | 35.5 | 40.9 | 33.9 | 29.5 |
| Environmental Conditions | | | | | |
| Average Windspeed | m/s | 2.56 | 1.43 | 4.03 | 1.72 |
| Max Windspeed | m/s | 3.11 | 1.78 | 5.31 | 2.89 |
| Average Temp | °C | 28.4 | 24.2 | 37.7 | 31.5 |

| Table 4: Noise measurement metrics for Mirfa Landfall, site N02 | | | | | |
|---|---|---|---|---|---|
| Site | | N02 | | | |
| Period | | Week Day | Week Night | Weekend D | Weekend N |
| Average Humidity | % | 85.2 | 92.4 | 47.1 | 80.5 |
| Table Key: | | | | | |
| | Exceeds the relevant ambient noise limit of 50 dBA (daytime) or 40 dBA (night-time) | | | | |
| D = Day / N = Night / dBA = Decibels / m/s = Metres per Second / °C = Degrees Centigrade / % = Percentage | | | | | |

| Table 5: Noise measurement metrics for Mirfa Landfall, site N03 | | | | | |
|---|---|---|---|---|---|
| Site | | N03 | | | |
| Period | | Week Day | Week Night | Weekend D | Weekend N |
| $L_{Aeq}$ | dBA | 51.5 | 39.8 | 35.2 | 35.9 |
| $L_{max}$ | dBA | 66.2 | 58.8 | 52.3 | 54.7 |
| $L_{10}$ | dBA | 55.0 | 43.8 | 37.0 | 37.0 |
| $L_{50}$ | dBA | 50.6 | 37.8 | 34.7 | 35.7 |
| $L_{90}$ | dBA | 44.0 | 35.7 | 33.2 | 34.1 |
| Environmental Conditions | | | | | |
| Average Windspeed | m/s | 2.24 | 1.90 | 3.87 | 0.56 |
| Max Windspeed | m/s | 3.39 | 2.50 | 5.11 | 0.92 |
| Average Temp | °C | 30.9 | 24.4 | 35.8 | 29.8 |
| Average Humidity | % | 75.7 | 93.4 | 53.8 | 85.8 |
| Table Key: | | | | | |
| | Exceeds the relevant ambient noise limit of 50 dBA (daytime) or 40 dBA (night-time) | | | | |
| D = Day / N = Night / dBA = Decibels / m/s = Metres per Second / °C = Degrees Centigrade / % = Percentage | | | | | |

## 3.2 Soil Analysis

Soil sampling was undertaken during site visits in May, at eight targeted locations within the survey area via a hand auguring tool to a target depth of 2m below ground level (bgl) or to the depth where bedrock or groundwater was encountered.

The excavated soil was placed on a clean plastic sheet, free from potential contaminants or cross contaminants. The soil samples were sealed and marked and stored in a dedicated sample box for transportation to the laboratory. The coordinates for the monitoring locations are presented in Table 6 and locations are provided in Figure 1.

Table 6: Soil Sampling Locations

| Site ID | Latitude | Longitude | Depth (m) |
|---|---|---|---|
| S01 | 24.1131 | 53.463 | 1.2 |
| S02 | 24.1151 | 53.4601 | 1.0 |
| S03 | 24.1168 | 53.4568 | 1.1 |
| S04 | 24.1159 | 53.454 | 1.0 |
| S05 | 24.1204 | 53.455 | 1.0 |
| S06 | 24.1113 | 53.4641 | 1.4 |
| S07 | 24.1117 | 53.4564 | 1.0 |
| S09 | 24.108 | 53.4519 | 1.0 |

Table Notes: Latitude / Longitude in WGS84 Decimal Degrees / m = Metres

The full results are presented in Table B1, Annex B. The results were compared with the Abu Dhabi Quality and Conformity Council (ADQCC) Environmental Specification for Soil Contamination Soil Limits for Industrial and Commercial use (ADS 19/2017). A copy of the standards is provided at Table B2, Annex B.

Results for all locations/depths where in compliance with the standards and there were no visible signs of soil contamination or significant odour recorded from any location or any sample collected.

## 3.3 Ecological Survey

### 3.3.1 Habitat Overview

The habitat classifications described in this report are defined based on a *priori schema* classification system devised by Brown and Boer in 'Interpretation Manual of the Major Terrestrial Natural and Semi-natural Habitat Types of Abu Dhabi Emirates'. These categories have been expanded by the EAD to include elements of land use and land cover.

NEA was part of a consortium that produced a habitat map for the whole of the emirate of Abu Dhabi, under contract from EAD. The main tool used in mapping was satellite imagery, but with a lot of ground-truthing by NEA. A computer was "trained" to recognise spectral signatures of habitats, and these were then mapped automatically. The accuracy of the map was confirmed by visiting a very large number of pre- selected random points. The distribution of the habitats discussed in this report are shown in Figure 2, which has been taken from the final habitat map for the emirate (which is available on the EAD website).

The latest revision of the Environment Agency Abu Dhabi (EAD) Habitat Map was referred to and was found to be generally accurate for the overall site and larger habitat expanses. However, some habitats, including some considered as critical, are completely absent from the map. The most notable example of a missing habitat is the area of mangroves on the coast to the south-east of the private villa compound.

A couple of habitats identified on-ground cover small areas, that are often interspersed within major habitat-types (such as beach rock within sandy beaches and mudflats) and are therefore absent from the map. It must be noted that the habitat map covers the whole of Abu Dhabi Emirate, so it was necessary to use a Minimum Mapping Unit (MMU) to limit the size of each habitat unit that would be separately mapped. This is likely the reason why some habitats covering minor areas were not picked up by the computer.

The proposed pipeline route will initially make landfall over an area of intertidal mudflats exposed at low tide. Upon reaching the coastline, the proposed route passes diagonally over a strip of coastal sand sheets and low dunes that at the point of planned dissection are approximately 150 metres wide. From this point on, the route will traverse exclusively over approximately 2.6km of the habitat: coastal plains on well-drained sandy ground, until the onshore processing plant is reached.

The greater survey area (within 500m of the pipeline footprint) encompasses a total of 9 terrestrial habitats. Of these, Oil Industry (EAD Habitat Code (HC) 9210), Low Density Urban (EAD HC 9120), Date Plantations (EAD HC 8100) and Pipelines Infrastructure (EAD HC 9500) constitute the anthropogenic habitats within the greater survey area. Natural habitats present within the greater site comprise of Mudflats and Sand Exposed at Low Tide (EAD HC 1010), Coastal Sand Sheets and Low Dunes (EAD HC 2020), Coastal Sabkha (EAD HC 3100), Mangroves (EAD HC 1040) and Coastal Plains on Well-drained Sandy Ground (EAD HC 2011).

The proposed pipeline will be directly situated in four of the abovementioned habitats. The threat status, area in $km^2$, description and percentage cover of the four habitats directly situated within the proposed route are presented in Table 7. Figure 2 shows an updated habitat distribution map that reflects changes made by NEA (addition of mangroves) to the pre-existing habitat map produced by EAD.

Habitats present at the site that are classified as critical and environmentally sensitive are discussed in greater detail in subsequent sections, with marine habitats/species not forming a part of this scope.

Table 7: Habitat Description & % cover (Pipeline Footprint)

| H/T | Description | Threat Status | Area ($km^2$) | % Cover |
|---|---|---|---|---|
| 1010 | Mudflats and sand exposed at low tide | Critical Habitat | 0.00637273 | 1.8% |
| 2011 | Coastal plains on well-drained sandy ground | Not Sensitive or Critical | 0.33734763 | 95.09% |
| 2020 | Coastal sand sheets and low dunes | Environmentally Sensitive Habitat | 0.01069161 | 3.01% |
| 3100 | Coastal sabkha, including sabkha matti | Not Sensitive or Critical | 0.00034359 | 0.1% |

Table Notes:

H/T = Habitat Type;

### 3.3.1.1 Coastal Sand Sheets & Low Dunes (2020)

This habitat type has a patchy coastal distribution within the Abu Dhabi emirate. With more than 3% vegetation cover, perennial grasses and dwarf shrubs are the most prominent elements of the flora here.

An interesting feature of the soil here is that it lacks direct influence of salt despite its proximity to the coast. This enables the growth is salt intolerant species (*glycophytes*). Heavy rains at the onset of winter followed by occasional showers provide favourable conditions for desert annuals although they are scarce during prolonged warmer periods.

These coastal white sands also support breeding Chestnut-bellied Sandgrouse, *Pterocles exustus*, a national priority species and also the Black-crowned Finch-Lark, *Eremopterix nigriceps*.

The landscape of this habitat is characterised by hummocky terrain on pale coralline and oolitic sand. These coarse sands are derived almost exclusively from the remnants of marine organisms and carbonate sediments. They are generally favourable for plant growth in arid regions because of their capacity to store water often for substantial periods.

After the winter showers, water percolates through the upper sand layers, to be stored in the sub surface layers where it is not lost through evaporation or surface run-off. Even plants with shallow roots are able to tap into this periodic reserve and once established they serve to stabilise the dunes.

Coastal Sand Sheets and Low Dunes currently face great pressures from the widespread coastal development in Abu Dhabi. They are likely to continue to deteriorate in the absence of impact mitigation measures and are hence classified as an environmentally sensitive habitat.

Plates 7 & 8: (top & bottom) Sand Sheets & Low Dunes

### 3.3.1.2 Mangroves (1040)

This habitat consists of inter-tidal areas dominated by the Grey Mangrove, *Avicennia marina*. Within the study area, the sheltered embayment to the south of Shuweihat Power Complex contains a mangrove forest that covers approximately 119,000$m^2$. *Avicennia marina* is an evergreen tree or shrub, growing up to 6-7 metres high.

The trunk is light brown and branches green. The leaves are dark glossy green and oval shaped with a pointed tip. Flowering between May and June, the flowers are orange-yellow. In the past, they could be used as wood for fuel and young branches as fodder for livestock.

Mangroves in Abu Dhabi are a protected critical habitat and occur along much of the coastline, but at a higher density in intertidal lagoons and surrounding off-shore islands. Mangroves are considered as a critical habitat due to a number of factors that include:

- They act as a nursery for juvenile fish and support sponges, worms, crustaceans, molluscs and algae and also provide shelter from wind and waves, to the benefit of many species of wader, herons, egrets, flamingos, gulls and terns;
- They provide protection to coastal areas from storms, with their root system also stabilising underlying sediment which is rich in nutrients;
- Some bird species nest in mangroves, particularly Western Reef Heron, *Egretta gularis*, and Striated Heron, *Butorides striata*, in the UAE, migratory birds also rest in them and feed on the insects that they support.

The mangroves in the study area appeared to be in good health with healthy leaves and branches (Plates 9 & 10) and no apparent diseases or dead trees were observed. Fish fry and the Mottled Crab, *Metopograpsus messor*, a grapsid crab that inhabits mangroves, were found in abundance between the mangrove pneumatophores. Plate 11 shows the latter photographed during the survey.

Covering a relatively small area (119,000$m^2$), the mangroves present in the survey area were absent from the EAD habitat. Figure 2 reflects the changes made by NEA to the existing habitat map, which now includes the mangroves, following investigations conducted on-ground.

Plates 9 & 10: (top) *Avicennia marina*; (bottom) *Avicennia marina* in flower

Plates 11 & 12: (top) *Metopograpsus messor*; (bottom) rope entangled with mangrove pneumatophores

### 3.3.1.3 Coastal Sabkha (3100)

Sabkha is originally an Arabic term referring to flat, salt encrusted desert that is usually devoid of any plant cover. The high concentration of salts on the sabkha surface prevents the growth of most flora. Halophytes (salt tolerant plants), however, may occur when there is a thin layer of sand over the surface. Soil salinity is another factor exerting a highly selective effect on plant growth.

High concentrations of salts on the sabkha surface prevents growth of most plant species and as a consequence sabkha appears to be distinctly barren. Plant species associated with this habitat type, predominantly halophytes such as the chenopod *Haloxylon salicornicum*, are restricted to the margins. Some species do germinate on the sabkhas but only after a period of heavy rainfall as this leads to a temporary reduction in the salt concentrations. *Tetraena mandavillei* is one such species. Once the plants have gained a foothold, they may survive for some years in a state of dormancy by shedding their succulent leaves. They then develop new leaves and resume growth after further heavy downpours.

Coastal sabkha is a major landscape feature in Abu Dhabi Emirate, and extends for over 300km from near Sila in the west, to the border of Dubai Emirate and beyond in the east. Although sabkha occurs in deserts throughout the world, the coastal sabkha present in Abu Dhabi has been described as the best example found anywhere and is deserving of world heritage status. The habitat is of particular interest to petroleum geologists.

Very low densities of plant life, a lack of shade and soils high in salt concentration make for harsh conditions that prevents any significant faunal and floral communities being able to inhabit such areas. That being said, a few species are associated with this habitat, but very few would be considered to wholly rely upon it.

A few small lacertids can be found on areas of sabkha, namely, these are Spotted Toad-headed Agama *Phrynocephalus maculatus*, Gulf Sand Gecko, *Pseudoceramodactylus khobarensis* and Arabian Toad-headed Agama, *Phrynocephalus arabicus*,

*P. arabicus* was found in close proximity to an area of coastal sabkha during the survey. The only other species proven to frequent the sabkha habitat in the site of study was Arabian Red Fox, *Vulpes vulpes arabica*, identified here by their tracks. Being highly mobile, home ranges of up to 50km are common. Though unlikely to find food in such barren expanses, foxes will instead traverse areas of sabkha into favourable habitats where food is more plentiful.

Plates 13 & 14: (top & bottom) Coastal Sabkha

### 3.3.1.4 Mudflats & Sand Exposed at Low Tide (1010)

This habitat consists of intertidal, coastal areas where sand and mud are deposited by tides and is mostly devoid of vegetation. Found along most of the mainland coast and surrounding offshore islands, mudflats cover approximately 290.94km$^2$ of the emirate of Abu Dhabi. The mudflats in the study area extend from the shoreline for 800 metres and cover an area of approximately 0.59km$^2$.

This is an important habitat for many species of shorebirds and waders and during certain times of the year, many thousands of birds can be present at this habitat throughout the country on any given day, feeding on benthic invertebrates during low tides.

Mudflats are often devoid of vegetation but can also be found with less than 10% vegetation cover. No plants are generally found in these habitats, with the exception of one species of seagrass, *Halodule uninervis*, which can be exposed at low tide (usually sparse).

According to the EAD Habitat Map this habitat type at the project location covers approximately an area of within the greater survey area, and 1.8% of the Proposed Pipeline Footprint. This is an important habitat for wading birds feeding on benthic invertebrates during low tides.

Plates 15 & 16: (top & bottom) Mudflats & Sand Exposed at Low Tide

### 3.3.2 Flora

With the exception of the *Conocarpus lancifolius* trees planted alongside the private villa perimeter wall at the east of the site boundary, just seven naturally occurring species of vascular plant were recorded across each habitat in the survey area, as follows:

- *Salsola imbricata*;
- *Halopeplis perfoliata*;
- *Heliotropium kotschyi*;
- *Suaeda vermiculata*;
- *Avicennia marina* (Grey Mangrove);
- *Tetraena qatarensis*;
- *Tetraena simplex*;

All these species are locally common along the UAE coast and are perennial, halophytic chenopods, except *Salsola imbricata*, which is an annual halophytic plant. No glycophytes were recorded in the survey though little rainfall had occurred in the months preceding the survey so it is likely that the seven plants recorded in the survey will be supplemented by additional annual glycophytes following periods of rain in cooler months.

*Halopeplis perfoliata* is the dominant plant within the coastal sand sheets and low dunes habitat, and indeed at the site overall, where it frequently forms monospecific stands. Common along the Arabian Gulf coast and inland, this halophytic shrub can be frequently found growing next to salt marshes and sabkhas.

*H. perfoliata* is described as a perennial and woody shrub, with stems that are covered in green, clustered flowers that form strings of beads. Flowering occurs from September to December.

The presence of *Heliotropium kotschyi* was determined at the site through the identification of a single specimen, making it the rarest plant in the survey area at the time of investigation. However, despite its uncommon presence in the survey area, it is common and widespread at coastal sites throughout the UAE, though less so in parts of the northern emirates.

*H. kotschyi* is described as a perennial and woody shrub with stems that are up to 60cm long, containing small, white flowers. *H. kotschyi* flowers all year round making it an important plant for pollinating insects. Plate 22 shows the lone specimen found in the survey, in flower.

A mature stand of the Grey Mangrove (*Avicenna marina*) Is present within the eastern intertidal shoreline where the coast to the north of the mangroves protrudes and creates shelter from wave action, which has allowed a relatively small but dense mangrove forest to develop. The mangroves here range in height from 2 to 5m.

*Salsola imbricata* was found on a couple of occasions during the survey. Common on both coasts of the UAE, this herb is found in saline sand and on disturbed ground. This plant was one of the first plants to colonise coastal landfills. *S. imbricata* is an annual herb that has 30-80cm long stems which are covered in green and brown leaves that form strings of beads. This plant flowers from September to December.

*Tetraena qatarensis* (Plate 19) occurs frequently in the survey area, particularly within the habitat transitional zone between coastal, low dunes and sandy coastal plains. *T. qatarensis* is one of the commonest and widely dispersed plants in the UAE. It occurs from coastal sites and offshore islands to deep sand deserts in the far south of the country. *T. qatarensis* is described as a small shrub with dense branches that extend up to 80cm in length. Its glossy, green leaves are cylindrical and are 0.3cm to 0.8cm long. Flowering from December to March, the flowers are small, white, and enclosed by green and brown sepals. This dwarf shrub was once used for purgative treatment on livestock.

Grazing pressures on the naturally occurring vegetation at the site are considered to be very low to non-existent. Livestock is not kept within the site or within adjacent lands and no evidence was found to suggest wandering livestock (such as domestic camels) frequent the site. Wild grazers (gazelle for example) may visit the site from time to time, but this was unsubstantiated during the study.

Plates 17 & 18: (top) *Halopeplis perfoliata* (foreground); (bottom) *Suaeda vermiculata*

Plates 19 & 20: (top) *Tetraena qatarensis*; (bottom) *Suaeda vermiculata*

Plates 21 & 22: (top) *Avicennia marina*; (bottom) *Heliotropium kotschyi*

| Table 8: Plant species recorded during the survey | | | |
|---|---|---|---|
| Family name | Scientific Name | Status During Survey | Status in UAE/IUCN |
| Amaranthaceae | *Halopeplis perfoliata* | The dominant plant species in the coastal dune habitat, occurring in high densities | UAE: Common saltmarsh plant<br>IUCN: NE |
| Amaranthaceae | *Salsola imbricata* | Occasionally noted | UAE: Common halophyte<br>IUCN: NE |
| Amaranthaceae | *Suaeda vermiculata* | Occasionally noted | UAE: Common halophyte<br>IUCN: NE |
| Avicenniaceae | *Avicennia marina* | A dense and mature stand present on the shoreline | UAE: Locally common<br>IUCN: NE |
| Boraginaceae | *Heliotropium kotschyi* | Rare in the survey area. Only a single specimen found | UAE: Common on the coastline of the UAE<br>IUCN: NE |
| Zygophyllaceae | *Tetraena qatarensis* | Most abundant flora within the overall site | UAE: Common to AD coast & N. Emirates.<br>IUCN: NE |
| Zygophyllaceae | *Tetraena simplex* | Occasionally noted | UAE: Common<br>IUCN: NE |

Table Key: C-Name = Common Name / IUCN = International Union for the Conservation of Nature / NE = Not Evaluated / UAE = United Arab Emirates

### 3.3.3 Mammals and Reptiles

An extensive diurnal walkover was conducted to search for the presence of mammals and reptiles within the site boundary. Five camera traps were also set overnight to record any nocturnal specimens. The traps were set at locations deemed to be support the highest density of fauna based on the frequency of ecological indicators such as tracks, burrows, and scats.

Arabian Red Fox, *Vulpes vulpes arabica*, Feral Cat, *Felis catus* and Cheesman's Gerbil, *Gerbillus cheesmani*, were the only mammals recorded in the survey; their presence initially indicated by frequent tracks, later proven through camera trap footage. An occupied burrow belonging to the latter was also located.

Lizard tracks were seen in several locations, normally where the density of vegetation was a higher such as along the low dunes landward of the beach. Gecko prints were clearly visible here although it would be very difficult to identify the gecko to species level using the tracks alone, due to the size of the prints and the almost identical prints of several geckos associated with such locations in the UAE.

Additional prints made by a small lizard were seen in the same location. These tracks were identified as being made by a member of the Phrynosomatidae family that are commonly referred to as the Fringe-toed Lizards. Tracks made by these lizards show a tail drag mark and, as their common name suggests, fringed toes of varying lengths. Based on the location and proximity to the coast, it is most likely that a Schmidt's Fringe-toed Lizard, *Acanthodactlyus schmidti*, made the tracks, but this cannot be verified by tracks alone.

Arabian Red Fox, *Vulpes Vulpes arabica* (Plate 23), tracks were frequently recorded during the diurnal survey. The numerous tracks indicated that the foxes were most active around the villas. A camera trap was placed at the end of a chokepoint where a villa compound wall at one side and mangroves at the other, funnels mobile fauna along a narrow strip which eventually leads to a gap in a fence that is clearly, frequently used by cats and foxes. Plates 23 and 25 show camera trap stills of a fox and cat traversing under the fence, respectively.

The Arabian Red Fox is known to be solitary, so it is possible that the tracks found belonged to one fox present within the study boundary. Common and widespread throughout the UAE, the Arabian Red Fox is highly adaptive to most habitats, such as deserts, mountains, and urban environments. Foxes feed on reptiles, rodents, and birds, which are all present in the survey area.

A small burrow that was clearly excavated by a rodent was found next to a pile of discarded anthropogenic debris approximately 50 metres away from an abandoned falcon trappers hide. A camera trap was subsequently placed pointing in the direction of the burrow entrance in order to identify the occupant.

Upon reviewal of the data captured by the camera trap, an identification of Cheesman's gerbil was able to be ascertained from stills captured by the camera trap which was triggered on several occasions as the gerbil entered and exited its burrow. Plate 26 shows the Gerbil, captured on camera in the early hours of the morning of 22.05.21.

Cheeseman's Gerbil is a common and widespread rodent in sandy deserts and gravel plain environs in the UAE. It is a nocturnal, desert-dwelling species that lives in semi-permanent burrows to escape the midday heat. Burrows are sometimes dug close to one another, forming colonies. A primarily herbivorous species, they also occasionally feed on invertebrates such as beetles and arachnids.

A single Arabian Toad-headed Agama, *Phrynocephalus arabicus*, was the sole reptilian species sighted and thus identified to species level throughout the entire survey period, showing the site supports a low diversity of reptiles. The agama was seen within a habitat transitional zone between sabkha and coastal plains where vegetation is sporadic, and some is dead/dormant.

*P. arabicus* is a small agamid, highly specialised for life on soft, aeolian sand and is one of the most common lizards in the UAE, found wherever there are sand sheets, dunes or sandy plains. They are most often seen during the heat of midday, as was the case during the survey.

Plates 23 & 24: (top) Arabian Red Fox, *Vulpes vulpes arabica*; (bottom) (NEA File Photo) White-spotted Lizard, *Acanthodactylus schmidtii*

Plates 25 & 26: (top) Feral Cat, *Felis catus*; (bottom) Cheesman's Gerbil, *Gerbilus cheesmani*

Plates 27 & 28: (top) Arabian Red Fox Tracks; (bottom) Cheesman's Gerbil tracks

| Table 9: Mammal and Reptile species recorded during the survey | | | |
|---|---|---|---|
| C-Name | Scientific Name | Status During Survey | Status in UAE & IUCN |
| Arabian Red fox | *Vulpes vulpes* | Common. Numerous tracks were found, and an individual was captured several times on camera trap | UAE: Common and widespread<br>IUCN: LC |
| Feral Dog | *Canis lupus familiaris* | Tracks were observed, but no actual sightings | UAE: Common with human habitation<br>IUCN: LC |
| Feral Cat | *Felis catus* | Caught on camera trap at a few locations | UAE: Common with human habitation<br>IUCN: LC |
| Cheesman's Gerbil | *Gerbillus cheesemani* | A burrow belonging to the species was located. A specimen was later captured on camera trap | UAE: Common / IUCN: LC |
| Arabian Toad-headed Agama | *Phyrocephalus arabicus* | One sighted within an area of coastal sabkha | UAE: Common / IUCN: LC |
| Gecko | *Buopus* sp. | Tracks seen on a couple of occasions | UAE: Common and widespread<br>IUCN: LC |
| Fringe-toed Lizard | *Acanthodactylus* sp. | Tracks seen on a couple of occasions | UAE: Common and widespread<br>IUCN: LC |

Table Key:
C-Name = Common Name / IUCN = International Union for the Conservation of Nature
LC = Least Concern / UAE = United Arab Emirates

## 3.3.4 Birds

Avifauna at the site was assessed throughout the days of 20th to the 22nd of May and on the morning of 24th of May 2021. Systematic counts of all species present were made using 10X binoculars and 20-60X telescopes. Every bird encountered during the survey was able to be identified to species level, using criteria outlined in various popular references.

Incidental observations were made covering the site overall. In addition, a dedicated duration was selected for a stationary count of shorebirds using a telescope from an elevated position on the beach ridge overlooking the intertidal flats where avian activity is concentrated at the site.

In total, 13 species of birds, totalling 73 individuals were recorded during the site visits. Counts of all the birds seen on the three days are given in Table 13, scientific names for all taxa, as well as IUCN status are presented therein.

Just six species of waders were recorded in the survey. The low diversity of shorebirds is not unusual for the time of the survey (early summer) as shorebird numbers using the site will naturally decline from April onwards as birds depart northwards to breeding grounds, although reduced (though still significant) numbers of non-breeders are likely to remain all summer, as they do in intertidal areas along the entirety of Abu Dhabi's coastline. Numbers will then start to increase again from late August onwards, as wintering birds arrive, and south-bound migrants pause to refuel.

The most numerous wader recorded in the survey was Kentish Plover, *Charadrius alexandrinus*, which was counted on 16 occasions foraging along the sandy beach and on the mudflats at low tide. The site is considered to be a suitable location for this species to breed, though no nests, fledglings, or any behaviour indicating breeding at the site was found in this instance.

One avian species was proven to be breeding at the site at the time of the survey. A single, Red-wattled Lapwing, *Vanellus indicus*, nest was located at night while NEA ecologists were driving between noise monitoring sites. The nest consisted of a scrape on the ground in a sparsely vegetated area, approximately one hundred metres inland of the vegetated coastal dune strip. The lapwing was incubating its eggs when first sighted but took flight upon seeing the survey vehicle from approximately 30 metres away. After the lapwing left the nest, four eggs were visible inside the scrape type nest. *V. indicus* nests are difficult to detect as the eggs are cryptically coloured and usually match the substrate on which they sit. It is therefore likely that additional nests are present at the site but remain well hidden. A photo was not taken of the nest as it was decided that the risk of disturbance from taking a close-up photo (the only option at night) was too great. A GPS coordinate, however, was swiftly taken of the breeding site by an ecologist on-foot.

Red-wattled Lapwing is an Indo-malayan species. It is now resident in much of Arabia, being dispersive, it is rapidly colonising new sites, particularly ephemeral wetlands which are generally man-made in Arabia. They nest colonially around fresh and saltwater pools, sewage ponds, lakes, and lagoons. The population in the country is almost certainly spreading and increasing due to proliferation of groundwater abstraction (which frequently results in the formation of surface flashes) which allows the species to frequent sites that were previously too arid and inhospitable. A recent trend in the UAE has been noted towards breeding in simply well-watered market gardens and fields of vegetables (Aspinall 2010).

Another bird that has been introduced to the UAE, the presence of Grey Francolin, *Francolinus pondicerianus*, (Plate 31) within the site footprint was initially indicated acoustically by their distinctive call, often heard in the early morning. Further evidence of the species common presence within the site footprint came from their tracks which were clearly imprinted into the soft coastal sands just above the high tide mark. Plate 32 shows tracks made by *F. pondicerianus*, along a mesh fence that marks the southern boundary of the EAD pearl oyster cultivation centre. A small covey of three francolins were eventually seen on the last morning of the survey as the birds were foraging along the vegetated, sandy hummocks. Up until the 1950s Grey francolin was restricted to the Batinah (Oman), Ra's al-Khaimah and some inland cultivations such as that at Dhaid (Guichard & Goodwin, 1952). Their presence in the survey area is therefore indicative of this species' increasing population and rapid spread from the north and east of the UAE.

Western Osprey, *Pandion haliaetus*, was recorded on a single occasion in the survey when an individual was seen in-flight passing over the stand of mangroves situated to the north-eastern shoreline of the site. Western Osprey has a very large global range being absent only from Antarctica, at both coastal and freshwater environments. The resident population on the coasts and islands of the Abu Dhabi emirate is one of the densest anywhere in the world. The Arabian Gulf population is thought to be genetically isolated from those in the Red Sea, which also has a large population. Osprey eyries are large and conspicuous and can grow to a very large size, as nesting materials are added every breeding season. Therefore, it is clear that Osprey seen during the survey are not breeding at the site or in adjacent land, as no eyries were visible. Instead, Osprey are likely to use the coastal site to catch fish or merely pass through the site in search of more plentiful fishing waters.

The UAE Osprey population is thought to number 75 to 100 pairs but is declining, most likely as a result of development on islands and increased human disturbance. *P. haliaetus* has one of the largest worldwide ranges of any bird and has an increasing population globally. Therefore, the species is considered as 'Least Concern' on the IUCN Red List of threatened species.

The most numerous avian species recorded was the House Sparrow, *Passer domesticus*. House Sparrows are the most widely distributed wild bird. They are found in most parts of the world and are a very common resident breeder in the UAE. They are often seen near human habitation and frequently roost and nest in buildings. They were frequently observed in the survey area away from sabkha and sparsely vegetated though in a higher concentration around the mangroves and adjacent to the occupied villas.

Two additional very common passerine species, associated with areas of human habitation were encountered during the survey area. These were Laughing Dove, *Spilopelia senegalensis* and Eurasian Collared Dove, *Streptopelia decaocto*. The former was recorded in higher numbers, eight in total, while six of the latter were sighted and heard, making their distinctive and frequently heard *coo-cooh-co* call, from the *Conocarpus* trees within the private villa grounds. The two species are quite easy to distinguish because of the smaller size of *S. senegalensis* and presence of a distinctive black stripe around the back of the neck of *S. decaocto*.

One wader recorded in the survey is listed as 'Near Threatened' on the IUCN Red List of threated species and has a declining population. This was Eurasian Curlew, *Numenius arquata*. Three were seen in the survey foraging on the intertidal flats at low tide. In the UAE, *N. arguata* occurs predominantly as a winter visitor and passage migrant and does not breed in the country. However, juveniles do not migrate to northerly breeding grounds in spring, therefore, a small number over-summer in the UAE, which explains their presence in low numbers noted in the survey. Threats to the above-mentioned threatened species include loss and disturbance of mudflats from construction works, development of high-tide roosting sites, and pollution.

All other avian species recorded in the survey are listed as 'Least Concern' on the IUCN Red List of threatened species. All bird species recorded during the survey are listed in below in Table 10, with threatened species highlighted in red.

Plates 29 & 30: (top) (NEA File Photo) Kentish Plover, *Charadrius alexandrus*; (bottom) White-eared Bulbuls, *Pycnonotus leucotis*

Plates 31 & 32: (top) Grey Francolin, *Francolinus pondicerianus*; (bottom) Grey Francolin tracks

Plates 33 & 34: (top) (NEA File Photo) Greater Hoopoe-lark, *Alaemon alaudipes*; (bottom) (NEA File Photo) Western Osprey, *Pandion haliaetus*

Plates 35 & 36: (top) (NEA File Photo) Red-wattled Lapwing, *Vanellus indicus*; (bottom) (NEA File Photo) Western Reef Heron, *Egretta gularis*

| Table 10: Bird species recorded during the survey | | | | |
|---|---|---|---|---|
| Common Name | Scientific Name | Count | Status On-site | Status in UAE / IUCN |
| Grey Francolin | *Francolinus pondicerianus* | 3 | Tracks frequently noted. Heard calling from within private villa grounds. A covey of 3 later observed | UAE: Common resident breeder<br>IUCN: LC |
| Western Reef Heron | *Egretta gularis* | 4 | Four seen on the intertidal mudflats | UAE: Common resident breeder<br>IUCN: LC |
| Osprey | *Pandion haliaetus* | 1 | Flew overhead on a single occasion over the mangrove area | UAE: Moderately common resident breeder<br>IUCN: LC |
| Red-wattled Lapwing | *Vanellus vanellus* | 1 | One adult found incubating a nest of 4 eggs | UAE: Common resident breeder<br>IUCN: LC |
| Kentish Plover | *Charadrius alexandrinus* | 16 | Seen foraging along beach and on intertidal flats | UAE: Common resident breeder<br>IUCN: LC |
| Lesser Sand Plover | *Charadrius mongolus* | 6 | Seen foraging along beach and on intertidal flats | UAE: Migrant/visitor primarily in winter<br>IUCN: LC |
| Eurasian Curlew | *Numenius arquata* | 3 | Three seen foraging on intertidal flats | UAE: Migrant/visitor primarily in winter<br>IUCN: NT |
| Common Greenshank | *Tringa nebularia* | 1 | One seen on the beach at high tide | UAE: Migrant/visitor primarily in winter |

| Table 10: Bird species recorded during the survey | | | | |
|---|---|---|---|---|
| Common Name | Scientific Name | Count | Status On-site | Status in UAE / IUCN |
| | | | | IUCN: LC |
| Eurasian Collared Dove | *Streptopelia decaocto* | 6 | Commonly seen within trees in and adjacent to the private villas | UAE: Very common resident breeder<br>IUCN: LC |
| Laughing Dove | *Spilopelia senegalensis* | 8 | Commonly seen within trees in and adjacent to the private villas | UAE: Very common resident breeder<br>IUCN: LC |
| Greater Hoopoe-lark | *Alaemon alaudipes* | 1 | One seen running between dwarf shrubs inland of the coastal dunes | UAE: Common resident breeder<br>IUCN: LC |
| White-eared Bulbul | *Pycnonotus leucotis* | 8 | Commonly seen within the mangroves and trees adjacent to the private villas | UAE: Very common resident breeder<br>IUCN: LC |
| House Sparrow | *Passer domesticus* | 15 | Commonly seen within the mangroves and trees adjacent to the private villas | UAE: Very common resident breeder<br>IUCN: LC |
| Table Key: IUCN = International Union for the Conservation of Nature / LC = Least Concern | | | | |

## 3.3.5 Arthropods

Arthropods were assessed in the area during day-time walkover investigations. Anthropogenic debris was also moved to look for insects hiding beneath. All Arthropod species recorded during the survey are listed in Table 11. Any arthropod species observed were recorded, photographed and where possible were identified to species level. Most insects are difficult to survey because of their small size, complex taxonomy, and cryptic habits. Flight seasons of particular insects may last for only a few days or weeks. Immature stages of most insects are very difficult to identify to species level.

Insects were found to be uncommon across the site at the time of survey. In fact, only four species were recorded throughout the duration of the survey. Namely, these were the Asian Dwarf Honeybee, *Apis florea*, Desert Locust, *Schistocera gregaria*, Desert Runner Ant, *Cataglyphis bicolor* and Darkling Beetle, *Pimelia* sp.

The honeybees (*Apis florea*) were abundant within the flowering mangroves at the time of the survey, where numbers in excess of 100 were observed pollinating the mature stand of Grey Mangroves, *Avicennia marina* (Plate 21). *A. florea* builds open nests primarily in trees but has also been known to use other structures such as walls. Honeybees (Apidae) are kept commercially worldwide, and honey is considered of economic importance worldwide. Although honey from these bees is collected by people in some countries, including Oman, in the UAE this bee is not cultivated.

Desert Locust, *Schistocera gregaria*, was recorded once during the survey. Swarms of these locusts have been decimating crops in East Africa and the Middle East in recent years. It is estimated that Desert Locusts can consume the equivalent of their body weight (2 g [0.07 oz]) each day in green vegetation. They are polyphagous and feed on leaves, shoots, flowers, fruit, seeds, stems and bark. Nearly all crops, and non-crop plants are also eaten. Although this species can form plagues, the lone individual seen during the survey is of little concern.

Widespread over much of the UAE, Desert Runner Ant, *Cataglyphis bicolor*, colonies can be frequently found under bushes, or in the open on gravelly and sandy plains. A diurnal insect, *C. bicolor* is predominantly subterraneous, but also less frequently nests in timber structures above ground.

Tracks made by a Darkling Beetle, *Pimelia* sp., were frequently seen around the vegetated beach hummocks (Plate 37). Darkling beetles are mainly nocturnal and primarily feed on seeds and leaves. The females lay eggs in rotten plants and upon hatching, the larvae feed on the decaying plant material until they become adults. To protect themselves, these beetles bury their heads in sand while keeping their bodies covered by a hard, exposed shell.

Plates 37 & 38: (top) Darkling Beetle, *Pimelia* sp. tracks; (bottom) colonies of Desert Runner Ants, *Cataglyphis niger*

Plates 39 & 40: (top) Asian Dwarf Honey bee, *Apis florea*; (bottom) (NEA File Photo) Desert Locust, *Schistocerca gregaria*

| Table 11: Arthropod species recorded during the survey | | | |
|---|---|---|---|
| C-Name | Scientific Name | Status On-site | Status in UAE / IUCN |
| Desert Locust | *Schistocerca gregaria* | Seen on one occasion | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Asian Dwarf Honeybee | *Apis florea* | >50 pollinating mangrove flowers | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Desert Runner Ant | *Cataglyphis niger* | Ant colonies made by this species seen within the vegetated coastal dune strip | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Darkling Beetle | *Pimelia* sp. | Tracks seen and photographed on coastal dune habitat | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Table Key:<br>C-Name = Common Name / IUCN = International Union for the Conservation of Nature<br>NE = Not Evaluated / LC = Least Concern / UAE = United Arab Emirates | | | |

## 3.3.6 Geomorphology

The area of study is located within the district of Mirfa, a strip of the UAE mainland along the Arabian Gulf coast from Thumariyah to the west and Tarif to the east. The coastline of Mirfa is situated in the mid-section of the extensive Khor Al Bazim lagoonal channel system that stretches for approximately 80km from its open, western flank marked by Al Bazam Al Gharbi Island to its eastern, semi-enclosed limits to the south of Abu Al Abyad Island where it becomes locally intertidal.

A series of offshore islands, of which the closest from the site of study is Jananah Island (9km away), form part of a coastal complex of barrier islands and lagoons. These barrier islands protect the mainland coast from wave action, allowing carbonate muds to accumulate and mangrove swamps to develop within the sheltered lagoons.

Onshore beach ridges, such as those seen at the site of study, consist of hummocky terrain on pale coralline and oolitic sand. These coarse sands are derived almost exclusively from the remnants of marine organisms and carbonate sediments and are locally elevated some 2 to 4m above sea level.

The beach ridges and thin coastal dunes at the site of study are backed inland by coastal sabkha. The sabkha is very flat, sloping slightly towards the coast. Its surface lies above the level of normal spring tides. Occasional storm induced flooding, however, transports carbonate muds onto its surface.

## 3.3.7 Anthropogenic Use

The site is evidently used recreationally for a couple of activities, some of which were observed taking place during the survey period. A small number of people were camping at the site in several tents, trailers, and motorhomes. The area seems to be well-used for this purpose as it has its own place marker on Google Maps named as "Mirfa Saltwater Camping" and people were continuing to use the site in early summer when temperatures reach intolerable levels, making it very likely that a higher number of persons utilise the site for camping through the cooler months.

Human litter associated with camping such as plastic bottles, disposable barbeques and tin cans were strewn along the beach, although a smaller proportion of the litter was probably washed up on high tides. Some people have seemingly attempted to clean up after themselves as some full bin bags were left in-situ at camping locations (Plate 43 and 44).

During low tides people were observed driving and walking across the intertidal flats and occasionally, small fishing vessels came in closer to shore. People were also seen fishing from the long breakwater that extends for 800m to the southeast of the survey area.

Tyre track marks intersect much of the site but are concentrated along the beach where a number of vehicles evidently park for camping, especially over the weekend. People living locally that reside in the private, walled villas to the north/northeast of the survey area, gain access by means of a sand/gravel track that runs parallel to the coast just north of the beach. A smaller number of vehicles access the villas from a track that follows the outer Mirfa Power Complex facility fence.

Plates 41 & 42 (top) People camping recreationally (background); (bottom) Numerous tyre tracks & a caravan & 4x4 vehicle

Plates 43 & 44: (top & bottom) Discarded litter

## 4.0 Conclusions, Recommendations & Mitigation Measures

### 4.1 Ambient Noise

The ambient noise climate of the project area shows little effect of anthropogenic disturbance. Two minor exceedances of the UAE residential ambient noise limits were observed, albeit over the shorter averaging period of 15 minutes, and in both cases the exceedances were less than 2 dBA above the limit.

Given the relatively undisturbed nature of the project site, and the nature of the proposed pipeline development, the operation of the cable alignment is not expected to cause long-term changes to the noise climate of the area or result in prolonged exceedances of the applicable noise limits.

### 4.2 Soil and Groundwater

The collection of soil samples was completed using a hand-augur and pre-prepared sample containers. Analysis of the eight collected samples was undertaken by a ESMA approved third-party laboratory (Element LLC). The vast majority of analytes were below the detection limits and were not registered in the analysis at all. Of those parameters which could be measured, all were recorded below screening or clean-up thresholds as outlined by the ADQCC soil standards.

Due to unavailability of suitable surface sampling locations or wells, groundwater samples were not collected from the site.

### 4.3 Terrestrial Ecology

The pipeline landfall location site encompasses a number of terrestrial habitats both natural and anthropogenic. A high percentage of the proposed footprint (95.19%) will be directly situated in habitats of species-poor, low ecological value i.e. coastal sabkha and sparsely vegetated coastal plains. Two critical habitats, however, will be directly impacted by the development and are discussed in detail below.

The footprint of the proposed pipeline landfall route traverses directly over a sporadically populated stand of immature mangroves (see datasheets CP1 & CP2 in Annex B). A relatively small number of immature mangroves and saplings (>10 and >20, respectively) will be at risk of being directly impacted by the development. Any direct loss of mangrove trees should be identified. Replanting of a greater quantity of mangroves (twice the area of mangrove disturbed or twice the number of mature trees lost) is the mitigative strategy against loss of this critical habitat. However, such plans are lengthy in terms of stakeholder commitment (>5 years), expensive to undertake and difficult to manage and monitor success rates effectively. As such, we recommend that the proposed route is altered slightly to avoid any direct loss of mangroves.

Another critical habitat that will be subject to some level of alteration/degradation through the development is intertidal mudflats and sand exposed at low tide. The proposed route passes over approximately 800 metres of this habitat when fully exposed on the lowest tides. Although low numbers of birds were foraging here at the time of the survey, this is largely related to the time of year. Much greater numbers of shorebirds, with some very likely consisting of threatened species, will undoubtedly use the site from autumn to spring, therefore, we recommend that the development takes place from July to September when disturbance to migrants and over-wintering birds from the construction of the pipeline on intertidal flats will be negligible.

A couple of ecologically sensitive receptor sites were identified during the survey. Namely, these were an active, Red-wattled lapwings nest containing four eggs and a burrow belonging to a Cheesman's Gerbil. Neither of these sites are located within the pipeline footprint but are close enough to be vulnerable to damage from vehicles associated with the development, particularly the lapwing nest which is just 90 metres from the pipeline's planned location.

After an incubation period of 28-30 days, once the lapwing eggs have hatched, juvenile, Red-wattled lapwings fledge and leave the nest when they are approximately four weeks old. Commencement of any construction activities should be postponed until mid-July at a minimum, which will ensure that the lapwings (and other birds potentially breeding nearby) have left the area before the start of the development.

The Cheesman's Gerbil burrow is likely to be periodically occupied through each season and is consequently susceptible to damage year-round. It is therefore recommended that the area where the gerbil burrow is situated (WPT 41) is avoided by vehicles and personnel associated with the works.

As most of the fauna at the site consists of highly mobile species, habitat fragmentation associated with a long, linear feature (such as a pipeline) would be primarily limited to smaller fauna with reduced mobilities such as lizards, gerbils, and non-flying insects.

If the pipeline will be situated above-ground, it would pose as an impassable object to these animals and could therefore limit their ability to feed and search for mates. The area where this potential risk of this would be highest is the location where the pipeline route intersects the beach and low coastal dunes area, where the highest density of fauna resides. Burying the pipeline here would lessen the potential ecological impact.

Anthropogenic activity at the site was found to be quite high, with the beach area in particular being used for recreational activities throughout the week.

Additional terrestrial ecology mitigation measures towards minimising impacts associated with the proposed construction not mentioned above are listed in brief below:

- Efficient transportation plan to minimise unnecessary vehicle movements across sensitive habitats.
- Avoid increased noise levels leading to behavioural impacts to wildlife in the area.
- Raise awareness to workers in the area to the habitats/species sensitivity (posters in accommodation).

# ANNEX A

## References

## Annex A – References

The following references were available and/or used on the current survey:


- Al Dhaheri, S., Javed, S., Alzahlawi, N., Binkulaib, R., Cowie,W., Grandcourt, E. and Kabshawi, M. (2017). Abu Dhabi Emirate Habitat Classification and Protection Guideline. Environment Agency Abu-Dhabi.
- Aspinall S.J. (2005). *Birds [of the UAE]. In:* Hellyer and Aspinall (eds.). The Emirates: A Natural History. Trident Press, UK.
- Aspinall S.J. (2010). *Breeding Birds of the United Arab Emirates*. Environment Agency Abu Dhabi, UAE.
- Brown G. and Boer B. (2004). *Interpretation Manual of the Major Terrestrial Natural and Semi-natural Habitat Types of Abu Dhabi Emirate*. ERWDA, Abu Dhabi.
- M.V.D. Jongbloed, G.R. Feulner, B.Boer, A.R Western (2003). *The comprehensive guide to the Wild Flowers of the United Arab Emirates*. ERWDA, Abu Dhabi.
- Environment Agency – Abu Dhabi (2015). *Terrestrial Habitat Classification*. EAD Enviro-portal Viewer. https://enviroportal.ead.ae/geoportal.
- Hellyer, P. and Aspinall, S.J. (Eds.) (2005). *The Emirates—A Natural History*. Trident Press, London, and the Environment Agency, Abu Dhabi.
- Gardner, A. (2013). *The amphibians and reptiles of Oman and the UAE*. Frankfurt am Main: Edition Chimaira.
- IUCN (2017). *Red List of Threatened Species*. http://www.iucnredlist.org.
- Javed S. (2008). Birds. In Perry R. *Terrestrial Habitats of Abu Dhabi Emirate*. Environment Agency - Abu Dhabi.
- Jennings M. (2010). *Atlas of the Breeding Birds of Arabia*. Fauna of Arabia Vol. 25. KACST, Riyadh and Senckenburg, Germany.
- Ornithological Society of the Middle East, the Caucasus and Central Asia (OSME). (2012). Simplified OSME list of bird taxa.
- Guichard & Goodwin (1952) *Notes on Birds Collected in Oman and Hadhramaut*.
- Perry R. (ed.) (2008). *Terrestrial Environment of Abu Dhabi Emirate*. Environment Agency, Abu Dhabi, UAE.
- Porter R. and Aspinall S.J. (2010). *Birds of the Middle East*. Second Edition. Christopher Helm, London

# ANNEX B

## Photographic Documentation and Data Sheets

## Figure B1: CP1

Coordinates: N24.11269, E53.46365
Location: Mirfa
Date: 21.05.2021

Figure B2: CP2

Coordinates: N24.11318, E53.46329

Location: Mirfa

Date: 21.05.2021


Figure B3: CP3

Coordinates: N24.11462, E53.46252

Location: Mirfa

Date: 21.05.2021




Figure B4: CP4

Coordinates: N24.11542, E53.46279

Location: Mirfa

Date: 21.05.2021



Figure B5: CP5

Coordinates: N24.11589, E53.46310

Location: Mirfa

Date: 21.05.2021

Test

Test

Figure B6: CP6

Coordinates: N24.11491, E53.46270
Location: Mirfa
Date-Time: 21.05.2021


Figure B7: CP7

Coordinates: N24.11447, E53.46294

Location: Mirfa

Date: 21.05.2021

Figure B8: CP8

Coordinates: N24.11436, E53.46176
Location: Mirfa
Date: 21.05.2021

Figure B9: CP9

Coordinates: N24.11491, E53.46102
Location: Mirfa
Date: 21.05.2021

Figure B10: CP10

Coordinates: N24.11500, E53.45988
Location: Mirfa
Date: 21.05.2021

Figure B11: CP11

Coordinates: N24.11681, E53.45675
Location: Mirfa
Date: 21.05.2021

Figure B12: CP12

Coordinates: N24.11583, E53.45458
Location: Mirfa
Date: 21.05.2021

Figure B13: CP13

Coordinates: N24.11681, E53.45675
Location: Mirfa
Date: 21.05.2021


Figure B14: CP14

Coordinates: N24.10956, E53.46611

Location: Mirfa

Date: 21.05.2021

Test

Test

Table B1: Soil Analyses

| Test Method | Parameter Name | Unit | Detection Limit | MS01 | MS02 | MS03 | MS04 | MS05 | MS06 | MS07 | MS08 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH [BS 1377-3: 2018] Soil-DXB | pH | pH units | 0.1 | 9 | 8.5 | 8.8 | 8.7 | 8.8 | 8.8 | 8.6 | 8.7 |
| Oil & Grease [APHA 5520 E]-DXB | Oil and Grease | % | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nitrogen (Ammonia) [HACH 8155] Solids-DXB | Nitrogen (Ammonia) | mg/kg | 0.25 | 2.1 | 1.5 | 1.55 | 1.75 | 2.05 | 9 | 1.7 | 1.9 |
| Nitrogen (Ammonia) [HACH 8155] Solids-DXB | Ammonium | mg/kg | 0.32 | 2.7 | 1.93 | 1.99 | 2.25 | 2.64 | 11.6 | 2.19 | 2.44 |
| Nitrogen (Ammonia) [HACH 8155] Solids-DXB | Ammonia | mg/kg | 0.3 | 2.55 | 1.82 | 1.88 | 2.12 | 2.49 | 10.9 | 2.06 | 2.31 |
| Salinity [APHA 2520 B]-DXB | Salinity | ppt | 1 | 2.4 | 1.7 | 7.6 | 4.7 | 1.9 | 1.8 | 5.6 | 4.4 |
| Sulphide [HACH 8131/DIN 38405-D27]-DXB | Sulphide ($S^{2-}$) | mg/kg | 5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Fluoride [HACH 8029]-DXB | Fluoride | mg/kg | 0.5 | 4 | 5.1 | 3.2 | 4 | 3.4 | 3.6 | 3.5 | 5.4 |
| Nitrate [HACH 8039]-DXB | Nitrate | mg/kg | 0.22 | 10.5 | 14.3 | 18.8 | 10.2 | 0.62 | 16.3 | 22.1 | 13.2 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Cadmium (Cd) | mg/kg | 0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Aluminium (Al) | mg/kg | 130 | 3320 | 2750 | 2940 | 2500 | 2310 | 2050 | 2850 | 2520 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Arsenic (As) | mg/kg | 1 | 2.9 | 3.5 | 3.9 | 3.9 | 2.6 | 3.3 | 4.4 | 3.9 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Barium (Ba) | mg/kg | 3 | 26.6 | 18.2 | 21.2 | 21.9 | 18.1 | 45.9 | 13 | 19.1 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Chromium (Cr) | mg/kg | 1 | 13.4 | 10.9 | 11.5 | 10.1 | 11.5 | 9.4 | 11.2 | 10 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Cobalt (Co) | mg/kg | 1 | 1.7 | 1.7 | 1.9 | 1.2 | 1.5 | 1 | 1.6 | 1 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Copper (Cu) | mg/kg | 3 | 5.3 | 5.3 | 5.8 | 4.8 | 4.8 | 4.8 | 4.9 | 4.5 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Lead (Pb) | mg/kg | 1 | 1.8 | 1.7 | 1.2 | 1.3 | 1.2 | 2.2 | 1.2 | 1.6 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Manganese (Mn) | mg/kg | 3 | 85.5 | 88.2 | 123 | 68.4 | 93.7 | 79 | 88.5 | 57.9 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Nickel (Ni) | mg/kg | 1 | 6.8 | 8.4 | 10.8 | 8.6 | 7.3 | 6 | 9.4 | 8.3 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Phosphorus (P) | mg/kg | 50 | 209 | 245 | 245 | 208 | 214 | 235 | 207 | 149 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Zinc (Zn) | mg/kg | 3 | 11.9 | 6.6 | 10.7 | 6.4 | 12.6 | 8.8 | 7.8 | 9.4 |
| Chromium (Hexavalent) [HACH 8023] Solids-DXB | Chromium (VI) | mg/kg | 0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Antimony (Sb) | mg/kg | 1 | <1.0 | <1.0 | <1.0 | <1.0 | 1.2 | <1.0 | 1.1 | <1.0 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Beryllium (Be) | mg/kg | 1 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Mercury by PSA [EPA 245.7] SSS-DXB | Mercury (Hg) | mg/kg | 0.01 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| VPH C5-C10 by GC-FID [EPA 8015B]-SSS-DXB | VPH C5-C10 | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| EPH C10-C40 by GC-FID [EPA 8015B] SSS-DXB | EPH C10-C40 | mg/kg | 50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |
| PAH in Soils [EPA 8270 D]-DXB | Acenaphthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Acenaphthylene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Anthracene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(a)anthracene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Table B1: Soil Analyses | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Test Method | Parameter Name | Unit | Detection Limit | MS01 | MS02 | MS03 | MS04 | MS05 | MS06 | MS07 | MS08 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(a)pyrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(b)fluoranthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(g,h,i)perylene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(k)fluoranthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Chrysene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Dibenzo(a,h)anthracene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Fluoranthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Fluorene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Indeno(1,2,3-c,d)pyrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Naphthalene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Phenanthrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Pyrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Phenols Soil [EPA 8270D]-DXB | 2,4,5-Trichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,4,6-Trichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,4-Dichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,4-Dimethylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2-Chlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2-Methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2-Nitrophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 4-Chloro-3-methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 4-Methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 4-Nitrophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | Pentachlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,3,4,6-Tetrachlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,6-Dichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 3-Methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | Phenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Dichlorodifluoromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Chloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Vinyl Chloride | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromomethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |

Table B1: Soil Analyses

| Test Method | Parameter Name | Unit | Detection Limit | MS01 | MS02 | MS03 | MS04 | MS05 | MS06 | MS07 | MS08 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VOCs in Soil [EPA 8260 B]-DXB | Chloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Trichlorofluoromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1-Dichloroethene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Methylene Chloride | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloroethene(trans) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1-Dichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloroethene(cis) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 2,2-Dichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromochloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Chloroform | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,1-Trichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1-Dichloropropene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Carbon Tetrachloride | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Benzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Trichloroethene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromodichloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Dibromomethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichloropropene(cis) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Toluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichloropropene(trans) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,2-Trichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Tetrachloroethene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Dibromochloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dibromoethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Chlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,1,2-Tetrachloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Ethyl benzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | m,p-Xylene | mg/kg | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

Table B1: Soil Analyses

| Test Method | Parameter Name | Unit | Detection Limit | MS01 | MS02 | MS03 | MS04 | MS05 | MS06 | MS07 | MS08 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VOCs in Soil [EPA 8260 B]-DXB | o-Xylene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Styrene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | iso-Propylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromoform | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,2,2-Tetrachloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,3-Trichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | n-Propylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3,5-Trimethylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 2-Chlorotoluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 4-Chlorotoluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | tert-Butylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,4-Trimethylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | sec-Butylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | p-Isopropyltoluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,4-Dichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | n-Butylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dibromo-3-Chloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,4-Trichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Hexachlorobutadiene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Naphthalene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,3-Trichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |

| Table B2: ADQCC Soil Limits for Industrial and Commercial use | | | |
|---|---|---|---|
| Parameter | Unit | Screening level | Clean-up level |
| Antimony (Sb) | mg/kg (DW) | 470 | 4700 |
| Arsenic (As) | mg/kg (DW) | 30 | 300 |
| Beryllium (Be) | gm/kg (DW) | 2.3 | 23.0 |
| Cadmium (Cd) | mg/kg (DW) | 980 | 9800 |
| Chromium (Cr VI) | mg/kg (DW) | 63 | 630 |
| Cobalt (Co) | mg/kg (DW) | 350 | 3500 |
| Lead (Pb) | gm/kg (DW) | 8.0 | 80 |
| Mercury (Hg) | mg/kg (DW) | 46 | 460 |
| Nickel (Ni) | gm/kg (DW) | 22 | 220 |
| Selenium (Se) | gm/kg (DW) | 5.8 | 58 |
| Asbestos | gm/10 kg (DW) | 5.0 | 5.0 |
| Benzene | mg/kg (DW) | 51 | 510 |
| Toluene | gm/kg (DW) | 47 | 470 |
| Ethylbenzene | mg/kg (DW) | 250 | 2500 |
| Xylene | gm/kg (DW) | 2.5 | 25.0 |
| Benzo (a) pyrene (BaP) | mg/kg (DW) | 2.9 | 29 |
| Polychlorinated Biphenyls | mg/kg (DW) | 330 | 3300 |

Table Notes:

- Taken from Environmental Specification for Soil Contamination ADS 19/2017
- Mg/kg = milligram per kilogram
- Gm/kg = gram per kilogram
- DW = Dry Weight

## Figure B3: Noise Data Sheet N01

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| User: | Ross Pappin | | | Job No: | N684 | Project: | MM Lightning |
| Report No: | N684-0621-MIR-1.0 | Survey Date: | See comments | Checked: | DT | Date: | - |
| Site No: | N01 | Mic. Height: | 155cm | Free Field | ✓ | Facade: | NA |

Location Description (draw a little picture of the area):


Noise Source:

Mosque, aircraft, power complex, boats, birds, incoming tide, generator

| Period | Calibration | | Wind | | Time | | LAeq | Cars (tally) | Trucks (tally) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Speed | Direction | On | Off | | | | |
| Day (Week) | 94.3dB | 94.0dB | 1.2m/s | N(340°) | 17:43 | 17:58 | 48.9 | | | 24.05.21 |
| Night (Week) | 94.2dB | 93.9dB | 1.4m/s | S(181°) | 04:45 | 05:00 | 34.3 | | | 31.05.21 |
| Day (Weekend) | 93.9dB | 94.0dB | 2.9m/s | NW(328°) | 12:22 | 12:37 | 40.4 | | | 21.05.21 |
| Night (Weekend) | 94.3dB | 94.0dB | 0.6m/s | E(99°) | 21:20 | 21:35 | 36.2 | | | 21.05.21 |

General Weather Conditions:

Noise measurements were collected only during periods of low wind speed

| Specific Conditions: | Calm | Fog | Precipitation | Frost | Tonal | Impulse |
|---|---|---|---|---|---|---|
| BS4142 Compliance: | ✓ | x | x | x | | |
| Factory Cal. Date: | 16.05.2021 | | | | | |
| Checked: | Doug Tilbury | | Date: | 16/06/2021 | | |

Key to Abbreviations: Mic = Microphone / LAeq = Equivalent Continuous Level / NW = Northwest / E = East / S = South / N = North / m/s = Metre per second / dB = Decibel / Cal = Calibration / cm = Centimetre / min = Minute

## Figure B4: Noise Data Sheet N02

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| User: | Ross Pappin | | | Job No: | N684 | Project: | MM Lightning |
| Report No: | N684-0621-MIR-1.0 | Survey Date: | See comments | Checked: | DT | Date: | - |
| Site No: | N02 | Mic. Height: | 155cm | Free Field | ✓ | Facade: | N/A |

Location Description (draw a little picture of the area):


Noise Source:

Mosque, aircraft, birds, power complex

| Period | Calibration | | Wind | | Time | | LAeq | Cars (tally) | Trucks (tally) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Speed | Direction | On | Off | | | | |
| Day (Week) | 94.4dB | 94.0dB | 1.6 | S(160°) | 07:00 | 07:15 | 36.6 | \| | | 31.05.2021 |
| Night (Week) | 94.3dB | 93.9dB | 1.7 | S(172°) | 5:10 | 5:25 | 41.6 | | | 31.05.2021 |
| Day (Weekend) | 94.0dB | 94.0dB | 4.1m/s | NW(300°) | 15:46 | 16:01 | 36.7 | | | 21.05.2021 |
| Night (Weekend) | 94.3dB | 94.1dB | 2.6m/s | E(88°) | 21:45 | 22:00 | 31.7 | | | 21.05.2021 |

General Weather Conditions:

Noise measurements were collected only during periods of low wind speed

| Specific Conditions: | Calm | Fog | Precipitation | Frost | Tonal | Impulse |
|---|---|---|---|---|---|---|
| BS4142 Compliance: | ✓ | Slight | x | x | | |
| Factory Cal. Date: | 16.05.2021 | | | | | |
| Checked: | Doug Tilbury | Date: | 16/06/2021 | | | |

Key to Abbreviations: Mic = Microphone / LAeq = Equivalent Continuous Level / NW = Northwest / E = East / S = South / m/s = Metre per second / dB = Decibel / Cal = Calibration / cm = Centimetre / min = Minute

## Figure B5: Noise Data Sheet N03

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| User: | Ross Pappin | | | Job No: | N684 | Project: | MM Lightning |
| Report No: | N684-0621-MIR-1.0 | Survey Date: | See comments | Checked: | DT | Date: | - |
| Site No: | N03 | Mic. Height: | 155cm | Free Field | ✓ | Facade: | N/A |

Location Description (draw a little picture of the area):


Noise Source:

Power complex, aircraft, birds, vehicles

| Period | Calibration | | Wind | | Time | | LAeq | Cars (tally) | Trucks (tally) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Speed | Direction | On | Off | | | | |
| Day (Week) | 94.4dB | 94.0dB | 2.5m/s | S(167°) | 07:34 | 07:49 | 51.5 | | | 31.05.2021 |
| Night (Week) | 94.4dB | 94.0dB | 1.6m/s | S(188°) | 05:37 | 05:52 | 39.8 | \|\| | | 31.05.2021 |
| Day (Weekend) | 94.2dB | 93.9dB | 5.7m/s | N(17°) | 17:09 | 17:24 | 35.2 | | | 21.05.2021 |
| Night (Weekend) | 94.3dB | 94.0dB | 1.0m/s | NE(52°) | 22:09 | 22:24 | 35.9 | | | 21.05.2021 |

General Weather Conditions:

Noise measurements were collected only during periods of low wind speed

| Specific Conditions: | Calm | Fog | Precipitation | Frost | Tonal | Impulse |
|---|---|---|---|---|---|---|
| BS4142 Compliance: | ✓ | x | x | x | | |
| Factory Cal. Date: | 16.05.2021 | | | | | |
| Checked: | Doug Tilbury | | Date: | 16/06/2021 | | |

Key to Abbreviations: Cal = Calibration / NE = Northeast / N = North / S = South / m/s = Metre per second / dB = Decibel / cm = Centimetre / LAeq = Equivalent Continuous Level / min = Minute

# ANNEX C

## Quaity Control Documentation

Contents:

## Part 1: Field Documentation

Table C1, below, details field logs, provided on subsequent pages.

| Table C1: Field Documentation | | |
|---|---|---|
| Figure № | Description | Usage |
| Figure C1 | NEA Field Log Day 20.05.2021 | Daily log of activities |
| Figure C2 | NEA Field Log Day 21.05.2021 | Daily log of activities |
| Figure C3 | NEA Field Log Day 22.05.2021 | Daily log of activities |
| Figure C4 | NEA Field Log Day 24.05.2021 | Daily log of activities |
| Figure C5 | NEA Field Log Day 31.05.2021 | Daily log of activities |

| Figure C1: NEA Activity Log 20.05.2021 | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 20.05.2021 / Thursday |
| Site Team: | RP, AM, PM | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 11:57 | NEA | Depart NEA office |
| 14:25 | MH | Arrived Mirfa Hotel and checked in |
| 15:05 | MH | Depart to site |
| 15:20 | MS01 | MS01 – Soil sampling |
| 16:35 | MS02 | MS02 – Soil sampling |
| 16:55 | MS03 | MS03 – Soil sampling |
| 17:25 | MS04 | MS04 – Soil sampling |
| 18:35 | MS04 | Stopped by CICPA personnel – document check |
| 19:05 | MH | Arrived back at Mirfa Hotel and debrief |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Key to Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment
PE = Personnel / PIR = Process Improvement Report / PM = Paulo Mendoza / AM = Aneeta Mathew
RP = Ross Pappin / DT = Doug Tilbury / CICPA = The Critical Infrastructure and Coastal Protection Authority
MH = Mirfa Hotel

| | |
|---|---|
| PM Name: | Ross Pappin |
| PM Signature and Stamp: | Ross Pappin<br>NAUTICA ENVIRONMENTAL ASSOCIATES LLC<br>POB 44780 ABU DHABI UAE |

## Figure C2: NEA Activity Log 21.05.2021

| | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 21.05.2021 / Friday |
| Site Team: | RP, AM, PM | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 08:05 | MH | Depart MH to site |
| 08:16 | Site | Ecology walkover survey |
| 11:53 | MS06 | MS06 – Soil sampling |
| 12:18 | MN01 | MN01 – Noise monitoring (Day – Weekend) |
| 13:14 | MH | Return to Mirfa Hotel |
| 15:11 | MH | Depart to site |
| 15:46 | MN02 | MN02 – Noise monitoring (Day – Weekend) |
| 16:57 | MN03+07 | MN03 – Noise monitoring (Day – Weekend); MS07 – Soil sampling |
| 18:12 | MS08 | MS08 – Soil sampling |
| 18:36 | MS05 | MS05 – Soil sampling |
| 18:55 | CT01 | Deployed CT – 01 |
| 19:01 | CT02 | Deployed CT – 02 |
| 19:11 | CT03 | Deployed CT – 03 |
| 19:19 | CT04 | Deployed CT – 04 |
| 19:24 | CT05 | Deployed CT – 05 |
| 21:10 | MN01 | MN01 – Noise monitoring (Night – Weekend) |
| 21:40 | MN02 | MN02 – Noise monitoring (Night – Weekend) |
| 22:05 | MN03 | MN03 – Noise monitoring (Night – Weekend) |
| 22:35 | MH | Arrived back at Mirfa Hotel and debrief |

COP/ EQ/PE/PIR: None

Key to Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel / PIR = Process Improvement Report / CT = Camera Trap / PM = Paulo Mendoza / AM = Aneeta Mathew / RP = Ross Pappin / DT = Doug Tilbury

| | |
|---|---|
| PM Name: | Ross Pappin |
| PM Signature and Stamp: | Ross P... NAUTICA ENVIRONMENTAL ASSOCIATES LLC POB 44780 ABU DHABI UAE |

## Figure C3: NEA Activity Log 22.05.2021

| | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 22.05.2021 / Saturday |
| Site Team: | RP, AM, PM | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 06:00 | MH | Team brief |
| 06:57 | MH | Depart MH to site |
| 07:16 | CT05 | Retrieved CT – 05 |
| 07:50 | CT03 | Retrieved CT – 03 |
| 07:54 | CT01 | Retrieved CT – 01 |
| 07:57 | CT04 | Retrieved CT – 04 |
| 08:03 | CT02 | Retrieved CT – 02 |
| 08:39 | MH | Return to Mirfa Hotel |
| 10:51 | MH | Depart Mirfa Hotel to Shuweihat |
| 13:30 | HEC | Arrive HEC, debrief and prep for following day |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Key to Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel / PIR = Process Improvement Report / CT = Camera Trap / PM = Paulo Mendoza / AM = Aneeta Mathew / RP = Ross Pappin / DT = Doug Tilbury / MH = Mirfa Htel

| | |
|---|---|
| PM Name: | Ross Pappin |
| PM Signature and Stamp: | NAUTICA ENVIRONMENTAL ASSOCIATES LLC POB 44780 ABU DHABI UAE |

| Figure C4: NEA Activity Log 24.05.2021 | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 24.05.2021 / Monday |
| Site Team: | RP, AM | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 13:00 | NEA | Brief and EQ prep NEA office, AD |
| 16:00 | NEA | Depart NEA by road |
| 17:30 | MN01 | Arrived Mirfa site |
| 17:40 | MN01 | MN01 – Noise monitoring (Day – Weekday) |
| 18: 10 | MN02 | MN02 – Noise monitoring (Day – Weekday) – Too windy |
| 18:35 | MN02 | Depart to NEA office |
| 21:10 | NEA | Arrived NEA office and debrief |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Key to Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel / PIR = Process Improvement Report / AM = Aneeta Mathew / RP = Ross Pappin / DT = Doug Tilbury

| | |
|---|---|
| PM Name: | Ross Pappin |
| PM Signature and Stamp: | Ross Pappin |

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## Figure C5: NEA Activity Log 31.05.2021

| | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 31.05.2021 / Monday |
| Site Team: | RP | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 03:32 | HEC | Depart Hans Esser for Mirfa site |
| 04:38 | MN01 | MN01 – Noise monitoring (Night – Weekday) |
| 05:09 | MN02 | MN02 – Noise monitoring (Night – Weekday) |
| 05:35 | MN03 | MN03 – Noise monitoring (Night – Weekday) |
| 06:46 | MN02 | MN02 – Noise monitoring (Day – Weekday) |
| 07:33 | MN03 | MN03 – Noise monitoring (Day – Weekday) |
| 07:55 | MN03 | Depart Mirfa location for Hans Esser |
| 09:20 | HEC | Arrived back at Hans Esser |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Key to Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment PE = Personnel / PIR = Process Improvement Report / RP = Ross Pappin / DT = Doug Tilbury / HEC = Hans Esser camp

| | |
|---|---|
| PM Name: | Ross Pappin |
| PM Signature and Stamp: | Ross Pappin<br>NAUTICA ENVIRONMENTAL ASSOCIATES LLC<br>POB 44780 ABU DHABI UAE |

## Part 2: NEA Licenses and Accreditations

Table C2, below, provides a list of NEA licenses and accreditations, provided on subsequent pages.

Table C3: NEA Licenses and Accreditations

| Figure № | Description | Usage |
| --- | --- | --- |
| Figure C6 | NEA Trade License | - |
| Figure C7 | NEA EAD Registration | - |
| Figure C8 | NEA Quality Assurance Accreditation | - |

## Figure C6: NEA Trade License

Abu Dhabi Business Center

THE EMIRATES

DEPARTMENT OF ECONOMIC DEVELOPMENT

# Professional License

# رخصـــة مهنية

| | | |
|---|---|---|
| License No | : CN-1006375 | رقم الرخصة |
| ADCCI No | : 226524 | عضوية الغرفة |
| Establishment Card MOHRE | : | |
| Establishment Card GDRFA | : | |
| Legal Form | : Limited Liability Company | الشكل القانوني |
| | | الإسم التجاري |
| Trade Name | : NAUTICA ENVIRONMENTAL ASSOCIATES - LLC | |
| Establishment Date | : 05/05/2007 | تاريخ تأسيس المنشأة |
| Issue Date | : 19/01/2021 | تاريخ الاصدار |
| Expiry Date | : 09/02/2022 | تاريخ الانتهاء |

| Role | Nationality | Owners / Partners | No. |
|---|---|---|---|
| شريك<br>Partner | الإمارات العربية المتحدة<br>United Arab Emirates | PETER ARTHUR HELLYER | 41208281 |
| شريك<br>Partner | المملكة المتحدة<br>United Kingdom | RICHARD JOHN HORNBY | 20029757 |
| شريك<br>Partner | المملكة المتحدة<br>United Kingdom | VERYAN GUY HENRY PAPPIN | 20029756 |

**Commercial Activities** : الأنشطة التجارية

- Environmental consultancy and studies and researches
- First Aids Training
- Wildlife Protectorate
- Services Of Testing And Measuring Of Environmental Indicators
- Oil and Gas Facilities Consultancy
- Survey Planning, Air Photography and Information Management Systems Engineering Consultancy
- Environment Protection Training
- Onshore And Offshore Oil And Gas Fields And Facilities Services
- Chemical and Biological Analysis Lab

Approved document issued without signature or stamp by the Department of Economic Development - Abu Dhabi. To verify the license kindly visit http://www.ded.abudhabi.ae

| | | |
|---|---|---|
| Official Email | : management@nea.ae | البريد الالكتروني الرسمي |
| Official Mobile | : 971508134040 | رقم التواصل الرسمي |

http://ded.abudhabi.ae

## Figure C7: NEA EAD Registration

| | | |
|---|---|---|
| EC- | 59/06 | رقم المكتب |
| ECR- | 778/21 | رقم التوصية |
| Date of Issue | 25/5/2021 | تاريخ الإصدار |
| Date of Expiry | 14/5/2022 | تاريخ الإنتهاء |

إعتماد مكتب استشاري في مجال البيئة

* فئة (أ)

Registration of Environmental Consultancy

* Class A

| | | | |
|---|---|---|---|
| Office Name: | Nautica Environmental Associates LLC | "نوتيكا للزمالة البيئية ذ م م" | اسم المكتب: |
| Type of Office: | Local (100 %) | محلي (100%) | نوع المكتب: |
| Address: | Office M3, East 14<br>Sheikha Zayed Ahmad and Others Bldg<br>Al Meena Street,<br>Abu Dhabi | جزيرة أبوظبي - شرق 14 - شارع الميناء - بناية السيدة شيخه سعيد احمد وآخرين - الميزانين مكتب رقم 3 | العنوان: |

Environment Agency – Abu Dhabi
Electronically generated permit - No signature required.

هيئة البيئة - أبوظبي
التصريح صادر إلكترونياً - لا يتطلب أي توقيع

## Figure C8: NEA ISO Accreditation

Lloyd's Register

Current issue date: 29 April 2020
Expiry date: 4 May 2023
Certificate identity number: [illegible]

Original approval(s):
ISO 14001 – 12 June 2011
ISO 45001 – 29 April 2020
ISO 9001 – 13 June 2011

# Certificate of Approval

This is to certify that the Management System of:

## Nautica Environmental Associates LLC

M03, Building No: P475, Behind Ramada Hotel, Meena Road, Abu Dhabi, United Arab Emirates

has been approved by Lloyd's Register to the following standards:

**ISO 14001:2015, ISO 45001:2018, ISO 9001:2015**

Approval number(s): ISO 14001 – 0045599E, ISO 45001 – 0045598, ISO 9001 – 0045597

**The scope of this approval is applicable to:**

1. Provision of Environmental Consultancy Services Typically Covering:
   - Baseline Surveys (Marine and Terrestrial)
   - Environmental Impact Assessments
   - Sampling and Monitoring Studies (Air, Land, Sediments, Marine)
   - Identification and Statistical Evaluation of Biological Specimens
2. Provision of First-Aid Training and Environmental Protection Training

**Luis Cunha**
Area Operations Manager - SAMEA

Issued by: Lloyd's Register Quality Assurance Limited

## Part 4: Support Equipment Specifications

Table C4, below, provides a list of key equipment either used or on hand for the survey programme, with specifications provided on subsequent pages.

Table C4: Survey equipment available

| Figure № | Description | Usage |
|---|---|---|
| Figure C9 | Beacon on a Belt (BOB) | DGPS locational system |
| Figure C10 | Trimble GoXT handheld unit | DGPS locational system |
| Figure C11 | Nikon Forestry Pro Laser Rangefinder | Tree height measurements (NU) |
| Figure C12 | Bushnell Camera Traps | Small mammal/reptile activity |
| Figure C13 | Sherman Traps | Small mammal activity |
| Figure C14 | Anabat Detector | Bat Detection |
| Figure C15 | Malaise Traps | Insect trapping |
| Figure C16 | RIDGID Micro-inspection unit | Den/Borrow/Hole investigation (NU) |
| Figure C17 | Pitfall Trap | Insect / small reptile trapping |
| Figure C18 | Mavik Pro 2 UAV (Drone) | Aerial photography/videography |

## Figure C12: Beacon-on-a-Belt (BOB)

# Beacon-on-a-Belt (BoB)

*Cable-free Differential Correction Receiver*

**Key features and benefits**

- Provides real-time DGPS accuracy to mapping receivers
- Cable-free communication with Trimble GeoExplorer 3
- Rugged, ergonomic design
- Noise-rejecting beacon receiver

Trimble's Beacon-on-a-Belt (or BoB™) receiver lets you add the extra precision of real-time differential GPS to your GIS projects— without adding the encumbrance of a bulky radio pack. The system incorporates a beacon receiver, an antenna and battery in one compact cable-free* package that you wear on your belt. The BoB receiver decodes GPS differential correction information from local MSK beacons and then transmits that information to any GPS receiver that accepts standard RTCM SC-104 data, eliminating the need to postprocess your data. Best of all, this is completely cable-free when used with Trimble's GeoExplorer® 3.

*Beacon-on-a-Belt (BoB) Receiver*

**Real-time DGPS Accuracy**

The accuracy of differential GPS not only means that your databases have better data, it also makes locating previously mapped assets in the field quicker and more accurate too. With differential GPS, distinguishing between closely spaced assets is fast and unambiguous. Back in the office you'll save time too. Since the data you collected was corrected as you gathered it, you can transfer that data directly into your GIS without the delay of a separate postprocessing step.

**Cable-Free Convenience**

To complement the convenience of Trimble's handheld GeoExplorer® 3 system, the BoB differential receiver communicates with that system automatically—with no cabling or accessories whatsoever. There's nothing to connect, nothing to forget, and nothing to carry on your back. Your crews will move faster and incur less downtime due to snagged or broken cables.

**Rugged and Easy to Operate**

No matter where your data collection and update projects take you, the BoB receiver is ready to follow. Shockproof and water-resistant, it will withstand all the rigors of fieldwork, in any weather. Right out of the box the BoB receiver is ready to start working with your Trimble GPS/GIS data collection system. Within seconds of powering on, it automatically selects the best beacon and starts transmitting corrections. If you want to reconfigure the receiver in the field an easy to use two-button interface simplifies the process.

**Powerful Software**

For more extensive configurations the versatile PC-BoB office software makes it easy to exclude beacon stations, define custom display names for stations, and configure the initial tracking mode. All in all, the BoB receiver is the most convenient and versatile beacon receiver we've ever developed.

*Some countries may not allow transmission on the frequency the BoB receiver uses. BoB receivers sold outside the US have the cable-free option disabled and must be used with a cable.

Trimble

## Figure C12: Beacon-on-a-Belt (BOB)

# Beacon-on-a-Belt (BoB™)
*Cable-free Differential Correction Receiver*

**FEATURES**

- Dual Channel Minimum Shift Keying (MSK) Differential GPS (DGPS) beacon receiver
- Cable free real time link to the Trimble GeoExplorer 3 mapping system in the United States
- Automatically tracks the strongest or closest beacon signal, or can be fixed to track a specified beacon station
- Rugged, dust, and water resistant housing
- Compact, ergonomic belt mounted design
- Immunity to noise and jamming signals
- All day internal rechargeable battery
- Simple two button/two LED interface
- Full DGPS status in the field via GeoExplorer 3
- Advanced configuration setup via PC-BoB software
- Advanced diagnostics via PC-BoB software

**HARDWARE SPECIFICATIONS**

| | |
|---|---|
| Size | 20.8 cm (8.1") H x 10.7 cm (4.2")W x 10.7 cm (4.2") D (at antenna) |
| Weight | 1.16 kg (2.56 lbs) |
| Power consumption | 1.5 W |
| Temperature | Operating: -10 C to +50 C (-14 F to +122 F)<br>Storage: -20 C to +70 C (-4 F to +158 F) |
| Humidity | Up to 90% non-condensing |
| Port settings | RS-232 at 2400 baud, 8 data bits, 1 stop bit, no parity |

**PERFORMANCE SPECIFICATIONS**

| | |
|---|---|
| Cold start time | <25 seconds typical |
| Warm start time | <10 seconds typical |
| Channels | 2 |
| Frequency | Range: 283.5-325 kHz<br>Spacing: 500 Hz |
| MSK modulation | 50, 100 & 200 b/s autoselection |
| Output protocol | RTCM SC-104 |
| Input protocol | NMEA 0183 |
| Battery life | Up to 10 hours |

**STANDARD ACCESSORIES**

- Belt and holster
- Charging cable for internal battery
- PC-BoB software for configuration and diagnostics
- Printed manual and Quick Reference Card
- Curly null modem cable

**OPTIONAL ACCESSORIES**

| | |
|---|---|
| External power kit | Includes camcorder battery, vehicle and camcorder adapters, vehicle splitter cable and soft shoulder pack |

**ORDERING INFORMATION**

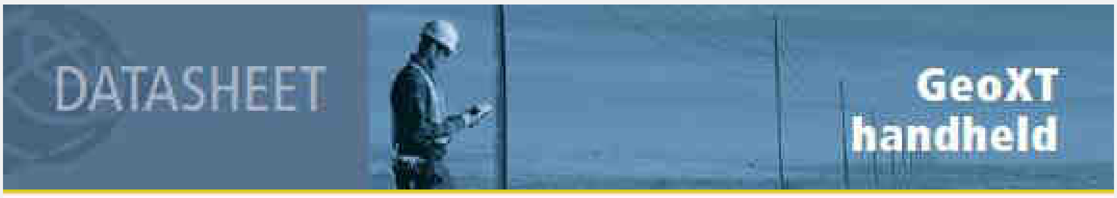
| | |
|---|---|
| Beacon-on-a-belt (BoB) | [illegible]-00-ENG* |
| BoB with GeoExplorer 3 | [illegible]-00-ENG* |
| BoB with GeoExplorer 3c | [illegible]-00-ENG* |
| External power kit | [illegible]-00 |

*These part numbers are for use in the US only. Outside the US contact your local Trimble dealer for local ordering information.

Trimble

YOUR LOCAL TRIMBLE OFFICE OR REPRESENTATIVE

## Figure C13: Trimble GeoXT 2005 Series




**KEY FEATURES**

- High-performance submeter GPS with integrated SBAS and EVEREST multipath technology
- Microsoft Windows Mobile version 5.0 software, allowing maximum flexibility in software choice
- 512 MB onboard memory plus removable SD memory
- Bluetooth and wireless LAN connectivity options
- Rugged handheld with all-day battery
- TrimPix technology for wireless camera support


**THE TOTAL GPS PLATFORM FOR ALL YOUR GIS FIELD REQUIREMENTS**

The GeoXT™ handheld, from Trimble's GeoExplorer® series, is the essential tool for maintaining your GIS. A high performance, submeter GPS receiver combined with a rugged handheld computer, the GeoXT handheld is ideal for use by utility companies, local government organizations, federal agencies, or anyone managing assets or mapping critical infrastructure who needs accurate data to do the job right—the first time.

Delivering consistent submeter accuracy both real-time and postprocessed, the GeoXT handheld is the most dependable submeter solution available. And it's specifically designed with your GIS in mind.

**Real-world submeter performance**

The GeoXT handheld is optimized to provide the reliable, high-accuracy location data when and where you need it. With advanced features like EVEREST™ multipath rejection technology, the GeoXT handheld outputs quality GPS positions even under canopy, in urban canyons, and in all the everyday environments you work in.

If you need submeter accuracy in real time, you can use corrections from a satellite-based augmentation system (SBAS) like WAAS or EGNOS, or use the integrated Bluetooth® radio to connect to a Trimble® GeoBeacon™ receiver. And if you need that extra edge in precision, you can collect data with Trimble TerraSync™ software or the GPScorrect™ extension for ESRI ArcPad software, and then postprocess back in the office.

**Software to fit your workflow**

The GeoXT handheld comes with a powerful 416 MHz processor running the most advanced operating system available—Microsoft® Windows Mobile® version 5.0 software. Windows Mobile is the industry standard open platform for mobile devices, so you can choose a software solution to match your workflow, whether off-the-shelf or purpose built.

Windows Mobile version 5.0 features familiar Microsoft software, including Word Mobile, Excel Mobile, and Outlook® Mobile, giving you all the tools you need for a seamless exchange of data between the field and the office.

**Built for the field**

The GeoXT handheld has an integrated battery, good for a full day's work; simply charge the battery overnight and you're ready to go again. The GeoXT handheld will last the distance, and its rugged design can take a lot of punishment. Rain, hail, or shine, it's built to keep working, whatever the weather throws at you.

**Convenient connectivity**

With the GeoXT handheld you have the flexibility to work exactly the way you want to. Do you need to access the Internet or your organization's secure network to get the most up-to-date data? No problem—with the GeoXT handheld you have built-in wireless LAN and Bluetooth technology to ensure you stay connected.

Using the built-in wireless LAN and TrimPix™ technology, the GeoXT handheld can connect to a range of WiFi-capable Nikon digital cameras for automated capture of digital images. Download the TrimPix software and you have an ideal solution for easily collecting high resolution digital photos to link to your GPS positions.

**All the memory you need**

There's plenty of storage space in the GeoXT handheld for all your GIS data, and with its fast processor even big graphics files load quickly. Because the GeoXT handheld runs Windows Mobile version 5.0 software, all your data and applications are stored in persistent memory, so your data is completely safe. And with a Secure Digital (SD) memory card slot, you can add gigabytes of memory for all your map data.

**Accuracy you can rely on**

Accurate information is crucial to making informed decisions and improving the way you do business. The GeoXT delivers consistent submeter accuracy both real-time and postprocessed, so you know your GIS has the information that others can depend on to do the job right—this time, next time and every time.

Trimble.

Figure C13: Trimble GeoXT 2005 Series

## Figure C14: Nikon Forestry Pro Laser Rangefinder Specifications

Unit Specifications:

1. Magnification: 6.0x
2. Objective Lens Diameter: 21mm
3. Angle of View: 6°
4. Laser Type: Class 1M
5. Range: 11-550 yd / 10-500 m
6. Exit Pupil Diameter: 3.5 mm
7. Eye Relief: 18.2 mm
8. Distance Display Increments: [Internal Display]
9. Actual Distance: Every 0.5m/yd. or 1.0' out to 100 m/yd or feet
   1.0 m/yd or 1.0' beyond 100 m/yd or feet
10. Horizontal distance and height: 0.2 m/yd or 0.5' up to 100 m/yd or feet
    `
    1.0 m/yd or 1.0' up to 100 m/yd or feet
11. Angle: 0.1° up to 10° / 1° beyond 10°

External Display:

- Actual Distance: 0.5 m/yd or 1.0'
  Horizontal distance and height: 0.2 m/yd or 0.5'
- Angle: 0.1°
- Weatherproofing: 3.3' (1.0 m) to 10 minutes
- Environment: RoHS/WEEE compliant
- Power Source: (1) CR2 battery
- Dimensions: 5.0 x 2.8 x 1.8" (12.7 x 7.1 x 4.5 cm)
- Weight (Without Batteries): 7.4 oz (209.8 g)

## Figure C15: Bushnell Camera Trap Specifications

| | |
|---|---|
| Model: | 119876 |
| Sensor Resolution | 2, 8, 20MP |
| Images Resolution: | 3MP sensor with 2MP compression and 20MP interpolation |
| Flash: | 48 LEDs No-Glow |
| Flash Range (ft/m): | 100ft/30m |
| Backlit LCD Display: | B&W text LCD |
| Colour: | Brown |
| Battery Type: | AA (8) |
| Battery Life: | up to 12 mo. |
| Video Resolution: | 1920x1080p |
| Infrared Sensor Range: | 80ft / 25m |
| Multi Flash Mode: | Yes |
| Hyper Night Vision: | Yes |
| Field Scan 2x: | Yes |

## Figure C16: Sherman Trap Specifications

Sherman traps are an environmentally friendly way to research small mammal populations and can be used for mammal collection, teaching and environmental impact studies.

Sherman folding traps have the advantage of folding down to a size and shape which is easy to transport. The trap works by use of a trigger platform which causes the door to shut when the animal runs into the trap.

This is a 'live catch' trap and should be checked regularly. Where appropriate traps should be provided with water and food.

The Small Folding Aluminum Trap is suitable for trapping small animals such as mice and shrews. The Sherman Trap is available in a range of sizes to suit specific needs as shown below.

| Model | Dimensions / cm | Weight / g |
|---|---|---|
| XLF15 | 10.2 x 11.4 x 38.1 | 544 |
| XLK | 7.6 x 9.5 x 30.5 | 408 |
| LFA | 7.6 x 8.9 x 22.9 | 227 |
| LFAHD | 7.6 x 8.9 x 22.9 | 254 |
| LFATDG | 7.6 x 8.9 x 22.9 | 254 |
| LFG | 7.6 x 8.9 x 22.9 | 363 |

| Model | Dimensions / cm | Weight / g |
|---|---|---|
| SFAL | 5.2 x 6.4 x 22.9 | 159 |
| SFA | 5.2 x 6.4 x 16.5 | 136 |
| SFG | 5.2 x 6.4 x 16.5 | 227 |
| Longworth | 14 x 6.5 x 8.5 | 300 |

## Figure C17: Anabat Express Bat Detector Unit Specifications

The Anabat Express is a compact and weatherproof recorder that is designed to be deployed in the field for several weeks. It will record bat calls which can then be used for species identification or activity monitoring.

Camouflaged and compact, the unit has a weatherproof casing and omni-directional weatherproof microphone with a 1.5m extension cable. An optional five-metre microphone extension cable allows you to position the microphone away from the unit, which makes it easier to site the recorder in an inconspicuous location, or to raise your microphone up to an elevated position when needed.

The Express is powered by 4 x AA batteries. The unit should record for around 14 nights on one set of batteries and up to 30 nights with high quality lithium batteries. Supplied with a padded case, wrist strap, 1.5m microphone extension, a magnet for status checking and USB cable.

Features:

- New, easy-to-use interface for setup & download;
- Weatherproof, camouflaged plastic case (IP67);
- Weatherproof, compact microphone;
- Records temperature and battery voltage;
- Built-in GPS for location, transect tracking, setting the clock and calculating sunset/rise;
- Runs for 14 nights on 4 AA batteries and up to 30 nights with lithium-ion batteries;
- One-touch for continuous, scheduled or night-only recording modes.
  SD card memory and easy downloading.

Specifications:

- Dimensions: (H) 182 x (W) 119 x (D) 43mm;
- Weight: 385g (without batteries)

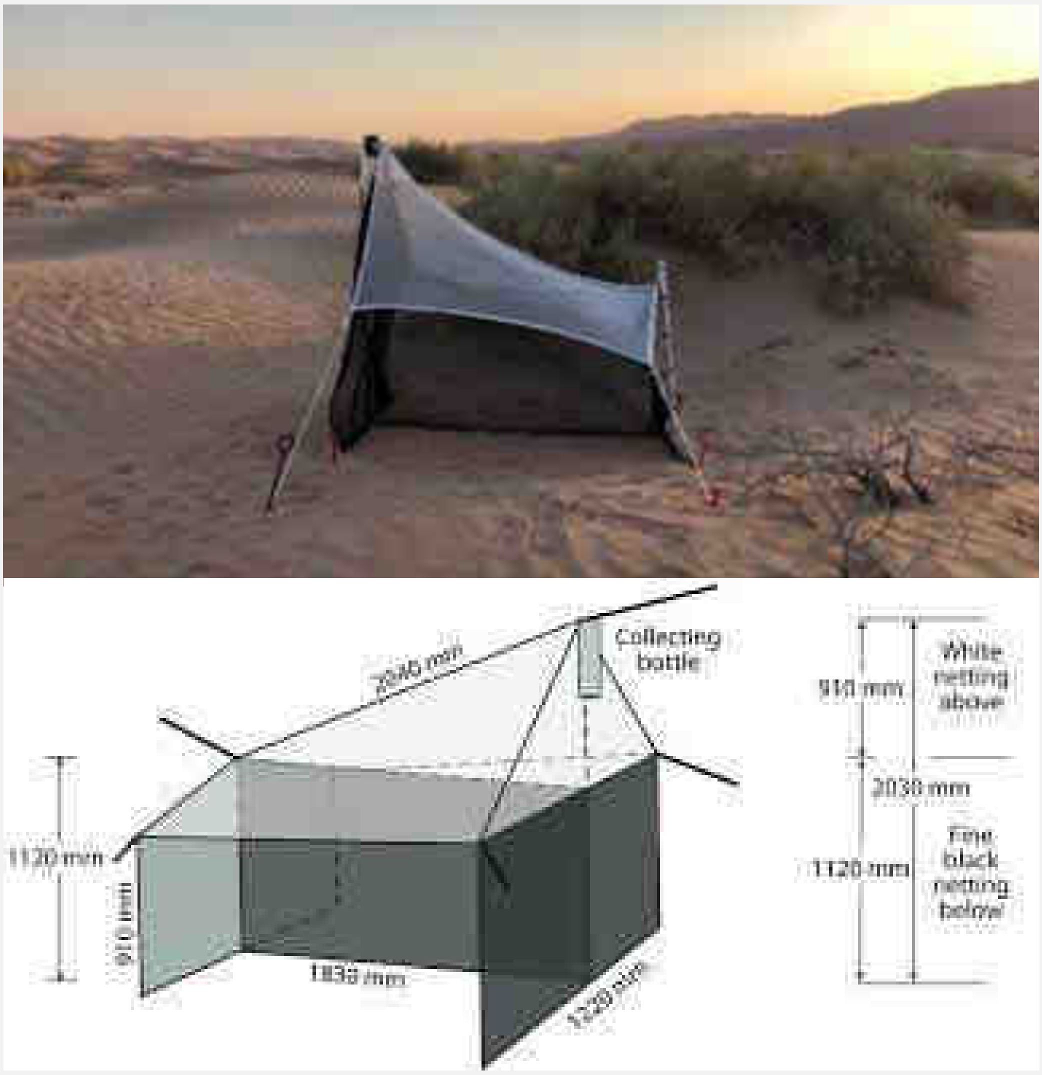
## Figure C18: Malaise Trap Specifications

A malaise trap is a large, tent-like structure used for trapping flying insects, particularly Hymenoptera and Diptera.

The trap is generally made of a material such as terylene netting and can vary in colour. Insects fly into the tent wall and are funnelled into a collecting vessel attached to highest point (see diagram below).

Typical Dimensions; Tall end height = 1.7m; Short end height = 0.9m; Width = 1.15m and Length = 1.88m. The opening is around 12–15 mm (0.47–0.59 in), and can vary according to the size of insect desired.

If using a dry agent, a smaller hole results in a faster death, limiting the amount of damage a newly caught insect can inflict on older, fragile specimens. In ethanol, this is less of a concern. Larger holes can potentially allow in more butterfly, moth and/or dragonfly species.



## Figure C19: RIDGID Micro-inspection Camera (Hole/Burrow Investigations)

The Ridgid 37888 micro CA-300 inspection camera is the next evolution of the SeeSnake micro inspection camera, it allows you to perform more detailed visual inspections in even harder-to-reach areas (see Plate below of an NEA scientist's use in a burrow investigation).

Comfortable pistol-grip design, one-hand controls, and large screen make it easy to detect and diagnose the unreachable. It comes standard with a rugged anodized aluminum camera head with 4 super bright LEDs.

Easily rotate the active image counter-clockwise to see in any situation. This micro CA300 inspection camera provides solutions whenever and wherever you need them. Easily record still images and videos of problems in hard-to-reach areas.

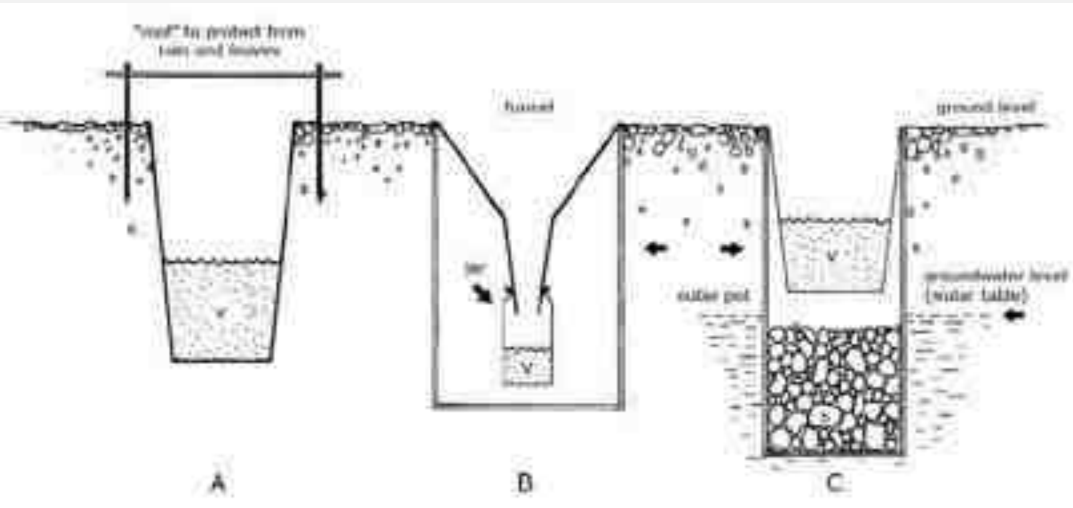
Specifications:

1. Item Name: Inspection Camera
2. Model: 37888
3. SV Code: 291302AAKY3
4. Brand: Ridgid
5. Resolution: 320 x 240
6. Video Output: 3 Feet (90 cm) RCA cable included (640 x 480 resolution)
7. Power Supply: 3.7V Li-Ion battery - 5VAC adapter
8. Cable Length: 3 Feet (90cm) expandable to 30 Feet (9m) w-optional extensions


## Figure C20: Pitfall Trap Specifications

A pitfall trap is a device used to trap insects that are active on the ground surface. Pitfall traps usually consist of a beaker that is buried so that the lip of the beaker is level with the ground surface. The trap is then left and returned to, at a later date, to inspect 'the catch'.

The diagram below the photograph of an NEA deployment, depicts the several variations of pitfall trap layout, with a recurring theme. Insects reaching the lip of the beaker slip and fall in and are then unable to climb back out. Sometimes alcohol or another substance is poured into the trap so that any insects falling in are killed. The rationale behind this is that predatory insects falling in to the trap will eat the rest of the catch.



## Figure C21: Mavic Pro 2 (Aerial photography/videography)

The Mavic 2 Pro from DJI is a drone that balances power, portability, and professional-quality visuals with the inclusion of a 20MP Hasselblad L1D-20c gimbal camera. The camera delivers a 1" CMOS sensor with an adjustable f/2.8 to f/11 aperture, support for a 10-bit Dlog-M color profile, and 4K 10-bit HDR video capture. The Mavic 2 Pro utilizes a low-drag aerodynamic body design for achieving speeds up to 47.7 mph, a four-cell LiPo battery for up to 31 minutes of flight time, and low-noise propellers for filming without being distracting. This power and performance are coupled with a variety of dynamic shooting modes and other capabilities that help you achieve cinematic results.

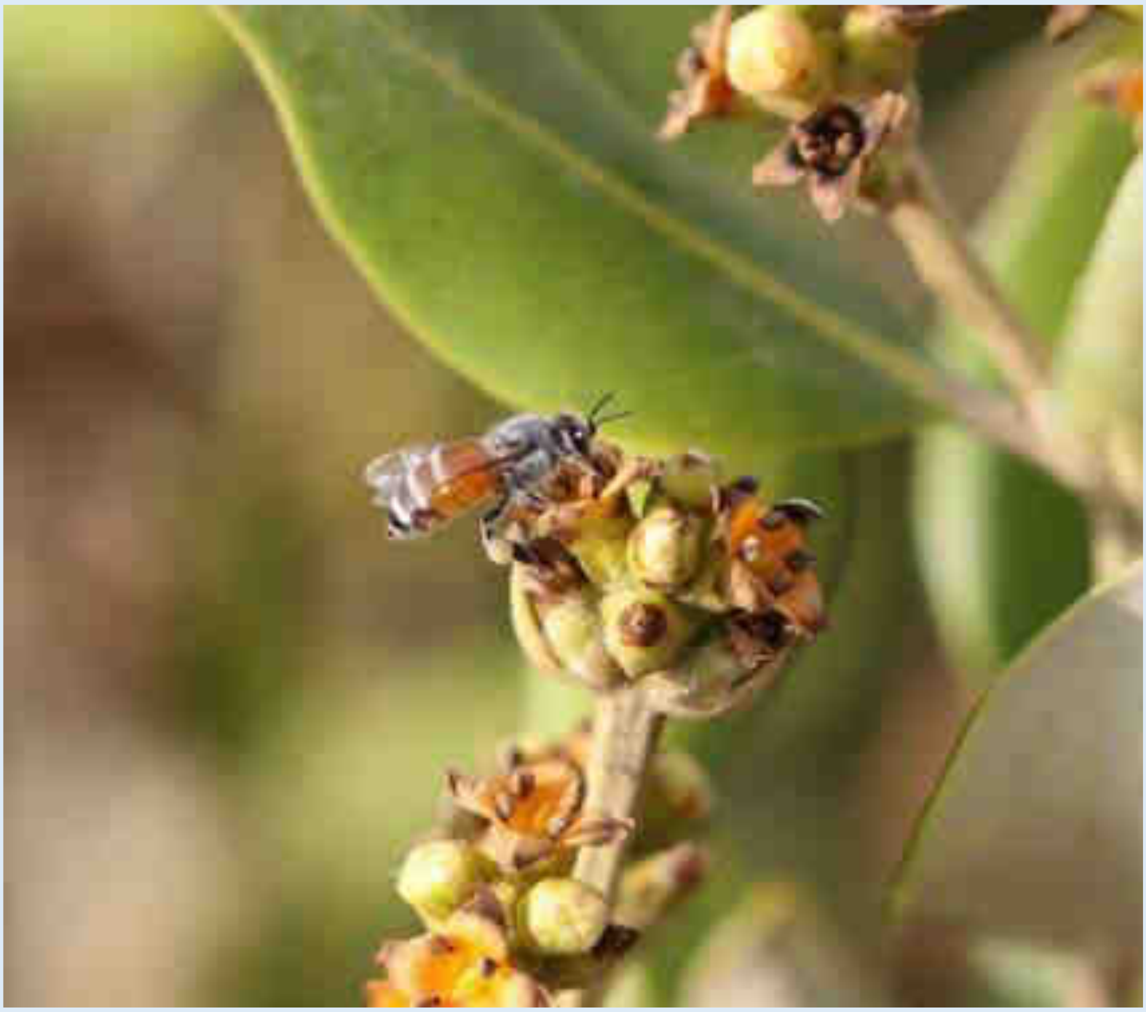
1. **Item Name:** Mavic Pro 2
2. **Model:** 37888
3. **SV Code:** 291302AAKY3
4. **Brand:** DJI
5. **Camera:** Hassleblad 20MP, 1” CMOS, 77° FOV, f/2.8 to f/11
6. **Max Video Output:** 4k 10 bit HDR (.MP4, .MOV), 5472 × 3648 Stills (.JPG or .DNG)
7. **Power Supply:** 15.4V, 3850 mAh, LiPo 4S
8. **Transmission Length:** 8 km (line of sight)

# Appendix 2.2.2 – Shuweihat Landfall Terrestrial Ecology Survey Report

Anthesis

# ADNOC Lightning Project
# Shuweihat Landfall
# Terrestrial Ecology Survey Report

NEA Reference: N684-0621-SHU-1.1 dated September 2021



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| | |
|---|---|
| Cover | Front cover – Asian Dwarf Honey Bee, *Apis florea* |
| Credits | Photos ©NEA on-site 2021, unless otherwise annotated. |

Document Issue and Revision

| Issue Date | Author(s) | Checked | Approved | Issue № | Comment |
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| 17.06.2021 | RP/BR/DT/VP | RP/DT | VP | 1.0 | 1st Issue |
| 12.09.2021 | RP/BR/DT/VP | RP/DT | VP | 1.1 | 2nd Issue |



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Plates used in Report

Plates used in Report

# 1.0 Background, Scope and Conduct

## 1.1 Background

Mott MacDonald (MM), on behalf of the Abu Dhabi National Oil Company (ADNOC), commissioned Nautica Environmental Associates LLC (NEA), an Abu Dhabi based environmental consultancy, to conduct environmental surveys at three landfall locations, for the ADNOC Lightning Project. These are located at Mirfa, Shuweihat and Das Island.

Figure 1 shows the Shuweihat landfall location to the south of the existing Shuweihat Power Complex (SPC) and on-land routing to the SPC on its eastern edge.

This document relates to the survey conducted at Shuweihat between 22-24.05.2021 (Table 1) and provides a report on the results from the surveys undertaken.

## 1.2 Scope and Conduct

### 1.2.1 Scope

The scope included evaluations of the following, along landfall pipeline footprints as shown in Figure 1:

- Evaluation of habitats and associated species.
- Ambient noise measurements, over weekend and week-day periods.
- Soil and groundwater sampling and analysis to evaluate possible contamination.

### 1.2.2 Conduct

A minimum of two NEA staff were on-site, supported by NEA 4x4 vehicle. Surveys were conducted using a combination of walkover and vehicle drive through of the site location, deploying camera traps and noise meters and undertaking soil sampling at selected locations.

Additionally, at certain locations within the survey area and in order to provide additional photographic records of habitat and general conditions, cardinal point photographs were taken from South, East and West (North was excluded on security grounds).

Table 2 provides an overview of site visits and activities undertaken by NEA specialists during the ecological survey. Figure 2 shows a habitat map of the plot location, together with sampling locations and camera traps. Camera traps were deployed at for one overnight period (≥12 hours) at these locations.

Cardinal point locations are shown in Figure 3 (see Annex B for records). Figure 4 shows points of interest and Figure 5 shows a track map or NEA staff movements across the location. These are detailed in Table 2 and discussed in subsequent sections.

In the current circumstances, COVID-19 mitigation involved NEA field scientists wearing full eye and nose/mouth masks, with gloves, when on-site and travelling to and from the location.

Table 1: Shuweihat Field Visit Overview

| Day | Date | Survey Activity | NEA Staff |
|---|---|---|---|
| 1 | 19.05.2021 | Survey planning and Preparation | RP, AM, PM |
| 2 | 22.05.2021 | Survey walkover & CT/NM deployment | RP, AM, PM |
| 3 | 23.05.2021 | Mangrove walkover & CT/NM deployment | RP, AM, PM |
| 4 | 24.05.2021 | Walkover, Trap/Meter Retrieval & GW | RP, AM, PM |

Table Key:
GW = Ground Water Sampling
CT = Camera Trap
NM = Noise Meter
NEA Staff: RP = Ross Pappin / AM = Aneeta Mathew / PM = Paulo Mendoza

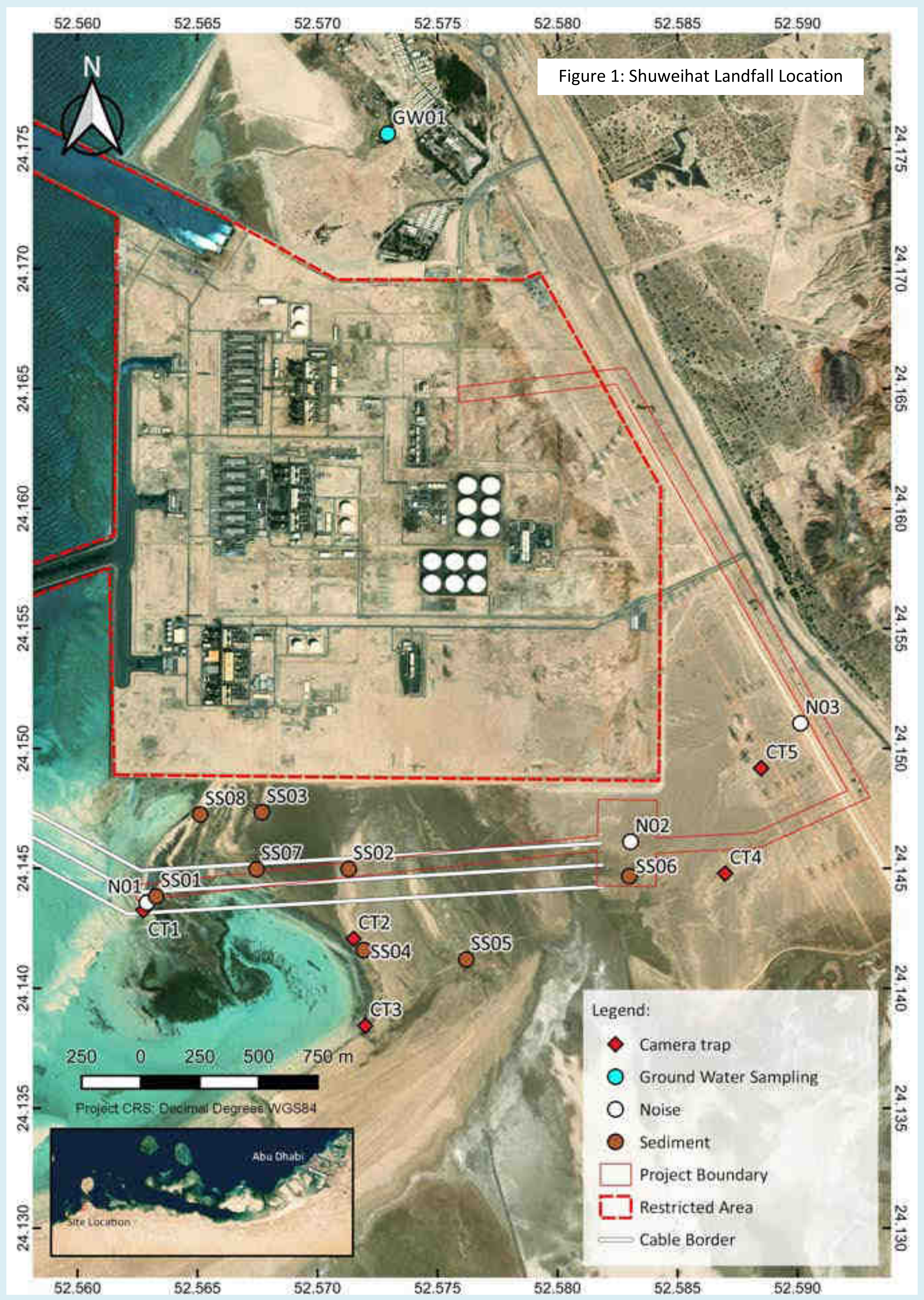
Figure 1: Shuweihat Landfall Location
N
GW01
N03
CT5
SS08
SS03
N02
SS07
SS02
SS06
CT4
N01
SS01
CT1
CT2
SS04
SS05
CT3
250 0 250 500 750 m
Project CRS: Decimal Degrees WGS84
Abu Dhabi
Site Location
Legend:
Camera trap
Ground Water Sampling
Noise
Sediment
Project Boundary
Restricted Area
Cable Border
52.560
52.565
52.570
52.575
52.580
52.585
52.590
24.175
24.170
24.165
24.160
24.155
24.150
24.145
24.140
24.135
24.130

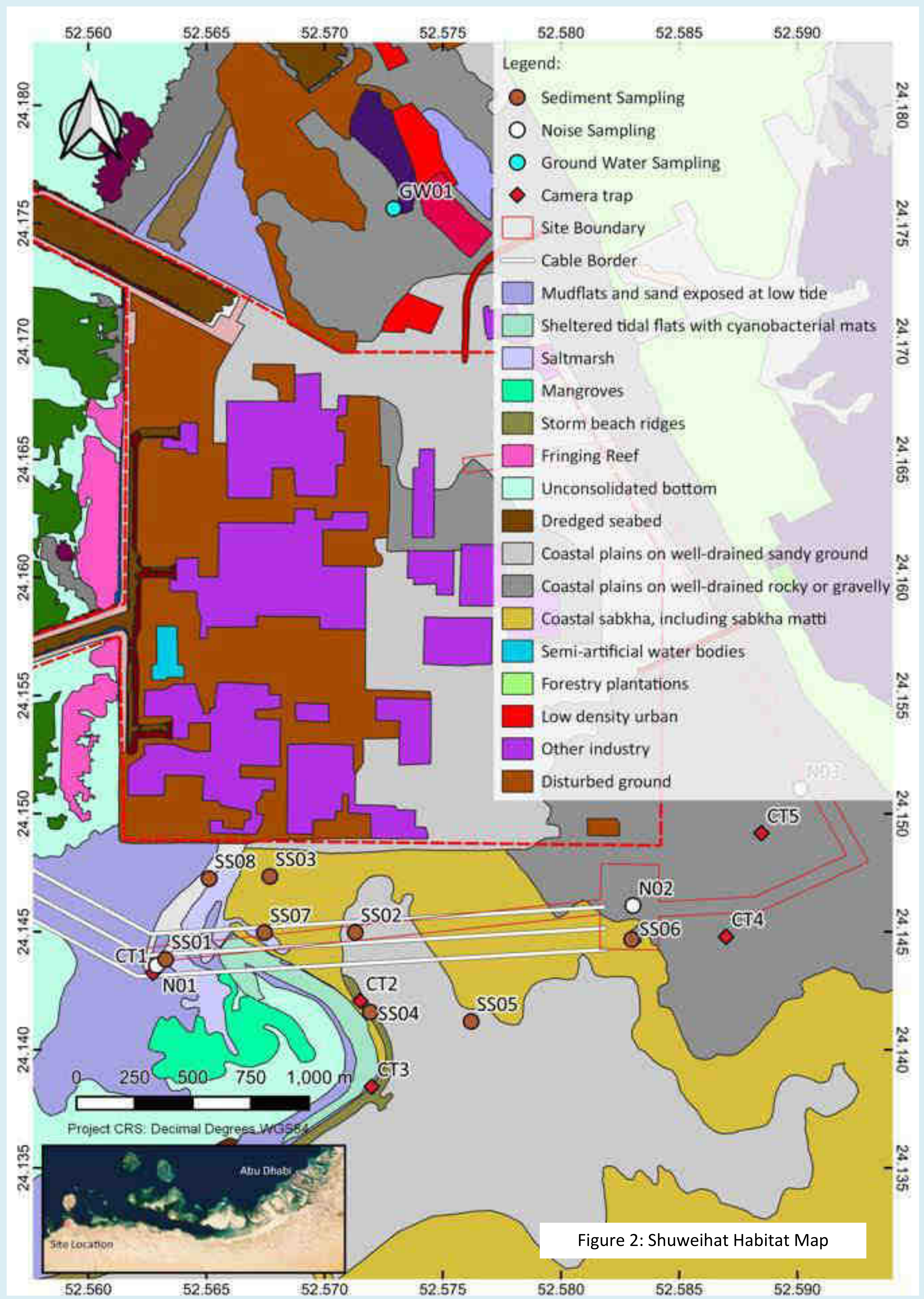

Figure 2: Shuweihat Habitat Map


Figure 3: Cardinal Point Locations
N
CP1
CP2
CP3
CP4
CP5
CP6
CP7
CP8
CP9
CP10
CP11
CP12
CP13
0 250 500 750 1,000 m
Project CRS: Decimal Degrees WGS84
Abu Dhabi
Site Location
Legend:
Cardinal Point
Project Boundary
Restricted Area
Cable Routing

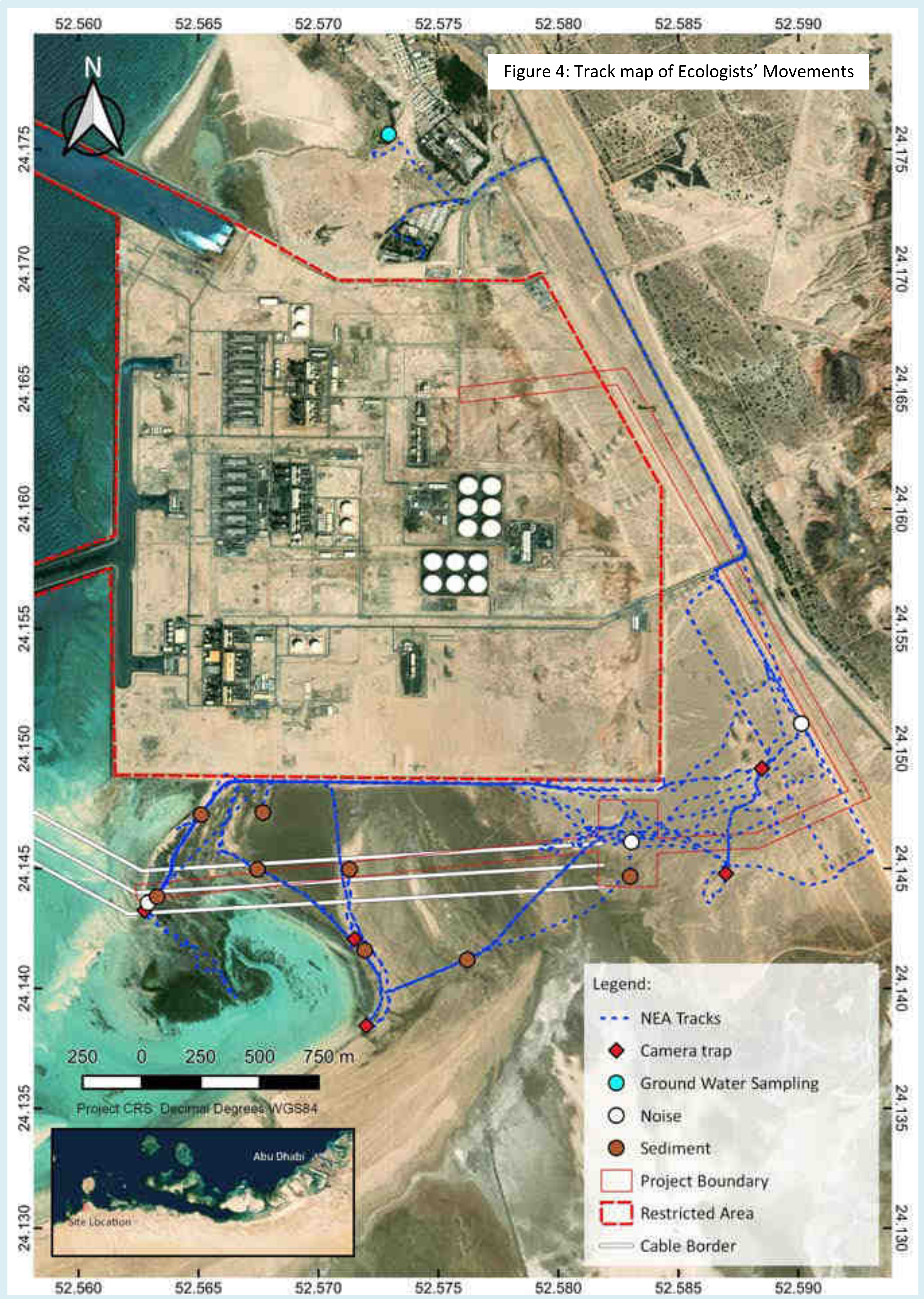
Figure 4: Track map of Ecologists' Movements
N
Legend:
NEA Tracks
Camera trap
Ground Water Sampling
Noise
Sediment
Project Boundary
Restricted Area
Cable Border
250 0 250 500 750 m
Project CRS: Decimal Degrees WGS84
Abu Dhabi
Site Location
52.560
52.565
52.570
52.575
52.580
52.585
52.590
24.175
24.170
24.165
24.160
24.155
24.150
24.145
24.140
24.135
24.130

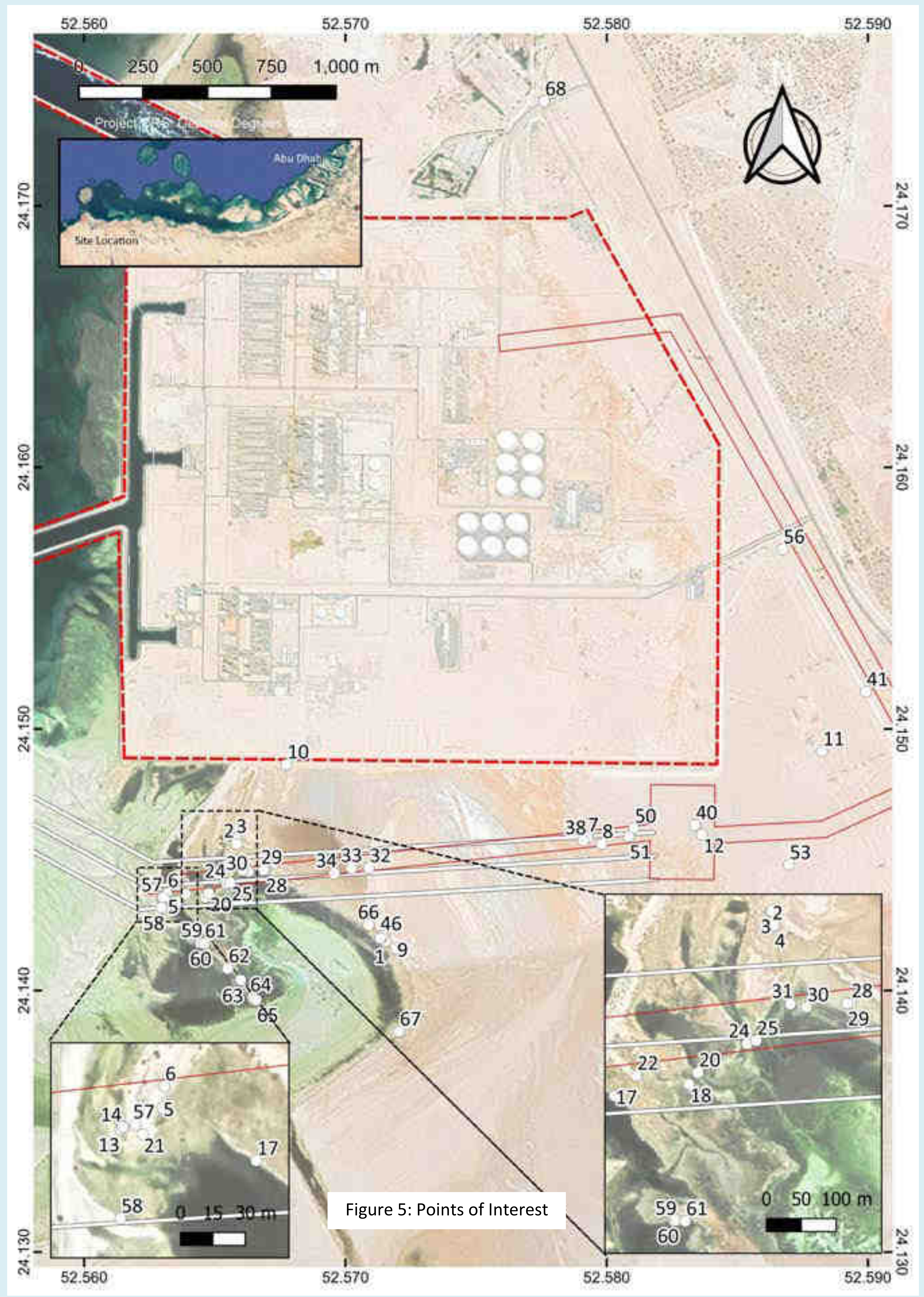


Figure 5: Points of Interest

| Table 2: Shuweihat Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
| GW01 | Ground Water Sampling | 24/05/2021 | 09:20 | NA | 24.17562526 | 52.57292094 | NA |
| N01 | Noise Sampling | 22/05/2021 | 17:30 | 15min | 24.14356397 | 52.56288604 | NA |
| N02 | Noise Sampling | 22/05/2021 | 20:30 | 15min | 24.14610227 | 52.58304192 | NA |
| N03 | Noise Sampling | 22/05/2021 | 19:55 | 15min | 24.15104399 | 52.59012404 | NA |
| SS01 | Sediment Sampling | 22/05/2021 | 14:15 | NA | 24.14382298 | 52.56327102 | NA |
| SS02 | Sediment Sampling | 22/05/2021 | 14:45 | NA | 24.14496526 | 52.57129242 | NA |
| SS03 | Sediment Sampling | 22/05/2021 | 17:00 | NA | 24.14733506 | 52.56767981 | NA |
| SS04 | Sediment Sampling | 22/05/2021 | 16:40 | NA | 24.14159004 | 52.57192902 | NA |
| SS05 | Sediment Sampling | 22/05/2021 | 16:25 | NA | 24.14119399 | 52.576197 | NA |
| SS06 | Sediment Sampling | 22/05/2021 | 16:15 | NA | 24.14466611 | 52.58298727 | NA |
| SS07 | Sediment Sampling | 22/05/2021 | 14:30 | NA | 24.14495797 | 52.567452 | NA |
| SS08 | Sediment Sampling | 22/05/2021 | 17:15 | NA | 24.14724296 | 52.56511101 | NA |
| CP1 | Cardinal Point | 23/05/2021 | 09:46 | NA | 24.14334 | 52.56285 | NA |
| CP2 | Cardinal Point | 23/05/2021 | 09:47 | NA | 24.14334 | 52.56287 | NA |
| CP3 | Cardinal Point | 23/05/2021 | 09:53 | NA | 24.14359 | 52.56474 | NA |
| CP4 | Cardinal Point | 23/05/2021 | 10:11 | NA | 24.14397 | 52.56493 | NA |

| Table 2: Shuweihat Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
| CP5 | Cardinal Point | 23/05/2021 | 10:15 | NA | 24.14424 | 52.56588 | NA |
| CP6 | Cardinal Point | 23/05/2021 | 10:21 | NA | 24.1446 | 52.56738 | NA |
| CP7 | Cardinal Point | 23/05/2021 | 10:52 | NA | 24.1444 | 52.56937 | NA |
| CP8 | Cardinal Point | 23/05/2021 | 10:57 | NA | 24.14482 | 52.57202 | NA |
| CP9 | Cardinal Point | 23/05/2021 | 11:07 | NA | 24.14582 | 52.57921 | NA |
| CP10 | Cardinal Point | 23/05/2021 | 11:10 | NA | 24.1457 | 52.57785 | NA |
| CP11 | Cardinal Point | 23/05/2021 | 17:28 | NA | 24.14367 | 52.56282 | NA |
| CP12 | Cardinal Point | 23/05/2021 | 18:06 | NA | 24.14605 | 52.5827 | NA |
| CP13 | Cardinal Point | 23/05/2021 | 18:22 | NA | 24.14643 | 52.5865 | NA |
| CT1 | Camera trap | 23/05/2021 | 17:38 | 12hrs | 24.14325 | 52.56274 | Arabian Red Fox |
| CT2 | Camera trap | 23/05/2021 | 17:50 | 12hrs | 24.14206 | 52.5715 | Arabian Red Fox |
| CT3 | Camera trap | 23/05/2021 | 18:01 | 12hrs | 24.13843 | 52.57199 | Arabian Red Fox |
| CT4 | Camera trap | 23/05/2021 | 18:34 | 12hrs | 24.14478 | 52.58698 | Nothing captured |
| CT5 | Camera trap | 23/05/2021 | 18:43 | 12hrs | 24.14917 | 52.58848 | Nothing captured |
| WPT 1 | Handheld GPS | 22/05/2021 | 15:08 | NA | 24.14189 | 52.57153 | Greater Hoopoe-Lark |
| WPT 2 | Handheld GPS | 22/05/2021 | 15:12 | NA | 24.14578 | 52.56579 | White-eared Bulbul |

| Table 2: Shuweihat Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
| WPT 3 | Handheld GPS | 22/05/2021 | 15:12 | NA | 24.14579 | 52.5658 | Grey Heron × 2 |
| WPT 4 | Handheld GPS | 22/05/2021 | 15:15 | NA | 24.1456 | 52.56583 | Kentish Plover nest (Eggs × 3) |
| WPT 5 | Handheld GPS | 22/05/2021 | 15:25 | NA | 24.14363 | 52.56315 | Kentish Plover |
| WPT 6 | Handheld GPS | 22/05/2021 | 16:08 | NA | 24.14372 | 52.56316 | Kentish Plover nest (Eggs × 1) |
| WPT 7 | Handheld GPS | 22/05/2021 | 17:02 | NA | 24.14584 | 52.57926 | Fox tracks |
| WPT 8 | Handheld GPS | 22/05/2021 | 17:03 | NA | 24.1456 | 52.5798 | Camel Skeleton |
| WPT 9 | Handheld GPS | 22/05/2021 | 18:40 | NA | 24.1416 | 52.57193 | Kentish Plover × 2 |
| WPT 10 | Handheld GPS | 22/05/2021 | 19:58 | NA | 24.14864 | 52.56774 | Kentish Plover nest (Eggs × 3) |
| WPT 11 | Handheld GPS | 22/05/2021 | 20:06 | NA | 24.14914 | 52.58824 | Hadramaut Sand Lizard |
| WPT 12 | Handheld GPS | 23/05/2021 | 09:20 | NA | 24.14596 | 52.58364 | Greater Hoopoe-Lark |
| WPT 13 | Handheld GPS | 23/05/2021 | 09:27 | NA | 24.14354 | 52.56296 | Graceful Prinia |
| WPT 14 | Handheld GPS | 23/05/2021 | 09:27 | NA | 24.14355 | 52.56297 | Western Reef Heron |
| WPT 15 | Handheld GPS | 23/05/2021 | 09:46 | NA | 24.14334 | 52.56285 | Cardinal Point 1 |
| WPT 16 | Handheld GPS | 23/05/2021 | 09:47 | NA | 24.14334 | 52.56287 | Cardinal Point 2 |
| WPT 17 | Handheld GPS | 23/05/2021 | 09:50 | NA | 24.14341 | 52.56358 | Grey Heron × 2 |
| WPT 18 | Handheld GPS | 23/05/2021 | 09:53 | NA | 24.14356 | 52.56463 | White-eared Bulbul |

| Table 2: Shuweihat Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
| WPT 19 | Handheld GPS | 23/05/2021 | 09:53 | NA | 24.14359 | 52.56474 | Cardinal Point 3 |
| WPT 20 | Handheld GPS | 23/05/2021 | 09:55 | NA | 24.14371 | 52.56476 | Mottled Crab |
| WPT 21 | Handheld GPS | 23/05/2021 | 10:05 | NA | 24.14352 | 52.56306 | Western Reef Heron |
| WPT 22 | Handheld GPS | 23/05/2021 | 10:08 | NA | 24.14367 | 52.56389 | Desert Hyacinth (Dead) |
| WPT 23 | Handheld GPS | 23/05/2021 | 10:11 | NA | 24.14397 | 52.56493 | Cardinal Point 4 |
| WPT 24 | Handheld GPS | 23/05/2021 | 10:13 | NA | 24.14408 | 52.56545 | Discarded fishing equipment |
| WPT 25 | Handheld GPS | 23/05/2021 | 10:14 | NA | 24.14412 | 52.56558 | Eurasian Curlew × 3 |
| WPT 26 | Handheld GPS | 23/05/2021 | 10:15 | NA | 24.14424 | 52.56588 | Cardinal Point 5 |
| WPT 27 | Handheld GPS | 23/05/2021 | 10:21 | NA | 24.1446 | 52.56738 | Cardinal Point 6 |
| WPT 28 | Handheld GPS | 23/05/2021 | 10:26 | NA | 24.1446 | 52.56691 | Fox tracks |
| WPT 29 | Handheld GPS | 23/05/2021 | 10:27 | NA | 24.1446 | 52.56686 | Grey Heron |
| WPT 30 | Handheld GPS | 23/05/2021 | 10:28 | NA | 24.14455 | 52.56629 | Kentish Plover |
| WPT 31 | Handheld GPS | 23/05/2021 | 10:28 | NA | 24.14459 | 52.56606 | Common Redshank |
| WPT 32 | Handheld GPS | 23/05/2021 | 10:46 | NA | 24.14468 | 52.57089 | Fox tracks |
| WPT 33 | Handheld GPS | 23/05/2021 | 10:48 | NA | 24.14467 | 52.57023 | Heron tracks (probably WRH) |
| WPT 34 | Handheld GPS | 23/05/2021 | 10:50 | NA | 24.14447 | 52.56957 | Heron tracks (probably GH) |

| Table 2: Shuweihat Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
| WPT 35 | Handheld GPS | 23/05/2021 | 10:52 | NA | 24.1444 | 52.56937 | Cardinal Point 7 |
| WPT 36 | Handheld GPS | 23/05/2021 | 10:57 | NA | 24.14482 | 52.57202 | Cardinal Point 8 |
| WPT 37 | Handheld GPS | 23/05/2021 | 11:07 | NA | 24.14582 | 52.57921 | Cardinal Point 9 |
| WPT 38 | Handheld GPS | 23/05/2021 | 11:08 | NA | 24.14573 | 52.57911 | Fox tracks |
| WPT 39 | Handheld GPS | 23/05/2021 | 11:10 | NA | 24.1457 | 52.57785 | Cardinal Point 10 |
| WPT 41 | Handheld GPS | 23/05/2021 | 12:05 | NA | 24.15142 | 52.58992 | Blue-cheeked Bee-eater |
| WPT 42 | Handheld GPS | 23/05/2021 | 17:28 | NA | 24.14367 | 52.56282 | Cardinal Point 11 |
| WPT 43 | Camera trap | 23/05/2021 | 17:38 | 12hrs | 24.14325 | 52.56274 | Camera Trap 1 |
| WPT 44 | Camera trap | 23/05/2021 | 17:50 | 12hrs | 24.14206 | 52.5715 | Camera Trap 2 |
| WPT 45 | Handheld GPS | 23/05/2021 | 17:51 | NA | 24.14214 | 52.57144 | White-spotted Lizard |
| WPT 46 | Handheld GPS | 23/05/2021 | 17:53 | NA | 24.14206 | 52.57144 | Antlion |
| WPT 47 | Handheld GPS | 23/05/2021 | 17:55 | NA | 24.142 | 52.57133 | Tiger Beetle |
| WPT 48 | Camera trap | 23/05/2021 | 18:01 | 12hrs | 24.13843 | 52.57199 | Camera Trap 3 |
| WPT 49 | Handheld GPS | 23/05/2021 | 18:06 | NA | 24.14605 | 52.5827 | Cardinal Point 12 |
| WPT 50 | Handheld GPS | 23/05/2021 | 18:12 | NA | 24.14619 | 52.58104 | Domestic dog tracks |
| WPT 51 | Handheld GPS | 23/05/2021 | 18:15 | NA | 24.14588 | 52.58085 | Fox scat |

| Table 2: Shuweihat Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
| WPT 52 | Handheld GPS | 23/05/2021 | 18:22 | NA | 24.14643 | 52.5865 | Cardinal Point 13 |
| WPT 53 | Handheld GPS | 23/05/2021 | 18:28 | NA | 24.1448 | 52.58697 | Gerbil burrow |
| WPT 54 | Camera trap | 23/05/2021 | 18:34 | 12hrs | 24.14478 | 52.58698 | Camera Trap 4 |
| WPT 55 | Camera trap | 23/05/2021 | 18:43 | 12hrs | 24.14917 | 52.58848 | Camera Trap 5 |
| WPT 56 | Handheld GPS | 24/05/2021 | 09:17 | NA | 24.15687 | 52.58673 | European Roller |
| WPT 57 | Handheld GPS | 24/05/2021 | 09:39 | NA | 24.14356 | 52.56303 | Blue-cheeked Bee-eater × 2 |
| WPT 58 | Handheld GPS | 24/05/2021 | 09:41 | NA | 24.14317 | 52.56296 | Graceful Prinia |
| WPT 59 | Handheld GPS | 24/05/2021 | 09:53 | NA | 24.1418 | 52.56442 | Asian Dwarf Honeybee x 100 |
| WPT 60 | Handheld GPS | 24/05/2021 | 09:53 | NA | 24.14181 | 52.56445 | Blue-spotted Arab Butterfly |
| WPT 61 | Handheld GPS | 24/05/2021 | 10:00 | NA | 24.1418 | 52.56458 | Oriental Wasp |
| WPT 62 | Handheld GPS | 24/05/2021 | 10:07 | NA | 24.14084 | 52.56549 | Globe Skimmer Dragonfly |
| WPT 63 | Handheld GPS | 24/05/2021 | 10:13 | NA | 24.1404 | 52.56599 | Carmine Darter Dragonfly |
| WPT 64 | Handheld GPS | 24/05/2021 | 10:15 | NA | 24.13972 | 52.56645 | Striated Heron |
| WPT 65 | Handheld GPS | 24/05/2021 | 10:16 | NA | 24.13964 | 52.56658 | Western Reef Heron × 7 |
| WPT 66 | Handheld GPS | 24/05/2021 | 10:34 | NA | 24.1425 | 52.57088 | Grey Heron × 7 |
| WPT 67 | Handheld GPS | 24/05/2021 | 10:43 | NA | 24.13843 | 52.57204 | Globe Skimmer Dragonfly × 5 |

| Table 2: Shuweihat Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
| WPT 68 | Handheld GPS | 24/05/2021 | 11:01 | NA | 24.174 | 52.5776 | Hooded Malpolon |

Table Key:

NA = Not Applicable

CT = Camera Trap

CP = Cardinal Point

ID = Site ID / min = Minute(s)

Lat + Long in Decimal Degrees

WRF = Western Reef Heron

GH = Grey Heron

## 2.0 Methodology

### 2.1 Baseline Noise Measurements

Baseline noise measurements were carried out at three sites at the Shuweihat location and included both weekday and weekend measurement periods. Measurements at each site were carried out for 15-minutes and repeated for day and night-time (total of four measurements per site). Surveys were undertaken in parallel with ongoing ecological surveys of the location.

Measurements were collected using a bench- and field-calibrated Rion NL-52 integrating Class 1 (IEC 61672-2002) sound level meter with data stored on the device's internal memory as well as on detailed field-sheets (Plate 1). Measurement locations were chosen to minimise reflective phenomena or interruptive weather conditions in accordance with ISO1996-1:2016.

Reported parameters included maximum and average noise levels as well as identification of specific sound events where feasible and were reflective of the characteristics of the ambient noise environment and nature of the project.

- Measurements Overview:
    - 15-minutes each site (day/night/weekday/weekend)
    - Total 1 hour per site
    - Total 3 hours at location
- Parameters:
    - $L_{Aeq}$, $L_{AMax}$, $L_{A10}$, $L_{A50}$, $L_{A90}$

### 2.2 Soil and Groundwater Inspection and Analysis

A visual survey of the surface for any signs of contamination was conducted in parallel with ecological and noise survey data collections at the location. Where visible contamination was identified, a GPS waypoint was collected. For large areas, a tracked path was walked around the edge, using the GPS tracklog to map the extent of contamination. All identified instances were reported with accompanying geo-referenced photographs.

8 soil samples were collected by hand augur along the cable corridor (see Figure 1) and analysed at an ENAS accredited laboratory. Data is provided in Annex B.

One groundwater sample was collected, GW01 in Figure 1, to the north of the Shuweihat power plant.

## 2.3 Ecology Survey Methodology

Field activities involved day-time drive-over and walkabouts (Plate 2) in selected areas, with one overnight trapping effort involving deployment of Browning camera traps (Plate 4) at selected locations. Figure 1 details trap and photo locations.

Browning camera traps were deployed at locations considered potentially suitable for mammal and/or reptile activity, such as near burrows or in areas of particularly dense vegetation and/or visible track activity. Plate 5 shows the result from one of the traps deployed.

Binoculars (Plate 3) were also used to help find and identify bird species within the area and where possible, high-definition pictures were taken and have been used in this report were deemed appropriate.

All photos displayed in this report were taken on location unless otherwise stated (NEA File Photo).

Plate 1: Noise meter deployment on location

Plates 2 & 3: Mangrove evaluations on location (top); Bird observations using monocular on location (bottom)

Plates 4 & 5: Camera Trap deployed on location close to fox tracks (top); Fox recorded on location (bottom)

## 3.0 Survey Results

### 3.1 Noise Measurement Analysis, Locations and Results

#### 3.1.1 Noise Measurement Analysis

A baseline survey was conducted in the area of the proposed landfall, including three separate locations, with four fifteen-minute measurements each. The combined measurement period at each location was 1 hour, representing weekday, week night, weekend day and weekend night time periods.

The aim of the noise measurements is to provide an indication of existing ambient conditions as well as to identify any significant anthropogenic noise sources which may affect any subsequent assessments of noise.

Measurements were collected using a bench- and field-calibrated Rion NL-52 integrating Class 1 (IEC 61672-2002) sound level meter (SLM) with data stored on the device's internal memory as well as on detailed field-sheets. The SLM and microphone were field calibrated before and after each measurement to detect and account for any drift in the measured noise levels.

Measurement locations were chosen to minimise reflective phenomena or interruptive weather conditions in accordance with ISO1996-1:2016.

#### 3.1.2 Noise Measurement Locations

Classification of the Shuweihat landfall area is debatable. While it would typically be classified as 'residential with light traffic' (day and night time noise limits of 50 dBA and 40 dBA respectively), the proximity to the powerplant and lack of any other anthropogenic receptors may be argued to assign a 'Heavy Industrial' classification (day and night time noise limits of 70 dBA and 60 dBA respectively). The completion of the landfall infrastructure would expectedly result in the area being reclassified as 'heavy industry' regardless, and as such all ambient noise levels have been assessed against the heavy industry limits for day and night time periods of 70 dBA and 60 dBA respectively.

Three noise measurement locations were identified for the purposes of capturing the ambient noise climate of the landfall project area. While these were located within the alignment of the cable landfall, the assessment conservatively considers them to be representative of residential noise receptors, such as those to the north of the alignment. The locations of the noise measurement stations (N01-N03) are shown in Figure 1.

### 3.1.3 Noise Results and Analysis

A breakdown of measured noise metrics for the measurement sites at the Shuweihat landfall is provided in Tables 3, 4 and 5.

It is noted that in each case, the ambient night time noise level would exceed the residential limit of 40 dBA and is higher than the corresponding day time noise level for the same location. While the exact cause is unclear, the otherwise undisturbed surroundings and the proximity of these sites to the neighbouring powerplant points to this as being the most likely cause. Operating practices within the plant are not known, however it is not unlikely that the plant emits a higher noise level during peak demand times (such as in the evenings and early mornings in order to accommodate the higher load.

Given that the area will fall under the less conservative ‘heavy industry’ classification following the completion of the landfall construction, the elevated night time noise level is not expected to result in any long term impacts to anthropogenic receptors. The same cannot however be said for ecological receptors which may inhabit the nearshore vegetative structures and beach areas. It would be proposed that a long-term noise measurement (minimum 96 hours) be collected from near the mangrove habitat, in order to determine a true baseline noise profile for this ecologically sensitive feature.

Table 3: Noise measurement metrics for Shuweihat Landfall, site N01

| | Site→ | N01 | | | |
|---|---|---|---|---|---|
| ↓Parameter | Period→ | Week Day | Week Night | Weekend D | Weekend N |
| $L_{Aeq}$ | dBA | 44.2 | 45.5 | 38.2 | 42.1 |
| $L_{max}$ | dBA | 56.4 | 54.2 | 49.9 | 49.3 |
| $L_{10}$ | dBA | 45.0 | 47.6 | 39.2 | 43.5 |
| $L_{50}$ | dBA | 44.1 | 44.9 | 38.0 | 41.8 |
| $L_{90}$ | dBA | 43.3 | 43.2 | 37.1 | 40.8 |
| Environmental Conditions | | | | | |
| Average Windspeed | m/s | 3.61 | 1.89 | 1.98 | 1.34 |
| Max Windspeed | m/s | 4.56 | 3.42 | 3.94 | 2.67 |
| Average Temp | °C | 37.4 | 33.1 | 40.3 | 31.6 |
| Average Humidity | % | 35.0 | 42.1 | 17.1 | 68.2 |
| Table Key: | | | | | |
| | Exceeds the relevant ambient noise limit of 70 dBA (daytime) or 60 dBA (night-time) | | | | |
| D = Day / N = Night / dBA = Decibels / m/s = Metres per Second / °C = Degrees Centigrade / % = Percentage | | | | | |

| Table 4: Noise measurement metrics for Shuweihat Landfall, site N02 | | | | | |
|---|---|---|---|---|---|
| Site | | N02 | | | |
| Period | | Week Day | Week Night | Weekend D | Weekend N |
| $L_{Aeq}$ | dBA | 37.9 | 44.4 | 39.0 | 40.5 |
| $L_{max}$ | dBA | 61.2 | 49.8 | 50.6 | 52.3 |
| $L_{10}$ | dBA | 39.5 | 45.4 | 41.3 | 41.5 |
| $L_{50}$ | dBA | 37.2 | 44.4 | 38.4 | 40.4 |
| $L_{90}$ | dBA | 35.6 | 43.4 | 36.5 | 39.4 |
| Environmental Conditions | | | | | |
| Average Windspeed | m/s | 3.64 | 3.92 | 4.82 | 2.37 |
| Max Windspeed | m/s | 4.69 | 5.58 | 5.81 | 3.81 |
| Average Temp | °C | 37.5 | 34.6 | 41.9 | 33.3 |
| Average Humidity | % | 34.6 | 37.0 | 14.1 | 57.4 |
| Table Key: | | | | | |
| | Exceeds the relevant ambient noise limit of 70 dBA (daytime) or 60 dBA (night-time) | | | | |
| D = Day / N = Night / dBA = Decibels / m/s = Metres per Second / °C = Degrees Centigrade / % = Percentage | | | | | |

| Table 5: Noise measurement metrics for Shuweihat Landfall, site N03 | | | | | |
|---|---|---|---|---|---|
| Site | | N03 | | | |
| Period | | Week Day | Week Night | Weekend D | Weekend N |
| $L_{Aeq}$ | dBA | 41.8 | 51.4 | 45.4 | 47.7 |
| $L_{max}$ | dBA | 50.2 | 62.8 | 57.2 | 59.2 |
| $L_{10}$ | dBA | 44.0 | 54.3 | 48.3 | 51.0 |
| $L_{50}$ | dBA | 41.4 | 50.5 | 44.2 | 46.9 |
| $L_{90}$ | dBA | 39.7 | 48.1 | 41.6 | 42.1 |
| Environmental Conditions | | | | | |
| Average Windspeed | m/s | 2.79 | 4.59 | 4.57 | 1.59 |
| Max Windspeed | m/s | 4.14 | 7.08 | 6.44 | 3.08 |
| Average Temp | °C | 39.1 | 34.1 | 42.0 | 33.8 |
| Average Humidity | % | 29.1 | 44.6 | 15.8 | 51.2 |
| Table Key: | | | | | |
| | Exceeds the relevant ambient noise limit of 70 dBA (daytime) or 60 dBA (night-time) | | | | |
| D = Day / N = Night / dBA = Decibels / m/s = Metres per Second / °C = Degrees Centigrade / % = Percentage | | | | | |

## 3.2 Soil and Groundwater Analysis

### 3.2.1 Soil Analysis

Soil sampling was undertaken during site visits in May, at eight targeted locations within the survey area via a hand auguring tool to a target depth of up to 2m below ground level (bgl) or to the depth where bedrock or groundwater was encountered.

The excavated soil was placed on a clean plastic sheet, free from potential contaminants or cross contaminants. Samples were then packaged, sealed, and marked and stored in a dedicated sample box for transportation to the laboratory.

The coordinates for the monitoring locations are presented in Table 6 and locations are provided in Figure 1.

Table 6: Soil Sampling Locations

| Site ID | Latitude | Longitude | Depth (m) |
|---|---|---|---|
| SS01 | 24.143799 | 52.563299 | 1.9 |
| SS02 | 24.145000 | 52.571300 | 1.5 |
| SS03 | 24.147300 | 52.565100 | 1.5 |
| SS04 | 24.141600 | 52.571899 | 1.6 |
| SS05 | 24.141200 | 52.576200 | 1.7 |
| SS06 | 24.144700 | 52.582999 | 1.2 |
| SS07 | 24.145000 | 52.567500 | 1.8 |
| SS08 | 24.147200 | 52.565100 | 1.6 |

Table Notes:

Latitude / Longitude in WGS84 Decimal Degrees

m = Metres

The full results are presented in Annex C. The results were compared with the Abu Dhabi Quality and Conformity Council (ADQCC) Environmental Specification for Soil Contamination Limits for Industrial and Commercial use (ADS 19/2017). A copy of the standards is provided at Table B2, Annex B.

Results for all locations/depths were in compliance with the standards and there were no visible signs of soil contamination or significant odour recorded from any location or any sample collected.

### 3.2.2 Groundwater Analysis

Although there were no wells or sources within the direct pipeline footprint, one groundwater sample was collected from a pond to the north of the SPP, GW01, shown in Figure 1. Table 7, below, provides location details and Annex B, Figure B3, provides the laboratory results.

| Table 7: Groundwater Sampling Locations | | | |
|---|---|---|---|
| Site ID | Latitude | Longitude | Depth (m) |
| GW01 | 24.175599 | 52.572899 | Surface (pond) |
| Table Notes: Latitude & Longitude in WGS84 Decimal Degrees / m = Metres | | | |

Results exceeding LOD are shown in Table 8, together with standard limits. Despite exceedances for salinity, other parameters were in general compliance with the standards, with no significant odour recorded. The location is also adjacent to two accommodation camps, NCC and Hans Esser Camp and is considered more likely to be influenced by their activities and possible impacts.

| Table 8: Groundwater Results above Limits of Detection | | | |
|---|---|---|---|
| Parameter | Unit | Value | Standard Limit |
| Fluoride | mg/L | 1.7 | Not specified |
| Chemical Oxygen Demand | mg/L | 50 | Not specified |
| Arsenic (As) | mg/L | 0.0093 | 0.06 |
| Cadmium (Cd) | mg/L | 0.0009 | 0.006 |
| Lead (Pb) | mg/L | 0.0021 | 0.075 |
| Copper (Cu) | mg/L | 0.0017 | 0.075 |
| Manganese (Mn) | mg/L | 0.028 | Not specified |
| Antimony (Sb) | mg/L | 0.0023 | 0.02 |
| Barium (Ba) | mg/L | 0.0087 | 0.625 |
| Cobalt (Co) | mg/L | 0.0042 | 0.1 |
| Chromium (Cr) | µg /L | 1.7 | 30 |
| Nickel (Ni) | µg/L | 6.3 | 75 |
| Table Notes: mg/L = Milligrams per Litre / µg/L = Micrograms per Litre | | | |

## 3.3 Ecological Survey

### 3.3.1 Habitats

The habitat classifications described in this report are defined based on a *priori schema* classification system devised by Brown and Boer in 'Interpretation Manual of the Major Terrestrial Natural and Semi-natural Habitat Types of Abu Dhabi Emirates'. These categories have been expanded by the EAD to include elements of land use and land cover.

NEA was part of a consortium that produced a habitat map for the whole of the emirate of Abu Dhabi, under contract from EAD. The main tool used in mapping was satellite imagery, but with a lot of ground-truthing by NEA. A computer was "trained" to recognise spectral signatures of habitats, and these were then mapped automatically. The accuracy of the map was confirmed by visiting a very large number of pre- selected random points. The distribution of the habitats discussed in this report are shown in Figure 2, which has been taken from the final habitat map for the emirate (which is available on the EAD website).

The latest revision of the Environment Agency Abu Dhabi (EAD) Habitat Map was referred to and was found to depict fairly accurately what is on-ground, therefore, no significant habitat revalidations are required for the site at the time of writing. However, a couple of habitats identified on-site cover small areas, that are often interspersed within major habitat-types (such as beach rock within mangroves and cyanobacterial mats covering sections of intertidal flats) and are therefore absent from the map (too small for the Minimum Mapping Units [MMU] used). Clear limitations inhibit habitat classification using satellite imagery only, particularly at small sites, highlighting the benefits of having an ecologist on-ground that can identify the habitats with greater accuracy.

Investigations conducted by NEA ecologists on-ground at the site, concluded that the strip of intertidal flats to the west of the sheltered embayment was covered almost entirely with mats of cyanobacteria (Plate 20) and thus warranted reclassification. Figure 2 shows an updated habitat distribution map that reflects changes made by NEA to the pre-existing habitat map produced by EAD.

The proposed landfall pipeline will be situated within several coastal habitats. Starting from the coast the pipeline will make landfall over an extensive area of intertidal mudflats before travelling over supratidal zones where mangrove forest, saltmarsh and cyanobacterial mats occur. The proposed route will then pass over a thin storm beach ridge which marks the high tide line and the end of the intertidal habitats. Beyond the intertidal zones, after traversing over coastal plains and sabkha, the route eventually reaches higher, rocky plains upon which the power complex's western limits and entrance sits.

The greater survey area (within 500m of pipeline footprint) encompasses a total of 11 terrestrial habitats. Of these, Other Industry (EAD Habitat Code (EAD HC) 9240), Low Density Urban (EAD HC 9120), Paved Roads (EAD HC 9400) and Disturbed Ground (EAD HC 9600) constitute the unnatural habitats within the greater survey area.

Natural habitats present within the greater site comprise of Mudflats and Sand Exposed at Low Tide (EAD HC 1010), Coastal Plains on Well-drained Rocky or Gravelly Terrain (EAD HC 2012), Coastal Sabkha (EAD HC 3100), Mangroves (EAD HC 1040), Coastal Plains on Well-drained Sandy Ground (EAD HC 2011), Storm Beach Ridges (EAD HC 1050), Saltmarsh (EAD HC 1030) and Sheltered Tidal Flats with Cyanobacterial Mats (EAD HC 1020).

The proposed pipeline will be directly situated in seven of the abovementioned natural habitats. The threat status, area in $km^2$, description and percentage cover of the seven habitats directly situated within the proposed route are presented in Table 9 overleaf.

Three habitats that are classified as 'Critical Habitats' by EAD, occur within the site footprint. These are Mangroves (EAD HC 1040), Saltmarsh (EAD HC 1030) and Intertidal Mudflats and Sand Exposed at Low Tide (EAD HC 1010).

'Critical' habitats are a highly threatened and/or unique ecosystem. They provide areas that play a key role in supporting the various life stages of local species. On a global scale these habitats support significant concentrations of migratory species. Further loss of these threatened habitat types could result in a severe loss of endemic or threatened species and ecosystem function.

The Shuweihat pipeline landfall project is bordered by a range of important terrestrial, intertidal and subtidal habitats worthy of mitigation and preservation. These include the following:

- Mudflats and sand exposed at low tide;
- Coastal plains on well-drained sandy ground;
- Mangroves, saltmarsh and coastal sabkha;
- Subtidal seagrass beds and unconsolidated bottom;
- Fringing macroalgal dominated reef (marine habitat);

Terrestrial habitats classified as critical and environmentally sensitive are discussed in greater detail in the following sections, with marine habitats/species not forming a part of this scope.

| Table 9: Habitat Description & % cover (Pipeline Footprint) | | | | |
|---|---|---|---|---|
| H/T | Description | Threat Status (EAD) | Area ($km^2$) | % Cover (PF) |
| 1010 | Mudflats and sand exposed at low tide | Critical Habitat | 0.19920396 | 21.19 |
| 1030 | Saltmarsh | Critical Habitat | 0.03771049 | 4.01 |
| 1040 | Mangroves | Critical Habitat | 0.00403992 | 0.43 |
| 2011 | Coastal plains on well-drained sandy ground | Not Sensitive or Critical | 0.13806982 | 14.69 |
| 2012 | Coastal plains on well-drained rocky or gravelly terrain | Not Sensitive or Critical | 0.28663813 | 30.50 |
| 2020 | Coastal sand sheets and low dunes | Environmentally Sensitive Habitat | 0.01168455 | 1.24 |
| 3100 | Coastal sabkha, including sabkha matti | Environmentally Sensitive Habitat | 0.26082332 | 27.75 |
| 9400 | Paved roads | Not Sensitive or Critical | 0.00172188 | 0.18 |

Table Key:

H/T = Habitat Type (EAD Classification, 2013)

PF = Pipeline Footprint

% = Percentage

$Km^2$ = Square Kilometres

### 3.3.1.1 Mangroves

A mature and dense mangrove forest fringes the embayment along the coast of the proposed pipeline landfall site. This habitat consists of inter-tidal areas dominated by the Grey Mangrove, *Avicennia marina*.

According to the EAD Habitat Map the mangrove habitat type covers approximately 0.43% of the proposed pipeline footprint. It is a critical habitat for many bird and fish species, acting as a nursery for the juvenile fish, as well as providing other ecosystem services such as coastal protection and aesthetic value.

The mangrove root systems stabilise the underlying sediment, which is rich in nutrients from decaying leaves and wood, and home to sponges, worms, crustaceans, molluscs, and algae. The habitat is home to small crabs; fish species; and bird species operating on the periphery of the mangroves.

During the time of the survey (late May) the mangroves were in flower which attracted an abundance of pollinators, including numerous Asian Dwarf Honeybees, *Apis florea*, several wasps including an Oriental Wasp, *Campsomeriella thoracica*, and the butterflies: Blue-spotted Arab, *Colotis phisadia phisadia* and Small Salmon Arab, *Colotis amata*. The insects found in the mangroves will be discussed in greater detail below in section 3.2.4. Though in flower during the survey period, the mangroves were not yet in fruit.

The mangroves in the study area appeared to be in good health with healthy leaves and branches and no apparent diseases or dead trees were observed. Fish fry and the Mottled Crab, *Metopograpsus messor*, a grapsid crab that inhabits mangroves, were found in abundance between the mangrove pneumatophores. Plate 8 shows the latter photographed during the survey.

In areas where surface water remained the longest between tidal cycles, macroalgal species, dominated by *Chaetomorpha* sp. was recorded covering pneumatophores (Plate 10). The mangrove stands were largely devoid of any anthropogenic debris. However, a couple of discarded fishing nets were recorded entangled with the pneumatophores (Plate 11).

Plates 6 and 7: Grey Mangrove, *Avicennia marina* (top and bottom)

Plates 8 and 9: Mottled Crab, *Metopograpsus messor* (top), Grey Mangrove, *Avicennia marina* (bottom)

Plates 10 and 11: Mangrove pneumatophores covered with some algae (top), fishing rope and nets entangled with mangrove pneumatophores (bottom)

### 3.3.1.2 Saltmarsh

The saltmarsh habitat consists of intertidal areas dominated by emergent halophytic herbaceous vegetation and shrubs. Saltmarsh vegetation types coexist with mangroves and are generally found in slightly higher elevations than mangroves.

Within the saltmarsh habitat of the study area, *Arthrocnemum macrostachyum*, is the dominant component of low-level saltmarsh that tolerates frequent inundation on the coast of the survey area. A striking feature of halophytic vegetation is that the individual stands tend to be species-poor or even monospecific where one species occupies large patches. This was found to be the case in the survey area where *A. macrostachyum* was predominant and often occurred in large swathes as the sole saltmarsh plant species representative of the habitat.

According to the EAD Habitat Map this habitat type covers an area of approximately 0.050km$^2$ of the greater survey area, seen in Plates 12 to 14.

Organisms found in saltmarsh habitats include crabs; gastropods; and polychaetes. Saltmarsh is considered a "Blue Carbon" habitat type because it is a coastal and marine habitat that is able to sequester and store carbon.

These habitats are currently facing pressures from dredging, excavation and infilling activities associated with coastal developments.

Plate 12: Saltmarsh in the study area

Plates 13 and 14: Saltmarsh adjacent to a tidal creek (top), NEA ecologist surveying saltmarsh habitat (bottom)

### 3.3.1.3 Coastal Sabkha

Coastal sabkha is salt-encrusted desert close to the coast covering wide expanses. It is devoid of vegetation due to the high salinity of the substrate. Halophytes, however, may occur where there is a thin carpeting of sand on the surface. Abu Dhabi's coastal sabkha are some of the best documented in the world.

The sabkha plains at the overall survey location cover approximately 27% of the pipeline footprint survey area. While not a traditional Blue Carbon ecosystem, historic soil carbon stocks in Coastal sabkha are likely to have a Blue Carbon origin. When these ecosystems are destroyed, buried carbon can be released into the atmosphere, which subsequently contributes to global warming. Coast is pro-grading and the elevation of the intertidal flats and sabkha has been gradually rising with accumulation of marine carbonate and other, mostly windblown, material. (Note that global sea-level rise caused by anthropogenic factors may affect this long-term trend).

The line between intertidal flats and coastal sabkha is not clearly defined, because it is determined by how far into the sabkha the seawater extends on the highest tides, and this is affected in turn by wind and wave energy. The upper limit of the intertidal flats roughly coincides with the upper limit of the area that is used as a feeding ground by waders. Similarly, the dividing line between sabkha and coastal plain can be very indistinct and may even vary throughout the course of the year.

Although coastal sabkha is an environmentally sensitive habitat, ecologically speaking, it is an especially species-poor habitat with very few, if any, species being wholly dependent on the habitat for their survival.

Plate 15: Coastal Sabkha in the study area

Plates 16 and 17: Coastal Sabkha (top), close-up of Coastal Sabkha (bottom)

## 3.3.1.4 Beach Ridges (1050)

This environmentally sensitive habitat type is characterised by sandy vegetated areas dotted with knolls rising above ground. Formerly present along the majority of the mainland west coast of Abu Dhabi, they usually lie parallel to the high-water mark rising a few decimetres to centimetres above the ground (Plate 18). They consist of shelly sand blown inland from the intertidal zone during storms and are subject to occasional inundation. The ridges or knolls may develop parallel to one another with the older ridges on the landward side vegetated by dense covers of halophytic chenopods.

Depending on the locality and precise environmental conditions, common floral species associated with this habitat type are *Salosa drummondii*, *Salsola imbricata*, *Halopeplis perfoliata*, *Tetraena qatarensis*, *Anabasis setifera*, *Cornulaca aucheri* and *Sesuvium verrucosum*. However, the most characteristic species of this habitat is *Sueda vermiculata*.

Kentish Plover, *Charadrius alexandrinus*, and Saunder's Tern, *Sternula saundersi*, locally breed in storm beach ridges, and Hawksbill Turtles, *Eretmochelys imbricata*, use them for nesting. This habitat faces threats from climate change as well as coastal development and its associated pressures such as dredging and land filling.

Plate 18: Storm Beach Ridge at the location

### 3.3.1.5 Mudflats and Sand Exposed at Low Tide

The intertidal flats at the eastern end of the development site are classified as mudflats and sand exposed at low tide, by EAD (Figure 2). These habitats are coastal wetlands that form when mud is deposited by tides and are classified as a critical habitat due to the number of species that they support.

Mudflats are often devoid of vegetation but can also be found with less than 10% vegetation cover. No plants are generally found in these habitats, with the exception of one species of seagrass, *Halodule uninervis*, which can be exposed at low tide (usually sparse).

Plate 19: Mudflats and Sand Exposed at Low Tide

According to the EAD Habitat Map this habitat type at the project location covers an area of approximately 0.86km$^2$ within the greater survey area, and 21.19% of the Proposed Pipeline Footprint. This is an important habitat for wading birds feeding on benthic invertebrates during low tides.

Migratory species in the plover and sandpiper families as well as herons frequent these habitats and feed on tidal flats at low tide. These habitats are currently facing pressures from dredging, excavation and infilling activities associated with coastal developments.

### 3.3.1.6 Sheltered Tidal Flats with Cyanobacterial Mats

This habitat consists of mats of cyanobacteria overlying saline sand in sheltered, low-lying locations that are adjacent to, or are on, the upper margin of intertidal flats. During unusually high tidal cycles these sheltered flats become inundated by rising seawater. This habitat is usually devoid of higher plants, although some halophytes may occur where there is a thin layer of surface sand. These flats are usually black or dark green in colour and are often entirely covered by cyanobacterial mats. Classified as an environmentally sensitive habitat, they hold immense value as a blue carbon storage habitat.

Marine mammal and reptile skeletal remains are often washed up on these flats, though none were found at the time of survey.

Covering a relatively minor area (0.088km$^2$) at the site of study, this habitat was absent from EAD's habitat map. Investigations conducted by NEA ecologists on-ground at the site, concluded that the strip of intertidal flats to the west of the sheltered embayment are covered almost entirely with mats of cyanobacteria (Plate 20) and thus warrant reclassification. Figure 2 shows an updated habitat distribution map that reflects alterations made by NEA to the pre-existing habitat map produced by EAD.

Plate 20: Sheltered Tidal Flats with Cyanobacterial Mats

### 3.3.2 Flora

With the exception of planted species along the roadside at the easternmost perimeter of the site, thirteen naturally occurring species of vascular plant were recorded across each habitat in the survey area, as follows:

- *Cornulaca aucheri*;
- *Salsola imbricata*;
- *Haloxylon salicornicum*;
- *Avicennia marina* (Grey Mangrove);
- *Anabasis setifera*;
- *Stipagrostis plumosa*;
- *Arthrocnemum macrostachyum* (Glasswort);
- *Halopeplis perfoliata*;
- *Heliotropium kotschyi*;
- *Suaeda vermiculata*;
- *Cistanche Tubulosa* (Desert Hyacinth);
- *Tetraena qatarensis*;
- *Tetraena simplex*;

All these species are halophytes except *Stipagrostis plumosa*, *Heliotropium kotschyi* and *Haloxylon salicornicum*, all of which were present further away from the coast at higher elevations within coastal plains on well-drained rocky ground. Grey Mangrove (*Avicenna marina*) Is present in high densities within the sheltered embayment to the east of the survey area. Mature, healthy trees, range in height from 2m up to 5m.

Little rainfall has occurred in the months preceding the survey so it is likely that the thirteen plants recorded in the survey will be supplemented by additional annuals following periods of rain in cooler months.

*Arthrocnemum macrostachyum*, is a typical component of low-level saltmarsh that tolerates frequent inundation on the coast of Abu Dhabi. A striking feature of halophytic vegetation is that the individual stands tend to be species-poor or even monospecific where one species occupies large patches. This was found to be the case in the survey area where *A. macrostachyum* was the dominant and often sole saltmarsh plant. *A. macrostachyum* is described as a much-branched growing in clumps up to a metre high (3 ft). It is a common and widespread in the UAE that occurs along the entire coast.

Within the survey area, *A. macrostachyum*, a species of very high salinity tolerance, is the commonest plant at, or just above the high tide and within the supralittoral zone. It is then replaced by *Halopeplis perfoliata* slightly further inland. Still further inland, *H.perfoliata* is replaced by the bean caper *Tetraena qatarensis*, one of the commonest plants in the UAE. Plate 29 shows a floral dominance transitional zone between *A. macrostachyum* and *H. perfoliata* where the latter species of lower salt-tolerance starts to replace the former relative to the distance from the shoreline.

Another common plant species in areas of higher elevation to the east of the site is *Tetraena simplex* (formally *Zygophyllum simplex*). It is common along both coasts in the UAE, as well as on offshore islands. It is the dominant annual west of Jebel Dhana and flowers between December and June with prominent yellow flowers. Plate 21 shows a specimen in late flower.

*Stipagrostis plumosa* (Plate 26), the only graminoid found in the survey, was noticed at a few locations in higher rockier ground to the west of the survey site. Coastal habitats of lower elevation are too saline for this species; hence, it was one of the rarest plants in the survey area. However, in the UAE as a whole is common and widespread.

Being a species of lower saline tolerance, the distribution of *Haloxylon salicornicum* in the survey area was limited to the coastal rocky plains of higher elevation to the east. Very common and widespread in the UAE, it is mostly found in gravel and sand plains, such as the gravelly expanses in the east of the survey area. This perennial dwarf shrub grows out horizontally, extending its base and stems to attain large ground coverage, up to two metres. The leaves are dark green, thin, long and cylindric. Flowering from September to December, the clusters of yellowish flowers can grow up to 8cm long.

*Cornulaca aucheri* (Plate 24) was found frequently during the survey within the coastal plain's habitat. Common and widespread in the emirate of Abu Dhabi, this shrub can be found in coastal saline sand and interior sandy desert. The woody branches can erect up to 50cm. Leaves are 0.1cm triangular shaped and spiny. Flowering between August and September, the green flowers are in clusters of eight, surrounded by tufts of short white hair.

Stands of *Heliotropium kotschyi* were noted on a few occasions at the site. *H. kotschyi* is described as a perennial and woody shrub with stems that are up to 60cm long, containing small, white flowers. *H. kotschyi* flowers all year round making it an important plant for pollinating insects.

*Halopeplis perfoliata* (Plate 29) was recorded several times during the survey. Common along the Arabian Gulf coast and inland, this shrub can be found growing next to salt marshes and Sabkhas. A perennial and woody shrub, the stems are covered with flowers which are green and clustered, forming strings of beads. Flowering occurs from September to December.

*Salsola imbricata* was found occasionally during the survey. Common on both coasts of the UAE, this herb is found in saline sand and on disturbed ground. This plant was one of the first plants to colonise coastal landfills. The annual herb has a total length of between 30-80cm.

Plate 21: *Tetraena qatarensis*

Plates 22 & 23: *Tetraena simplex* (top), *Arthrocnemum macrostachyum* (bottom)

Plate 24: *Cistanche Tubulosa* (dead)

Plates 25 & 26: *Cornulaca aucheri* (top), *Anabasis setifera* (bottom)

Plates 27 & 28: *Stipagrostis plumosa* (top) *Haloxylon salicornicum* (bottom)

Plates 29 & 30: *Suaeda vermiculata* (top), *Arthrocnemum macrostachyum* (bottom-right, bottom photo), *Halopeplis perfoliata* (bottom)

| Table 10: Plant species recorded during the survey | | | |
|---|---|---|---|
| Family name | Scientific Name | Status During Survey | Status in UAE/IUCN |
| Acanthaceae | *Avicennia marina* | Present at a high density within the sheltered embayment and fringes | UAE: Common and widespread on the coastline of the UAE<br>IUCN: LC |
| Amaranthaceae | *Arthrocnemum macrostachyum* | Very common. Dominant saltmarsh plant in survey | UAE: Common and widespread on both coasts<br>IUCN: NE |
| Amaranthaceae | *Anabasis setifera* | Fairly common on the coastal plains at the site | UAE: Common in coastal areas, also on offshore islands<br>IUCN: NE |
| Amaranthaceae | *Cornulaca aucheri* | Widespread within the survey area | UAE: Common and widespread in Abu Dhabi Emirate<br>IUCN: NE |
| Amaranthaceae | *Halopeplis perfoliata* | Common along storm beach ridge | UAE: Common along the Arabian Gulf coast<br>IUCN: NE |
| Amaranthaceae | *Haloxylon salicornicum* | Most common at higher ground to the east of the site | UAE: Common and widespread, except at higher elevations in mountains<br>IUCN: NE |
| Amaranthaceae | *Salsola imbricata* | Occasionally noted in the storm beach ridge habitat | UAE: Common and widespread on both coasts<br>IUCN: NE |

Table 10: Plant species recorded during the survey

| Family name | Scientific Name | Status During Survey | Status in UAE/IUCN |
|---|---|---|---|
| Amaranthaceae | *Suaeda vermiculata* | Infrequently noted in the storm beach ridge habitat | UAE: Common on the coastline and offshore Islands<br>IUCN: NE |
| Boraginaceae | *Heliotropium kotschyi* | Uncommonly noted on the coastal plains | UAE: Common and widespread in coastal areas<br>IUCN: NE |
| Orobanchaceae | *Cistanche Tubulosa* | A couple of dead specimens encountered | UAE: Common along coast and inland saline sand plains<br>IUCN: NE |
| Poaceae | *Stipagrostis plumosa* | Occasionally present on coastal plains of higher elevation and lower salinity | UAE: Common and widespread. Very common along roadsides<br>IUCN: NE |
| Zygophyllaceae | *Tetraena qatarensis* | Most abundant species away from saltmarsh and mangroves | UAE: Common on the coast of Abu Dhabi and in northern Emirates.<br>IUCN: NE |
| Zygophyllaceae | *Tetraena simplex* | Frequently noted on coastal plains | UAE: Common and widespread along UAE coastline and on offshore islands<br>IUCN: NE |

Table Key:

C-Name = Common Name / IUCN = International Union for the Conservation of Nature / NE = Not Evaluated

### 3.3.3 Mammals and Reptiles

An extensive diurnal walk/drive-over was conducted to search for the presence of mammals and reptiles within the site boundary. Five camera traps were also set overnight to record any nocturnal specimens. The traps were set at locations deemed to be support the highest density of fauna indicated by the presence of ecological markers such as tracks, scats, and burrows. Arabian Red Fox, *Vulpes vulpes arabica* and feral dog, *Canis familiaris*, were the only mammals recorded in the survey. Three reptile species were identified during the survey, these were: Hadramaut Sand Lizard, *Mesalina adramitana*, White-spotted Lizard, *Acanthodactylus schmidti*, and Hooded Malpolon, *Malpolon moilensis*. All Mammal and Reptile species recorded during the survey are listed in Table 11.

The presence of foxes was initially indicated to NEA ecologists following the discovery of numerous tracks throughout the entire survey area, particularly along the storm beach ridge. The tracks were clearly fox-like with distinctive claw marks evident on each print. Data captured on camera traps later proved that the site is frequented by at least two Arabian Red Foxes (Plate 32). The Arabian Red Fox is generally a solitary hunter, foraging alone out of the breeding season (late winter in the UAE), however, they are known to group together very occasionally in a pack. It is most probable that the two foxes captured on the camera trap were a late breeding pair, or an adult and a fully grown juvenile that is currently unable to fend for itself. Common and widespread throughout the UAE, the Arabian Red Fox is highly adaptive and can be found in virtually every natural and man-made environment.

Red Foxes are known to walk very long distances, particularly at night in search of food. The foxes clearly forage along the vegetated storm beach ridge from time to time in search of anything edible that may have drifted in with the tide, such as dead fish, birds, or waste human food.

No fox burrows/dens were found in the survey area despite tracks and scats being found in abundance. It is likely that the foxes' den and spend the majority of their time beyond the east of the survey area within coastal cliffs, headlands, and rocky slopes environs in the centre of Jebel Dhana that provide ample rocky crevices that enable the foxes to easily excavate burrows of greater permanence.

Hadramaut Sand Lizard, *Mesalina adramitana* (Plate 30) was recorded on one occasion during the survey. Widespread, particularly throughout the north half of the UAE, these lizards are chiefly found in sand and gravel plain habitats which contains sparse vegetation cover. Lightly built, the Hadramaut Sand Lizard is fast-moving and has the ability to climb branches of desert shrubs and travel long distances in order to catch its prey. It is a diurnal and mainly feeds on small insects including ants.

A single, White-spotted Lizard, *Acanthodactylus schmidti*, was seen amongst washed up debris on the storm beach ridge, where it quickly fled and concealed itself under a bush when approached. As the common name suggests, the white spots covering the body of the lizard are a unique characteristic of this species. These white spots are boldest when the lizard is young, slowly fading away as they reach maturity. Widespread and common, they can be seen in almost all sandy areas of the UAE and mainly prey on insects, particularly beetles, ants, and flies. Well known to be very aggressive, they regularly get into skirmishes with other members of the same species when defending their territories.

A Hooded Malpolon, *malpolon moilensis*, was observed crossing the road that leads to Hans Esser Camp to the north of the power plant. NEA ecologists stopped their vehicle to allow the snake to safely cross the road and were able to take a few photographs (Plate 31) before it slithered into a patch of vegetation at the side of the road. Although the sighting was a moderate distance away from the proposed pipeline route (2.1km), it is likely that these snakes are occasionally present within one of their preferred habitats: vegetated coastal plains on well-drained rocky ground, which constitute a large proportion of habitat cover to the east of the survey area.

A fast-moving diurnal snake with a chequered pattern and large, reddish coloured eyes. *M. moilensis* have large dark spots at the side of the head between the eye and neck (as seen on the individual in Plate 31), which are almost always distinctive. This species is capable of moving large amounts of sand aside with sideways movements with the head bent downwards and can thus make shelters under stones and logs (Gardner, 2013).

The IUCN status, national status, and notes relative to the presence of every mammal and reptile identified in the survey area are presented in Table 11 on page 52 below.

Plate 31: *Mesalina adramitana*

Plates 32 & 33: Hooded Malpolon, *Malpolon moilensis* (top), A pair of Arabian Red Foxes, *Vulpes vulpes arabica*

Plates 34 & 35: Feral Dog tracks (top), Red Fox scats (bottom)

| Table 11: Mammal and Reptile species recorded during the survey | | | |
|---|---|---|---|
| Common Name | Scientific Name | Status During Survey | Status in UAE & IUCN |
| Arabian Red fox | *Vulpes vulpes arabica* | Very Common. Numerous tracks were found, and at least two individuals were captured several times on camera trap. | UAE: Common and widespread<br>IUCN: LC |
| Feral Dog | *Canis lupus familiaris* | Tracks were observed, but no actual sightings. | UAE: Common and widespread<br>IUCN: LC |
| Hadramaut Sand Lizard | *Mesalina adramitana* | Found on a few occasions. | UAE: Poorly known species<br>IUCN: LC |
| White-spotted Lizard | *Acanthodactylus schmidti* | Found on one occasion. | UAE: Common and widespread<br>IUCN: LC |
| Hooded Malpolon | *Malpolon moilensis* | Seen on a single occasion crossing a road to the north of the power plant. | UAE: Fairly common within gravelly habitats<br>IUCN: LC |
| Table Key: IUCN = International Union for the Conservation of Nature / LC = Least Concern | | | |

### 3.3.4 Birds

Avian abundancy and diversity were assessed at the site through incidental, diurnal sightings that were conducted at high and low tides across the intertidal zone, at the shoreline and in-land within the proposed pipeline footprint area and surrounding habitats. Additionally, on the morning of 23.05.21 a dedicated avian survey was conducted, where a telescope was set-up just landward of the intertidal mudflats (Plate 36) in order to identify and count shorebirds foraging a further distance away.

In all, 15 species of birds, totalling 109 individuals were recorded during the site visits. Counts of all the birds seen on the three days are given in Table 13, scientific names for all taxa, as well as IUCN status are presented therein.

Plate 36: NEA ecologists using a telescope to count shorebirds

Eight waders, totalling 48 individuals were counted at the site, most of these records consisted of birds foraging on intertidal flats and at the edge of tidal creeks fringed by mangroves. The relatively low diversity and abundancy of waders noted during the survey is to be expected in early summer, as shorebird numbers using the site will naturally decline from April onwards as birds depart northwards to breeding grounds. Reduced (though still significant) numbers of non-breeders are likely to remain all summer, as they do in intertidal areas all around Abu Dhabi Island and its environs. Numbers will then start to increase again from late August onwards, as wintering birds arrive, and south-bound migrants pause to refuel.

One of only a few waders that breed in the UAE, an indication that Kentish Plover, *Charadrius alexandrinus*, were breeding at the site was observed when an adult was seen displaying distraction behaviour on the morning of 22.05.20. Some birds have developed modalities of parental defence based on performing displays with the aim to divert predator attention from offspring or nests. This can be achieved through the display of dishonest signals concerning their physical condition or by mimicking a reduced ability to escape. In this case, the adult plover imitated a broken wing. This behaviour, coupled with the time of year, made NEA ecologists suspect that a nest or fledglings could be present in the immediate vicinity of the plover sighting.

The suspicion was confirmed when the plover approached a bare patch of ground and sat over an inconspicuous scrape, which on closer inspection was found to contain three eggs. The survey team took coordinates of the nest site before promptly leaving the area to avoid disturbing the nesting plover.

Following the discovery that Kentish Plover were currently breeding within the survey area, further investigations were conducted in suitable habitat nearby. These investigations uncovered two further Kentish Plover nests, one contained another three eggs, while the other housed a solitary egg. Table 12 below contains the coordinates of, and information on, the Kentish Plover nest sites.

Table 12: Kentish Plover Nest Information and Coordinates

| WPT № | № Eggs | Latitude (N) | Longitude (E) | Date Discovered |
|---|---|---|---|---|
| 4 | 3 | 24.1456 | 52.56583 | 22.05.21 |
| 6 | 1 | 24.14372 | 52.56316 | 22.05.21 |
| 10 | 3 | 24.14864 | 52.56774 | 23.05.21 |

Table Key: WPT = Waypoint / Northing + Easting = WGS84 Decimal Degrees

The nests are located within the immediate vicinity of the proposed pipeline route and would be subject to disturbance and possible direct impacts from construction activities. The proposed work should be postponed until the end of the breeding season (late June/early July), this will ensure that eggs have hatched, and nestlings fledged, which will enable the birds to move into to suitable habitat nearby away from potential sources of harm. Plate 38 shows an adult Kentish Plover at a nest location.

Kentish Plovers are considered to be a 'Priority Bird Species' in the UAE. This is due to the percentage of the world population that breed in the country. An estimated 1000-3000 pairs breed in the UAE, both at coastal and in-land locations.

Plates 37 & 38: House Sparrow, *Passer domesticus* (NEA File Photo) (top), Kentish Plover nest, *Charadrius alexandrinus* (bottom)

Western Reef Heron, *Egretta gularis*, were seen at the mangrove habitat in and on the mudflats to the east of the power plant. Western Reef Herons are strongly associated with coastal sites and are almost entirely restricted to coastal sites with mangroves in the breeding season. They more rarely have been known to nest in low shrubby halophytes on some islands in the absence of any mangroves.

*E. gularis* have an estimated breeding population in the UAE of 500-1000 pairs (Aspinall, 2010). The population is imprecisely known due to the impenetrability or inaccessibility of most breeding sites. An attempt was made to search for nests belonging to *E. gularis* within mangroves closest to the planned development, however, non were found, allowing an assumption that they choose to nest only in the densest, mature mangroves at the site to be made.

A small heron was flushed from a dense stand of mangroves while the survey team were investigating the mangrove habitats. Although only a fleeting glimpse was made of the bird as it took flight, species identification was determined acoustically by the loud and distinctive call synonymous with Striated Heron, *Buorides striatus*.

In the UAE, Striated Herons breed almost exclusively in mangroves, therefore, their distribution along the coast is patchy and is determined by coastal habitats that are suitable for breeding and foraging. Away from mangrove breeding grounds, these herons also frequent coral reefs, rocky islets, and breakwaters where they feed primarily on small fish in shallow waters.

A third heron from the Ardeidae family was recorded at the time of the survey. Namely, these were Grey Heron, *Ardea cinerea*. The Grey Herons at the site were primarily present at the waterline, fishing in the shallower water, but were also seen in small flocks of up seven flying over the embayment and mangroves.

The Grey Heron is a large predatory bird that feeds mostly on aquatic animals, which it catches after standing stationary beside water waiting to ambush, or by stalking prey through the shallows. It is a common winter visitor and passage migrant in the UAE, and can often be seen by freshwater lakes, or in mangrove areas.

A pair of Greater Hoopoe-larks were seen foraging within the vegetated strip along the storm beach ridge on three consecutive days. They have a distinctive long bill, well designed for probing and digging for invertebrates. These birds frequently nest at the base of vegetation or in low bushes, therefore, an additional effort was made to search for a nest site. However, despite a thorough search, none were located.

The Greater Hoopoe-lark is a resident of arid, desert, and semi-desert regions, across much of northern Africa and the Arabian Peninsula. They are resident breeders in the UAE, being commonly encountered throughout the year in habitats with sand sheets and dunes with dwarf shrub cover.

Plates 39 & 40: Western Reef Heron, *Egretta gularis*, on intertidal mudflats and sand (top), large tracks probably made by Grey Heron, *Ardea cinerea* (bottom)

A couple of Blue-cheeked Bee-eaters, *Merops persicus*, were seen in-flight passing over an area of mature mangroves. They were also heard on a couple of occasions while the survey team were taking noise measurements adjacent to the power lines to the east of the survey area. It is likely that the bee-eaters were perched out of view on the pylon structures which act as a vantage point, allowing them to easily spot flying insects, their preferred prey. *M. persicus* is a late migrant, one of a small number of passage migrants that can still be seen in the UAE in late May. During migration, flocks may turn up virtually anywhere in the country, though more frequently in farmlands and parks. Some over-summer in the northern emirates and records of a small number breeding there do exist. For this reason, they are considered as a priority bird species in the UAE.

Another late migrant seen one a single occasion was European Roller, *Coracias garrulus*. The roller was perched on one of the large electricity pylons towards the entrance of the power complex. Upon seeing the survey vehicle, the roller took flight over the road towards Jebel Dhana. Due to the brief sighting no photograph was taken but clear diagnostic features were visible, such as the blue crown, which distinguishes it from Indian Roller that has brown coloured plumage on the face and crown. From breeding grounds in Europe and Asia, *C. garrulus* flies more than 5,000km to sub-Saharan Africa.

The most numerous avian species recorded was the House Sparrow (Plate 37). House Sparrows are the most widely distributed wild bird and are a very common resident breeder in the UAE. They are often seen near human habitation and frequently roost and nest in buildings. They were observed throughout much of survey area, though in a higher concentration along mangrove fringes and saltmarsh habitat.

Within the mangrove area at the site, Indian (previously Clamorous) Reed Warblers, *Acrocephalus stentoreus*, were identified by their loud and distinctive call. They are seldom seen, preferring to remain hidden in dense vegetation such as reeds or mangroves, thus identification of this species is principally ascertained by acoustics alone, as was the case in the survey.

Two waders that were recorded in the survey are listed as 'Near Threatened', with a declining population. These are Eurasian Curlew, *Numenius arquata* and Bar-tailed Godwit, *Limosa lapponica*. These species are predominantly winter visitors and passage migrants in the region and do not breed in the UAE. However, juveniles do not migrate to northerly breeding grounds in Spring, therefore, a small number over-summer in the UAE, which explains their presence in low numbers noted in the survey. Threats to the above-mentioned threatened species include loss and disturbance of mudflats from construction works, development of high-tide roosting sites, and pollution.

All other avian species recorded in the survey are listed as 'Least Concern' on the IUCN Red List of threatened species. Every bird species recorded during the survey is listed in Table 13, with threatened species highlighted in red.

Plates 41 & 42: Greater Hoopoe-lark, *Alaemon alaudipes* (top), White-eared Bulbul, *Pycnonotus leucotis* (bottom)

| Table 13: Bird species recorded during the survey | | | | |
|---|---|---|---|---|
| Common Name | Scientific Name | Count(s) | Status On-site | Status in UAE / IUCN |
| Western Reef Heron | *Egretta gularis* | 9 | 9 seen in total, within the mangroves and on the intertidal mudflats | UAE: Common resident breeder<br>IUCN: LC |
| Grey Heron | *Ardea cinera* | 12 | Commonly present on the intertidal mudflats. Also seen in-flight over the mangroves | UAE: Visitor, mostly winter<br>IUCN: LC |
| Striated Heron | *Butorides striata* | 1 | One flushed from mangroves at the edge of a tidal creek | UAE: Common resident breeder<br>IUCN: LC |
| Kentish Plover | *Charadrius alexandrinus* | 14 | Primarily seen foraging on intertidal mudflats. 3 nests containing eggs also found | UAE: Common resident breeder<br>IUCN: LC |
| Lesser Sand Plover | *Charadrius mongolus* | 5 | Foraging on intertidal mudflats at low tide | UAE: Migrant/visitor primarily in winter<br>IUCN: LC |
| Eurasian Curlew | *Numenius arquata* | 3 | Three seen foraging on intertidal mudflats at low tide | UAE: Migrant/visitor primarily in winter<br>IUCN: NT |
| Common Redshank | *Tringa totanus* | 1 | One present within mangrove fringes | UAE: Migrant/visitor primarily in winter<br>IUCN: LC |
| Bar-tailed Godwit | *Limosa lapponica* | 3 | A flock of 3 seen foraging on intertidal mudflats at low tide | UAE: Migrant/visitor primarily in winter<br>IUCN: NT |

| Table 13: Bird species recorded during the survey | | | | |
|---|---|---|---|---|
| Common Name | Scientific Name | Count(s) | Status On-site | Status in UAE / IUCN |
| Eurasian Collared Dove | *Streptopelia decaocto* | 8 | Heard and seen on the electricity pylons to the east of the site | UAE: Very common resident breeder<br>IUCN: LC |
| Greater Hoopoe-lark | *Alaemon alaudipes* | 2 | A pair seen on 3 consecutive days at the storm beach ridge | UAE: Common resident breeder<br>IUCN: LC |
| Graceful Prinia | *Prinia gracilis* | 2 | Both seen within the saltmarsh habitat | UAE: Common resident breeder<br>IUCN: LC |
| Blue-cheeked Bee-eater | *Merops persicus* | 4 | Heard on the electricity pylons at the site. Later observed in-flight over mangroves | UAE: Migrant/migrant breeder<br>IUCN: LC |
| Clamorous Reed Warbler | *Acrocephalus stentoreus* | 1 | One heard singing from within mangroves | UAE: Moderately common resident breeder<br>IUCN: LC |
| White-eared Bulbul | *Pycnonotus leucotis* | 20 | Commonly seen within the mangroves | UAE: Very common resident breeder<br>IUCN: LC |
| House Sparrow | *Passer domesticus* | 24 | Commonly seen within the mangroves | UAE: Very common resident breeder<br>IUCN: LC |

Table Key: IUCN = International Union for the Conservation of Nature / LC = Least Concern

### 3.3.5 Arthropods

Arthropods were assessed in the area of study by means of diurnal walkover investigations. Anthropogenic debris was also moved to look for insects hiding beneath. Any arthropod species observed were recorded, photographed and where possible were identified to species level. Most insects are difficult to survey because of their small size, complex taxonomy, and cryptic habits. Flight seasons of particular insects may last for only a few days or weeks. Immature stages of most insects are very difficult to identify to species level. The full list of insect species and numbers recorded from walkover surveys is shown in Table 14.

Globe Skimmer, *Pantala flavescens*, was recorded on several occasions during the survey. Observed throughout the UAE, they are commonly found in areas with stagnant water and adults in areas with abundant vegetation. This dragonfly can migrate long distances, recordings indicate Globe Skimmers are capable of traveling from India to Africa, passing through the Arabian Gulf during their migration. Their diet consists primarily of mosquitos and fly's.

Carmine Darter, *Crocothemis erythrea*, was recorded on one single occasion perched on mangrove pneumatophore. Widespread in the UAE, this dragonfly can mostly be found in rocky wadis and desert pools. The males are bright red, while females are yellowish brown. In its nymph stages they are wholly aquatic, once fully adult and outside of water they live no more than two months. Adults are seen in dry areas around desert shrubs and grasses, and not often around water.

Blue-spotted Arab, *Colotis phisadia phisadia*, was often recorded in large groups around the Jebels and vegetation. The most common butterfly found in the UAE, this insect breeds during the warmest part of the year. Growing up to 30mm, the butterfly is salmon-pink ground coloured with a characteristic black spot on the top of the wings.

Small Salmon Arab, *Colotis fausta*, were recorded on several occasions perched on mangrove flowers and leaves. Easily confused with the Blue-spotted Arab Butterfly, Small Salmon Arabs are twice smaller, measuring between 10-15mm. Common throughout UAE, adults feed on nectar and larvae feed on vegetation, primarily on *Salvadora persica*.

Regal Blowfly, *Chrysomya marginalis*, was recorded on a single occasion perched on a mangrove leaf. A medium sized fly, around 16mm, they have distinct orange heads and metallic blue green bodies. Commonly found in UAE's desert, these flies are highly vital for the eco-system, breaking down carcases of dead animals.

Numerous Asian Dwarf Honeybees, *Apis florea*, were present in the mangroves, pollinating the Grey Mangroves that were in flower at the time of the survey.

Commonly found in abundant vegetated areas and urban gardens, combs are exposed and built on single branches. Hives compromises of one queen bee that lay eggs, while other bees of the colony tend to the larvae, maintain and protect the hive, and gather pollen from flowers in close proximity.

Streakywing Antlion, *Lopezus fedtschenkoi*, was recorded once, seen on a *Halopeplis perfoliata* shrub. Widespread through-out the UAE, they are mostly found in the hottest periods of the year, July, and August. Females lay eggs in the sand, which afterwards larvae create sand traps in order to capture smaller insects. Nocturnal, adult antlions rest on leaves and branches during the day and feed at night. Throughout the larvae stage their diets primarily consists of ants and in the adult stage pollen and nectar.

An Arabian Darkling Beetle, *Pimelia arabica*, was found on a single occasion. This species of darkling beetle can be found throughout the UAE in large numbers. Mainly nocturnal, they primarily feed on seeds and leaves. The females lay eggs in rotten plants. Once the eggs hatches, the larvae feed on the decaying plant until they become adults. To protect itself the beetle will bury its head in the sand while keeping its body, covered by hard shell, exposed.

A Sulphurous Jewel Beetle, *Julodis euphratica castelnau* were seen on a single occasion hovering over mangroves. The larvae of these beetles are wood borers and have one of the longest lifespans of any beetle, taking up to 35 years to develop into an adult and emerge from their host tree. On the outside the adults then feed, mate and die within a relatively short time period, 2 days to 2 weeks.

Tiger Beetle, *Cicindelidae sp.*, was recorded on several occasions within intertidal zones. Commonly found on sandy and clay soil near water, they create burrows in order to lay eggs. In the larval stage, tiger beetles ambush prey by hiding in burrows. Unlike other species of beetles, they are fast and aggrieve, preying on other insects and spiders as adults and larvae. Mainly diurnal, tiger beetles can be found hunting during the hottest times of the day.

An Oriental Wasp, *Campsomeriella thoracica*, was recorded once while pollinating a mangrove flower. Widespread in the UAE, these wasps are primarily found in areas which have readily available water. Fully black with golden yellow heads and orange at the base of wings, they measure between 12-17mm. Females burrow into the ground and softer part of trees in search of beetle larvae. Once found, they paralyze and lay eggs next to the beetle larvae which is then consumed by the hatched oriental wasps. Adults mainly feed on pollen and nectar, mainly seen around large areas of vegetation with exposed sources of water.

Plates 43 & 44: Asian Dwarf Honey Bee, *Apis florea* (top), Blue-spotted Arab Butterfly, *Colotis phisadia* (bottom)

Plates 45 & 46: Oriental Wasp, *Campsomeriella thoracica* (top), Globe Skimmer, *Pantala flavescens* (bottom)

Plates 47 & 48: Carmine Darter, *Crocothemis erythraea* (top), Sulphurous Jewel Beetle, *Julodis euphratica castelnau* (bottom) (NEA File Photo)

Plates 49 & 50: Streaky-wing Antlion, *Lopezus fedtschenkoi* (top), Regal Blowfly, *Chrysomya marginalis* (bottom)

Plates 51 & 52: Small Salmon Arab Butterfly, *Colotis amata* (top), Tiger Beetle, *Cicindelidae* sp. (bottom) (NEA File Photo)

| Table 14: Arthropod species recorded during the survey | | | |
|---|---|---|---|
| Common Name | Scientific Name | Status On-site | Status in UAE / IUCN |
| Globe Skimmer | *Pantala flavescens* | Observed on a few occasions, perched on mangroves | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Carmine Darter | *Crocothemis erythraea* | One seen perched on a mangrove pneumatophore | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Blue-spotted Arab Butterfly | *Colotis phisadia* | Approximately 10 seen pollinating mangrove flowers | UAE: Very common to Abu Dhabi Emirate<br>IUCN: NE |
| Small Salmon Arab Butterfly | *Colotis amata* | Approximately 5 seen pollinating mangrove flowers | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Regal Blowfly | *Chrysomya marginalis* | One seen on a mangrove leaf | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Oriental Wasp | *Campsomeriella thoracica* | One seen pollinating a mangrove flower | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Asian Dwarf Honeybee | *Apis florea* | >100 pollinating mangrove flowers | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Streaky-wing Antlion | *Lopezus fedtschenkoi* | One seen on a *Halopeplis perfoliata* shrub | UAE: Moderately common to Abu Dhabi Emirate<br>IUCN: NE |

| Table 14: Arthropod species recorded during the survey | | | |
|---|---|---|---|
| Common Name | Scientific Name | Status On-site | Status in UAE / IUCN |
| Arabian Darkling Beetle | *Pimelia arabica* | Seen on one occasion burying itself in sand | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Sulphurous Jewel Beetle | *Julodis euphratica castelnau* | Observed on one occasion flying | UAE: Common to Abu Dhabi Emirate<br>IUCN: NE |
| Tiger Beetle | *Cicindelidae* sp. | One seen on the intertidal mudflats | UAE: Uncommon to Abu Dhabi Emirate<br>IUCN: NE |
| Table Key: IUCN = International Union for the Conservation of Nature / NE = Not Evaluated / LC = Least Concern | | | |

## 3.3.6 Geomorphology

The proposed pipeline landfall location site is situated to the southwest of Jebel Dhana Peninsula. Jebel Dhana is a small rocky abrupt hill formed over an active salt dome on the western shore of Khor al Bazam. Salt domes and plugs are distributed irregularly throughout the southern Arabian Gulf. The Jebel Dhana salt diapirs are narrow, emergent plugs underlying small islands on which rocks of the Precambrian Hormuz series outcrop.

Within the intertidal zone to the southwest of Jebel Dhana Peninsula and the SPC, the pipeline route is planned to traverse through the northern limits of an embayment enclosed by spits. Intertidal spits are one of the most common features associated with the shoreline to the west of Khor Al Bazam. They delineate the upper limit of the intertidal flats and trend from east to west, formed by longshore drift. The seaward side of each spit has a beach face slope that is usually marked at the base by brown alga. The spits increase in width seaward unless another spit develops seaward of them.

The extensive coastal spit that encloses the embayment from a northeasterly direction protects the coast from turbulent wave action, which has allowed the Grey Mangrove, *Avicennia marina*, to develop and thrive between the tidal creeks and cyanobacterial mats (Plates 53 and 54).

The coastline that fringes the landward side of the embayment is lined with similar compound forms of spits that are now stranded inland by coastal accretion, in the form of a series of storm beach ridges. *Halopeplis perfoliata* is the dominant flora along these ridges and is a vital component to the habitat as it traps sediments and stabilises low dunes.

Oolitic grains are accumulating on coastal terraces to the to the west of the Jebel Dhana peninsula. Closer to the shoreline, the terraces may be divided, based on species composition, into Cerithid shell (medium-sized marine gastropod mollusks) dominated lower-lying flats, into *Scopimera crabricauda* (Sand Bubbler Crab) dominated upper flats. The characteristic crab of the latter zone inhabits sandy beaches and produces numerous radial pseudofaecal balls comprised of sand. Bubbler crabs feed by filtering sand through their mouthparts, which leaves behind characteristic ball shapes (Plate 53).

Small areas of beach rock and indurated cemented crust surfaces are periodically interspersed in the middle tidal flats situated seaward of the beach ridges. Most of these indurated cemented crust facies are not coated with carbonate cement crusts.

Plates 53 & 54: Pseudofaecal balls made by *Scopimera crabricauda* (top) and unidentified biota in the intertidal zone (bottom)

Eastwards, further inland, halite encrusted coastal sabkha covers the low-lying ground and extends for 1.3km until the slightly higher ground marks a transition into rockier strata. The line between intertidal flats and coastal sabkha is not very clearly defined, because it is determined by how far into the sabkha seawater extends on the highest tides, and this is affected in turn by wind and wave energy.

The upper limit of the intertidal flats roughly coincides with the upper limit of the area that is used as a feeding ground by waders. Similarly, the dividing line between sabkha and coastal plain can be very indistinct and may even vary throughout the course of a year.

### 3.3.7 Anthropogenic Use

Anthropogenic activity at the site is currently relatively minimal. Occasional vehicle tyre track marks were the only indicators that people drive through the site on an infrequent basis. No other evidence was found that would suggest that any other recreational activity, such as camping and fishing, takes place at the landfall location.

Over much of the site little litter was found. However, along beach ridges some debris has been washed up. These included a couple of 'ghost' fishing nets, brought in by the tide, found entangled in mangrove pneumatophores and a large metal floating buoy, washed ashore (Plate 55).

Plate 55: Large metal buoy washed ashore in the landfall area

# 4.0 Conclusions, Recommendations & Mitigation Measures

## 4.1 Ambient Noise

The ambient noise climate of the site is affected by anthropogenic activity in the neighbouring powerplant. As a result of this activity, night time noise levels are consistently higher than those recorded during the day. The classification of the site is debatable, however the assessment considers the ‘heavy industrial’ classification as being more appropriate, given the lack of residential sensitive receptors in the vicinity.

As such, no exceedances of the 70 dBA (day time) or 60 dBA (night time) limits were reported for the site and it is considered unlikely, given the nature of the development, that the addition of the Project infrastructure will result in any exceedances of these limits.

## 4.2 Soil and Groundwater

Although there were no wells or sources within the direct pipeline footprint, one groundwater sample was collected from a pond to the north of the SPP. Despite an exceedance for salinity, which is likely due to the site’s proximity to the coast and low elevation, all other parameters were in compliance with the standards outlined in ‘Circular for Soil Remediation Target and Intervention Values’, Dutch standards. No significant odour from the water source was noted.

The collection of soil samples was completed using a hand-augur and pre-prepared sample containers. Analysis of the eight collected samples was undertaken by a ESMA approved third-party laboratory (Element LLC). The vast majority of analytes were below the detection limits and were not registered in the analysis at all. Of those parameters which could be measured, all were recorded below screening or clean-up thresholds as outlined by the ADQCC soil standards.

## 4.3 Terrestrial Ecology

The overall site, despite its proximity to the highly developed SPC, is currently in a largely natural, untouched state. Several coastal habitats are considered critical habitats, the largest of which are the expansive mudflats at the landfall location, to the south of the SPC. Three critical habitats will be directly impacted by the development, these are mangroves, saltmarsh and intertidal mudflats and sand exposed at low tide. 54.62% of the proposed landfall footprint will be directly situated in threatened habitats, 25.63% within critical habitats and 28.99% in environmentally sensitive habitats, respectively. It is, therefore, vital that any loss of these threatened habitats is mitigated against.

The footprint of the proposed pipeline landfall route traverses directly over an area of intermittent mangrove cover (see datasheets CP4 & CP5 in Annex B). The sparsity of mangroves within the landfall footprint explains why the minor area is absent from the habitat map. Due to the sporadic mangrove cover in this area, it is difficult to give an accurate estimate as to how many mangroves could be directly lost as a result of the planned construction. However, an effort on-ground was made by the NEA survey team to evaluate the landfall area and from those investigations, we estimate that number of mangroves directly lost would stand approximately at >20 mangrove shrubs and >40 saplings.

Although this is a relatively small number at risk of being directly impacted by the development, any direct loss of mangrove trees should be mitigated for. Replanting (or afforestation) of a greater quantity of mangroves (twice the area of mangrove disturbed or twice the number of mature trees lost) is the standard strategy against loss of this critical habitat. However, such plans are lengthy in terms of stakeholder commitment (>5 years), expensive to undertake and difficult to manage and monitor success rates effectively. As such, we would recommend that the proposed route is altered slightly to avoid any direct loss of mangroves.

Another critical habitat that will be subject to some level of alteration/degradation through the development is intertidal mudflats and sand exposed at low tide. The proposed route passes over approximately 900 metres of this habitat when fully exposed on the lowest tides. Although low numbers of birds were foraging here at the time of the survey, this is largely related to the time of year. Much greater numbers of shorebirds will undoubtedly use the site from autumn to spring, therefore, we recommend that the development takes place from July to September when disturbance to migrants and over-wintering birds from the construction of the pipeline on intertidal flats will be negligible.

The proposed pipeline route is planned to traverse through an area of ornithological importance. The dense and mature mangroves, in close proximity to expansive intertidal mudflats, support a diverse avifaunal community comprising primarily of shorebirds (also passerines to a lesser but still significant extent) that depend on such areas to forage, roost and breed.

The lands in the immediate to medium vicinity of the proposed pipeline footprint are a proven breeding locale for Kentish Plover, and a very probable breeding area for Western Reef Heron, Clamorous Reed Warbler, Greater Hoopoe-lark and Graceful Prinia. Commencement of any construction activities should be postponed until mid-July at a minimum, this will ensure that the plovers (and other birds potentially breeding nearby) have left the area before the start of the development.

If the pipeline is planned to be situated above ground, habitat fragmentation associated with such a structure that will extend for several kilometres in this instance, is an impact to consider. This impact would principally be restricted to smaller fauna of lower mobility. The highest concentration of fauna that fit the aforementioned criteria, ie. lizards, rodents, and non-flying insects, are present within the storm beach ridge habitat. Therefore, if subsurface installation is not planned for the pipeline, a crossing point should be added here and ideally, periodically along the entire route to allow animals to cross.

Anthropogenic activity at the site was found to be quite low. Occasional vehicle tyre track marks were really the only indicators that people drive through the site on an infrequent basis. No other evidence was found that would suggest recreational activities, such as camping and fishing, take place at the site. Over much of the site little litter was found. However, along beach ridges some debris has been washed up. In addition, a couple of 'ghost' fishing nets, brought in by the tide, were found entangling mangrove pneumatophores and a large floating buoy had washed ashore in the landfall area.

Additional terrestrial ecology mitigation measures towards minimising impacts associated with the proposed construction not mentioned above are listed in brief below;

- Efficient transportation plan to minimise unnecessary vehicle movements across critical and sensitive habitats;
- Avoid unnecessary noise levels that may lead to leading to behavioural changes to wildlife in the area;
- Raise awareness to workers in the area to the habitats/species sensitivity (posters in accommodation).

# ANNEX A

## References

## Annex A – References

The following references were available and/or used on the current survey:


- Al Dhaheri, S., Javed, S., Alzahlawi, N., Binkulaib, R., Cowie,W., Grandcourt, E. and Kabshawi, M. (2017). Abu Dhabi Emirate Habitat Classification and Protection Guideline. Environment Agency Abu-Dhabi.
- Aspinall S.J. (2005). *Birds [of the UAE]*. *In:* Hellyer and Aspinall (eds.). The Emirates: A Natural History. Trident Press, UK.
- Aspinall S.J. (2010). *Breeding Birds of the United Arab Emirates*. Environment Agency Abu Dhabi, UAE.
- Brown G. and Boer B. (2004). *Interpretation Manual of the Major Terrestrial Natural and Semi-natural Habitat Types of Abu Dhabi Emirate*. ERWDA, Abu Dhabi.
- M.V.D. Jongbloed, G.R. Feulner, B.Boer, A.R Western (2003). *The comprehensive guide to the Wild Flowers of the United Arab Emirates*. ERWDA, Abu Dhabi.
- Environment Agency – Abu Dhabi (2015). *Terrestrial Habitat Classification*. EAD Enviro-portal Viewer. https://enviroportal.ead.ae/geoportal.
- Hellyer, P. and Aspinall, S.J. (Eds.) (2005). *The Emirates—A Natural History*. Trident Press, London, and the Environment Agency, Abu Dhabi.
- Gardner, A. (2013). *The amphibians and reptiles of Oman and the UAE*. Frankfurt am Main: Edition Chimaira.
- IUCN (2017). *Red List of Threatened Species*. http://www.iucnredlist.org.
- Javed S. (2008). Birds. In Perry R. *Terrestrial Habitats of Abu Dhabi Emirate*. Environment Agency - Abu Dhabi.
- Jennings M. (2010). *Atlas of the Breeding Birds of Arabia*. Fauna of Arabia Vol. 25. KACST, Riyadh and Senckenburg, Germany.
- Ornithological Society of the Middle East, the Caucasus and Central Asia (OSME). (2012). Simplified OSME list of bird taxa.
- Gardner A. and Aspinall S.J. *Journal Of The Emirates Natural History Group, Tribulus no.17*.
- Perry R. (ed.) (2008). *Terrestrial Environment of Abu Dhabi Emirate*. Environment Agency, Abu Dhabi, UAE.
- Porter R. and Aspinall S.J. (2010). *Birds of the Middle East*. Second Edition. Christopher Helm, London

# ANNEX B

## Photographic Documentation and Data Sheets

Cardinal Point

Figure B1: CP1

Coordinates: N24.143340, E52.56285

Location: Shuweihat

Date-Time: 23.05.2021

# Cardinal Point

Figure B2: CP2

Coordinates: N24.143340, E52.56287

Location: Shuweihat

Date-Time: 23.05.2021

# Cardinal Point

Figure B3: CP3

Coordinates: N24.14359, E52.56474

Location: Shuweihat

Date-Time: 23.05.2021

# Cardinal Point

Figure B4: CP4

Coordinates: N24.143970, E52.564930

Location: Shuweihat

Date-Time: 23.05.2021

Cardinal Point

Figure B5: CP5

N24.144240, E52.52.56588

Shuweihat

23.05.2021

# Cardinal Point

## Figure B6: CP6

Coordinates: N24.144600, E52.567380

Location: Shuweihat

Date-Time: 23.05.2021

# Cardinal Point

## Figure B7: CP7

Coordinates: N24.144400, E52.56937

Location: Shuweihat

Date-Time: 23.05.2021

## Cardinal Point

Figure B8: CP8

Coordinates: N24.144820, E52.572020

Location: Shuweihat

Date-Time: 23.05.2021

Cardinal Point

Figure B9: CP9

Coordinates: N24.145820, E52.579210

Location: Shuweihat

Date Time: 23.05.2021

Cardinal Point

Figure B10: CP10

Coordinates: N24.1457000, E52.577850

Location: Shuweihat

Date-Time: 23.05.2021


# Cardinal Point

Figure B11: CP11

Coordinates: N24.143670, E52.562820

Location: Shuweihat

Date-Time: 23.05.2021

# Cardinal Point

## Figure B12: CP12

Coordinates: N24.146050, E52.582700

Location: Shuweihat

Date-Time: 23.05.2021

Table B1: Soil Analyses

| Method | Parameter Name | Unit | Detection Limit | SS01 | SS02 | SS03 | SS04 | SS05 | SS06 | SS07 | SS08 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH [BS 1377-3: 2018] Soil-DXB | pH | pH units | 0.1 | 9 | 9.6 | 9.7 | 9.6 | 8.7 | 8.7 | 9.4 | 9.3 |
| Oil & Grease [APHA 5520 E]-DXB | Oil and Grease | % | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nitrogen (Ammonia) [HACH 8155] Solids-DXB | Nitrogen (Ammonia) | mg/kg | 0.25 | 1.45 | 1.8 | 2.15 | 1.55 | 2.3 | 2.2 | 1.95 | 1.9 |
| Nitrogen (Ammonia) [HACH 8155] Solids-DXB | Ammonium | mg/kg | 0.32 | 1.86 | 2.31 | 2.76 | 1.99 | 2.96 | 2.83 | 2.51 | 2.44 |
| Nitrogen (Ammonia) [HACH 8155] Solids-DXB | Ammonia | mg/kg | 0.3 | 1.76 | 2.19 | 2.61 | 1.88 | 2.79 | 2.67 | 2.37 | 2.31 |
| Salinity [APHA 2520 B]-DXB | Salinity | ppt | 1 | 2.1 | 4.7 | 7.2 | 5.5 | 8.5 | 3 | 3.6 | 3.2 |
| Sulphide [HACH 8131/DIN 38405-D27]-DXB | Sulphide ($S^{2-}$) | mg/kg | 5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Fluoride [HACH 8029]-DXB | Fluoride | mg/kg | 0.5 | 3.4 | 4 | 4.2 | 4.8 | 2.7 | 5.2 | 3.3 | 3.6 |
| Nitrate [HACH 8039]-DXB | Nitrate | mg/kg | 0.22 | 0.89 | 8.63 | 1.33 | 2.88 | 25.5 | 10.6 | 0.66 | 6.2 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Cadmium (Cd) | mg/kg | 0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Aluminium (Al) | mg/kg | 130 | 1580 | 1890 | 2520 | 1770 | 3500 | 3130 | 1770 | 1850 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Arsenic (As) | mg/kg | 1 | 3 | 1.8 | 2.1 | 3 | 2.4 | 1.7 | 2.2 | 2.7 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Barium (Ba) | mg/kg | 3 | 13.6 | 9.2 | 11.7 | 10.6 | 7.9 | 30.9 | 10.9 | 14.8 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Chromium (Cr) | mg/kg | 1 | 5.3 | 7.7 | 8.5 | 6.1 | 12.3 | 12.4 | 5.6 | 5.8 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Cobalt (Co) | mg/kg | 1 | <1.0 | <1.0 | 1.3 | 1 | 2.2 | 2 | <1.0 | <1.0 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Copper (Cu) | mg/kg | 3 | 5 | 3.8 | 3.8 | 3.5 | 5.5 | 5.6 | <3.0 | 3.4 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Lead (Pb) | mg/kg | 1 | 1.8 | 1.8 | 1.8 | 1.9 | 1.4 | 15.8 | 1.9 | 2 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Manganese (Mn) | mg/kg | 3 | 35.1 | 74.1 | 53 | 54.5 | 129 | 119 | 36.1 | 38.3 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Nickel (Ni) | mg/kg | 1 | 3.2 | 3.8 | 5.2 | 3.7 | 12.4 | 10 | 3.3 | 3.6 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Phosphorus (P) | mg/kg | 50 | 131 | 124 | 112 | 136 | 202 | 152 | 96 | 113 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Zinc (Zn) | mg/kg | 3 | 22.3 | 21.7 | 14.3 | 11.4 | 15.9 | 26.1 | 6.8 | 7.2 |
| Chromium (Hexavalent) [HACH 8023] Solids-DXB | Chromium (VI) | mg/kg | 0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Antimony (Sb) | mg/kg | 1 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Beryllium (Be) | mg/kg | 1 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Mercury by PSA [EPA 245.7] SSS-DXB | Mercury (Hg) | mg/kg | 0.01 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | 0.014 |
| VPH C5-C10 by GC-FID [EPA 8015B]-SSS-DXB | VPH C5-C10 | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| EPH C10-C40 by GC-FID [EPA 8015B] SSS-DXB | EPH C10-C40 | mg/kg | 50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |
| PAH in Soils [EPA 8270 D]-DXB | Acenaphthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Acenaphthylene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Anthracene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(a)anthracene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Table B1: Soil Analyses | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Method | Parameter Name | Unit | Detection Limit | SS01 | SS02 | SS03 | SS04 | SS05 | SS06 | SS07 | SS08 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(a)pyrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(b)fluoranthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(g,h,i)perylene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(k)fluoranthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Chrysene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Dibenzo(a,h)anthracene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Fluoranthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Fluorene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Indeno(1,2,3-c,d)pyrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Naphthalene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Phenanthrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Pyrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Phenols Soil [EPA 8270D]-DXB | 2,4,5-Trichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,4,6-Trichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,4-Dichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,4-Dimethylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2-Chlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2-Methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2-Nitrophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 4-Chloro-3-methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 4-Methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 4-Nitrophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | Pentachlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,3,4,6-Tetrachlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,6-Dichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 3-Methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | Phenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Dichlorodifluoromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Chloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Vinyl Chloride | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromomethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |

| Table B1: Soil Analyses | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Method | Parameter Name | Unit | Detection Limit | SS01 | SS02 | SS03 | SS04 | SS05 | SS06 | SS07 | SS08 |
| VOCs in Soil [EPA 8260 B]-DXB | Chloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Trichlorofluoromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1-Dichloroethene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Methylene Chloride | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloroethene(trans) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1-Dichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloroethene(cis) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 2,2-Dichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromochloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Chloroform | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,1-Trichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1-Dichloropropene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Carbon Tetrachloride | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Benzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Trichloroethene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromodichloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Dibromomethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichloropropene(cis) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Toluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichloropropene(trans) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,2-Trichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Tetrachloroethene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Dibromochloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dibromoethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Chlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,1,2-Tetrachloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Ethyl benzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | m,p-Xylene | mg/kg | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

| Table B1: Soil Analyses | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Method | Parameter Name | Unit | Detection Limit | SS01 | SS02 | SS03 | SS04 | SS05 | SS06 | SS07 | SS08 |
| VOCs in Soil [EPA 8260 B]-DXB | o-Xylene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Styrene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | iso-Propylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromoform | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,2,2-Tetrachloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,3-Trichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | n-Propylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3,5-Trimethylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 2-Chlorotoluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 4-Chlorotoluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | tert-Butylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,4-Trimethylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | sec-Butylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | p-Isopropyltoluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,4-Dichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | n-Butylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dibromo-3-Chloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,4-Trichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Hexachlorobutadiene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Naphthalene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,3-Trichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |

| Table B2: ADQCC Soil Limits for Industrial and Commercial use | | | |
|---|---|---|---|
| Parameter | Unit | Screening level | Clean-up level |
| Antimony (Sb) | mg/kg (DW) | 470 | 4700 |
| Arsenic (As) | mg/kg (DW) | 30 | 300 |
| Beryllium (Be) | gm/kg (DW) | 2.3 | 23.0 |
| Cadmium (Cd) | mg/kg (DW) | 980 | 9800 |
| Chromium (Cr VI) | mg/kg (DW) | 63 | 630 |
| Cobalt (Co) | mg/kg (DW) | 350 | 3500 |
| Lead (Pb) | gm/kg (DW) | 8.0 | 80 |
| Mercury (Hg) | mg/kg (DW) | 46 | 460 |
| Nickel (Ni) | gm/kg (DW) | 22 | 220 |
| Selenium (Se) | gm/kg (DW) | 5.8 | 58 |
| Asbestos | gm/10 kg (DW) | 5.0 | 5.0 |
| Benzene | mg/kg (DW) | 51 | 510 |
| Toluene | gm/kg (DW) | 47 | 470 |
| Ethylbenzene | mg/kg (DW) | 250 | 2500 |
| Xylene | gm/kg (DW) | 2.5 | 25.0 |
| Benzo (a) pyrene (BaP) | mg/kg (DW) | 2.9 | 29 |
| Polychlorinated Biphenyls | mg/kg (DW) | 330 | 3300 |

Table Notes:

- Taken from Environmental Specification for Soil Contamination ADS 19/2017
- Mg/kg = milligram per kilogram
- Gm/kg = gram per kilogram
- DW = Dry Weight

## Figure B13: GW01 Groundwater Analytical Report (1 of 3)

element

### Analytical Report

| | |
|---|---|
| Job Ref. No. | 99401 |
| Report No | 130130 |
| Date Reported | 07/06/2021 |

| | |
|---|---|
| Client: | Nautica Environmental Associates LLC |
| | P.O Box: 44700 |
| | Abu Dhabi |
| | ABU DHABI, United Arab Emirates |
| Attn: | Veryan O.H. Pappin |
| Project ID: | Ground Water Das Island and 2 Locations Mainland N/2007.21 |
| Project Name: | Nautica Environmental Associates LLC |
| Project Location: | N/A |
| Tel. No: | +971 (0)2 6731250 |

Approved by: Saji SK

Asst. Laboratory Manager–Chemistry & Microbiology

**Sample Details**

| | | | |
|---|---|---|---|
| Job Ref. No.: | 99401 | Sample ID: | 99401-1 |
| Sample Sub Matrix: | Ground Water | Date Received: | 25/05/2021 |
| Sampling Location: | Not Given | Sampling Date: | 25/05/2021 |
| Sampled By : | Nautica Rep | Sampling Time : | Not Given |
| Sample Description: | GW 01 | Sampling Method: | Not Given |

**Test Results**

| Test Name | Units | Result | Method Limit of Detection |
|---|---|---|---|
| **Inorganic Parameters** | | | |
| pH Value @ 20°C | pH units | 7.9 | - |
| Total Suspended Solids | mg/L | <5.0 | 5 |
| Total Dissolved Solids | mg/L | 190000 | 5 |
| Dissolved & Emulsified Oil | mg/L | <10 | 10 |
| Free Oil | % vol./vol. | <0.01 | 0.01 |
| Turbidity | NTU | 2.9 | 0.1 |
| Ammonia | mg/L | <0.06 | 0.06 |
| Nitrogen (Ammonia) | mg/L | <0.05 | 0.05 |
| Ammonium | mg/L | <0.064 | 0.064 |
| Sulphide | mg/L | <0.005 | 0.005 |
| Salinity | ppt | >90 | 1 |
| Nitrogen Kjeldhal | mg/L | <1.00 | 1 |
| **Anions** | | | |
| Fluoride | mg/L | 1.7 | 0.1 |
| Nitrate | mg/L | <0.04 | 0.04 |
| **Chemical Analysis** | | | |
| Chemical Oxygen Demand | mg/L | 50 | 5 |
| Biochemical Oxygen Demand | mg/L | <2 | 2 |
| **Metals** | | | |
| Chromium (VI) | mg/L | <0.05 | 0.05 |
| Arsenic (As) | mg/L | 0.0093 | 0.0005 |
| Cadmium (Cd) | mg/L | 0.0009 | 0.0001 |
| Lead (Pb) | mg/L | 0.0021 | 0.0002 |
| Zinc (Zn) | mg/L | <0.010 | 0.002 |
| Copper (Cu) | mg/L | 0.0017 | 0.0003 |
| Aluminium (Al) | mg/L | <0.005 | 0.005 |
| Manganese (Mn) | mg/L | 0.026 | 0.001 |
| Antimony (Sb) | mg/L | 0.0023 | 0.0002 |
| Barium (Ba) | mg/L | 0.0067 | 0.0005 |
| Beryllium (Be) | mg/L | <0.0015 | 0.0015 |
| Cobalt (Co) | mg/L | 0.0042 | 0.0001 |
| Mercury (Hg) | mg/L | <0.0001 | 0.0001 |

Page 1 of 3

## Figure B13: GW01 Groundwater Analytical Report (2 of 3)

element

### Analytical Report

| | |
|---|---|
| Job Ref. No. : | 93461 |
| Report No : | 128190 |
| Date Reported : | 07/06/2021 |

| | |
|---|---|
| Client: | Nautica Environmental Associates LLC |
| | P.O Box: 44700 |
| | Abu Dhabi |
| | ABU DHABI, United Arab Emirates |
| Attn: | Meryan G.H. Papper |
| Project ID: | Ground Water Das Island and 2 Locations Mainland N0007-21 |
| Project Name: | Nautica Environmental Associates LLC |
| Project Location: | N/A |
| Tel. No: | +971 (0)2 6731292 |

Approved by: Saji SK

**Sample Details**

| | | | |
|---|---|---|---|
| Job Ref. No.: | 93461 | Sample ID: | 93461-1 |
| Sample Sub Matrix: | Ground Water | Date Received: | 25/05/2021 |
| Sampling Location: | Not Given | Sampling Date: | 25/05/2021 |
| Sampled By : | Nautica Rep. | Sampling Time : | Not Given |
| Sample Description: | GW 03 | Sampling Method: | Not Given |

**Test Results**

| Test Name | Units | Result | Method Limit of Detection |
|---|---|---|---|
| **Metals - Continued** | | | |
| Phosphorus (P) | mg/L | <0.03 | 0.03 |
| Chromium (Cr) | µg/L | 1.7 | 0.3 |
| Nickel (Ni) | µg/L | 6.3 | 0.3 |
| **Hydrocarbons** | | | |
| EPH C10-C40 | µg/L | <10 | 10 |
| VPH C5-C10 | µg/L | <7 | 7 |
| **Phenols** | | | |
| 2,4,5-Trichlorophenol | µg/L | <1.0 | 1 |
| 2,4,6-Trichlorophenol | µg/L | <1.0 | 1 |
| 2,4-Dichlorophenol | µg/L | <1.0 | 1 |
| 2,4-Dimethylphenol | µg/L | <1.0 | 1 |
| 2-Chlorophenol | µg/L | <1.0 | 1 |
| 2-Methylphenol | µg/L | <1.0 | 1 |
| 2-Nitrophenol | µg/L | <1.0 | 1 |
| 4-Chloro-3-methylphenol | µg/L | <1.0 | 1 |
| 4-Methylphenol | µg/L | <1.0 | 1 |
| 4-Nitrophenol | µg/L | <1.0 | 1 |
| Pentachlorophenol | µg/L | <1.0 | 1 |
| 2,3,4,6-Tetrachlorophenol | µg/L | <1.0 | 1 |
| 2,3,5,6-Tetrachlorophenol | µg/L | <1.0 | 1 |
| 2,6-Dichlorophenol | µg/L | <1.0 | 1 |
| 3-Methylphenol | µg/L | <1.0 | 1 |
| Phenol | µg/L | <0.5 | 0.5 |
| **Microbiology** | | | |
| E-Coli | CFU/100mL | Not Detected | 10 |
| Total Coliform | CFU/100mL | Not Detected | 10 |
| Faecal Coliform | CFU/100mL | Not Detected | 10 |

Page 2 of 3

# Figure B13: GW01 Groundwater Analytical Report (3 of 3)

Element Materials Technology AE Limited Abu Dhabi
P.O. Box [illegible]
Abu Dhabi, United Arab Emirates
P: +971 (0)2 [illegible]
F: +971 (0)2 [illegible]
www.element.com

## Analytical Report

| | |
|---|---|
| Job Ref. No. | [illegible] |
| Report No. | [illegible] |
| Date Reported | 07/06/2021 |

| | |
|---|---|
| Client: | Nautica Environmental Associates LLC |
| | P O Box: 44780 |
| | Abu Dhabi |
| | ABU DHABI, United Arab Emirates |
| Attn: | Velyan G.H. Pappin |
| Project ID: | Ground Water Das Island and 2 Locations Mainland-N0007-21 |
| Project Name: | Nautica Environmental Associates LLC |
| Project Location: | N/A |
| Tel. No: | +971 (0)2 6731250 |

Approved by: Saji SK

Asst. Laboratory Manager Chemistry & Microbiology

### Method of Analysis

| Method Name | Reference |
|---|---|
| Biochemical Oxygen Demand [APHA 5210 B]Water-DXB | APHA [5210 B] |
| Chemical Oxygen Demand [APHA 5220 B]Water-DXB | APHA [5220 B] |
| Chromium (Hexavalent) [HACH 8023] Water-DXB | HACH [8023] |
| E.Coli [APHA 9222 I]-DXB | APHA [9222 I] |
| EPH C10-C40 (Low LOD) by GC-FID [EPA 8015B] Water-DXB | EPA [8015B] |
| Faecal Coliform by MF Technique [APHA 9222D]Water-DXB | APHA [9222 D] |
| Fluoride [HACH 8029]-DXB | HACH [8029] |
| Metals ICP-MS [APHA 3125] SW-DXB | APHA [3125] |
| Nitrate [HACH 8039]-DXB | HACH [8039] |
| Nitrogen (Ammonia) [HACH 8155]-DXB | HACH [8155] |
| Nitrogen Kjeldhal [APHA 4500 Norg B]Water-DXB | APHA [4500 Norg B] |
| Oil & Grease [APHA 5520 B]Water-DXB | APHA [5520 B] |
| pH [APHA 4500 H+ B]Water-DXB | APHA [4500 H+ B] |
| Phenols water [EPA 528]-DXB | EPA [528] |
| Salinity [APHA 2520 B]-DXB | APHA [2520 B] |
| Solids (Total Dissolved) [APHA 2540 C]Water-DXB | APHA [2540 C] |
| Solids (Total Suspended) [APHA 2540 D]Water-DXB | APHA [2540 D] |
| Sulphide [HACH 8131]-DXB | HACH [8131] |
| Total Coliform [APHA 9222 B]Water-DXB | APHA [9222 B] |
| Turbidity [APHA 2130 B]-DXB | APHA [2130 B] |
| VPH C5-C10 by GC-FID [EPA 8015B] Water-DXB | EPA [8015B] |

### Comments:

Tested By: QAN, HRA, JCH, NAH, SKR, SMO

Date Tested: 26/05/2021 To 07/06/2021

Please note that all tests shown containing the 'DXB' extension are subcontracted to Al Futtaim Element Materials Technology Dubai L.L.C.

Please note that if the sample has to be diluted due to the matrix, the reported Limit of Detection (LOD) value will increase from the method LOD.

Any APHA methods stated herein are documented in-house procedures, referenced to 23rd edition.

Page 3 of 3

| Table B3: Noise Data Sheet N01 | | | | | | | |
|---|---|---|---|---|---|---|---|
| User: | Ross Pappin | | | Job No: | N684 | Project: | MM Lightning |
| Report No: | N684-0621-SHU-1.0 | Survey Date: | See comments | Checked: | DT | Date: | - |
| Site No: | N01 | Mic. Height: | 155cm | Free Field | ✓ | Facade: | N/A |

Location Description (draw a little picture of the area):


Noise Source:

Power complex, crickets

| Period | Calibration | | Wind | | Time | | LAeq | Cars (tally) | Trucks (tally) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Speed | Direction | On | Off | | | | |
| Day (Week) | 94.2dB | 94.0dB | 1.9m/s | SW(227°) | 07:45 | 08:00 | 44.2 | | | 23.05.2021 |
| Night (Week) | 94.2dB | 94.0dB | 1.4m/s | E(68.15°) | 21:04 | 21:19 | 45.5 | | | 23.05.2021 |
| Day (W-end) | 94.1dB | 93.9dB | 3.9m/s | N(6°) | 17:34 | 17:49 | 38.2 | | | 22.05.2021 |
| Night (W-end) | 94dB | 93.8dB | 1.4m/s | NE(40°) | 21:04 | 21:19 | 42.1 | | | 22.05.2021 |

General Weather Conditions:

Noise measurements were collected only during periods of low wind speed

| Specific Conditions: | Calm | Fog | Precipitation | Frost | Tonal | Impulse |
|---|---|---|---|---|---|---|
| BS4142 Compliance: | ✓ | x | x | x | | |
| Factory Cal. Date: | 16.05.2021 | | | | | |
| Checked: | Doug Tilbury | | Date: | 16/06/2021 | | |

Key to Abbreviations: Mic = Microphone / LAeq = Equivalent Continuous Level / SW = Southwest / NE = Northeast / N = North / E = East / m/s = Metre per second / dB = Decibel / Cal = Calibration / cm = Centimetre / min = Minute

## Table B4: Noise Data Sheet N02

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| User: | Ross Pappin | | | Job No: | N684 | Project: | MM Lightning |
| Report No: | N684-0621-SHU-1.0 | Survey Date: | See comments | Checked: | DT | Date: | - |
| Site No: | N02 | Mic. Height: | 155cm | Free Field | ✓ | Facade: | N/A |

Location Description (draw a little picture of the area):


Noise Source:

Vehicles

| Period | Calibration | | Wind | | Time | | LAeq | Cars (tally) | Trucks (tally) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Speed | Direction | On | Off | | | | |
| Day (Week) | 94.2dB | 94dB | 4.2m/s | SE(121°) | 09:21 | 09:36 | 37.9 | | | 23.05.2021 |
| Night (Week) | 94.2dB | 94dB | 3.9m/s | NE(36.38°) | 21:03 | 21:18 | 44.4 | | | 23.05.2021 |
| Day (Weekend) | 94.1dB | 93.9dB | 4.6m/s | NE(50°) | 15:47 | 16:02 | 39.0 | | | 22.05.2021 |
| Night (Weekend) | 94.1dB | 94.0dB | 1.7m/s | N(345°) | 20:32 | 20:47 | 40.5 | | | 22.05.2021 |

General Weather Conditions:

Noise measurements were collected only during periods of low wind speed

| Specific Conditions: | Calm | Fog | Precipitation | Frost | Tonal | Impulse |
|---|---|---|---|---|---|---|
| BS4142 Compliance: | ✓ | x | x | x | | |

| | | | |
|---|---|---|---|
| Factory Cal. Date: | 16.05.2021 | | |
| Checked: | Doug Tilbury | Date: | 16/06/2021 |

Key to Abbreviations: No = Number / Mic = Microphone / LAeq = Equivalent Continuous Level / SE = Southeast / NE = Northeast / N = North / m/s = Metre per second / dB = Decibel / Cal = Calibration / cm = Centimetre / min = Minute

## Table B5: Noise Data Sheet N03

| | | | | | |
|---|---|---|---|---|---|
| User: | Ross Pappin | Job No: | N684 | Project: | MM Lightning |
| Report No: | N684-0621-SHU-1.0 | Survey Date: | See comments | Checked: | DT |
| Date: | - | Site No: | SN03 | Mic. Height: | 155cm |
| Free Field | ✓ | Facade: | N/A | | |

Location Description (draw a little picture of the area):


Noise Source:

Vehicles, powerlines

| Period | Calibration | | Wind | | Time | | LAeq | Cars (tally) | Trucks (tally) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Speed | Direction | On | Off | | | | |
| Day (Week) | 94.3dB | 94.1dB | 2.6m/s | SE(124°) | 09:48 | 10:02 | 41.8 | 𝍸 𝍸 | 𝍸 𝍸 𝍸 | 23.05.2021 |
| Night (Week) | 94.3dB | 94.0dB | 4.5m/s | NE(29.38°) | 20:32 | 20:47 | 51.4 | 𝍸 𝍸 \|\| | 𝍸 \|\|\| | 23.05.2021 |
| Day (Weekend) | 94.0dB | 93.9dB | 3.8m/s | N(356°) | 15:17 | 15:32 | 45.4 | 𝍸 𝍸 𝍸 | 𝍸 𝍸 \|\|\|\| | 22.05.2021 |
| Night (Weekend) | 94.0dB | 93.8dB | 1.6m/s | N(13°) | 20:01 | 20:16 | 47.7 | 𝍸 𝍸 𝍸 \|\| | 𝍸 𝍸 | 22.05.2021 |

General Weather Conditions:

Noise measurements were collected only during periods of low wind speed

| Specific Conditions: | Calm | Fog | Precipitation | Frost | Tonal | Impulse |
|---|---|---|---|---|---|---|
| BS4142 Compliance: | ✓ | x | x | x | | |
| Factory Cal. Date: | 16.05.2021 | | | | | |
| Checked: | Doug Tilbury | Date: | 16/06/2021 | | | |

Key to Abbreviations: No = Number / Mic = Microphone / LAeq = Equivalent Continuous Level / SE = Southeast / NE = Northeast / N = North / m/s = Metre per second / dB = Decibel / Cal = Calibration / cm = Centimetre / min = Minute

# ANNEX C

## Quaity Control Documentation

Contents:

## Part 1: Field Documentation

Table C1, below, details field logs, provided on subsequent pages.

| Table C1: Field Documentation | | |
|---|---|---|
| Figure № | Description | Usage |
| Figure C1 | NEA Field Log Day 22.05.2021 | Daily log of activities |
| Figure C2 | NEA Field Log Day 23.05.2021 | Daily log of activities |
| Figure C3 | NEA Field Log Day 24.05.2021 | Daily log of activities |

## Figure C1: NEA Activity Log 22.05.2021

| | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 22.05.2021 / Saturday |
| Site Team: | RP, AM, PM | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 12:20 | HEC | Arrived Hans Esser Camp and checked in |
| 13:00 | HEC | Depart to site |
| 14:15 | SS01 | SS01 – Soil sampling |
| 14:30 | SS07 | SS07 – Soil sampling |
| 14:45 | SS02 | SS02 – Soil sampling |
| 15:17 | SN03 | SN03 – Noise monitoring (Day – Weekend) |
| 15:47 | SN02 | SN02 – Noise monitoring (Day – Weekend) |
| 16:15 | SS06 | SS06 – Soil sampling |
| 16:25 | SS05 | SS05 – Soil sampling |
| 16:40 | SS04 | SS04 – Soil sampling |
| 17:00 | SS03 | SS03 – Soil sampling |
| 17:15 | SS08 | SS08 – Soil sampling |
| 17:30 | SN01 | SN01 – Noise monitoring (Day – Weekend) |
| 19:55 | SN03 | SN03 – Noise monitoring (Night – Weekend) |
| 20:30 | SN02 | SN02 – Noise monitoring (Night – Weekend) |
| 21:00 | SN01 | SN01 – Noise monitoring (Night – Weekend) |
| 21:30 | HEC | Arrived back at Hans Esser and debrief |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel PIR = Process Improvement Report / PM = Paulo Mendoza / AM = Aneeta Mathew / RP = Ross Pappin / DT = Doug Tilbury / HEC = Hans Esser Camp

| | |
|---|---|
| PM Name: | Ross Pappin |
| PM Signature and Stamp: | Ross P... NAUTICA ENVIRONMENTAL ASSOCIATES LLC POB 44780 ABU DHABI UAE |

| Figure C2: NEA Activity Log 23.05.2021 | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 23.05.2021 / Sunday |
| Site Team: | RP, AM, PM | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 07:15 | HEC | Depart to site |
| 07:35 | SN01 | SN01 – Noise monitoring (Day – Weekday) |
| 08:05 | Site | Mangrove ecology walkover survey |
| 09:21 | SN02 | SN02 – Noise monitoring (Day – Weekday) |
| 09:50 | SN03 | SN03 – Noise monitoring (Day – Weekday) |
| 10:25 | HEC | Arrived back at Hans Esser |
| 15:15 | Site | Ecology walkover survey |
| 15:45 | CT01 | Deployed CT – 01 |
| 15:55 | CT02 | Deployed CT – 02 |
| 16:05 | CT03 | Deployed CT – 03 |
| 16:40 | CT04 | Deployed CT – 04 |
| 16:47 | CT05 | Deployed CT – 05 |
| 20:26 | SN03 | SN03 – Noise monitoring (Night – Weekday) |
| 20:57 | SN02 | SN02 – Noise monitoring (Night – Weekday) |
| 21:25 | SN01 | SN01 – Noise monitoring (Night – Weekday) |
| 22:10 | HEC | Arrived back at Hans Esser and debrief |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel PIR = Process Improvement Report / CT = Camera Trap / PM = Paulo Mendoza / AM = Aneeta Mathew / RP = Ross Pappin / DT = Doug Tilbury / HEC = Hans Esser Camp

| | |
|---|---|
| PM Name: | Ross Pappin |
| PM Signature and Stamp: | Ross P... NAUTICA ENVIRONMENTAL ASSOCIATES LLC • POB 44780 ABU DHABI UAE |

## Figure C3: NEA Activity Log 24.05.2021

| | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 24.05.2021 / Monday |
| Site Team: | RP, AM | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 07:15 | HEC | Depart to site |
| 07:30 | Site | Ecology walkover survey |
| 08:25 | CT01 | Retrieved CT – 01 |
| 08:39 | CT02 | Retrieved CT – 02 |
| 08:51 | CT03 | Retrieved CT – 03 |
| 08:55 | CT04 | Retrieved CT – 04 |
| 08:59 | CT05 | Retrieved CT – 05 |
| 09:20 | GW03 | GW03 – Groundwater sampling |
| 16:00 | HEC | Depart Hans Esser to Mirfa |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Key to Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel
PIR = Process Improvement Report / CT = Camera Trap / AM = Aneeta Mathew / RP = Ross Pappin / DT = Doug Tilbury
HEC = Hans Esser Camp

| | |
|---|---|
| PTL Name: | Ross Pappin |
| PM Signature and Stamp: | Ross Pi NAUTICA ENVIRONMENTAL • ASSOCIATES LLC • PO8 44780 ABU DHABI UAE |

## Part 2: NEA Licenses and Accreditations

Table C2, below, provides a list of NEA licenses and accreditations, provided on subsequent pages.

Table C2: NEA Licenses and Accreditations

| Figure № | Description | Usage |
|---|---|---|
| Figure C4 | NEA Trade License | - |
| Figure C5 | NEA EAD Registration | - |
| Figure C6 | NEA Quality Assurance Accreditation | - |

## Figure C4: NEA Trade License

مركز أبوظبي للأعمال
Abu Dhabi Business Center

الإمارات
THE EMIRATES

دائرة التنمية الاقتصادية
DEPARTMENT OF ECONOMIC DEVELOPMENT

# Professional License رخصـــة مهنية

| | | | |
|---|---|---|---|
| License No | CN-1006375 | | رقم الرخصة |
| ADCCI No | 226824 | | عضوية الغرفة |
| Establishment Card MOHRE | | | وزارة الموارد البشرية والتوطين بطاقة المنشأة |
| Establishment Card GDRFA | | | الإدارة العامة للإقامة وشؤون الأجانب - بطاقة المنشأة |
| Legal Form | Limited Liability Company | شركة ذات مسؤولية محدودة | الشكل القانوني |
| | | نوتيكا للاستشارات البيئية ذ م م | الإسم التجاري |
| Trade Name | NAUTICA ENVIRONMENTAL ASSOCIATES - LLC | | |
| Establishment Date | 05/05/2007 | | تاريخ تأسيس المنشأة |
| Issue Date | 19/01/2021 | | تاريخ الإصدار |
| Expiry Date | 09/02/2022 | | تاريخ الانتهاء |

| الصفة<br>Role | الجنسية<br>Nationality | الملاك / الشركاء<br>Owners / Partners | الرقم<br>No. |
|---|---|---|---|
| شريك<br>Partner | الإمارات العربية المتحدة<br>United Arab Emirates | بيتر ارثر هليار<br>PETER ARTHUR HELLYER | 41208281 |
| شريك<br>Partner | المملكة المتحدة<br>United Kingdom | ريتشارد جون هورنبي<br>RICHARD JOHN HORNBY | 20029757 |
| شريك<br>Partner | المملكة المتحدة<br>United Kingdom | فيريان جوي هنري بابين<br>VERYAN GUY HENRY PAPPIN | 20029756 |

**Commercial Activities** : الأنشطة التجارية

| | |
|---|---|
| - Environmental consultancy and studies and researches | - الاستشارات والدراسات والبحوث البيئية |
| - First Aids Training | - التدريب على الإسعافات الأولية |
| - Wildlife Protectorate | - محمية الحياة البرية |
| - Services Of Testing And Measuring Of Environmental Indicators | - خدمات اختبار وقياس المؤشرات البيئية |
| - Oil and Gas Facilities Consultancy | - استشارات هندسية في منشآت النفط والغاز |
| - Survey Planning, Air Photography and Information Management Systems Engineering Consultancy | - استشارات هندسة التخطيط المساحي والتصوير الجوي ونظم إدارة المعلومات |
| - Environment Protection Training | - التدريب في مجال حماية البيئة |
| - Onshore And Offshore Oil And Gas Fields And Facilities Services | - خدمات حقول ومنشآت النفط والغاز البرية والبحرية |
| - Chemical and Biological Analysis Lab | - مختبر تحاليل الكيماوية والبيولوجية |

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| | | |
|---|---|---|
| Official Email | management@nea.ae | البريد الالكتروني الرسمي |
| Official Mobile | 971506134043 | رقم التواصل الرسمي |

غرفة أبوظبي

http://ded.abudhabi.ae

## Figure C5: NEA EAD Registration

هيئة البيئة - أبوظبي
Environment Agency - ABU DHABI

| | | |
|---|---|---|
| EC- | 59/06 | رقم المكتب |
| ECR- | 778/21 | رقم التوصية |
| Date of Issue | 25/5/2021 | تاريخ الإصدار |
| Date of Expiry | 14/5/2022 | تاريخ الإنتهاء |

إعتماد مكتب استشاري في مجال البيئة

* فئة (أ)

Registration of Environmental Consultancy

* Class A

| | | | |
|---|---|---|---|
| Office Name: | Nautica Environmental Associates LLC | "نوتيكا للزمالة البيئية ذ م م" | اسم المكتب: |
| Type of Office: | Local (100 %) | محلي (100%) | نوع المكتب: |
| Address: | Office M3, East 14<br>Sheikha Zayed Ahmad and Others Bldg<br>Al Meena Street,<br>Abu Dhabi | جزيرة أبوظبي - شرق 14 - شارع الميناء - بناية الشيخة شيخه سعيد أحمد وآخرين - الميزانين مكتب رقم 3 | العنوان: |

Environment Agency – Abu Dhabi
Electronically generated permit - No signature required.

هيئة البيئة - أبوظبي
التصريح صادر إلكترونياً - لا يتطلب أي توقيع

Figure C6: NEA ISO Accreditation

Lloyd's Register

Current issue date: 29 April 2020
Expiry date: 4 May 2021
Certificate identity number: [illegible]

Original approval(s):
ISO 14001 – 12 June 2011
ISO 45001 – 29 April 2020
ISO 9001 – 13 June 2011

# Certificate of Approval

This is to certify that the Management System of:

## Nautica Environmental Associates LLC

M03, Building No: P475, Behind Ramada Hotel, Meena Road, Abu Dhabi, United Arab Emirates

has been approved by Lloyd's Register to the following standards:

**ISO 14001:2015, ISO 45001:2018, ISO 9001:2015**

Approval number(s): ISO 14001 – 0045599E, ISO 45001 – 0045598, ISO 9001 – 0045597

**The scope of this approval is applicable to:**

1. Provision of Environmental Consultancy Services Typically Covering:
   - Baseline Surveys (Marine and Terrestrial)
   - Environmental Impact Assessments
   - Sampling and Monitoring Studies (Air, Land, Sediments, Marine)
   - Identification and Statistical Evaluation of Biological Specimens
2. Provision of First-Aid Training and Environmental Protection Training

**Luis Cunha**
Area Operations Manager - SAMEA

Issued by: Lloyd's Register Quality Assurance Limited

UKAS 001

## Part 3: Support Equipment Specifications

Table C3, below, provides a list of key equipment either used or on hand for the survey programme, with specifications provided on subsequent pages.

Table C3: Survey equipment available

| Figure № | Description | Usage |
|---|---|---|
| Figure C7 | Beacon on a Belt (BOB) | DGPS locational system |
| Figure C8 | Trimble GoXT handheld unit | DGPS locational system |
| Figure C9 | Nikon Forestry Pro Laser Rangefinder | Tree height measurements (NU) |
| Figure C10 | Bushnell Camera Traps | Small mammal/reptile activity |
| Figure C11 | Sherman Traps | Small mammal activity |
| Figure C12 | Anabat Detector | Bat Detection |
| Figure C13 | Malaise Traps | Insect trapping |
| Figure C14 | RIDGID Micro-inspection unit | Den/Borrow/Hole investigation (NU) |
| Figure C15 | Pitfall Trap | Insect / small reptile trapping |
| Figure C16 | Mavik Pro 2 UAV (Drone) | Aerial photography/videography |

## Figure C7: Beacon-on-a-Belt (BOB)

# Beacon-on-a-Belt (BoB)

*Cable-free Differential Correction Receiver*

**Key features and benefits**

- Provides real-time DGPS accuracy to mapping receivers
- Cable-free communication with Trimble GeoExplorer 3
- Rugged, ergonomic design
- Noise-rejecting beacon receiver

Trimble's Beacon-on-a-Belt (or BoB™) receiver lets you add the extra precision of real-time differential GPS to your GIS projects— without adding the encumbrance of a bulky radio pack. The system incorporates a beacon receiver, an antenna and battery in one compact cable-free* package that you wear on your belt. The BoB receiver decodes GPS differential correction information from local MSK beacons and then transmits that information to any GPS receiver that accepts standard RTCM SC-104 data, eliminating the need to postprocess your data. Best of all, this is completely cable-free when used with Trimble's GeoExplorer® 3.

*Beacon-on-a-Belt (BoB) Receiver*

**Real-time DGPS Accuracy**

The accuracy of differential GPS not only means that your databases have better data, it also makes locating previously mapped assets in the field quicker and more accurate too. With differential GPS, distinguishing between closely spaced assets is fast and unambiguous. Back in the office you'll save time too. Since the data you collected was corrected as you gathered it, you can transfer that data directly into your GIS without the delay of a separate postprocessing step.

**Cable-Free Convenience**

To complement the convenience of Trimble's handheld GeoExplorer® 3 system, the BoB differential receiver communicates with that system automatically—with no cabling or accessories whatsoever. There's nothing to connect, nothing to forget, and nothing to carry on your back. Your crews will move faster and incur less downtime due to snagged or broken cables.

**Rugged and Easy to Operate**

No matter where your data collection and update projects take you, the BoB receiver is ready to follow. Shockproof and water-resistant, it will withstand all the rigors of fieldwork, in any weather. Right out of the box the BoB receiver is ready to start working with your Trimble GPS/GIS data collection system. Within seconds of powering on, it automatically selects the best beacon and starts transmitting corrections. If you want to reconfigure the receiver in the field an easy-to-use two-button interface simplifies the process.

**Powerful Software**

For more extensive configurations the versatile PC-BoB office software makes it easy to exclude beacon stations, define custom display names for stations, and configure the initial tracking mode. All in all, the BoB receiver is the most convenient and versatile beacon receiver we've ever developed.

*Some countries may not allow transmission on the frequency the BoB receiver uses. [illegible]

Trimble

## Figure C7: Beacon-on-a-Belt (BOB)

# Beacon-on-a-Belt (BoB™)

*Cable-free Differential Correction Receiver*

**FEATURES**

- Dual Channel Minimum Shift Keying (MSK) Differential GPS (DGPS) beacon receiver
- Cable free real time link to the Trimble GeoExplorer 3 mapping system in the United States
- Automatically tracks the strongest or closest beacon signal, or can be fixed to track a specified beacon station
- Rugged, dust, and water resistant housing
- Compact, ergonomic belt mounted design
- Immunity to noise and jamming signals
- All day internal rechargeable battery
- Simple two button/two LED interface
- Full DGPS status in the field via GeoExplorer 3
- Advanced configuration setup via PC BoB software
- Advanced diagnostics via PC BoB software

**HARDWARE SPECIFICATIONS**

| | |
|---|---|
| Size | 20.6 cm (8.1") H x 10.7 cm (4.2")W x 10.7 cm (4.2") D (at antenna) |
| Weight | 1.16 kg (2.56 lbs) |
| Power consumption | 1.5 W |
| Temperature | Operating: -10 C to +50 C (+14 F to +122 F)<br>Storage: -20 C to +70 C (-4 F to +158 F) |
| Humidity | Up to 95% non-condensing |
| Port settings | RS-232 at 2400 baud, 8 data bits, 1 stop bit, no parity |

**PERFORMANCE SPECIFICATIONS**

| | |
|---|---|
| Cold start time | <25 seconds typical |
| Warm start time | <10 seconds typical |
| Channels | 2 |
| Frequency | Range: 283.5–325 kHz<br>Spacing: 500 Hz |
| MSK modulation | 50, 100 & 200 b/s autoselection |
| Output protocol | RTCM SC-104 |
| Input protocol | NMEA 0183 |
| Battery life | Up to 10 hours |

**STANDARD ACCESSORIES**

- Belt and holster
- Charging cable for internal battery
- PC BoB software for configuration and diagnostics
- Printed manual and Quick Reference Card
- Curly null modem cable

**OPTIONAL ACCESSORIES**

| | |
|---|---|
| External power kit | Includes camcorder battery, vehicle and camcorder adapters, vehicle splitter cable and soft shoulder pack |

**ORDERING INFORMATION**

| | |
|---|---|
| Beacon-on-a-belt (BoB) | 28000-00-ENG* |
| BoB with GeoExplorer 3 | 28100-00-ENG* |
| BoB with GeoExplorer 3c | 28400-10-ENG* |
| External power kit | 28003-00 |

*These part numbers are for use in the US only. Outside the US contact your local Trimble dealer for local ordering information.

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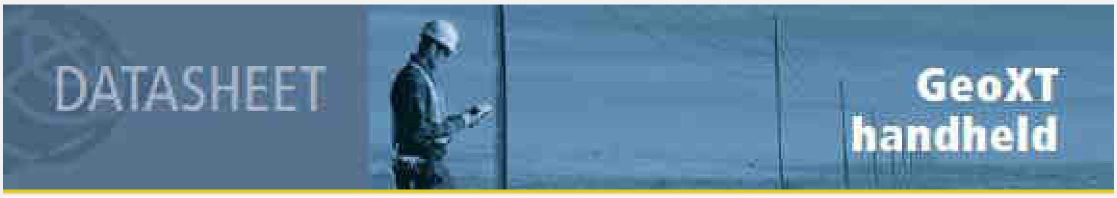
YOUR LOCAL TRIMBLE OFFICE OR REPRESENTATIVE

## Figure C8: Trimble GeoXT 2005 Series




**KEY FEATURES**

High-performance submeter GPS with integrated SBAS and EVEREST multipath technology

Microsoft Windows Mobile version 5.0 software, allowing maximum flexibility in software choice

512 MB onboard memory plus removable SD memory

Bluetooth and wireless LAN connectivity options

Rugged handheld with all-day battery

TrimPix technology for wireless camera support

**THE TOTAL GPS PLATFORM FOR ALL YOUR GIS FIELD REQUIREMENTS**

The GeoXT™ handheld, from Trimble's GeoExplorer® series, is the essential tool for maintaining your GIS. A high performance, submeter GPS receiver combined with a rugged handheld computer, the GeoXT handheld is ideal for use by utility companies, local government organizations, federal agencies, or anyone managing assets or mapping critical infrastructure who needs accurate data to do the job right—the first time.

Delivering consistent submeter accuracy both real-time and postprocessed, the GeoXT handheld is the most dependable submeter solution available. And it's specifically designed with your GIS in mind.

**Real-world submeter performance**

The GeoXT handheld is optimized to provide the reliable, high-accuracy location data when and where you need it. With advanced features like EVEREST™ multipath rejection technology, the GeoXT handheld outputs quality GPS positions even under canopy, in urban canyons, and in all the everyday environments you work in.

If you need submeter accuracy in real-time, you can use corrections from a satellite-based augmentation system (SBAS) like WAAS or EGNOS, or use the integrated Bluetooth® radio to connect to a Trimble® GeoBeacon™ receiver. And if you need that extra edge in precision, you can collect data with Trimble TerraSync™ software or the GPScorrect™ extension for ESRI ArcPad software, and then postprocess back in the office.

**Software to fit your workflow**

The GeoXT handheld comes with a powerful 416 MHz processor running the most advanced operating system available—Microsoft® Windows Mobile® version 5.0 software. Windows Mobile is the industry standard open platform for mobile devices, so you can choose a software solution to match your workflow, whether off-the-shelf or purpose built.

Windows Mobile version 5.0 features familiar Microsoft software, including Word Mobile, Excel Mobile, and Outlook® Mobile, giving you all the tools you need for a seamless exchange of data between the field and the office.

**Built for the field**

The GeoXT handheld has an integrated battery, good for a full day's work; simply charge the battery overnight and you're ready to go again. The GeoXT handheld will last the distance, and its rugged design can take a lot of punishment. Rain, hail, or shine, it's built to keep working, whatever the weather throws at you.

**Convenient connectivity**

With the GeoXT handheld you have the flexibility to work exactly the way you want to. Do you need to access the Internet or your organization's secure network to get the most up-to-date data? No problem—with the GeoXT handheld you have built-in wireless LAN and Bluetooth technology to ensure you stay connected.

Using the built-in wireless LAN and TrimPix™ technology, the GeoXT handheld can connect to a range of Wi-Fi-capable Nikon digital cameras for automated capture of digital images. Download the TrimPix software and you have an ideal solution for easily collecting high resolution digital photos to link to your GPS positions.

**All the memory you need**

There's plenty of storage space in the GeoXT handheld for all your GIS data, and with its fast processor even big graphics files load quickly. Because the GeoXT handheld runs Windows Mobile version 5.0 software, all your data and applications are stored in persistent memory, so your data is completely safe. And with a Secure Digital (SD) memory card slot, you can add gigabytes of memory for all your map data.

**Accuracy you can rely on**

Accurate information is crucial to making informed decisions and improving the way you do business. The GeoXT delivers consistent submeter accuracy both real-time and postprocessed, so you know your GIS has the information that others can depend on to do the job right—this time, next time and every time.

Trimble

## Figure C8: Trimble GeoXT 2005 Series

## Figure C9: Nikon Forestry Pro Laser Rangefinder Specifications

Unit Specifications:

- Magnification: 6.0x
- Objective Lens Diameter: 21mm
- Angle of View: 6°
- Laser Type: Class 1M
- Range: 11-550 yd / 10-500 m
- Exit Pupil Diameter: 3.5 mm
- Eye Relief: 18.2 mm
- Distance Display Increments: [Internal Display]
- Actual Distance: Every 0.5m/yd. or 1.0' out to 100 m/yd or feet
  1.0 m/yd or 1.0' beyond 100 m/yd or feet
- Horizontal distance and height: 0.2 m/yd or 0.5' up to 100 m/yd or feet
  ` 1.0 m/yd or 1.0' up to 100 m/yd or feet
- Angle: 0.1° up to 10° / 1° beyond 10°

External Display:

- Actual Distance: 0.5 m/yd or 1.0'
  Horizontal distance and height: 0.2 m/yd or 0.5'
- Angle: 0.1°
- Weatherproofing: 3.3' (1.0 m) to 10 minutes
- Environment: RoHS/WEEE compliant
- Power Source: (1) CR2 battery
- Dimensions: 5.0 x 2.8 x 1.8" (12.7 x 7.1 x 4.5 cm)
- Weight (Without Batteries): 7.4 oz (209.8 g)

## Figure C10: Bushnell Camera Trap Specifications

| | |
|---|---|
| Model: | 119876 |
| Sensor Resolution | 2, 8, 20MP |
| Images Resolution: | 3MP sensor with 2MP compression and 20MP interpolation |
| Flash: | 48 LEDs No-Glow |
| Flash Range (ft/m): | 100ft/30m |
| Backlit LCD Display: | B&W text LCD |
| Colour: | Brown |
| Battery Type: | AA (8) |
| Battery Life: | up to 12 mo. |
| Video Resolution: | 1920x1080p |
| Infrared Sensor Range: | 80ft / 25m |
| Multi Flash Mode: | Yes |
| Hyper Night Vision: | Yes |
| Field Scan 2x: | Yes |

## Figure C11: Sherman Trap Specifications

Sherman traps are an environmentally friendly way to research small mammal populations and can be used for mammal collection, teaching and environmental impact studies.

Sherman folding traps have the advantage of folding down to a size and shape which is easy to transport. The trap works by use of a trigger platform which causes the door to shut when the animal runs into the trap.

This is a ‘live catch’ trap and should be checked regularly. Where appropriate traps should be provided with water and food.

The Small Folding Aluminum Trap is suitable for trapping small animals such as mice and shrews. The Sherman Trap is available in a range of sizes to suit specific needs as shown below.

| Model | Dimensions / cm | Weight / g |
|---|---|---|
| XLF15 | 10.2 x 11.4 x 38.1 | 544 |
| XLK | 7.6 x 9.5 x 30.5 | 408 |
| LFA | 7.6 x 8.9 x 22.9 | 227 |
| LFAHD | 7.6 x 8.9 x 22.9 | 254 |
| LFATDG | 7.6 x 8.9 x 22.9 | 254 |
| LFG | 7.6 x 8.9 x 22.9 | 363 |

| Model | Dimensions / cm | Weight / g |
|---|---|---|
| SFAL | 5.2 x 6.4 x 22.9 | 159 |
| SFA | 5.2 x 6.4 x 16.5 | 136 |
| SFG | 5.2 x 6.4 x 16.5 | 227 |
| Longworth | 14 x 6.5 x 8.5 | 300 |

## Figure C12: Anabat Express Bat Detector Unit Specifications

The Anabat Express is a compact and weatherproof recorder that is designed to be deployed in the field for several weeks. It will record bat calls which can then be used for species identification or activity monitoring.

Camouflaged and compact, the unit has a weatherproof casing and omni-directional weatherproof microphone with a 1.5m extension cable. An optional five-metre microphone extension cable allows you to position the microphone away from the unit, which makes it easier to site the recorder in an inconspicuous location, or to raise your microphone up to an elevated position when needed.

The Express is powered by 4 x AA batteries. The unit should record for around 14 nights on one set of batteries and up to 30 nights with high quality lithium batteries. Supplied with a padded case, wrist strap, 1.5m microphone extension, a magnet for status checking and USB cable.

Features:

- New, easy-to-use interface for setup & download;
- Weatherproof, camouflaged plastic case (IP67);
- Weatherproof, compact microphone;
- Records temperature and battery voltage;
- Built-in GPS for location, transect tracking, setting the clock and calculating sunset/rise;
- Runs for 14 nights on 4 AA batteries and up to 30 nights with lithium-ion batteries;
- One-touch for continuous, scheduled or night-only recording modes.
  SD card memory and easy downloading.

Specifications:

- Dimensions: (H) 182 x (W) 119 x (D) 43mm;
- Weight: 385g (without batteries)

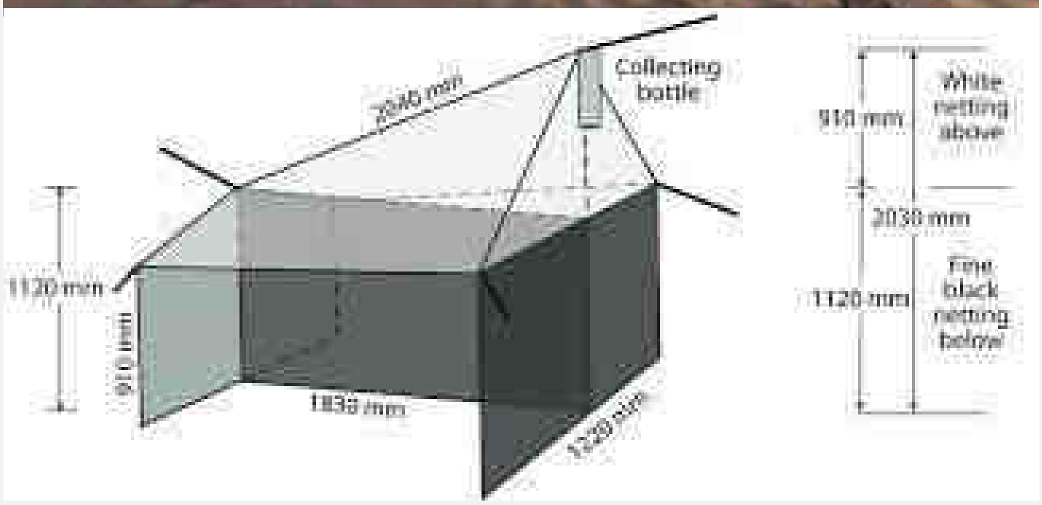
## Figure C13: Malaise Trap Specifications

A malaise trap is a large, tent-like structure used for trapping flying insects, particularly Hymenoptera and Diptera.

The trap is generally made of a material such as terylene netting and can vary in colour. Insects fly into the tent wall and are funnelled into a collecting vessel attached to highest point (see diagram below).

Typical Dimensions; Tall end height = 1.7m; Short end height = 0.9m; Width = 1.15m and Length = 1.88m. The opening is around 12–15 mm (0.47–0.59 in), and can vary according to the size of insect desired.

If using a dry agent, a smaller hole results in a faster death, limiting the amount of damage a newly caught insect can inflict on older, fragile specimens. In ethanol, this is less of a concern. Larger holes can potentially allow in more butterfly, moth and/or dragonfly species.



## Figure C14: RIDGID Micro-inspection Camera (Hole/Burrow Investigations)

The Ridgid 37888 micro CA-300 inspection camera is the next evolution of the SeeSnake micro inspection camera, it allows you to perform more detailed visual inspections in even harder-to-reach areas (see Plate below of an NEA scientist's use in a burrow investigation).

Comfortable pistol-grip design, one-hand controls, and large screen make it easy to detect and diagnose the unreachable. It comes standard with a rugged anodized aluminum camera head with 4 super bright LEDs.

Easily rotate the active image counter-clockwise to see in any situation. This micro CA300 inspection camera provides solutions whenever and wherever you need them. Easily record still images and videos of problems in hard-to-reach areas.

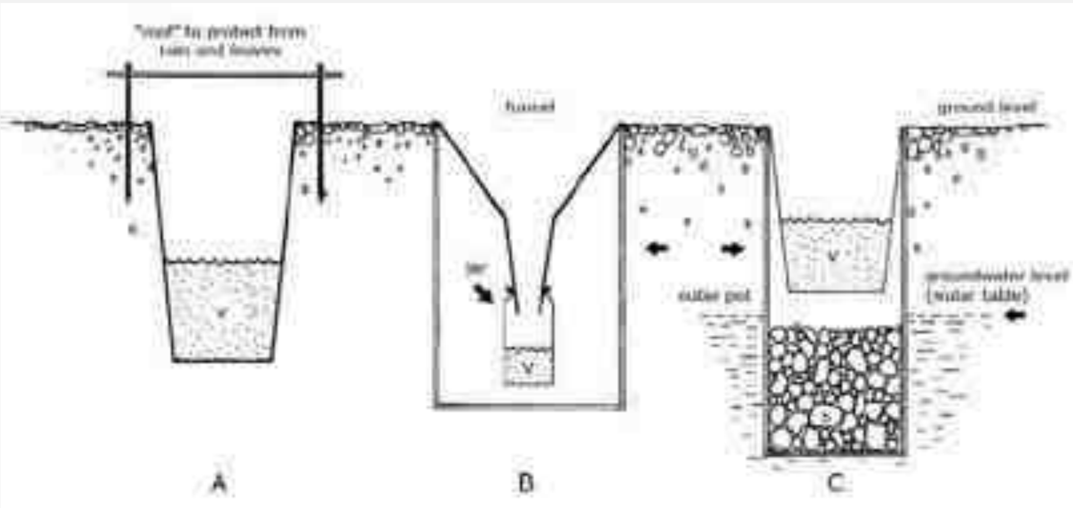
Specifications:

- Item Name: Inspection Camera
- Model: 37888
- SV Code: 291302AAKY3
- Brand: Ridgid
- Resolution: 320 x 240
- Video Output: 3 Feet (90 cm) RCA cable included (640 x 480 resolution)
- Power Supply: 3.7V Li-Ion battery - 5VAC adapter
- Cable Length: 3 Feet (90cm) expandable to 30 Feet (9m) w-optional extensions

## Figure C15: Pitfall Trap Specifications

A pitfall trap is a device used to trap insects that are active on the ground surface. Pitfall traps usually consist of a beaker that is buried so that the lip of the beaker is level with the ground surface. The trap is then left and returned to, at a later date, to inspect 'the catch'.

The diagram below the photograph of an NEA deployment, depicts the several variations of pitfall trap layout, with a recurring theme. Insects reaching the lip of the beaker slip and fall in and are then unable to climb back out. Sometimes alcohol or another substance is poured into the trap so that any insects falling in are killed. The rationale behind this is that predatory insects falling in to the trap will eat the rest of the catch.



## Figure C16: Mavic Pro 2 (Aerial photography/videography)

The Mavic 2 Pro from DJI is a drone that balances power, portability, and professional-quality visuals with the inclusion of a 20MP Hasselblad L1D-20c gimbal camera. The camera delivers a 1" CMOS sensor with an adjustable f/2.8 to f/11 aperture, support for a 10-bit Dlog-M color profile, and 4K 10-bit HDR video capture. The Mavic 2 Pro utilizes a low-drag aerodynamic body design for achieving speeds up to 47.7 mph, a four-cell LiPo battery for up to 31 minutes of flight time, and low-noise propellers for filming without being distracting. This power and performance are coupled with a variety of dynamic shooting modes and other capabilities that help you achieve cinematic results.

- **Item Name:** Mavic Pro 2
- **Model:** 37888
- **SV Code:** 291302AAKY3
- **Brand:** DJI
- **Camera:** Hassleblad 20MP, 1" CMOS, 77° FOV, f/2.8 to f/11
- **Max Video Output:** 4k 10 bit HDR (.MP4, .MOV), 5472 × 3648 Stills (.JPG or .DNG)
- **Power Supply:** 15.4V, 3850 mAh, LiPo 4S
- **Transmission Length:** 8 km (line of sight)

*Appendix 2.2.3 – Das Island Landfall Terrestrial Ecology Survey Report*

Anthesis

# ADNOC Lightning Project
# Das Island Landfall
# Terrestrial Ecology Survey Report

NEA Reference: N684-0821-DAS-1.1 dated September 2021

| Table of Contents | Page |
|---|---|



| | |
|---|---|
| Cover | Front cover – Osprey, *Pandion haliaetus* |
| Credits | Photos ©NEA on-site 2021, unless otherwise annotated. |

## Document Issue and Revision

| Issue Date | Author(s) | Checked | Approved | Issue № | Comment |
|---|---|---|---|---|---|
| 20.08.2021 | RP/BC/VP/DT | RP | VP | 1.0 | 1st Issue |
| 12.09.2021 | RP/BC/VP/DT | RP | VP | 1.1 | 2nd Issue |



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## Figures used in Report



## Tables used in Report



## Plates used in Report

Plates used in Report

# 1.0 Background, Scope and Conduct

## 1.1 Background

Mott MacDonald (MM), on behalf of the Abu Dhabi National Oil Company (ADNOC), commissioned Nautica Environmental Associates LLC (NEA), an Abu Dhabi based environmental consultancy, to conduct environmental surveys at three landfall locations, for the ADNOC Lightning Project. These are located at Mirfa, Shuweihat and Das Island.

This document relates to the survey conducted at Das Island between 03-06.08.2021 (Table 1) and provides a report on the results from the surveys undertaken.

Figure 1 shows the Das island landfall location and on-land routing.

## 1.2 Scope and Conduct

### 1.2.1 Scope

The scope included evaluations of the following, along landfall pipeline footprints as shown in Figure 1:

- Evaluation of habitats and associated species.
- Ambient noise measurements, over weekend and week-day periods.
- Soil and groundwater sampling and analysis to evaluate possible contamination.

### 1.2.2 Conduct

One NEA ecological specialist conducted the surveys using a combination of walkover and vehicle drive through of the site location, deploying camera traps and noise meters and undertaking soil sampling at selected locations. The 4-day survey period was pre-ceded by a 16-day COVID quarantine period, 12 of which was in Abu Dhabi and the remainder on Das Island itself.

Additionally, at certain locations within the survey area and in order to provide additional photographic records of habitat and general conditions, cardinal point photographs were taken from South, East and West (North was excluded on security grounds).

Table 2 provides an overview of site visits and activities undertaken during the ecological survey. Figure 2 shows a habitat map of the plot location, together with sampling locations and camera traps. Camera traps were deployed at for one overnight period (≥12 hours) at these locations.

Cardinal point locations are shown in Figure 3 (see Annex B for records). Figure 4 shows points of interest and Figure 5 shows a track map or NEA staff movements across the location. These are detailed in Table 2 and discussed in subsequent sections.

In the current circumstances, COVID-19 mitigation involved the NEA ecologist wore full eye and nose/mouth masks, with gloves, when on-site and travelling to and from the location.

Table 1: Das Island Field Visit Overview

| Day | Date | Survey Activity | NEA Site Staff |
|---|---|---|---|
| 1 | 18.07 to 02.08.2021 | Quarantine period | RP |
| 2 | 03.08.2021 | Site walkover & CT/NM dep/ret | RP |
| 3 | 04.08.2021 | Site walkover & CT/NM dep/ret | RP |
| 4 | 05.08.2021 | Site walkover & CT/NM dep/ret | RP |
| 5 | 06.08.2021 | Site walkover & CT/NM dep/ret | RP |

Table Key:
CT = Camera Trap
NM = Noise Meter
NEA Staff: RP = Ross Pappin

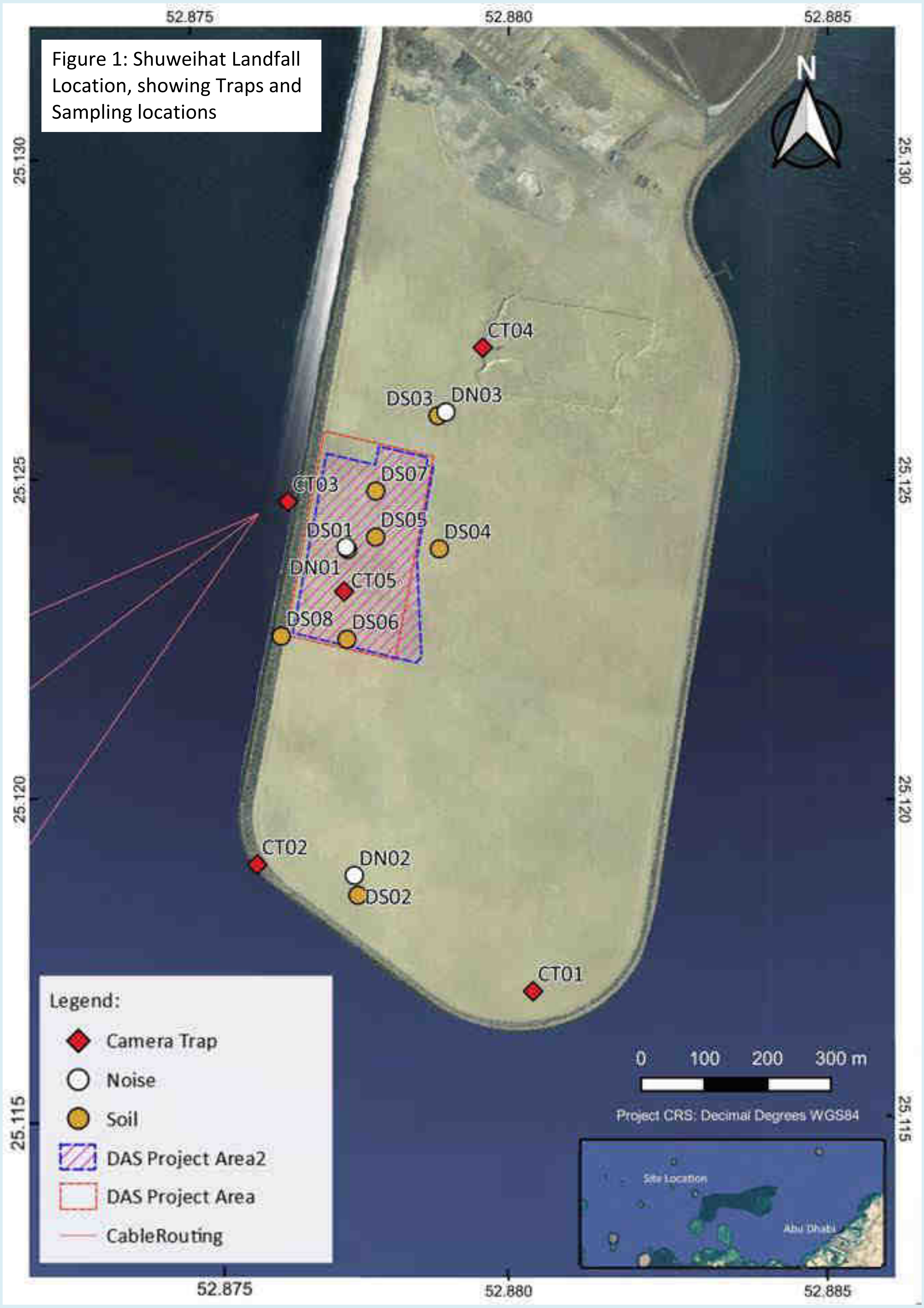


Figure 1: Shuweihat Landfall Location, showing Traps and Sampling locations
52.875
52.880
52.885
25.130
25.125
25.120
25.115
N
CT04
DS03
DN03
CT03
DS07
DS01
DS05
DS04
DN01
CT05
DS08
DS06
CT02
DN02
DS02
CT01
Legend:
Camera Trap
Noise
Soil
DAS Project Area2
DAS Project Area
CableRouting
0 100 200 300 m
Project CRS: Decimal Degrees WGS84
Site Location
Abu Dhabi


Figure 2: Track map of Ecologists' Movements
52.870
52.875
52.880
52.885
52.890
25.145
25.140
25.135
25.130
25.125
25.120
25.115
25.110
N
CT04
DS03
DN03
CT03
DS07
DS01
DS04
DN01
CT05
DS08
DS06
CT02
DN02
DS02
CT01
Legend:
NEA Tracks
Camera Trap
Noise
Soil
DAS Project Area2
DAS Project Area
CableRouting
0 200 400 600 m
Project CRS: Decimal Degrees WGS84
Site Location
Abu Dhabi

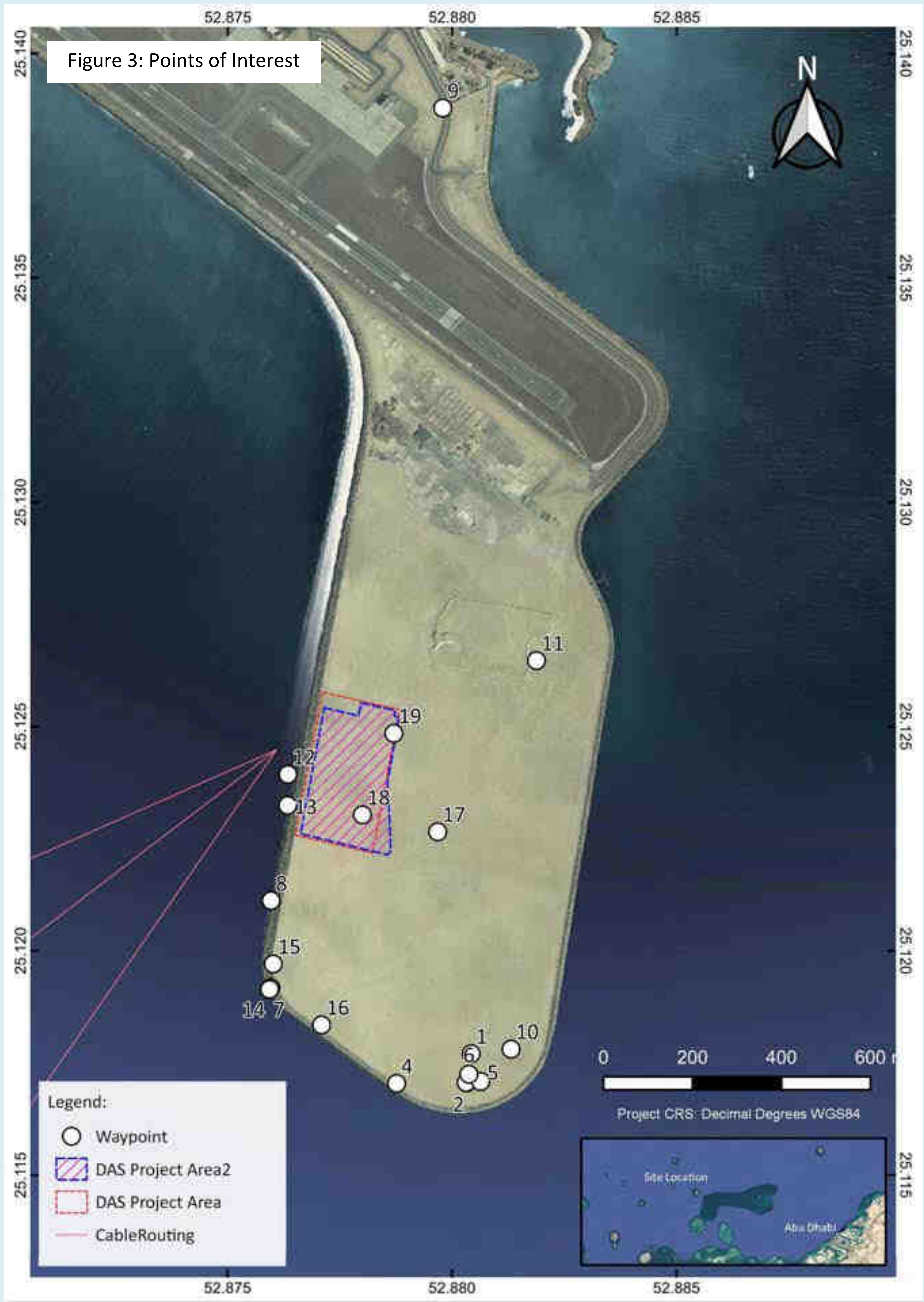


Figure 3: Points of Interest
52.875
52.880
52.885
25.140
25.135
25.130
25.125
25.120
25.115
N
9
11
19
12
13
18
17
8
15
14 7
16
1
10
6
5
4
2
0
200
400
600
Project CRS: Decimal Degrees WGS84
Site Location
Abu Dhabi
Legend:
Waypoint
DAS Project Area2
DAS Project Area
CableRouting

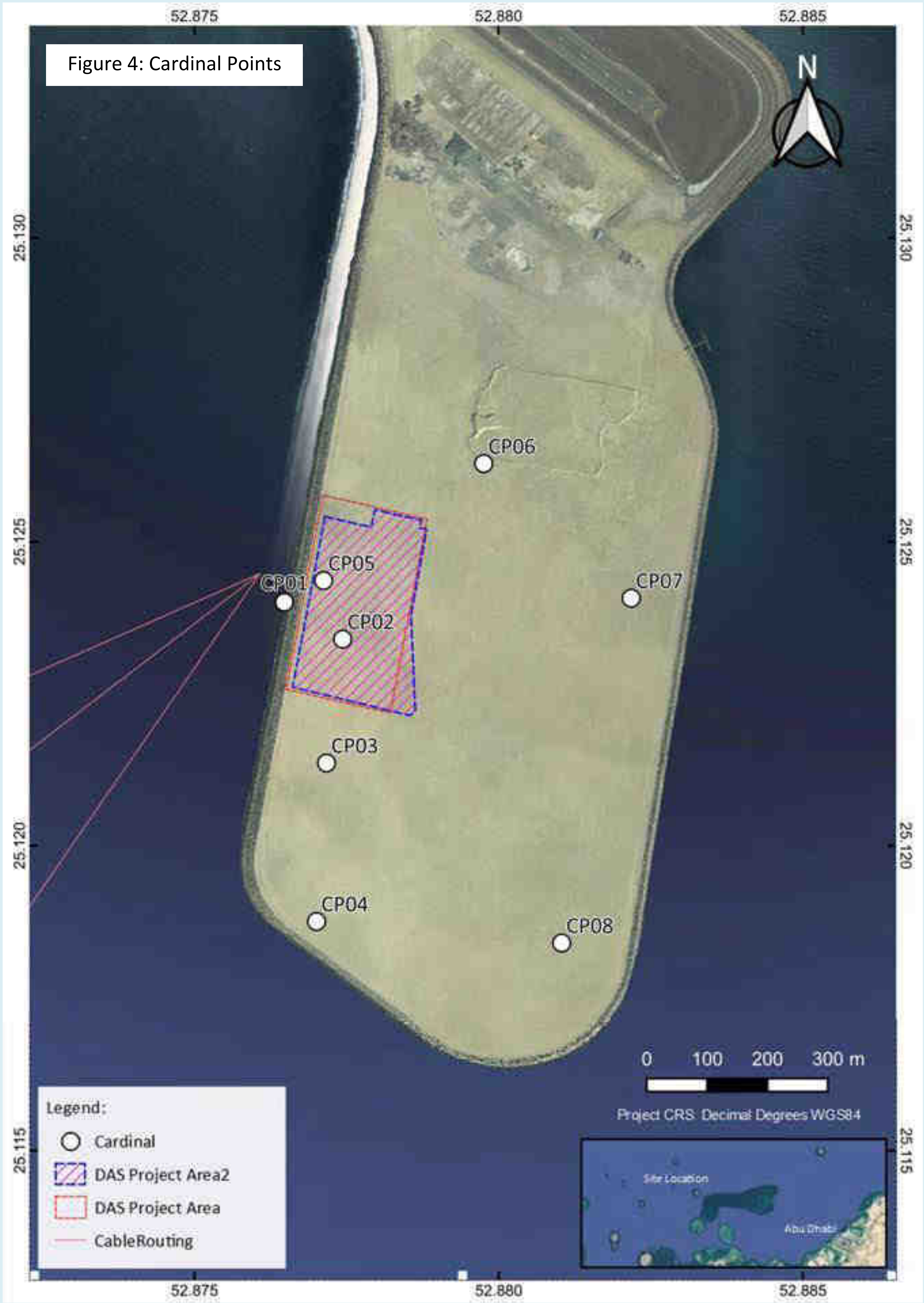


Figure 4: Cardinal Points
52.875
52.880
52.885
25.130
25.125
25.120
25.115
N
CP01
CP02
CP03
CP04
CP05
CP06
CP07
CP08
0
100
200
300 m
Project CRS: Decimal Degrees WGS84
Site Location
Abu Dhabi
Legend:
Cardinal
DAS Project Area2
DAS Project Area
CableRouting

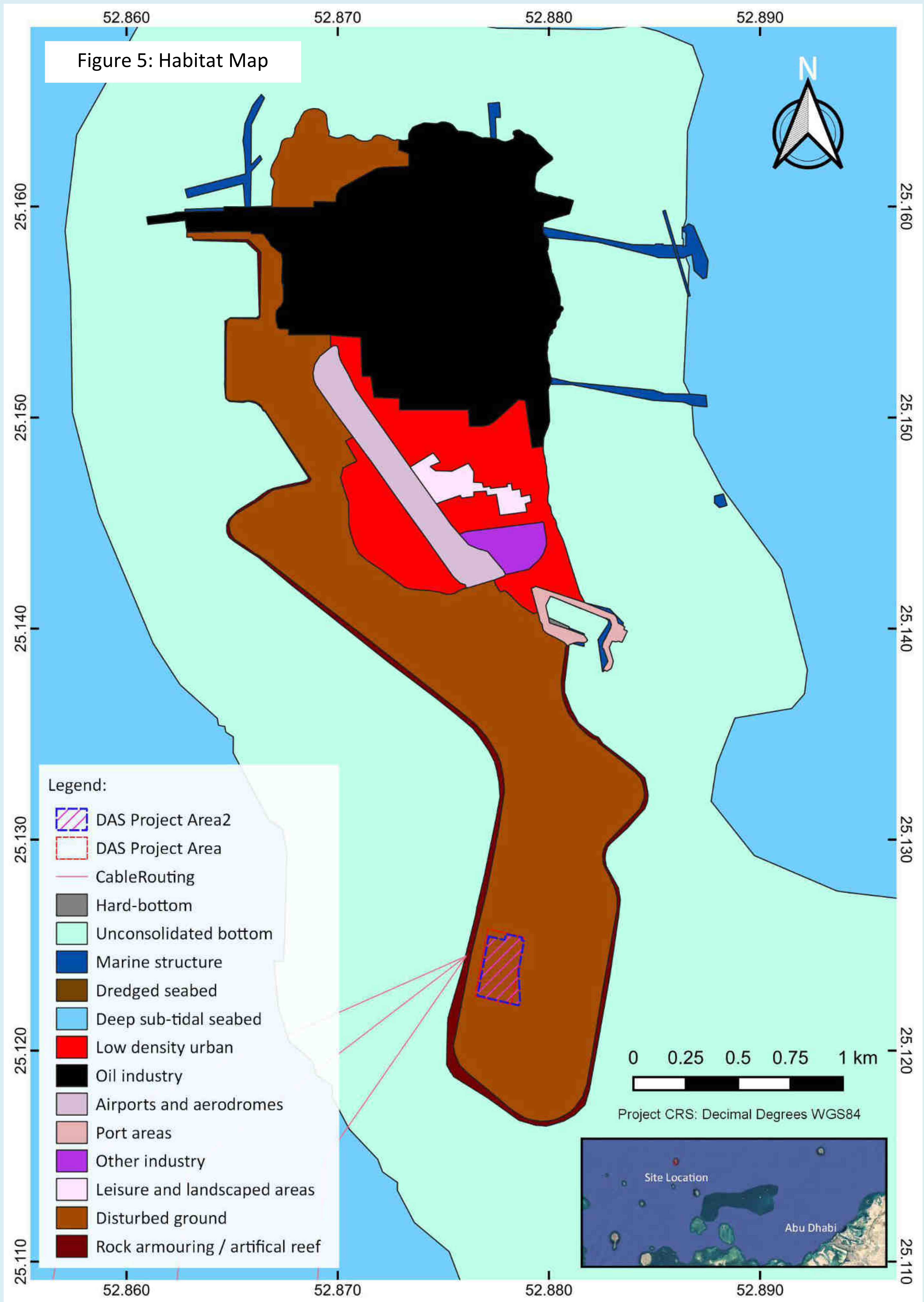


Figure 5: Habitat Map
52.860
52.870
52.880
52.890
25.160
25.150
25.140
25.130
25.120
25.110
N
Legend:
DAS Project Area2
DAS Project Area
CableRouting
Hard-bottom
Unconsolidated bottom
Marine structure
Dredged seabed
Deep sub-tidal seabed
Low density urban
Oil industry
Airports and aerodromes
Port areas
Other industry
Leisure and landscaped areas
Disturbed ground
Rock armouring / artifical reef
0 0.25 0.5 0.75 1 km
Project CRS: Decimal Degrees WGS84
Site Location
Abu Dhabi

Table 2: Das Island Survey Records

| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
|---|---|---|---|---|---|---|---|
| DN01 | Noise Sampling | 03-06.08.21 | Various | 15 minutes x 4 | 25.12395 | 52.87745 | - |
| DN02 | Noise Sampling | 03-06.08.21 | Various | 15 minutes x 4 | 25.11881 | 52.87758 | - |
| DN03 | Noise Sampling | 03-06.08.21 | Various | 15 minutes x 4 | 25.12607 | 52.87901 | - |
| DS01 | Sediment Sampling | 06.08.21 | 08:02 | NA | 25.12391 | 52.87748 | - |
| DS02 | Sediment Sampling | 06.08.21 | 08:24 | NA | 25.1185 | 52.87764 | - |
| DS03 | Sediment Sampling | 06.08.21 | 08:55 | NA | 25.12601 | 52.87889 | - |
| DS04 | Sediment Sampling | 06.08.21 | 09:19 | NA | 25.12392 | 52.87891 | - |
| DS05 | Sediment Sampling | 06.08.21 | 09:33 | NA | 25.12411 | 52.87791 | - |
| DS06 | Sediment Sampling | 06.08.21 | 09:52 | NA | 25.12251 | 52.87746 | - |
| DS07 | Sediment Sampling | 06.08.21 | 10:13 | NA | 25.12483 | 52.87792 | - |
| DS08 | Sediment Sampling | 06.08.21 | 10:27 | NA | 25.12256 | 52.87644 | - |
| CP1 | Cardinal Point | 03.08.21 | 09:52 | NA | 25.124 | 52.87648 | - |
| CP2 | Cardinal Point | 03.08.21 | 09:54 | NA | 25.1234 | 52.87744 | - |
| CP3 | Cardinal Point | 03.08.21 | 10:00 | NA | 25.12136 | 52.87717 | - |
| CP4 | Cardinal Point | 03.08.21 | 10:04 | NA | 25.11875 | 52.87701 | - |
| CP5 | Cardinal Point | 03.08.21 | 10:10 | NA | 25.12436 | 52.87712 | - |

| Table 2: Das Island Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
| CP6 | Cardinal Point | 03.08.21 | 10:17 | NA | 25.12628 | 52.87976 | - |
| CP7 | Cardinal Point | 03.08.21 | 10:24 | NA | 25.12407 | 52.88218 | - |
| CP8 | Cardinal Point | 03.08.21 | 10:30 | NA | 25.1184 | 52.88104 | - |
| CT1 | Camera trap | 03.08.21 | 10:50 | 22hrs | 25.11699 | 52.88038 | - |
| CT2 | Camera trap | 03.08.21 | 11:01 | 22hrs | 25.11898 | 52.87606 | House Crow x 3 |
| CT3 | Camera trap | 03.08.21 | 11:08 | 22hrs | 25.12466 | 52.87654 | House Crow x 3 |
| CT4 | Camera trap | 03.08.21 | 11:17 | 23hrs | 25.12707 | 52.87959 | - |
| CT5 | Camera trap | 03.08.21 | 11:25 | 23hrs | 25.12325 | 52.87742 | - |
| WPT1 | Handheld GPS | 03.08.21 | 09:27 | NA | 25.1177 | 52.88042 | White-cheeked Tern x 2 |
| WPT2 | Handheld GPS | 03.08.21 | 09:30 | NA | 25.11705 | 52.88032 | White-cheeked Tern x 10 |
| WPT3 | Handheld GPS | 03.08.21 | 09:31 | NA | 25.11706 | 52.88031 | Sooty Gull |
| WPT4 | Handheld GPS | 03.08.21 | 09:35 | NA | 25.11704 | 52.87876 | White-cheeked Tern x 5 |
| WPT5 | Handheld GPS | 03.08.21 | 10:37 | NA | 25.11708 | 52.88063 | Socotra Cormorant tracks |
| WPT6 | Handheld GPS | 03.08.21 | 10:41 | NA | 25.11725 | 52.88037 | Socotra Cormorant x 3 |
| WPT7 | Handheld GPS | 03.08.21 | 17:14 | NA | 25.11918 | 52.87596 | Sooty Gull x 3 |
| WPT8 | Handheld GPS | 03.08.21 | 17:19 | NA | 25.12112 | 52.87596 | Dead Cormorant (Nat.) |

| Table 2: Das Island Survey Records | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID | Unit Type | Date | Time | Duration | Latitude | Longitude | Notes |
| WPT9 | Handheld GPS | 03.08.21 | 18:25 | NA | 25.13879 | 52.87979 | Grey Heron |
| WPT10 | Handheld GPS | 04.08.21 | 08:23 | NA | 25.11781 | 52.88131 | White-cheeked Tern x 32 |
| WPT11 | Handheld GPS | 05.08.21 | 07:23 | NA | 25.12647 | 52.88188 | House Crow x 3 |
| WPT12 | Handheld GPS | 05.08.21 | 07:38 | NA | 25.12393 | 52.87634 | Cat tracks |
| WPT13 | Handheld GPS | 05.08.21 | 07:50 | NA | 25.12324 | 52.87633 | Osprey x 2 |
| WPT14 | Handheld GPS | 05.08.21 | 07:55 | NA | 25.11914 | 52.87593 | Socotra Cormorant x 2 |
| WPT15 | Handheld GPS | 05.08.21 | 08:01 | NA | 25.1197 | 52.87601 | Sooty Gull |
| WPT16 | Handheld GPS | 05.08.21 | 08:14 | NA | 25.11835 | 52.87709 | White-cheeked Tern x 70 |
| WPT17 | Handheld GPS | 06.08.21 | 06:30 | NA | 25.12265 | 52.87968 | Isabelline Wheatear |
| WPT18 | Handheld GPS | 06.08.21 | 06:33 | NA | 25.12303 | 52.878 | Rock Dove x 85 |
| WPT19 | Handheld GPS | 06.08.21 | 06:41 | NA | 25.12484 | 52.8787 | Kentish Plover |

Table Key:

NA = Not Applicable / CT = Camera Trap / CP = Cardinal Point

ID = Site ID / min = Minute(s) / Lat + Long in Decimal Degrees

Nat = Natural (death)

# 2.0 Methodology

## 2.1 Baseline Noise Measurements

Baseline noise measurements were carried out at three sites at the Das Island location and included both weekday and weekend measurement periods. Measurements at each site were carried out for 15-minutes and repeated for day and night-time (total of four measurements per site). Surveys were undertaken in parallel with ongoing ecological surveys of the location.

Measurements were collected using a bench- and field-calibrated Rion NL-52 integrating Class 1 (IEC 61672-2002) sound level meter with data stored on the device’s internal memory as well as on detailed field-sheets (Plate 1). Measurement locations were chosen to minimise reflective phenomena or interruptive weather conditions in accordance with ISO1996-1:2016. A weather meter was deployed at the location for this purpose (Plate 2).

Reported parameters included maximum and average noise levels as well as identification of specific sound events where feasible and were reflective of the characteristics of the ambient noise environment and nature of the project.

- Measurements Overview:
  - 15-minutes each site (day/night/weekday/weekend)
  - Total 1 hour per site
  - Total 3 hours at location
- Parameters:
  - $L_{Aeq}$, $L_{AMax}$, $L_{A10}$, $L_{A50}$, $L_{A90}$

## 2.2 Soil and Groundwater Inspection and Analysis

A visual survey of the surface for any signs of contamination was conducted in parallel with ecological and noise survey data collections at the location. Where visible contamination was identified, a GPS waypoint was collected. For large areas, a tracked path was walked around the edge, using the GPS tracklog to map the extent of contamination. All identified instances were reported with accompanying geo-referenced photographs.

Eight soil samples were collected by hand augur along the cable corridor (see Figure 1 for locations and Plate 4) and analysed at an ENAS accredited laboratory. Data is provided in Annex B.

No groundwater samples were collected, as there were no nearby sources available.

## 2.3 Ecology Survey Methodology

Field activities involved day-time drive-over and walkabouts (Plate 2) in selected areas, with one overnight trapping effort involving deployment of Browning camera traps (Plate 4) at selected locations. Figure 1 details trap and photo locations.

Browning camera traps were deployed at locations considered potentially suitable for mammal and/or reptile activity, such as near burrows or in areas of particularly dense vegetation and/or visible track activity. Plate 5 shows the result from one of the traps deployed.

Binoculars (Plate 3) were also used to help find and identify bird species within the area and where possible, high-definition pictures were taken and have been used in this report were deemed appropriate.

All photos displayed in this report were taken on location unless otherwise stated (NEA File Photo).

Plate 1: Noise meter deployment on location

Plates 2 & 3: Weather meter deployed on location (top); Camera trap deployed on location (bottom)

Plate 4: Using a soil auger to reach deeper soils for analysis

## 3.0 Survey Results

### 3.1 Noise Measurement Analysis, Locations and Results

#### 3.1.1 Noise Measurement Analysis

A baseline survey was conducted in the area of the proposed landfall, including three separate locations, with four fifteen-minute measurements each. The combined measurement period at each location was 1 hour, representing weekday, week night, weekend day and weekend night time periods.

The aim of the noise measurements is to provide an indication of existing ambient conditions as well as to identify any significant anthropogenic noise sources which may affect any subsequent assessments of noise.

Measurements were collected using a bench- and field-calibrated Rion NL-52 integrating Class 1 (IEC 61672-2002) sound level meter (SLM) with data stored on the device's internal memory as well as on detailed field-sheets. The SLM and microphone were field calibrated before and after each measurement to detect and account for any drift in the measured noise levels.

Measurement locations were chosen to minimise reflective phenomena or interruptive weather conditions in accordance with ISO1996-1:2016.

#### 3.1.2 Noise Measurement Locations

Classification of the Das Island landfall area is considered to be 'heavy industry', due to the far proximity to residential receptors, as well as the overall classification of the island as an Oil and Gas facility.

The 'Heavy Industrial' classification (day and night-time noise limits of 70 dBA and 60 dBA respectively), means that the undeveloped site is unlikely to exhibit exceedances of the noise limits, however the development will likely result in significant changes to the noise climate.

Three noise measurement locations were identified for the purposes of capturing the ambient noise climate of the undeveloped landfall project area. While these were located within the alignment of the cable landfall, the impact of installation and development will ultimately be experienced by receptors located (mostly) to the north of the site itself.

The locations of the noise measurement stations (N01-N03) are shown in Figure 1.

### 3.1.3 Noise Results and Analysis

A breakdown of measured noise metrics for the measurement sites at the Das landfall is provided in Tables 3, 4 and 5.

As expected, the ambient noise climate of the landfall area falls well below the thresholds of the applied day and night time noise limits. All measured LAeq noise metrics fall well below 50 dBA and as such meet the limits by more than 10dBA for all periods. It is expected however that following development of the southern end of Das island, the ambient noise climate of the area will show a more significant change.

Table 3: Noise measurement metrics for Das Island Landfall, site DN01

| Site→ | | DN01 | | | |
|---|---|---|---|---|---|
| ↓Parameter | Period→ | Week Day | Week Night | Weekend D | Weekend N |
| $L_{Aeq}$ | dBA | 31.4 | 39.9 | 30.9 | 37.2 |
| $L_{max}$ | dBA | 47.8 | 50.7 | 45.1 | 48.7 |
| $L_{10}$ | dBA | 33.4 | 41.3 | 32.0 | 38.3 |
| $L_{50}$ | dBA | 30.8 | 39.7 | 30.7 | 37.0 |
| $L_{90}$ | dBA | 29.4 | 38.5 | 29.9 | 36.1 |
| Environmental Conditions | | | | | |
| Average Windspeed | m/s | 2.99 | 1.20 | 1.63 | 1.25 |
| Max Windspeed | m/s | 3.67 | 1.78 | 2.42 | 1.86 |
| Average Temp | °C | 37.7 | 34.7 | 34.6 | 34.6 |
| Average Humidity | % | 60.8 | 75.3 | 77.2 | 69.2 |

Table Key:

Exceeds the relevant ambient noise limit of 70 dBA (daytime) or 60 dBA (night-time)

D = Day / N = Night

dBA = Decibels / m/s = Metres per Second

°C = Degrees Centigrade / % = Percentage

| Table 4: Noise measurement metrics for Das Island Landfall, site DN02 | | | | | |
|---|---|---|---|---|---|
| Site | | DN02 | | | |
| Period | | Week Day | Week Night | Weekend D | Weekend N |
| $L_{Aeq}$ | dBA | 36.2 | 42.6 | 32.0 | 35.1 |
| $L_{max}$ | dBA | 48.5 | 62.2 | 49.2 | 47.5 |
| $L_{10}$ | dBA | 38.1 | 44.4 | 33.7 | 36.0 |
| $L_{50}$ | dBA | 35.8 | 42.2 | 31.5 | 35.0 |
| $L_{90}$ | dBA | 34.2 | 40.5 | 30.5 | 34.3 |
| Environmental Conditions | | | | | |
| Average Windspeed | m/s | 2.33 | 0.12 | 1.66 | 0.72 |
| Max Windspeed | m/s | 3.00 | 0.56 | 3.11 | 0.94 |
| Average Temp | °C | 37.8 | 33.5 | 36.0 | 34.2 |
| Average Humidity | % | 62.0 | 77.3 | 68.1 | 69.7 |
| Table Key: | | | | | |
| | Exceeds the relevant ambient noise limit of 70 dBA (daytime) or 60 dBA (night-time) | | | | |
| D = Day / N = Night / dBA = Decibels / m/s = Metres per Second / °C = Degrees Centigrade / % = Percentage | | | | | |

| Table 5: Noise measurement metrics for Das Island Landfall, site DN03 | | | | | |
|---|---|---|---|---|---|
| Site | | DN03 | | | |
| Period | | Week Day | Week Night | Weekend D | Weekend N |
| $L_{Aeq}$ | dBA | 37.2 | 44.2 | 33.7 | 39.1 |
| $L_{max}$ | dBA | 47.9 | 53.6 | 50.3 | 52.9 |
| $L_{10}$ | dBA | 39.0 | 46.2 | 35.1 | 40.5 |
| $L_{50}$ | dBA | 36.8 | 43.7 | 33.2 | 38.9 |
| $L_{90}$ | dBA | 35.3 | 42.6 | 32.0 | 37.7 |
| Environmental Conditions | | | | | |
| Average Windspeed | m/s | 2.35 | 1.33 | 1.57 | 0.02 |
| Max Windspeed | m/s | 2.94 | 2.44 | 2.19 | 0.47 |
| Average Temp | °C | 36.7 | 34.1 | 37.1 | 32.7 |
| Average Humidity | % | 65.7 | 75.5 | 63.4 | 76.2 |
| Table Key: | | | | | |
| | Exceeds the relevant ambient noise limit of 70 dBA (daytime) or 60 dBA (night-time) | | | | |
| D = Day / N = Night / dBA = Decibels / m/s = Metres per Second / °C = Degrees Centigrade / % = Percentage | | | | | |

## 3.2 Soil and Groundwater Analysis

### 3.2.1 Soil Analysis

Soil sampling was undertaken during site visits in August, at eight targeted locations within the survey area via a hand auguring tool to a target depth of up to 0.5m below ground level (bgl) or to the depth where bedrock or groundwater was encountered.

The excavated soil was placed on a clean plastic sheet, free from potential contaminants or cross contaminants. Samples were then packaged, sealed, and marked and stored in a dedicated sample box for transportation to the laboratory.

The coordinates for the monitoring locations are presented in Table 6 and locations are provided in Figure 1.

Table 6: Soil Sampling Locations and Depths

| Site ID | Latitude | Longitude | Depth (m) |
|---|---|---|---|
| DS01 | 25.12391 | 52.87748 | 0.5 |
| DS02 | 25.11850 | 52.87764 | 0.5 |
| DS03 | 25.12601 | 52.87889 | 0.5 |
| DS04 | 25.12392 | 52.87891 | 0.4 |
| DS05 | 25.12411 | 52.87791 | 0.5 |
| DS06 | 25.12251 | 52.87746 | 0.4 |
| DS07 | 25.12483 | 52.87791 | 0.5 |
| DS08 | 25.12255 | 52.87643 | 0.5 |

Table Notes: Latitude / Longitude in WGS84 Decimal Degrees / m = Metres

The full results are presented in Annex C. The results were compared with the Abu Dhabi Quality and Conformity Council (ADQCC) Environmental Specification for Soil Contamination Limits for Industrial and Commercial use (ADS 19/2017). A copy of the standards is provided at Table B2, Annex B.

Results for all locations/depths were in compliance with the standards and there were no visible signs of soil contamination or significant odour recorded from any location or any sample collected.

No groundwater sampling was undertaken, given the lack of natural source from which to sample from.

## 3.3 Ecological Survey

### 3.3.1 Geology and Geomorphology

Das Island is located in UAE waters towards the southern end of the Arabian Gulf, about 165km northwest of Abu Dhabi City and some 25km west of Umm Shaif oil field. Geologically it was formed from a salt plug and is rocky at the north end. The island is one of eight diapiric islands in UAE waters that owe their existence to 500 million-year-old Infracambrian to Cambrian Hormuz rock structures. Diapiric rocks refer to an anticlinal fold in which a mobile core breaks through more brittle overlying rocks. In the case of Das, these rocks are named after Hormuz Island, situated at the entrance to the Gulf, and describe exotic salt plug material.

The prevailing northwest (shamal) winds have deposited coral sand and eroded detritus in the lee of the low rocky hills, creating the natural part of the island, which is about 3 km long by 1 km wide, flat in the south with sandy beaches, higher in the north with exposed rocks that are among the oldest visible in the whole of the UAE. The island's original form has been severely modified by heavy industrialisation, leaving little natural vegetation. However, amenity trees and shrubs along with some small gardens have been introduced mainly into the flat southern half. There is no natural freshwater, but plenty is now available due to human activity.

### 3.3.2 Habitats

The habitat classifications described in this report are defined based on a *priori schema* classification system devised by Brown and Boer in 'Interpretation Manual of the Major Terrestrial Natural and Semi-natural Habitat Types of Abu Dhabi Emirate.' These categories have been expanded by the EAD to include elements of land use and land cover.

NEA was part of a consortium that produced a habitat map for the whole of the emirate of Abu Dhabi, under contract from EAD. The main tool used in mapping was satellite imagery, but with a lot of ground-truthing by NEA. A computer was "trained" to recognise spectral signatures of habitats, and these were then mapped automatically. The accuracy of the map was confirmed by visiting a very large number of pre- selected random points. The distribution of the habitats discussed in this report are shown in Figure 5, which has been taken from the final habitat map for the emirate (which is available on the EAD website).

The latest revision of the Environment Agency Abu Dhabi (EAD) Habitat Map was referred to and was found to accurately depict the overall site, which is was correctly classified as Disturbed Ground. However, investigations on-ground revealed that the thin strip of land comprising the supralittoral zone, currently classified as Hard

Bottom, is actually made up of rock armouring. Therefore, a reclassification to the latter habitat is warranted. Clear limitations inhibit habitat classification using satellite imagery only, particularly at small sites, highlighting the benefits of having an ecologist on-ground to identify the habitats with greater accuracy. Figure 5 reflects the changes made by NEA to EAD's existing habitat map following investigations conducted on-ground during the survey.

The proposed pipeline will be directly situated within just two unnatural habitats. The threat status, area in $km^2$ and description of both habitats identified within the cable landfall location footprint, are presented in Table 7 below.

Table 7: Habitat Description & % cover (Landfall Footprint)

| H/T | Description | Threat Status (EAD) | Area (ha) | % Cover (PF) |
|---|---|---|---|---|
| 15100 | Rock Armouring | Not Sensitive or Critical | 0.10 | 98.6 |
| 9600 | Disturbed Ground | Not Sensitive or Critical | 7.04 | 1.4 |

Table Key:

H/T = Habitat Type (EAD Classification, 2013)

PF = Pipeline Footprint

% = Percentage

$Km^2$ = Square Kilometres

### 3.3.2.1 Disturbed Ground / Reclaimed Land

With the exception of the thin strip of rock armouring, the site is exclusively situated within the island extension that has been reclaimed in preparation for the residential development, which will eventually house staff accommodation facilities, related amenity buildings and external and infrastructure works. As this land is disturbed and unnatural, it is classified as Disturbed Ground (EAD Habitat Code 9600). This habitat constitutes 98.6% of the total terrestrial habitat cover within the proposed site footprint.

Land reclamation is the process of creating new land from the sea. The simplest method of land reclamation involves simply filling the area with large amounts of heavy rock and/or cement, then filling with clay and soil until the desired height is reached.

Although the site is classified as disturbed ground, this is a rather broad categorisation that typically refers to longstanding natural habitats that have been subject to excavation and levelling/grading in preparation for development. In contrast, in the case of the survey site, the land consists of reclaimed ground that is just a few years old. Natural forces have been left to prevail for the last four to five years since the reclamation works were completed, which has allowed some halophytic vegetation to colonise the site. If left in a natural state for enough time, the site will become something reminiscent of the habitat: coastal plain on well-drained sandy ground, which the site's current state bears much resemblance to.

*Salsola imbricata* is the dominant shrub within the disturbed ground habitat and is abundant at the survey site, particularly at the southern end.

Plate 5: Disturbed ground/reclaimed land with *Salsola imbricata* dominant

Plate 6: Disturbed ground/reclaimed land with *Salsola imbricata* dominant

### 3.3.2.2 Rock Armouring / Artificial Breakwater

Upon reaching land, the proposed cable landfall route will traverse over a rock armouring revetment that is classified through EAD's habitat classification system as Rock Armouring/Artificial Reef (EAD habitat code 15100). This mand-made habitat consists of large limestone boulders that are moved into place by heavy machinery. The boulders are designed in such a way that their complex shapes dissipate wave energy, and their sheer mass absorbs wave energy, thereby protecting land from coastal erosion.

The revetment face is made up of sizeable modular limestone boulders (Plate 7). The top of the revetment stands at approximately six metres above sea level. Two metres are permanently submerged underwater from the seabed, three metres are situated within the supralittoral zone (splash zone), and three metres lie above the highest tides. Between the concrete supporting wall on the landward side and the boulders on the seaward edge, irregularly shaped smaller rocks infill the flat raised midsection (Plate 8).

The submerged blocks act as complex structures that facilitate colonisation of a plethora of marine life. Sessile organisms including filter-feeding bivalves, corals (if sheltered enough from wave-action) and algae are able attach themselves to the solid structures. Mobile fauna, particularly juvenile fish, are susceptible to predation in open water; therefore, rocky structures improve the survivability of certain species and are often selected as nursery sites.

Avian activity at the site was found to be concentrated along the rock armouring habitat. Birds are able to perch comfortably on the boulders, and the elevated structures proximate to the coast, act as a vantage point to scan for fish in the shallows below. When the wind blows perpendicular to the revetment slope, up-drafts are formed, creating a steady stream of lift that allows birds to slope-soar with minimal effort while scanning the sea surface for prey.

Plates 7 & 8: Rock armouring revetments

### 3.3.3 Flora

With the exception of the two planted Date Palms, *Phoenix dactylifera*, and Bougainvillea to the south of the reclaimed island extension, just two other naturally occurring vascular plant species were recorded across the entire survey area. Namely, these were *Salsola imbricata* and *Sporobolus spicata*. Several circumstances can be attributed to an extremely limited botanical diversity at the survey site on the island, as follows:

- A lack of rain in the months preceding the survey will have limited the germination of ephemeral plants
- The survey site is located entirely on unnatural reclaimed land which is just a few years old, resulting in a very limited soil seed bank and hyper saline soils consisting of former marine sediments which inhibits the growth of any glycophytic, and indeed many halophytic plants
- Islands often contain a lower diversity of plants due to their isolation, though this is mainly dependent on the age of the island

*Salsola imbricata* (Plate 10) is the dominant plant in the survey area, where it occupies large swathes of the island extension, particularly within the southern portion. Common on both coasts of the UAE, *S. imbricata* is frequently found in saline sands and disturbed ground and is, therefore, one of the first plants to colonise coastal landfills and reclaimed land, as has been the case at the survey site.

Known as “harm” in Arabic this is a grey-green coloured shrub up to half a metre tall and around a metre in diameter. The word ‘salsola’ comes from the latin for ‘salt’ as *S. imbrictata* is only found in saline conditions. It is often a favoured plant of tiny migrant warblers as it provides food, shade, and protection in often otherwise barren locations where plants of lower salt tolerance are often unable to grow.

*Sporobolus spicata* (Plate 9) was the only other plant that was occasionally noted within the survey site. *S spicata* is a common and widespread graminoid in the UAE. It is absent from mountainous areas but abundant in open desert conditions on the mainland and is also known from several offshore islands, including Das.

| Table 8: Plant species recorded during the survey | | | |
|---|---|---|---|
| Family name | Scientific Name | Status During Survey | Status in UAE/IUCN |
| Chenopodiaceae | *Salsola imbricata* | Present at a high density within the sheltered embayment and fringes | UAE: Common and widespread on the coastline of the UAE<br>IUCN: LC |
| Poaceae | *Sporobolus spicata* | Very common. Dominant saltmarsh plant in survey | UAE: Common and widespread on both coasts<br>IUCN: NE |
| Table Key: C-Name = Common Name / IUCN = International Union for the Conservation of Nature / NE = Not Evaluated | | | |

Plates 9 & 10: *Sporobolus spicata* (above left); *Salsola imbricata* (above right)

### 3.3.4 Mammals and Reptiles

An extensive diurnal walk/drive-over was conducted to search for the presence of mammals and reptiles within the site boundary. Five camera traps were also set overnight to record any nocturnal specimens. The traps were set at locations deemed to support the highest density of fauna indicated by the presence of ecological markers such as tracks, scats, and burrows. A stray cat, *Felis catus*, was the only mammal noted at the survey site. Its presence was determined by the identification of a set of tracks running parallel to the revetment supporting wall that were clearly made by a cat (Plate 11).

Another mammal introduced to the island: three Indian Palm squirrels, *Funambulus palmarum*, were sighted in Zayed Park Garden in the residential part of the island. Though an interesting discovery, the squirrels are 2.4 km away from the new island extension and will not inhabit the tree-less survey site but could move there following the development when some trees are likely to be planted.

No reptiles were recorded during the survey despite a concerted effort to search for any sign of them. Their absence in the study area was unsurprising as the island's isolation prevents colonisation by small fauna of low mobility. Further, the species-poor survey site would currently not sustain a population of lizards, primarily due to the low abundancy of arthropods.

*Mesalina brevirostris* is known from several offshore islands nearby in a much more natural state than Das Island, although these islands are located closer to the mainland. A couple of species of gecko probably inhabit the northern rocky parts of the island, though those habitats of the island are unrelated to the development discussed in this report.

The IUCN status, national status, and notes relative to the presence of every mammal identified in the survey area are presented in Table 9 overleaf.

| Table 9: Mammal and Reptile species recorded during the survey | | | |
|---|---|---|---|
| Common Name | Scientific Name | Status During Survey | Status in UAE & IUCN |
| Stray Cat | *Felis catus* | Very Common. Numerous tracks were found, and at least two individuals were captured several times on camera trap. | UAE: Common and widespread<br>IUCN: LC |
| Indian Palm Squirrel | *Funambulus palmarum* | Three seen in a date palm tree in Zayed Garden | UAE: Introduced<br>IUCN: LC |
| Table Key: IUCN = International Union for the Conservation of Nature / LC = Least Concern | | | |

Plate 11: Stray Cat tracks

### 3.3.5 Birds

Avian abundancy and diversity were assessed at the site through incidental sightings conducted at the cable landfall location and across the reclaimed new island site. In all, nine species of birds, totalling 137 individuals, were recorded during the site visits. Counts of all the birds seen on the three days are given in Table 10; scientific names for all taxa and IUCN status are presented therein.

The main ornithological importance of Das Island is as a resting area for migratory birds, particularly passerines, and as a roosting and foraging area for terns and gulls. It is also possible that White-cheeked Terns still breed at the northern end of the island, though this was unsubstantiated during the survey, as access to that part of the island is strictly controlled.

Migrating waders can rest on the island, but the absence of intertidal flats or other suitable foraging grounds proximate to the site cannot encourage waders to remain on the island for long, even during peak migration periods. The small beach to the north of the harbour is a suitable location for waders to feed, but due to its size, it could only sustain a small population for a limited time.

The only wader recorded during the survey was a Kentish Plover, *Charadrius alexandrinus*, as it was perched on the breakwater close to the waterline. The low diversity and abundancy of waders noted during the survey is to be expected in mid-summer, as shorebird numbers using the site will naturally decline from April onwards as birds depart northwards to breeding grounds. Reduced numbers of non-breeding waders remain in the region through the summer, numbers will then start to increase again from late August onwards, as wintering birds arrive and south-bound migrants pause to refuel.

Kentish Plovers are considered to be a ‘Priority Bird Species’ in the UAE. This is due to the percentage of the world population that breeds in the country. An estimated 1000-3000 pairs breed in the UAE, both at coastal and inland locations. The survey site is a suitable location for this species to breed, but a visit earlier in the year (late spring to early summer) would be needed to confirm whether they indeed nest at the site.

Six Socotra Cormorants, *Phalacrocorax nigrogularis* (Plate 12), were recorded during the survey. A recently deceased individual who appeared to have succumbed to natural causes was also found next to a track. Numerous cormorant tracks (Plate 13) intersect the site closer to the concrete supporting wall containing the rock armouring boulders.

This colonial-breeding fish-eating seabird has a limited global breeding range in eastern Arabia. Over recent decades the species has suffered a significant population decline, although there seems to have been some local recovery in Abu Dhabi in recent years. The overall decline is mostly because of the total loss of several islands as breeding sites. The species is classified as Vulnerable in the IUCN Red List and is one of the most endangered species to be found in UAE. Breeding may have taken place on Das island before pre-industrialisation in the mid-1950s, but the species has certainly not bred on the island ever since.

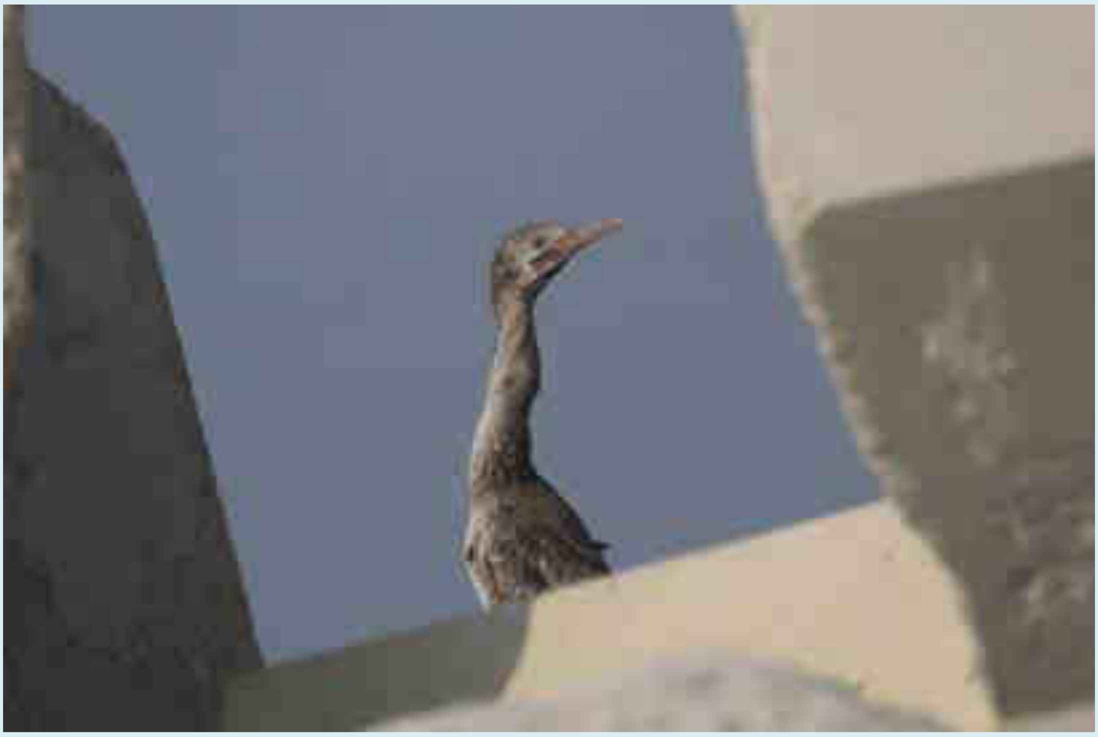


Plate 12: Socotra Cormorant

Plate 13: Socotra Cormorant Track

Two Osprey, *Pandion haliaetus*, were recorded at the survey site on the morning of 05.08.21 (Plate 14). The pair were hunting for fish, using updrafts of wind above the rock armouring revetment to enable them to soar back and forth with minimal effort while scouring the shallow waters for prey. Western Osprey has a very large global range being absent only from Antarctica, at both coastal and freshwater environments. The resident population on the coasts and islands of the Abu Dhabi emirate is one of the densest anywhere in the world.

The Arabian Gulf population is thought to be genetically isolated from those in the Red Sea, which also has a large population. Osprey eyries are large and conspicuous and can grow to a very large size, as nesting materials are added every breeding season. Therefore, it is clear that Osprey seen during the survey are not breeding at the site or in adjacent land, as no eyries were visible. Instead, Osprey are likely to use the coastal site to catch fish or merely pass through the area searching for more plentiful fishing waters.

The UAE Osprey population is thought to number 75 to 100 pairs but is declining, most likely due to development on islands and increased human disturbance. *P. haliaetus* has one of the largest worldwide ranges of any bird and has an increasing population globally. Therefore, the species is considered as 'Least Concern' on the IUCN Red List of threatened species.

Plate 14: A pair of Osprey in-flight over the site

Three Indian House Crows, *Corvus splendens*, were captured by two camera traps (CT02 & CT04 – Plate 15). These birds are prevalent around the residential areas of the island but are much rarer at the site of study, which they infrequently visit as an expansion of their usual foraging grounds closer to the areas of human habitation. A relatively recent arrival in Arabia, these birds are notorious stowaways (having even reached Europe by boat). They are found mainly at urban coastal sites, including fishing villages, rubbish dumps, and date palm plantations.

The first confirmed breeding record for the species on Das Island came from 1998, when there were mixed feelings about removing the nest or not, for fear of the species eventually becoming established in force and plundering the nearby island tern colonies (Aspinall 2010). The fears were justified as the population has increased exponentially in recent years, with an estimated 300 to 400 pairs now breeding and residing on Das Island. However, confirmation and the extent of their predation of nesting terns in the area is currently unknown. Indian House Crow is considered a pest in many areas. Control is advocated on islands as they are certainly not part of the indigenous island fauna, nor could they be without man's presence.

Plate 15: Two Indian House Crows captured by camera trap

Eight Sooty Gulls, *Ichthyaetus hemprichii* (Plate 16), were recorded at the site, with numbers concentrated along the rock armoured revetment. On a couple of occasions during the survey, these birds were observed chasing White-cheeked Terns to steal their food, a form of feeding known as kleptoparasitism.

Although there is a regular migratory passage of Sooty Gulls northwards along the east coast of the UAE in spring, Sooty Gulls often remain on or around Arabian Gulf islands, including Das, year-round. Das's closest neighbouring island is Qarnein, which is situated approximately 20km to the south. Up to 4% of the estimated world breeding population of Sooty Gull is housed on Qarnein.

Gulls will roost on the sea in large flocks when conditions are calm, but they must seek the shelter of islands during rough weather. Das island is therefore important to Sooty Gulls as an essential element of their annual movements and feeding strategies. Other gull species (generally non-breeding winter visitors to the region) are more opportunistic feeders and are more dependent on land areas, particularly the mainland, where they take advantage of anthropogenic waste.

Plate 16:  A juvenile Sooty Gull resting on a rock armouring boulder

White-cheeked Terns, *Sterna repressa*, were commonly encountered during the survey. Recently fledged juveniles were still largely dependent on the adults, as they were frequently observed calling to for food while perched on the breakwater and ground (Plate 17). In adult breeding plumage (Plate 17 background), a blackcap extends over the eyes, nape, and hindneck, while the forehead is pale grey.  the upperparts and wings are greyer than the very similar-looking Common Tern. A juvenile in Plate 17 (foreground) can be seen displaying immature plumage with a brown forehead, brown wings, and a blacker bill.

White-cheeked Terns are a common summer breeding visitor to the UAE, arriving in April, breeding from May to July, and remaining until October when they migrate eastwards to coastal regions of Pakistan, Iran, and Western India to over-winter. White-cheeked Terns are known to have bred at a colony to the north of Das island where tanker berths and emergency flare pits were tenanted. It was impossible to confirm whether the breeding colony is still used during the survey as access to that part of the island is strictly controlled.

It is possible that a colony could become established at the reclaimed island extension due to the site’s relative seclusion and occurrence of some low shrubby vegetation, but the presence of cats and increased anthropogenic disturbance will probably prohibit the terns from breeding at the site. Although the survey was conducted after the tern breeding season in the region (May to July), the site was thoroughly searched for signs that would confirm whether terns had recently bred (i.e. egg casings, deceased fledglings, and small, round depressions in the ground where an inconspicuous scrape-type nest may have been tenanted). Despite an extensive search, no signs of terns breeding were found over the entire survey area.

Das Island is valuable as a stop-over site for tired migrant birds crossing the Arabian Gulf. As of August 2021, 145 bird species have been recorded on the island, most of these are passerines visiting the island while on migration. A full avian species list for the island is available on the following website: https://ebird.org/hotspot/L1142987. A couple of early autumn migrants were seen during the survey in early August, but the visit was well before the peak of autumn migration.

Plate 17: An adult White-cheeked Tern

Plate 18: An adult White-cheeked Tern (background) with a juvenile White-cheeked Tern (foreground)

A single Isabelline Wheatear, *Oenanthe isabelline*, was the only migrant seen at the survey area. A Barn Swallow, *Hirundo rustica*, was also sighted on the island near to the residential buildings.

A single Grey Heron, *Ardea* cinerea, was another possible migrant, although some do over-summer in the UAE. The heron was sighted in-flight during the survey as it passed south of the new runway. The Grey Heron is a large predatory bird that feeds mostly on aquatic animals, which it catches after standing stationary beside water waiting to ambush, or by stalking prey through the shallows. It is a common winter visitor and passage migrant in the UAE, and can often be seen by freshwater lakes, or in mangrove areas.

A large flock (approximately 75 birds) of Rock Dove/Feral Pigeon, *Columba livia*, were seen at the survey site during the early morning of 06.08.21. Numerous tracks made by these birds are visible across the survey site, indicating that the area is used for foraging and roosting by the species. Rock Doves breed widely on many islands and in mountains and foothills. Only in the latter is there any chance of a pure population existing. In Arabia, as is the case in much of the world, these birds are represented mainly by Feral Pigeons or impure strains resulting from 'crossing' with pure Rock Doves. Numbers of Feral Pigeons on islands often reach pest proportions, where control is certainly necessary due in part to them outcompeting tern nesting sites.

The IUCN status, national status, and notes relative to the presence of every bird identified in the survey area are presented in Table 10 overleaf.

| Table 10: Bird species recorded during the survey | | | | |
|---|---|---|---|---|
| Common Name | Scientific Name | Count(s) | Status On-site | Status in UAE / IUCN |
| Socotra Cormorant | *Phalacrocorax nigrogularis* | 6 | Resting on the rock armouring and in-flight over the site | UAE: Visitor, mostly winter<br>IUCN: VU |
| Grey Heron | *Ardea cinera* | 1 | One sighted in-flight to the south of the runway | UAE: Visitor, mostly winter<br>IUCN: LC |
| Osprey | *Pandion haliaetus* | 2 | Two fishing along the rock armoring breakwater | UAE: Resident breeder<br>IUCN: LC |
| Kentish Plover | *Charadrius alexandrinus* | 1 | One seen perched on a low rock armoring boulder close to the waters edge | UAE: Common resident breeder<br>IUCN: LC |
| Sooty Gull | *Ichthyaetus hemprichii* | 8 | Seen in-flight chasing White-cheeked Terns and resting on the rock armouring | UAE: Resident breeder<br>IUCN: LC |
| White-cheeked Tern | *Sterna repressa* | 45 | Flocks of adults and juveniles resting on the island in the mornings and evenings and fishing in the shallows during the day | UAE: Common resident breeder<br>IUCN: LC |
| Rock Dove/Feral Pigeon | *Columba livia* | 70 | A large flock sighted at the survey site early one morning | UAE: Very common resident breeder<br>IUCN: LC |
| Isabelline Wheatear | *Oenanthe isabellina* | 1 | The only migrant seen at the survey site foraging on the ground | UAE: Common passage migrant and winter visitor<br>IUCN: LC |

| Table 10: Bird species recorded during the survey | | | | |
|---|---|---|---|---|
| Common Name | Scientific Name | Count(s) | Status On-site | Status in UAE / IUCN |
| House Crow | *Corvus splendens* | 3 | Three captured on camera trap | UAE: Very common at coastal sites<br>IUCN: LC |
| Table Key: IUCN = International Union for the Conservation of Nature / LC = Least Concern | | | | |

## 3.3.7 Anthropogenic Use

Anthropogenic activity at the site is currently relatively minimal. Occasional vehicle tyre track marks were the only indicators that people drive through the site on an infrequent basis. During the evenings, people exercise by walking/running a looped circuit around the perimeter of the island extension. No other evidence was found that would suggest that any other recreational activity, such as camping and fishing takes place at the landfall location.

Parts of the island extension are currently being used to store construction equipment, but overall, the site is clear of anthropogenic materials and litter. Plate 19 shows some construction materials at the northern end of the site.

Plate 19: Construction materials at the northern end of the site

## 4.0 Conclusions and Recommendations

### 4.1 Ambient Noise

The ambient noise climate of the site is relatively undisturbed by the nearby anthropogenic noise sources, with all measurements falling considerably below the limits applied to the area.

No exceedances of the 70 dBA (day time) or 60 dBA (night time) limits were reported for the site and it is considered unlikely, given the nature of the development, that the addition of the Project-specific infrastructure will result in any exceedances of these limits. The long term development plan for the southern end of Das Island is not known and as such may result in a more significant change to the noise climate of the wider project area.

### 4.2 Soil and Groundwater

GIven the lack of bearby sources, there were no groundwater samples collected at the location.

The collection of soil samples was completed using a hand-augur and pre-prepared sample containers. Analysis of the eight collected samples was undertaken by a ESMA approved third-party laboratory (Element LLC). The vast majority of analytes were below the detection limits and were not registered in the analysis at all. Of those parameters which could be measured, all were recorded below screening or clean-up thresholds as outlined by the ADQCC soil standards.

### 4.3 Terrestrial Ecology

The overall site footprint consists of reclaimed land, which is just a few years old. The island's isolation and hypersaline soils have further hindered colonisation by all but a handful of species. Patches of low shrubs and grass in the island’s interior, comprising two common and adaptable plants, are likely the only species that will be directly impacted by the development.

Small passerine migrants can rest and find shelter at the site, but, because of the very limited botanical diversity, the cable landfall location site’s current state cannot be considered as a good "refueling stop" for hungry migrants. After completion of the island residential development, migrant passerines will undoubtedly benefit from the habitat creation of some planted trees and lawns. However, without control of pest species, these areas are likely to be taken over by crows and pigeons (as has been the case with the other developed parts of the island), which outcompete and displace native birds of greater concern.

Low numbers of resident breeding shorebirds, including cormorants, terns and gulls, frequent the site to rest and feed in surrounding shallow waters. However, none were found to be breeding at the site, despite the survey occurring towards the end of the breeding season when evidence of breeding would be expected to remain.

Socotra Cormorant is the species of greatest conservation concern recorded in the survey (see Section 3.3.5) and has Vulnerable status in the IUCN Red List on account of range contraction and the observed rate of decline. Fourteen of the 17 known breeding colonies are in the Arabian Gulf. Despite the species' threatened status, breeding does not take place on Das Island and the survey site serves primarily as a resting/feeding area for small population. Therefore, impacts to the species associated with the development are considered to be insignificant. All other avian species recorded in the survey are listed as 'Least Concern' on the IUCN Red List of threatened species.

The prospect of encouraging ospreys to nest successfully on Das Island is very real. Given the size of the island and new island extension, at least two pairs could be accommodated. Abu Dhabi's islands hold over 90% of the osprey breeding population of the western Arabian Gulf and are thus extremely important. Several islands have lost their breeding pairs following disturbance and development. With little effort, it would be possible to construct two artificial nest structures, preferably on the flat area of the rock armouring revetment at the most secluded locations of the island. Breeding would unlikely occur while construction is ongoing, but following the development, after the Osprey have become accustomed to the artificial nests, it is likely that the platforms would be successfully used.

Indian House Crows are considered as pests in many areas. Control is advocated on islands as they are certainly not part of the indigenous island fauna, and nor could they be without the presence of man. In addition, numbers of Feral Pigeons on islands (numbering in the hundreds on Das) often reach pest proportions, where control is certainly necessary due in part to them outcompeting tern nesting sites.

# ANNEX A

## References

## Annex A – References

The following references were available and/or used on the current survey:


- Al Dhaheri, S., Javed, S., Alzahlawi, N., Binkulaib, R., Cowie,W., Grandcourt, E. and Kabshawi, M. (2017). Abu Dhabi Emirate Habitat Classification and Protection Guideline. Environment Agency Abu-Dhabi.

- Aspinall S.J. (2005). *Birds [of the UAE]. In:* Hellyer and Aspinall (eds.). The Emirates: A Natural History. Trident Press, UK.

- Aspinall S.J. (2010). *Breeding Birds of the United Arab Emirates*. Environment Agency Abu Dhabi, UAE.

- Brown G. and Boer B. (2004). *Interpretation Manual of the Major Terrestrial Natural and Semi-natural Habitat Types of Abu Dhabi Emirate*. ERWDA, Abu Dhabi.

- M.V.D. Jongbloed, G.R. Feulner, B.Boer, A.R Western (2003). *The comprehensive guide to the Wild Flowers of the United Arab Emirates*. ERWDA, Abu Dhabi.

- Environment Agency – Abu Dhabi (2015). *Terrestrial Habitat Classification*. EAD Enviro-portal Viewer. https://enviroportal.ead.ae/geoportal.

- Hellyer, P. and Aspinall, S.J. (Eds.) (2005). *The Emirates—A Natural History*. Trident Press, London, and the Environment Agency, Abu Dhabi.

- Gardner, A. (2013). *The amphibians and reptiles of Oman and the UAE*. Frankfurt am Main: Edition Chimaira.

- IUCN (2017). *Red List of Threatened Species*. http://www.iucnredlist.org.

- Javed S. (2008). Birds. In Perry R. *Terrestrial Habitats of Abu Dhabi Emirate*. Environment Agency - Abu Dhabi.

- Jennings M. (2010). *Atlas of the Breeding Birds of Arabia*. Fauna of Arabia Vol. 25. KACST, Riyadh and Senckenburg, Germany.

- Ornithological Society of the Middle East, the Caucasus and Central Asia (OSME). (2012). Simplified OSME list of bird taxa.

- Perry R. (ed.) (2008). *Terrestrial Environment of Abu Dhabi Emirate*. Environment Agency, Abu Dhabi, UAE.

- Porter R. and Aspinall S.J. (2010). *Birds of the Middle East*. Second Edition. Christopher Helm, London

# ANNEX B

## Photographic Documentation and Data Sheets

## Cardinal Point CP01

Coordinates: N25.124, E52.87648
Location: Das Island
Date-Time: 03 Aug 2021 - 09:52

Figure B1: CP1

## Cardinal Point CP02

Coordinates: N25.1234, E52.87744
Location: Das Island
Date-Time: 03 Aug 2021 - 09:54

Figure B2: CP2

**Cardinal Point CP03**

Coordinates: N25.12136, E52.87717
Location: Das Island
Date-Time: 03 Aug 2021 - 10:00

Figure B3: CP3

## Cardinal Point CP04

Coordinates: N25.11875, E52.87701
Location: Das Island
Date-Time: 03 Aug 2021 - 10:04

Figure B4: CP4

## Cardinal Point CP05

Coordinates: N25.12436, E52.87712
Location: Das Island
Date-Time: 03 Aug 2021 - 10:10

Figure B5: CP5

**Cardinal Point CP06**

Coordinates: N25.12628, E52.87976
Location: Das Island
Date-Time: 03 Aug 2021 - 10:17

Figure B6: CP6

## Cardinal Point CP07

Coordinates: N25.12407, E52.88218
Location: Das Island
Date-Time: 03 Aug 2021 - 10:24

Figure B7: CP7

## Cardinal Point CP08

Coordinates: N25.1184, E52.88104
Location: Das Island
Date-Time: 03 Aug 2021 - 10:30

Figure B8: CP8

Table B1: Soil Analyses

| Method | Parameter Name | Unit | Detection Limit | DS01 | DS02 | DS03 | DS04 | DS05 | DS06 | DS07 | DS08 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH [BS 1377-3: 2018] Soil-DXB | pH | pH units | 0.1 | 8.7 | 8.8 | 8.8 | 8.6 | 8.8 | 9 | 8.8 | 9 |
| Oil & Grease [APHA 5520 E]-DXB | Oil and Grease | % | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Nitrogen (Ammonia) [HACH 8155] Solids-DXB | Nitrogen (Ammonia) | mg/kg | 0.25 | 1.95 | 2.05 | 2 | 0.5 | 3.05 | 1.9 | 1.5 | 2 |
| Nitrogen (Ammonia) [HACH 8155] Solids-DXB | Ammonium | mg/kg | 0.32 | 2.51 | 2.64 | 2.57 | 0.64 | 3.92 | 2.44 | 1.93 | 2.57 |
| Nitrogen (Ammonia) [HACH 8155] Solids-DXB | Ammonia | mg/kg | 0.3 | 2.37 | 2.49 | 2.43 | 0.61 | 3.7 | 2.31 | 1.82 | 2.43 |
| Salinity [APHA 2520 B]-DXB | Salinity | ppt | 1 | 1 | 1.15 | 2.25 | 1.35 | 1.3 | <1.00 | 1.93 | <1.00 |
| Sulphide [HACH 8131/DIN 38405-D27]-DXB | Sulphide ($S^{2-}$) | mg/kg | 5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Fluoride [HACH 8029]-DXB | Fluoride | mg/kg | 0.5 | 4.8 | 3 | 4.2 | 3 | 5.7 | 3.2 | 3.4 | 2.5 |
| Nitrate [HACH 8039]-DXB | Nitrate | mg/kg | 0.22 | 75.3 | 86.3 | 84.1 | 38.5 | 64.1 | 12.2 | 106 | 37.6 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Cadmium (Cd) | mg/kg | 0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Aluminium (Al) | mg/kg | 130 | 583 | 323 | 413 | 401 | 365 | 360 | 314 | 264 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Arsenic (As) | mg/kg | 1 | 4.1 | 3.2 | 2.7 | 2.6 | 2.6 | 2.7 | 2.6 | 2.6 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Barium (Ba) | mg/kg | 3 | 12.6 | 16.5 | 14.5 | 14.1 | 14.7 | 13.6 | 14.9 | 12.5 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Chromium (Cr) | mg/kg | 1 | 4.8 | 3.1 | 3.3 | 4.6 | 3 | 3.2 | 2.8 | 2.6 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Cobalt (Co) | mg/kg | 1 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Copper (Cu) | mg/kg | 3 | 3.6 | 4.2 | 4.8 | 4.7 | 4.7 | 4.3 | 4.1 | 3.7 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Lead (Pb) | mg/kg | 1 | 1.6 | 1.3 | 1 | 1.6 | 1.1 | 1.2 | 1.3 | <1.0 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Manganese (Mn) | mg/kg | 3 | 20 | 11.7 | 14.3 | 13 | 12.3 | 11.6 | 10.2 | 10.4 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Nickel (Ni) | mg/kg | 1 | 2.5 | 2.1 | 2.3 | 2.1 | 1.9 | 2 | 1.5 | 1.5 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Phosphorus (P) | mg/kg | 50 | 337 | 308 | 319 | 310 | 306 | 321 | 289 | 313 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Zinc (Zn) | mg/kg | 3 | 14.3 | 45.5 | 16.2 | 33.4 | 12.2 | 17.2 | 15.3 | 11 |
| Chromium (Hexavalent) [HACH 8023] Solids-DXB | Chromium (VI) | mg/kg | 0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Antimony (Sb) | mg/kg | 1 | <1.0 | <1.0 | <1.0 | 1.4 | 1.4 | 2.5 | 1.7 | 1.7 |
| Metals ICP OES [APHA 3120 B] SSS-DXB | Beryllium (Be) | mg/kg | 1 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Mercury by PSA [EPA 245.7] SSS-DXB | Mercury (Hg) | mg/kg | 0.01 | <1.980 | <1.990 | <2.000 | <1.990 | <1.980 | <2.000 | <1.980 | <1.990 |
| VPH C5-C10 by GC-FID [EPA 8015B]-SSS-DXB | VPH C5-C10 | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| EPH C10-C40 by GC-FID [EPA 8015B] SSS-DXB | EPH C10-C40 | mg/kg | 50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |
| PAH in Soils [EPA 8270 D]-DXB | Acenaphthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Acenaphthylene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Anthracene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(a)anthracene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Table B1: Soil Analyses | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Method | Parameter Name | Unit | Detection Limit | DS01 | DS02 | DS03 | DS04 | DS05 | DS06 | DS07 | DS08 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(a)pyrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(b)fluoranthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(g,h,i)perylene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Benzo(k)fluoranthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Chrysene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Dibenzo(a,h)anthracene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Fluoranthene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Fluorene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Indeno(1,2,3-c,d)pyrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Naphthalene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Phenanthrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| PAH in Soils [EPA 8270 D]-DXB | Pyrene | mg/kg | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Phenols Soil [EPA 8270D]-DXB | 2,4,5-Trichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,4,6-Trichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,4-Dichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,4-Dimethylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2-Chlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2-Methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2-Nitrophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 4-Chloro-3-methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 4-Methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 4-Nitrophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | Pentachlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,3,4,6-Tetrachlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 2,6-Dichlorophenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | 3-Methylphenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Phenols Soil [EPA 8270D]-DXB | Phenol | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Dichlorodifluoromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Chloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Vinyl Chloride | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromomethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |

| Table B1: Soil Analyses | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Method | Parameter Name | Unit | Detection Limit | DS01 | DS02 | DS03 | DS04 | DS05 | DS06 | DS07 | DS08 |
| VOCs in Soil [EPA 8260 B]-DXB | Chloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Trichlorofluoromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1-Dichloroethene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Methylene Chloride | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloroethene(trans) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1-Dichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloroethene(cis) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 2,2-Dichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromochloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Chloroform | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,1-Trichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1-Dichloropropene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Carbon Tetrachloride | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Benzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Trichloroethene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromodichloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Dibromomethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichloropropene(cis) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Toluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichloropropene(trans) | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,2-Trichloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Tetrachloroethene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Dibromochloromethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dibromoethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Chlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,1,2-Tetrachloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Ethyl benzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | m,p-Xylene | mg/kg | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

| Table B1: Soil Analyses | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Method | Parameter Name | Unit | Detection Limit | DS01 | DS02 | DS03 | DS04 | DS05 | DS06 | DS07 | DS08 |
| VOCs in Soil [EPA 8260 B]-DXB | o-Xylene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Styrene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | iso-Propylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromoform | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,1,2,2-Tetrachloroethane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,3-Trichloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | n-Propylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Bromobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3,5-Trimethylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 2-Chlorotoluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 4-Chlorotoluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | tert-Butylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,4-Trimethylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | sec-Butylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | p-Isopropyltoluene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,3-Dichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,4-Dichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | n-Butylbenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2-Dibromo-3-Chloropropane | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,4-Trichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Hexachlorobutadiene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | Naphthalene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| VOCs in Soil [EPA 8260 B]-DXB | 1,2,3-Trichlorobenzene | mg/kg | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |

Table B2: ADQCC Soil Limits for Industrial and Commercial use

| Parameter | Unit | Screening level | Clean-up level |
|---|---|---|---|
| Antimony (Sb) | mg/kg (DW) | 470 | 4700 |
| Arsenic (As) | mg/kg (DW) | 30 | 300 |
| Beryllium (Be) | gm/kg (DW) | 2.3 | 23.0 |
| Cadmium (Cd) | mg/kg (DW) | 980 | 9800 |
| Chromium (Cr VI) | mg/kg (DW) | 63 | 630 |
| Cobalt (Co) | mg/kg (DW) | 350 | 3500 |
| Lead (Pb) | gm/kg (DW) | 8.0 | 80 |
| Mercury (Hg) | mg/kg (DW) | 46 | 460 |
| Nickel (Ni) | gm/kg (DW) | 22 | 220 |
| Selenium (Se) | gm/kg (DW) | 5.8 | 58 |
| Asbestos | gm/10 kg (DW) | 5.0 | 5.0 |
| Benzene | mg/kg (DW) | 51 | 510 |
| Toluene | gm/kg (DW) | 47 | 470 |
| Ethylbenzene | mg/kg (DW) | 250 | 2500 |
| Xylene | gm/kg (DW) | 2.5 | 25.0 |
| Benzo (a) pyrene (BaP) | mg/kg (DW) | 2.9 | 29 |
| Polychlorinated Biphenyls | mg/kg (DW) | 330 | 3300 |

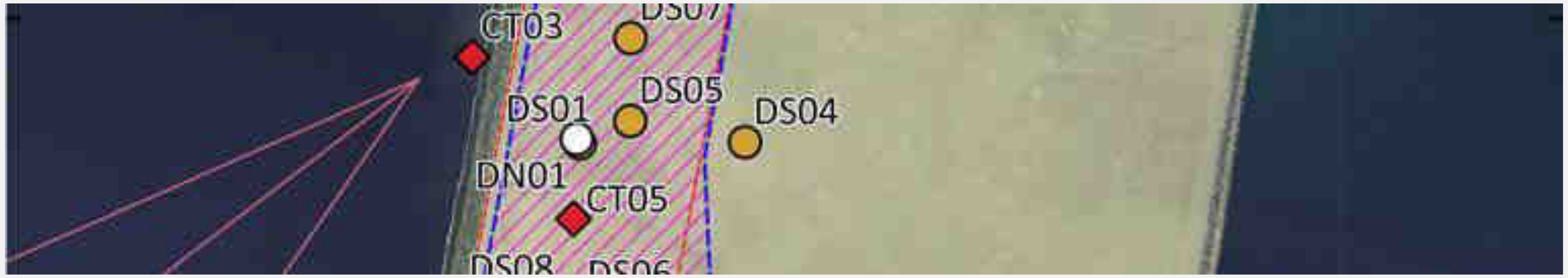
Table Notes:

- Taken from Environmental Specification for Soil Contamination ADS 19/2017
- Mg/kg = milligram per kilogram
- Gm/kg = gram per kilogram
- DW = Dry Weight

Table B3: Noise Data Sheet DN01

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| User: | Ross Pappin | | | Job No: | N684 | Project: | MM Lightning |
| Report No: | N684-0821-DAS-1.0 | Survey Date: | See comments | Checked: | DT | Date: | - |
| Site No: | DN01 | Mic. Height: | 155cm | Free Field | ✓ | Facade: | N/A |

Location Description (draw a little picture of the area):




Noise Source:

Birds, machinery (distant), people exercising and talking, oil facilities (distant)

| Period | Calibration | | Wind | | Time | | LAeq | Cars (tally) | Trucks (tally) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Speed | Direction | On | Off | | | | |
| Day (Week) | 94.4dB | 94.1dB | 3.0m/s | SW (245°) | 16:20 | 16:35 | 31.4 dBA | - | - | 03.08.2021 |
| Night (Week) | 94.3dB | 93.9dB | 1.2m/s | S (176°) | 19:39 | 19:54 | 39.9 dBA | - | - | 04.08.2021 |
| Day (W-end) | 94.3dB | 94.0dB | 1.6m/s | SW (247°) | 06:44 | 06:59 | 30.9 dBA | - | - | 06.08.2021 |
| Night (W-end) | 94.4dB | 94.0dB | 1.3m/s | NE (50°) | 19:42 | 19:57 | 37.2 dBA | - | - | 06.08.2021 |

General Weather Conditions:

Noise measurements were collected only during periods of low wind speed

| Specific Conditions: | Calm | Fog | Precipitation | Frost | Tonal | Impulse |
|---|---|---|---|---|---|---|
| BS4142 Compliance: | ✓ | x | x | x | - | - |
| Factory Cal. Date: | 16.05.2021 | | | | | |
| Checked: | Doug Tilbury | | Date: | 03-06.08.2021 | | |

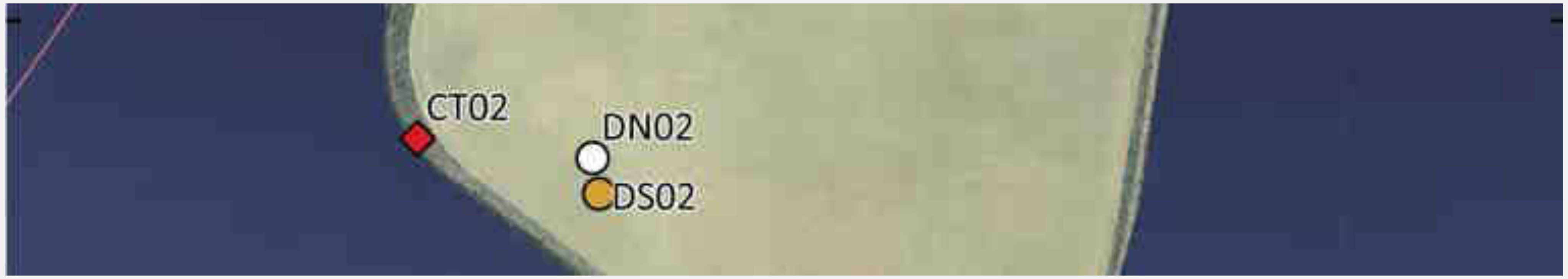
Key to Abbreviations:

Mic = Microphone / LAeq = Equivalent Continuous Level / SW = Southwest / NE = Northeast / N = North / E = East / m/s = Metre per second / dB = Decibel / Cal = Calibration / cm = Centimetre / min = Minute

Table B4: Noise Data Sheet DN02

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| User: | Ross Pappin | | | Job No: | N684 | Project: | MM Lightning |
| Report No: | N684-0821-DAS-1.0 | Survey Date: | See comments | Checked: | DT | Date: | - |
| Site No: | DN02 | Mic. Height: | 155cm | Free Field | ✓ | Facade: | N/A |

Location Description (draw a little picture of the area):




Noise Source:

Mosque, aircraft, birds, oil facilities

| Period | Calibration | | Wind | | Time | | LAeq | Cars (tally) | Trucks (tally) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Speed | Direction | On | Off | | | | |
| Day (Week) | 94.6dB | 94.2dB | 2.3m/s | SW (229°) | 16:53 | 17:08 | 36.2 dBA | 1 (distant) | - | 03.08.2021 |
| Night (Week) | 94.4dB | 94.0dB | 0.1m/s | SSW (196°) | 20:06 | 20:21 | 42.6 dBA | - | - | 04.08.2021 |
| Day (Weekend) | 94.6dB | 94.0dB | 1.7m/s | SW (231°) | 07:17 | 07:33 | 32.0 dBA | - | - | 06.08.2021 |
| Night (Weekend) | 94.5dB | 94.1dB | 0.7m/s | SSW (208°) | 20:05 | 20:20 | 35.1 dBA | - | - | 06.08.2021 |

General Weather Conditions:

Noise measurements were collected only during periods of low wind speed

| Specific Conditions: | Calm | Fog | Precipitation | Frost | Tonal | Impulse |
|---|---|---|---|---|---|---|
| BS4142 Compliance: | ✓ | x | x | x | - | - |
| Factory Cal. Date: | 16.05.2021 | | | | | |
| Checked: | Doug Tilbury | | Date: | 03-06.08.2021 | | |

Key to Abbreviations:

No = Number / Mic = Microphone / LAeq = Equivalent Continuous Level / SE = Southeast / NE = Northeast / N = North / m/s = Metre per second / dB = Decibel / Cal = Calibration / cm = Centimetre / min = Minute

## Table B5: Noise Data Sheet DN03

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| User: | Ross Pappin | | | Job No: | N684 | Project: | MM Lightning |
| Report No: | N684-0621-DAS-1.0 | Survey Date: | See comments | Checked: | DT | Date: | - |
| Site No: | DN03 | Mic. Height: | 155cm | Free Field | ✓ | Facade: | N/A |

| Location Description (draw a little picture of the area): | Noise Source: |
|---|---|
| <br> | Vehicles, powerlines |

| Period | Calibration | | Wind | | Time | | LAeq | Cars (tally) | Trucks (tally) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Speed | Direction | On | Off | | | | |
| Day (Week) | 94.6dB | 94.0dB | 2.4m/s | SW (235°) | 17:34 | 17:49 | 37.2 dBA | - | - | 03.08.2021 |
| Night (Week) | 94.4dB | 94.0dB | 1.6m/s | WNW (285°) | 20:35 | 20:50 | 44.2 dBA | - | - | 04.08.2021 |
| Day (Weekend) | 94.4dB | 94.0dB | 1.1m/s | SSW (217°) | 07:44 | 07:59 | 33.7 dBA | - | - | 06.08.2021 |
| Night (Weekend) | 94.4dB | 94.0dB | 0.1m/s | SW (225°) | 20:41 | 20:56 | 39.1 dBA | - | - | 06.08.2021 |

General Weather Conditions:

Noise measurements were collected only during periods of low wind speed

| Specific Conditions: | Calm | Fog | Precipitation | Frost | Tonal | Impulse |
|---|---|---|---|---|---|---|
| BS4142 Compliance: | ✓ | x | x | x | - | - |

| | | | |
|---|---|---|---|
| Factory Cal. Date: | 16.05.2021 | | |
| Checked: | Doug Tilbury | Date: | 03-06.08.2021 |

Key to Abbreviations:

No = Number / Mic = Microphone / LAeq = Equivalent Continuous Level / SE = Southeast / NE = Northeast / N = North / m/s = Metre per second / dB = Decibel / Cal = Calibration / cm = Centimetre / min = Minute

# ANNEX C

## Quaity Control Documentation

Contents:

## Part 1: Field Documentation

Table C1, below, details field logs, provided on subsequent pages.

| Table C1: Field Documentation | | |
|---|---|---|
| Figure № | Description | Usage |
| Figure C1 | NEA Field Log Day 03.08.2021 | Daily log of activities |
| Figure C2 | NEA Field Log Day 04.08.2021 | Daily log of activities |
| Figure C3 | NEA Field Log Day 05.08.2021 | Daily log of activities |
| Figure C4 | NEA Field Log Day 06.08.2021 | Daily log of activities |

| Figure C1: NEA Activity Log 03.08.2021 | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 03.08.2021 / Tuesday |
| Site Team: | RP | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | ADNOC Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 09:10 | AF1 | Depart Al Falalah 1 Camp for site |
| 09:25 | DS | Arrive at Das survey location - ecology investigations and CT deployment |
| 11:20 | DS | Depart survey site for main office |
| 11:38 | NA | Arrive at Das main office |
| 15:35 | AF1 | Depart accommodation for survey site |
| 15:59 | DS | Arrive at survey site |
| 16:05 | DN01 | DN01 – Noise monitoring (Day – Weekday) |
| 16:43 | DN02 | DN02 – Noise monitoring (Day – Weekday) |
| 17:26 | DN03 | DN03 – Noise monitoring (Day – Weekday) |
| 18:36 | DS | Depart survey site for accommodation |
| 18:50 | AF1 | Arrive at Al Falalah 1 Camp |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel
PM = Project Manager / PD = Project Director / PIR = Process Improvement Report / CT = Camera Trap
RP = Ross Pappin / DT = Doug Tilbury / AQF1 = Al Falalah 1 Camp / DS = Das Survey location

| | |
|---|---|
| PM Name: | Ross Pappin |
| PM Signature and Stamp: | Ross P. NAUTICA ENVIRONMENTAL ASSOCIATES LLC POB 44780 ABU DHABI UAE |

| Figure C2: NEA Activity Log 04.08.2021 | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 04.08.2021 / Wednesday |
| Site Team: | RP | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | ADNOC Pick-up | Visitors: | 1 x driver (at night) |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 07:45 | AF1 | Depart Al Falalah 1 Camp for site |
| 08:24 | DS | Arrive at Das survey location - ecology investigations and CT collection |
| 09:04 | DS | Depart survey site for accommodation |
| 09:20 | AF1 | Arrive at Al Falalah 1 Camp. Data download and reviewal |
| 19:05 | AF1 | Depart accommodation for survey site |
| 19:20 | DS | Arrive at survey site |
| 19:30 | DN01 | DN01 – Noise monitoring (Night – Weekday) |
| 20:02 | DN02 | DN02 – Noise monitoring (Night – Weekday) |
| 20:33 | DN03 | DN03 – Noise monitoring (Night – Weekday) |
| 20:54 | DS | Depart survey site for accommodation |
| 21:09 | AF1 | Arrive at Al Falalah 1 Camp |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel
PM = Project Manager / PD = Project Director / PIR = Process Improvement Report / CT = Camera Trap
RP = Ross Pappin / DT = Doug Tilbury / AQF1 = Al Falalah 1 Camp / DS = Das Survey location

| | |
|---|---|
| PM Name: | Ross Pappin |
| PM Signature and Stamp: | Ross P. — NAUTICA • ENVIRONMENTAL • ASSOCIATES LLC • POB 44780 ABU DHABI UAE |

| Figure C3: NEA Activity Log 05.08.2021 | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 05.08.2021 / Thursday |
| Site Team: | RP | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | ADNOC Pick-up | Visitors: | None |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 07:01 | AF1 | Depart Al Falalah 1 Camp for site |
| 07:20 | DS | Arrive at Das survey location to undertake ecology investigations |
| 08:40 | DS | Depart survey site for accommodation |
| 08:58 | AF1 | Arrive at Al Falalah 1 Camp. Data download and reviewal |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel
PM = Project Manager / PD = Project Director / PIR = Process Improvement Report / CT = Camera Trap
RP = Ross Pappin / DT = Doug Tilbury / AQF1 = Al Falalah 1 Camp / DS = Das Survey location

| | |
|---|---|
| PTL Name: | Ross Pappin |
| PM Signature and Stamp: | Ross Pappin |

NAUTICA ENVIRONMENTAL ASSOCIATES LLC • PO8 44780 ABU DHABI UAE

## Figure C4: NEA Activity Log 06.08.2021

| | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 06.08.2021 / Friday |
| Site Team: | RP | PD/PM: | DT/RP |
| Vessel(s)/Vehicle(s): | ADNOC Pick-up | Visitors: | 1 x driver (at night) |
| Weather: | - | W/Source: | AD MET |

| Time | ID | Activities / Notes |
|---|---|---|
| 06:13 | AF1 | Depart Al Falalah 1 Camp for site |
| 06:27 | DS | Arrive at Das survey location – ecology and noise investigations |
| 06:34 | DN01 | DN01 – Noise monitoring (Day – Weekend) |
| 07:11 | DN02 | DN02 – Noise monitoring (Day – Weekend) |
| 07:39 | DN03 | DN03 – Noise monitoring (Day – Weekend) |
| 08:02 | DS01 | DS01 – Soil sample collection |
| 08:24 | DS02 | DS02 – Soil sample collection |
| 08:55 | DS03 | DS03 – Soil sample collection |
| 09:19 | DS04 | DS04 – Soil sample collection |
| 09:33 | DS05 | DS05 – Soil sample collection |
| 09:52 | DS06 | DS06 – Soil sample collection |
| 10:13 | DS07 | DS07 – Soil sample collection |
| 10:27 | DS08 | DS08 – Soil sample collection |
| 10:30 | DS | Depart survey site for accommodation |
| 10:45 | AF1 | Arrive at Al Falalah 1 Camp |
| 19:11 | AF1 | Depart Al Falalah 1 Camp for site |
| 19:20 | DS | Arrive at Das survey location to take noise measurements |
| 19:45 | DN01 | DN01 – Noise monitoring (Night – Weekend) |
| 20:03 | DN02 | DN02 – Noise monitoring (Night – Weekend) |
| 20:37 | DN03 | DN03 – Noise monitoring (Night – Weekend) |
| 21:02 | DS | Depart survey site for accommodation |
| 21:18 | AF1 | Arrive at Al Falalah 1 Camp |

| | |
|---|---|
| Change of Plans: | None |
| EQ/PE issues: | None |
| Incidents/PIR №: | None |

Abbreviations: NEA = Nautica Environmental Associates LLC / ID = Site ID / EQ = Equipment / PE = Personnel
PM = Project Manager / PD = Project Director / PIR = Process Improvement Report / CT = Camera Trap
RP = Ross Pappin / DT = Doug Tilbury / AQF1 = Al Falalah 1 Camp / DS = Das Survey location

## Figure C4: NEA Activity Log 06.08.2021

| | | | |
|---|---|---|---|
| Project № & Client: | N684 | Date/Day: | 06.08.2021 / Friday |
| PM Name: | Ross Pappin | | |
| PM Signature and Stamp: | Ross Pappin / NAUTICA ENVIRONMENTAL ASSOCIATES LLC POB 44780 ABU DHABI UAE | | |

## Part 2: NEA Licenses and Accreditations

Table C2, below, provides a list of NEA licenses and accreditations, provided on subsequent pages.

Table C2: NEA Licenses and Accreditations

| Figure № | Description | Usage |
|---|---|---|
| Figure C5 | NEA Trade License | - |
| Figure C6 | NEA EAD Registration | - |
| Figure C7 | NEA Quality Assurance Accreditation | - |

Figure C5: NEA Trade License

Abu Dhabi Business Center

THE EMIRATES

DEPARTMENT OF ECONOMIC DEVELOPMENT

# Professional License

رخصــــة مهنية

| | | |
|---|---|---|
| License No | CN-1006375 | رقم الرخصة |
| ADCCI No | 228824 | عضوية الغرفة |
| Establishment Card MOHRE | | |
| Establishment Card GDRFA | | |
| Legal Form | Limited Liability Company | الشكل القانوني |
| Trade Name | NAUTICA ENVIRONMENTAL ASSOCIATES - LLC | الاسم التجاري |
| Establishment Date | 05/05/2007 | تاريخ تأسيس المنشأة |
| Issue Date | 19/01/2021 | تاريخ الإصدار |
| Expiry Date | 09/02/2022 | تاريخ الانتهاء |

| Role | Nationality | Owners / Partners | No. |
|---|---|---|---|
| شريك Partner | United Arab Emirates | PETER ARTHUR HELLYER | 41208281 |
| شريك Partner | United Kingdom | RICHARD JOHN HORNBY | 20029757 |
| شريك Partner | United Kingdom | VERYAN GUY HENRY PAPPIN | 20029756 |

**Commercial Activities** : الأنشطة التجارية

- Environmental consultancy and studies and researches
- First Aids Training
- Wildlife Protectorate
- Services Of Testing And Measuring Of Environmental Indicators
- Oil and Gas Facilities Consultancy
- Survey Planning, Air Photography and Information Management Systems Engineering Consultancy
- Environment Protection Training
- Onshore And Offshore Oil And Gas Fields And Facilities Services
- Chemical and Biological Analysis Lab

| | | |
|---|---|---|
| Official Email | management@nea.ae | البريد الالكتروني الرسمي |
| Official Mobile | 971506134040 | رقم التواصل الرسمي |

http://ded.abudhabi.ae

Approved Training Centre
Licensed by The Abu Dhabi Center for Technical and Vocational Education and Training (ACTVET)
License No: 0890/2020

## Figure C6: NEA EAD Registration

هيئة البيئة - أبوظبي
Environment Agency - ABU DHABI

| | | |
|---|---|---|
| EC- | 59/06 | رقم المكتب |
| ECR- | 778/21 | رقم التوصية |
| Date of Issue | 25/5/2021 | تاريخ الإصدار |
| Date of Expiry | 14/5/2022 | تاريخ الإنتهاء |

### إعتماد مكتب استشاري في مجال البيئة

### * فئة (أ)

### Registration of Environmental Consultancy

### * Class A

| | | | |
|---|---|---|---|
| Office Name: | Nautica Environmental Associates LLC | "نوتيكا للرعاية البيئية ذ م م" | اسم المكتب: |
| Type of Office: | Local (100 %) | محلي (100%) | نوع المكتب: |
| Address: | Office M3, East 14<br>Sheikha Zayed Ahmad and Others Bldg<br>Al Meena Street,<br>Abu Dhabi | جزيرة أبوظبي - شرق 14 - شارع الميناء - بناية الشيخة شيخه سعيد احمد وآخرين - الميزانين مكتب رقم 3 | العنوان: |

Environment Agency – Abu Dhabi
Electronically generated permit - No signature required.

هيئة البيئة - أبوظبي
التصريح صادر إلكترونياً - لا يتطلب أي توقيع

Figure C7: NEA ISO Accreditation

Lloyd's Register

Current issue date: 24 April 2020
Expiry date: 4 May 2023
Certificate identity number: [illegible]

Original approval(s):
ISO 14001 - 12 June 2011
ISO 45001 - 24 April 2020
ISO 9001 - 15 June 2011

# Certificate of Approval

This is to certify that the Management System of:

## Nautica Environmental Associates LLC

M03, Building No: P475, Behind Ramada Hotel, Meena Road, Abu Dhabi, United Arab Emirates

has been approved by Lloyd's Register to the following standards:

**ISO 14001:2015, ISO 45001:2018, ISO 9001:2015**

Approval number(s): ISO 14001 – 0045598, ISO 45001 – 0045598, ISO 9001 – 0045597

**The scope of this approval is applicable to:**

1. Provision of Environmental Consultancy Services Typically Covering:
   - Baseline Surveys (Marine and Terrestrial)
   - Environmental Impact Assessments
   - Sampling and Monitoring Studies (Air, Land, Sediments, Marine)
   - Identification and Statistical Evaluation of Biological Specimens
2. Provision of First-Aid Training and Environmental Protection Training

Luis Cunha

**Luis Cunha**

Area Operations Manager - SAMEA

Issued by: Lloyd's Register Quality Assurance Limited

## Part 3: Support Equipment Specifications

Table C3, below, provides a list of key equipment either used or on hand for the survey programme, with specifications provided on subsequent pages.

Table C3: Survey equipment available

| Figure № | Description | Usage |
|---|---|---|
| Figure C8 | Beacon on a Belt (BOB) | DGPS locational system |
| Figure C9 | Trimble GoXT handheld unit | DGPS locational system |
| Figure C10 | Nikon Forestry Pro Laser Rangefinder | Tree height measurements (NU) |
| Figure C11 | Bushnell Camera Traps | Small mammal/reptile activity |
| Figure C12 | Sherman Traps | Small mammal activity |
| Figure C13 | Anabat Detector | Bat Detection |
| Figure C14 | Malaise Traps | Insect trapping |
| Figure C15 | RIDGID Micro-inspection unit | Den/Borrow/Hole investigation (NU) |
| Figure C16 | Pitfall Trap | Insect / small reptile trapping |
| Figure C17 | Mavik Pro 2 UAV (Drone) | Aerial photography/videography |

## Figure C8: Beacon-on-a-Belt (BOB)

# Beacon-on-a-Belt (BoB)

*Cable-free Differential Correction Receiver*

**Key features and benefits**

- Provides real-time DGPS accuracy to mapping receivers
- Cable-free communication with Trimble GeoExplorer 3
- Rugged, ergonomic design
- Noise-rejecting beacon receiver

Trimble

Trimble's Beacon-on-a-Belt (or BoB™) receiver lets you add the extra precision of real-time differential GPS to your GIS projects— without adding the encumbrance of a bulky radio pack. The system incorporates a beacon receiver, an antenna and battery in one compact cable-free* package that you wear on your belt. The BoB receiver decodes GPS differential correction information from local MSK beacons and then transmits that information to any GPS receiver that accepts standard RTCM SC-104 data, eliminating the need to postprocess your data. Best of all, this is completely cable-free when used with Trimble's GeoExplorer® 3.

*Beacon-on-a-Belt (BoB) Receiver*

**Real-time DGPS Accuracy**

The accuracy of differential GPS not only means that your databases have better data, it also makes locating previously mapped assets in the field quicker and more accurate too. With differential GPS, distinguishing between closely spaced assets is fast and unambiguous. Back in the office you'll save time too. Since the data you collected was corrected as you gathered it, you can transfer that data directly into your GIS without the delay of a separate postprocessing step.

**Cable-Free Convenience**

To complement the convenience of Trimble's handheld GeoExplorer® 3 system, the BoB differential receiver communicates with that system automatically—with no cabling or accessories whatsoever. There's nothing to connect, nothing to forget, and nothing to carry on your back. Your crews will move faster and incur less downtime due to snagged or broken cables.

**Rugged and Easy to Operate**

No matter where your data collection and update projects take you, the BoB receiver is ready to follow. Shockproof and water-resistant, it will withstand all the rigors of fieldwork, in any weather. Right out of the box the BoB receiver is ready to start working with your Trimble GPS/GIS data collection system. Within seconds of powering on, it automatically selects the best beacon and starts transmitting corrections. If you want to reconfigure the receiver in the field an easy-to-use two-button interface simplifies the process.

**Powerful Software**

For more extensive configurations the versatile PC-BoB office software makes it easy to exclude beacon stations, define custom display names for stations, and configure the initial tracking mode. All in all, the BoB receiver is the most convenient and versatile beacon receiver we've ever developed.

* [illegible]

## Figure C8: Beacon-on-a-Belt (BOB)

# Beacon-on-a-Belt (BoB™)

*Cable-free Differential Correction Receiver*

**FEATURES**

- Dual Channel Minimum Shift Keying (MSK) Differential GPS (DGPS) beacon receiver
- Cable free real time link to the Trimble GeoExplorer 3 mapping system in the United States
- Automatically tracks the strongest or closest beacon signal, or can be fixed to track a specified beacon station
- Rugged, dust, and water resistant housing
- Compact, ergonomic belt mounted design
- Immunity to noise and jamming signals
- All day internal rechargeable battery
- Simple two button/two LED interface
- Full DGPS status in the field via GeoExplorer 3
- Advanced configuration setup via PC BoB software
- Advanced diagnostics via PC BoB software

**HARDWARE SPECIFICATIONS**

| | |
|---|---|
| Size | 20.8 cm (8.1") H x 10.7 cm (4.2") W x 10.7 cm (4.2") D (at antenna) |
| Weight | 1.16 kg (2.56 lbs) |
| Power consumption | 1.5 W |
| Temperature | Operating: −10 °C to +50 °C (+14 °F to +122 °F)<br>Storage: −20 °C to +70 °C (−4 °F to +158 °F) |
| Humidity | Up to 98% non-condensing |
| Port settings | RS-232 at 2400 baud, 8 data bits, 1 stop bit, no parity |

**PERFORMANCE SPECIFICATIONS**

| | |
|---|---|
| Cold start time | <25 seconds typical |
| Warm start time | <10 seconds typical |
| Channels | 2 |
| Frequency | Range: 283.5–325 kHz<br>Spacing: 500 Hz |
| MSK modulation | 50, 100 & 200 b/s autoselection |
| Output protocol | RTCM SC-104 |
| Input protocol | NMEA 0183 |
| Battery life | Up to 10 hours |

**STANDARD ACCESSORIES**

- Belt and holster
- Charging cable for internal battery
- PC BoB software for configuration and diagnostics
- Printed manual and Quick Reference Card
- Curly null modem cable

**OPTIONAL ACCESSORIES**

| | |
|---|---|
| External power kit | Includes camcorder battery, vehicle and camcorder adapters, vehicle splitter cable and soft shoulder pack |

**ORDERING INFORMATION**

| | |
|---|---|
| Beacon-on-a-belt (BoB) | 38000-00-ENG* |
| BoB with GeoExplorer 3 | 38400-00-ENG* |
| BoB with GeoExplorer 3c | 38400-10-ENG* |
| External power kit | 39003-00 |

[illegible]

Trimble

[illegible]

## Figure C9: Trimble GeoXT 2005 Series

DATASHEET

**GeoXT handheld**

**KEY FEATURES**

- High-performance submeter GPS with integrated SBAS and EVEREST multipath technology
- Microsoft Windows Mobile version 5.0 software, allowing maximum flexibility in software choice
- 512 MB onboard memory plus removable SD memory
- Bluetooth and wireless LAN connectivity options
- Rugged handheld with all-day battery
- TrimPix technology for wireless camera support


**THE TOTAL GPS PLATFORM FOR ALL YOUR GIS FIELD REQUIREMENTS**

The GeoXT™ handheld, from Trimble's GeoExplorer® series, is the essential tool for maintaining your GIS. A high performance, submeter GPS receiver combined with a rugged handheld computer, the GeoXT handheld is ideal for use by utility companies, local government organizations, federal agencies, or anyone managing assets or mapping critical infrastructure who needs accurate data to do the job right—the first time.

Delivering consistent submeter accuracy both real-time and postprocessed, the GeoXT handheld is the most dependable submeter solution available. And it's specifically designed with your GIS in mind.

**Real-world submeter performance**

The GeoXT handheld is optimized to provide the reliable, high-accuracy location data when and where you need it. With advanced features like EVEREST™ multipath rejection technology, the GeoXT handheld outputs quality GPS positions even under canopy, in urban canyons, and in all the everyday environments you work in.

If you need submeter accuracy in real-time, you can use corrections from a satellite-based augmentation system (SBAS) like WAAS or EGNOS, or use the integrated Bluetooth® radio to connect to a Trimble® GeoBeacon™ receiver. And if you need that extra edge in precision, you can collect data with Trimble TerraSync™ software or the GPScorrect™ extension for ESRI ArcPad software, and then postprocess back in the office.

**Software to fit your workflow**

The GeoXT handheld comes with a powerful 416 MHz processor running the most advanced operating system available—Microsoft® Windows Mobile® version 5.0 software. Windows Mobile is the industry standard open platform for mobile devices, so you can choose a software solution to match your workflow, whether off-the-shelf or purpose built.

Windows Mobile version 5.0 features familiar Microsoft software, including Word Mobile, Excel Mobile, and Outlook® Mobile, giving you all the tools you need for a seamless exchange of data between the field and the office.

**Built for the field**

The GeoXT handheld has an integrated battery, good for a full day's work; simply charge the battery overnight and you're ready to go again. The GeoXT handheld will last the distance, and its rugged design can take a lot of punishment. Rain, hail, or shine, it's built to keep working, whatever the weather throws at you.

**Convenient connectivity**

With the GeoXT handheld you have the flexibility to work exactly the way you want to. Do you need to access the Internet or your organization's secure network to get the most up-to-date data? No problem—with the GeoXT handheld you have built-in wireless LAN and Bluetooth technology to ensure you stay connected.

Using the built-in wireless LAN and TrimPix™ technology, the GeoXT handheld can connect to a range of Wi-Fi-capable Nikon digital cameras for automated capture of digital images. Download the TrimPix software and you have an ideal solution for easily collecting high resolution digital photos to link to your GPS positions.

**All the memory you need**

There's plenty of storage space in the GeoXT handheld for all your GIS data, and with its fast processor even big graphics files load quickly. Because the GeoXT handheld runs Windows Mobile version 5.0 software, all your data and applications are stored in persistent memory, so your data is completely safe. And with a Secure Digital (SD) memory card slot, you can add gigabytes of memory for all your map data.

**Accuracy you can rely on**

Accurate information is crucial to making informed decisions and improving the way you do business. The GeoXT delivers consistent submeter accuracy both real-time and postprocessed, so you know your GIS has the information that others can depend on to do the job right—this time, next time and every time.

Trimble

## Figure C9: Trimble GeoXT 2005 Series

## Figure C10: Nikon Forestry Pro Laser Rangefinder Specifications

Unit Specifications:


- Magnification: 6.0x
- Objective Lens Diameter: 21mm
- Angle of View: 6°
- Laser Type: Class 1M
- Range: 11-550 yd / 10-500 m
- Exit Pupil Diameter: 3.5 mm
- Eye Relief: 18.2 mm
- Distance Display Increments: [Internal Display]
- Actual Distance: Every 0.5m/yd. or 1.0' out to 100 m/yd or feet<br>1.0 m/yd or 1.0' beyond 100 m/yd or feet
- Horizontal distance and height: 0.2 m/yd or 0.5' up to 100 m/yd or feet<br>1.0 m/yd or 1.0' up to 100 m/yd or feet
- Angle: 0.1° up to 10° / 1° beyond 10°

External Display:

- Actual Distance: 0.5 m/yd or 1.0'<br>Horizontal distance and height: 0.2 m/yd or 0.5'
- Angle: 0.1°
- Weatherproofing: 3.3' (1.0 m) to 10 minutes
- Environment: RoHS/WEEE compliant
- Power Source: (1) CR2 battery
- Dimensions: 5.0 x 2.8 x 1.8" (12.7 x 7.1 x 4.5 cm)
- Weight (Without Batteries): 7.4 oz (209.8 g)

## Figure C11: Bushnell Camera Trap Specifications

| | |
|---|---|
| Model: | 119876 |
| Sensor Resolution | 2, 8, 20MP |
| Images Resolution: | 3MP sensor with 2MP compression and 20MP interpolation |
| Flash: | 48 LEDs No-Glow |
| Flash Range (ft/m): | 100ft/30m |
| Backlit LCD Display: | B&W text LCD |
| Colour: | Brown |
| Battery Type: | AA (8) |
| Battery Life: | up to 12 mo. |
| Video Resolution: | 1920x1080p |
| Infrared Sensor Range: | 80ft / 25m |
| Multi Flash Mode: | Yes |
| Hyper Night Vision: | Yes |
| Field Scan 2x: | Yes |

## Figure C12: Sherman Trap Specifications

Sherman traps are an environmentally friendly way to research small mammal populations and can be used for mammal collection, teaching and environmental impact studies.

Sherman folding traps have the advantage of folding down to a size and shape which is easy to transport. The trap works by use of a trigger platform which causes the door to shut when the animal runs into the trap.

This is a ‘live catch’ trap and should be checked regularly. Where appropriate traps should be provided with water and food.

The Small Folding Aluminum Trap is suitable for trapping small animals such as mice and shrews. The Sherman Trap is available in a range of sizes to suit specific needs as shown below.

| Model | Dimensions / cm | Weight / g |
|---|---|---|
| XLF15 | 10.2 x 11.4 x 38.1 | 544 |
| XLK | 7.6 x 9.5 x 30.5 | 408 |
| LFA | 7.6 x 8.9 x 22.9 | 227 |
| LFAHD | 7.6 x 8.9 x 22.9 | 254 |
| LFATDG | 7.6 x 8.9 x 22.9 | 254 |
| LFG | 7.6 x 8.9 x 22.9 | 363 |

| Model | Dimensions / cm | Weight / g |
|---|---|---|
| SFAL | 5.2 x 6.4 x 22.9 | 159 |
| SFA | 5.2 x 6.4 x 16.5 | 136 |
| SFG | 5.2 x 6.4 x 16.5 | 227 |
| Longworth | 14 x 6.5 x 8.5 | 300 |

## Figure C13: Anabat Express Bat Detector Unit Specifications

The Anabat Express is a compact and weatherproof recorder that is designed to be deployed in the field for several weeks. It will record bat calls which can then be used for species identification or activity monitoring.

Camouflaged and compact, the unit has a weatherproof casing and omni-directional weatherproof microphone with a 1.5m extension cable. An optional five-metre microphone extension cable allows you to position the microphone away from the unit, which makes it easier to site the recorder in an inconspicuous location, or to raise your microphone up to an elevated position when needed.

The Express is powered by 4 x AA batteries. The unit should record for around 14 nights on one set of batteries and up to 30 nights with high quality lithium batteries. Supplied with a padded case, wrist strap, 1.5m microphone extension, a magnet for status checking and USB cable.

Features:

- New, easy-to-use interface for setup & download;
- Weatherproof, camouflaged plastic case (IP67);
- Weatherproof, compact microphone;
- Records temperature and battery voltage;
- Built-in GPS for location, transect tracking, setting the clock and calculating sunset/rise;
- Runs for 14 nights on 4 AA batteries and up to 30 nights with lithium-ion batteries;
- One-touch for continuous, scheduled or night-only recording modes.
  SD card memory and easy downloading.

Specifications:

- Dimensions: (H) 182 x (W) 119 x (D) 43mm;
- Weight: 385g (without batteries)

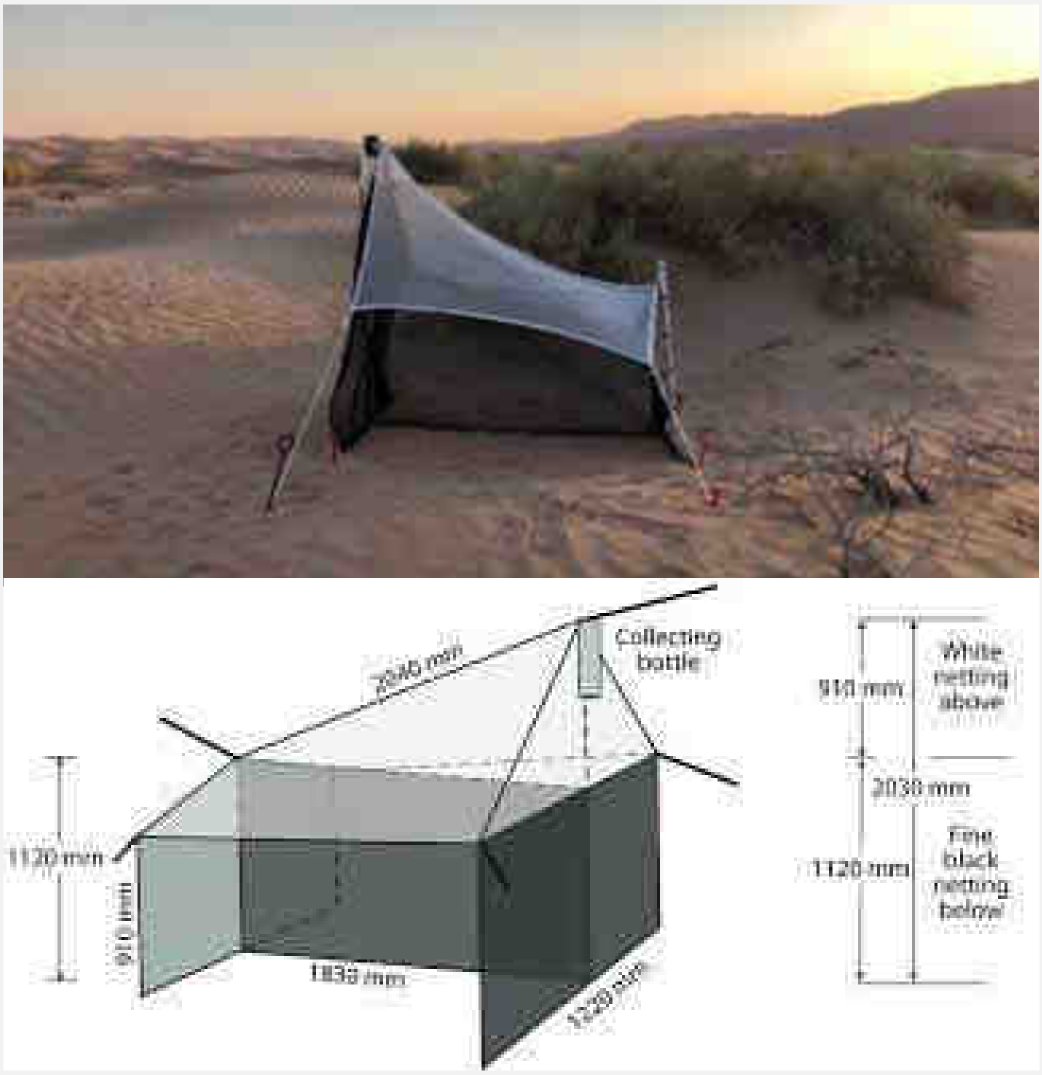
## Figure C14: Malaise Trap Specifications

A malaise trap is a large, tent-like structure used for trapping flying insects, particularly Hymenoptera and Diptera.

The trap is generally made of a material such as terylene netting and can vary in colour. Insects fly into the tent wall and are funnelled into a collecting vessel attached to highest point (see diagram below).

Typical Dimensions; Tall end height = 1.7m; Short end height = 0.9m; Width = 1.15m and Length = 1.88m. The opening is around 12–15 mm (0.47–0.59 in), and can vary according to the size of insect desired.

If using a dry agent, a smaller hole results in a faster death, limiting the amount of damage a newly caught insect can inflict on older, fragile specimens. In ethanol, this is less of a concern. Larger holes can potentially allow in more butterfly, moth and/or dragonfly species.



## Figure C15: RIDGID Micro-inspection Camera (Hole/Burrow Investigations)

The Ridgid 37888 micro CA-300 inspection camera is the next evolution of the SeeSnake micro inspection camera, it allows you to perform more detailed visual inspections in even harder-to-reach areas (see Plate below of an NEA scientist's use in a burrow investigation).

Comfortable pistol-grip design, one-hand controls, and large screen make it easy to detect and diagnose the unreachable. It comes standard with a rugged anodized aluminum camera head with 4 super bright LEDs.

Easily rotate the active image counter-clockwise to see in any situation. This micro CA300 inspection camera provides solutions whenever and wherever you need them. Easily record still images and videos of problems in hard-to-reach areas.

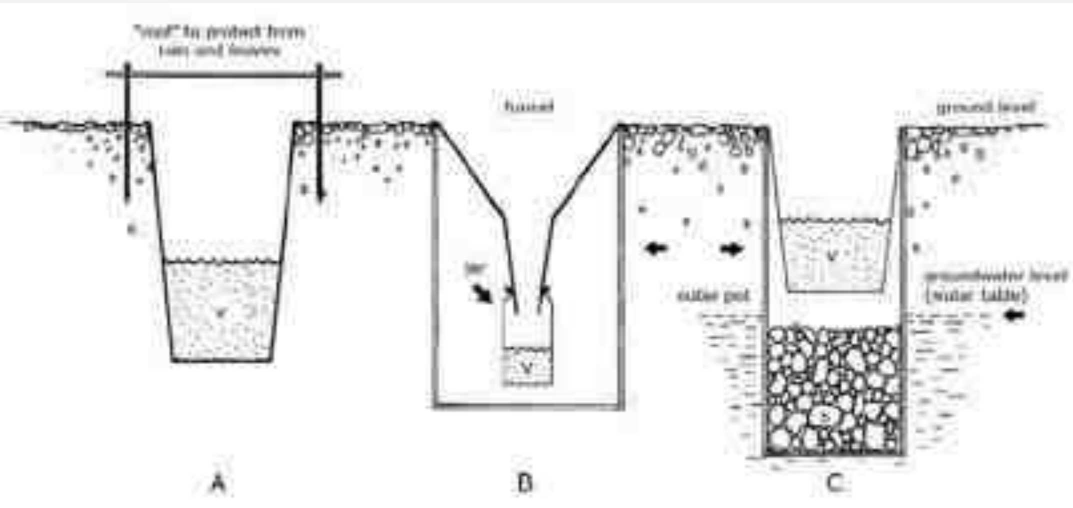
Specifications:

- Item Name: Inspection Camera
- Model: 37888
- SV Code: 291302AAKY3
- Brand: Ridgid
- Resolution: 320 x 240
- Video Output: 3 Feet (90 cm) RCA cable included (640 x 480 resolution)
- Power Supply: 3.7V Li-Ion battery - 5VAC adapter
- Cable Length: 3 Feet (90cm) expandable to 30 Feet (9m) w-optional extensions

## Figure C16: Pitfall Trap Specifications

A pitfall trap is a device used to trap insects that are active on the ground surface. Pitfall traps usually consist of a beaker that is buried so that the lip of the beaker is level with the ground surface. The trap is then left and returned to, at a later date, to inspect 'the catch'.

The diagram below the photograph of an NEA deployment, depicts the several variations of pitfall trap layout, with a recurring theme. Insects reaching the lip of the beaker slip and fall in and are then unable to climb back out. Sometimes alcohol or another substance is poured into the trap so that any insects falling in are killed. The rationale behind this is that predatory insects falling in to the trap will eat the rest of the catch.



## Figure C17: Mavic Pro 2 (Aerial photography/videography)

The Mavic 2 Pro from DJI is a drone that balances power, portability, and professional-quality visuals with the inclusion of a 20MP Hasselblad L1D-20c gimbal camera. The camera delivers a 1" CMOS sensor with an adjustable f/2.8 to f/11 aperture, support for a 10-bit Dlog-M color profile, and 4K 10-bit HDR video capture. The Mavic 2 Pro utilizes a low-drag aerodynamic body design for achieving speeds up to 47.7 mph, a four-cell LiPo battery for up to 31 minutes of flight time, and low-noise propellers for filming without being distracting. This power and performance are coupled with a variety of dynamic shooting modes and other capabilities that help you achieve cinematic results.

- **Item Name:** Mavic Pro 2
- **Model:** 37888
- **SV Code:** 291302AAKY3
- **Brand:** DJI
- **Camera:** Hassleblad 20MP, 1” CMOS, 77° FOV, f/2.8 to f/11
- **Max Video Output:** 4k 10 bit HDR (.MP4, .MOV), 5472 × 3648 Stills (.JPG or .DNG)
- **Power Supply:** 15.4V, 3850 mAh, LiPo 4S
- **Transmission Length:** 8 km (line of sight)

# Appendix 2.3 – Fugro Marine Environmental Baseline Survey Reports

# *Appendix 2.3.1 – Environmental Baseline Survey Results Report – Route 1*

# E-0395 - LIGHTNING PROJECT

# PROVISION OF GEOPHYSICAL, GEOTECHNICAL & ENVIRONMENTAL BASELINE SURVEYS FOR SUBSEA CABLE ROUTES

# ENVIRONMENTAL BASELINE SURVEY RESULTS REPORT - ROUTE 1

| | |
|---|---|
| ADNOC OFFSHORE PROJECT NO. | E-0395 |
| CONTRACTOR DOC TITLE | ENVIRONMENTAL BASELINE SURVEY RESULTS REPORT - ROUTE 1 |
| CONTRACTOR | FUGRO |
| FUGRO PROJECT NO. | OEU021 |

**CONTRACTOR DOC NO: OEU021-V01-Route-1**

| Rev. | Date | Status | Status Description | Prepared | Reviewed | Approved | Company Approval |
|---|---|---|---|---|---|---|---|
| 04 | 16/09/2020 | Final | Issued as Final | B. Wright<br>A. Sutherland<br>J. Kuru<br>T. Sidiropoulos<br>S. Pedicini<br>L.A. Baker<br>J. Greig | S. Brittain<br>G. Harris-Bryant<br>H. George | M. Ramn | DJ. Bouremel |
| 03 | 27/08/2020 | IFR | Issued for Review | S. Whyte | H. George | M. Ramn | DJ. Bouremel |
| 02 | 08/07/2020 | IAP | Preliminary Issue (Issue 2) | H. George | H. George | M. Ramn | DJ. Bouremel |
| 01 | 27/05/2020 | IAP | Preliminary Issue | H. George | H. George | M. Ramn | DJ. Bouremel |

## SUMMARY OF DOCUMENT REVISIONS

| Rev. No. | Date Revised | Section Revised | Revision Description |
|---|---|---|---|
| 01 | 27/05/2020 | IAP | Preliminary Issue |
| 02 | 08/07/2020 | IAP | Preliminary Issue (Issue 2) |
| 03 | 27/08/2020 | IFR | EBS Report, Issued for Review |
| 04 | 16/09/2020 | IAF | EBS Report, Issued as Final |

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| PROJECT DEFINITIONS AND REFERENCES | |
|---|---|
| **PROJECT DEFINITIONS** | |
| PROJECT: | LIGHTNING PROJECT - OFFSHORE GEOPHYSICAL, GEOTECHNICAL & ENVIRONMENTAL BASELINE SURVEYS FOR SUBSEA CABLE ROUTES |
| COMPANY: | Abu Dhabi National Oil Company Offshore (ADNOC Offshore) |
| CLIENT: | Abu Dhabi National Oil Company Offshore (ADNOC Offshore) |
| CONTRACTOR: | FUGRO |
| ADNOC JOB NO: | E-0395 |
| SCOPE OF WORK: | AD41-G-450-023796 and Drawing AD102-450-PLG-80432 |

## ABBREVIATIONS

| | |
|---|---|
| ADNOC | Abu Dhabi Specification |
| BGS | British Geological Survey |
| BOD | Biochemical Oxygen Demand |
| BOT | Near Seabed Water Sample |
| BSL | Below Sea Level |
| BTEX | Benzene, Toluene, Ethylbenzene and Xylene |
| CBD | Convention on Biological Diversity |
| CCC | Criterion Continuous Concentration |
| CCME | Canadian Council of Ministers of the Environment |
| CD | Chart Datum |
| CFU | Coliform Forming Unit |
| CH | Critical Habitats |
| CITES | Convention on International Trade in Endangered Species |
| CM | Central Meridian |
| CMC | Criterion Maximum Concentration |
| COD | Chemical Oxygen Demand |
| CTD | Conductivity, Temperature, Depth |
| DO | Dissolved Oxygen |
| DP | Dynamic Positioning |
| DTI | Department of Trade and Industry |
| DNV | Det Norsk Veritas |
| EAD | Environment Agency–Abu Dhabi |
| EBS | Environmental Baseline Survey |
| EOL | End of Line |
| EPH | Extractable Petroleum Hydrocarbons |
| ERL | Effects Range Low |
| ERM | Effects Range Median |
| ESH | Environmentally Sensitive Habitats |

## ABBREVIATIONS

| | |
|---|---|
| FGBML | Fugro GB Marine Limited |
| GC | Gas Chromatography |
| GC-μECD | Gas Chromatography with micro-Electron Capture Detection |
| GC-FID-HS | Headspace Gas Chromatography with Flame Ionisation Detection |
| GC-MS | Gas Chromatography-Mass Spectrometry |
| HC | Hydrocarbon Sample |
| HM | Heavy Metal Sample |
| HVDC | High Voltage Direct Current |
| ICP–MS | Inductively Coupled Plasma–Mass Spectrometry |
| ICP-OES | Inductively Coupled Plasma-Mass Spectrometry |
| IUCN | International Union of Conservation of Nature |
| KP | Kilometre Point |
| LTDP | Long Term Development Plan |
| MAC | Maximum Allowable Concentration |
| MID | Mid Water Depth Water Sample |
| MLEAD | Marine Life of the Emirate of Abu Dhabi |
| MOCCAE | Ministry of Climate Change and Environment |
| MRV | Minimum Reporting Value |
| MV | Motor Vessel |
| NBSAP | National Biodiversity Strategy and Action Plan |
| ND | Not Detected |
| NDIR | Non-Dispersive Infrared Detection |
| NMBAQC | National Marine Biological Association Quality Control |
| NOAA | National Oceanographic and Atmospheric Administration |
| NPCC | National Petroleum Construction Company |
| NS | No Sample |
| NTU | Nephelometric Turbidity Units |
| QCC | Abu Dhabi Quality and Conformity Council |

## ABBREVIATIONS

| | |
|---|---|
| PAH | Polycyclic Aromatic Hydrocarbon |
| PC | Physico-chemical Sample |
| PCB | Polychlorinated Biphenyl |
| PSA | Particle Size Analysis |
| PSD | Particle Size Distribution |
| ppt | Parts Per Thousand |
| PSU | Practical Salinity Unit |
| RSD | Relative Standard Deviation |
| SD | Standard Deviation |
| SLMXD | Sublittoral Mixed Deposit |
| SLSED | Sublittoral Sediment |
| SOL | Start of Line |
| SoW | Scope of Work |
| SSS | Side Scan Sonar |
| TDS | Total Dissolved Solids |
| THC | Total Hydrocarbon Content |
| TOC | Total Organic Carbon |
| TOP | Surface Water Sample |
| TSS | Total Suspended Solids |
| UAE | United Arab Emirates |
| UNEP | United Nations Environment Programme |
| US EPA | United States Environmental Protection Agency |
| UTC | Coordinated Universal Time |
| UTM | Universal Transverse Mercator |
| UV | Ultra Violet |
| VPH | Volatile Petroleum Hydrocarbons |
| VV | Single Van Veen Grab |
| WCMC | World Conservation Monitoring Centre |

## ABBREVIATIONS

| | |
|---|---|
| WGS84 | World Geodetic System 1984 |
| WHO | World Health Organisation |
| WP | Water Profile |
| WS | Water Sample |
| ? | Identification of a Taxon Not Certain |

# Document Control

## Document Information

| | |
|---|---|
| ADNOC Offshore Project No. | E-0395 |
| Project Title | Lightning Project - Provision of Geophysical, Geotechnical, and Environmental Baseline Surveys for Subsea Cable Routes |
| Document Title | EBS Survey Results Report    Route 1 |
| Fugro Project No. | OEU021 |
| Fugro Document No. | OEU021-V01-Route-1 |
| Issue Number | 04 |
| Issue Status | Issued for Review |

## Client Information

| | |
|---|---|
| Client | Abu Dhabi National Oil Company for Offshore Oil Operations (ADNOC Offshore) |
| Client Address | PO Box 303, Abu Dhabi, U.A.E. |
| Client Contact | Mr. Djaafar Bouremel |
| Client Document No. | AD41-457-G-24202 |

## Revision History

| Issue | Date | Status | Comments on Content | Prepared By | Checked By | Approved By |
|---|---|---|---|---|---|---|
| 01 | 27 May 2020 | Preliminary | For Review | HG | HG | MR |
| 02 | 08 July 2020 | Preliminary (Issue 2) | For Review | HG | HG | MR |
| 03 | 27 August 2020 | IFR | For Review | SGW | HG | SW/MR |
| 04 | 15 September 2020 | Final | Final | BW/AIS/JKK/TXS/LAB/JSG/SXP | SRB/GHB/HG | MR |


GENERAL LOCATION MAP

# Summary of Survey Results

### Introduction

Fugro was contracted by ADNOC Offshore (Client) for the conduct of bathymetric, geotechnical and geophysical investigations and environmental baseline surveys (EBS) along two proposed cable routes. Proposed Route 1 will connect Lower Zakum Island G to Mirfa and Route 2 will connect Umm Shaif LTDP Island to Shuweihat, within the Zakum Field and the Umm Shaif field, respectively.

### Survey Strategy

The EBS was designed to characterise the water column and seabed sediments at 130 stations along the vicinity of Route 1. Water column profiles were taken to characterise water column physical parameters. Water column samples were taken for physico-chemical analysis. Seabed sediment and soil samples were taken for physico-chemical analysis, whereas seabed photographic data were obtained to characterise benthic habitats and epifauna.

Water samples were acquired from all proposed stations. A complete suite of physico-chemical sediment sub-samples was acquired at 60 stations and partial suite of samples at 12 stations. Photographic still and video data were successfully acquired along all proposed camera transects. Soil samples were acquired at nine out of the seventeen proposed stations.

### Water Column Profiles

No major stratification was present in the water columns. Temperature, salinity, turbidity, dissolved oxygen content and pH remained generally constant throughout the water column at all stations. Differences displayed between stations were considered to be representative of ambient seawater conditions for the region and season across all parameters.

### Inorganic Water Quality Parameters

The majority of inorganic water quality parameters (total suspended solids (TSS), ammonia, ammonium, silicon, sulphide, nitrite, total phosphorus, orthophosphate, chemical oxygen demand (COD), biochemical oxygen demand (BOD) and total coliform) were below their respective minimum reporting values (MRVs) at all stations across the survey area. Most parameters with values greater than the MRV (pH, total dissolved solids (TDS), sulphate, chloride and total organic carbon (TOC), total nitrogen, total cyanide, nitrate, nitrite, total phosphorus, turbidity) were considered to be of no environmental concern.

**Water Column Hydrocarbons**

Concentrations of volatile petroleum hydrocarbons, extractable petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene and xylene (BTEX) and phenols were below their respective minimum reporting values in all samples obtained, and unlikely to be of environmental concern. Naphthalene, phenanthrene and pyrene concentrations recorded at a limited number of stations exceeded their respective MRVs, but they were considered unlikely to be of environmental concern. Benzene, toluene and ethylbenzene were below the Canadian Council of Ministers of the Environment (CCME) guideline values and considered to be representative of background conditions.

**Water Column Metals**

Chromium, copper, lead and zinc, concentrations exceeded their respective Abu Dhabi Specification (ADS) 18/2017 Ambient Marine Water Standards Maximum Allowable Concentration (MAC) for both general use areas and marine protected areas (QCC, 2017) in 100, 17, 31 and 129 samples respectively. Copper and lead concentrations exceeded the United States Environmental Protection Agency (US EPA) criterion continuous concentration (CCC) in 16 and 4 samples, respectively. Copper and zinc concentrations exceeded the US EPA criterion maximum concentration (CMC; US EPA, 2020) in 8 and 5 samples, respectively. Except for chromium, copper, lead and zinc, concentrations of all major and trace elements were below their respective ADS 18/2017 MACs, where available, as well as the US EPA CCC and CMC values and considered to be of no environmental concern.

**Sediment Characterisation**

Using the Wentworth (1922) sediment description, stations across the Route 1 survey area comprised coarse sand to fine silt. High interstation variability was demonstrated for all fractional composition parameters, except for sand which showed moderate variability.

**Sediment Nutrients**

All sediment concentrations across the Route 1 survey area demonstrated low to moderate variation. No spatial patterns were observed, indicating broadly homogenous sediments within the region.

**Sediment Hydrocarbons**

Concentrations of total hydrocarbon content were considered as typical for the region as they were comparable to concentrations previously recorded around non-industrialised coastal environments distant from hydrocarbon inputs. The concentrations of BTEX and individual PAHs were below their respective MRVs at all stations across the Route 1 survey area. Total sediment PAH concentrations were below the ADS 18/2017 MAC and are therefore unlikely to harm the sediment macrofauna.

**Sediment Polychlorinated Biphenyls**

The concentrations of polychlorinated biphenyls (PCBs) were below the method MRV (0.020 ng/g) at most stations across the Route 1 survey area. All total PCB concentrations were below the ADS 18/2017 MAC.

**Sediment Metals**

All sediment metals concentrations across the survey area were below their respective US National Oceanographic and Atmospheric Administration (NOAA) effects range low (ERL) and effects range median (ERM) threshold values. With the exception of chromium, lead and nickel, concentrations of all sediment metals were below their respective ADS 18/2017 MAC for both general use areas and marine protected areas. Concentrations of chromium and nickel exceeded the ADS 18/2017 MAC (QCC, 2017) for marine protected areas at numerous stations and lead at one station. Nickel concentrations also exceeded the ADS 18/2017 MAC (QCC, 2017) for general use areas at 4 stations. There was no clear spatial distribution pattern that would indicate a point source related to possible anthropogenic activities within the survey area, and the differences recorded are therefore most likely to be associated with natural sediment variations.

**Seabed Habitats and Epifauna**

Within the survey area, three distinct seabed habitats were identified under Marine Life of the Emirate of Abu Dhabi (MLEAD) (John & George, 2001) and Environment Agency–Abu Dhabi (EAD; Al Dhaheri et al., 2017) habitat classifications.

‘Sublittoral mixed deposit’ (SLMXD)/“13,000 - Hard bottom” habitat comprised a mainly flat substratum of calcarenite (cemented sand), covered by a veneer of sand sediment, with occasional coral outcrops mainly including finger corals (Porites sp.) and boulder corals (Faviidae).

‘Sublittoral sediment’ (SLSED)/“14,000 – Unconsolidated bottom” habitat comprised predominantly sand sediment, with varying proportions of gravel and shell and coral fragments.

‘Seagrass bed’/“12,000 - Seagrass bed” habitat comprised predominantly sand sediment, colonised by varying densities of the seagrasses *Halodule uninervis*, Halophila ovalis and *Halophila stipulacea*.

# Survey Deliverables

| Document Description | ADNOC Document No. | Fugro Document No. |
|---|---|---|
| **EBS Results Report – Route 1** | **AD41-457-G-24202** | **OEU021-V01-Route-1** |
| EBS Results Report Route 2 | AD41-457-G-24203 | OEU021-V02-Route-2 |

# Contents

# Appendices

# Tables in the Main Text

# Figures in the Main Text



# Tables in the Appendices

# 1. Introduction

## 1.1 General

Fugro was contracted by ADNOC Offshore (Client) to provide bathymetric, geotechnical and geophysical investigations and environmental baseline surveys (EBS) along two proposed cable routes. This project consists of the development of two independent sub-sea high voltage direct current (HVDC) transmission links complete with onshore and offshore HVDC converter stations in the Emirate of Abu Dhabi. Cable Route 1 will connect Lower Zakum Island G to Mirfa and Route 2 will connect Umm Shaif Long Term Development Plan (LTDP) Island to Shuweihat, within the Zakum field and the Umm Shaif field, respectively.

Offshore survey operations were carried out by the MV DMS Challenger, a non-Dynamic Positioning (DP) vessel on a 24-hour basis, and the Fugro owned and operated survey launch small boat ‘Thea’ on a daylight only basis. The MV DMS Challenger acted as the mother vessel for the survey launch. Nearshore field operations were carried out onboard a nearshore vessel of opportunity on a daylight only basis.

This document, AD41-457-G-24202, details the results of the EBS undertaken at the proposed Route 1 location. Survey operations were undertaken between 14 April and 20 June 2020.

All survey-related works were carried out in accordance with client requirements and Fugro’s standing Survey Work Practices.

## 1.2 Scope of Work

The scopes of work (SoW) for the EBS surveys are detailed in Fugro document P158874 Lightning EBS SoW, Rev.2, 7 May 2020, which covers the methods to be employed to conduct the environmental surveys for Project Lightning.

The EBS was designed to characterise the water column and seabed sediments at 130 stations, including a reference station, along the vicinity of Route 1. This was proposed to be achieved through collection of the following samples and data:

- Water column profiles to characterise water column physical parameters;
- Water column samples for physico-chemical and biological analysis;
- Seabed sediment samples for physico-chemical analysis;
- Seabed photographic data to characterise benthic habitats and epifauna.

## 1.3 Units and Conversion Parameters

### 1.3.1 Units

- Coordinates are expressed in metres [m];

- Linear measurements are expressed in metres [m];
- Angular units are expressed in degrees [º].

### 1.3.2 Geodetic and Projection Parameters

All coordinates detailed in this report are referenced to the Nahrwan (1967) datum, Universal Transverse Mercator (UTM) projection Zone 39N, central meridian 51° East (CM 51° E). Table 1.1 provides the detailed geodetic and projection parameters.

Table 1.1: Geodetic and projection parameters (Fugro Starfix NG navigation format)

| | | | | | |
|---|---|---|---|---|---|
| **Global Positioning Geodetic Coordinate Reference System Parameters*** | | | | | |
| Datum: | | WGS84 (ITRF 2000) | | Epoch 2000.0 | |
| Ellipsoid: | | WGS84 | | EPSG Code 6326 | |
| Semi-major Axis: | | a = 6 378 137.000 0 m | | | |
| Semi-minor Axis: | | b = 6 356 752.314 2 m | | | |
| Inverse Flattening: | | 1/f = 298.257 223 6 | | | |
| **Local Datum Geodetic Coordinate Reference System Parameters†** | | | | | |
| Datum: | | Nahrwan 1967 | | EPSG: 6270 | |
| Ellipsoid: | | Clarke 1880 (Mod) | | EPSG: 7012 | |
| Semi-major Axis: | | a = 6 378 249.145 m | | | |
| Semi-minor Axis: | | b = 6 356 514.870 m | | | |
| Inverse Flattening: | | 1/f = 293.465 000 0 | | | |
| **Datum Transformation Parameters from WGS84 to Nahrwan 1967‡** | | | | | |
| X-axis Translation | + 233.4 m | X-axis Rotation | 0.00 arcsec | Scale Difference: | 0.2263 ppm |
| Y-axis Translation | + 160.7 m | Y-axis Rotation | 0.00 arcsec | | |
| Z-axis Translation | 381.5 m | Z-axis Rotation | 0.554 arcsec | Fugro Code: | 41231 |
| **Local Projection Parameters** | | | | | |
| Map Projection: | | Universal Transverse Mercator | | EPSG Code 16039 | |
| Grid System: | | UTM Zone 39 N | | | |
| Central Meridian: | | | | | |
| Latitude of Origin: | | | | | |
| False Easting: | | 500 000 m | | | |
| False Northing: | | 0 m | | | |
| Scale Factor on Central Meridian: | | 0.9996 | | | |
| Units: | | Metre | | | |

Notes
* = Fugro Starfix navigation software always uses WGS84 as the primary datum for any geodetic calculations
† = ADNOC Offshore Technical Standard A0-ENG-Y-SP-001 (Rev.0)
‡ = Right-handed coordinate frame rotation convention used by Fugro Starfix navigation software

### 1.3.3 Vertical Datum

All water depths on charts are reduced to Chart Datum (CD) using predicted tides. Water depths measured while using sampling equipment, such as the drop-down camera and in situ water profiler, are depths below sea level (BSL).

### 1.3.4 Time

All survey data were logged in Coordinated Universal Time (UTC). United Arab Emirates local time is UTC + 4 hours.

## 1.4 Background Information

The Arabian Gulf is a semi-enclosed marginal sea, connected to the Gulf of Oman through the 56 km Strait of Hormuz (Chao et al., 1992). Several biotopes of potential ecological importance are known to occur in the Arabian Gulf, within the region of the Hail and Mubarraz Islands.

Coral communities of the Arabian Gulf occur in two main forms: patch or platform reefs in shallow water, and as fringing reefs around offshore islands and bathymetric highs. Coral reefs support high abundances of a diverse array of fauna. They act as nurseries for commercial fish species and provide shoreline protection from erosion and inundation during storms (Environment Agency-Abu Dhabi [EAD], 2008).

Coral reefs in the Arabian Gulf are often patchy in nature, which is reported to be attributed to high rates of sedimentation, and a lack of suitable substrate. The corals of the Arabian Gulf are also species poor when compared to communities in other areas of the world (John & George, 2001). John and George (1998) observed that extremely high sea water temperatures, recorded during El Niño events in 1996 and 1998, were primarily responsible for the coral bleaching and subsequent mass mortality of coral in this part of the world. Coral reefs in the Arabian Gulf are also subject to very high salinity levels, typically 40 parts per thousand (ppt), to 50 ppt, but sometimes up to 60 ppt (John & George, 2001), which add to the rigors of this habitat.

Approximately 540 species of coral are reported to exist in the Arabian Gulf (Basson et al., 1977). The shallow water reefs contain large areas of Acropora with under stories of *Porites, Platygyra* and *Favia* spp. at depths of 1 m to 4 m. Deeper waters are dominated by large *Porites* colonies, with an under story of *Acropora* (John & George, 2001; Riegl, 2001; Rezai et al., 2004).

Sheppard et al. (2010) reported changes to the extent of natural marine habitats in the Arabian Gulf and general deterioration of their condition. The authors report this is due to a combination of natural stressors (high temperatures and salinity), the rapid development of the region and lack of cross border collaboration to mitigate environmental impacts.

In the Arabian Gulf only three species of seagrass can tolerate the seasonal variations of water temperature and salinity (*Halodule uninervis, Halophila stipulacea* and *Halophila ovalis*). These seagrasses are important as they support the world's second largest population of dugongs (Erftemeijer & Shuail, 2012). These seagrasses develop in deep soft sediment and encourage sedimentation, leading to the stabilisation of an area for other species to colonise the fine sediment (John & George, 2001).

Macroalgae communities are unable to grow on living corals and are found in shallow areas where corals reef coverage is lower. Where coral reefs dominate an area the brown algae *Lobophora variegata*, hard red coralline algae (Corallinales) and turf algae are found on surrounding rock or damaged/dead corals (John & George, 2001). These areas of macroalgae, coralline algae and turf algae have increased with the demise of the corals (John & George, 2001).

## 1.5 Environmental Legislation

Several Federal laws and policies regarding the protection of the marine and coastal environment are in place in the UAE. The primary legislation for environmental protection in the UAE is Federal Law No. 24 of 1999 for the environment protection and development of the environment which relates to environmental protection and development, pollution control, conservation of biodiversity, sustainable exploitation and compliance with international and regional conventions.

Other laws relevant to environmental issues are:

- Federal Law 9 was introduced in 1983 in response to a marked decline in desert and marine species in the UAE and regulates the hunting and gathering of various species including the dugong and several seabirds;
- Federal law 23 on the exploitation, protection and development of marine biological resources was introduced in 1999 to regulate fisheries and mitigate overfishing;
- Federal Laws 11 of 2002 and 16 of 2007 respectively regard the regulation and control of international trade in endangered species of wild flora and fauna animal protection. In addition to the latter, an executive order was issued by the Council of Ministers Decree No. 22 of 2003.

A number of international conventions involving the environment also apply in the UAE. Among these, the Convention on Biological Diversity (CBD) is the single most important multi-lateral framework for the conservation of biodiversity. To ensure its implementation, the National Biodiversity Strategy and Action Plan (NBSAP) has been developed to implement global commitment through local actions. The objectives and targets of the Biodiversity Strategy are aligned to the National Biodiversity Strategy and Action Plan 2014 to 2021, which was developed by the Ministry of Climate Change and Environment (MOCCAE) (Al Dhaheri et al., 2017). In 1990, the Convention on International Trade in Endangered Species of Fauna and Flora (CITES), which prevents the trade of listed threatened species such as the dugong (United Nations Environment Programme World Conservation Monitoring Centre [UNEP-WCMC], 2014), was also applied in UAE.

In line with the Emirate's commitment to sustainable development and to implementing an ecosystem approach to biodiversity conservation, the EAD has identified 12 critical habitats (CH) and 8 environmentally sensitive habitats (ESH) within Abu Dhabi Emirate (QCC, 2017). The classification of these habitats as 'critical' or 'environmentally sensitive' is based on the importance of the habitat and its threat status as outlined in the International Union of Conservation of Nature (IUCN) Red List of Ecosystems Criteria for assessing the risk of ecosystem collapse (IUCN, 2020).

Table 1.2 provides a list of sensitive habitats that may occur within the current survey area, along with their designation. Figure 1.1 spatially displays the marine protected areas of Abu Dhabi in relation to the Route 1 survey area.

Table 1.2: Potential sensitive species and habitats, Route 1

| Species/Habitat | Habitat Classification Manual Code (2015) | Description | Designation/Status |
|---|---|---|---|
| Coral reef | 11,000 | Areas characterized by a substrate or environmental setting largely constructed by the reef-building activities of corals and associated organisms | Critical habitat |
| Seagrass | 12,000 | Subtidal benthic substrates, generally composed of unconsolidated sediments, and characterised by greater than 10 % cover of rooted vascular seagrass species | Critical habitat |
| Algae communities | 13,010 | Seaweeds (macro algae) that are found either in combination with seagrass and reef communities or in a separate community aggregation | Environmentally sensitive |


Figure 1.1: Protected areas relevant to the survey area, Route 1

## 1.6 Regional Standards and Comparable Studies

Sediments and water sample data were compared to the Abu Dhabi Specification ADS 18/2017 Ambient Marine Water and Sediments Maximum Allowable Concentrations (MAC) (QCC, 2017).

Additionally, water sample data were also compared to the internationally recognised United States Environmental Protection Agency (US EPA) criterion continuous concentration (CCC) and criterion maximum concentration (CMC) values (US EPA, 2020), where available. Benzene, toluene, ethylbenzene and xylene (BTEX) concentrations were compared to the Canadian Council of Ministers of the Environment (CCME) Marine Long Term Water Quality Guidelines for the Protection of Aquatic Life values (CCME, 2020).

Sediment sample data were compared to US National Oceanographic and Atmospheric Administration (NOAA) effects range low (ERL) values (Buchman, 2008). Detrimental effects are rarely observed in biota when concentrations are below these values.

# 2. Environmental Survey Methods

## 2.1 Survey Strategy

The survey strategy comprised the acquisition of seabed video data to assess the benthic habitats and communities present in the survey area. Sediment sampling (including soil samples taken every 8 km along the proposed route) was to be undertaken to determine the physico-chemical properties of the marine sediments. Water column sampling and water profiling was undertaken to assess water column physico-chemistry at the time of sampling.

Eleven transects were proposed along Route 1. Acquisition of seabed video data was required to assess the benthic habitats and communities.

Tables 2.1 to 2.3 provide the coordinates, data to be acquired and rationale for each location, Figure 2.1 a and b provide a spatial display of the proposed survey positions.

Table 2.1: Proposed camera transects, Route 1

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | |
|---|---|---|---|---|---|
| Station | Point on Line | Easting [m] | Northing [m] | Rationale | Data Acquisition |
| R1_TR01 | SOL | 760 179.2 | 2 671 403.9 | Transition on slope from lower area to shallower area up slope. Area of mottled bathymetry surface | Video and stills |
| | EOL | 760 273.9 | 2 671 448.8 | | |
| R1_TR02 | SOL | 762 897.0 | 2 672 216.3 | Shallow area of survey corridor with uneven bathymetric surface. Shallowest point with a depression at centre | Video and stills |
| | EOL | 762 782.8 | 2 672 177.5 | | |
| R1_TR03 | SOL | 764 845.6 | 2 673 959.7 | Running across deeper area across shallow area with uneven bathymetric surface | Video and stills |
| | EOL | 764 727.5 | 2 673 927.2 | | |
| R1_TR04 | SOL | 764 987.8 | 2 675 363.7 | Mound in the deeper area of the survey corridor, possible coral | Video and stills |
| | EOL | 765 082.0 | 2 675 363.3 | | |
| R1_TR04B | SOL | 788 820.3 | 2 711 668.3 | Selected for coverage of a slight bathymetric trough with higher reflectivity and to give coverage on route as alternative to R1_TR04 | Video and stills |
| | EOL | 788 932.0 | 2 711 776.1 | | |
| R1_TR05 | SOL | 771 193.4 | 2 689 055.8 | Chosen for ground truthing in area of higher reflectivity sediments to cover Route 1B | Video and stills |
| | EOL | 771 217.7 | 2 689 171.2 | | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | |
|---|---|---|---|---|---|
| Station | Point on Line | Easting [m] | Northing [m] | Rationale | Data Acquisition |
| R1_TR06 | SOL | 777 401.5 | 2 701 779.7 | Depth change and sediment boundary | Video and stills |
| | EOL | 777 340.1 | 2 701 657.1 | | |
| R1_TR07 | SOL | 793 049.3 | 2 722 052.6 | Depth change and sediment boundary, as well as being located within the deepest part of the route | Video and stills |
| | EOL | 792 993.1 | 2 722 185.4 | | |
| R1_TR08 | SOL | 791 645.3 | 2 713 424.6 | Reference station chosen by ADNOC | Video and stills |
| | EOL | 791 736.9 | 2 713 316.5 | | |
| R1_TR09 | SOL | 786 713.4 | 2 744 250.3 | Patches of higher reflectivity chosen by geophysicist interpreted to be possible gas discharges from sediments | Video and stills |
| | EOL | 786 810.6 | 2 744 305.3 | | |
| R1_TR10 | SOL | 779 346.7 | 2 761 563.9 | Chosen for ground-truthing of hard area where low sample retention was observed. | Video and stills |
| | EOL | 779 443.5 | 2 761 547.3 | | |
| Notes<br>SOL = Start of line<br>EOL = End of line | | | | | |

Table 2.2: Proposed environmental sampling stations, Route 1

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Rationale | Data/Sample Acquisition |
| R1_ENV_001 | 751 800.5 | 2 669 184.1 | Approx. KP 1.000 | PC, WP, WS |
| R1_ENV_002 | 752 765.9 | 2 669 444.8 | Approx. KP 2.000 | PC, WP, WS |
| R1_ENV_003 | 753 732.2 | 2 669 702.4 | Approx. KP 3.000 | PC, WP, WS |
| R1_ENV_004 | 754 698.0 | 2 669 961.5 | Approx. KP 4.000 | PC, WP, WS |
| R1_ENV_005 | 755 664.9 | 2 670 216.9 | Approx. KP 5.000 | PC, WP, WS |
| R1_ENV_006 | 756 631.1 | 2 670 474.6 | Approx. KP 6.000 | PC, WP, WS |
| R1_ENV_007 | 757 597.3 | 2 670 732.2 | Approx. KP 7.000 | PC, WP, WS |
| R1_ENV_008 | 758 565.9 | 2 670 981.4 | Approx. KP 8.000 | PC, WP, WS |
| R1_ENV_009 | 759 529.8 | 2 671 247.5 | Approx. KP 9.000 | PC, WP, WS |
| R1_ENV_010 | 760 496.1 | 2 671 505.1 | Approx. KP 10.000 | PC, WP, WS |
| R1_ENV_011 | 761 468.0 | 2 671 740.2 | Approx. KP 11.000 | PC, WP, WS |
| R1_ENV_012 | 762 431.8 | 2 672 008.6 | Approx. KP 12.000 | PC, WP, WS |
| R1_ENV_013 | 763 402.3 | 2 672 259.4 | Approx. KP 13.000 | PC, WP, WS |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Rationale | Data/Sample Acquisition |
| R1_ENV_014 | 764 370.7 | 2 672 508.5 | Approx. KP 14.000 | PC, WP, WS |
| R1_ENV_015 | 764 666.3 | 2 673 463.8 | Approx. KP 15.000 | PC, WP, WS |
| R1_ENV_016 | 764 873.6 | 2 674 442.1 | Approx. KP 16.000 | PC, WP, WS |
| R1_ENV_017 | 765 082.2 | 2 675 420.1 | Approx. KP 17.000 | PC, WP, WS |
| R1_ENV_018 | 765 298.5 | 2 676 396.5 | Approx. KP 18.000 | PC, WP, WS |
| R1_ENV_019 | 765 502.2 | 2 677 375.5 | Approx. KP 19.000 | PC, WP, WS |
| R1_ENV_020 | 765 711.4 | 2 678 353.4 | Approx. KP 20.000 | PC, WP, WS |
| R1_ENV_021 | 766 221.4 | 2 679 183.1 | Approx. KP 21.000 | PC, WP, WS |
| R1_ENV_022 | 766 890.2 | 2 679 926.5 | Approx. KP 22.000 | PC, WP, WS |
| R1_ENV_023 | 767 564.6 | 2 680 664.9 | Approx. KP 23.000 | PC, WP, WS |
| R1_ENV_024 | 768 867.9 | 2 681 362.2 | Approx. KP 24.000 | PC, WP, WS |
| R1_ENV_025 | 768 797.8 | 2 682 774.6 | Approx. KP 25.000 | PC, WP, WS |
| R1_ENV_026 | 770 226.2 | 2 683 071.7 | Approx. KP 26.000 | PC, WP, WS |
| R1_ENV_027 | 769 598.4 | 2 684 338.9 | Approx. KP 27.000 | PC, WP, WS |
| R1_ENV_028 | 770 865.6 | 2 684 966.7 | Approx. KP 28.000 | PC, WP, WS |
| R1_ENV_029 | 770 237.8 | 2 686 233.9 | Approx. KP 29.000 | PC, WP, WS |
| R1_ENV_030 | 771 505.1 | 2 686 861.7 | Approx. KP 30.000 | PC, WP, WS |
| R1_ENV_031 | 770 877.3 | 2 688 128.9 | Approx. KP 31.000 | PC, WP, WS |
| R1_ENV_032 | 772 144.5 | 2 688 756.7 | Approx. KP 32.000 | PC, WP, WS |
| R1_ENV_033 | 771 516.7 | 2 690 024.0 | Approx. KP 33.000 | PC, WP, WS |
| R1_ENV_034 | 772 783.5 | 2 690 650.6 | Approx. KP 34.000 | PC, WP, WS |
| R1_ENV_035 | 772 156.1 | 2 691 919.0 | Approx. KP 35.000 | PC, WP, WS |
| R1_ENV_036 | 773 423.4 | 2 692 546.8 | Approx. KP 36.000 | PC, WP, WS |
| R1_ENV_037 | 772 795.6 | 2 693 814.0 | Approx. KP 37.000 | PC, WP, WS |
| R1_ENV_038 | 774 062.8 | 2 694 441.8 | Approx. KP 38.000 | PC, WP, WS |
| R1_ENV_039 | 773 435.0 | 2 695 709.1 | Approx. KP 39.000 | PC, WP, WS |
| R1_ENV_040 | 774 702.2 | 2 696 336.8 | Approx. KP 40.000 | PC, WP, WS |
| R1_ENV_041 | 774 074.4 | 2 697 604.1 | Approx. KP 41.000 | PC, WP, WS |
| R1_ENV_042 | 775 341.7 | 2 698 231.9 | Approx. KP 42.000 | PC, WP, WS |
| R1_ENV_043 | 774 713.9 | 2 699 499.1 | Approx. KP 43.000 | PC, WP, WS |
| R1_ENV_044 | 775 981.1 | 2 700 126.9 | Approx. KP 44.000 | PC, WP, WS |
| R1_ENV_045 | 775 622.5 | 2 701 529.6 | Approx. KP 45.000 | PC, WP, WS |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Rationale | Data/Sample Acquisition |
| R1_ENV_046 | 777 033.2 | 2 701 428.9 | Approx. KP 46.000 | PC, WP, WS |
| R1_ENV_047 | 777 133.9 | 2 702 839.5 | Approx. KP 47.000 | PC, WP, WS |
| R1_ENV_048 | 778 544.5 | 2 702 738.8 | Approx. KP 48.000 | PC, WP, WS |
| R1_ENV_049 | 778 638.4 | 2 704 157.3 | Approx. KP 49.000 | PC, WP, WS |
| R1_ENV_050 | 780 062.6 | 2 704 040.9 | Approx. KP 50.000 | PC, WP, WS |
| R1_ENV_051 | 780 156.5 | 2 705 459.4 | Approx. KP 51.000 | PC, WP, WS |
| R1_ENV_052 | 781 567.1 | 2 705 358.7 | Approx. KP 52.000 | PC, WP, WS |
| R1_ENV_053 | 781 667.8 | 2 706 769.3 | Approx. KP 53.000 | PC, WP, WS |
| R1_ENV_054 | 783 078.5 | 2 706 668.6 | Approx. KP 54.000 | PC, WP, WS |
| R1_ENV_055 | 783 179.2 | 2 708 079.2 | Approx. KP 55.000 | PC, WP, WS |
| R1_ENV_056 | 784 589.8 | 2 707 978.5 | Approx. KP 56.000 | PC, WP, WS |
| R1_ENV_057 | 784 690.5 | 2 709 389.1 | Approx. KP 57.000 | PC, WP, WS |
| R1_ENV_058 | 786 101.1 | 2 709 288.4 | Approx. KP 58.000 | PC, WP, WS |
| R1_ENV_059 | 786 201.8 | 2 710 699.1 | Approx. KP 59.000 | PC, WP, WS |
| R1_ENV_060 | 787 612.4 | 2 710 598.3 | Approx. KP 60.000 | PC, WP, WS |
| R1_ENV_061 | 787 713.1 | 2 712 009.0 | Approx. KP 61.000 | PC, WP, WS |
| R1_ENV_062 | 789 123.8 | 2 711 908.3 | Approx. KP 62.000 | PC, WP, WS |
| R1_ENV_063 | 789 224.5 | 2 713 318.9 | Approx. KP 63.000 | PC, WP, WS |
| R1_ENV_064 | 790 729.0 | 2 713 506.2 | Approx. KP 64.000 | PC, WP, WS |
| R1_ENV_065 | 790 019.4 | 2 714 729.5 | Approx. KP 65.000 | PC, WP, WS |
| R1_ENV_066 | 791 242.6 | 2 715 439.1 | Approx. KP 66.000 | PC, WP, WS |
| R1_ENV_067 | 790 533.0 | 2 716 662.4 | Approx. KP 67.000 | PC, WP, WS |
| R1_ENV_068 | 791 756.3 | 2 717 372.1 | Approx. KP 68.000 | PC, WP, WS |
| R1_ENV_069 | 791 046.6 | 2 718 595.3 | Approx. KP 69.000 | PC, WP, WS |
| R1_ENV_070 | 792 269.9 | 2 719 305.0 | Approx. KP 70.000 | PC, WP, WS |
| R1_ENV_071 | 791 560.3 | 2 720 528.3 | Approx. KP 71.000 | PC, WP, WS |
| R1_ENV_072 | 792 783.6 | 2 721 237.9 | Approx. KP 72.000 | PC, WP, WS |
| R1_ENV_073 | 792 073.9 | 2 722 461.2 | Approx. KP 73.000 | PC, WP, WS |
| R1_ENV_074 | 793 197.5 | 2 723 445.7 | Approx. KP 74.000 | PC, WP, WS |
| R1_ENV_075 | 791 945.8 | 2 724 103.8 | Approx. KP 75.000 | PC, WP, WS |
| R1_ENV_076 | 792 603.9 | 2 725 355.6 | Approx. KP 76.000 | PC, WP, WS |
| R1_ENV_077 | 791 352.1 | 2 726 013.7 | Approx. KP 77.000 | PC, WP, WS |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Rationale | Data/Sample Acquisition |
| R1_ENV_078 | 792 010.3 | 2 727 265.4 | Approx. KP 78.000 | PC, WP, WS |
| R1_ENV_079 | 790 758.5 | 2 727 923.5 | Approx. KP 79.000 | PC, WP, WS |
| R1_ENV_080 | 791 416.6 | 2 729 175.3 | Approx. KP 80.000 | PC, WP, WS |
| R1_ENV_081 | 790 164.9 | 2 729 833.4 | Approx. KP 81.000 | PC, WP, WS |
| R1_ENV_082 | 790 823.0 | 2 731 085.2 | Approx. KP 82.000 | PC, WP, WS |
| R1_ENV_083 | 789 571.2 | 2 731 743.3 | Approx. KP 83.000 | PC, WP, WS |
| R1_ENV_084 | 790 229.4 | 2 732 995.0 | Approx. KP 84.000 | PC, WP, WS |
| R1_ENV_085 | 788 881.5 | 2 733 962.3 | Approx. KP 85.000 | PC, WP, WS |
| R1_ENV_086 | 789 635.7 | 2 734 904.9 | Approx. KP 86.000 | PC, WP, WS |
| R1_ENV_087 | 788 384.0 | 2 735 563.0 | Approx. KP 87.000 | PC, WP, WS |
| R1_ENV_088 | 789 042.1 | 2 736 814.8 | Approx. KP 88.000 | PC, WP, WS |
| R1_ENV_089 | 787 790.3 | 2 737 472.9 | Approx. KP 89.000 | PC, WP, WS |
| R1_ENV_090 | 788 448.5 | 2 738 724.6 | Approx. KP 90.000 | PC, WP, WS |
| R1_ENV_091 | 787 196.7 | 2 739 382.8 | Approx. KP 91.000 | PC, WP, WS |
| R1_ENV_092 | 787 854.8 | 2 740 634.5 | Approx. KP 92.000 | PC, WP, WS |
| R1_ENV_093 | 786 603.1 | 2 741 292.6 | Approx. KP 93.000 | PC, WP, WS |
| R1_ENV_094 | 787 261.2 | 2 742 544.4 | Approx. KP 94.000 | PC, WP, WS |
| R1_ENV_095 | 786 009.4 | 2 743 202.5 | Approx. KP 95.000 | PC, WP, WS |
| R1_ENV_096 | 786 750.8 | 2 744 304.6 | Approx. KP 96.000 | PC, WP, WS |
| R1_ENV_097 | 785 770.7 | 2 745 324.1 | Approx. KP 97.000 | PC, WP, WS |
| R1_ENV_098 | 786 790.2 | 2 746 304.2 | Approx. KP 98.000 | PC, WP, WS |
| R1_ENV_099 | 785 810.1 | 2 747 323.7 | Approx. KP 99.000 | PC, WP, WS |
| R1_ENV_100 | 786 829.6 | 2 748 303.8 | Approx. KP 100.000 | PC, WP, WS |
| R1_ENV_101 | 785 849.5 | 2 749 323.3 | Approx. KP 101.000 | PC, WP, WS |
| R1_ENV_102 | 786 869.0 | 2 750 303.4 | Approx. KP 102.000 | PC, WP, WS |
| R1_ENV_103 | 785 888.8 | 2 751 322.9 | Approx. KP 103.000 | PC, WP, WS |
| R1_ENV_104 | 786 908.3 | 2 752 303.1 | Approx. KP 104.000 | PC, WP, WS |
| R1_ENV_105 | 785 928.2 | 2 753 314.2 | Approx. KP 105.000 | PC, WP, WS |
| R1_ENV_106 | 786 864.4 | 2 754 382.3 | Approx. KP 106.000 | PC, WP, WS |
| R1_ENV_107 | 785 725.6 | 2 755 221.2 | Approx. KP 107.000 | PC, WP, WS |
| R1_ENV_108 | 786 565.0 | 2 756 359.7 | Approx. KP 108.000 | PC, WP, WS |
| R1_ENV_109 | 785 425.7 | 2 757 198.6 | Approx. KP 109.000 | PC, WP, WS |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Rationale | Data/Sample Acquisition |
| R1_ENV_110 | 786 265.5 | 2 758 337.2 | Approx. KP 110.000 | PC, WP, WS |
| R1_ENV_111 | 785 125.7 | 2 759 176.0 | Approx. KP 111.000 | PC, WP, WS |
| R1_ENV_112 | 785 966.0 | 2 760 314.7 | Approx. KP 112.000 | PC, WP, WS |
| R1_ENV_113 | 784 772.4 | 2 760 185.6 | Approx. KP 113.000 | PC, WP, WS |
| R1_ENV_114 | 783 859.2 | 2 761 244.2 | Approx. KP 114.000 | PC, WP, WS |
| R1_ENV_115 | 782 782.9 | 2 760 393.0 | Approx. KP 115.000 | PC, WP, WS |
| R1_ENV_116 | 781 863.5 | 2 761 380.8 | Approx. KP 116.000 | PC, WP, WS |
| R1_ENV_117 | 780 793.3 | 2 760 600.4 | Approx. KP 117.000 | PC, WP, WS |
| R1_ENV_118 | 779 867.9 | 2 761 517.3 | Approx. KP 118.000 | PC, WP, WS |
| R1_ENV_119 | 778 769.3 | 2 760 811.4 | Approx. KP 119.000 | PC, WP, WS |
| R1_ENV_120 | 777 872.3 | 2 761 653.9 | Approx. KP 120.000 | PC, WP, WS |
| R1_ENV_121 | 776 814.2 | 2 761 015.2 | Approx. KP 121.000 | PC, WP, WS |
| R1_ENV_122 | 775 876.6 | 2 761 790.4 | Approx. KP 122.000 | PC, WP, WS |
| R1_ENV_123 | 775 086.9 | 2 760 965.0 | Approx. KP 123.000 | PC, WP, WS |
| R1_ENV_124 | 773 137.2 | 2 761 211.9 | Approx. KP 124.000 | PC, WP, WS |
| R1_ENV_125 | 774 141.5 | 2 759 676.9 | Approx. KP 125.000 | PC, WP, WS |
| R1_ENV_126 | 772 466.7 | 2 759 400.9 | Approx. KP 126.000 | PC, WP, WS |
| R1_ENV_127 | 773 006.5 | 2 758 130.4 | Approx. KP 127.000 | PC, WP, WS |
| R1_ENV_128 | 772 093.6 | 2 757 483.3 | Approx. KP 128.000 | PC, WP, WS |
| R1_ENV_129 | 772 016.8 | 2 756 312.8 | Approx. KP 129.000 | PC, WP, WS |
| R1_ENV_REF | 791 692.6 | 2 713 369.3 | Reference station | PC, WP, WS |

Notes
KP = Kilometre point
PC = Physico-chemical sample
WP = Water profile
WS = Water samples

Table 2.3: Proposed soil sampling stations, Route 1

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Rationale | Sample Acquisition |
| SO_R1_001 | 758 565.9 | 2 670 981.4 | Approx. KP 7.000 | Soil sample |
| SO_R1_002 | 764 873.6 | 2 674 442.1 | Approx. KP 16.000 | Soil sample |
| SO_R1_003 | 768 867.9 | 2 681 362.2 | Approx. KP 24.000 | Soil sample |
| SO_R1_004 | 772 144.5 | 2 688 756.7 | Approx. KP 32.000 | Soil sample |
| SO_R1_005 | 774 702.2 | 2 696 336.8 | Approx. KP 40.000 | Soil sample |
| SO_R1_006 | 778 544.5 | 2 702 738.8 | Approx. KP 48.000 | Soil sample |
| SO_R1_007 | 784 589.8 | 2 707 978.5 | Approx. KP 56.000 | Soil sample |
| SO_R1_008 | 790 729.0 | 2 713 506.2 | Approx. KP 64.000 | Soil sample |
| SO_R1_009 | 792 783.6 | 2 721 237.9 | Approx. KP 72.000 | Soil sample |
| SO_R1_010 | 791 416.6 | 2 729 175.3 | Approx. KP 80.000 | Soil sample |
| SO_R1_011 | 789 042.1 | 2 736 814.8 | Approx. KP 88.000. | Soil sample |
| SO_R1_012 | 786 750.8 | 2 744 304.6 | Approx. KP 96.000 | Soil sample |
| SO_R1_013 | 786 908.3 | 2 752 303.1 | Approx. KP 104.000 | Soil sample |
| SO_R1_014 | 785 966.0 | 2 760 314.7 | Approx. KP 112.000 | Soil sample |
| SO_R1_015 | 777 872.3 | 2 761 653.9 | Approx. KP 120.000 | Soil sample |
| SO_R1_016 | 772 093.6 | 2 757 483.3 | Approx. KP 128.000 | Soil sample |
| SO_R1_REF | 791 692.6 | 2 713 369.3 | Reference station | Soil sample |
| Notes<br>KP = Kilometre point | | | | |

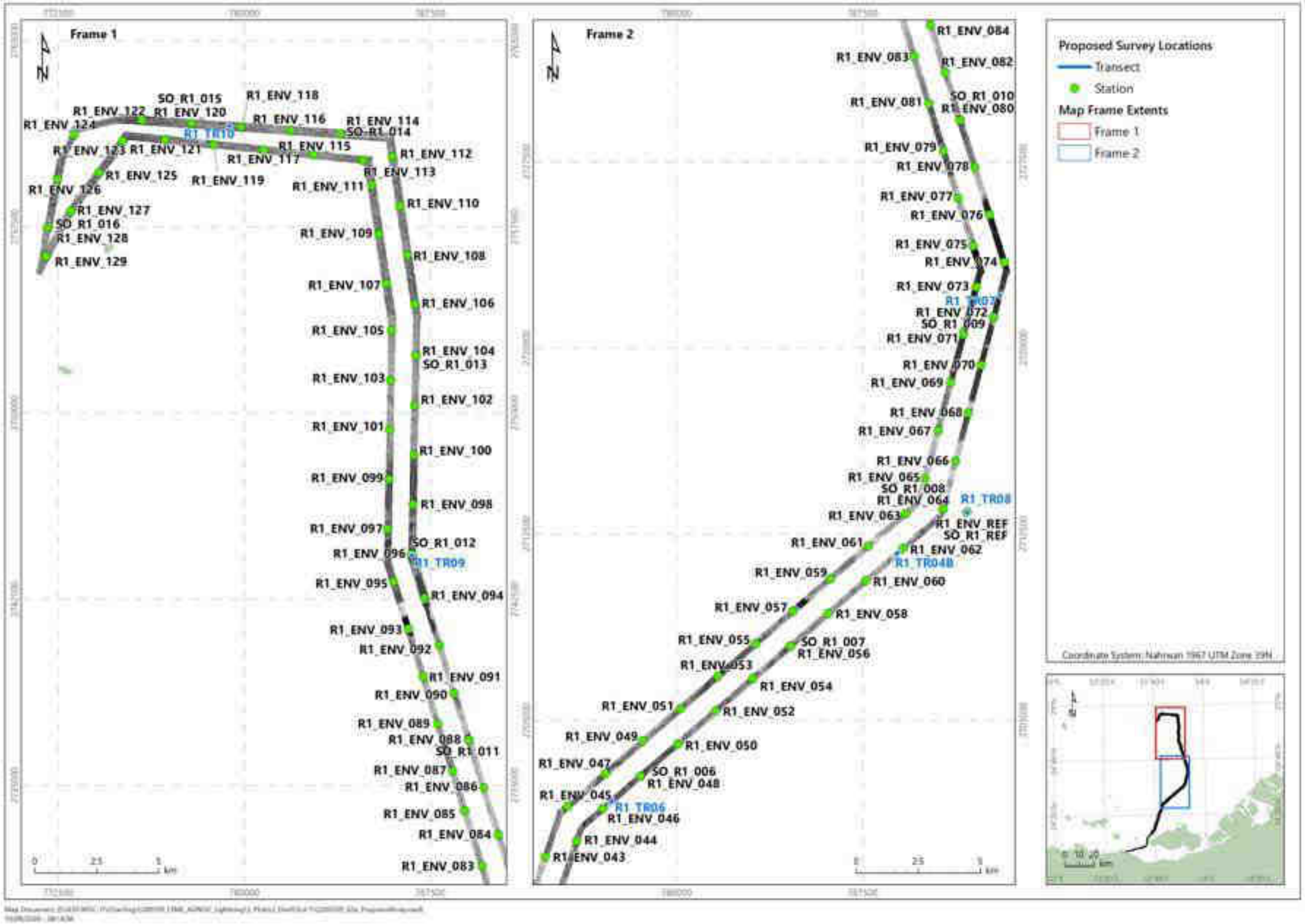



Figure 2.1a: Proposed environmental survey locations overlain on survey area side scan sonar (SSS) mosaic, Route 1

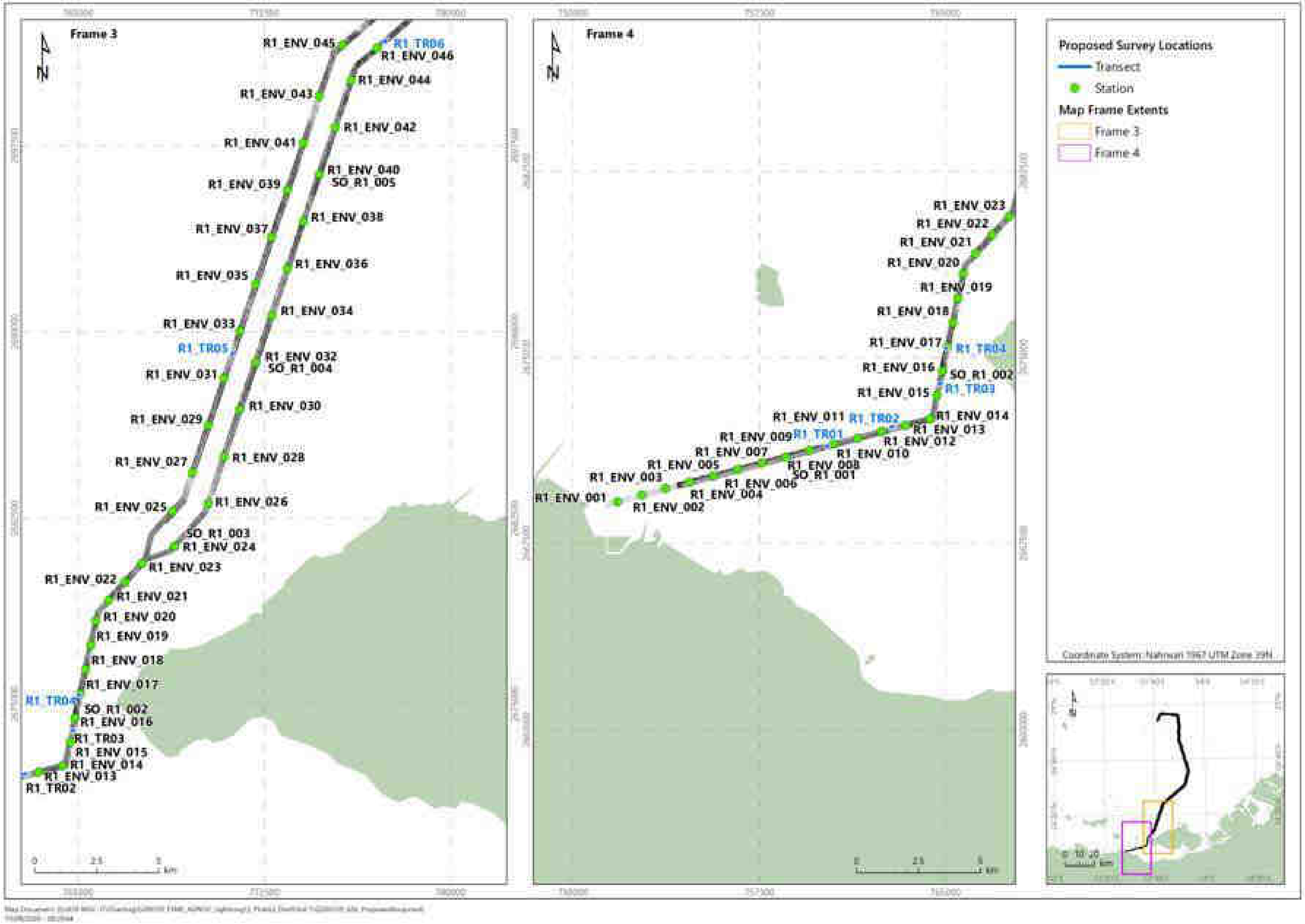



Figure 2.1b: Proposed environmental survey locations overlain on survey area side scan sonar (SSS) mosaic, Route 1

## 2.2 Survey Methods

### 2.2.1 Water Column Profiling

Water profiles were to be acquired from sea surface to near seabed during deployment and recovery of a YSI EXO2 conductivity, temperature and depth (CTD) profiler. The water column profiler was set up to record depth, dissolved oxygen (DO), pH, salinity, turbidity and temperature. At each station, the instrument was stabilised in the water column for 5 minutes before being slowly lowered to the bottom, where a fix was taken. The instrument was then recovered to the surface, resulting in the acquisition of data on both the down-cast and the up-cast.

### 2.2.2 Water Column Sampling

Water samples were to be collected using a 5 L Niskin water sampler at three water depths for each station. At each station, one water sample was collected approximately 1 m below the surface (‘top’), one approximately halfway (middle) and one from approximately 1 m above the seabed (‘bottom’). Due to water depth limitations in shallow coastal areas, the following criteria was established to determine where the samples would be recovered from.

Where the water depth was:

- < 5 m, a mid-depth sample was taken;
- Between 5 m to 10 m, a bottom and top sample were taken;
- > 10 m, a bottom, mid-depth and top sample were taken.

The water at each depth/station was recovered and decanted into labelled sample bottles provided by the laboratories with subsamples for water quality, hydrocarbons and metals parameters.

### 2.2.3 Sediment Grab Sampling

Seabed samples were to be acquired using a 0.1 $m^2$ single van Veen grab with a KC Denmark Day grab as a back-up. At each station, grab samples were to be acquired for physico-chemical analysis (particle size distribution (PSD), metals and hydrocarbons, sediment nutrients and polychlorinated biphenyls (PCBs)).

### 2.2.4 Seabed Video/Photography

Seabed video and photography were acquired using a Subsea Technology and Rentals SeaSpyder Nano underwater camera.

Seabed video footage was displayed on a computer monitor, and viewed in real time, assisting in the control of the camera in the water. A video overlay was used to overlay a navigation string including the time, date, depth (below sea level) and location (easting and northing). The survey location and station number were also displayed (manually updated).

Video footage and video frame captures (stills) were taken during all deployments. Manual positional fixes were taken for all stills.

The standard height of the camera above the seabed was ~ 0.5 m, which provided an approximate field of view of 1 m of seabed. Two lasers were set up at 6.8 cm apart to provide a scale.

## 2.3 Analytical Sampling

The following list briefly describes the suites of analyses carried out. Further details of the methods used for the analyses are in Appendix B.

- Water column physical parameters were measured using a multiparameter sonde; data are presented in Section 4.
- Water quality was assessed by analysis of a suite of analytes, presented in Sections 5, 6 and 7;
- Water total hydrocarbon content (THC) by gas chromatography–flame ionisation detection (GC–FID; Section 6.2.1);
- Water 2 to 6 ring aromatic hydrocarbons, by gas chromatography-mass spectrometry (GC–MS; Section 6.2.2);
- Benzene, toluene, ethylbenzene and xylene (BTEX) by headspace gas chromatography with flame ionisation detection (GC–FID–HS) and phenols by GC–MS, Sections 6.2.3 and 6.2.4;
- Water trace and major elements, by inductively coupled plasma-mass spectrometry (ICP-MS; Section 7);
- The results of the sediment characterisation (PSD, total organic carbon, carbonate and nutrient content) are presented in Sections 8 and 9;
- Sediment THC by gas chromatography–flame ionisation detection (GC-FID) is presented in Section 10.2.1 and 10.3;
- Sediment polycyclic aromatic hydrocarbons (PAHs) are presented in Section 10.2.2 and 10.3;
- BTEX by gas chromatography-flame ionisation detection (GC-MS) are presented in Section 10.2.3 and 10.3;
- Polychlorinated biphenyls (PCBs) were analysed by gas chromatography with micro-electron capture detection (GC-µECD) (Section 11);
- Sediment trace and major elements, by ICP-OES and ICP-MS are presented in Section 12;
- Habitats were classified in accordance with the Marine Life of the Emirate of Abu Dhabi (MLEAD) and EAD classifications (Section 13).

The results from the soil samples are detailed within Sections 8.3, 0, 10.3 and 12.3.

# 3. Field Operations

## 3.1 Seabed Video/Photography

Photographic still and video data were successfully acquired along all proposed camera transects.

Table 3.1 lists the completed environmental camera transects surveyed and details the data acquired from each transect.

Table 3.1: Completed camera transects, Route 1

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | |
|---|---|---|---|---|---|---|
| Transect | | Easting [m] | Northing [m] | Depth [m BSL] | Length [m] | Data Acquisition |
| R1_TR01 | SOL | 760 295.3 | 2 671 460.7 | 6.1 | 138 | 2 min 28 sec<br>13 stills |
| | EOL | 760 168.6 | 2 671 405.4 | 7.1 | | |
| R1_TR02 | SOL | 762 923.0 | 2 672 225.9 | 3.8 | 151 | 3 min 21 sec<br>11 stills |
| | EOL | 762 779.9 | 2 672 177.4 | 3.8 | | |
| R1_TR03 | SOL | 764 719.3 | 2 673 923.9 | 6.2 | 131 | 3 min 36 sec<br>10 stills |
| | EOL | 764 847.7 | 2 673 949.4 | 6.9 | | |
| R1_TR04B | SOL | 788 940.4 | 2 711 779.3 | 16.5 | 170 | 15 min 27 sec<br>18 stills |
| | EOL | 788 817.7 | 2 711 661.5 | 16.5 | | |
| R1_TR05A | SOL | 771 190.9 | 2 689 048.2 | 12.8 | 129 | 10 min 38 sec<br>14 stills |
| | EOL | 771 217.1 | 2 689 174.4 | 12.8 | | |
| R1_TR06 | SOL | 777 336.0 | 2 701 650.7 | 14.4 | 148 | 11 min 41 sec<br>17 stills |
| | EOL | 777 401.6 | 2 701 783.0 | 16.4 | | |
| R1_TR07 | SOL | 793 050.8 | 2 722 048.5 | 22.6 | 151 | 12 min 10 sec<br>19 stills |
| | EOL | 792 992.7 | 2 722 187.8 | 26.0 | | |
| R1_TR08A | SOL | 791 639.0 | 2 713 431.6 | 19.8 | 154 | 12 min 38 sec<br>19 stills |
| | EOL | 791 738.5 | 2 713 314.5 | 19.9 | | |
| R1_TR09 | SOL | 786 709.7 | 2 744 249.1 | 12.7 | 116 | 7 min 34 sec<br>24 stills |
| | EOL | 786 810.8 | 2 744 306.9 | 12.5 | | |
| R1_TR10 | SOL | 779 340.6 | 2 761 566.1 | 16.1 | 126 | 5 min 49 sec<br>12 stills |
| | EOL | 779 465.0 | 2 761 544.1 | 16.4 | | |

Notes
BSL = Below sea level
SOL = Start of line
EOL = End of line

## 3.2 Seabed Sampling

Due to the presence of hard substrate, suitable seabed samples were not obtained from 58 of the 130 proposed sampling stations. At least three grab attempts were made at each station. At 12 stations, limited sediment recovery enabled a partial suite of samples to be obtained. At the remaining 60 stations, a complete suite of physico-chemical sub-samples was acquired.

Sediment sampling at station SO_R1_012 was moved away from the proposed sampling location due to suspected presence of surficial gas charged sediments. Stations R1_ENV_083, R1_ENV_128 and R1_ENV_129 were moved as the proposed sampling locations fell within 200 m of subsea infrastructure.

Table 3.2 details the samples acquired, and Appendix C.1 presents detailed sampling logs.

Table 3.2: Completed sediment sampling stations, Route 1

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Depth [m BSL] | Sample Acquisition |
| R1_ENV_001 | 751 795.0 | 2 669 186.9 | 9.7 | PC |
| R1_ENV_002 | 752 759.6 | 2 669 445.5 | 11.0 | PC |
| R1_ENV_011 | 761 465.2 | 2 671 732.8 | 4.3 | Partial sample |
| R1_ENV_014 | 764 373.4 | 2 672 513.5 | 6.1 | PC |
| R1_ENV_024 | 768 866.7 | 2 681 374.1 | 9.1 | Partial sample |
| R1_ENV_029 | 770 239.1 | 2 686 236.2 | 11.7 | PC |
| R1_ENV_030 | 771 505.4 | 2 686 863.6 | 12.5 | PC |
| R1_ENV_031 | 770 878.2 | 2 688 129.7 | 13.2 | PC |
| R1_ENV_038 | 774 057.4 | 2 694 442.0 | 9.3 | PC |
| R1_ENV_039 | 773 435.0 | 2 695 709.8 | 15.3 | PC |
| R1_ENV_040 | 774 703.5 | 2 696 337.3 | 15.4 | PC |
| R1_ENV_041 | 774 074.8 | 2 697 605.5 | 14.4 | PC |
| R1_ENV_042 | 775 347.5 | 2 698 224.1 | 12.8 | Partial sample |
| R1_ENV_043 | 774 713.7 | 2 699 499.7 | 14.6 | PC |
| R1_ENV_044 | 775 972.8 | 2 700 121.8 | 14.7 | PC |
| R1_ENV_045 | 775 614.5 | 2 701 524.1 | 17.1 | PC |
| R1_ENV_046 | 777 033.2 | 2 701 429.0 | 19.0 | PC |
| R1_ENV_047 | 777 128.9 | 2 702 846.8 | 16.2 | Partial sample |
| R1_ENV_048 | 778 544.1 | 2 702 738.6 | 17.6 | PC |
| R1_ENV_049 | 778 645.1 | 2 704 149.8 | 17.3 | PC |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Depth [m BSL] | Sample Acquisition |
| R1_ENV_050 | 780 056.3 | 2 704 048.2 | 17.2 | PC |
| R1_ENV_051 | 780 162.0 | 2 705 453.1 | 13.6 | Partial sample |
| R1_ENV_052 | 781 567.6 | 2 705 358.4 | 18.6 | PC |
| R1_ENV_053 | 781 665.7 | 2 706 771.1 | 18.3 | PC |
| R1_ENV_054 | 783 071.0 | 2 706 673.9 | 16.9 | PC |
| R1_ENV_055 | 783 178.6 | 2 708 079.3 | 19.4 | PC |
| R1_ENV_056 | 784 591.0 | 2 707 980.0 | 18.6 | PC |
| R1_ENV_057 | 784 689.4 | 2 709 390.7 | 19.1 | PC |
| R1_ENV_058 | 786 103.8 | 2 709 289.1 | 18.6 | PC |
| R1_ENV_059 | 786 201.3 | 2 710 700.1 | 18.5 | PC |
| R1_ENV_060 | 787 611.7 | 2 710 598.3 | 19.4 | PC |
| R1_ENV_061 | 787 713.6 | 2 712 013.0 | 18.6 | PC |
| R1_ENV_064 | 790 026.1 | 2 714 734.2 | 20.6 | PC |
| R1_ENV_065 | 791 246.4 | 2 715 446.9 | 20.2 | PC |
| R1_ENV_066 | 790 533.9 | 2 716 672.0 | 21.9 | PC |
| R1_ENV_067 | 791 751.4 | 2 717 380.0 | 19.4 | PC |
| R1_ENV_068 | 791 038.4 | 2 718 601.0 | 22.5 | PC |
| R1_ENV_069 | 792 262.3 | 2 719 300.8 | 20.9 | PC |
| R1_ENV_070 | 791 561.8 | 2 720 521.1 | 24.1 | PC |
| R1_ENV_071 | 792 783.9 | 2 721 238.6 | 23.4 | PC |
| R1_ENV_072 | 792 073.4 | 2 722 462.6 | 25.4 | PC |
| R1_ENV_073 | 793 197.0 | 2 723 444.5 | 23.8 | PC |
| R1_ENV_074 | 791 945.4 | 2 724 102.9 | 24.5 | PC |
| R1_ENV_075 | 792 603.9 | 2 725 355.0 | 23.1 | PC |
| R1_ENV_076 | 792 019.0 | 2 727 262.8 | 22.1 | PC |
| R1_ENV_078 | 791 415.2 | 2 729 175.1 | 20.0 | PC |
| R1_ENV_079 | 790 164.9 | 2 729 832.1 | 19.9 | PC |
| R1_ENV_080 | 790 816.1 | 2 731 090.5 | 20.4 | PC |
| R1_ENV_081 | 789 396.8 | 2 732 329.4 | 15.4 | PC |
| R1_ENV_082 | 790 229.5 | 2 732 994.6 | 17.7 | PC |
| R1_ENV_083 | 789 635.0 | 2 734 905.0 | 19.2 | PC |
| R1_ENV_084 | 788 391.8 | 2 735 568.2 | 18.3 | PC |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Depth [m BSL] | Sample Acquisition |
| R1_ENV_086 | 789 042.8 | 2 736 815.3 | 18.7 | PC |
| R1_ENV_087 | 787 783.0 | 2 737 467.4 | 20.8 | PC |
| R1_ENV_088 | 787 198.2 | 2 739 382.2 | 24.9 | PC |
| R1_ENV_089 | 787 853.1 | 2 740 641.4 | 19.9 | PC |
| R1_ENV_091 | 786 603.9 | 2 741 292.2 | 19.4 | PC |
| R1_ENV_092 | 787 262.7 | 2 742 542.1 | 21.0 | PC |
| R1_ENV_093 | 786 009.9 | 2 743 200.7 | 22.0 | PC |
| R1_ENV_094 | 786 757.9 | 2 744 407.7 | 20.4 | PC |
| R1_ENV_095 | 785 768.5 | 2 745 325.7 | 16.6 | PC |
| R1_ENV_096 | 785 809.0 | 2 747 324.1 | 11.3 | PC |
| R1_ENV_097 | 786 910.7 | 2 752 302.1 | 10.2 | PC |
| R1_ENV_099 | 785 931.4 | 2 753 306.7 | 8.9 | PC |
| R1_ENV_104 | 786 572.6 | 2 756 355.4 | 14.6 | Partial sample |
| R1_ENV_105 | 785 428.8 | 2 757 191.5 | 13.5 | Partial sample |
| R1_ENV_108 | 775 873.8 | 2 761 791.0 | 14.6 | Partial sample |
| R1_ENV_109 | 773 137.0 | 2 761 220.8 | 17.3 | Partial sample |
| R1_ENV_122 | 774 147.8 | 2 759 683.1 | 21.5 | PC |
| R1_ENV_124 | 772 462.1 | 2 759 408.7 | 22.2 | Partial sample |
| R1_ENV_125 | 751 795.0 | 2 669 186.9 | 21.1 | Partial sample |
| R1_ENV_126 | 752 759.6 | 2 669 445.5 | 21.1 | Partial sample |
| Notes<br>PC = Physico-chemical sample | | | | |

## 3.3 Water Sampling and Profiling

Water samples were acquired from all proposed stations. Due to water depth limitations, a single mid water sample was acquired at 5 stations, whilst top and bottom samples were acquired at 20 stations.

Table 3.3 provides coordinates of water profiles and water samples acquired within the Route 1 survey area.

Table 3.3: Completed water sampling stations, Route 1

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Depth [m BSL] | Sample/Data Acquisition |
| R1_ENV_001 | 751 799.1 | 2 669 198.9 | 9.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_002 | 752 779.7 | 2 669 441.6 | 11.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_003 | 753 734.6 | 2 669 700.6 | 6.0 | WS (Bottom, Top), WP |
| R1_ENV_004 | 754 694.5 | 2 669 957.8 | 5.0 | WS (Bottom, Top), WP |
| R1_ENV_005 | 755 666.3 | 2 670 215.3 | 5.0 | WS (Bottom, Top), WP |
| R1_ENV_006 | 756 636.4 | 2 670 472.9 | 5.5 | WS (Bottom, Top), WP |
| R1_ENV_007 | 757 596.2 | 2 670 730.4 | 6.0 | WS (Bottom, Top), WP |
| R1_ENV_008 | 758 557.1 | 2 671 023.0 | 6.5 | WS (Bottom, Top), WP |
| R1_ENV_009 | 759 522.9 | 2 671 328.8 | 6.0 | WS (Bottom, Top), WP |
| R1_ENV_010 | 760 497.7 | 2 671 501.7 | 4.5 | WS (Bottom, Top), WP |
| R1_ENV_011 | 761 469.8 | 2 671 735.7 | 5.0 | WS (Bottom, Top), WP |
| R1_ENV_012* | 762 365.0 | 2 671 999.7 | 2.5 | WS (Mid), WP |
| R1_ENV_013* | 763 399.3 | 2 672 270.6 | 1.7 | WS (Mid), WP |
| R1_ENV_014 | 764 357.1 | 2 672 491.3 | 5.5 | WS (Bottom, Top), WP |
| R1_ENV_015 | 764 659.3 | 2 673 442.7 | 5.0 | WS (Bottom, Top), WP |
| R1_ENV_016 | 764 864.3 | 2 674 442.2 | 11.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_017 | 765 086.2 | 2 675 416.4 | 4.5 | WS (Bottom, Top), WP |
| R1_ENV_018* | 765 316.6 | 2 676 381.1 | 3.9 | WS (Mid) WP |
| R1_ENV_019* | 765 485.6 | 2 677 370.6 | 2.5 | WS (Mid) WP |
| R1_ENV_020* | 765 710.8 | 2 678 333.2 | 4.7 | WS (Mid), WP |
| R1_ENV_021 | 766 219.4 | 2 679 177.0 | 5.5 | WS (Bottom, Top), WP |
| R1_ENV_022 | 766 874.4 | 2 679 920.1 | 6.0 | WS (Bottom, Top), WP |
| R1_ENV_023 | 767 561.1 | 2 680 670.4 | 6.0 | WS (Bottom, Top), WP |
| R1_ENV_024 | 768 882.8 | 2 681 291.1 | 8.0 | WS (Bottom, Top) |
| R1_ENV_025 | 768 670.1 | 2 682 683.6 | 11.0 | WS (Bottom, Mid, Top) |
| R1_ENV_026 | 770 223.0 | 2 683 068.2 | 11.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_027 | 769 599.4 | 2 684 339.8 | 11.8 | WS (Bottom, Mid, Top), WP |
| R1_ENV_028 | 770 862.5 | 2 684 956.8 | 10.0 | WS (Bottom, Top), WP |
| R1_ENV_029 | 771 505.2 | 2 686 860.7 | 12.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_030 | 770 878.3 | 2 688 125.8 | 13.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_031 | 772 145.3 | 2 688 754.8 | 11.9 | WS (Bottom, Mid, Top), WP |
| R1_ENV_032 | 770 234.6 | 2 686 234.2 | 11.7 | WS (Bottom, Mid, Top), WP |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Depth [m BSL] | Sample/Data Acquisition |
| R1_ENV_033 | 771 517.1 | 2 690 024.1 | 10.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_034 | 772 786.0 | 2 690 648.9 | 11.7 | WS (Bottom, Mid, Top), WP |
| R1_ENV_035 | 772 158.9 | 2 691 919.4 | 13.8 | WS (Bottom, Mid, Top), WP |
| R1_ENV_036 | 773 423.4 | 2 692 546.5 | 12.8 | WS (Bottom, Mid, Top), WP |
| R1_ENV_037 | 772 795.4 | 2 693 814.0 | 12.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_038 | 774 064.2 | 2 694 441.0 | 9.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_039 | 773 435.2 | 2 695 708.8 | 15.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_040 | 774 703.1 | 2 696 337.4 | 15.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_041 | 774 075.3 | 2 697 603.8 | 14.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_042 | 775 343.2 | 2 698 231.5 | 12.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_043 | 774 714.2 | 2 699 499.2 | 14.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_044 | 775 981.1 | 2 700 127.3 | 14.8 | WS (Bottom, Mid, Top), WP |
| R1_ENV_045 | 775 622.4 | 2 701 530.2 | 17.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_046 | 777 033.1 | 2 701 428.9 | 18.9 | WS (Bottom, Mid, Top), WP |
| R1_ENV_047 | 777 135.0 | 2 702 837.8 | 15.9 | WS (Bottom, Mid, Top), WP |
| R1_ENV_048 | 778 545.6 | 2 702 738.2 | 17.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_049 | 778 639.3 | 2 704 157.3 | 17.3 | WS (Bottom, Mid, Top), WP |
| R1_ENV_050 | 780 062.9 | 2 704 041.3 | 17.3 | WS (Bottom, Mid, Top), WP |
| R1_ENV_051 | 780 156.5 | 2 705 459.5 | 13.7 | WS (Bottom, Mid, Top), WP |
| R1_ENV_052 | 781 566.7 | 2 705 359.2 | 18.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_053 | 781 670.1 | 2 706 769.2 | 18.3 | WS (Bottom, Mid, Top), WP |
| R1_ENV_054 | 783 081.6 | 2 706 670.9 | 17.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_055 | 783 177.5 | 2 708 079.6 | 19.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_056 | 784 589.8 | 2 707 977.4 | 18.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_057 | 784 689.8 | 2 709 388.3 | 19.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_058 | 786 103.4 | 2 709 289.4 | 18.8 | WS (Bottom, Mid, Top), WP |
| R1_ENV_059 | 786 201.7 | 2 710 699.6 | 18.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_060 | 787 612.1 | 2 710 599.3 | 19.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_061 | 787 715.6 | 2 712 013.1 | 18.7 | WS (Bottom, Mid, Top), WP |
| R1_ENV_062 | 789 125.0 | 2 711 908.4 | 14.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_063 | 789 222.5 | 2 713 319.4 | 19.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_064 | 790 728.9 | 2 713 505.9 | 20.7 | WS (Bottom, Mid, Top), WP |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Depth [m BSL] | Sample/Data Acquisition |
| R1_ENV_065 | 790 020.0 | 2 714 730.2 | 20.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_066 | 791 241.3 | 2 715 439.8 | 22.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_067 | 790 532.0 | 2 716 662.9 | 19.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_068 | 791 756.0 | 2 717 371.1 | 22.3 | WS (Bottom, Mid, Top), WP |
| R1_ENV_069 | 791 046.5 | 2 718 595.2 | 20.7 | WS (Bottom, Mid, Top), WP |
| R1_ENV_070 | 792 269.4 | 2 719 304.7 | 24.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_071 | 791 560.1 | 2 720 529.0 | 23.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_072 | 792 783.6 | 2 721 239.0 | 25.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_073 | 792 075.0 | 2 722 460.8 | 23.3 | WS (Bottom, Mid, Top), WP |
| R1_ENV_074 | 793 196.8 | 2 723 445.3 | 24.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_075 | 791 946.6 | 2 724 103.1 | 23.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_076 | 792 604.1 | 2 725 355.4 | 22.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_077 | 791 351.3 | 2 726 012.6 | 18.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_078 | 792 012.1 | 2 727 266.5 | 20.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_079 | 790 757.9 | 2 727 924.6 | 19.9 | WS (Bottom, Mid, Top), WP |
| R1_ENV_080 | 791 415.9 | 2 729 175.3 | 20.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_081 | 790 164.9 | 2 729 832.5 | 15.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_082 | 790 822.9 | 2 731 084.7 | 17.9 | WS (Bottom, Mid, Top), WP |
| R1_ENV_083 | 789 397.1 | 2 732 329.7 | 19.3 | WS (Bottom, Mid, Top), WP |
| R1_ENV_084 | 790 229.4 | 2 732 995.1 | 18.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_085 | 788 882.2 | 2 733 962.4 | 18.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_086 | 789 635.0 | 2 734 903.7 | 18.8 | WS (Bottom, Mid, Top), WP |
| R1_ENV_087 | 788 384.5 | 2 735 560.4 | 20.8 | WS (Bottom, Mid, Top), WP |
| R1_ENV_088 | 789 042.0 | 2 736 813.8 | 24.9 | WS (Bottom, Mid, Top), WP |
| R1_ENV_089 | 787 790.1 | 2 737 471.1 | 19.7 | WS (Bottom, Mid, Top), WP |
| R1_ENV_090 | 788 447.3 | 2 738 724.0 | 20.7 | WS (Bottom, Mid, Top), WP |
| R1_ENV_091 | 787 197.4 | 2 739 383.7 | 19.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_092 | 787 855.8 | 2 740 635.4 | 21.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_093 | 786 602.9 | 2 741 292.7 | 22.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_094 | 787 259.2 | 2 742 546.3 | 20.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_095 | 786 009.1 | 2 743 199.9 | 16.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_096 | 786 749.7 | 2 744 305.5 | 12.1 | WS (Bottom, Mid, Top), WP |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Depth [m BSL] | Sample/Data Acquisition |
| R1_ENV_097 | 785 770.8 | 2 745 324.3 | 10.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_098 | 786 790.3 | 2 746 304.6 | 9.7 | WS (Bottom, Top), WP |
| R1_ENV_099 | 785 811.1 | 2 747 323.5 | 9.0 | WS (Bottom, Top), WP |
| R1_ENV_100 | 786 828.9 | 2 748 303.3 | 9.6 | WS (Bottom, Top), WP |
| R1_ENV_101 | 785 849.1 | 2 749 323.1 | 10.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_102 | 786 870.7 | 2 750 302.6 | 11.9 | WS (Bottom, Mid, Top), WP |
| R1_ENV_103 | 785 889.2 | 2 751 322.1 | 12.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_104 | 786 908.8 | 2 752 302.9 | 15.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_105 | 785 929.1 | 2 753 313.6 | 13.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_106 | 786 864.1 | 2 754 382.9 | 14.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_107 | 785 724.8 | 2 755 220.2 | 15.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_108 | 786 565.4 | 2 756 359.7 | 14.7 | WS (Bottom, Mid, Top), WP |
| R1_ENV_109 | 785 426.3 | 2 757 198.6 | 17.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_110 | 786 266.5 | 2 758 337.1 | 16.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_111 | 785 125.2 | 2 759 176.6 | 17.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_112 | 785 966.3 | 2 760 315.0 | 18.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_113 | 784 773.6 | 2 760 185.6 | 17.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_114 | 783 859.1 | 2 761 249.7 | 17.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_115 | 782 789.9 | 2 760 392.3 | 18.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_116 | 781 863.4 | 2 761 381.4 | 18.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_117 | 780 794.6 | 2 760 600.7 | 17.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_118 | 779 867.8 | 2 761 517.6 | 17.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_119 | 778 776.2 | 2 760 801.3 | 17.0 | WS (Bottom, Mid, Top), WP |
| R1_ENV_120 | 777 875.5 | 2 761 655.0 | 18.8 | WS (Bottom, Mid, Top), WP |
| R1_ENV_121 | 776 817.0 | 2 761 013.2 | 20.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_122 | 775 879.4 | 2 761 789.9 | 21.4 | WS (Bottom, Mid, Top), WP |
| R1_ENV_123 | 775 087.2 | 2 760 961.7 | 21.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_124 | 773 137.1 | 2 761 208.5 | 22.2 | WS (Bottom, Mid, Top), WP |
| R1_ENV_125 | 774 141.4 | 2 759 677.8 | 21.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_126 | 772 467.4 | 2 759 400.9 | 21.1 | WS (Bottom, Mid, Top), WP |
| R1_ENV_127 | 773 007.0 | 2 758 131.3 | 17.6 | WS (Bottom, Mid, Top), WP |
| R1_ENV_128 | 772 192.6 | 2 757 601.0 | 15.5 | WS (Bottom, Mid, Top), WP |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Depth [m BSL] | Sample/Data Acquisition |
| R1_ENV_129 | 771 972.9 | 2 756 199.9 | 13.5 | WS (Bottom, Mid, Top), WP |
| R1_ENV_REF | 791 694.0 | 2 713 367.7 | 19.3 | WS (Bottom, Mid, Top), WP |

Notes
Coordinates provided for bottom water sample
* = Coordinates provided for a single mid-water sample taken
BSL = Below sea level
WS = Water sample
WP = Water profile

## 3.4 Soil Sampling

Soil samples were acquired at ten out of the seventeen proposed stations. A partial soil sample was collected from stations SO_R1_003 and SO_R1_013.

Table 3.4 provides the details of soil samples acquired.

Table 3.4: Completed soil sampling, Route 1

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | |
|---|---|---|---|---|
| Station | Easting [m] | Northing [m] | Depth [m BSL] | Sample Acquisition |
| SO_R1_003 | 768 878.1 | 2 681 357.4 | 8.9 | Partial soil sample |
| SO_R1_005 | 774 702.9 | 2 696 337.3 | 15.3 | Soil sample |
| SO_R1_006 | 778 544.5 | 2 702 736.6 | 17.4 | Soil sample |
| SO_R1_007 | 784 582.9 | 2 707 985.5 | 18.7 | Soil sample |
| SO_R1_008 | 790 722.2 | 2 713 510.2 | 20.6 | Soil sample |
| SO_R1_009 | 792 783.7 | 2 721 238.9 | 25.4 | Soil sample |
| SO_R1_010 | 791 412.5 | 2 729 165.9 | 20.5 | Soil sample |
| SO_R1_011 | 789 042.6 | 2 736 816.0 | 24.8 | Soil sample |
| SO_R1_012 | 786 759.1 | 2 744 406.9 | 10.5 | Soil sample |
| SO_R1_013 | 786 910.1 | 2 752 301.8 | 14.5 | Partial soil sample |

Notes
BSL = Below sea level

## 3.5 Bathymetry and Seabed Features

The water depth along Route 1 ranged from 0.0 m to 25.4 m CD.

The seabed features consisted of pockmarks, seabed depressions, spudcan depressions, seabed scars, ridges, mounds and pinnacles as well as areas of boulders, dredged areas and areas of sand ripple marks.

Further details can be found in the geophysical report (Fugro, 2020a,b).

Figure 3.1 displays the actual sampling stations, overlain on side scan sonar (SSS).

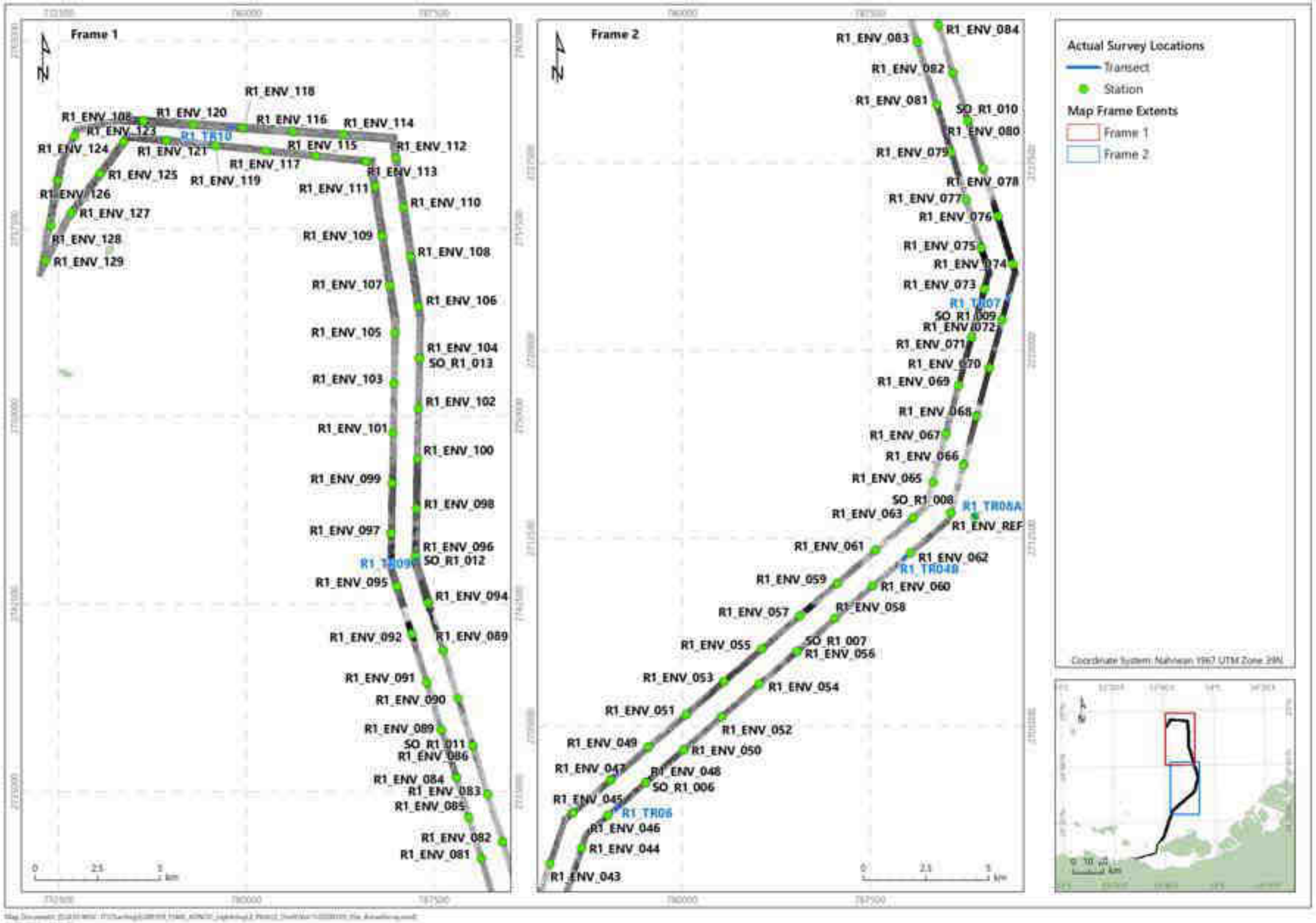
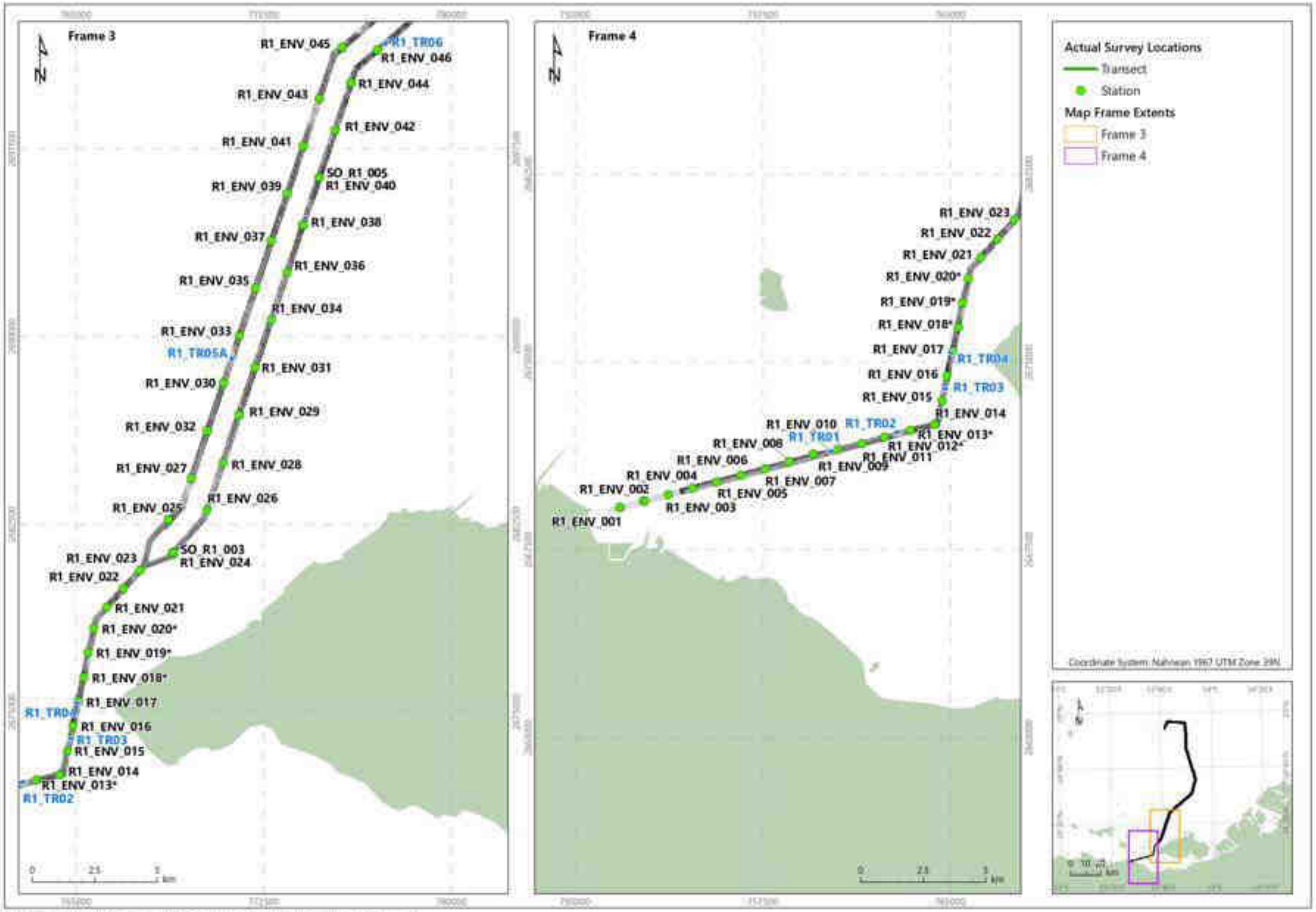



Figure 3.1a: Completed environmental sampling locations overlain on survey area side scan sonar (SSS) mosaic, Route 1



Frame 3
R1_ENV_045
R1_TR06
R1_ENV_046
R1_ENV_043
R1_ENV_044
R1_ENV_041
R1_ENV_042
R1_ENV_039
SO_R1_005
R1_ENV_040
R1_ENV_037
R1_ENV_038
R1_ENV_035
R1_ENV_036
R1_ENV_034
R1_ENV_033
R1_TR05A
R1_ENV_030
R1_ENV_031
R1_ENV_029
R1_ENV_032
R1_ENV_027
R1_ENV_028
R1_ENV_025
R1_ENV_026
SO_R1_003
R1_ENV_024
R1_ENV_023
R1_ENV_022
R1_ENV_021
R1_ENV_020*
R1_ENV_019*
R1_ENV_018*
R1_ENV_017
R1_TR04
R1_ENV_016
R1_TR03
R1_ENV_015
R1_ENV_014
R1_ENV_013*
R1_TR02
Frame 4
R1_ENV_023
R1_ENV_022
R1_ENV_021
R1_ENV_020*
R1_ENV_019*
R1_ENV_018*
R1_ENV_017
R1_TR04
R1_ENV_016
R1_TR03
R1_ENV_015
R1_ENV_014
R1_ENV_010
R1_TR02
R1_TR01
R1_ENV_013*
R1_ENV_008
R1_ENV_012*
R1_ENV_011
R1_ENV_006
R1_ENV_009
R1_ENV_004
R1_ENV_007
R1_ENV_002
R1_ENV_005
R1_ENV_003
R1_ENV_001
Actual Survey Locations
Transect
Station
Map Frame Extents
Frame 3
Frame 4
Coordinate System: Nahrwan 1967 UTM Zone 39N

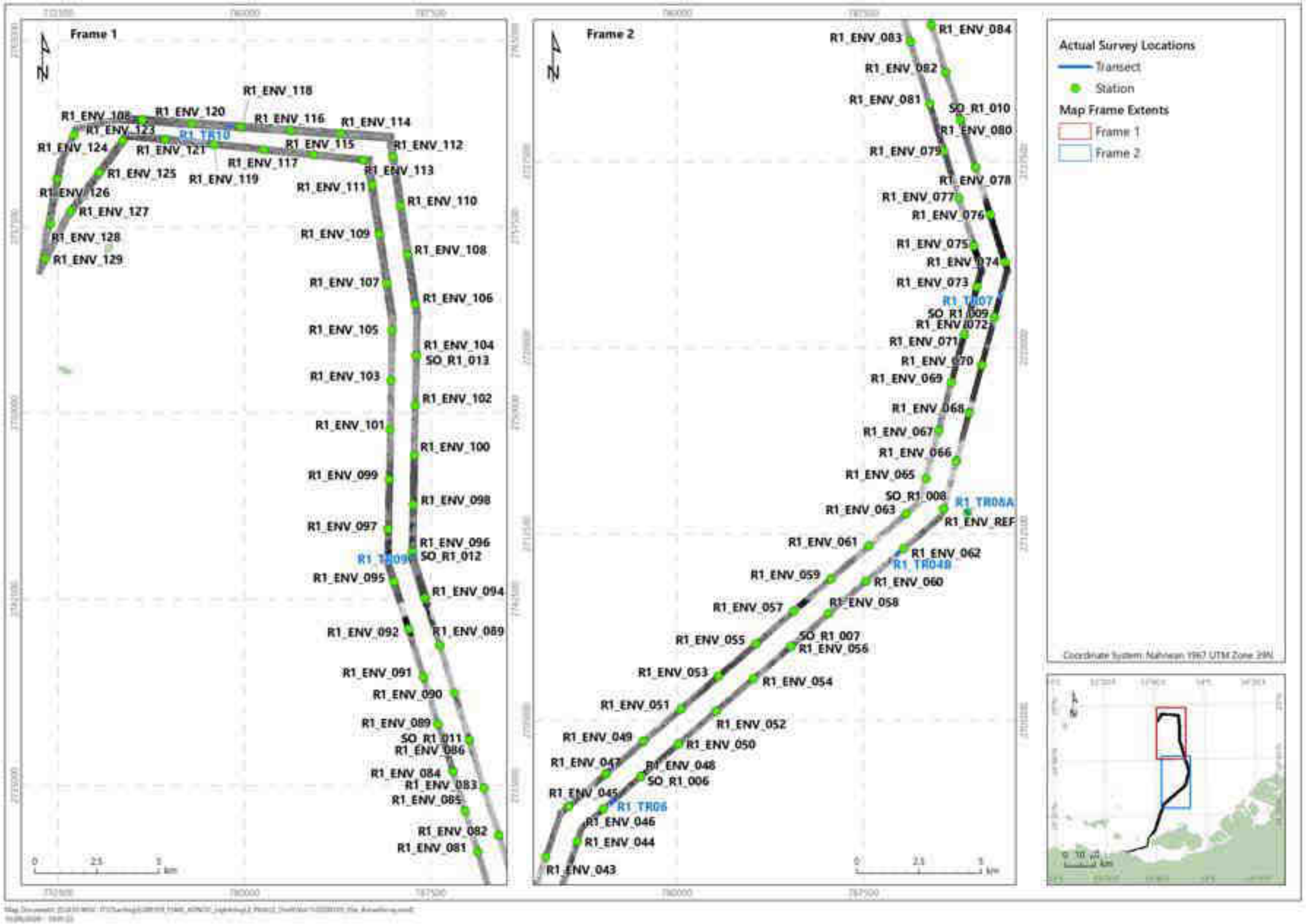



Figure 3.1b: Completed environmental sampling locations overlain on survey area side scan sonar (SSS) mosaic, Route 1

# 4. Water Column Profiles

## 4.1 Introduction

Water column profiles were successfully acquired at 128 stations within the survey area. Profiles were collected using a YSI EXO2 CTD instrument, which was setup to continuously log (0.5 s intervals) temperature, salinity, depth, turbidity, DO saturation and pH.

Example water profiles are presented in Figures 4.1 to 4.6 with all water profiles acquired during the survey presented in Appendix D.

## 4.2 Results

### 4.2.1 Temperature

Water temperatures within the survey area varied between stations, with an overall range between 26 °C and 35 °C.

At nearshore stations (R1_ENV_001 to R1_ENV_023), temperatures ranged from approximately 26 °C to 27 °C (sampled 14 April 2020), apart from at station R1_ENV_019, where the temperature was approximately 34.9 °C throughout the water column (2.5 m depth, sampled 11 June 2020). Figure 4.1 displays an example profile from station R1_ENV_005.

At offshore stations (R1_ENV_027 and R1_ENV_029 to R1_ENV_037), water temperatures typically ranged from 28 °C to 29 °C (sampled on 14 and 15 April 2020). This can be observed in Figure 4.2.

At stations R1_ENV_063 to R1_ENV_099 and R1_ENV_106 to R1_ENV_129, water temperatures ranged from approximately 30 °C to 32 °C (sampled 22 May and 3 June). A slight decrease in temperatures from approximately 8 m depth was observed at some stations, with temperatures at stations R1_ENV_116 to R1_ENV_124 decreasing to a minimum of 28.5 °C. This can be observed in Figures 4.5 and 4.6.

The highest water temperatures were recorded between 5 and 15 June 2020 (stations R1_ENV_026, R1_ENV_028, R1_ENV_038 to R1_ENV_062, R1_ENV_100 to R1_ENV_105, R1_ENV_108 and R1_ENV_REF). These ranged from approximately 32 °C to 33 °C throughout the water column. At stations R1_ENV_038 to R1_ENV_042, these temperatures were elevated within the surface waters (< 1 m depth), reaching a maximum of 33.7 °C (station R1_ENV_041, Figure 4.3). However, stations R1_ENV_048 to R1_ENV_062 presented a slight increase in temperatures below approximately 8 m depth.

### 4.2.2 Salinity

At nearshore stations (ENV_001 to ENV_023), salinity ranged from approximately 44 practical salinity units (PSU) to 46 PSU, with values generally consistent throughout the water column. At offshore stations, the salinity values ranged from approximately 40 PSU to 44.5 PSU, with the majority falling between 40 PSU and 42 PSU. A slight, gradual increase in salinity was occasionally recorded below approximately 8 m to 10 m depth in numerous stations (e.g. stations R1_ENV_048 to R1_ENV_094 and R1_ENV_127 to R1_ENV_REF, Figure 4.4).

Salinities in the Gulf typically reach between 40 ppt and 50 ppt (Carpenter et al., 1997), with ranges between 35.2 to 44.0 previously demonstrated in the wider region (Shriadah & Al-Ghais, 1999). Whilst units are not clarified; these are likely to be ppt or PSU, with these two units of measurement approximately equivalent to each other. With this assumption, the salinity recorded in the offshore survey area were considered to be within these ranges, whilst salinity at the nearshore stations was slightly higher.

### 4.2.3 Turbidity

Turbidity values at stations ENV_001 to ENV_023 typically ranged from approximately 0.8 nephelometric turbidity units (NTU) to 4.8 NTU, apart from station ENV_019 where the turbidity values were between 0.1 NTU and 0.5 NTU. The remaining offshore stations had turbidity values between 0.0 NTU and 1.5 NTU, occasionally with a gradual increase observed below 14 m.

Some anomalous readings were recorded when the sensor contacted the seabed and were removed from the dataset. There were no major trends between turbidity and water depth at any of the stations profiled.

### 4.2.4 Dissolved Oxygen (DO) Saturation

The DO measurements obtained during the profiling operations ranged between approximately 80 % saturation (% sat.) and 119.3 % sat. Overall, DO measurements either decreased or remained relatively stable with increasing depth.

### 4.2.5 pH

pH values ranged from 7.9 to 8.2, with no clear depth-related trends in pH values at any of the stations profiled.

The pH values reported in the current survey were within the range of values reported previously in the Arabian Gulf (7.91 to 8.60; Shriadah & Al-Ghais, 1999).

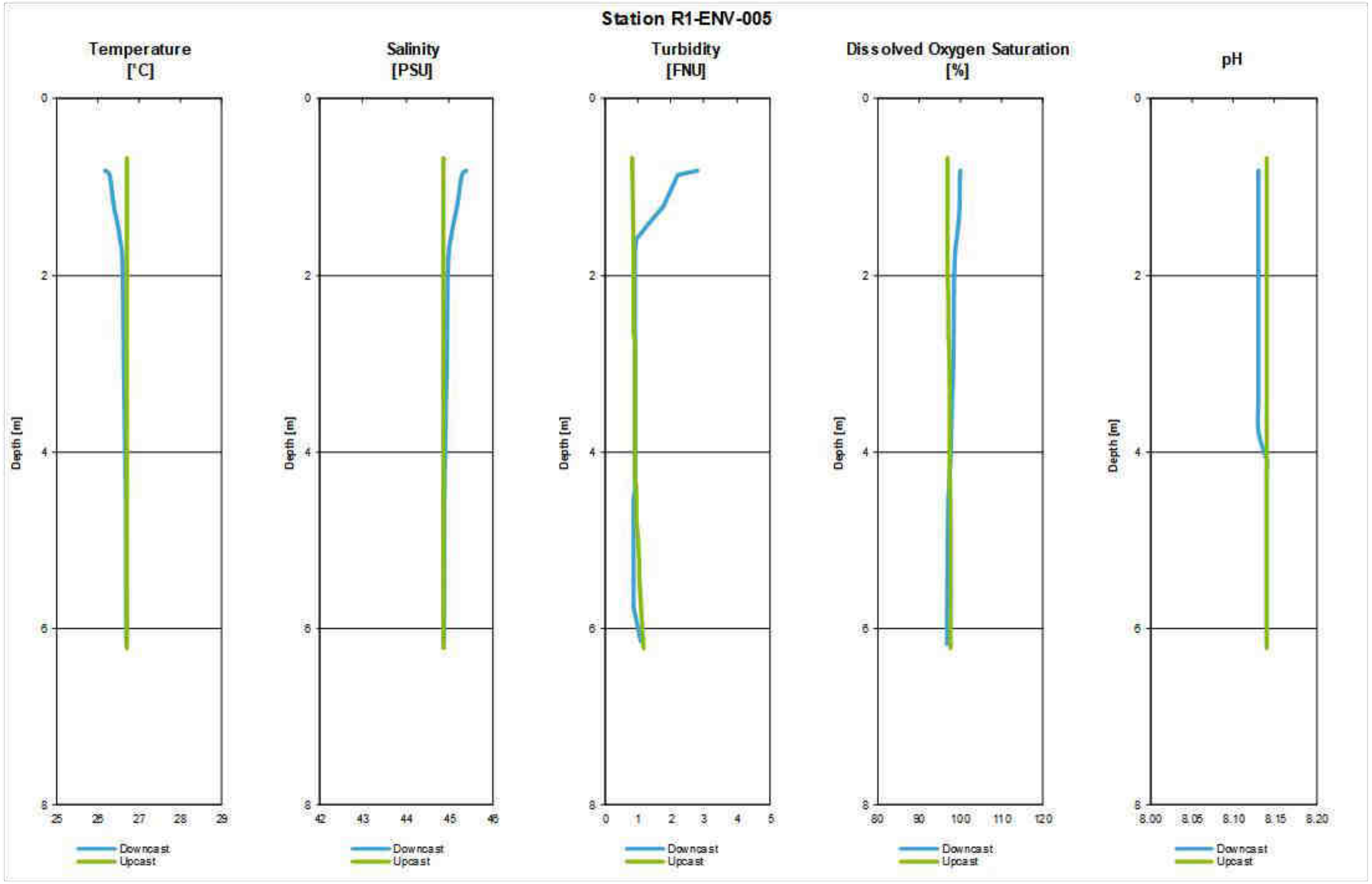



Figure 4.1: Example water profile showing temperature, salinity, turbidity, dissolved oxygen and pH at station R1_ENV_005, Route 1

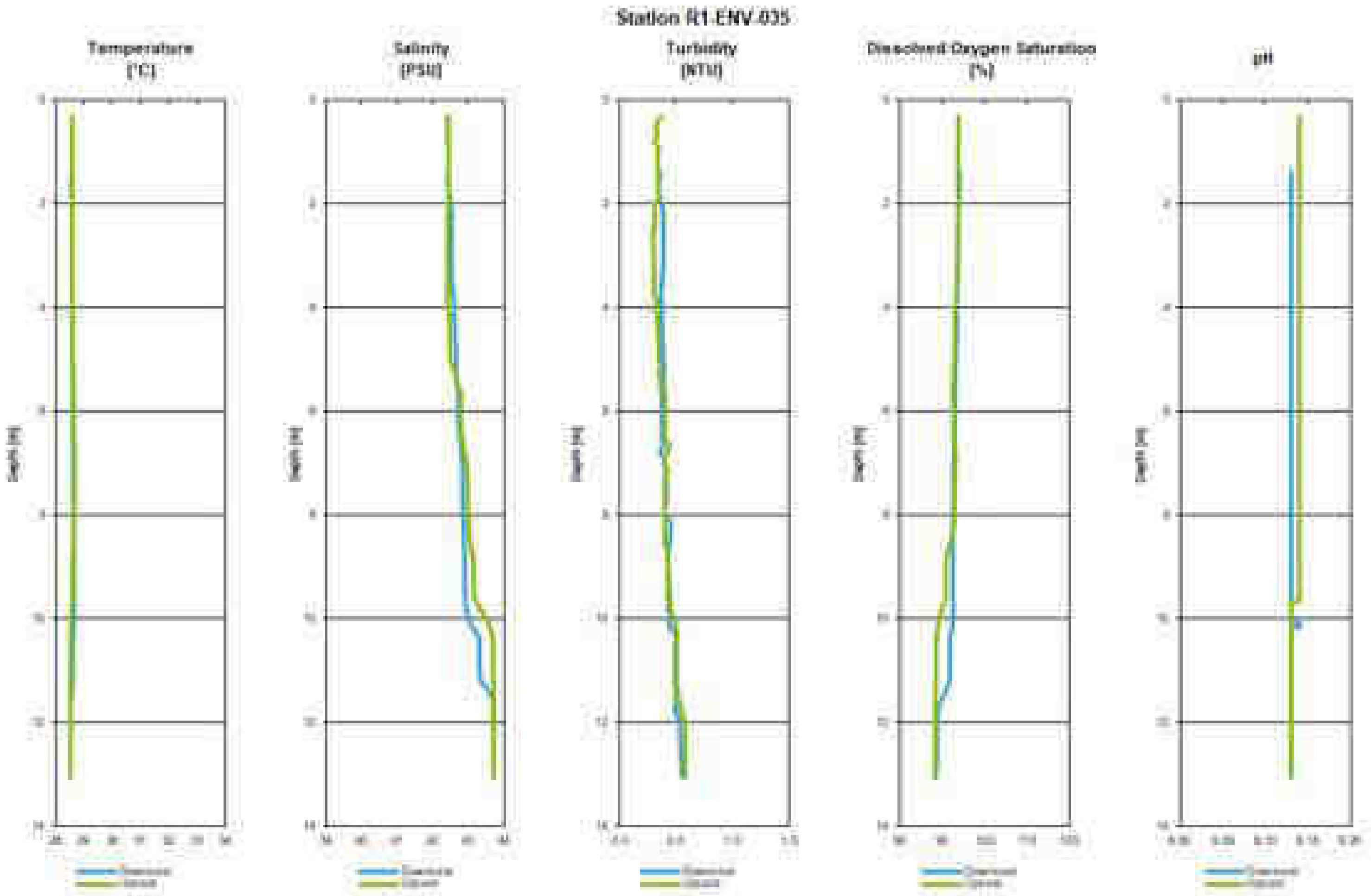



Figure 4.2: Example water profile showing temperature, salinity, turbidity, dissolved oxygen and pH at station R1_ENV_035, Route 1

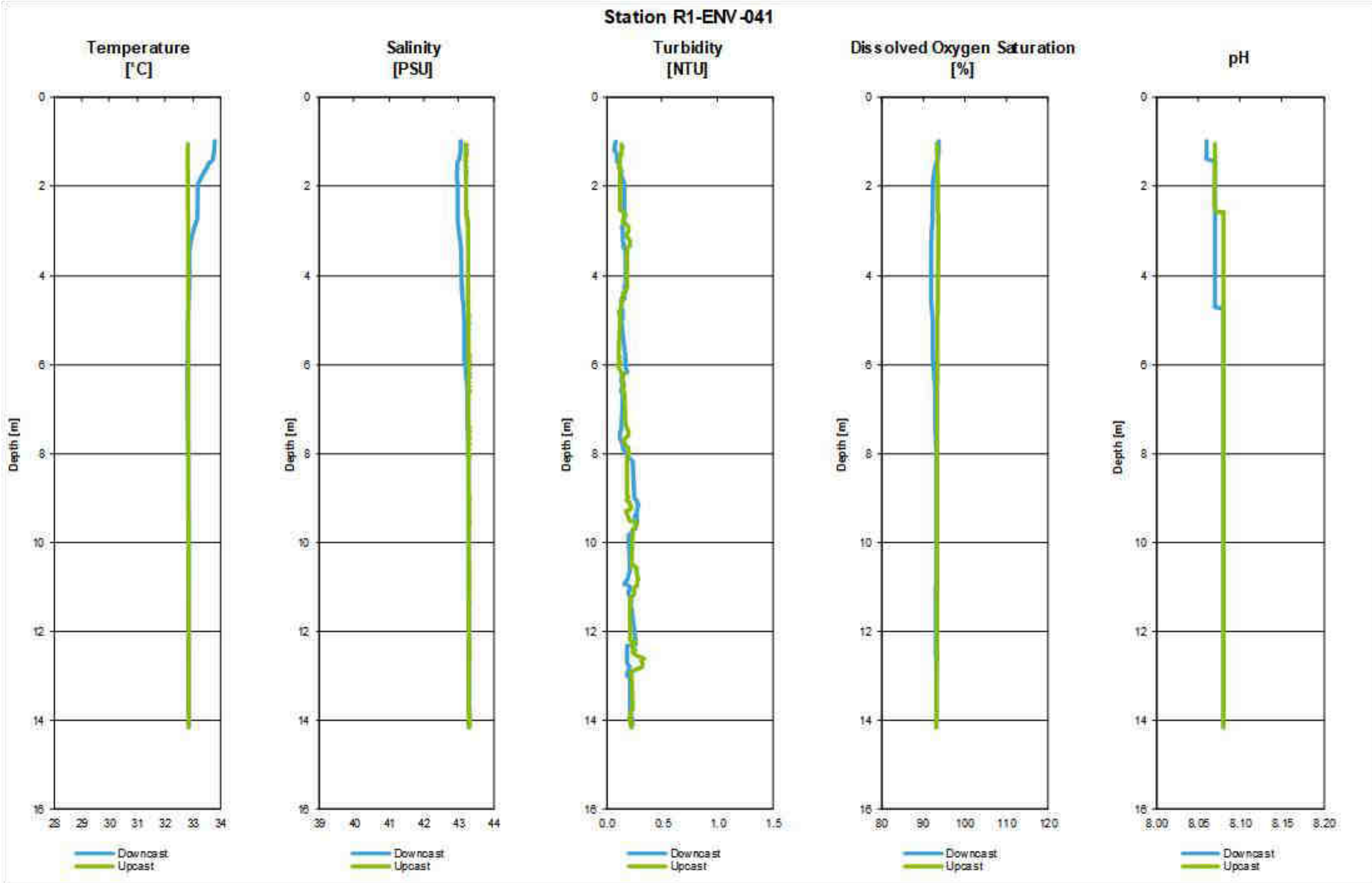



Figure 4.3: Example water profile showing temperature, salinity, turbidity, dissolved oxygen and pH at station R1_ENV_041, Route 1

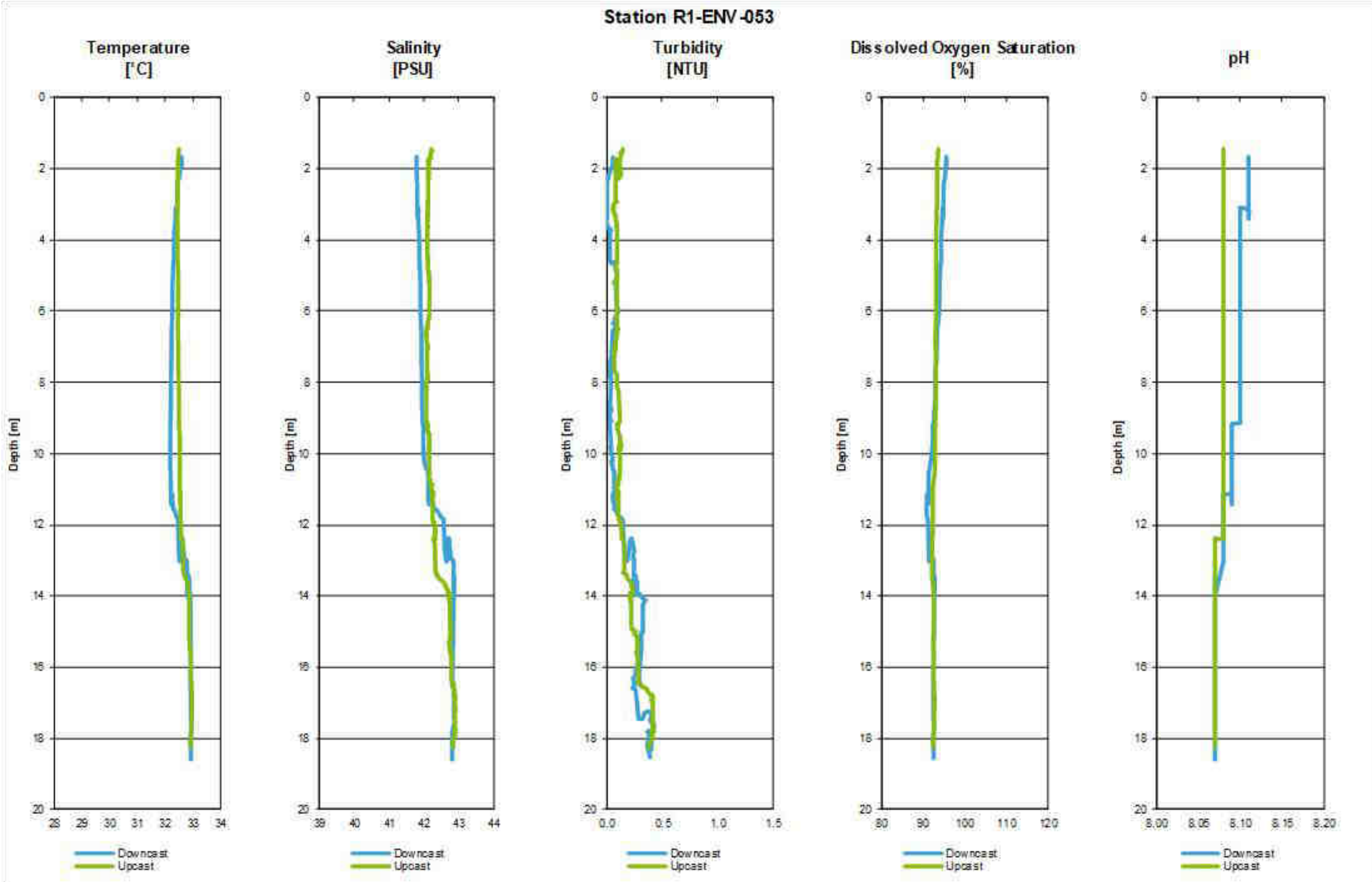



Figure 4.4: Example water profile showing temperature, salinity, turbidity, dissolved oxygen and pH at station R1_ENV_053, Route 1

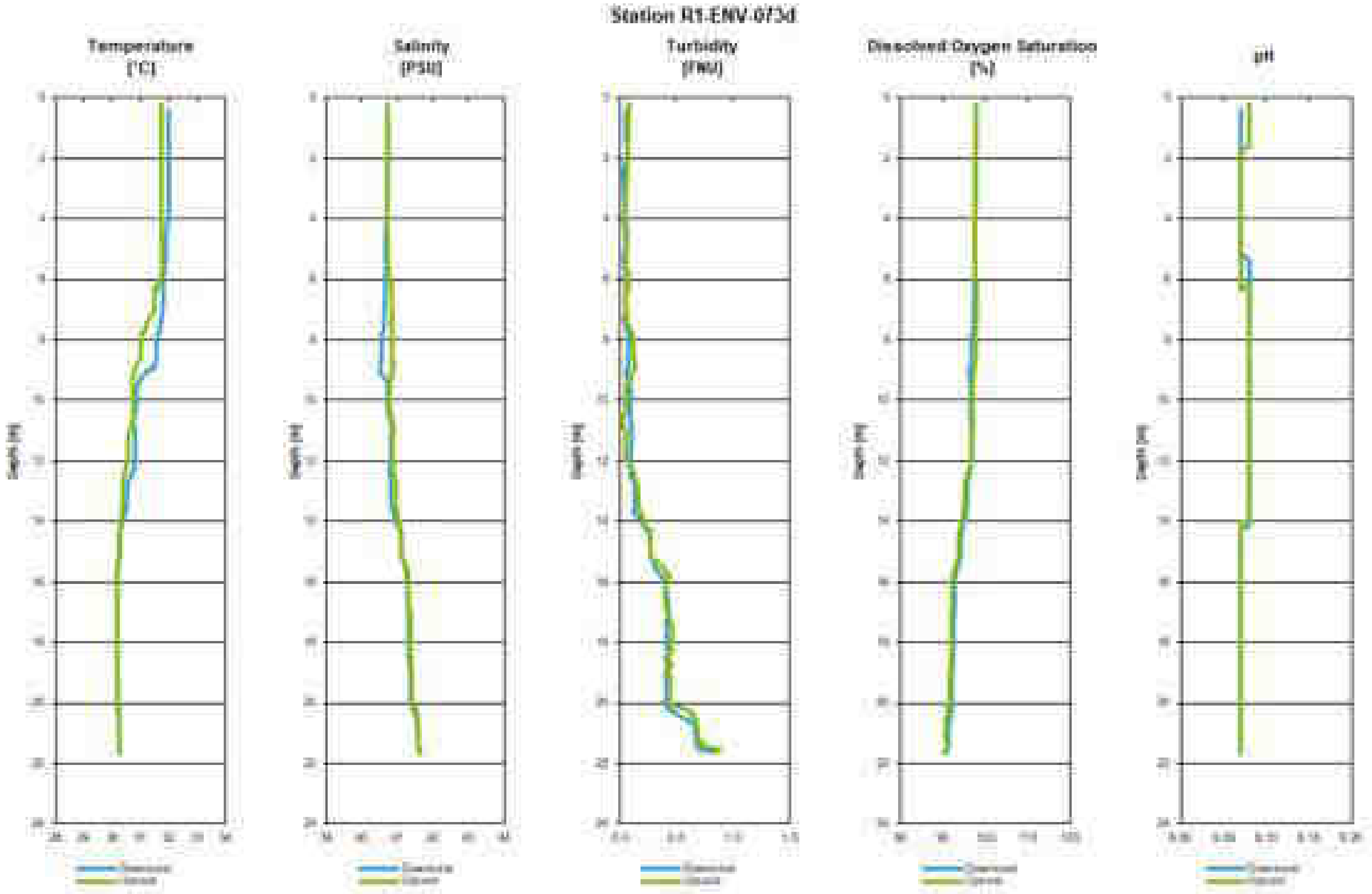



Figure 4.5: Example water profile showing temperature, salinity, turbidity, dissolved oxygen and pH at station R1_ENV_113, Route 1

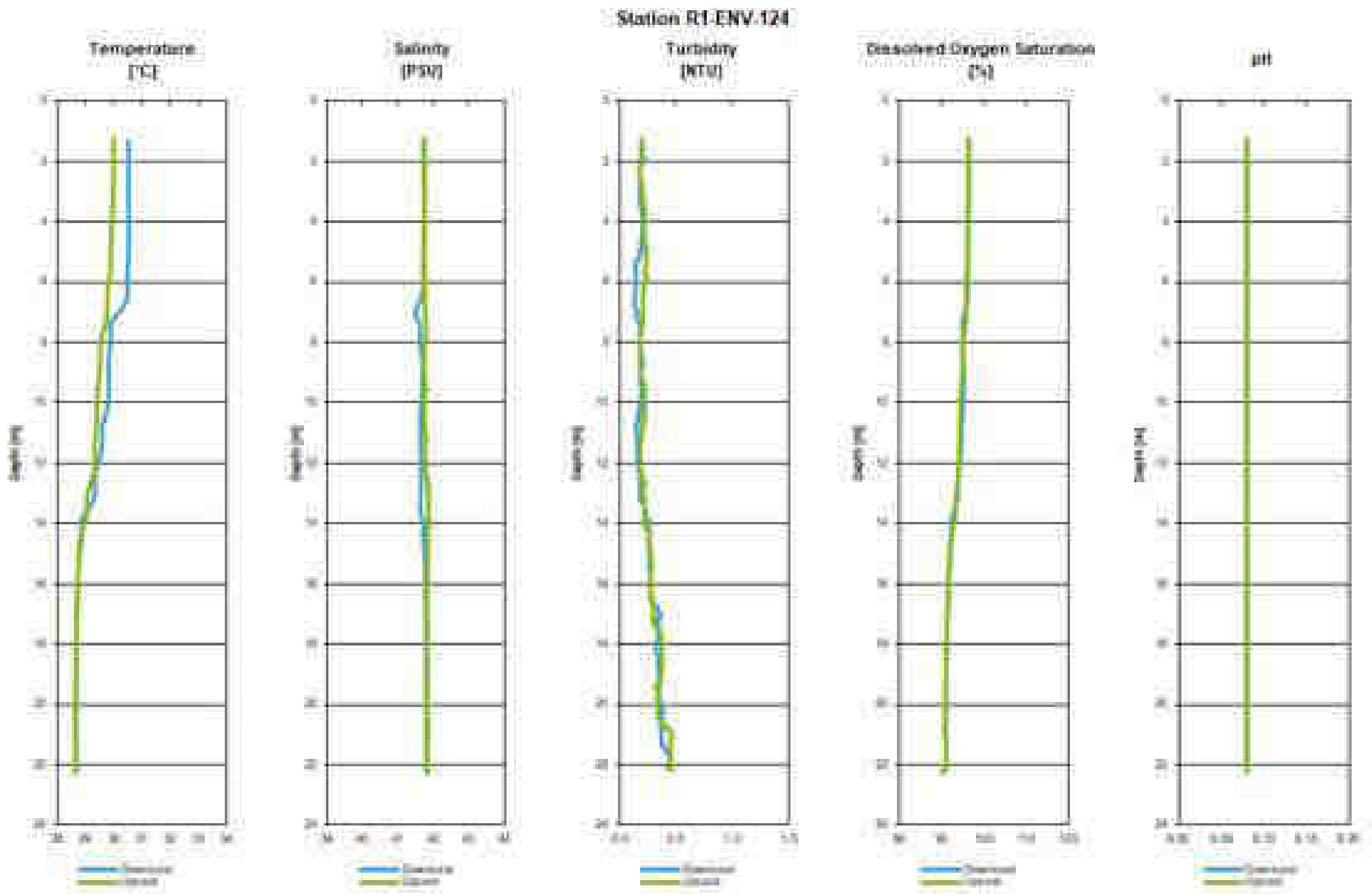



Figure 4.6: Example water profile showing temperature, salinity, turbidity, dissolved oxygen and pH at station R1_ENV_124, Route 1

# 5. Inorganic Water Quality Parameters

## 5.1 Introduction

Water samples were analysed for a suite of inorganic indicators of water quality, presented in Appendix E.1.

Inorganic water quality parameters were compared to their respective ADS 18/2017 MACs (QCC, 2017), US EPA CCC and CMC values (US EPA, 2020). Concentrations below the CCC and CMC values are considered concentrations at which detrimental effects are rarely observed in biota.

Relative standard deviation (RSD) indicates the extent of variability in a dataset in relation to the mean value. The RSD value expresses the standard deviation as a percentage of the mean. For the purpose of this report, RSD of less than 30 % will be considered low variability, 30 % to 70 % will be considered moderate variability and more than 70 % will be considered high variability.

## 5.2 Results

The pH ranged between 7.9 and 8.2 in all water samples acquired. These values fall within the US EPA CCC range of 6.5 to 8.5 (US EPA, 2020).

Turbidity ranged from < 0.1 NTU in 32 samples to 3.6 NTU in sample R1_ENV_002-Bottom, with a mean value of 0.4 NTU and high variability (RSD 105 %).

Total dissolved solids (TDS) ranged from 45500 mg/L in samples R1_ENV_075-Top, R1_ENV_079-Top and R1_ENV_084-Top to 53000 mg/L in sample R1_ENV_016-Middle, with a mean value of 48200 mg/L and low variability (RSD 4 %).

Total organic carbon (TOC) ranged from 1.2 mg/L in 14 samples to 2.6 mg/L in sample R1_ENV_063-Bottom, with a mean value of 1.5 mg/L and low variability (RSD 13 %).

Total nitrogen concentrations were below the MRV (0.5 mg/L) in all samples except in sample R1_ENV_028-Top (0.7 mg/L).

Nitrate concentrations were below the MRV (0.04 mg/L) in 282 samples and the remaining 77 samples ranged from 0.04 mg/L (10 samples) to 0.85 mg/L in sample R1_ENV_036-Middle.

Total phosphorus concentrations were below the MRV (0.03 mg/L) in all but nine samples where concentrations ranged from 0.04 mg/L (5 samples) to 0.15 mg/L in sample R1_ENV_004- Bottom.

Nitrite concentrations were below the MRV (0.016 mg/L) at all samples except in sample R1_ENV_083-Middle which recorded a concentration of 0.017 mg/L.

Sulphate concentrations ranged from 2930 mg/L in samples R1_ENV_016-Top and R1_ENV_024-Bottom to 3710 mg/L in sample R1_ENV_001-Middle, with a mean of 3170 mg/L and low variability (RSD 4 %).

Chloride concentrations ranged from 22300 mg/L (8 samples) to 26600 mg/L (7 samples), with a mean of 24200 mg/L and low variability (RSD 4 %).

Total cyanide concentrations were below the MRV (0.01 mg/L) in all but three samples (R1_ENV_022- Bottom, R1_ENV_055-Middle and R1_ENV_077-Top). The MRV for total cyanide concentrations (0.01 mg/L) was higher than the US EPA CCC and CMC threshold values (0.001 mg/L) and therefore could not be compared.

The remaining water quality parameters presented in Appendix E.1 were below their respective MRVs for all samples obtained.

# 6. Water Column Hydrocarbons

## 6.1 Introduction

Seawater samples were analysed for their hydrocarbon content, including volatile hydrocarbons, extractable petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), BTEX and phenols.

Concentrations of extractable petroleum hydrocarbons were compared to their ADS 18/2017 MACs (QCC, 2017). In the absence of local guideline values, BTEX concentrations were compared to the CCME Marine Long-Term Water Quality Guidelines for the Protection of Aquatic Life values (CCME, 2020).

Appendix F.1 displays the concentrations of volatile petroleum hydrocarbons, extractable petroleum hydrocarbons, dissolved and emulsified oil and free oil.

## 6.2 Results

### 6.2.1 Hydrocarbons

Most concentrations of all analytes sampled across the Route 1 survey area were below their respective MRVs. Concentrations of free oil were above the MRV in all samples obtained at stations R1_ENV_036, R1_ENV_037, R1_ENV_120, R1_ENV_121, R1_ENV_122 and R1_ENV_123, as well as sample R1_ENV_119 top.

The MRV (10 µg/L) for extractable petroleum hydrocarbons was above the ADS 18/2017 MAC for both general use areas (7.0 µg/L) and marine protected areas (7.0 µg/L) and therefore no meaningful comparison of the current data can be made to the reference values.

### 6.2.2 Polycyclic Aromatic Hydrocarbons (PAHs)

Naphthalene concentrations were below the MRV (0.02 µg/L) in all samples except R1_ENV_001-Middle, R1_ENV_028-Top, R1_ENV_049-Top, R1_ENV_080-Top, R1_ENV_095-Top and R1_ENV_108- Top which recorded concentrations of 0.02 µg/L.

Phenanthrene concentrations were below the MRV (0.01 µg/L) in all samples except R1_ENV_061- Middle (0.02 µg/L), R1_ENV_004-Bottom (0.03 µg/L) and R1_ENV_017-Bottom (0.05 µg/L).

Pyrene concentrations were below the MRV (0.01 µg/L) in all samples except R1_ENV_001-Bottom and R1_ENV_004-Bottom which recorded concentrations of 0.01 µg/L.

The remaining PAH parameters presented in Appendix F.2 were below their respective MRVs for all samples.

### 6.2.3 Benzene, Toluene, Ethylbenzene and Xylene (BTEX)

Concentrations of BTEX were below their respective MRVs at all samples across the Route 1 survey area (Appendix F.3). Benzene, toluene and ethylbenzene concentrations were below their respective CCME guideline values for the protection of aquatic life (CCME, 2020).

### 6.2.4 Phenols

Concentrations of phenol and phenolic compounds were below their respective MRVs at all samples across the Route 1 survey area (Appendix F.4).

# 7. Water Column Major and Trace Elements

## 7.1 Introduction

Water samples collected from the survey area were analysed for selected elements: aluminium, arsenic, barium, cadmium, chromium, copper, iron, lead, mercury, silver, vanadium and zinc using ICP-MS.

Concentrations of metals in the water samples were compared to their respective ADS 18/2017 MACs (QCC, 2017), US EPA CCC and criterion maximum concentration CMC values (US EPA, 2020).

## 7.2 Results

Appendix G.1 summarises the concentrations of major and trace elements in the water samples from the Route 1 survey area.

Aluminium concentrations ranged from below the MRV (0.005 mg/L) in 252 samples to 0.100 mg/L in sample R1_ENV_045-Bottom.

Arsenic concentrations ranged from below the MRV (0.0005 mg/L) in seven samples to 0.0053 mg/L in sample R1_ENV_052-Top, with a mean of 0.0027 mg/L and moderate variability (RSD 32 %). Concentrations of arsenic were below the US EPA CCC threshold of 0.036 mg/L in at all samples.

Barium concentrations ranged from below the MRV (0.0005 mg/L) in sample R1_ENV_103-Top to 0.0235 mg/L (sample R1_ENV_077-Bottom), with a mean of 0.0068 mg/L and moderate variability (RSD 53 %).

Cadmium concentrations were below the MRV (0.0001 mg/L) in all samples, except 23 samples with a concentration of 0.0001 mg/L, 4 samples with a concentration of 0.0002 mg/L and one sample with a concentration of 0.0019 mg/L (sample R1_ENV_081-Top). Concentrations of cadmium were above the ADS 18/2017 MAC for both general use areas (0.0003 mg/L) and marine protected areas (0.0007 mg/L) in sample R1_ENV_081-Top, but below the US EPA CCC threshold of 0.0079 mg/L and US EPA CMC threshold of 0.033 mg/L.

Chromium concentrations ranged from below the MRV (0.0001 mg/L) in 237 samples to 0.0055 mg/L (sample R1_ENV_051-Top). Concentrations of chromium were above the ADS 18/2017 MAC for both general use areas (0.0002 mg/L) and marine protected areas (0.0002 mg/L) in 100 samples but below the US EPA CCC threshold of 0.050 mg/L. All samples were below the US EPA CMC threshold of 1.100 mg/L.

Copper concentrations ranged from below the MRV (0.0003 mg/L) in 276 samples to 0.1300 mg/L (sample R1_ENV_077-Bottom). Concentrations of copper were above the ADS 18/2017 MACs for both general use areas (0.0030 mg/L) and marine protected areas (0.0030 mg/L) in 17 samples, as well as the US EPA CCC threshold of 0.0031 mg/L in 16 samples and the US EPA CMC threshold of 0.0048 mg/L in 8 samples.

Iron concentrations were below the MRV (0.02 mg/L) at all samples, apart from 34 samples where the concentrations ranged from 0.02 mg/L to 0.19 mg/L.

Lead concentrations were below the MRV (0.0002 mg/L) at 210 samples to 0.0175 mg/L (sample R1_ENV_077-Bottom). The lead concentrations were above the ADS 18/2017 MAC for both general use areas (0.0022 mg/L) and marine protected areas (0.0022 mg/L) in 31 samples, the US EPA CCC threshold of 0.0056 mg/L in 4 samples and were below the US EPA CMC threshold of 0.140 mg/L in all samples.

Vanadium concentrations ranged from 0.0011 mg/L in sample R1-ENV-084-Top to 0.0049 mg/L in sample R1_ENV_121 Top, with a mean concentration of 0.0026 mg/L and low variability (RSD 17 %).

Zinc concentrations ranged from below the MRV (0.002 mg/L) in 128 samples to 0.156 mg/L in sample R1_ENV_095-Bottom. Concentrations of zinc were above the ADS 18/2017 MAC for general use areas (0.015 mg/L) and for marine protected areas (0.015 mg/L) in 129 samples, as well as US EPA CCC and CMC thresholds (US EPA, 2020; 5 samples).

Concentrations of mercury and silver were all below their respective MRVs (presented in Appendix G.1) at all samples across the survey area and were below their respective ADS 18/2017 MAC for both general use and marine protected areas, as well as the US EPA CCC and CMC thresholds (US EPA, 2020).

# 8. Sediment Characterisation

## 8.1 Introduction

Sediment samples were analysed for their PSD using a combination of two techniques; sieve analysis for all material retained by a 1 mm sieve followed by laser diffraction analysis of the finer material. The results of the particle size analysis were treated statistically to characterise the sediment type (Wentworth Scale and Folk) and particle size homogeneity (sorting index).

Carbonate content was analysed with the following method. A pre-dried aliquot of the sediment was weighed and then treated with hydrochloric acid to remove inorganic carbon in the form of carbonate. Fresh acid was added until all effervescence ceased; the sediment was then washed over a glass-fibre filter and the residue dried to a constant weight.

The TOC content was determined by combustion with Non-Dispersive Infrared Detection (NDIR).

Appendix B provides full details of the analytical techniques employed and Appendix H.1 displays the histograms of particle size class summary for each station.

## 8.2 Sediment Sample Results

Appendix H.2 presents the sediment characteristics, including granulometry, TOC and carbonate content across the Route 1 survey area. Figure 8.1 presents the granulometry of the sediments at each station, whilst Figure 8.2a and b presents the fractional composition of the sediments spatially across the Route 1 survey area.

The TOC content across Route 1 ranged from 0.08 % at station R1_ENV_030 to 0.83 % at station R1_ENV_074 (mean 0.34 %) with moderate interstation variability (RSD 65 %).

The carbonate content across Route 1 ranged from 73.7 % at station R1_ENV_002 to 99.1 % at stations R1_ENV_038, R1_ENV_081, R1_ENV_096 and R1_ENV_ 099 (mean 95.0 %), with low interstation variability (RSD 5 %).

When fractional composition (Table H.2 and Figure 8.1) was considered, the sand fraction was the prevalent sediment fraction at the majority of the stations across Route 1 and ranged from 12.02 % at station R1_ENV_074 to 99.66 % at station R1_ENV_122 (mean 70.73 %) with moderate variability (RSD 34 %). The gravel fraction was recorded in low levels across the survey area whereas the fines fraction dominated 10 stations (stations R1_ENV_068, R1_ENV_070 to R1_ENV_076, R1_ENV_088 and R1_ENV_093). The Folk descriptions classify sediment by the relative proportion of sediment fractions (gravel, sand and fines). The Folk description (BGS modified) classified twenty-nine stations as slightly gravelly muddy sand, ten stations as slightly gravelly sand, ten stations as slightly gravelly sandy mud, eight stations as gravelly muddy sand and three stations as gravelly sand.

The fractional composition of the Route 1 survey area was comparable to previously reported data from the Zakum area, which recorded sand as the dominant sediment type (mean 82 %) (Blue Sea Environmental Consultants, 2011).

Appendix H.3 presents the physical composition of the sediments (Folk and Ward) at each station across the Route 1 survey area. The mode (or modal distribution) represents the peak of the particle size frequency distribution. Within the Route 1 survey area, distributions were mixed, with 40 stations displaying a unimodal distribution, 17 stations displaying a bimodal distribution and 3 stations displaying a trimodal distribution (Appendix H.1).

The mean particle size (μm) (Appendix H.3) across Route 1 ranged from 14 μm at station R1_ENV_074 to 750 μm at station R1_ENV_038 (mean 263 μm), with moderate interstation variability (RSD 67 %).

The Wentworth description, assigned from mean particle size, categorised sediments across Route 1 as coarse sand (3 stations), coarse silt (4 stations), fine sand (14 stations), fine silt (1 station), medium sand (28 stations), medium silt (6 stations) and very fine sand (4 stations).

The sorting coefficient of particle size indicates the degree of spread of individual size classes about the mean and provides the basis of a sorting index, in which low values indicate sediments to be fairly homogeneous (well sorted) while high values suggest a relatively large scatter of particle sizes about the mean (poorly sorted). Across Route 1 six stations were described as moderately sorted, sixteen stations described as poorly sorted and thirty-eight stations described as very poorly sorted.

Skewness indicates the tendency of particle size classes to be skewed about the mean, either towards coarser sediment (negative skewness) or finer sediment (positive skewness). Across Route 1 skewness ranged from −0.23 μm at station R1_ENV_099 to 0.50 μm at station R1_ENV_058 (mean 0.28 μm). Thirty-four stations were described as very fine skewed, fourteen as fine skewed, two stations as coarse skewed and ten stations as symmetrical.

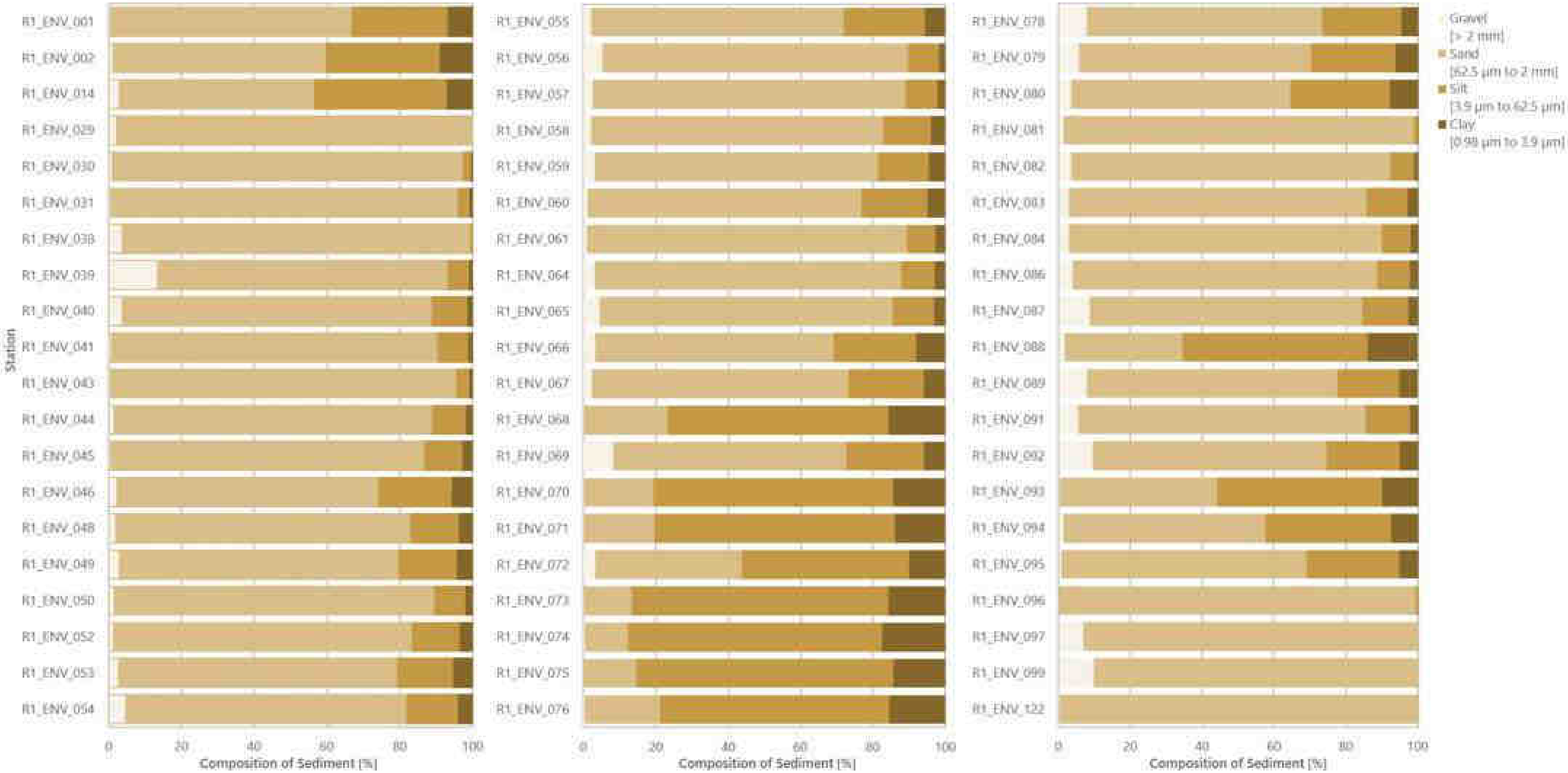



Figure 8.1: Sediment composition, Route 1

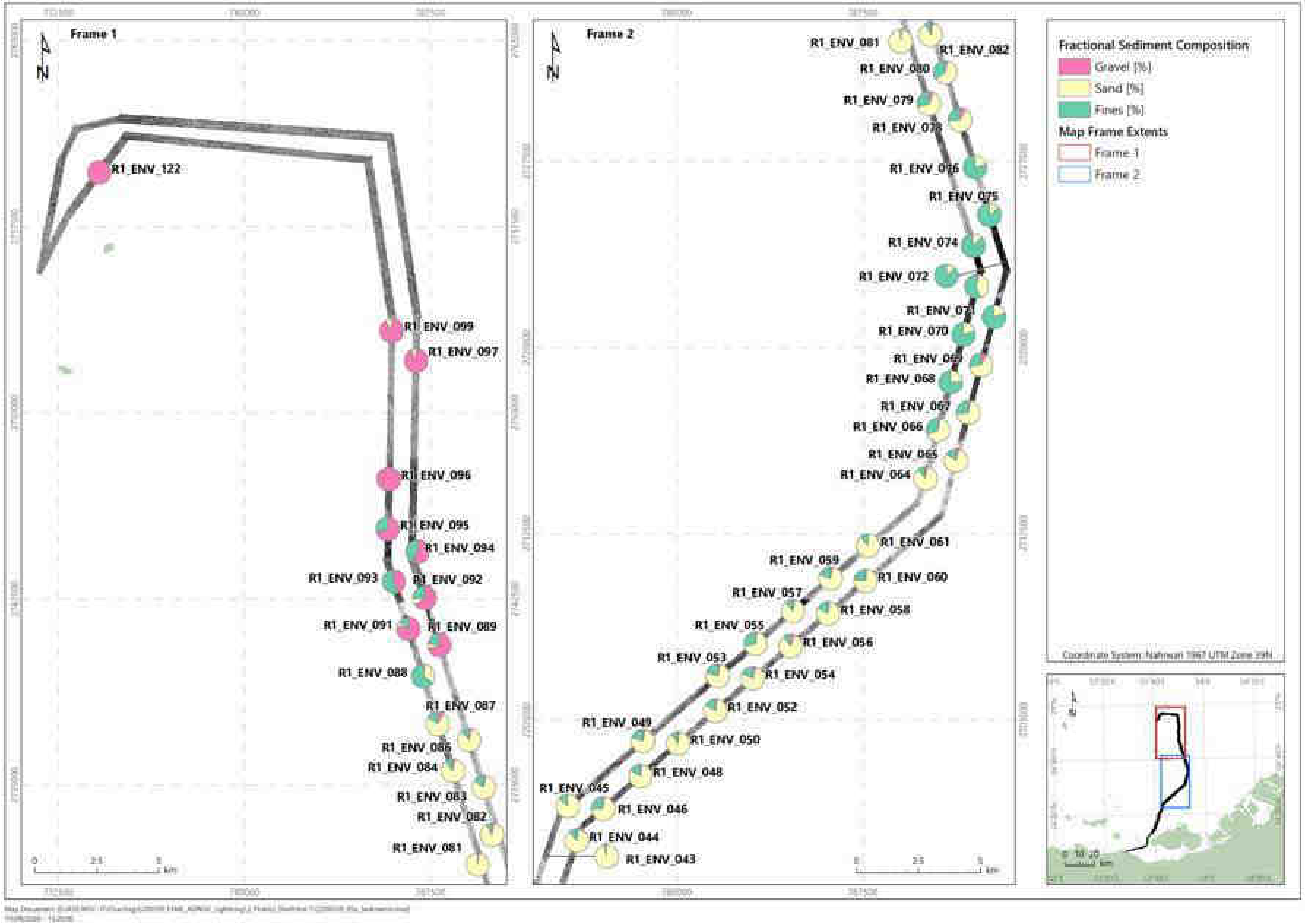



Figure 8.2a: Sediment fractional composition overlaid on bathymetry, Route 1

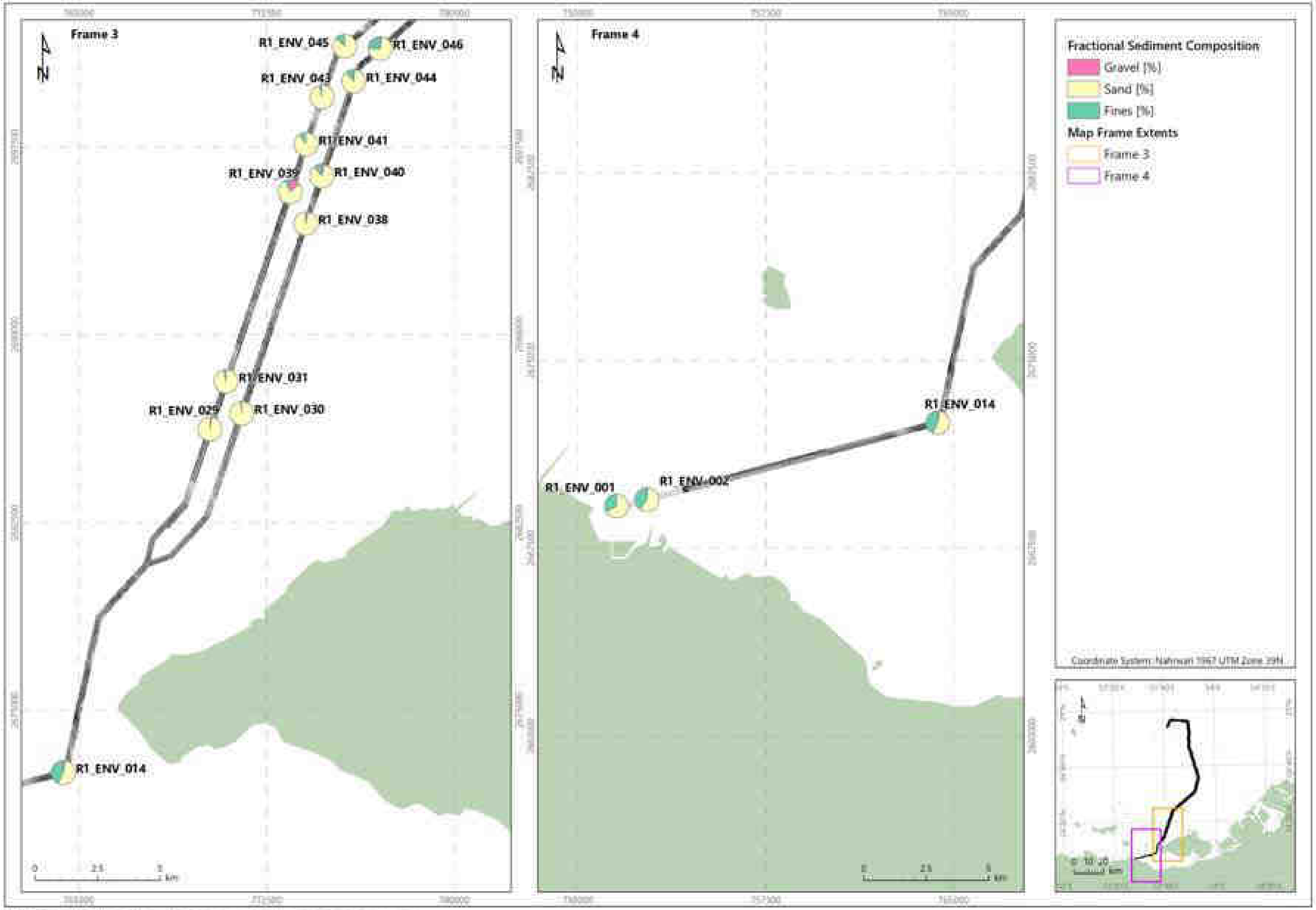



Figure 8.2b: Sediment fractional composition overlaid on bathymetry, Route 1

## 8.3 Soil Sample Results

The TOC content across Route 1 within the eight soil samples ranged from 0.13 % at station SO_R1_005 (R1_ENV_040) to 0.75 % at station SO_R1_009 (R1_ENV_072) (mean 0.37 %) with moderate interstation variability (RSD 64 %).

Table 8.1: Soil sample TOC content, Route 1

| Station | TOC [%] |
|---|---|
| SO_R1_005 | 0.13 |
| SO_R1_006 | 0.29 |
| SO_R1_007 | 0.24 |
| SO_R1_008 | 0.21 |
| SO_R1_009 | 0.75 |
| SO_R1_010 | 0.37 |
| SO_R1_011 | 0.74 |
| SO_R1_012 | 0.25 |
| **Minimum** | **0.13** |
| **Maximum** | **0.75** |
| **Mean** | **0.37** |
| **Standard Deviation** | **0.240** |
| **RSD [%]** | **64** |
| Upper Zakum Pipelines Replacement Project EBS (NPCC, 2019)* | |
| **Mean** | **0.4692** |

Notes
TOC = Total organic carbon
RSD = Relative standard deviation
* = Mean taken from Environmental Baseline Survey Upper Zakum Replacement Project Phase 1 (NPCC, 2019)

# 9. Sediment Nutrients

## 9.1 Introduction

Seabed sediments were analysed for silicon, phosphorus, total cyanide and total nitrogen.

Silicon and phosphorus were determined on an air dried and ground sample following an aqua regia digest with analysis by ICP-OES. Total cyanide was determined on wet sediment by segmented flow analysis with colorimetric detection. Total nitrogen was determined on an air dried and ground sediment sample by an elemental analyser.

## 9.2 Sediment Sample Results

Silicon concentrations ranged from 64 mg/kg at station R1_ENV_076 to 408 mg/kg at station R1_ENV_014, with a mean of 164 mg/kg and moderate variability (RSD 47 %).

Phosphorus concentrations ranged from 171 mg/kg at station R1_ENV_038 to 611 mg/kg at station R1_ENV_072, with a mean of 375 mg/kg and low variability (RSD 26 %).

Total cyanide concentrations were below the MRV (0.5 mg/kg) at all stations sampled.

Total nitrogen concentrations ranged from less than the MRV (0.04 % or 0.05 %) at nine stations to 0.16 % at station R1_ENV_072, with a mean of 0.07 % and moderate variability (RSD 60 %).

Table 9.1 presents the concentration of nutrients in the surface sediment samples across the Route 1 survey area.

Table 9.1: Sediment nutrient concentrations, Route 1

| Station | Silicon* | Phosphorus* | Total Cyanide* | Total Nitrogen† |
|---|---|---|---|---|
| R1_ENV_001 | 226 | 266 | < 0.5 | 0.05 |
| R1_ENV_002 | 246 | 215 | < 0.5 | 0.06 |
| R1_ENV_014 | 408 | 306 | < 0.5 | 0.15 |
| R1_ENV_029 | 194 | 303 | < 0.5 | < 0.04 |
| R1_ENV_030 | 197 | 283 | < 0.5 | < 0.04 |
| R1_ENV_031 | 117 | 236 | < 0.5 | < 0.04 |
| R1_ENV_038 | 208 | 171 | < 0.5 | < 0.04 |
| R1_ENV_039 | 193 | 349 | < 0.5 | < 0.04 |
| R1_ENV_040 | 279 | 347 | < 0.5 | 0.04 |
| R1_ENV_041 | 238 | 322 | < 0.5 | 0.04 |
| R1_ENV_043 | 250 | 270 | < 0.5 | 0.05 |

| Station | Silicon* | Phosphorus* | Total Cyanide* | Total Nitrogen† |
|---|---|---|---|---|
| R1_ENV_044 | 124 | 277 | < 0.5 | 0.05 |
| R1_ENV_045 | 231 | 342 | < 0.5 | 0.05 |
| R1_ENV_046 | 199 | 291 | < 0.5 | 0.05 |
| R1_ENV_048 | 170 | 254 | < 0.5 | 0.06 |
| R1_ENV_049 | 189 | 355 | < 0.5 | 0.05 |
| R1_ENV_050 | 125 | 323 | < 0.5 | 0.05 |
| R1_ENV_052 | 174 | 360 | < 0.5 | 0.04 |
| R1_ENV_053 | 120 | 339 | < 0.5 | 0.05 |
| R1_ENV_054 | 125 | 283 | < 0.5 | 0.05 |
| R1_ENV_055 | 166 | 389 | < 0.5 | 0.1 |
| R1_ENV_056 | 124 | 224 | < 0.5 | < 0.05 |
| R1_ENV_057 | 97 | 346 | < 0.5 | 0.06 |
| R1_ENV_058 | 293 | 436 | < 0.5 | 0.06 |
| R1_ENV_059 | 107 | 433 | < 0.5 | < 0.05 |
| R1_ENV_060 | 90 | 406 | < 0.5 | 0.05 |
| R1_ENV_061 | 94 | 373 | < 0.5 | < 0.05 |
| R1_ENV_064 | 315 | 433 | < 0.5 | 0.04 |
| R1_ENV_065 | 101 | 433 | < 0.5 | 0.05 |
| R1_ENV_066 | 97 | 435 | < 0.5 | 0.1 |
| R1_ENV_067 | 94 | 440 | < 0.5 | 0.08 |
| R1_ENV_068 | 112 | 547 | < 0.5 | 0.13 |
| R1_ENV_069 | 83 | 394 | < 0.5 | 0.07 |
| R1_ENV_070 | 98 | 549 | < 0.5 | 0.13 |
| R1_ENV_071 | 99 | 539 | < 0.5 | 0.14 |
| R1_ENV_072 | 291 | 611 | < 0.5 | 0.16 |
| R1_ENV_073 | 93 | 555 | < 0.5 | 0.14 |
| R1_ENV_074 | 114 | 599 | < 0.5 | 0.14 |
| R1_ENV_075 | 76 | 525 | < 0.5 | 0.15 |
| R1_ENV_076 | 64 | 380 | < 0.5 | 0.14 |
| R1_ENV_078 | 90 | 474 | < 0.5 | 0.06 |
| R1_ENV_079 | 80 | 365 | < 0.5 | 0.06 |
| R1_ENV_080 | 318 | 516 | < 0.5 | 0.09 |
| R1_ENV_081 | 163 | 252 | < 0.5 | 0.04 |
| R1_ENV_082 | 121 | 358 | < 0.5 | 0.06 |

| Station | Silicon* | Phosphorus* | Total Cyanide* | Total Nitrogen† |
|---|---|---|---|---|
| R1_ENV_083 | 193 | 402 | < 0.5 | 0.05 |
| R1_ENV_084 | 96 | 372 | < 0.5 | 0.05 |
| R1_ENV_086 | 139 | 412 | < 0.5 | 0.04 |
| R1_ENV_087 | 125 | 375 | < 0.5 | 0.05 |
| R1_ENV_088 | 280 | 441 | < 0.5 | 0.15 |
| R1_ENV_089 | 120 | 380 | < 0.5 | 0.05 |
| R1_ENV_091 | 157 | 364 | < 0.5 | 0.05 |
| R1_ENV_092 | 173 | 403 | < 0.5 | 0.08 |
| R1_ENV_093 | 94 | 396 | < 0.5 | 0.13 |
| R1_ENV_094 | 92 | 443 | < 0.5 | 0.13 |
| R1_ENV_095 | 103 | 376 | < 0.5 | 0.11 |
| R1_ENV_096 | 328 | 390 | < 0.5 | 0.05 |
| R1_ENV_097 | 175 | 353 | < 0.5 | 0.05 |
| R1_ENV_099 | 163 | 202 | < 0.5 | 0.05 |
| R1_ENV_122 | 196 | 308 | < 0.5 | < 0.04 |
| **Minimum** | **64** | **171** | **Y** | **< 0.04** |
| **Maximum** | **408** | **611** | **< 0.5** | **0.16** |
| **Mean** | **164** | **375** | **-** | **0.07** |
| **Standard Deviation** | **77.1** | **97.8** | **-** | **0.041** |
| **RSD [%]** | **47** | **26** | **-** | **60** |

Notes
For statistical evaluation, results < MRV were treated as absolute values determined by MRV/2
* = Concentrations expressed as mg/kg of dry sediment
† = Concentrations expressed as a percentage [%] of dry sediment
RSD = Relative standard deviation
MRV = Minimum reporting value

## 9.3 Soil Sample Results

Fluoride concentrations across the Route 1 survey area ranged from below the MRV (4.0 mg/kg) at four stations to 4.8 mg/kg at station SO_R1_007, with a mean of 3.2 mg/kg and moderate variability observed (RSD 41 %).

Total cyanide concentrations were below the MRV (0.5 mg/kg) at all stations.

Total nitrogen concentrations ranged from 0.04 % at stations SO_R1_005 and SO_R1_008 to 0.16 % at station SO_R1_009, with a mean of 0.08 % and moderate variability observed (RSD 59 %).

Phosphate concentrations across Route 1 ranged from 106 mg/l at station SO_R1_005 to 180 mg/l at station SO_R1_009, with a mean of 143 mg/l and low variability observed (RSD 19 %).

The acid soluble sulphate concentrations ranged from 3470 mg/kg at station SO_R1_007 to 8630 mg/kg at station SO_R1_011, with a mean of 5670 mg/kg and low variability (RSD 29 %).

Similarly, the water soluble sulphate concentrations ranged from 765 mg/l at station SO_R1_012 to 2110 mg/l at station SO_R1_011, with a mean of 1100 mg/l and moderate variability (RSD 46%).

Table 9.2: Soil sample nutrient concentrations, Route 1

| Station | Fluoride Water Soluble* | Total Cyanide* | Total Nitrogen† | Phosphates‡ | Sulphates | |
|---|---|---|---|---|---|---|
| | | | | | Acid Soluble* | Water Soluble‡ |
| SO_R1_005 | < 4.0 | < 0.5 | 0.04 | 106 | 4800 | 981 |
| SO_R1_006 | 4.5 | < 0.5 | 0.06 | 140 | 5470 | 779 |
| SO_R1_007 | 4.8 | < 0.5 | 0.06 | 134 | 3470 | 789 |
| SO_R1_008 | 4.4 | < 0.5 | 0.04 | 118 | 4820 | 768 |
| SO_R1_009 | < 4.0 | < 0.5 | 0.16 | 180 | 7570 | 1670 |
| SO_R1_010 | < 4.0 | < 0.5 | 0.09 | 163 | 5080 | 933 |
| SO_R1_011 | < 4.0 | < 0.5 | 0.15 | 128 | 8630 | 2110 |
| SO_R1_012 | 4.0 | < 0.5 | 0.05 | 174 | 5540 | 765 |
| **Minimum** | **< 4.0** | **< 0.5** | **0.04** | **106** | **3470** | **765** |
| **Maximum** | **4.8** | **< 0.5** | **0.16** | **180** | **8630** | **2110** |
| **Mean** | **3.2** | - | **0.08** | **143** | **5670** | **1100** |
| **Standard Deviation** | **1.31** | - | **0.048** | **26.8** | **1650** | **508** |
| **RSD [%]** | **41** | - | **59** | **19** | **29** | **46** |

Notes
For statistical evaluation, results < MRV were treated as absolute values determined by MRV/2
* = Concentrations expressed as mg/kg of dry sediment
† = Concentrations expressed as % of dry sediment
‡ = Concentrations expressed as mg/l of dry sediment
RSD = Relative standard deviation
MRV = Minimum reporting value

# 10. Sediment Hydrocarbons

## 10.1 Introduction

Seabed sediments were analysed for hydrocarbon concentrations including THC ($C_{10}$ to $C_{40}$), BTEX and the US EPA 16 PAHs.

Samples were extracted by ultrasonication of wet sediments with mixed solvents. The sample extracts were then cleaned up using absorption column chromatography with the resulting extracts analysed for THC and US EPA 16 PAHs.

The total hydrocarbon material present was quantified using response factors calculated from the analysis of mixed oil standard solutions over an appropriate range and analysed by GC-FID.

Calibration was undertaken using a range of PAH standard solutions, a number of alkylated PAH, dibenzothiophene and a range of suitable internal standards. Individual response factors were calculated for each of the compounds present in the calibration solution. Response factors for the non-calibrated alkylated PAH were taken to be equivalent to closely related compounds. The MRV of individual and alkylated PAHs is 0.1 ng/g. PAHs were analysed by GC-MS.

BTEX were determined using static headspace sampling and analysed by GC-MS.

Full details of all the analytical techniques employed are included in Appendix B.2.2.

Reference criteria are available for some sediment hydrocarbons, including ADS 18/2017 MACs (QCC, 2017) and internationally recognised environmental effect threshold values, specifically effects range low (ERL) and effects range median (ERM), have been established for several US EPA 16 PAHs (Buchman, 2008).

## 10.2 Sediment Sample Results

### 10.2.1 Total Hydrocarbon Content

Table 10.1 presents the THC concentrations in the surface sediment samples across the Route 1 survey area.

Concentrations of THC across the Route 1 survey area ranged from 1.2 µg/g at stations R1_ENV_029 to R1_ENV_031 to 37.4 µg/g at station R1_ENV_94 (mean 5.4 µg/g) with high variability (RSD 105 %).

Table 10.1: Summary of sediment total hydrocarbon content analysis, Route 1

| Station | THC ($C_{10}$-$C_{40}$) |
|---|---|
| R1_ENV_001 | 3.1 |
| R1_ENV_002 | 2.3 |
| R1_ENV_011 | 15.4 |
| R1_ENV_014 | 4.4 |
| R1_ENV_024 | 4.6 |
| R1_ENV_029 | 1.2 |
| R1_ENV_030 | 1.2 |
| R1_ENV_031 | 1.2 |
| R1_ENV_038 | 1.5 |
| R1_ENV_039 | 2.0 |
| R1_ENV_040 | 2.6 |
| R1_ENV_041 | 1.8 |
| R1_ENV_042 | 5.9 |
| R1_ENV_043 | 1.4 |
| R1_ENV_044 | 1.7 |
| R1_ENV_045 | 2.6 |
| R1_ENV_046 | 2.5 |
| R1_ENV_047 | 6.7 |
| R1_ENV_048 | 2.5 |
| R1_ENV_049 | 2.2 |
| R1_ENV_050 | 1.4 |
| R1_ENV_051 | 10.1 |
| R1_ENV_052 | 1.9 |
| R1_ENV_053 | 2.3 |
| R1_ENV_054 | 2.0 |
| R1_ENV_055 | 3.4 |
| R1_ENV_056 | 2.2 |
| R1_ENV_057 | 2.6 |
| R1_ENV_058 | 3.2 |
| R1_ENV_059 | 2.3 |
| R1_ENV_060 | 1.9 |
| R1_ENV_061 | 2.6 |

| Station | THC ($C_{10}$-$C_{40}$) |
|---|---|
| R1_ENV_064 | 2.5 |
| R1_ENV_065 | 2.4 |
| R1_ENV_066 | 1.5 |
| R1_ENV_067 | 4.2 |
| R1_ENV_068 | 4.9 |
| R1_ENV_069 | 4.9 |
| R1_ENV_070 | 7.4 |
| R1_ENV_071 | 9.8 |
| R1_ENV_072 | 10.8 |
| R1_ENV_073 | 12.1 |
| R1_ENV_074 | 8.7 |
| R1_ENV_075 | 10.2 |
| R1_ENV_076 | 4.8 |
| R1_ENV_078 | 6.8 |
| R1_ENV_079 | 10.5 |
| R1_ENV_080 | 3.7 |
| R1_ENV_081 | 1.8 |
| R1_ENV_082 | 3.6 |
| R1_ENV_083 | 4.0 |
| R1_ENV_084 | 3.7 |
| R1_ENV_086 | 3.9 |
| R1_ENV_087 | 3.2 |
| R1_ENV_088 | 13.0 |
| R1_ENV_089 | 5.5 |
| R1_ENV_091 | 8.7 |
| R1_ENV_092 | 12.7 |
| R1_ENV_093 | 22.5 |
| R1_ENV_094 | 37.4 |
| R1_ENV_095 | 18.0 |
| R1_ENV_096 | 4.5 |
| R1_ENV_097 | 2.6 |
| R1_ENV_099 | 1.8 |
| R1_ENV_104 | 8.1 |
| R1_ENV_105 | 4.6 |

| Station | THC ($C_{10}$-$C_{40}$) |
|---|---|
| R1_ENV_108 | 5.7 |
| R1_ENV_122 | 2.7 |
| R1_ENV_124 | 2.0 |
| R1_ENV_125 | 3.9 |
| R1_ENV_126 | 4.2 |
| **Minimum** | **1.2** |
| **Maximum** | **37.4** |
| **Mean** | **5.4** |
| **Standard Deviation** | **5.71** |
| **RSD [%]** | **105** |

Notes
Concentrations expressed as µg/g of dry sediment
RSD = Relative standard deviation
THC = Total hydrocarbon content

### 10.2.2 Aromatic Hydrocarbon Content

Appendix I.1 summarises the individual concentrations of the US EPA 16 PAHs across the Route 1 survey area. Comparison of the total US EPA 16 concentrations was made to the ADS 18/2017 MAC value for total PAHs (QCC, 2017). Although this document does not state which PAHs constitute the total PAH value, comparison of the total US EPA 16 concentration to this value has been undertaken.

Individual US EPA 16 PAH concentrations were below the MRV (0.1 ng/g) at most stations across Route 1. The total US EPA 16 PAH values were treated as absolute values to enable comparison with the ADS 18/2017 MAC dataset. All values were reported as lower than their respective ADS 18/2017 MAC value for total PAHs (1700 ng/g; QCC, 2017) for both general use and marine protected areas.

### 10.2.3 Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)

Table 10.2 presents the concentrations of BTEX compounds in sediment samples within across the Route 1 survey area.

The concentrations of BTEX compounds along the Route 1 were below the MRV (5.0 ng/g) at all stations.

Table 10.2: Sediment benzene, toluene, ethylbenzene, xylenes (BTEX) compound concentrations, Route 1

| Station | Benzene | Toluene | Ethylbenzene | m, p-Xylene | o-Xylene |
|---|---|---|---|---|---|
| R1_ENV_001 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_002 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_011 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_014 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_024 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_029 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_030 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_031 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_038 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_039 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_040 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_041 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_042 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_043 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_044 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_045 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_046 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_047 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_048 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_049 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_050 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_051 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_052 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_053 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_054 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_055 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_056 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_057 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_058 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_059 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_060 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_061 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_064 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |

| Station | Benzene | Toluene | Ethylbenzene | m, p-Xylene | o-Xylene |
|---|---|---|---|---|---|
| R1_ENV_065 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_066 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_067 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_068 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_069 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_070 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_071 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_072 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_073 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_074 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_075 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_076 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_078 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_079 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_080 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_081 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_082 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_083 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_084 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_086 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_087 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_088 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_089 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_091 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_092 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_093 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_094 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_095 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_096 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_097 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_099 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_104 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_105 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_108 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |

| Station | Benzene | Toluene | Ethylbenzene | m, p-Xylene | o-Xylene |
|---|---|---|---|---|---|
| R1_ENV_122 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_124 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_125 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| R1_ENV_126 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| **Minimum** | **< 5.0** | **< 5.0** | **< 5.0** | **< 5.0** | **< 5.0** |
| **Maximum** | **< 5.0** | **< 5.0** | **< 5.0** | **< 5.0** | **< 5.0** |

Notes
Concentrations expressed as ng/g of dry sediment
BTEX = Benzene, toluene, ethylbenzene, m' and p'-xylene and o'-xylene. Note that m-xylene and p-xylene are not separated by the method. The result is reported as the sum of both isomers

## 10.3 Soil Sample Results

Table 10.3 presents the concentrations of THC and oil and grease concentrations in the soil samples. Concentrations of THC in the soil samples across Route 1 ranged from 2.5 µg/g at station SO_R1_006 to 13.0 µg/g at station SO_R1_011, with a mean of 5.55 µg/g and moderate variability (RSD 68 %). The concentrations of oil and grease will be consistently lower than the THC results. The MRV for oil and grease in sediment was determined to be 50 µg/g, therefore there was no requirement to carry out the analysis.

Table 10.3: Soil sample total petroleum hydrocarbons and oil and grease concentrations, Route 1

| Station | THC ($C_{10}$-$C_{40}$) | Oil and Grease |
|---|---|---|
| SO_R1_003 | 4.6 | < 50.0 |
| SO_R1_005 | 2.6 | < 50.0 |
| SO_R1_006 | 2.5 | < 50.0 |
| SO_R1_007 | 3.2 | < 50.0 |
| SO_R1_008 | 2.5 | < 50.0 |
| SO_R1_009 | 10.8 | < 50.0 |
| SO_R1_010 | 3.7 | < 50.0 |
| SO_R1_011 | 13.0 | < 50.0 |
| SO_R1_012 | 4.5 | < 50.0 |
| SO_R1_013 | 8.1 | < 50.0 |
| **Minimum** | **2.5** | **< 50.0** |
| **Maximum** | **13.0** | **< 50.0** |
| **Mean** | **5.55** | - |
| **Standard Deviation** | **3.77** | - |
| **RSD [%]** | **68** | - |

Notes
Concentrations expressed as µg/g of dry sediment
THC = Total hydrocarbon content

| Station | THC ($C_{10}$-$C_{40}$) | Oil and Grease |
|---|---|---|
| RSD = Relative standard deviation | | |

Table 10.4 presents the concentrations of BTEX compounds in soil samples across the Route 1. The concentrations of BTEX compounds within the Route 1 soil samples were below the MRV (5.0 ng/g) at all stations.

Table 10.4: Soil sample benzene, toluene, ethylbenzene, xylene (BTEX) compound concentrations, Route 1

| Station | Benzene | Toluene | Ethylbenzene | m, p-Xylene | o-Xylene |
|---|---|---|---|---|---|
| SO_R1_003 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| SO_R1_005 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| SO_R1_006 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| SO_R1_007 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| SO_R1_008 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| SO_R1_009 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| SO_R1_010 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| SO_R1_011 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| SO_R1_012 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| SO_R1_013 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 |
| **Minimum** | **< 5.0** | **< 5.0** | **< 5.0** | **< 5.0** | **< 5.0** |
| **Maximum** | **< 5.0** | **< 5.0** | **< 5.0** | **< 5.0** | **< 5.0** |

Notes
Concentrations expressed as ng/g of dry sediment
BTEX = Benzene, toluene, ethylbenzene, m’ and p’-xylene and o’-xylene. Note that m-xylene and p-xylene are not separated by the method. The result is reported as the sum of both isomers

Table 10.5 presents the concentrations of VOCs in the soil samples across Route 1. Concentrations of VOCs in the soil samples across the Route 1 were all below their respective MRVs, apart from at station SO_R1_009 where the tetrachloroethene concentration exceeded the MRV (3 µg/kg) with a concentration of 17 µg/kg.

Table 10.5: Soil sample volatile organic compound concentrations, Route 1

| VOC | Station | | | | | | | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|---|---|
| | SO_R1_005 | SO_R1_006 | SO_R1_007 | SO_R1_008 | SO_R1_009 | SO_R1_010 | SO_R1_011 | SO_R1_012 | | |
| 1,1,1,2-Tetrachloroethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,1,1-Trichloroethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,1,2,2-Tetrachloroethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,1,2-Trichloroethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |

| VOC | Station | | | | | | | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|---|---|
| | SO_R1_005 | SO_R1_006 | SO_R1_007 | SO_R1_008 | SO_R1_009 | SO_R1_010 | SO_R1_011 | SO_R1_012 | | |
| 1,1-Dichloroethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,1-Dichloroethene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,1-Dichloropropene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,2,3-Trichlorobenzene | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 |
| 1,2,3-Trichloropropane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,2,4-Trichlorobenzene | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 |
| 1,2,4-Trimethylbenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,2-Dibromo-3-chloropropane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,2-Dibromoethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,2-Dichlorobenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,2-Dichloroethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,2-Dichloropropane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,3,5-Trimethylbenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,3-Dichlorobenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,3-Dichloropropane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 1,4-Dichlorobenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 2,2-Dichloropropane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 2-Chlorotoluene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 4-Chlorotoluene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Benzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Bromobenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Bromochloromethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Bromodichloromethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Bromoform | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Bromomethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Carbon Tetrachloride | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Chlorobenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Chloroethane | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 |
| Chloroform | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Chloromethane | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 | < 3.0 |
| cis 1,2-Dichloroethene | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 6.0 | < 5.0 | < 5.0 | < 6.0 |
| cis 1,3-Dichloropropene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |

| VOC | Station | | | | | | | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|---|---|
| | SO_R1_005 | SO_R1_006 | SO_R1_007 | SO_R1_008 | SO_R1_009 | SO_R1_010 | SO_R1_011 | SO_R1_012 | | |
| Dibromochloromethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Dibromomethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Dichlorodifluoromethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Ethylbenzene | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 |
| Hexachlorobutadiene | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 |
| iso-Propylbenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| m and p-Xylene | < 4.0 | < 4.0 | < 4.0 | < 4.0 | < 4.0 | < 4.0 | < 4.0 | < 4.0 | < 4.0 | < 4.0 |
| MTBE | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Naphthalene | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 6.0 | < 5.0 | < 5.0 | < 6.0 |
| n-Butylbenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| o-Xylene | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 |
| p-Isopropyltoluene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Propylbenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| sec-Butylbenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Styrene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| tert-Butylbenzene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Tetrachloroethene | < 3.0 | < 3.0 | < 3.0 | < 3.0 | 17 | < 3.0 | < 3.0 | < 3.0 | < 0.3 | 17.0 |
| Toluene | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 5.0 | < 6.0 | < 5.0 | < 5.0 | < 6.0 |
| trans 1,2-Dichloroethene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| trans 1,3-Dichloropropene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Trichloroethene | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Trichlorofluoromethane | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Vinyl Chloride | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |

Notes
Concentrations expressed as µg/kg of dry sediment
VOCs = Volatile organic compounds

# 11. Sediment Polychlorinated Biphenyls

## 11.1 Introduction

Seabed sediments were analysed for a group of 12 PCBs compiled by the World Health Organisation (WHO) by GC-µECD.

Full details of these methodologies are provided in Appendix B.2.2.5.

## 11.2 Results

Appendix J.1 presents the concentrations of individual PCB congeners and total WHO12 concentrations across the Route 1 survey area. Concentrations of all 12 individual PCBs were reported below the MRV (0.020 ng/g) at all stations across Route 1 except for PCB 77 at station R1_ENV_088, which was slightly above the MRV at 0.021 ng/g. The total WHO12 concentrations are below the ADS 18/2017 MAC (22.0 ng/g) for general use areas and MPAs. However, this comparison should be treated with caution as PCB congeners were not specified in the QCC (2017) document.

# 12. Sediment Metals

## 12.1 Introduction

Sediments collected from the Route 1 survey areas were analysed for selected elements: aluminium, arsenic, barium, cadmium, chromium, copper, iron, mercury, nickel, lead, silver, vanadium and zinc.

Metals were extracted from the sediment matrix using an aqua regia digest technique. This provides a partial digest and the results obtained from this method are typically considered indicative of the concentration of metals available for biological interactions. The resulting digests were then analysed for aluminium, barium, iron and vanadium using ICP-OES and analysed for arsenic, cadmium, lead, copper, chromium, nickel, mercury, silver and zinc using ICP-MS. Appendix B.2.2.6 provides full details of all analytical techniques employed.

Concentrations of metals in the sediment samples were compared to their respective ADS 18/2017 MACs (QCC, 2017) and the US National Oceanographic and Atmospheric Administration (NOAA) effects range low (ERL) and effects range median (ERM) values (Buchman, 2008).

## 12.2 Sediment Sample Results

Appendix K.1 summarises the concentrations of the aqua regia extractable metals in the sediment samples across the Route 1 survey area.

Aluminium concentrations ranged from 128 µg/g at station R1_ENV_038 to 5100 µg/g at station R1_ENV_002, with a mean of 1560 µg/g and high variability (RSD 79 %).

Arsenic concentrations ranged from 0.810 µg/g at station R1_ENV_038 to 5.96 µg/g at station R1_ENV_124, with a mean of 3.67 µg/g and moderate variability (RSD 36 %). Concentrations of arsenic were below the US EPA CCC threshold of 7.0 µg/g at all stations sampled.

Barium concentrations ranged from 9.18 µg/g at station R1_ENV_038 to 1700 µg/g at station R1_ENV_095, with a mean of 143 µg/g and high variability (RSD 230 %).

Chromium concentrations ranged from 1.08 µg/g at station R1_ENV_038 to 23.5 µg/g at station R1_ENV_002, with a mean of 8.72 µg/g and moderate variability (RSD 51 %). Concentrations of chromium were above the ADS 18/2017 MAC for marine protected areas (11 µg/g; QCC, 2017) at 14 stations but below the ERL (81.0 µg/g) and ERM (370 µg/g) thresholds (Buchman, 2008).

Copper concentrations ranged from below the MRV (0.800 µg/g) at 5 stations including R1_ENV_038, R1_ENV_096, R1_ENV_097, R1_ENV_099 and R1_ENV_105, to 5.06 µg/g at station R1_ENV_093, with a mean of 1.96 µg/g and high variability (RSD 71 %). The copper concentrations recorded across the survey area were below the

ADS 18/2017 MAC for general use areas and marine protected areas (20.0 µg/g; QCC, 2017).

Iron concentrations ranged from 142 µg/g at station R1_ENV_038 to 5780 µg/g at station R1_ENV_001, with a mean of 1760 µg/g and moderate variability (RSD 63 %).

Lead concentrations ranged from 0.774 µg/g at station R1_ENV_040 to 9.45 µg/g at station R1_ENV_093, with a mean of 2.28 µg/g and high variability (RSD 79 %). The lead concentrations were above the ADS 18/2017 MAC for marine protected areas (5.0 µg/g) at 4 stations, including R1_ENV_088, R1_ENV_093 to R1_ENV_095, but below their respective ERL and ERM values (Buchman, 2008).

Nickel concentrations ranged from 1.00 µg/g at station R1_ENV_104 to 19.8 µg/g at station R1_ENV_002, with a mean of 6.36 µg/g and high variability (RSD 71 %). Concentrations of nickel were above the ADS 18/2017 MAC for general use areas (16.0 µg/g; QCC, 2017) at 4 stations (stations R1_ENV_001, R1_ENV_002, R1_ENV_073, R1_ENV_074) and marine protected areas (7.0 µg/g; QCC, 2017) at 18 stations but below the ERL (20.9 µg/g) and ERM (51.6 µg/g) thresholds at all stations (Buchman, 2008).

Silver concentrations ranged from below the MRV (0.00700 µg/g) at 42 stations to 0.313 µg/g at station R1_ENV_093. All silver concentrations recorded were below their respective ERL and ERM values (Buchman, 2008).

Vanadium concentrations ranged from 1.21 µg/g at station R1_ENV_038 to 20.5 µg/g at station R1_ENV_001, with a mean of 7.76 µg/g and moderate variability (RSD 46 %).

Zinc concentrations ranged from 0.830 µg/g at station R1_ENV_051 to 20.6 µg/g at station R1_ENV_053, with a mean of 4.60 µg/g and high variability (RSD 83 %). The zinc concentrations recorded across the survey area were below the ADS 18/2017 MAC for general use areas (125.0 µg/g; QCC, 2017) and marine protected areas (70.0 µg/g; QCC, 2017).

Concentrations of cadmium and mercury were all below their respective MRVs (presented in Appendix G.1) at all stations across the survey area and were below their respective ADS 18/2017 MAC for both general use and marine protected areas, as well as their respective ERL and ERM thresholds (Buchman, 2008).

Figure 12.1 presents the overall trend in individual metals concentrations, assessed by comparing the relative (maximum normalised) concentrations. By maximum normalising the elemental data for the sediment samples to the highest concentration for each element, it can be seen that the some of the highest concentrations for most metals were recorded at nearshore stations R1_ENV_001 and R1_ENV_002, as well as station R1_ENV_093, and the lowest at stations R1_ENV_096 to R1_ENV_099.

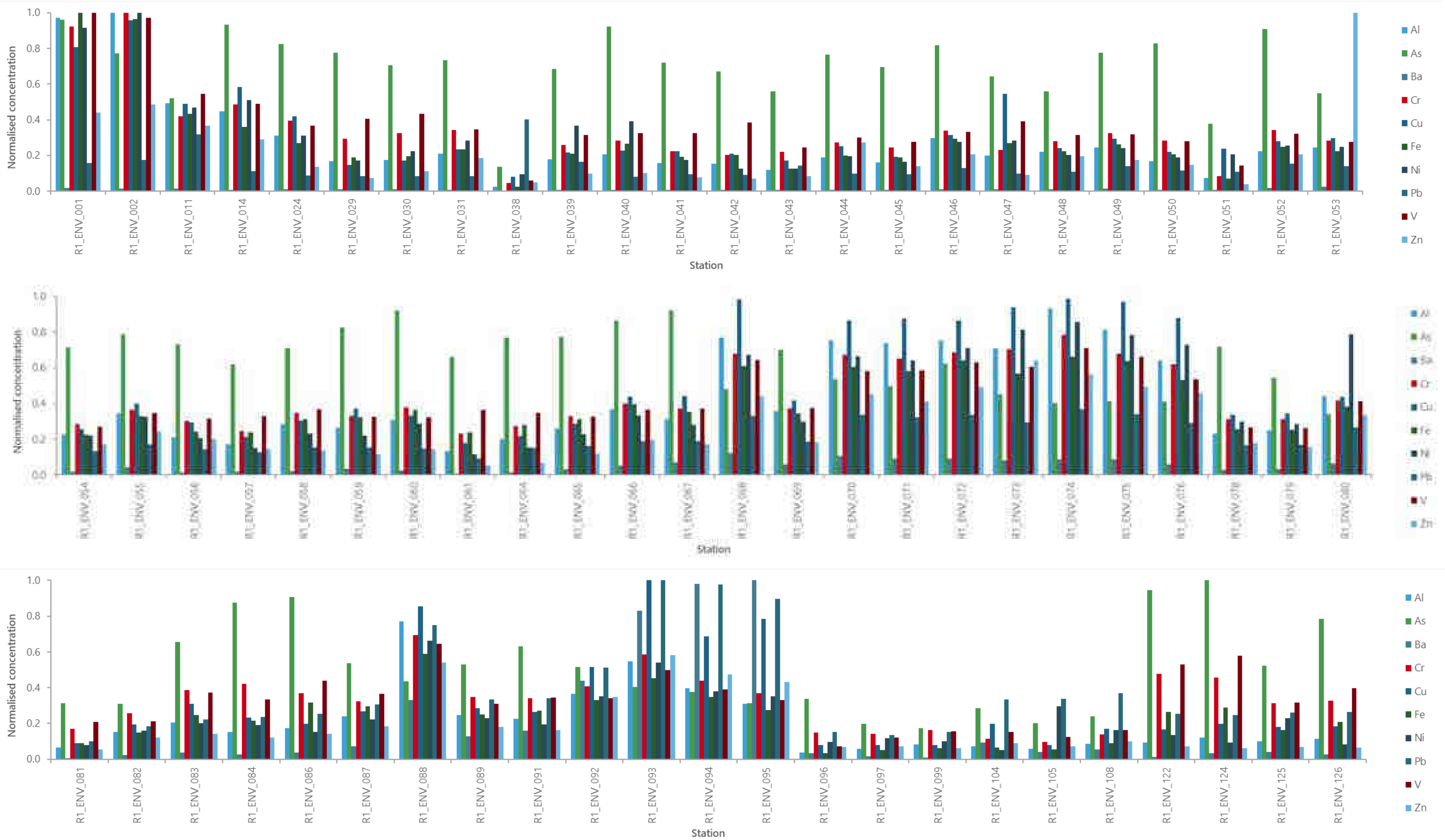



Figure 12.1: Relative (maximum normalised) elemental concentrations in sediments, Route 1

## 12.3 Soil Sample Results

Table 12.1 presents the concentrations of the aqua regia extractable metals in the ten soil samples across the Route 1 survey area, including antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, mercury, molybdenum, nickel, lead, selenium and zinc.

Arsenic concentrations across the survey area ranged from 1.70 µg/g at station SO_R1_013 to 5.49 µg/g at station SO_R1_005, with a mean of 3.46 µg/g and moderate variability (RSD 39 %). All arsenic concentrations were below the ADS 18/2017 MAC for general use areas (7.0 µg/g; QCC, 2017) and marine protected areas (7.0 µg/g; QCC, 2017).

Barium concentrations ranged from 13.8 µg/g at station SO_R1_005 to 564 µg/g at station SO_R1_011, with a mean of 116 µg/g and high variability (RSD 144 %).

Cobalt concentrations ranged from 0.077 µg/g at station SO_R1_012 to 1.45 µg/g at station SO_R1_009, with a mean of 0.664 µg/g and moderate variability (RSD 69 %).

Chromium concentrations ranged from 2.67 µg/g at station SO_R1_013 to 16.3 µg/g at station SO_R1_011, with a mean of 8.55 µg/g and moderate variability (RSD 54 %). Chromium concentrations at stations SO_R1_009 and SO_R1_011 exceeded the ADS18/2017 MAC for marine protected areas (11 µg/g; QCC, 2017). However, these values were below the NOAA ERL value (81.0 µg/g), so deemed not to be of environmental concern.

Copper concentrations ranged from below the MRV (0.800 µg/g) at station SO_R1_012 to 4.37 µg/g at station SO_R1_009, with a mean of 1.95 µg/g and moderate variability (RSD 70 %). All copper concentrations were below the ADS 18/2017 MAC for general use areas and marine protected areas (20.0 µg/g; QCC, 2017).

Iron concentrations ranged from 206 µg/g at station SO_R1_012 to 3700 µg/g at station SO_R1_009, with a mean of 1770 µg/g and moderate variability (RSD 63 %).

Molybdenum concentrations ranged from 0.205 µg/g at station SO_R1_013 to 1.24 µg/g at station SO_R1_009, with a mean of 0.669 µg/g and moderate variability (RSD 48 %).

Nickel concentrations ranged from 1.00 µg/g at station SO_R1_013 to 15.6 µg/g at station SO_R1_010, with a mean of 7.13 µg/g and high variability (RSD 75 %). Nickel concentrations at stations SO_R1_005, SO_R1_009, SO_R1_010 and SO_R1_011 were above the ADS 18/2017 MAC (7.0 µg/g; QCC, 2017) for marine protected areas. However, these values were below the NOAA ERL threshold value (20.9 µg/g).

Lead concentrations ranged from 0.774 µg/g at station SO_R1_005 to 7.09 µg/g at station SO_R1_011, with a mean of 2.29 µg/g and high variability (RSD 83 %). The lead concentration at station SO_R1_011 exceeded the ADS18/2017 MAC (5.0 µg/g;

QCC, 2017) for marine protected areas, but was below the NOAA ERL threshold value (46.7 µg/g).

Antimony concentrations ranged from below the MRV (0.0400 µg/g) at stations SO_R1_012 and SO_R1_013 to 0.161 µg/g at station SO_R1_011, with a mean of 0.097 µg/g and moderate variability (RSD 53 %).

Selenium concentrations ranged from 0.140 µg/g at station SO_R1_013 to 0.508 µg/g at station SO_R1_009, with a mean of 0.307 µg/g and moderate variability (RSD 40 %).

Zinc concentrations ranged from 1.42 µg/g at station SO_R1_008 to 11.1 µg/g at station SO_R1_011, with a mean of 4.46 µg/g and high variability (RSD 81 %). All zinc concentrations were below the ADS 18/2017 MAC for general use areas (125.0 µg/g; QCC, 2017) and marine protected areas (70.0 µg/g; QCC, 2017).

All cadmium and mercury concentrations recorded across the survey area were below their respective MRVs at all stations sampled, as well as below their respective ADS 18/2017 MAC for general use areas and marine protected areas (QCC, 2017).

Table 12.1: Summary of soil sample metals analysis, Route 1

| Station | As | Ba | Cd | Co | Cr | Cu | Fe | Hg | Mo | Ni | Pb | Sb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SO_R1_003 | 4.91 | 16.6 | < 0.0800 | 0.735 | 9.29 | 2.13 | 1560 | < 0.0400 | 1.01 | 6.19 | 0.830 | 0.145 | 0.381 | 2.79 |
| SO_R1_005 | 5.49 | 13.8 | < 0.0800 | 0.527 | 6.62 | 1.15 | 1540 | < 0.0400 | 0.708 | 7.73 | 0.774 | 0.125 | 0.384 | 2.12 |
| SO_R1_006 | 3.34 | 17.5 | < 0.0800 | 0.500 | 6.60 | 1.23 | 1300 | < 0.0400 | 0.408 | 4.01 | 1.04 | 0.0869 | 0.198 | 4.06 |
| SO_R1_007 | 4.23 | 37.1 | < 0.0800 | 0.611 | 8.16 | 1.55 | 1810 | < 0.0400 | 0.703 | 4.62 | 1.46 | 0.133 | 0.296 | 2.82 |
| SO_R1_008 | 4.58 | 26.2 | < 0.0800 | 0.416 | 6.46 | 1.10 | 1620 | < 0.0400 | 0.663 | 3.04 | 1.43 | 0.130 | 0.272 | 1.42 |
| SO_R1_009 | 3.71 | 159 | < 0.0800 | 1.45 | 16.1 | 4.37 | 3700 | < 0.0400 | 1.24 | 14.1 | 3.19 | 0.101 | 0.508 | 10.1 |
| SO_R1_010 | 2.03 | 110 | < 0.0800 | 0.820 | 9.78 | 2.21 | 2200 | < 0.0400 | 0.613 | 15.6 | 2.51 | 0.0513 | 0.290 | 6.96 |
| SO_R1_011 | 2.59 | 564 | < 0.0800 | 1.37 | 16.3 | 4.32 | 3400 | < 0.0400 | 0.878 | 13.1 | 7.09 | 0.161 | 0.439 | 11.1 |
| SO_R1_012 | 2.01 | 55.0 | < 0.0800 | 0.0770 | 3.48 | < 0.800 | 206 | < 0.0400 | 0.260 | 1.94 | 1.43 | < 0.0400 | 0.158 | 1.44 |
| SO_R1_013 | 1.70 | 161 | < 0.0800 | 0.136 | 2.67 | 0.999 | 385 | < 0.0400 | 0.205 | 1.00 | 3.15 | < 0.0400 | 0.140 | 1.83 |
| Minimum | 1.70 | 13.8 | < 0.0800 | 0.0770 | 2.67 | < 0.800 | 206 | < 0.0400 | 0.205 | 1.00 | 0.774 | < 0.0400 | 0.140 | 1.42 |
| Maximum | 5.49 | 564 | < 0.0800 | 1.45 | 16.3 | 4.37 | 3700 | < 0.0400 | 1.24 | 15.6 | 7.09 | 0.161 | 0.508 | 11.1 |
| Mean | 3.46 | 116 | - | 0.664 | 8.55 | 1.95 | 1770 | - | 0.669 | 7.13 | 2.29 | 0.097 | 0.307 | 4.46 |
| Standard Deviation | 1.34 | 168 | - | 0.457 | 4.61 | 1.37 | 1120 | - | 0.324 | 5.32 | 1.91 | 0.051 | 0.121 | 3.63 |
| RSD [%] | 39 | 144 | - | 69 | 54 | 70 | 63 | - | 48 | 75 | 83 | 53 | 40 | 81 |
| Sediment Standards (QCC, 2017) | | | | | | | | | | | | | | |
| General use areas | 7.0 | - | 0.7 | - | 52 | 20.0 | - | 0.2 | - | 16.0 | 30.0 | - | - | 125.0 |
| Marine protected areas | 7.0 | - | 0.2 | - | 11 | 20.0 | - | 0.2 | - | 7.0 | 5.0 | - | - | 70.0 |

| Station | As | Ba | Cd | Co | Cr | Cu | Fe | Hg | Mo | Ni | Pb | Sb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOAA Assessment Criteria (Buchman, 2008) | | | | | | | | | | | | | | |
| ERL | 8.20 | - | 1.20 | - | 81.0 | 34.0 | - | 0.150 | - | 20.9 | 46.7 | - | - | 150 |
| ERM | 70.0 | - | 9.60 | - | 370 | 270 | - | 0.710 | - | 51.6 | 218 | - | - | 410 |

Notes
Concentrations expressed in µg/g dry sediment
For statistical evaluation, results < MRV were treated as absolute values determined by MRV/2

As = Arsenic Ba = Barium Cd = Cadmium Co = Cobalt Cr = Chromium Cu = Copper Fe= Iron Hg = Mercury
Mo = Molybdenum Ni=Nickel Pb = Lead Sb = Antimony Se = Selenium Zn = Zinc
QCC = Abu Dhabi Quality and Conformity Council MRV = Minimum reporting value RSD = Relative standard deviation
NOAA = National Oceanic and Atmospheric Administration ERL = Effects range low ERL = Effects range median

| Key: | Below Sediment Standards | Above Sediment Standard for General Use Areas | Above Sediment Standard for Marine Protected Areas |
|---|---|---|---|

# 13. Seabed Habitats and Epifauna

## 13.1 Introduction

Video data from the 10 video transects surveyed were analysed by experienced Fugro marine biologists/taxonomists. Habitats were classified in accordance with the MLEAD (John & George, 2001) and EAD (Al Dhaheri et al., 2017) habitat classifications. Epifauna were identified to the lowest practicable taxonomic level and the presence of sensitive species (hard corals) assessed.

## 13.2 Results

Three distinct seabed habitats were identified within the survey area:

'Sublittoral mixed deposit' (SLMXD) was identified from five transects (R1_TR04B, R1_TR06, R1_TR07, R1_TR08A and R1_TR10). This habitat was restricted to relatively deeper water depths of between ~14.0 m and ~26.0 m below sea level (BSL).

'Sublittoral sediment' (SLSED) comprising sand and gravel was identified interspersed with seagrass beds habitat from three transects (R1_TR02, R1_TR03 and R1_TR09). This habitat was restricted to relatively shallower water depths of between ~4.0 m and ~12.0 m BSL.

'Seagrass beds' were identified within the survey area and displayed two biotopes variants:

'Maturing beds of the seagrasses *H. uninervis*, H. ovalis and *H. stipulacea'* (SLSED.Huni.Hoval.Hstip) biotope was identified from three transects (R1_TR01, R1_TR02 and R1_TR03). This biotope consisted of more stable and dense seagrass meadows (*H. uninervis, H. ovalis* and *H. stipulacea* complex), growing on relatively deeper soft sediment at lower depths of between ~4.0 m and ~6.0 m BSL.

'Low density beds of the seagrasses *H. ovalis* and *H. stipulacea* colonising bare sediment' (SLSED.Hoval.Hstip) was identified from two transects (R1_TR05A and R1_TR09). This biotope variant consisted of a lower density of the seagrasses *H. ovalis* and *H. stipulacea*, colonising bare sediment at deeper depths of between ~12.0 m and ~13.0 m BSL.

Although, theoretically a biotope can be assigned to any sized area of seabed, for the purposes of this assessment, the commonly accepted minimum habitat size of 25 m2 (Parry, 2019) was adopted for the designation of the biotopes encountered within the survey area. Therefore, this biotope variant identified from small areas of transect TR09 (although relative seagrass cover ≥ 10 %) was not assigned to the 'Seagrass beds' habitat.

Table 13.1 presents the habitat classification hierarchy for the habitats observed within the survey area. This is detailed in the video and photographic log presented in Appendix C.3.

Table 13.1: Habitat Classifications, Route 1

| MLEAD (2001) Habitat Classification | | MLEAD Classification (John & George, 2001) | EAD Habitat Classification and Protection Guideline (Al Dhaheri et al., 2017) |
|---|---|---|---|
| Depth Zone<br>Level 1 | Substratum<br>Level 2 | - | - |
| SL<br>Sublittoral zone | MXD<br>Mixed deposit | SLMXD | 13,000 - hard bottom" |
| | SED<br>Sediment<br>(gravels/sands deposit) | SLSED sediment | "14,000 - unconsolidated bottom" |
| | | SLSED.Huni.Hoval.Hstip | "12,000 - seagrass bed" |
| | | SLSED.Hoval.Hstip* | |

Notes
MLEAD = The Marine Life of the Emirate of Abu Dhabi
EAD = Environment Agency–Abu Dhabi
* = This habitat was adapted from MLEAD habitat classification to better describe the habitat observed within the survey area

### 13.2.1 Seabed Habitats and Fauna

#### 13.2.1.1 'Sublittoral Mixed Deposit' (SLMXD)/"13,000 – Hard Bottom"

Mixed sediment areas were classified as the 'Sublittoral mixed deposit' (SLMXD) habitat defined by John & George (2001) and under the "13,000 - Hard bottom" habitat defined by Al Dhaheri et al. (2017). This habitat comprised a mainly flat substratum of calcarenite (cemented sand) with occasional coral outcrops including finger corals (*Porites sp*.), plate corals (*Turbinaria* sp.) and boulder corals (Faviidae). The calcarenite was generally covered by a veneer of sand sediment.

This habitat displayed generally a scarce diversity and abundance of corals within the survey area; with exception of transect R1_TR10, where a low abundance of corals was recorded and a segment of transect R1_TR06, which displayed moderate density. This is detailed in the hard coral assessment presented in Appendix B.3.2.1. The most frequently recorded corals across the survey area were boulder corals (*Faviidae, ?Cyphastrea* sp.), plate coral (*Turbinaria* sp.), finger corals (Porites sp.) and gorgonians (Alcyonacea including ?*Subergorgia suberosa*).

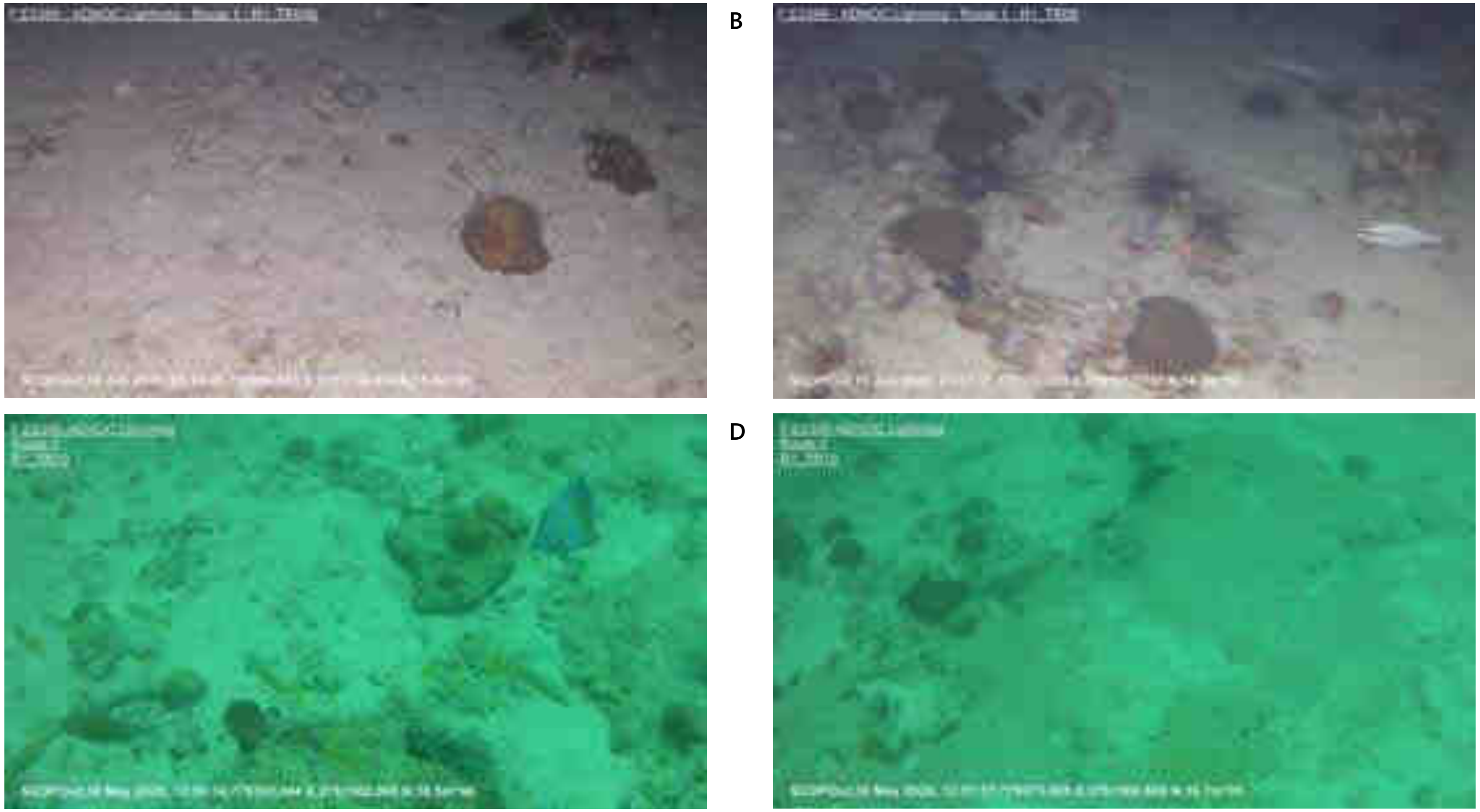
Sessile epifauna included sponges (Porifera), ascidians (*Phallusia nigra, Didemnum* sp.), faunal turf (Bryozoa/Hydrozoa), hydroids (Hydrozoa), sea cucumber (Holothuroidea), shells (Bivalvia), fanshell (*Pinna muricata*), pearl oyster (Pinctada sp.) and hammer oysters (*Malleus* sp.).

Mobile epifauna included snails (Gastropoda), cone shells (Conidae), sea urchins (Echinoidea including *Echinometra mathei*), long spined sea urchins (*Diadema setosum*), sand dollar (Clypeasteroidea inc. *Clypeaster humilis*, ?*Echinodiscus* sp), pencil urchins (*Phyllacanthus imperialis*), starfish (Asteroidea including *Linckia* sp., *Astropecten* polyacanthusphragmorus*, Pentaceraster mammillatus, Luidia maculata, Aquilonastra burtoni*), brittlestars (Ophiuroidea including possible *Ophiothela* sp.), hermit crabs (Paguroidea), crabs (Decapoda) including decorator crab (Majoidea) and shrimps (Caridea). Some seaweeds and algal turf, including peacock weed (*Padina boergesenii*) and coralline algae (Corallinales), were occasionally observed across the survey area.

Fish fauna was diverse and included yellowband angel fish (*Pomacanthus maculosus*), emperor fish (*Lethrinus* sp.) including the pink ear emperor fish (*Lethrinus lentjan*), snapper (*Lutjanus* sp.) including blackspot snapper (*Lutjanus fulviflamma*), orange spot grouper (*Epinephelus coioides*), doublebar bream (*Acanthopagrus bifasciatus*), Arabian monocle bream (*Scolopsis ghanam*), black-streaked monocle bream (*Scolopsis taeniatus*), blackspotted rubberlip (*Plectorhinchus gaterinus*), marbled spinefoot (*Siganus rivulatus*), parrotfish (*Chlorurus sordidus*), scad (Carangidae) including yellowstripe scad (*Selaroides leptolepis*), goatfish (Mullidae including *Upeneus* sp.), pearly goatfish (*Parupeneus margaritatus*), yellowstripe goatfish (*Mulloidichthys flavolineatus*), flatfish (Pleuronectiformes), mojarra fish (Gerreidae), small scale terapon (*Terapon puta*), anchovies (Clupeiformes), cardinal fish (Apogonidae), goby (Gobiidae), unidentified fish (Pisces).

Figure 13.1 presents example seabed photographs of this habitat.

A B C D



**A: Photograph R1_TR4b_012**
Gravelly sand with shell fragments and coral rubble veneer overlying calcarenite

**B: Photograph R1_TR06_01**
Calcarenite with a veneer of sand, relict coral and coral rubble
Encrusting plate corals (*Turbinaria* sp.), finger corals (*Porites* sp.), long spined sea urchins (*Diadema* sp.), *arabian monocle bream (Scolopsis ghanam)*

**C: Photograph R1_TR10_03**
Gravelly sand and shell fragments veneer overlying calcarenite, coral rubble.
Calcarenite outcrops
Boulder corals (Faviidae), finger corals (*Porites* sp.), long spined urchin (*Diadema setosum*), yellowband angel fish (*Pomacanthus maculosus*), parrotfish (*Chlorurus sordidus*), black spot snapper (*Lutjanus* sp.)

**D: Photograph R1_TR10_05**
Gravelly sand and shell fragments veneer overlying calcarenite, coral rubble.
Calcarenite outcrops
Boulder corals (Faviidae), finger corals (*Porites* sp.), doublebar bream (*Acanthopagrus bifasciatus*)

Figure 13.1: Example seabed photographs of ‘Sublittoral mixed deposit’ (SLMXD)/ “13,000 - Hard bottom”, Route 1

#### 13.2.1.2 Sublittoral Sand and Gravel' (Sublittoral Sediment; SLSED)/"14,000 – Unconsolidated Bottom"

'Sublittoral sand and gravel' was classified within the 'Sublittoral sediment' (SLSED) habitat of John & George (2001) and "14,000 – Unconsolidated bottom" habitat by Al Dhaheri et al. (2017).

This habitat comprised predominantly sand sediment, with varying proportions of gravel and shell and coral fragments. Visible epifauna and epiflora was very sparse and generally restricted to occasional outcrops of hard material or aggregations of rubble. Some red algae (Rhodophyta, ?*Chondria dasyphylla*) and peacock weed (*P. boergesenil*) were also occasionally observed. Errant invertebrates included hermit crabs (Paguroidea). Fish fauna including goby (*Cryptocentrus* sp.) and unidentified fish (Pisces) were sporadically observed. Faunal burrows and tracks were also present.

Within this habitat, small patches of seagrass (*H. uninervis*, *H. stipulacea* and *H. ovalis* complex) were observed in low density in segments of transects R1_TR02 and R1_TR03. However, seagrass cover was scattered and less than 10 %. For the purpose of this survey, the lower limit of what constitutes a seagrass bed is approximately 10 % cover.

Figure 13.2 presents example seabed photographs of this habitat.

A


B


C


D


**A: Photograph R1_TR03_003**
Sand with shell and coral rubble fragments
No visible fauna

**B: Photograph R1_TR09_001**
Sand
Hermit crabs (Paguroidea)
Faunal burrows and tracks

**C: Photograph R1_TR09_002**
Sand
Hermit crabs (Paguroidea)
Faunal burrows and tracks

**D: Photograph R1_TR09_009**
Sand
Hermit crabs (Paguroidea)
Faunal burrows and tracks

Figure 13.2: Example seabed photographs of ‘Sublittoral sand and gravel’ (SLSED)/ “14,000 – Unconsolidated bottom”, Route 1

#### 13.2.1.3 'Seagrass Bed'/"12,000 – Seagrass Bed"

'Seagrass bed' was classified within 'Sublittoral sediment' (SLSED) habitat of John & George (2001) and the "12,000 – Seagrass bed" habitat by Al Dhaheri et al. (2017).

This habitat comprised predominantly sand sediment, where the seagrass *H. uninervis* is the dominant cover species and in places *H. ovalis* and *H. stipulacea* form an understorey. Soft sediments were relatively deep and stable to provide a three-dimensional habitat on and amongst seagrass blades for the establishment of other organisms.

Within the survey area, 'Seagrass beds' displayed two habitat variants:

'SLSED.Huni.Hoval.Hstip' ('Maturing beds of the seagrasses *H. uninervis*, *H. ovalis* and *H. stipulacea*').

'Maturing beds of the seagrasses *H. uninervis*, *H. ovalis* and *H. stipulacea*' was defined within 'Sublittoral sediment' (SLSED) habitat of John & George (2001).

This habitat displays more stable seagrass beds and a considerably greater biological diversity. Soft sediments are relatively deeper, and shrimp-gobies can form burrows. In this habitat, the seagrass *H. uninervis* is dominant along with an understorey of *H. ovalis* and *H. stipulacea.* In current swept areas, drift algal material may occur and small scale terapon (*Terapon puta*), a small fish species characteristic of seagrass habitats, are commonly encountered. In areas with lower currents, orange botrylloid ascidians may occur with a branching purple sponge (Porifera).

Visible epifauna and epiflora included sponges (Porifera), ascidians (Ascidiacaea, including ?*Didemnum* sp.), epiphytic branching sponges/ascidians (Porifera/Ascidiacea) red algae (Rhodophyta, possibly *Chondria dasyphylla*) and peacock weed (*Padina boergesenil*). Faunal burrows and fish (Pisces) were occasionally observed.

Figure 13.3 presents example seabed photographs of this habitat.

'SLSED.Hoval.Hstip' 'Low density beds of H. ovalis and H. stipulacea colonizing bare sediment'

Across the survey area, low density beds of the seagrasses *H. ovalis* and *H. stipulacea* colonising bare sediment were also observed in areas where the seagrass *H. uninervis* was absent. This habitat variant was adapted from the 'seagrass bed' habitat classification defined by John & George (2001) and, for the use of this report, classified as 'low density beds of *H. ovalis* and *H. stipulacea* colonising bare sediment' ('SLSED.Hoval.Hstip').

Visible epifauna and epiflora included sponges (Porifera), faunal turf (Bryozoa), fanshells (*Pinna muricata*), sand dollar (Clypeasteroidea), hermit crabs (Paguroidea) and red algae (Rhodophyta). Fish fauna included goatfish (Mullidae inc. *Upeneus* sp.), yellowstripe scad (*Selaroides leptolepis*), pink ear emperor (*Lethrinus lentjan*), anchovies (Clupeiformes) and mojarra fish (Gerreidae).

Figure 13.3 presents example seabed photographs of this habitat.

A

B


'Seagrass beds'

'Maturing beds of the seagrasses *H. uninervis*, *H. ovalis* and *H. stipulacea*' (SLSED.Huni.Hoval.Hstip)

**A: Photograph R1_TR01_001**
Sand
Seagrass (*H. uninervis*, possible *H. stipulacea* and *H. ovalis* complex)

**B: Photograph R1_TR03_001**
Sand
Epiphytic branching sponges/ascidians (Porifera/Ascidiacea)
Seagrass (*H. uninervis*, possible *H. stipulacea* and *H. ovalis* complex)

C

D


**'Low density beds of *H. ovalis* and *H. stipulacea* colonizing bare sediment' ('SLSED.Hoval.Hstip')**

**C: Photograph R1_TR05a_003**
Sand
Seagrass (possible *H. stipulacea* and *H. ovalis* complex)

**D: Photograph R1_TR09_005**
Sand
Seagrass (*H. stipulacea* and *H. ovalis* complex), hermit crabs (Paguroidea)

Figure 13.3: Example seabed photographs of "12,000 – Seagrass bed", Route 1

### 13.2.2 Potentially Sensitive Habitats

#### 13.2.2.1 Corals

Hard Corals

Table 13.2 summarises the hard coral assessment with proportions of transects and this is displayed spatially in Figure 13.4. Appendix C.3 provides the detailed assessment for the individual transects.C.3.

Within the survey area, the majority of the transects displayed ‘No coral cover’ with few or no live corals reported. Sporadic coral outcrops were identified from transect R1_TR04B, where the density of live corals reached ‘low live coral cover’ (1 % to 5 %) in two segments of the transect, and at R1_TR10 which displayed an average ‘low live coral cover’ (5 % to 10 %). In a segment of transect R1_TR06, the density of live corals was classified as ‘moderate live coral cover’ (10 % to 20 %).

Hard corals diversity was generally low within the survey area and included finger corals (*Porites* spp.), boulder corals (Faviidae, ?*Cyphastrea* sp.) and plate corals (*Turbinaria* sp.).

Soft Corals

Only a very low density of gorgonians (Alcyonacea) were identified during the survey, with these only recorded from transects R1_TR07 and R1_TR10 at very low density (< 1 %). Under the assessment methodology adopted all areas with < 1 % coral cover were defined as containing ‘No coral’.

Table 13.2: Hard coral assessment, Route 1

| Transect | Hard Coral Assessment (Proportion of Transect) [%] | |
|---|---|---|
| R1_TR01 | N (100 %) | |
| R1_TR02 | N (100 %) | |
| R1_TR03 | N (100 %) | |
| R1_TR04B | N (88.7 %) | L (11.3 %) |
| R1_TR05A | N (100 %) | |
| R1_TR06 | M (36.2 %) | R (63.8%) |
| R1_TR07 | N (100 %) | |
| R1_TR08A | N (100 %) | |
| R1_TR09 | N (100 %) | |
| R1_TR10 | L (100 %) | |

Notes
N = No coral (< 1 %)
L = Low coral cover (1 % to 10 %)
M = Moderate coral cover (10 % to 50 %)
R = Coral rubble (< 1 %)

| Key: | No coral | Coral rubble | Dead coral framework | Low live coral cover | Moderate live coral cover | High live coral cover |
|---|---|---|---|---|---|---|

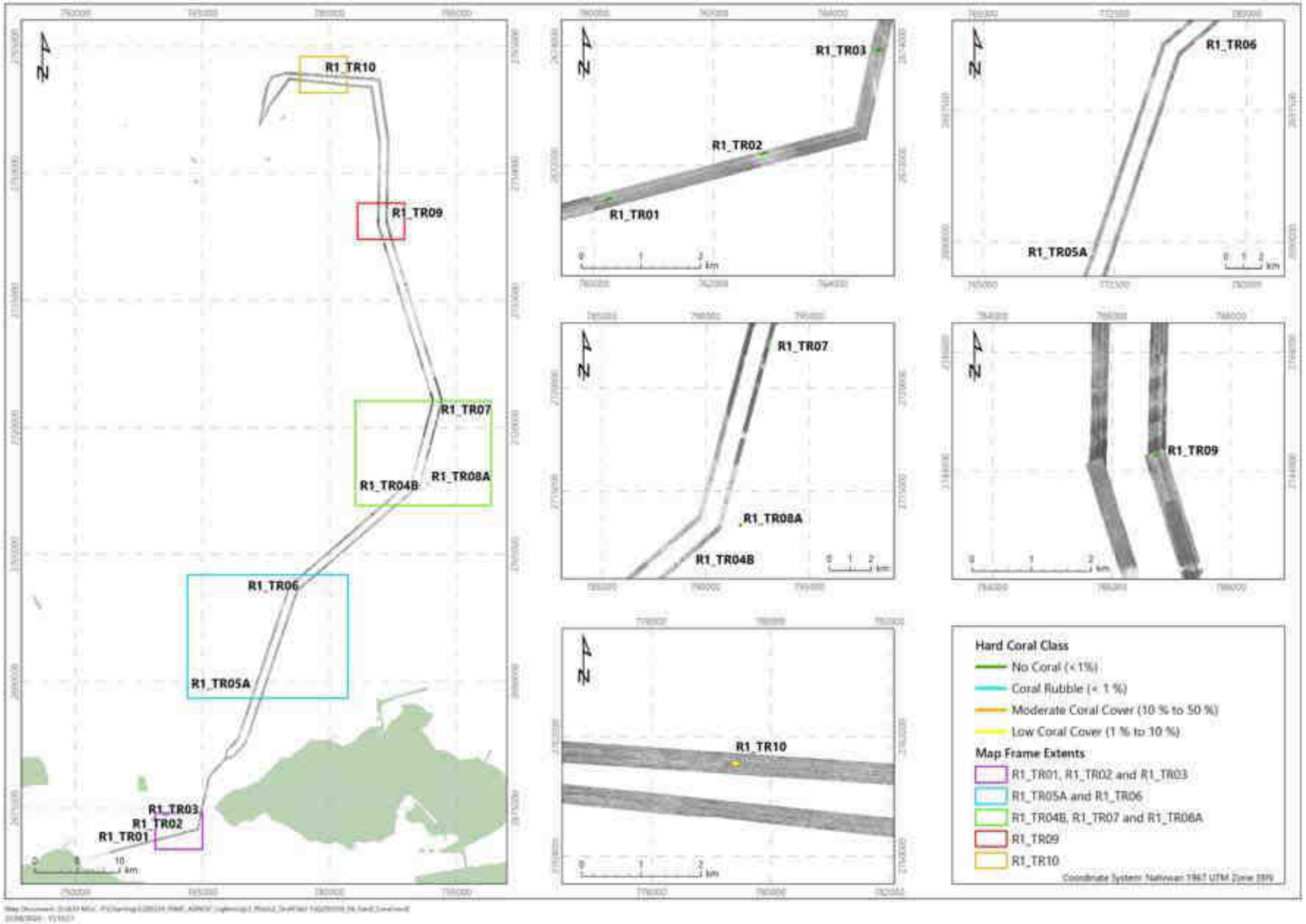



Figure 13.4: Completed environmental transects, showing hard coral assessment results, Route 1

#### 13.2.2.2 Seagrass

Table 13.3 summarises the seagrass assessment and this is displayed spatially in Figure 13.4. Appendix C.3 provides the detailed assessment for the individual transects.

Within the survey area, the seagrasses *H. uninervis, H. stipulacea and H. ovalis complex* were recorded in higher density with more than 10 % cover in transect R1_TR01, and in segments of transects R1_TR02 and R1_TR03, forming dense and long-leaved seagrass meadows.

The seagrasses *H. stipulacea and H. ovalis* were recorded in lower density, but at greater than 10 % cover, in transect R1_TR05A and in segments of R1_TR09, forming patchy and short-leaved seagrass beds.

Small patches of seagrass (*H. uninervis*, *H. stipulacea* and *H. ovalis* complex) were also observed in low density in segments of transects R1_TR02, R1_TR03 and R1_TR09. However, seagrass cover was scattered and less than 10 %. For the purpose of this survey, the lower limit of what constitutes a seagrass bed is approximately 10 % cover.

Table 13.3: Seagrass assessment, Route 1

| Transect | Seagrass Assessment (Proportion of Transect) [%] | |
|---|---|---|
| R1_TR01 | (100 %) | |
| R1_TR02 | (93.9 %) | (6.1 %) |
| R1_TR03 | (58.1 %) | (41.9 %) |
| R1_TR04B | (100 %) | |
| R1_TR05A | (100 %) | |
| R1_TR06 | (100 %) | |
| R1_TR07 | (100 %) | |
| R1_TR08A | (100 %) | |
| R1_TR09 | (25.4 %) | (74.6%) |
| R1_TR10 | (100 %) | |

Notes
N = No seagrass (< 1 %)
L = Low seagrass cover (1 % to 10 %)
S = Seagrass bed (≥ 10 %)

| Key: | No Seagrass < 1 % | Low Seagrass Cover 1 to 10 % | Seagrass Bed ≥ 10 % |
|---|---|---|---|

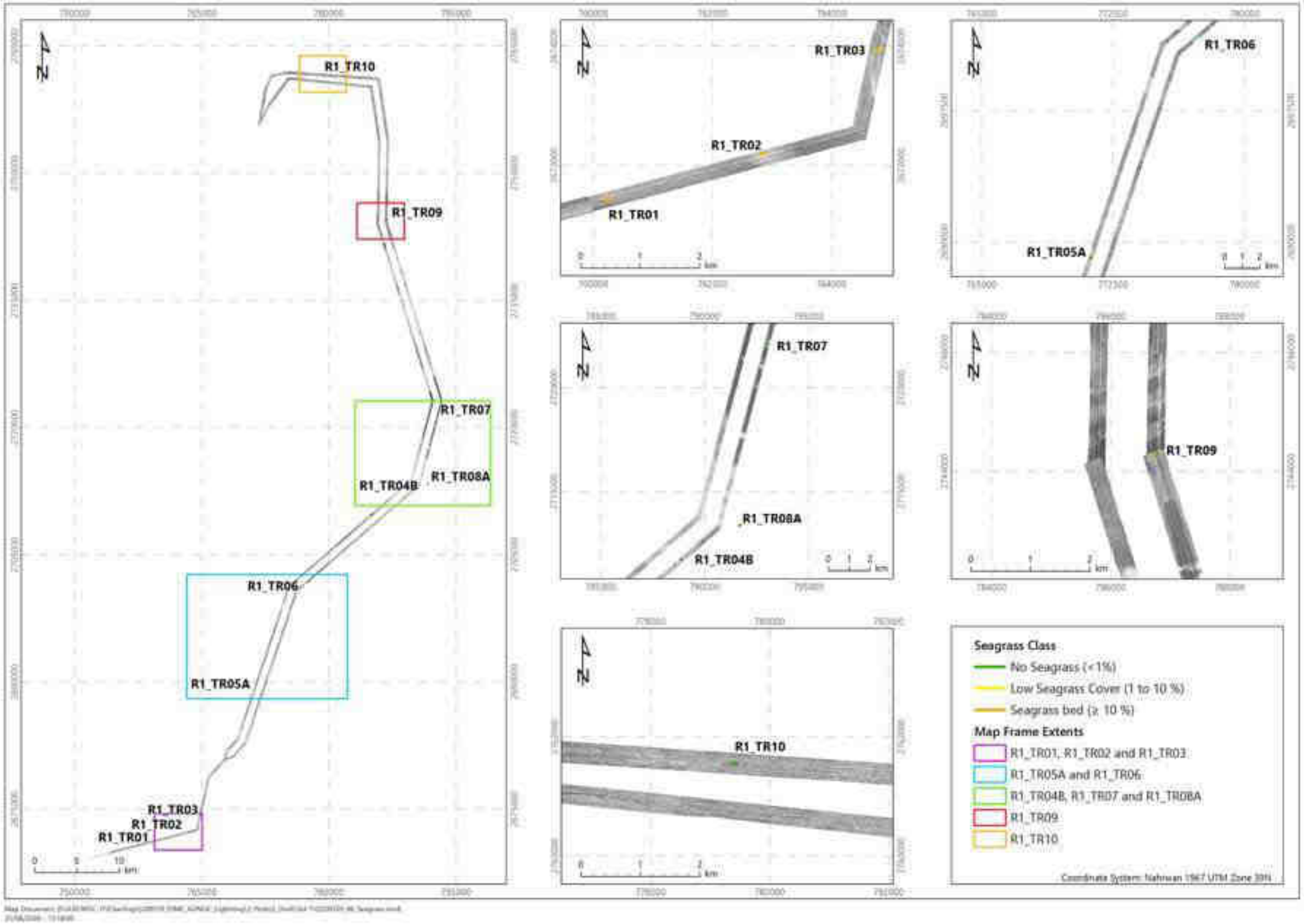



Figure 13.5: Completed environmental transects, showing seagrass assessment results, Route 1

# 14. Discussion

This survey was undertaken to establish the current biological and physico-chemical conditions of the seabed sediments and water column along the proposed Route 1 that will connect Lower Zakum Island G to Mirfa within the Zakum Field, Offshore Abu Dhabi. The survey and analytical strategies were designed to provide a comprehensive baseline dataset of the physico-chemical characteristics within the survey area. An assessment of likely habitats and biotopes, with particular attention to environmentally sensitive habitats and species, was also conducted. The sampling plan included the collection of water profiles, water samples and surface sediments at 130 pre-selected stations along Route 1. Photographic data was acquired from 10 transects approximately 116 m to 170 m in length.

Water profiles were collected to record in situ parameters throughout the water column, including temperature, turbidity, salinity, DO saturation and pH. Water samples (from top, middle and bottom depths) were analysed for inorganic parameters (ammonium, ammoniacal nitrogen, COD, chloride, nitrate, nitrite, sulphide, total nitrogen, total cyanide, TSS, total coliform, BOD, chloride, pH, phosphate, sulphate, TDS, TOC, orthophosphate, silicon, turbidity, total phosphorus), hydrocarbons and heavy and trace metals.

The surface (0 cm to 2 cm) sediment samples were analysed for nutrients, TOC, carbonate content, hydrocarbons (including THC, PAHs and BTEX), PCBs and heavy metal content. The surface (0 cm to 5 cm) sediment samples were analysed for selected physical characteristics (e.g. PSD).

The previous sections of this report have presented the data generated from the analysis programme stated above with the aid of data tables and graphics. This discussion section will review the data with respect to cited reference levels. The Abu Dhabi Specification Ambient Marine Water and Sediments Maximum Allowable Concentrations (ADS 18/2017 MAC) (QCC, 2017) and the US EPA CCC and CMC values (US EPA, 2020) were used to support the interpretation of data from the current survey. Respectively, these set maximum allowable limits for general use areas and MPAs, as well as maximum concentrations that if exceeded could potentially cause detrimental effects in biota. The NOAA screening quick reference tables provide assessment criteria for contaminants in sediments in the form of ERL and ERM threshold values (Buchman, 2008). Adverse effects on organisms are rarely observed when concentrations are present below the ERL value but are generally observed when above the ERM value (NOAA, 1999).

## 14.1 Water Profiles

The Arabian Gulf is a semi-enclosed body marine body of water that connects to open waters via the Strait of Hormuz. In that area, ecosystems are under high environmental pressures with high temperatures causing high evaporation rates and high salinity, poor flushing causing limited dilution, slow dispersion and high resident time, atmospheric fallout from dust storms and high ultra violet (UV) exposure.

The water profiles within the survey area were considered to be representative of ambient seawater conditions for the region and time of year across all parameters.

A monthly hydrographical survey carried out in the Arabian Gulf between October 1993 and September 1994 (Shriadah & Al-Ghais, 1999) demonstrated water temperatures ranged from 16.9 °C to 34.6 °C. Similarly, seawater temperatures around Abu Dhabi have been recorded as increasing from 21.0 °C in February to 33.3 °C in July (Taher et al., 2012). The nearshore stations sampled in the current survey had the lowest recorded temperatures in the survey area (approximately 26 °C to 27 °C). This increased to 34.9 °C in station R1_ENV_019 (< 2.5 m depth), located in the same area, but sampled two months later in June 2020. A similar trend was observed between offshore stations, in which temperatures increased from approximately 28 °C in April 2020, to 33 °C in June 2020. The temperature values across the survey area are therefore consistent with previous findings in the wider area and suggest a seasonal trend.

Temperature profiles were broadly consistent throughout the water column, with the exception of some offshore stations (R1_ENV_063 to R1_ENV_94 and R1_ENV_0127 to R1_ENV_REF), which showed a minor decrease in temperature (< 2 °C) below approximately 8 m depth. This reflects a weak thermocline due to the sinking of colder (< 29 °C), denser water below warmer waters at these stations. However, at stations R1_ENV_048 to R1_ENV_062 there was a slight increase in water temperatures (by < 1 °C) with depth, which corresponded to a similar increase in salinity (by approximately 1 ppt), indicating the subduction (sinking) of warmer (> 32 °C), hypersaline water below cooler, less saline surface waters. Despite these changes, the stability of the water profiles across the survey area generally reflects a lack of pronounced thermoclines and suggests a certain degree of mixing throughout water column.

The arid climate influences the sea salinity, which together with shallow water and a limited circulation pattern, as well as inconsequential freshwater runoff due to the low annual rainfall, means that salinities in the Gulf normally reach between 40 ppt and 50 ppt (Carpenter et al., 1997). However, this can average 37 ppt in deeper, central waters and as high as 70 ppt in southern bays and shallow lagoons (Simmonds & Lamboeuf, 1981; Taher et al., 2012). The salinity profiles in the current survey ranged between 39.8 ppt and 46.1 ppt. The highest salinity ranges (> 44 ppt) were found at nearshore stations, whilst lower salinities (< 42 ppt) were typical of offshore stations.

Salinity was broadly consistent throughout the water column, likely due to the shallow water depths across the survey area; however, a slight increase in salinity was observed below approximately 10 m depth for some deeper offshore stations. These corresponded to both an increase in water temperature (subduction) and decrease in water temperatures (weak thermocline), depending on the density of the water, and reflects a weak halocline for some stations. This is consistent with previous findings in the wider area.

Turbidity can be an indicator of suspended solids within the water column, often related to factors including erosion, seasonal inputs from rivers and resuspension of sediments. High turbidity may also be indicative of phytoplankton or algal growth. In particular, prevailing north-westerly ‘shamal’ winds occur between November and April. These drive seasonal eddies in the central Gulf and influence coastal storms surges and currents in the south (Sheppard, 1993). Not only does this cause fluctuations in seawater temperature, but the resulting wave-driven sediment resuspension across the shallow (< 10 m) coastal areas can cause periods of elevated turbidity (> 20 NTU) (Paparella et al., 2019).

Water turbidity profiles across the survey area were generally constant with low values (< 1.5 NTU) at all offshore stations. This suggests clear waters with low levels of suspended material in the water, despite a slight increase in turbidity towards the seabed at some stations. Nearshore stations had a higher turbidity average (up to 5 NTU) which would be expected in shallow waters (< 10 m) due to the resuspension of sediments. However, in station R1_ENV_019, which was sampled two months later in June 2020, the turbidity was recorded between 0 NTU and 0.5 NTU, which could also suggest a seasonal influence. Large anomalies recorded at stations were attributed to the sensor contacting the seabed.

The oxygen content of natural waters varies with temperature, salinity, turbulence, the photosynthetic activity of algae and plants and atmospheric pressure. Biological respiration, including that related to decomposition processes, reduces DO concentrations. The solubility of oxygen also decreases as temperature and salinity increase. Dissolved oxygen saturation across the survey area was between 80 % to 120 % throughout the water column. A slight decrease was observed with depth, with higher concentrations recorded at shallower stations. The observed pattern typically reflects greater photosynthesis (from increased light levels) in surface waters, as well as greater gas exchange with the atmosphere, compared to deeper waters. Overall, the water profiles demonstrate that marine waters within the survey area were at, or near, oxygen saturation at the time of survey, with little indication of oxygen depletion.

The average pH value of the water profiles acquired during water profiling was approximately 8.1 and were relatively constant throughout the water column. High pH in water samples can occur during algae blooms due to chemical processes associated with photosynthesis but moderate to high salinities usually ‘buffer’ pH in the range 7 to 8 range. A typical pH range for seawater is 6.5 to 8.5 (US EPA, 2020); the pH in all survey areas were within these criteria indicating little evidence of algal blooms.

Overall, the results indicate a poorly developed thermocline and halocline across the survey area, which could be attributed to shallow waters, seasonal winds and currents that mostly disturb stratification.

## 14.2 Water Quality

Most of the inorganic water quality parameters (including total suspended solids, ammonia, ammonium, sulphide, nitrite, silicon, orthophosphate, COD, BOD and total coliform) were below their respective MRVs at all stations across the survey area. Values for total nitrogen, total cyanide, nitrate and total phosphorus, were below their respective MRVs for the majority of stations across the survey area. Reference values were available for some parameters (pH, total cyanide and total coliform).

Total suspended solids (TSS) are related to turbidity and linked to factors including erosion, seasonal inputs from rivers and resuspension of sediments. TSS have a deleterious effect on water quality due to a reduction in light transmission and the transport of nutrients and bacteria in the water column (Bilotta & Brazier, 2008). Across the survey area TSS values were < 5.0 mg/L and turbidity ranged from below the MRV (0.1 mg/L) to 3.6 mg/L. According to the EPA (Klemas, 2012), TSS concentrations of < 10 mg/L are classified as clear waters, therefore the results from the survey area are indicative of clear water.

In water the forms of nitrogen that are of greatest interest are nitrate, nitrite, ammonia and organic nitrogen. Nitrate is the final oxidation product of nitrogen compounds in seawater and is considered the most thermodynamically stable oxidation level under aerobic conditions; it is one of the most important nutrients controlling primary production. Nitrite forms the intermediate between the reduction of nitrate and the oxidation of ammonia in sea and estuarine water. The concentrations of nitrite are typically low except in transition zones between oxic and anoxic conditions (Mordy et al., 2010). In oxygenated natural water systems, nitrite is rapidly oxidised to nitrate and consequently, concentrations of nitrite would be expected to be low. Throughout sediments where oxygen is depleted, nitrite is reduced by anaerobic bacteria to ammonia (Koike & Sorensen, 1988). Nitrite levels across the survey area were below the MRV (0.016 mg/L) at all stations, and nitrate ranged from below the MRV of 0.04 mg/L to 0.85 mg/L.

Phosphorus in waters occurs mostly as dissolved orthophosphate, polyphosphates and organically bound phosphates. Changes between these forms occur continuously due to decomposition and synthesis of organically bound forms and oxidised inorganic forms. Natural sources of phosphorus are mainly the weathering of phosphorus-bearing rocks and the decomposition of organic matter. Domestic waste waters (particularly those containing detergents), industrial effluents and fertilisers' run-off contribute to elevated levels in surface waters. Phosphorus associated with organic and mineral constituents in water bodies can also be mobilised by bacteria and released to the water column. Because phosphorus is actively taken up by algae and marine plants, there can be considerable seasonal fluctuations in concentrations in surface waters, and elevated phosphorus levels may lead to the eutrophication of water. The orthophosphate concentrations were below the MRV (0.060 mg/L). Total phosphorus concentrations exceeded the MRV (0.03 mg/L) in nine samples.

TOC consists of both dissolved and particulate organic carbon and can be an approximate indicator of productivity in marine waters where anthropogenic inputs are not present. The mean TOC values observed across the Lightning Route 1 survey area were comparable at different depths suggesting no evidence of stratification.

Sulphate concentrations (ranging from 2930 mg/L to 3710 mg/L) did not show clear spatial or depth-driven trends within the dataset and were below the sulphate concentrations reported from the wider Arabian Gulf region (3750 mg/L to 4490 mg/L; Taher et al., 2012).

Chemical oxygen demand (COD) is a measurement of the oxygen required to oxidise soluble and particulate organic matter in water. Biochemical oxygen demand (BOD) is a measurement of the amount of dissolved oxygen that is used by aerobic microorganisms when decomposing organic matter in water. High BOD and COD values can be indicative of nutrient enrichment in marine waters. BOD and COD levels were < MRV (2 mg/L and 5 mg/L respectively), and they were broadly comparable to the levels reported previously in the region (BOD < 5 mg/L and COD < 10 mg/L; Fugro unpublished, 2019).

Microbiological analysis of coliforms showed that bacterial colonies were not present within the water samples, suggesting no influence of human or animal wastes.

Generally, the water samples from the Lightning Route 1 survey area demonstrated no evidence of anthropogenic pollution and are likely to be representative of background conditions for the local area.

## 14.3 Water Column Hydrocarbons

Hydrocarbon content can be used as an indicator of petrogenic inputs into water columns. This is because soluble fractions of hydrocarbons can partition between dissolved and particulate bound phases in the water column (Latimer & Zheng, 2003; Thibodeaux et al., 2011).

Concentrations of volatile petroleum hydrocarbons, extractable petroleum hydrocarbons and dissolved and emulsified oil were below their respective MRVs at all stations. The concentration of free oil was below the MRV at all stations except for all sample depths at six stations (R1_ENV_036, R1_ENV_037, R1_ENV_120, R1_ENV_121, R1_ENV_122 and R1_ENV_123) and the top sample of station R1_ENV_119; all of which had a concentration of 0.02 % vol/vol.

The MRV for extractable petroleum hydrocarbons was above the ADS 18/2017 MACs for both general use areas and marine protected areas, thus no comparison to the threshold could be made.

Polycyclic aromatic hydrocarbons and their alkyl homologues have been recorded in a wide range of marine matrices (Laflamme & Hites, 1978; Neff, 1979; Youngblood & Blumer, 1975). These compounds consist of two or more fused benzene rings in linear, angular or cluster arrangements. By definition, PAHs only contain carbon and hydrogen atoms. However, other atoms (e.g. nitrogen, sulphur and oxygen) may be readily substituted into the benzene ring to form heterocyclic compounds that are present in significant levels in petroleum and refined products.

Monitoring of aromatic hydrocarbon type and content is important due to the particularly toxic nature (mutagenic/carcinogenic) of several PAHs even at very low concentrations. The EPA has identified sixteen priority PAHs to be monitored that primarily reflect inputs from man-made combustion sources (further alkylated and parent compounds are normally studied because of the information they provide on PAH origin and fate). Many PAHs have long been recognised as universal environmental pollutants with the heavier molecular weight PAHs (mainly 4 to 6 ring PAH) generally being regarded as carcinogens and mutagens. Indeed, 11 of 40 PAHs ranging from 3 to 6 ring structures have been listed as being strongly carcinogenic or mutagenic with a further ten listed as weakly carcinogenic or mutagenic (Edwards, 1983).

By far the greatest concentrations of PAHs released into the environment are formed during fossil fuel combustion and man-made forest and agricultural fires (Sims & Overcash, 1983; Edwards, 1983). Once released into the atmosphere PAHs may be carried long distances adsorbed to particulate material (e.g. soot and fly-ash; Windsor & Hites, 1979). Similarly, when deposited within the water environment PAHs may undergo further transport (e.g. by rivers or ocean currents) before final deposition in the sediments. Due to the low solubility and hydrophobic nature of PAHs, when deposited within the water column they tend to be adsorbed to suspended inorganic and organic particulate matter, which gradually settles out. Once deposited in the sediment PAHs are less susceptible to photochemical and biological degradation and may accumulate to relatively high concentrations.

Concentrations of PAHs were below their respective MRVs at all stations across the Lightning Route 1 survey area, apart from naphthalene, phenanthrene and pyrene. Concentrations of naphthalene and pyrene equalled their respective MRVs for six (R1_ENV_001-Middle, R1_ENV_028-Top, R1_ENV_049-Top, R1_ENV_080-Top, R1_ENV_095-Top and R1_ENV_108-Top) and two (R1_ENV_001-Bottom and R1_ENV_004-Bottom) samples respectively. Phenanthrene concentrations exceeded the MRV for three samples (R1_ENV_061-Middle, R1_ENV_004-Bottom and R1_ENV_017-Bottom). However, the concentrations of PAHs recorded across the Route 1 survey area are unlikely to be of environmental concern.

BTEX is the term used to describe a group of compounds related to benzene: toluene (methyl benzene), ethyl benzene, xylenes and benzene itself. BTEX are volatile and present in light crude oils and gasoline and sources are primarily from oil and gas industries, chemical industries and other combustion processes. BTEX compounds are volatile in nature and can be lost through evaporation processes, however they are toxic to organisms when in the marine environment if contact time is sufficient (Alpar & Unlu, 2010).

BTEX concentrations were all below their respective MRVs. The concentrations of benzene, toluene and ethylbenzene were all below their respective CCME values, and therefore unlikely to be of environmental concern.

Phenol and its derivatives are common by-products of industrial processes such refining or treatment of fossil fuels and the production of coke, steel, paint, fiberglass etc. (Krastanov et al., 2013). Phenol and phenolic compounds are water-soluble substances and toxic to marine organisms (Duan et al., 2017; Duan et al., 2018). The concentrations of phenol and phenolic compounds were below their respective MRVs at all stations across the Lightning Route 1 survey area.

## 14.4 Water Column Major and Trace Elements

Metals and metalloids occur naturally in the marine environment and are widely distributed in both dissolved and sedimentary forms. Some are essential to marine life while others have no biological function and therefore are toxic to numerous organisms at certain levels (Paez-Osuna & Ruiz Fernandez, 1995; Boening, 1999). Metals can enter the environment via natural methods such as riverine transport, coastal discharges, geological weathering and atmospheric fallout (Brady et al., 2015). Other routes into marine waters are from anthropogenic activities such as direct discharges from industrial activities.

Except for chromium, copper, lead and zinc, concentrations of all major and trace elements were below their respective ADS 18/2017 MAC for both general use areas and marine protected areas in all samples, as well as the US EPA CCC and CMC thresholds (US EPA, 2020) and considered to be of no environmental concern. Concentrations of chromium, copper, lead and zinc exceeded the ADS 18/2017 MAC for both general use areas and marine protected areas in 100, 17, 31 and 129 samples respectively. The chromium concentrations determined across the Lightning Route 1 survey area were total chromium concentrations including hexavalent chromium (Cr VI), whereas the ADS 18/2017 standard is for hexavalent chromium only. As such, the analysis results are not directly comparable to the MACs.

It is not clear if the ADS 18/2017 MACs are for total or dissolved metals, whereas the major and trace element concentrations analysed across the Lightning Route 1 survey area are total concentrations, consisting of both dissolved and particulate forms. Consequently, the copper, lead and zinc concentrations in the particulate fraction could influence total concentrations resulting in an exceedance of the water quality standards across the Lightning Route 1 survey area.

There were no spatial patterns in the dataset, or any relationships with depth, suggesting no influence on water column concentrations from the underlying sediment.

## 14.5 Sediment Characterisation

The general physical and chemical characteristics of sediment particles have a significant effect on how other chemical components and biological species interact with seabed sediments. For example, the silt/clay fraction is known to adsorb petroleum hydrocarbons/heavy metals from seawater and through this pathway, these chemicals become incorporated into the sediment system (Meyers & Quinn, 1973). Granulometry data can therefore be critical when interpreting chemical and biological data obtained in this type of benthic study.

With regard to macrofaunal communities, the species distributions and community structure can be greatly influenced by the nature of the sediment, which represents the effects of a complex set of hydrological factors, such as water movement, turbulence and suspended load, at one particular point in time. Some animals have a behavioural preference for sediment of a particular grain size (Meadows, 1964; Gray, 1981), while this factor and organic matter content are closely associated with other properties of the sediment such as density, porosity, permeability, oxygenation and bacterial count (Buchanan, 1984), all of which affect animal functions such as locomotion, attachment, tube construction and feeding. Specifically, the proportion of fine (silt/clay) material often influences the distribution of macrofaunal communities.

The sediments within the Route 1 survey areas demonstrated moderate interstation variability in mean diameter (μm) and sand content (Appendix H.2). Sediment descriptions using the Folk description (1954) categorised the seabed across Route 1 as slightly gravelly muddy sand, slightly gravelly sandy mud, slightly gravelly sand, gravelly muddy sand and gravelly sand. This was classified further within the laboratory to Wentworth (1922) sediment descriptions of 'coarse sand' to 'fine silt', with sand as the dominant fraction (mean 70.73 %). No clear spatial patterns between depth and sediment type were apparent along Route 1.

Carbonate content within sediments in the Arabian Gulf has been well documented to be high and closely correlated with grain size, with an average of 85 % in coarser sediment (Basaham & El Sayed, 1998). Carbonate content across the Route 1 survey area was higher than this (mean 95.0 %). Elevated carbonate percentages have been associated with high temperature and high salinity, as observed in the water column profiles (Section 4), in addition to low dilution from land derived inputs and low precipitation, which increases the carbonate production of benthic organisms (Fugro, 2016).

Sediment TOC content within the Route 1 survey area was lower (mean 0.34 %) than data presented by the National Petroleum Construction Company (2019) for the Zakum Field, (0.4692 %).

## 14.6 Sediment Nutrients

Sediment nutrient concentrations are important indicators of primary production and the health of an ecosystem. All sediment nutrient concentrations recorded across the survey area demonstrated low to moderate variation. No spatial patterns were observed or any association with depth, hence the concentrations recorded were considered as background for the region.

## 14.7 Sediment Hydrocarbons

Marine sediments contain hydrocarbons derived from many sources that enter the marine environment via three general processes: biosynthesis (marine and land organisms biosynthesise hydrocarbons), geochemical processes (submarine and coastal/terrestrial oil-seeps) and anthropogenic sources (from accidental or intentional discharge of fossil fuel) (Farrington & Meyer, 1975; Myers & Gunnerson, 1976).

Biosynthesised hydrocarbons are ubiquitous in the marine environment (Harada et al., 1995; Parinos et al., 2013). Odd carbon number, long chain n-alkanes are widely distributed in the plant kingdom (Eglinton et al., 1962; Douglas & Eglinton, 1966; Bush & McInerney, 2013) as components of cuticle waxes. These are common on the surfaces of leaves, stems, flowers and pollen and their presence in sediment is indicative of terrestrial inputs from adjacent land masses. Relatively high concentrations of $nC_{29}$, $nC_{31}$ and $nC_{33}$ are therefore a common feature of many marine sediments (Farrington et al., 1977), particularly inshore marine sediments (Bouloubassi et al., 1997).

Anthropogenic hydrocarbon inputs enter the marine environment from a number of sources: for example, marine transportation, offshore oil production, coastal oil refineries, accidental shipping losses, industrial and municipal waste (including sewage and dredged spoils) with a significant contribution to the global budget entering via urban and river run-off, atmospheric deposition (i.e. from combustion sources, including PAHs) and natural seepages (Johnston, 1980; Dicks et al., 1987).

The total hydrocarbon content concentrations measured in sediment samples collected along the cable route displayed high variability (RSD 105 %). The three stations (R1_ENV_93, 22.5 µg/g; R1_ENV_94, 37.4 µg/g and R1_ENV_95, 18.0 µg/g) with the highest THC concentrations were grouped together. Overall, concentrations were low (ranging from 1.2 µg/g to 37.4 µg/g) with values that are typical of concentrations recorded around non-industrialised coastal environments distant from hydrocarbon inputs (de Mora et al., 2010).

Most of the sediment individual PAH concentrations were below the MRV (0.1 ng/g). Total PAH concentrations did not exceed the ADS 18/2017 MAC value (1700 ng/g) at any station. Although comparison of total US EPA 16 PAH concentrations was made to the MAC values for total PAHs (QCC, 2017), they should be treated with caution as this document does not state which PAHs constitute the total PAH value. The concentrations of individual PAHs were also lower than the available estimated environmental effect threshold values (ERL values, listed in Appendix I.1). Total PAH concentrations were broadly comparable to the range (0 ng/g to 31.5 ng/g) reported previously in offshore UAE waters (Al Katheeri, 2004).

The concentrations of BTEX measured in the sediment samples collected throughout the Route 1 survey area were all below the MRV (5.0 ng/g). Previous site-specific studies in UAE offshore waters (Fugro, 2016) reported BTEX sediment concentrations below the MRV (range from < 0.05 mg/kg to < 0.1 mg/kg), which were higher than the current survey.

## 14.8 Sediment Polychlorinated Biphenyls

PCBs are a group of industrial chemicals that were widely used in electrical equipment. They are manufactured by reacting chlorine with biphenyl resulting in the formation of a complex mixture of compounds (known as congeners). The properties of the final product are modified by varying the proportion of chlorine to biphenyl present. PCBs in environmental samples are therefore present as technical mixtures not as individual compounds. PCBs have been identified as being potentially harmful to the environment and are no longer commercially produced but may still be present on offshore installations in sealed units (such as power transformers). Releases of PCBs to the environment would therefore not be expected to be widespread with the most likely source of contamination being related to historic use of coatings/paint containing PCBs or spillages from damaged equipment.

PCB concentrations along Route 1 were below the MRV (0.020 ng/g) at most stations and all total WHO12 PCB concentrations were below the ADS 18/2017 MAC (22.0 ng/g) for general use areas and MPAs. Although comparison to the MAC values have been made, the ADS 18/2017 (QCC, 2017) document does not specify which PCBs constitute the PCB total. Previous studies in UAE offshore waters demonstrated higher PCB sediment concentrations (< 0.01 mg/kg Fugro, 2016), than those from the current survey.

## 14.9 Sediment Metals

The analysis of samples for heavy metal content can provide further corroboration in conjunction with the physical characteristics and hydrocarbon content of marine sediments in assessing either the background levels or the dispersion of discharged material around offshore installations.

Trace metal contaminants in the marine environment tend to form associations with the non-residual phases of mineral matter, such as iron and manganese oxides and hydroxides, metal sulphides, clays, organics and carbonates (Warren & Zimmerman, 1993; Dang et al., 2015; Wang et al., 2015). Non-residual trace metals are associated with more reactive and available sediment components through processes such as adsorption onto mineral surfaces and organic complexation. Metals associated with these more reactive phases are prone to various environmental interactions and transformations (physical, chemical and biological) potentially increasing their mobility and biological availability (Tessier et al., 1979; Warren & Zimmerman, 1993; Du Laing et al., 2009). Residual trace metals are defined as those that are part of the crystal structure of the component minerals and are generally unavailable to organisms (de Orte et al., 2018). Therefore, in monitoring trace metal contamination of the marine environment, it is important to distinguish the more mobile non-residual trace metals from the residual metals held tightly in the sediment lattice (Chester & Voutsinou, 1981), which are of comparatively lesser environmental significance because of their low reactivity and availability.

In this study, an analytical procedure involving the digestion of sediment using aqua regia was employed to analyse the elemental content of the sediments. The aqua regia digest releases for analysis the non-residual heavy metals, which are not incorporated in the mineral matrix and are therefore potentially available for biological uptake.

Except for chromium, lead and nickel, concentrations of all sediment metals were below their respective ADS 18/2017 MAC for both general use areas and marine protected areas. Concentrations of chromium, lead and nickel exceeded the ADS 18/2017 MAC (QCC, 2017) for marine protected areas at 14, 4 and 18 stations respectively. Nickel concentrations also exceeded the ADS 18/2017 MAC (QCC, 2017) for general use areas at 4 stations, including the two nearshore stations R1_ENV_001 and R1_ENV_002.

There were no spatial patterns in the dataset, or any relationships with depth. None of the metal concentrations recorded across the survey area exceeded ERL threshold values (NOAA, 1999), hence no adverse effects on organisms are expected.

## 14.10 Seabed Habitats

Seabed across the survey area encompasses three distinct habitats in accordance with the MLEAD (John and George, 2001) and EAD (Al Dhaheri et al., 2017) habitat classifications.

'Sublittoral mixed deposit' (SLMXD) habitat was identified from five transects (R1_TR04B, R1_TR06, R1_TR07, R1_TR08A and R1_TR10). This habitat consisted of a hard, calcarenite substratum, overlaid with a veneer of sand, shell sediment and coral rubble. Calcarenite substrata comprise cemented calcareous sand grains and can be formed in marine or terrestrial settings. Calcarenite is widespread throughout shallower waters and coastal areas of the UAE (Macklin et al., 2012). The findings of the seabed photography analysis aligned with those of the geophysical survey (Fugro, 2020b) which reported calcarenite surficial sediments throughout the Route 1 survey area. The authors of this classification describe shallower water variants of this habitat, in which macroalgae are the dominant biota, as being widespread throughout Abu Dhabi waters. Previous surveys offshore Abu Dhabi (e.g. Fugro, 2016) and across the wider region have also reported habitats more akin to that recorded from Route 1 survey area; these appear to be deeper variants of the mixed sediment habitat reported by John & George (2001), with boulder corals and other attached invertebrates found to be the dominant taxa.

Overall, the survey area comprised a low diversity and abundance of corals, including boulder corals (Faviidae, ?Cyphastrea sp.), plate coral (Turbinaria sp.), finger corals (Porites sp.), all of which are widespread offshore UAE (Riegl et al., 2012). The majority of coral colonies identified were small (less than 20 cm diameter), with the largest colony reported (Porites sp.) reaching approximately 50 cm diameter.

A hard coral assessment was undertaken in line with internationally recognised assessment criteria (Det Norske Veritas [DNV], 2019; Santavy et al., 2012) and coral cover was classified as ‘no coral’ (< 1 % cover) from all but three transects. In transect R1_TR04B small coral outcrops were sporadically observed and, in two segments of the transect, coral cover was classified as ‘low’ (estimated 1 % to 5 %), whereas in transect R1_TR10 corals outcrops were occasionally observed throughout the transect and displayed a ‘low’ cover of 5 % to 10 %. Coral cover in a segment of transect R1_TR06 was classified as ‘moderate coral’ (estimated at 10 % to 20 %). No transects were interpreted to have high (greater than 50 %) coral cover.

‘Sublittoral sand and gravel’ (SLSED) habitat was identified from segments of three transects (R1_TR02, R1_TR03 and R1_TR09), where bare soft sediment was interspersed with seagrass beds. Compared to the other two habitats observed across the survey area, the ‘Sublittoral sand and gravel’ displayed the lowest diversity and abundance in terms of epifauna and epiflora. The biological assemblages usually associated to this habitat are largely represented by infauna, including a range of polychaetes and crustaceans. Large burrows in stable sediment are often occupied by shrimp gobies (*Cryptocentrus lutheri*) and their attendant bulldozer alpheid shrimps (John & George, 2004).

‘Seagrass beds’ were identified from five transects across the survey area. Seagrass beds are common in the vast shallow subtidal areas (< 15 m) that dominate much of the south and southwestern Gulf, with the most extensive beds occurring off of the coast of the UAE and Qatar (Jones, 1985). Three main seagrass species occur regionally, *Halodule uninervis* (most widely distributed), *Halophila stipulacea* (less common, but forming dense meadows in some areas) and Halophila ovalis (rarely forming dense monospecific meadows), with > 90 % of seagrass being H. uninervis alone (Erftemeijer & Shuail, 2012).

Across the survey area, ‘Seagrass beds’ displayed two habitat variants. ‘Maturing beds of the seagrasses *H. uninervis*, H. ovalis and *H. stipulacea’* (SLSED.Huni.Hoval.Hstip) habitat was identified from transects R1_TR01, R1_TR02 and R1_TR03. This habitat consisted of relatively deeper soft sediment at lower depths, where can form more stable and dense seagrass meadows (*H. uninervis*, H. ovalis and *H. stipulacea* complex). The type of substratum plays a major role in the distribution of seagrasses. For the rhizomes to grow and for the anchoring of roots, seagrasses typically require a soft substrate of gravel, sand or mud (Greve & Binzer, 2004). In the Arabian Gulf, seagrasses are subject to extreme natural variations in water temperature which plays a major stressor in the seagrass productivity. Among seagrass species, *H. uninervis* shows the highest tolerance when compared to the broader leaved plants (Ballorain, et al., 2010). This could explain the higher density of *H. uninervis* at shallower depths, where waters reach higher temperature. The upright growth form of the seagrass blades supports further deposition of fines sediment from the water column as the beds develop to maturity, thus providing a habitat for a further range of infauna that favour finer sediment (John & George, 2004). At deeper depths, ranging between ~12.0 m and ~13.0 m BSL, 'Low density beds of H. ovalis and *H. stipulacea* colonising bare sediment' (SLSED.Hoval.Hstip) was identified from two transects (R1_TR05A and R1_TR09). This habitat variant consisted of lower density of the understorey seagrass *H. ovalis* and *H. stipulacea*, colonising bare sediment.

Seagrasses have significant ecological and economic importance in the Gulf. They are a direct food source for many herbivores, they provide indirect energy to the detrital food web (Coles & McCain, 1990), and provide nursery habitats for a variety of commercially important fishes (Jones et al., 2002; Sheppard et al., 2010).

# 15. Conclusions

The aim of this report is to establish the current biological and physico-chemical conditions of the seabed sediments and water column along the proposed Route 1 that will connect Lower Zakum Island G to Mirfa within the Zakum Field, Offshore Abu Dhabi. A review of the environmental data in context with other cited studies from the region and estimated water and sediment effects threshold values (QCC, 2017; US EPA 2020, Buchman, 2008 and CCME, 2020) was also undertaken. Based on the overall assessment of the survey area, the following key conclusions can be stated:

Water profiling identified an unstratified water column, in which the majority of parameters remained near-constant from sea surface to seabed. Variation recorded for all water profile parameters sampled within the water column across the survey area can be attributed to seasonality differences within sampling regimes.

The concentrations of inorganic water quality parameters > MRV (TDS, sulphate, pH, chloride, total nitrogen, total cyanide, nitrate, total phosphorus, nitrite, turbidity and TOC) displayed low to moderate variability where statistics were available and were typical of marine water. The majority of inorganic water quality parameters were below their respective MRVs at all stations across the survey area.

Concentrations of volatile petroleum hydrocarbons, extractable petroleum hydrocarbons, polycyclic aromatic hydrocarbons, BTEX and phenols in the water samples were below their respective minimum reporting values in all samples, apart from naphthalene, phenanthrene and pyrene, where some samples had values above the MRV. However, the concentrations recorded are unlikely to be of environmental concern. Benzene, toluene and ethylbenzene were below the CCME guideline values and considered to be representative of background conditions.

Except for chromium, copper, lead and zinc, concentrations of all major and trace elements were below their respective ADS 18/2017 MACs, as well as the US EPA CCC and CMC values and considered to be of no environmental concern. Concentrations of chromium, copper, lead and zinc exceeded the ADS 18/2017 MACs for both general use areas and marine protected areas in 100, 17, 31 and 129 samples respectively. Copper and lead concentrations exceeded the US EPA CCC in 16 and 4 samples, respectively. Copper and zinc concentrations exceeded the US EPA CMC in 8 and 5 samples, respectively.

Using the Wentworth (1922) sediment description, stations along the Route 1 survey area comprised mainly sand and were classified as coarse sand to fine silt. No clear spatial patterns between depth and sediment type were apparent along Route 1. Total organic carbon content was low across the survey area and lower than previous studies in the region. Conversely, the carbonate content observed within sediments was higher than previously reported values.

All sediment nutrient concentrations demonstrated low to moderate variation across the survey area with no spatial patterns, demonstrating broadly homogenous sediments.

Concentrations of THC were low and typical of concentrations recorded around non-industrialised coastal environments distant from hydrocarbon inputs. Total PAH concentrations were below the ADS 18/2017 MAC. The concentrations of BTEX in the current survey were below the MRV at all stations along the Route 1 survey area and lower than the values reported previously in the region.

The concentrations of PCBs in the current survey were below the MRV at most stations along the Route 1 survey area and lower than the values reported previously in the region. Total WHO12 PCB concentrations were below the ADS 18/2017 MAC.

All sediment metals concentrations recorded across the survey area were below their respective US National Oceanographic and Atmospheric Administration (NOAA) effects range low (ERL) and effects range median (ERM) threshold values. Except for chromium, lead and nickel, concentrations of all sediment metals were below their respective ADS 18/2017 MAC for both general use areas and marine protected areas. Concentrations of chromium and nickel exceeded the ADS 18/2017 MAC (QCC, 2017) for marine protected areas in numerous stations. Lead concentrations exceeded the ADS 18/2017 MAC (QCC, 2017) for marine protected areas in one station. Nickel concentrations also exceeded the ADS 18/2017 MAC (QCC, 2017) for general use areas in 4 stations. There was no clear spatial distribution pattern that would indicate a point source related to possible anthropogenic activities within the survey area, and the differences recorded are therefore most likely to be associated with natural sediment variations.

The seabed was heterogeneous across the survey area and encompassed three distinct habitats: ‘Sublittoral mixed deposit’, ‘Sublittoral sediment’ and ‘Seagrass bed’. ‘Sublittoral mixed deposit’ comprised a mainly flat substratum of calcarenite (cemented sand) with a veneer of sand sediment and occasional coral outcrops, mainly including finger corals (*Porites* sp.), plate corals (*Turbinaria* sp.) and boulder corals (Faviidae). ‘Sublittoral sediment’ encompasses predominantly sand sediment, with varying proportions of gravel, shell and coral fragments. ‘Seagrass bed’ comprised predominantly sand sediment seagrass of which *Halodule uninervis* is the dominant cover species and/or in places *Halophila ovalis* and *Halophila stipulacea* form an understorey. All habitats reported, and the taxa resident therein, were typical of areas of similar sediment and water depth in the southern Arabian Gulf.

# 16. References

Al Dhaheri, S.S., Al Cibahi, A., Javed, S., Grandcourt, E., Bin Kulaib, R., & Al Mazrouei, S. (2017). *Abu Dhabi State of Environment report 2017*. Biodiversity, Environment Agency-Abu Dhabi.

Al Katheeri, B.S., 2004. Geochemical Studies to Assess Marine Oil Pollution Zakum Field, Abu Dhabi, UAE. United Arab Emirates University Thesis. 575. Available at: https://scholarworks.uaeu.ac.ae/all_theses/575

Alpar, B. and Unlu, S. (2010). Volatile aromatic compounds (BTEX) in sediments offshore Zonguldak industrial region, Black Sea, Turkey. *Asian Journal of Chemistry*, *22*(5), 3531.

Ballorain, K., Ciccione, S., Bourjea, J., Grizel, H., Enstipp, M. R. and Georges, J.-Y. (2010). Habitat use of a multispecific seagrass meadow by green turtles Chelonia mydas at Mayotte Island. *Marine Biology*, 157, 2581-2590.

Basaham, A.S., & El-Sayed, M.A. (1998). Distribution and phase association of some major and trace elements in the Arabian Gulf sediments. *Estuarine, Coastal and Shelf Science, 46*(2), 185-194.

Basson, P.W., Burchard Jr, J.E., Hardy, J.T., & Price, A.R. (1977). Biotopes of the western Arabian Gulf; marine life and environments of Saudi Arabia.

Bilotta, G.S. & Brazier, R.E. (2008). Understanding the influence of suspended solids on water quality and aquatic biota, *Water Research*, *42*(12), 2849-2861.

Blott, S. (2010). *GRADISTAT Version 8.0: a grain size distribution and statistics package for the analysis of unconsolidated sediment by sieving or laser granulometer.* Berkshire: Kenneth Pye Associates.

Blue Sea Environmental Consultants, 2011. *Environmental baseline study ADMA OPCO'S existing facilities Zakum Oil Field Abu Dhabi.* Report of February 2011 Survey. Document No. OP/04-001/ZK-EBS/029.

Bouloubassi, I., Lipiatou, E., Saliot, A., Tolosa, I., Bayona, J.M., & Albaiges, J. (1997). Carbon sources and cycle in the Western Mediterranean: II. The use of molecular markers to determine the origin of organic matter. *Deep Sea Research*, *44*(7), 81-799.

Boening, D.W. (1999). An evaluation of bivalves as biomonitors of heavy metals pollution in marine waters. *Environmental Monitoring and Assessment*, *55*(3), 459-470.

Brady, J.P., Ayoko, G.A., Martens, W.N., & Goonetilleke, A. (2015). Development of a hybrid pollution index for heavy metals in marine and estuarine sediments. *Environmental Monitoring and Assessment*, *187*(5), 306.

Buchanan, J.B. (1984). Sediment analysis. In N.A. Holme and A.D. McIntyre (Eds.) *Methods for the study of marine benthos*. 2nd edition. IBP Handbook No 16. Blackwell Scientific Publications, Oxford, London, Edinburgh, Boston, Palo Alto and Melbourne.

Buchman, M.F., 2008. *NOAA screening quick reference tables, NOAA OR&R report 08-01.* Seattle, NOAA.

Bush, R.T. & McInerney, F.A. (2013). Leaf wax n-alkane distributions in and across modern plants: Implications for paleoecology and chemotaxonomy. *Geochimica et Cosmochimica Acta*, *117*, 161-179.

Canadian Council of Ministers of the Environment [CCME]. (2020). *Canadian Water Quality Guidelines for the Protection of Aquatic Life: CCME Water Quality Index Summary Table.* http://st-ts.ccme.ca/en/index.html Accessed August 2020.

Carpenter K.E., Krupp F., Jones D.A., & Zajonz, U. (1997). *Living marine resources of Kuwait, Eastern Saudi Arabia, Bahrain, Qatar, and the United Arab Emirates*. Report to Food and Agriculture Organisation of the United Nations (FAO), Rome. ISBN 92-5-103741-8.

Chao, S.Y., Kao, T.W., & Al-Hajri, K.R. (1992). A numerical investigation of circulation in the Arabian Gulf. *Journal of Geophysical Research, 97*(11), 219-236.

Chester, R., & Voutsinou, F.G. (1981). The initial assessment of trace metal pollution in coastal sediments. *Marine Pollution Bulletin, 12*, 84-91.

Coles, S.L., & McCain, J.C., 1990. Environmental factors affecting benthic infaunal communities of the western Arabian Gulf. *Marine Environmental Research, 29*(4), 289-315.

Dang, D.H., Lenoble, V., Durrieu, G., Omanović, D., Mullot, J.U., Mounier, S., & Garnier, C. (2015). Seasonal variations of coastal sedimentary trace metals cycling: Insight on the effect of manganese and iron (oxy)hydroxides, sulphide and organic matter. *Marine Pollution Bulletin*, *92*(1-2), 113-124.

de Mora S., Tolosa I., Fowler S.W., Villeneuve J-P., Cassi R., & Cattini C. (2010). Distribution of petroleum hydrocarbons and organochlorinated contaminants in marine biota and coastal sediments from the ROPME Sea Area during 2005. *Marine Pollution Bulletin, 60*(12), 2323-2349.

de Orte, M.R., Bonnail, E., Sarmiento, A.M., Bautista-Chamizo, E., Basallote, M.D., Riba, I., DelValls, Á., & Nieto, J.M. (2018). Metal fractionation in marine sediments acidified by enrichment of $CO_2$: a risk assessment. *Marine Pollution Bulletin*, *131*, 611-619.

Department of Trade and Industry [DTI]. (1993). *Conditions for the discharge of oil contaminated cuttings resulting from offshore drilling.* Department of Trade and Industry, Oil and Gas Division.

Det Norske Veritas [DNV]. (2019). *Species and habitats of environmental concern. Mapping, risk assessment, mitigation and monitoring - in relation to oil and gas activities.* (No. 2019–007, Rev. 0).

Dicks, B., Bakke, T., & Dixon, I.M.T. (1987). Oil exploration and production: impacts of the North Sea. *Oil and Chemistry Pollution*, *3*, 289-306.

Douglas, A.G., & Eglinton, G. (1966). The distribution of alkanes. In T. Swain (Ed.) *Comparative Phytochemistry*, 57-71. Academic Press, London.

Duan, W., Meng, F., Lin, Y., & Wang, G. (2017). Toxicological effects of phenol on four marine microalgae. *Environmental toxicology and pharmacology, 52*, 170-176.

Duan, W., Meng, F., Cui, H., Lin, Y., Wang, G., & Wu, J. (2018). Ecotoxicity of phenol and cresols to aquatic organisms: a review. *Ecotoxicology and environmental safety*, *157*, 441-456.

Du Laing, G., Rinklebe, J., Vandecasteele, B., Meers, E,. & Tack, F.M.G. (2009). Trace metal behaviour in estuarine and riverine floodplain sediments: a review. *Science of the Total Environment*, *407*, 3972-3985.

Edwards, N.T. (1983). Polycyclic aromatic hydrocarbons (PAHs) in the terrestrial environment – a review. *Journal of Environmental Quality*, *12*, 427-441.

Eglinton, G., Gonzalez, A.G., Hamilton, R.J., & Raphael, R.A. (1962). Hydrocarbon constituents of the wax coatings of plant leaves: a taxonomic survey. *Phytochemistry*, *1*, 89-102.

Environment Agency-Abu Dhabi [EAD], (2008). *Marine and coastal environments of Abu Dhabi Emirates, United Arab Emirates*. Abu Dhabi Global Environmental Data Initiative. pp. 12.

Environment Agency – Abu Dhabi [EAD]. (2017). *Marine water quality annual summary report*. https://www.ead.gov.ae/storage/Post/files/353857ac9178887858be8de07b843904.pdf

Erftemeijer, P.L,. & Shuail, D.A. (2012). Seagrass habitats in the Arabian Gulf: distribution, tolerance thresholds and threats. *Aquatic Ecosystem Health & Management*, *15*(sup1), pp.73-83.

Farrington, J.W., Frew, N.M., Gschwend, P.M,. & Tripp, B.W. (1977). Hydrocarbons in cores of north-western Atlantic coastal and continental marine sediments. *Estuary Coast Marine Science*, *5*, 793-808.

Farrington, J.W., & Meyer, P.A. (1975). Hydrocarbons in the marine environment. In G. Eglinton (Ed.) *Environmental Chemistry, Chemical Society*, *1*, 109-136.

Folk, R.L. (1954). The distinction between grain size and mineral composition in sedimentary rock nomenclature. *Journal of Geology, 65*(4), 344-359.

Folk, R.L., & Ward, W.C. (1957). Brazos River bar (Texas); a study in the significance of grain size parameters. *Journal of Sedimentary Research,* 27(1), 3-26.

Fugro. (2016). *Environmental baseline study, offshore UAE.* Fugro Job no. 160482.

Fugro, (2019). *Environmental baseline report, offshore Qatar.* Fugro Document No.: MRQ024-V04-EBS-NF18.

Fugro. (2019). *Environmental Baseline Report North Field NF-18, State of Qatar.* Fugro Document No.: MRQ024-V04-EBS-NF18.

Fugro. (2020a). *Survey results report – Cable Route 1a. From Mira Landfall to Lower Zakum Island G United Arab Emirates.* Report number MRU093-Vol 2-1A.

Fugro. (2020b). *Survey results report – Cable Route 1b. From Mira Landfall to Lower Zakum Island G United Arab Emirates.* Report number MRU088-Vol 3-1B.

Gray, J.S. (1981). *The ecology of marine sediments. an introduction to structure and function of benthic communities.* Cambridge University Press, pp. 185.

Greve, T.M., & Binzer, T. (2004). *Which factors regulate seagrass growth and distribution. European seagrasses: an introduction to monitoring and management*, pp. 19.

Harada, N., Handa, N., Fukuchi, M., & Ishiwatari, R. (1995). Source of hydrocarbons in marine sediments in Lutzow-Holm Bay, Antarctica. *Organic Geochemistry*, *23*(3), 229-237.

International Union for Conservation of Nature [IUCN]. (2020). *The IUCN Red List of Threatened Species. Version 2020-2.* https://www.iucnredlist.org/

John, D.M., & George, J.D. (1998). Report on the marine benthic biota of the Emirate of Abu Dhabi and the impact of coastal developments upon them. In P.J. Whybrow (Ed.) *reports on marine biological studies in the Emirate of Abu Dhabi*, United Arab Emirates. Seventh report prepared for the Abu Dhabi National Oil Company and the Abu Dhabi Company for Onshore Oil Operations. London: The Natural History Museum, pp. 43.

John, D.M., & George, J.D. (2001). *The marine life of Abu Dhabi*. A report for the Abu Dhabi Company for Onshore Oil Operations. London: The National History Museum.

John, D.M., & George, J.D. (2004). *Intertidal and subtidal benthic communities in Abu Dhabi, United Arab Emirates. Marine Atlas of Abu Dhabi*. Emirates Heritage Club, Abu Dhabi, UAE, pp.94-123.

Johnston, C.S. (1980). Sources of hydrocarbons in the marine environment. In: C.S. Johnston & R.J. Morris (Eds.) *Oily Water Discharges*, Applied Science Publishers Ltd, London, pp. 41-62.

Jones, D. (1985). *The biological characteristics of the marine habitats found within the ROPME Sea area*. In Proceedings of the symposium on Regional Marine Pollution Monitoring and Research Programmes, Al-Ain (pp. 71–89).

Jones, D.A., Price, A.R.G., Al-Yamani, F., & Al-Zaidan, A. (2002). Coastal and marine ecology. In Khan et al. (Eds.) *The Gulf Ecosystem: Health and Sustainability*. Leiden, The Netherlands, pp. 65–103.

Klemas, C. (2012). Remote sensing of algal blooms: An overview with case studies. *Journal of Coastal Research, 28*(1A), pp. 34-43.

Koike I., & Sorensen, J. (1988). Nitrate reduction and denitrification in marine sediments. In: T.D. Blackburn and J. Sorensen (eds). *Nitrogen Cycling in Coastal Marine Environments.* Chichester: John Wiley and Sons Ltd.

Krastanov, A., Alexieva, Z., & Yemendzhiev, H. (2013). Microbial degradation of phenol and phenolic derivatives. *Engineering in Life Sciences*, *13*(1), 76-87.

Laflamme, R.E., & Hites, R.A. (1978). The global distribution of polycyclic aromatic hydrocarbons. *Geochimica et Cosmochimica Acta*, *42*, 289–303.

Latimer, J.S., & Zheng, J. (2003). The sources, transport and fate of PAHs in the marine environment. *PAHs: an ecotoxicological perspective*, pp. 9.

Long, D. (2006). BGS *Detailed explanation of seabed sediment modified Folk classification.* Mapping European Seabed Habitats. https://www.researchgate.net/publication/284511408_BGS_detailed_explanation_of_seabed_sediment_modified_folk_classification

Macklin, S., Ellison, R., Manning, J., Farrant, A., & Lorenti, L. 2012. Engineering geological characterisation of the Barzaman Formation, with reference to coastal Dubai, UAE. *Bulletin of Engineering, Geology and the Environment, 71*, 1-35.

Meadows, P.S. (1964). Substrate selection by *Corophium* species: the particle size of substrates. *Journal of Animal Ecology*, *33*, 387-394.

Meyers, P.A., & Quinn, J.G. (1973). Association of hydrocarbons and mineral particles in saline solution. *Nature*, *224*, 23-24.

Myers, E.P. & Gunnerson, C.G. (1976). *Hydrocarbons in the ocean*. Washington DC: US Department of Commerce (NOAA), 42.

Mordy, C. W., Eisner, L.B., Proctor, P., Stabeno, P., Devol., A.H., Shull, D.H., Napp, J.M., & Whitledge, T. (2010). Temporary uncoupling of the marine nitrogen cycle: Accumulation of nitrite on the Bering Sea shelf. *Marine Chemistry*, *121*(1-4), 157-166.

National Petroleum Construction Company [NPCC]. (2019). *Upper Zakum pipelines replacement project phase 1 environmental baseline survey report*. Report Number E1077-SUR-300-V-0010.

Neff, J.M. (1979). *Polycyclic aromatic hydrocarbons in the aquatic environment. Sources, fates and biological effects.* Applied Science Publishers, London, pp. 1-262.

National Oceanic and Atmospheric Administration (NOAA), 1999. *Sediment quality guidelines developed for the National Status and Trends Program.*

Paez-Osuna, F., & Ruiz-Fernandez, C. (1995). Comparative bioaccumulation of trace metals in *Penaneus stylirostris* in estuarine and coastal environments. *Estuarine, Coastal and Shelf Science, 40*, 35-44.

Paparella, F., Xu, C., Vaughan, G.O., & Burt, J.A. (2019). Coral bleaching in the Persian/Arabian Gulf is modulated by summer winds. *Frontiers in Marine Science, 6*, 205.

Parinos, C., Gogou, A., Bouloubassi, I., Pedrosa-Pames, R., Hatzianestis, I, Sanchez-Vidal, A., Rousakis, G., Velaoras, D., Krokas, G., & Lykousis, V. (2013). Occurrence, sources and transport pathways of natural and anthropogenic hydrocarbons in deep-sea sediments of the eastern Mediterranean Sea. *Biogeosciences*, *10*, 6069-6089.

Parry, M.E.V. (2019). *Guidance on assigning benthic biotopes using EUNIS or the marine habitat classification of Britain and Ireland* (revised 2019). Joint Nature Conservation Committee Report 546, ISSN 0963-8091

Quality and Conformity Council [QCC]. (2017). Abu Dhabi Specifications. Ambient and Marine Water Specifications ADS 18/2017. [online] Available at: https://www.qcc.gov.ae/-/media/Project/QCC/QCC/Documents/Quality-Infrastructure-Documents/Abu-Dhabi-Specification/Abu-Dhabi-Specifications/ADS-18---Ambient-Marine-Water-and-Sediments-Specification.pdf [Accessed June 2020].

Rezai, H., Wilson, S., Claereboudt, M., & Riegl, B. (2004). Coral reef status in the ROPME Sea area: Arabian/Persian Gulf, Gulf of Oman and the Arabian Sea. In *Status of Coral Reefs of the World: 2004*. Australian Institute of Marine Sciences, pp. 155-170.

Riegl, B. (2001). Inhibition of reef framework by frequent disturbance: examples from the Arabian Gulf, South Africa, and the Cayman Islands. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *175*, pp.79-101.

Riegl B., Benzoi, F., Sheppard, C., & Samini-Namin, K. (2012) The Hermatypic Scleractinian (Hard) Coral Fauna of the Gulf. In B. Riegl & S.J. Purkis. (Eds.) *Coral Reefs of the Gulf. Adaptation to Climatic Extremes. Coral Reefs of the World, Vol. 3.* Springer, Dordrecht.

Santavy, D.L., Fisher, W.S., Campbell, J.G., & Quarles, R.L. (2012). *Field manual for coral reef assessments*. U.S. Environmental Protection Agency, Office of Research and Development, Gulf Ecology Division, Gulf Breeze, FL. EPA/600/R-12/029. April 2012.

Sheppard, C., Al-Husiani, M., Al-Jamali, F., Al-Yamani, F., Baldwin, R., Bishop, J., Benzoni, F., Dutrieux, E., Dulvy, N.K., Durvasula, S.R.V., Jones, D.A., Loughland, R., Medio, D., Nithyanandan, M., Pilling, G.M., Polikarpov, I., Price, A.R.G., Purkis, S., Riegl, B., Saburova, M., Namin, K.S., Taylor, O., Wilson, S., & Zainal, K. (2010). The Gulf: a young sea in decline. *Marine Pollution Bulletin, 60*, 13-38.

Sheppard, C.R.C. (1993) Physical environment of the Gulf relevant to marine pollution: an overview. *Marine Pollution Bulletin, 27*, 3–8

Shriadah, M.M.A., & Al-Ghais, S.M. (1999). Environmental characteristics of the United Arab Emirates waters along the Arabian Gulf: *Hydrographical survey and nutrient salts. Indian Journal of Marine Sciences, 28*, 225-232.

Sims, R.C., & Overcash, M.R. (1983). Fate of polynuclear aromatic compounds (PNAs) in soil plant systems. *Residue Reviews*, *88*, 1-68.

Simmonds, E.J., & Lamboeuf, M. (1981). Environmental conditions in the Gulf and the Gulf of Oman and their influence on the propagation of sound. UNDP/FAO, *Regional Fishery Survey and Development Project,* pp. 62.

Taher, M.M., Mohamed, A.R.M., & Al-Ali, A.K.H. (2012). Some ecological characteristics and ichthyofauna of surrounding Sammaliah Island, Abu Dhabi, UAE. Basrah *Journal of Science, 30*, 31-49.

Tessier, A., Campbell, P.G.C., & Bisson, M. (1979). Sequential extraction procedure for the speciation of particulate trace metals. *Analytical Chemistry, 51*, 844-851.

Thibodeaux, L.J., Valsaraj, K.T., John, V.T., Papadopoulos, K.D., Pratt, L.R., & Pesika, N.S. (2011). Marine oil fate: knowledge gaps, basic research, and development needs; a perspective based on the Deepwater Horizon spill. *Environmental Engineering Science*, *28*(2), 87-93.

United Nations Environment Programme World Conservation Monitoring Centre [UNEP-WCMC]. (2014). *Checklist of CITES species.* CITES Secretariat, Geneva, Switzerland and UNEP-WCMC, Cambridge, United Kingdom.

United States Environmental Protection Agency [US EPA]. (2020). *National recommended water quality criteria*. https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table. [Accessed August 2020].

Wang, Z., Wang, Y., Zhao, P., Chen, L., Yan, C., Yan, Y., & Chi, Q. (2015). Metal release from contaminated coastal sediments under changing pH conditions: Implications for metal mobilization in acidified oceans. *Marine Pollution Bulletin*, *101*(2), 707-715.

Warren, L.A., & Zimmerman, A.P. (1993). Trace metal-suspended particulate matter associations in a fluvial system: Physical and chemical influences. *Particulate and matter and aquatic contaminants. Lewis Publishers, Boca Raton*, pp. 127-155.

Wentworth, C.K., 1922. A scale of grade and class terms for clastic sediments. *The Journal of Geology*, *30*(5), 377-392.

Windsor, J.G. Jr., & Hites, R.A. (1979). Polycyclic aromatic hydrocarbons in Gulf of Maine sediments and Nova Scotia soils. *Geochimica et Cosmochimica Acta*, *43*, 7-33.

Youngblood, W.W., & Blumer, M. (1975). Polycyclic aromatic hydrocarbons in the environment: homologous series in soils and recent marine sediments. *Geochimica et Cosmochimica Acta*, *39*, 1303–1314.

# Appendices

# A. Guidelines on Use of Report

This report (the “Report”) was prepared as part of the services (the “Services”) provided by Fugro Survey (Middle East) Limited (“Fugro”) for its client (the “Client”) under terms of the relevant contract between the two parties (the “Contract”). The Services were performed by Fugro based on requirements of the Client set out in the Contract or otherwise made known by the Client to Fugro at the time.

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# B. Methodologies

## B.1 Laboratory Analysis of Water Samples

### B.1.1 Water Quality

pH was determined using the method APHA 4500 H + B: pH Value in Water by Potentiometry Using a Standard Hydrogen Electrode.

Total suspended solids (TSS) were determined by method APHA 2540 D: D: Total Suspended Solids Dried at 103 °C to 105 °C.

Total dissolved solids (TDS) were determined by the method APHA 2540 C: Total Dissolved Solids Dried at 180 °C.

Turbidity was analysed using method APHA 2130 B: Nephelometric Method.

Nitrogen (ammonia) and ammonium were analysed using method HACH 8155: Salicylate Method. Ammonia compounds combined with chlorine to form monochloramine. Monochloramine reacted with salicylate to form 5-aminosalicylate. The 5-aminosalicylate was oxidised in the presence of a sodium nitroprusside catalyst to form a blue coloured compound. The blue colour was masked by the yellow colour from the excess reagent present to give a final green-coloured solution which was measured colorimetrically.

Sulphide was determined by method APHA 4500 S2- F: Sulphide by Iodometry.

Total nitrogen was analysed using method ASTM D5176: Standard Test Method for Total Chemically Bound Nitrogen in Water by Pyrolysis and Chemiluminescence Detection. The sample of water was introduced into a stream of oxygen or inert gas/oxygen mix flowing through a quartz pyrolysis tube. Oxidative pyrolysis converted chemically bound nitrogen to nitric oxide (NO). The gas stream was dried and the NO was contacted with ozone ($O_3$) producing metastable nitrogen dioxide ($NO_2$*). As the $NO_2$* decayed, light was emitted and detected by a photomultiplier tube. The resulting signal was a measure of the total chemically bound nitrogen in the sample.

Total cyanide was analysed by a modified version of method US EPA method OIA-1667: Available Cyanide by Flow Injection, Ligand Exchange and Amperometry.

Nitrate was analysed by method HACH 8039: Cadmium Reduction Method. Cadmium metal reduced nitrates in the sample to nitrite. The nitrite ion reacted in an acidic medium with sulfanilic acid to form an intermediate diazonium salt. The salt coupled with gentisic acid to form an amber coloured solution. The measurement wavelength was 500 nm for spectrophotometers or 520 nm for colorimeters.

Nitrite was determined using method HACH 8507: Nitrite method. Nitrite in the sample reacted with sulfanilic acid to form an intermediate diazonium salt. This coupled with chromotropic acid to produce a pink coloured complex directly proportional to the amount of nitrite present. Test results were measured at 507 nm.

Phosphorus was analysed using the method APHA 3125: Metals by Inductively Coupled Plasma Mass Spectrometry (2017).

Orthophosphate was analysed using method HACH 8048: Phosphorus, Reactive (Orthophosphate). Orthophosphate reacted with molybdate in an acid medium to produce a mixed phosphate/molybdate complex. Ascorbic acid then reduced the complex, which gave an intense molybdenum blue colour. The measurement wavelength was 880 nm (DR 1900:710 nm) for spectrophotometers or 610 nm for colorimeters.

Sulphate was determined by method APHA 4500 SO42- C: Gravimetric Analysis with Ignition of Residue. Sulphate was precipitated in an HCl solution as barium sulphate by the addition of barium chloride. The precipitation was carried out near the boiling temperature, and after a period of digestion, the precipitate was filtered, washed with water until free of chloride, ignited or dried, and weighed as barium sulphate.

Chloride was determined by method APHA 4500 Cl- B: Iodometric Method I. Chlorine liberates free iodine from potassium iodide (KI) solutions at pH 8 or less. The liberated iodine was titrated with a standard solution of sodium thiosulfate ($Na_2S_2O_3$) with starch as the indicator. Titrate at pH 3 to 4 because the reaction is not stoichiometric at neutral pH due to partial oxidation of thiosulphate to sulphate.

Silicon was determined by method APHA 3125: inductively coupled plasma-mass spectrometry (ICP-MS).

Chemical oxygen demand (COD) was determined by method APHA 5220 B: Closed Reflux, Colorimetric Method. The sample was digested, resulting in the dichromate ion oxidising COD material in the sample. This resulted in the change of chromium from the hexavalent (VI) state to the trivalent (III) state. Both the chromium species were coloured and absorb in the visible region of the spectrum.

Total organic carbon (TOC) was determined by method APHA 5310 B: High-Temperature Combustion Method. The sample was homogenised and diluted as necessary and a micro portion was injected into a heated reaction chamber packed with an oxidative catalyst such as cobalt oxide, platinum group metals or barium chromate. The water was vaporised, and the organic carbon and inorganic carbon was oxidised to $CO_2$ and $H_2O$. The $CO_2$ was transported in the carrier-gas stream and was measured by means of a nondispersive infrared analyser or titrated colormetrically.

Biochemical oxygen demand (BOD) was analysed using method APHA 5210 B: 5-Day BOD Test. The method consisted of filling an airtight bottle of the specified size with sample to overflowing and incubating it at the specified temperature for 5 days. Dissolved oxygen was measured initially and after incubation and the BOD was computed from the difference between the initial and final dissolved oxygen (DO) value.

Total coliforms were determined using method APHA 9222 B: Membrane Filter Technique for Members of the Coliform Group 9222B. The sample was filtered through a membrane filter in the field immediately after collection. The filter was placed in the transport medium and shipped to the laboratory in a sealed container. The membrane was transferred to les-ENDO or m-ENDO agar containing basic Fuchsin as the indicator. This was incubated at 35 °C +/- 0.5 °C for 20 h to 22 h. Red colonies with a metallic (golden) sheen were coliform positive.

### B.1.2 Hydrocarbon Content

Volatile petroleum hydrocarbons ($C_5$-$C_{10}$) were analysed using the method EPA 8015B: Nonhalogenated Organics Using GC-FID.

Extractable petroleum hydrocarbons were analysed for the n-alkane range $nC_{10}$ to $nC_{40}$, using the method EPA 8015B: Nonhalogenated Organics Using GC-FID.

Dissolved and emulsified oil and free oil were analysed using the method: APHA 5520B: Oil and Grease by Partition-Gravimetric Method.

### B.1.3 Polycyclic Aromatic Hydrocarbons (PAHs)

Concentrations of US EPA 16 PAHs in water were analysed using US EPA method 8270D: Semivolatile Organic Compounds by GC-MS.

### B.1.4 Benzene, Toluene, Ethylbenzene and Xylene (BTEX)

Concentrations of BTEX were analysed using the method EPA 8015B: Nonhalogenated Organics Using GC-FID.

### B.1.5 Phenols

Phenol concentrations were analysed using the US EPA method 528: Determination of Phenols in Drinking Water.

Analytes and surrogates were extracted by passing a 1 L water sample through a solid phase extraction cartridge containing 0.5g of a modified polystyrene divinyl benzene copolymer.

The organic compounds were eluted from the solid phase with a small quantity of methylene chloride. The sample components were separated, identified, and measured by injecting an aliquot of the concentrated extract into a high resolution fused silica capillary column of a GC-MS system. Compounds eluting from the GC column were identified by comparing their measured mass spectra and retention times to reference spectra and retention times in a data base.

### B.1.6 Major and Trace Elements

Water samples were analysed using the method APHA 3125: Metals by Inductively Coupled Plasma-Mass Spectrometry (2017).

Water samples collected from the survey area were analysed for selected elements: aluminium, arsenic, barium, cadmium, chromium, copper, iron, lead, mercury, silver, silicon, vanadium and zinc using ICP-MS.

## B.2 Laboratory Analysis for Sediment Samples

### B.2.1 Sediment Characterisation

#### B.2.1.1 Particle Size Distribution

**Dry Sieve Analysis**

Particle size distribution (PSD) analysis was undertaken in accordance with Fugro GB Marine Limited (FGBML) in house methods based on the National Marine Biological Association Quality Control (NMBAQC) scheme's best practice guidance document – Particle Size Analysis (PSA) for Supporting Biological Analysis, and BS1377: Parts 1: 2016 and 2: 1990.

Representative material > 1 mm was split from the bulk subsample and oven dried before sieving through a series of sieves with apertures corresponding to 0.5 phi intervals between 63 mm and 1 mm as described by the Wentworth scale (Wentworth, 1922). The weight of the sediment fraction retained on each mesh was subsequently measured and recorded.

**Laser Diffraction**

Particle size distribution (PSD) analysis was undertaken in accordance with FGBML in house methods based on the National Marine Biological Association Quality Control (NMBAQC) scheme's best practice guidance document – Particle Size Analysis (PSA) for Supporting Biological Analysis, and BS ISO 13320: 2009.

Representative material < 1 mm was removed from the bulk subsample for laser analysis, a minimum of three triplicate analyses (mixed samples) or one triplicate analyses (sands) were analysed using the laser sizer at 0.5 phi intervals between < 1 mm to < 3.9 µm. Laser diffraction was carried out using a Malvern Mastersizer 2000 with a Hydro 2000G dispersion unit.

**Outputs and Deliverables**

Sieve and laser data are merged and entered into GRADISTAT to derive statistics including mass and percentage retained within each size fraction, mean and median grain size, bulk sediment classes (percentage gravel, sand and silt/clay), skewness, sorting coefficients and Folk classification.

#### B.2.1.2 Calcium Carbonate

A pre-dried aliquot of the sediment was weighed and then treated with hydrochloric acid to remove inorganic carbon in the form of carbonate. Fresh acid was added until all effervescence ceased; the sediment was then washed over a glass-fibre filter and the residue dried to a constant weight before being ignited in a muffle furnace at 600 °C for 2 hours. The organic content of the sediment is then calculated using the weight difference from the original dry weight to the ignited residue (taking into account the loss of carbonate).

#### B.2.1.3 Total Organic Content

Sediment samples were analysed for total organic carbon (TOC) by Element Materials Technology. The dry, homogenised sample was treated with hydrochloric acid, then rinsed with deionised water to remove mineral carbon. The sample was then combusted in an Eltra TOC furnace/analyser in the presence of oxygen. Organic carbon was oxidised to CO2 and measured by non-dispersive infrared analysis. This method does not quantify volatile organic carbon, which should be determined by another technique. The limit of detection for this method was < 0.02 % w/w.

#### B.2.1.4 Sediment Nutrients

Total cyanide was determined on wet sediment by segmented flow analysis with colormetric detection. Total nitrogen was determined on an air dried and ground sediment sample by an elemental analyser. Silicon, sulphates and phosphorus were determined on an air dried and ground sample following an aqua regia digest with analysis by ICP- OES. Fluoride was determined using an ion selective electrode. Phosphates were determined by ion selective spectrometry.

### B.2.2 Sediment Hydrocarbons

#### B.2.2.1 Total Hydrocarbons by Gas Chromatography–Flame Ionisation Detection (GC-FID)

The total hydrocarbon material ($C_{10}$-$C_{40}$) present was quantified using response factors calculated from the analysis of mixed oil standard solutions over an appropriate range. The unresolved complex mixture was determined by subtracting the area of all the resolved peaks from the total hydrocarbon area and applying the total hydrocarbon response factor. The minimum reporting value (MRV) is 0.5 µg/g dry weight.

### B.2.2.2 Oil and grease

Samples would have been extracted using n-hexane then following EPA 9071B for n-hexane extractable material. The procedure below would have been followed if data had not been derived from the THC method. Samples were homogenised by mixing, and a representative sample (approximately 10 g) weighed and blended with approximately 10 g of anhydrous sodium sulphate. The sediments were then extracted in a glass wool thimble by Soxhlet extraction for 4 hours using 90 mL of n-hexane. The extract was transferred to a 250 mL round-bottom flask and evaporated to dryness using a rotary evaporator. The round bottom flask was then placed in a desiccator for 30 minutes and the weight recorded every 30 minutes until it remained constant. The water content of the sediment was determined by drying a subsample of the homogenised sediment to constant weight at 105 °C.

### B.2.2.3 Polycyclic Aromatic Hydrocarbons (PAHs)

The US EPA range of 16 polycyclic aromatic hydrocarbon (PAH) quantified as specified by Department of Trade and Industry (DTI) regulations (DTI, 1993).

Calibration was undertaken using a range of PAH standard solutions, a number of alkylated PAH, dibenzothiophene and a range of suitable internal standards. Individual response factors were calculated for each of the compounds present in the calibration solution. Response factors for the non calibrated alkylated PAH were taken to be equivalent to closely related compounds. The MRV of individual and alkylated PAHs is 0.1 ng/g.

### B.2.2.4 Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)

BTEX analysis of sediments was carried out by FGBML.

**General Precautions**

To effectively eliminate all possible sources of BTEX contamination from the analysis the following precautionary measures were taken prior to sample work-up:

- All solvents were purchased as high purity grade. Each batch was checked for purity by concentrating approximately 400 mL down to a small volume (< 1 mL) and analysing by gas chromatography (GC);
- All water used was distilled through an all glass still;
- All glassware was cleaned using an acid/base machine wash. The glassware was rinsed with acetone then finally with dichloromethane prior to use.

### BTEX Analysis in Sediment

The BTEX compounds are concentrated in the headspace above the sediment sample containing distilled water and internal standards in a sealed vial. A subsample of the headspace is then analysed by GC-MS.

Sediment samples were thawed, homogenised and accurately weighed into a 20 mL headspace vial. A solution containing an appropriate amount of the following internal standards was added to each sample using a microsyringe.

| BTEX Standards |
|---|
| $d_6$ Benzene |
| $d_8$ Toluene |
| $d_{10}$ Ethylbenzene |
| $d_{10}$ P-xylene |
| $d_{10}$ O-xylene |

Distilled water (10 mL) was added to the headspace vial and the vial was sealed using a crimped cap.

Correction factors for wet/dry sediments were obtained by drying a subsample of the homogenised sediment to constant weight at 105 °C.

### BTEX Analysis by Gas Chromatography–Mass Spectrometry Detection (GC-MS)

Calibration was undertaken using a range of BTEX standard solutions containing the BTEX compounds, and a range of suitable internal standards. Individual response factors were calculated for each of the BTEX present in the calibration solution. The minimum reporting value of individual BTEX is 0.5 ng/g dry weight.

Instrument Conditions for BTEX Analysis

| | |
|---|---|
| GC Injector | Split |
| Injector Temperature | 250 °C |
| Injection Volume | 100 µL manual injection |
| Purge Valve | Off |
| Carrier Gas | Helium |
| Column Flow | 0.4 mL/min |
| Split Flow | 32 mL/min |
| Oven Temperature | 40 °C 3 min; 40 °C to 200 °C at 20 °C/min |
| Transfer Line Temperature | 325 °C |
| Tune File | ATUNE.U |
| Acquisition Mode | SIM |
| Source Temperature | 300 °C |

| | |
|---|---|
| SIM Groups Dwell Time | 0.03 sec |
| SIM Width | 0.3 |
| Resolution | Low |
| Group Ions | 78, 84, 92, 100, 106, 116 |

### B.2.2.5 Sediment Polychlorinated Biphenyls

#### Microwave Digestion Extraction Procedure

Sediment samples were thawed and added into a Teflon sample vessel. Sediment samples were accurately weighed into the cells and a known quantity of hexabromobiphenyl added as internal standard. The cells were extracted using hexane:acetone (1:1, v:v). as the extraction solvent at 120 °C and 1800 W.

#### Clean-up of Sediment Extracts by Column Chromatography

Sample extracts are cleaned up by column chromatography using 40 % (w/w) acid silica. The silica gel used was 70 to 230 mesh, muffled at 400 °C for at least 4 hours to remove impurities and activate it then stored at 200 °C. Prior to use, acid silica is prepared by the addition of sulphuric acid to silica. The sediment extract was added to the silica gel column, containing 5 g of adsorbent and eluted with 30 mL of hexane. The eluent was reduced in volume using the evaporator to approximately 2 mL before being further reduced under a gentle stream of nitrogen to an appropriate volume, approximately 1 g of activated copper powder (for removal of free sulphur) before being concentrated to 0.5 mL for analysis.

#### GC-µECD Analysis of WHO12 PCBs

Sample extracts were analysed by GC-µECD for the WHO12 Congeners (PCBs 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169 and 189). The instrument parameters are shown on the following table.

| | Gas Chromatography [GC] |
|---|---|
| Instrument | HP 6890N Series GC with 7683B autoinjector |
| Column | 8 %-phenyl polysilphenylene-siloxane bonded fused silica, 50 m, 0.25 µm film thickness, 0.25 mm internal diameter |
| Carrier Gas | Hydrogen (constant flow 2.1 mL/min) |
| Injector | On  column (1 µL injection) |
| Oven Temperature Programme | 60 °C - 1 min<br>60 °C to 190 °C at 35 °C/min<br>190 °C to 300 °C at 3 °C/min<br>300 °C to 330 °C at 45 °C/min<br>330 °C - 8 min |
| Detector Temperature | 340 °C (µECD) |

#### B.2.2.6 VOC Analysis in Soil

VOCs were determined using static headspace sampling and analysis by GC-MS.

#### B.2.2.7 Sediment Metals

Sediment samples were dried at 40 °C and then sieved to the required size fraction (2000 µm). Samples were subjected to an aqua regia microwave digestion. This acid mixture allows a partial dissolution of metals, predominately releasing those associated with the sediment fines.

The resulting digests were then analysed for aluminium, barium, iron and vanadium by coupled plasma-optical emission spectrometry (ICP-OES) and analysed for antimony, arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver and zinc by using inductively coupled plasma-mass spectrometry (ICP-MS).

## B.3 Habitat Assessment

### B.3.1 Seabed Habitat Classification

To assess the habitats present within the survey area, acquired video footage was reviewed by experienced Fugro marine biologists/taxonomists. Changes in sediment type and/or morphology of the seabed in conjunction with the associated faunal community were logged. Interpretive logs for the stations surveyed during the survey are provided in Appendix C.

The habitat classification in the current study followed that outlined in ‘The Marine Life of the Emirate of Abu Dhabi’ (John & George, 2001). This document provides information on Abu Dhabi’s inshore environment that included the biodiversity and distribution of its marine flora and fauna and encompasses all of the principal habitat types known in the Arabian Gulf.

This system adopts a hierarchical approach, beginning with the major habitat type at the highest level and finishing with the sub-biotope (or variant) at the lowest. Major habitats (Levels 1 and 2) are defined on gross physical/chemical features, habitat complexes by major differences in species or community form (Level 3), biotope complexes by broad biological groups (Level 4) and biotopes by dominant taxa (Level 5).

An example hierarchy from the MLEAD classification system is provided in Table B.1.

Major habitats are defined on gross physical/chemical features, habitat complexes by major differences in species or community form, biotope complexes by broad biological or habitat species, biotopes by dominant species or taxa linked to distinctive habitat characteristics, and the sub-biotope (variant) by sub-species.

Biotope codes are defined for habitat complexes, biotopes and variants using the habitat complex code, a full stop and then the biotope code. As far as possible, the codes used within the Marine Life of the Emirate of Abu Dhabi, follow those adopted by the Marine Nature Conservation Review (MNCR) for the British Isles.

Table B.1: Example hierarchy from the MLEAD classification system

| Level | Example Classification Name | Example Classification Code |
|---|---|---|
| 1. Depth Zone | Sublittoral Zone | SL |
| 2. Substratum | Mixed Deposit | MXD |
| 3. Life Forms | Sponges Ascidians | SPAS |
| 4. Functional Groups | Macroalgae | MACA |
| 5. Taxa | Epibiota dominated by sponges, ascidians and seasonal flushes of macroalgae on small unstable sand embedded hard surfaces | SL.MXD.SP.AS.MACA |

In addition to the classification defined by MLEAD, habitats were also classified in accordance with the ‘Abu Dhabi Emirate Habitat Classification and Protection Guideline’ (Al Dhaheri et al., 2017).

Although, theoretically a biotope can be assigned to any sized area of seabed, for the purposes of this assessment, the commonly accepted minimum habitat size of 25 m2 (Parry, 2019) was adopted for the designation of the biotopes encountered within the survey area.

## B.3.2 Seabed Habitat Assessment

### B.3.2.1 Coral Assessment

A hard-coral habitat assessment was undertaken based on the guidance outlined in the United States Environmental Protection Agency (US EPA) Field Manual for Coral Reef Assessment (Santavy et al., 2012) and the Det Norsk Veritas (DNV) visual benthic mapping guidelines (DNV, 2019). To assess the quality of coral habitats found within the survey area a classification scheme that classifies data based on the presence of live coral and dead reef structures was derived. This system was loosely based on that used by DNV (2019), but the classification and ranges for live coral cover have been adapted to make them appropriate for the coral communities of the Arabian Gulf. Habitats with percentage cover of live coral greater than 50 have the potential to be classified as reef.

The assessment criteria followed in the current study are summarised in Table B.2.

Video data have been utilised to estimate the percentage cover of living coral colonies. The occurrence and extent of any adverse health conditions, such as bleaching, disease or overgrowth by boring sponges have also been recorded to assess the relative health of living coral colonies.

Table B.2: Hard coral assessment criteria

| Classification | Live Coral Cover [%] | Description |
|---|---|---|
| No Coral | < 1 | Areas with no living coral or very sporadic small corals. No evidence of dead reef structures |
| Coral Rubble | < 1 | Fragments of coral, detached from reef structures or other hard substrates. Little or no living coral |
| Dead Coral Framework | < 1 | Reef structure, clearly of coralline origin and attached to hard substrata. Little or no living coral |
| Low Live Coral Cover | < 10 | Sparse (< 10 % cover) live corals on dead coral framework or other hard substrata |
| Moderate Live Coral Cover | | Abundant (10 % to 50 % cover) live corals on dead coral framework or other hard substrata |
| High Live Coral Cover | > 50 | Reef structure comprising predominantly live corals (e.g. healthy *Acropora* or *Porites* reef) |

A similar classification system was used to assess soft coral abundance within the survey area, which is summarised in Table B.3.

Table B.3: Soft coral assessment criteria

| Classification | Live Coral Cover [%] | Description |
|---|---|---|
| No Coral | < 1 | Areas with no living soft coral (or sea whips) or very sporadic small soft corals |
| Low Live Coral Cover | < 10 | Sparse (< 10 % cover) live soft corals (or sea whips) |
| Moderate Live Coral Cover | | Common (10 % to 50 % cover) live soft corals (or sea whips) |
| High Live Coral Cover | > 50 | Abundant (> 50 % cover) live soft corals (or sea whips) |

### B.3.2.2 Seagrass Assessment

A seagrass assessment, based on the method described in the EAD's 'Abu Dhabi Emirate Habitat Classification and Protection Guideline' (Al Dhaheri et al., 2017), has been performed on the habitats that contained seagrasses. The video data were analysed to estimate if the cover of rooted vascular seagrass taxa was greater than 10 %.

Video data have been utilised to estimate the percentage cover of seagrass. The assessment criteria followed in the current study are summarised in Table B.4.

Table B.4: Seagrass assessment criteria

| Classification | Seagrass [%] | Description |
|---|---|---|
| No Seagrass | < 1 % | Areas with no living seagrass or very sporadic small patches of seagrass |
| Low Seagrass Cover | < 10 | Sparse (< 10 % cover) live seagrass |
| Seagrass Bed | 10 % | 10 % cover) live seagrass forming |

# C. Logs

## C.1 Survey Log

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 14/04/2020 | 06:02:39 | R1_ENV_001 | WP | YSI Exo2 | 53 | 12.9 | 751 800.5 | 2 669 184.1 | 751 807.2 | 2 669 199.8 | |
| 14/04/2020 | 06:18:18 | R1_ENV_002 | WP | YSI Exo2 | 54 | 11.3 | 752 765.9 | 2 669 444.8 | 752 783.7 | 2 669 432.0 | |
| 14/04/2020 | 06:36:58 | R1_ENV_003 | WP | YSI Exo2 | 55 | 5.6 | 753 732.2 | 2 669 702.4 | 753 735.0 | 2 669 708.6 | |
| 14/04/2020 | 06:45:40 | R1_ENV_004 | WP | YSI Exo2 | 56 | 6.0 | 754 698.0 | 2 669 961.5 | 754 710.5 | 2 669 978.4 | |
| 14/04/2020 | 06:54:39 | R1_ENV_005 | WP | YSI Exo2 | 57 | 6.3 | 755 664.9 | 2 670 216.9 | 755 680.9 | 2 670 220.5 | |
| 14/04/2020 | 07:03:55 | R1_ENV_006 | WP | YSI Exo2 | 58 | 6.3 | 756 631.1 | 2 670 474.6 | 756 639.8 | 2 670 468.7 | |
| 14/04/2020 | 07:14:06 | R1_ENV_007 | WP | YSI Exo2 | 59 | 6.2 | 757 597.3 | 2 670 732.2 | 757 609.8 | 2 670 732.5 | |
| 14/04/2020 | 07:26:23 | R1_ENV_008 | WP | YSI Exo2 | 60 | 6.4 | 758 565.9 | 2 670 981.4 | 758 548.5 | 2 670 998.9 | |
| 14/04/2020 | 07:37:05 | R1_ENV_009 | WP | YSI Exo2 | 61 | 6.8 | 759 529.8 | 2 671 247.5 | 759 530.0 | 2 671 244.5 | |
| 14/04/2020 | 07:46:29 | R1_ENV_010 | WP | YSI Exo2 | 62 | 4.6 | 760 496.1 | 2 671 505.1 | 760 505.6 | 2 671 505.6 | |
| 14/04/2020 | 08:03:05 | R1_ENV_011 | WP | YSI Exo2 | 63 | 4.3 | 761 468.0 | 2 671 740.2 | 761 481.4 | 2 671 748.2 | |
| 14/04/2020 | 08:15:03 | R1_ENV_012 | WP | YSI Exo2 | 64 | 3.3 | 762 431.8 | 2 672 008.6 | 762 420.4 | 2 671 996.4 | |
| 14/04/2020 | 08:44:29 | R1_ENV_014 | WP | YSI Exo2 | 66 | 5.7 | 764 370.7 | 2 672 508.5 | 764 388.2 | 2 672 525.4 | |
| 14/04/2020 | 08:55:03 | R1_ENV_015 | WP | YSI Exo2 | 67 | 6.7 | 764 666.3 | 2 673 463.8 | 764 684.1 | 2 673 473.0 | |
| 14/04/2020 | 09:10:42 | R1_ENV_013 | WP | YSI Exo2 | 65 | 3.4 | 763 402.3 | 2 672 259.4 | 763 390.6 | 2 672 236.0 | |
| 14/04/2020 | 09:23:56 | R1_ENV_016 | WP | YSI Exo2 | 68 | 11.6 | 764 873.6 | 2 674 442.1 | 764 880.6 | 2 674 449.5 | |
| 14/04/2020 | 09:37:27 | R1_ENV_017 | WP | YSI Exo2 | 69 | 6.0 | 765 082.2 | 2 675 420.1 | 765 102.2 | 2 675 438.8 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 14/04/2020 | 09:48:42 | R1_ENV_018 | WP | YSI Exo2 | 70 | 3.9 | 765 298.5 | 2 676 396.4 | 765 290.1 | 2 676 418.2 | |
| 14/04/2020 | 10:42:52 | R1_ENV_020 | WP | YSI Exo2 | 72 | 4.7 | 765 711.4 | 2 678 353.3 | 765 714.4 | 2 678 344.2 | |
| 14/04/2020 | 10:57:30 | R1_ENV_021 | WP | YSI Exo2 | 73 | 6.6 | 766 221.4 | 2 679 183.1 | 766 207.0 | 2 679 178.5 | |
| 14/04/2020 | 11:03:00 | R1_ENV_019 | WP | YSI Exo2 | 71 | 2.5 | 765 502.2 | 2 677 375.5 | 765 506.5 | 2 677 379.7 | |
| 14/04/2020 | 11:11:43 | R1_ENV_022 | WP | YSI Exo2 | 74 | 5.8 | 766 890.2 | 2 679 926.5 | 766 916.0 | 2 679 915.3 | |
| 14/04/2020 | 11:23:27 | R1_ENV_023 | WP | YSI Exo2 | 75 | 7.2 | 767 564.6 | 2 680 664.9 | 767 579.9 | 2 680 645.2 | |
| 16/04/2020 | 04:48:00 | R1_ENV_001 | WS | BOT | 76 | 9.5 | 751 800.5 | 2 669 184.1 | 751 799.1 | 2 669 198.9 | |
| 16/04/2020 | 05:17:00 | R1_ENV_001 | WS | TOP | 77 | 1.0 | 751 800.5 | 2 669 184.1 | 751 799.1 | 2 669 198.9 | |
| 16/04/2020 | 05:40:00 | R1_ENV_002 | WS | BOT | 78 | 11.0 | 752 765.9 | 2 669 444.8 | 752 779.7 | 2 669 441.6 | |
| 16/04/2020 | 05:53:00 | R1_ENV_002 | WS | MID | 79 | 6.0 | 752 765.9 | 2 669 444.8 | 752 779.7 | 2 669 441.6 | |
| 16/04/2020 | 06:21:00 | R1_ENV_002 | WS | TOP | 80 | 1.0 | 752 765.9 | 2 669 444.8 | 752 779.7 | 2 669 441.6 | |
| 16/04/2020 | 06:42:00 | R1_ENV_003 | WS | BOT | 81 | 6.0 | 753 732.2 | 2 669 702.4 | 753 734.6 | 2 669 700.5 | |
| 16/04/2020 | 07:01:00 | R1_ENV_003 | WS | TOP | 82 | 1.0 | 753 732.2 | 2 669 702.4 | 753 734.6 | 2 669 700.5 | |
| 16/04/2020 | 07:25:00 | R1_ENV_004 | WS | BOT | 83 | 5.0 | 754 698.0 | 2 669 961.5 | 754 694.5 | 2 669 957.8 | |
| 16/04/2020 | 07:42:00 | R1_ENV_004 | WS | TOP | 84 | 1.0 | 754 698.0 | 2 669 961.5 | 754 694.5 | 2 669 957.8 | |
| 16/04/2020 | 08:07:00 | R1_ENV_005 | WS | BOT | 85 | 5.0 | 755 664.9 | 2 670 216.9 | 755 666.3 | 2 670 215.3 | |
| 16/04/2020 | 08:26:00 | R1_ENV_005 | WS | TOP | 86 | 1.0 | 755 664.9 | 2 670 216.9 | 755 666.3 | 2 670 215.3 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 16/04/2020 | 08:59:00 | R1_ENV_006 | WS | BOT | 87 | 5.5 | 756 631.1 | 2 670 474.6 | 756 636.4 | 2 670 472.9 | |
| 16/04/2020 | 09:15:00 | R1_ENV_006 | WS | TOP | 88 | 1.0 | 756 631.1 | 2 670 474.6 | 756 636.4 | 2 670 472.9 | |
| 16/04/2020 | 09:36:00 | R1_ENV_007 | WS | BOT | 89 | 6.0 | 757 597.3 | 2 670 732.2 | 757 596.2 | 2 670 730.4 | |
| 16/04/2020 | 09:50:00 | R1_ENV_007 | WS | TOP | 90 | 1.0 | 757 597.3 | 2 670 732.2 | 757 596.2 | 2 670 730.4 | |
| 17/04/2020 | 04:20:00 | R1_ENV_008 | WS | BOT | 91 | 6.5 | 758 565.9 | 2 670 981.4 | 758 557.1 | 2 671 023.0 | |
| 17/04/2020 | 04:40:00 | R1_ENV_008 | WS | TOP | 92 | 1.0 | 758 565.9 | 2 670 981.4 | 758 557.1 | 2 671 023.0 | |
| 17/04/2020 | 05:07:00 | R1_ENV_009 | WS | BOT | 93 | 6.0 | 759 529.8 | 2 671 247.5 | 759 522.8 | 2 671 328.8 | |
| 17/04/2020 | 05:34:00 | R1_ENV_009 | WS | TOP | 94 | 1.0 | 759 529.8 | 2 671 247.5 | 759 522.8 | 2 671 328.8 | |
| 17/04/2020 | 06:00:00 | R1_ENV_010 | WS | BOT | 95 | 4.5 | 760 496.1 | 2 671 505.1 | 760 497.7 | 2 671 501.7 | |
| 17/04/2020 | 06:14:00 | R1_ENV_010 | WS | TOP | 96 | 1.0 | 760 496.1 | 2 671 505.1 | 760 497.7 | 2 671 501.7 | |
| 17/04/2020 | 06:34:00 | R1_ENV_011 | WS | BOT | 97 | 5.0 | 761 468.0 | 2 671 740.2 | 761 469.8 | 2 671 735.7 | |
| 17/04/2020 | 06:55:00 | R1_ENV_011 | WS | TOP | 98 | 1.0 | 761 468.0 | 2 671 740.2 | 761 469.8 | 2 671 735.7 | |
| 17/04/2020 | 07:25:00 | R1_ENV_012 | WS | MID | 99 | 2.5 | 762 431.8 | 2 672 008.6 | 762 365.0 | 2 671 999.7 | |
| 17/04/2020 | 07:43:00 | R1_ENV_013 | WS | MID | 100 | 1.7 | 763 402.3 | 2 672 259.4 | 763 399.3 | 2 672 270.6 | |
| 17/04/2020 | 08:08:00 | R1_ENV_014 | WS | BOT | 101 | 5.5 | 764 370.7 | 2 672 508.5 | 764 357.1 | 2 672 491.3 | |
| 17/04/2020 | 08:35:00 | R1_ENV_014 | WS | TOP | 102 | 1.0 | 764 370.7 | 2 672 508.5 | 764 357.1 | 2 672 491.3 | |
| 17/04/2020 | 09:14:00 | R1_ENV_015 | WS | BOT | 103 | 5.0 | 764 666.3 | 2 673 463.8 | 764 659.3 | 2 673 442.7 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 17/04/2020 | 09:35:00 | R1_ENV_015 | WS | TOP | 104 | 1.0 | 764 666.3 | 2 673 463.8 | 764 659.3 | 2 673 442.7 | |
| 17/04/2020 | 10:25:00 | R1_ENV_016 | WS | BOT | 105 | 11.0 | 764 873.6 | 2 674 442.1 | 764 864.3 | 2 674 442.2 | |
| 17/04/2020 | 10:47:00 | R1_ENV_016 | WS | MID | 106 | 5.5 | 764 873.6 | 2 674 442.1 | 764 864.3 | 2 674 442.2 | |
| 17/04/2020 | 11:00:00 | R1_ENV_016 | WS | TOP | 107 | 1.0 | 764 873.6 | 2 674 442.1 | 764 864.3 | 2 674 442.2 | |
| 17/04/2020 | 11:16:00 | R1_ENV_017 | WS | BOT | 108 | 4.5 | 765 082.2 | 2 675 420.1 | 765 086.2 | 2 675 416.4 | |
| 17/04/2020 | 11:40:00 | R1_ENV_017 | WS | TOP | 109 | 1.0 | 765 082.2 | 2 675 420.1 | 765 086.2 | 2 675 416.4 | |
| 17/04/2020 | 12:01:00 | R1_ENV_018 | WS | MID | 110 | 2.5 | 765 298.5 | 2 676 396.4 | 765 316.6 | 2 676 381.1 | |
| 17/04/2020 | 12:20:00 | R1_ENV_019 | WS | MID | 111 | 1.0 | 765 502.2 | 2 677 375.5 | 765 485.6 | 2 677 370.6 | |
| 17/04/2020 | 12:45:00 | R1_ENV_020 | WS | MID | 112 | 2.5 | 765 711.4 | 2 678 353.3 | 765 710.8 | 2 678 333.2 | |
| 17/04/2020 | 13:10:00 | R1_ENV_021 | WS | BOT | 113 | 5.5 | 766 221.4 | 2 679 183.1 | 766 219.4 | 2 679 177.0 | |
| 17/04/2020 | 13:40:00 | R1_ENV_021 | WS | TOP | 114 | 1.0 | 766 221.4 | 2 679 183.1 | 766 219.4 | 2 679 177.0 | |
| 18/04/2020 | 04:16:00 | R1_ENV_022 | WS | BOT | 115 | 6.0 | 766 890.2 | 2 679 926.5 | 766 874.4 | 2 679 920.1 | |
| 18/04/2020 | 05:00:00 | R1_ENV_022 | WS | TOP | 116 | 1.0 | 766 890.2 | 2 679 926.5 | 766 874.4 | 2 679 920.1 | |
| 18/04/2020 | 05:25:00 | R1_ENV_023 | WS | BOT | 117 | 6.0 | 767 564.6 | 2 680 664.9 | 767 561.1 | 2 680 670.4 | |
| 18/04/2020 | 05:54:00 | R1_ENV_023 | WS | TOP | 118 | 1.0 | 767 564.6 | 2 680 664.9 | 767 561.1 | 2 680 670.4 | |
| 18/04/2020 | 06:25:00 | R1_ENV_024 | WS | BOT | 119 | 8.0 | 768 867.9 | 2 681 362.2 | 768 882.8 | 2 681 291.1 | |
| 18/04/2020 | 06:51:00 | R1_ENV_024 | WS | TOP | 120 | 1.0 | 768 867.9 | 2 681 362.2 | 768 882.8 | 2 681 291.1 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 18/04/2020 | 08:20:00 | R1_ENV_025 | WS | BOT | 121 | 11.0 | 768 797.8 | 2 682 774.6 | 768 670.1 | 2 682 683.6 | |
| 18/04/2020 | 08:44:00 | R1_ENV_025 | WS | MID | 122 | 6.0 | 768 797.8 | 2 682 774.6 | 768 670.1 | 2 682 683.6 | |
| 18/04/2020 | 09:10:00 | R1_ENV_025 | WS | TOP | 123 | 1.0 | 768 797.8 | 2 682 774.6 | 768 670.1 | 2 682 683.6 | |
| 18/04/2020 | 09:40:00 | R1_ENV_026 | WS | BOT | 124 | 9.5 | 770 226.2 | 2 683 071.7 | 770 196.9 | 2 683 091.4 | |
| 18/04/2020 | 10:19:00 | R1_ENV_026 | WS | MID | 125 | 5.0 | 770 226.2 | 2 683 071.7 | 770 196.9 | 2 683 091.4 | |
| 18/04/2020 | 10:37:00 | R1_ENV_026 | WS | TOP | 126 | 1.0 | 770 226.2 | 2 683 071.7 | 770 196.9 | 2 683 091.4 | |
| 18/04/2020 | 11:17:00 | R1_ENV_027 | WS | BOT | 127 | 11.0 | 769 598.4 | 2 684 338.9 | 769 571.3 | 2 684 365.2 | |
| 18/04/2020 | 12:10:00 | R1_ENV_027 | WS | MID | 128 | 5.5 | 769 598.4 | 2 684 338.9 | 769 571.3 | 2 684 365.2 | |
| 18/04/2020 | 12:27:00 | R1_ENV_027 | WS | TOP | 129 | 1.0 | 769 598.4 | 2 684 338.9 | 769 571.3 | 2 684 365.2 | |
| 14/05/2020 | 15:37:33 | R1_ENV_030 | WP | YSI Exo2 | 262 | 12.5 | 771 505.1 | 2 686 861.7 | 771 502.7 | 2 686 861.7 | |
| 14/05/2020 | 16:08:28 | R1_ENV_030 | WS | BOT | 263 | 12.5 | 771 505.1 | 2 686 861.7 | 771 505.2 | 2 686 860.7 | |
| 14/05/2020 | 16:30:47 | R1_ENV_030 | WS | MID | 264 | 12.5 | 771 505.1 | 2 686 861.7 | 771 505.0 | 2 686 860.4 | |
| 14/05/2020 | 16:48:24 | R1_ENV_030 | WS | TOP | 265 | 12.6 | 771 505.1 | 2 686 861.7 | 771 504.7 | 2 686 861.8 | |
| 14/05/2020 | 17:15:52 | R1_ENV_030 | VV | PC | 266 | 12.5 | 771 505.1 | 2 686 861.7 | 771 505.4 | 2 686 863.6 | |
| 14/05/2020 | 17:54:42 | R1_ENV_031 | VV | PC | 267 | 13.2 | 770 877.3 | 2 688 128.9 | 770 878.2 | 2 688 129.6 | |
| 14/05/2020 | 18:25:43 | R1_ENV_031 | WS | BOT | 268 | 13.2 | 770 877.3 | 2 688 128.9 | 770 878.3 | 2 688 125.8 | |
| 14/05/2020 | 18:50:09 | R1_ENV_031 | WS | MID | 269 | 13.3 | 770 877.3 | 2 688 128.9 | 770 877.1 | 2 688 131.4 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 14/05/2020 | 19:08:51 | R1_ENV_031 | WS | TOP | 270 | 13.2 | 770 877.3 | 2 688 128.9 | 770 874.7 | 2 688 128.2 | |
| 14/05/2020 | 19:34:40 | R1_ENV_031 | WP | YSI Exo2 | 271 | 13.2 | 770 877.3 | 2 688 128.9 | 770 875.9 | 2 688 128.7 | |
| 14/05/2020 | 20:22:02 | R1_ENV_032 | WP | YSI Exo2 | 272 | 11.9 | 772 144.5 | 2 688 756.7 | 772 143.0 | 2 688 757.1 | |
| 14/05/2020 | 20:38:30 | R1_ENV_032 | WS | BOT | 273 | 11.9 | 772 144.5 | 2 688 756.7 | 772 145.3 | 2 688 754.8 | |
| 14/05/2020 | 20:53:59 | R1_ENV_032 | WS | MID | 274 | 11.9 | 772 144.5 | 2 688 756.7 | 772 145.7 | 2 688 756.9 | |
| 14/05/2020 | 21:08:42 | R1_ENV_032 | WS | TOP | 275 | 11.9 | 772 144.5 | 2 688 756.7 | 772 144.2 | 2 688 756.0 | |
| 14/05/2020 | 21:23:07 | SO_R1_004 | VV | NS | 276 | 11.9 | 772 144.5 | 2 688 756.7 | 772 146.0 | 2 688 757.2 | |
| 14/05/2020 | 21:35:49 | R1_ENV_032 | VV | NS | 277 | 11.9 | 772 144.5 | 2 688 756.7 | 772 145.5 | 2 688 757.1 | |
| 14/05/2020 | 21:42:32 | R1_ENV_032 | VV | NS | 278 | 11.9 | 772 144.5 | 2 688 756.7 | 772 146.9 | 2 688 757.8 | |
| 14/05/2020 | 21:50:25 | R1_ENV_032 | VV | NS | 279 | 11.9 | 772 144.5 | 2 688 756.7 | 772 142.5 | 2 688 767.0 | |
| 14/05/2020 | 22:16:38 | R1_ENV_033 | VV | NS | 280 | 10.6 | 771 516.7 | 2 690 024.0 | 771 517.3 | 2 690 024.6 | |
| 14/05/2020 | 22:21:08 | R1_ENV_033 | VV | NS | 281 | 10.6 | 771 516.7 | 2 690 024.0 | 771 517.2 | 2 690 034.6 | |
| 14/05/2020 | 22:26:38 | R1_ENV_033 | VV | NS | 282 | 10.6 | 771 516.7 | 2 690 024.0 | 771 517.0 | 2 690 015.3 | |
| 14/05/2020 | 22:41:55 | R1_ENV_033 | WS | NS | 283 | 10.6 | 771 516.7 | 2 690 024.0 | 771 517.4 | 2 690 022.0 | |
| 14/05/2020 | 22:48:47 | R1_ENV_033 | WS | BOT | 284 | 10.6 | 771 516.7 | 2 690 024.0 | 771 517.1 | 2 690 024.1 | |
| 14/05/2020 | 23:04:48 | R1_ENV_033 | WS | NS | 285 | 10.6 | 771 516.7 | 2 690 024.0 | 771 517.5 | 2 690 024.8 | |
| 14/05/2020 | 23:12:30 | R1_ENV_033 | WS | MID | 286 | 10.7 | 771 516.7 | 2 690 024.0 | 771 518.4 | 2 690 024.4 | Only one bottle closed |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 14/05/2020 | 23:29:07 | R1_ENV_033 | WS | MID | 287 | 10.7 | 771 516.7 | 2 690 024.0 | 771 517.8 | 2 690 023.5 | |
| 14/05/2020 | 23:37:55 | R1_ENV_033 | WS | TOP | 288 | 10.7 | 771 516.7 | 2 690 024.0 | 771 516.1 | 2 690 025.7 | |
| 14/05/2020 | 23:55:43 | R1_ENV_033 | WP | YSI Exo2 | 289 | 10.7 | 771 516.7 | 2 690 024.0 | 771 515.9 | 2 690 025.0 | |
| 15/05/2020 | 05:12:30 | R1_ENV_025 | VV | NS | 365 | 10.9 | 768 797.8 | 2 682 774.6 | 768 799.7 | 2 682 786.9 | |
| 15/05/2020 | 05:28:26 | R1_ENV_025 | VV | NS | 366 | 10.8 | 768 797.8 | 2 682 774.6 | 768 798.5 | 2 682 777.9 | Grab not locked |
| 15/05/2020 | 05:32:44 | R1_ENV_025 | VV | NS | 367 | 10.8 | 768 797.8 | 2 682 774.6 | 768 795.0 | 2 682 780.9 | |
| 15/05/2020 | 05:43:12 | R1_ENV_025 | VV | NS | 368 | 10.9 | 768 797.8 | 2 682 774.6 | 768 811.5 | 2 682 780.4 | |
| 15/05/2020 | 06:03:45 | R1_ENV_024 | VV | Partial Sample | 369 | 9.1 | 768 867.9 | 2 681 362.2 | 768 866.7 | 2 681 374.1 | PSD only |
| 15/05/2020 | 06:27:51 | R1_ENV_024 | VV | NS | 370 | 9.0 | 768 867.9 | 2 681 362.2 | 768 877.7 | 2 681 368.6 | |
| 15/05/2020 | 06:35:41 | R1_ENV_024 | VV | NS | 371 | 8.9 | 768 867.9 | 2 681 362.2 | 768 864.7 | 2 681 355.2 | |
| 15/05/2020 | 06:42:05 | SO_R1_003 | VV | SOIL | 372 | 8.9 | 768 867.9 | 2 681 362.2 | 768 878.1 | 2 681 357.4 | |
| 15/05/2020 | 07:01:15 | R1_ENV_023 | VV | NS | 373 | 7.1 | 767 564.6 | 2 680 664.9 | 767 571.1 | 2 680 671.7 | |
| 15/05/2020 | 07:07:45 | R1_ENV_023 | VV | NS | 374 | 7.1 | 767 564.6 | 2 680 664.9 | 767 570.0 | 2 680 662.2 | |
| 15/05/2020 | 07:13:47 | R1_ENV_023 | VV | NS | 375 | 7.1 | 767 564.6 | 2 680 664.9 | 767 553.9 | 2 680 669.0 | |
| 15/05/2020 | 07:27:11 | R1_ENV_022 | VV | NS | 376 | 6.3 | 766 890.2 | 2 679 926.5 | 766 903.0 | 2 679 925.0 | |
| 15/05/2020 | 07:33:10 | R1_ENV_022 | VV | NS | 377 | 6.3 | 766 890.2 | 2 679 926.5 | 766 896.8 | 2 679 935.4 | |
| 15/05/2020 | 07:38:09 | R1_ENV_022 | VV | NS | 378 | 6.4 | 766 890.2 | 2 679 926.5 | 766 889.4 | 2 679 927.1 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 15/05/2020 | 07:57:18 | R1_ENV_021 | VV | NS | 379 | 6.6 | 766 221.4 | 2 679 183.1 | 766 231.8 | 2 679 193.7 | |
| 15/05/2020 | 08:03:55 | R1_ENV_021 | VV | NS | 380 | 6.9 | 766 221.4 | 2 679 183.1 | 766 217.8 | 2 679 180.0 | |
| 15/05/2020 | 08:12:06 | R1_ENV_021 | VV | NS | 381 | 6.7 | 766 221.4 | 2 679 183.1 | 766 219.2 | 2 679 192.2 | |
| 15/05/2020 | 08:28:09 | R1_ENV_020 | VV | NS | 382 | 4.8 | 765 711.4 | 2 678 353.3 | 765 725.9 | 2 678 345.0 | |
| 15/05/2020 | 08:34:12 | R1_ENV_020 | VV | NS | 383 | 5.4 | 765 711.4 | 2 678 353.3 | 765 715.8 | 2 678 365.1 | |
| 15/05/2020 | 08:39:41 | R1_ENV_020 | VV | NS | 384 | 5.2 | 765 711.4 | 2 678 353.3 | 765 697.9 | 2 678 357.5 | |
| 15/05/2020 | 08:52:45 | R1_ENV_019 | VV | NS | 385 | 3.0 | 765 502.2 | 2 677 375.5 | 765 506.1 | 2 677 376.8 | |
| 15/05/2020 | 09:02:23 | R1_ENV_019 | VV | NS | 386 | 3.1 | 765 502.2 | 2 677 375.5 | 765 501.0 | 2 677 382.1 | |
| 15/05/2020 | 09:10:52 | R1_ENV_019 | VV | NS | 387 | 3.2 | 765 502.2 | 2 677 375.5 | 765 498.4 | 2 677 369.6 | |
| 15/05/2020 | 09:24:00 | R1_ENV_018 | VV | NS | 388 | 4.0 | 765 298.5 | 2 676 396.4 | 765 310.0 | 2 676 410.6 | |
| 15/05/2020 | 09:27:29 | R1_ENV_018 | VV | NS | 389 | 3.8 | 765 298.5 | 2 676 396.4 | 765 287.6 | 2 676 403.8 | |
| 15/05/2020 | 09:35:50 | R1_ENV_018 | VV | NS | 390 | 3.8 | 765 298.5 | 2 676 396.4 | 765 308.4 | 2 676 395.9 | |
| 15/05/2020 | 09:53:58 | R1_ENV_017 | VV | NS | 391 | 7.3 | 765 082.2 | 2 675 420.1 | 765 081.3 | 2 675 435.3 | |
| 15/05/2020 | 09:57:33 | R1_ENV_017 | VV | NS | 392 | 8.2 | 765 082.2 | 2 675 420.1 | 765 085.1 | 2 675 424.8 | |
| 15/05/2020 | 10:01:36 | R1_ENV_017 | VV | NS | 393 | 7.5 | 765 082.2 | 2 675 420.1 | 765 079.9 | 2 675 413.3 | |
| 15/05/2020 | 10:13:50 | R1_ENV_016 | VV | NS | 394 | 11.4 | 764 873.6 | 2 674 442.1 | 764 876.8 | 2 674 429.1 | |
| 15/05/2020 | 10:20:33 | R1_ENV_016 | VV | NS | 395 | 11.4 | 764 873.6 | 2 674 442.1 | 764 888.2 | 2 674 451.3 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 15/05/2020 | 10:27:55 | R1_ENV_016 | VV | NS | 396 | 11.3 | 764 873.6 | 2 674 442.1 | 764 859.0 | 2 674 451.6 | |
| 15/05/2020 | 10:43:40 | SO_R1_002 | VV | NS | 397 | 11.7 | 764 873.6 | 2 674 442.1 | 764 883.2 | 2 674 457.7 | |
| 15/05/2020 | 11:28:57 | R1_TR03 | Video | SOL | 398 | 6.2 | 764 727.5 | 2 673 927.2 | 764 719.3 | 2 673 923.9 | |
| 15/05/2020 | 11:29:18 | R1_TR03 | Still | R1_TR03_001 | 399 | 5.9 | - | - | 764 735.8 | 2 673 924.7 | |
| 15/05/2020 | 11:29:31 | R1_TR03 | Still | R1_TR03_002 | 400 | 5.2 | - | - | 764 744.8 | 2 673 924.7 | |
| 15/05/2020 | 11:29:46 | R1_TR03 | Still | R1_TR03_003 | 401 | 5.2 | - | - | 764 752.2 | 2 673 926.7 | |
| 15/05/2020 | 11:29:53 | R1_TR03 | Still | R1_TR03_004 | 402 | 5.2 | - | - | 764 756.6 | 2 673 927.0 | |
| 15/05/2020 | 11:30:27 | R1_TR03 | Still | R1_TR03_005 | 403 | 5.2 | - | - | 764 772.5 | 2 673 934.0 | |
| 15/05/2020 | 11:30:54 | R1_TR03 | Still | R1_TR03_006 | 404 | 4.8 | - | - | 764 788.3 | 2 673 939.4 | |
| 15/05/2020 | 11:31:18 | R1_TR03 | Still | R1_TR03_007 | 405 | 4.7 | - | - | 764 801.0 | 2 673 945.5 | |
| 15/05/2020 | 11:31:33 | R1_TR03 | Still | R1_TR03_008 | 406 | 5.1 | - | - | 764 811.1 | 2 673 947.2 | |
| 15/05/2020 | 11:32:04 | R1_TR03 | Still | R1_TR03_009 | 407 | 6.5 | - | - | 764 831.5 | 2 673 947.2 | |
| 15/05/2020 | 11:32:25 | R1_TR03 | Still | R1_TR03_010 | 408 | 6.9 | - | - | 764 844.1 | 2 673 948.6 | |
| 15/05/2020 | 11:32:32 | R1_TR03 | Video | EOL | 409 | 6.9 | 764 845.6 | 2 673 959.7 | 764 847.7 | 2 673 949.4 | |
| 15/05/2020 | 19:36:56 | R1_ENV_027 | WP | YSI Exo2 | 290 | 11.8 | 769 598.4 | 2 684 338.9 | 769 596.7 | 2 684 339.9 | |
| 15/05/2020 | 19:46:06 | R1_ENV_027 | WS | BOT | 291 | 11.8 | 769 598.4 | 2 684 338.9 | 769 599.4 | 2 684 339.8 | |
| 15/05/2020 | 20:00:04 | R1_ENV_027 | WS | NS | 292 | 11.8 | 769 598.4 | 2 684 338.9 | 769 598.9 | 2 684 338.7 | Bottle open |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 15/05/2020 | 20:08:48 | R1_ENV_027 | WS | MID | 293 | 11.8 | 769 598.4 | 2 684 338.9 | 769 599.2 | 2 684 340.1 | |
| 15/05/2020 | 20:18:40 | R1_ENV_027 | WS | TOP | 294 | 11.8 | 769 598.4 | 2 684 338.9 | 769 599.5 | 2 684 339.2 | |
| 15/05/2020 | 20:30:58 | R1_ENV_027 | VV | NS | 295 | 11.8 | 769 598.4 | 2 684 338.9 | 769 600.7 | 2 684 339.0 | |
| 15/05/2020 | 20:37:37 | R1_ENV_027 | VV | NS | 296 | 11.8 | 769 598.4 | 2 684 338.9 | 769 596.6 | 2 684 348.7 | |
| 15/05/2020 | 20:43:13 | R1_ENV_027 | VV | NS | 297 | 11.8 | 769 598.4 | 2 684 338.9 | 769 603.1 | 2 684 330.3 | |
| 15/05/2020 | 21:16:02 | R1_ENV_029 | VV | PC | 298 | 11.7 | 770 237.8 | 2 686 233.9 | 770 239.1 | 2 686 236.2 | |
| 15/05/2020 | 21:29:51 | R1_ENV_029 | WS | BOT | 299 | 11.7 | 770 237.8 | 2 686 233.9 | 770 234.6 | 2 686 234.2 | |
| 15/05/2020 | 21:41:42 | R1_ENV_029 | WS | MID | 300 | 11.6 | 770 237.8 | 2 686 233.9 | 770 239.4 | 2 686 234.7 | |
| 15/05/2020 | 21:57:38 | R1_ENV_029 | WS | TOP | 301 | 11.6 | 770 237.8 | 2 686 233.9 | 770 238.4 | 2 686 234.7 | |
| 15/05/2020 | 22:09:16 | R1_ENV_029 | WP | YSI Exo2 | 302 | 11.6 | 770 237.8 | 2 686 233.9 | 770 239.0 | 2 686 231.5 | |
| 15/05/2020 | 23:08:21 | R1_ENV_034 | WP | YSI Exo2 | 303 | 11.7 | 772 783.5 | 2 690 650.6 | 772 782.3 | 2 690 650.4 | |
| 15/05/2020 | 23:18:33 | R1_ENV_034 | WS | BOT | 304 | 11.7 | 772 783.5 | 2 690 650.6 | 772 785.9 | 2 690 648.9 | |
| 15/05/2020 | 23:29:36 | R1_ENV_034 | WS | MID | 305 | 11.7 | 772 783.5 | 2 690 650.6 | 772 783.7 | 2 690 650.7 | |
| 15/05/2020 | 23:37:52 | R1_ENV_034 | WS | TOP | 306 | 11.8 | 772 783.5 | 2 690 650.6 | 772 785.3 | 2 690 649.4 | |
| 15/05/2020 | 23:46:15 | R1_ENV_034 | VV | NS | 307 | 11.8 | 772 783.5 | 2 690 650.6 | 772 786.3 | 2 690 650.0 | |
| 15/05/2020 | 23:51:11 | R1_ENV_034 | VV | NS | 308 | 11.8 | 772 783.5 | 2 690 650.6 | 772 782.3 | 2 690 662.0 | |
| 15/05/2020 | 23:55:30 | R1_ENV_034 | VV | NS | 309 | 11.8 | 772 783.5 | 2 690 650.6 | 772 784.0 | 2 690 641.7 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 16/05/2020 | 00:18:53 | R1_ENV_035 | VV | NS | 310 | 13.8 | 772 156.1 | 2 691 919.0 | 772 157.7 | 2 691 919.4 | |
| 16/05/2020 | 00:23:46 | R1_ENV_035 | VV | NS | 311 | 13.8 | 772 156.1 | 2 691 919.0 | 772 156.7 | 2 691 929.5 | |
| 16/05/2020 | 00:28:20 | R1_ENV_035 | VV | NS | 312 | 13.7 | 772 156.1 | 2 691 919.0 | 772 159.1 | 2 691 910.2 | |
| 16/05/2020 | 00:35:39 | R1_ENV_035 | WS | BOT | 313 | 13.8 | 772 156.1 | 2 691 919.0 | 772 156.6 | 2 691 919.2 | One bottle open |
| 16/05/2020 | 00:46:02 | R1_ENV_035 | WS | BOT | 314 | 13.8 | 772 156.1 | 2 691 919.0 | 772 158.9 | 2 691 919.4 | |
| 16/05/2020 | 00:53:42 | R1_ENV_035 | WS | MID | 315 | 13.8 | 772 156.1 | 2 691 919.0 | 772 157.0 | 2 691 920.7 | One bottle open |
| 16/05/2020 | 01:04:43 | R1_ENV_035 | WS | MID | 316 | 13.8 | 772 156.1 | 2 691 919.0 | 772 157.4 | 2 691 918.3 | |
| 16/05/2020 | 01:09:11 | R1_ENV_035 | WS | TOP | 317 | 13.8 | 772 156.1 | 2 691 919.0 | 772 156.1 | 2 691 919.0 | |
| 16/05/2020 | 01:19:19 | R1_ENV_035 | WP | YSI Exo2 | 318 | 13.8 | 772 156.1 | 2 691 919.0 | 772 155.9 | 2 691 919.7 | |
| 16/05/2020 | 05:27:48 | R1_TR02 | Video | SOL | 416 | 3.8 | 762 897.0 | 2 672 216.3 | 762 923.0 | 2 672 225.9 | |
| 16/05/2020 | 05:29:02 | R1_TR02 | Still | R1_TR02_001 | - | 3.9 | - | - | 762 871.8 | 2 672 205.9 | |
| 16/05/2020 | 05:29:09 | R1_TR02 | Still | R1_TR02_002 | 417 | 3.8 | - | - | 762 866.9 | 2 672 204.2 | |
| 16/05/2020 | 05:29:10 | R1_TR02 | Still | R1_TR02_003 | 418 | 3.8 | - | - | 762 866.2 | 2 672 203.9 | |
| 16/05/2020 | 05:29:22 | R1_TR02 | Still | R1_TR02_004 | 419 | 3.6 | - | - | 762 858.1 | 2 672 199.5 | |
| 16/05/2020 | 05:29:35 | R1_TR02 | Still | R1_TR02_005 | 420 | 3.8 | - | - | 762 848.2 | 2 672 199.3 | |
| 16/05/2020 | 05:29:46 | R1_TR02 | Still | R1_TR02_006 | 421 | 3.6 | - | - | 762 840.0 | 2 672 198.7 | |
| 16/05/2020 | 05:30:00 | R1_TR02 | Still | R1_TR02_007 | 422 | 3.8 | - | - | 762 830.2 | 2 672 195.7 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 16/05/2020 | 05:30:23 | R1_TR02 | Still | R1_TR02_008 | 423 | 3.8 | - | - | 762 813.7 | 2 672 189.5 | |
| 16/05/2020 | 05:30:40 | R1_TR02 | Still | R1_TR02_009 | 424 | 3.8 | - | - | 762 801.0 | 2 672 182.3 | |
| 16/05/2020 | 05:30:52 | R1_TR02 | Still | R1_TR02_010 | 425 | 3.9 | - | - | 762 792.1 | 2 672 181.5 | |
| 16/05/2020 | 05:31:01 | R1_TR02 | Still | R1_TR02_011 | - | 3.9 | - | - | 762 785.6 | 2 267 179.8 | |
| 16/05/2020 | 05:31:09 | R1_TR02 | Video | EOL | 426 | 3.8 | 762 782.8 | 2 672 177.5 | 762 779.9 | 2 672 177.4 | |
| 16/05/2020 | 05:50:11 | R1_TR01 | Video | SOL | 427 | 6.1 | 760 273.9 | 2 671 448.8 | 760 295.3 | 2 671 460.7 | |
| 16/05/2020 | 05:50:37 | R1_TR01 | Still | R1_TR01_001 | 428 | 6.3 | - | - | 760 272.8 | 2 671 452.7 | |
| 16/05/2020 | 05:50:47 | R1_TR01 | Still | R1_TR01_002 | - | 6.4 | - | - | 760 264.2 | 2 671 448.9 | |
| 16/05/2020 | 05:50:48 | R1_TR01 | Still | R1_TR01_003 | 429 | 6.4 | - | - | 760 263.4 | 2 671 448.4 | |
| 16/05/2020 | 05:50:54 | R1_TR01 | Still | R1_TR01_004 | 430 | 6.4 | - | - | 760 258.6 | 2 671 445.6 | |
| 16/05/2020 | 05:51:13 | R1_TR01 | Still | R1_TR01_005 | 431 | 6.7 | - | - | 760 242.6 | 2 671 438.3 | |
| 16/05/2020 | 05:51:18 | R1_TR01 | Still | R1_TR01_006 | - | 6.7 | - | - | 760 239.4 | 2 671 435.6 | |
| 16/05/2020 | 05:51:22 | R1_TR01 | Still | R1_TR01_007 | - | 6.7 | - | - | 760 236.7 | 2 671 433.4 | |
| 16/05/2020 | 05:51:31 | R1_TR01 | Still | R1_TR01_008 | 432 | 6.7 | - | - | 760 229.3 | 2 671 429.8 | |
| 16/05/2020 | 05:51:47 | R1_TR01 | Still | R1_TR01_009 | 433 | 6.9 | - | - | 760 216.6 | 2 671 422.9 | |
| 16/05/2020 | 05:52:01 | R1_TR01 | Still | R1_TR01_010 | 434 | 7.0 | - | - | 760 204.3 | 2 671 418.0 | |
| 16/05/2020 | 05:52:24 | R1_TR01 | Still | R1_TR01_011 | - | 7.0 | - | - | 760 183.8 | 2 671 409.4 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 16/05/2020 | 05:52:24 | R1_TR01 | Still | R1_TR01_012 | - | 7.0 | - | - | 760 183.8 | 2 671 409.4 | |
| 16/05/2020 | 05:52:32 | R1_TR01 | Still | R1_TR01_013 | 435 | 7.1 | - | - | 760 175.9 | 2 671 407.9 | |
| 16/05/2020 | 05:52:39 | R1_TR01 | Video | EOL | 436 | 7.1 | 760 273.9 | 2 671 448.8 | 760 168.6 | 2 671 405.4 | |
| 16/05/2020 | 06:14:58 | R1_ENV_006 | VV | NS | 437 | 6.8 | 756 631.1 | 2 670 474.6 | 756 625.7 | 2 670 486.6 | |
| 16/05/2020 | 06:54:54 | R1_ENV_006 | VV | NS | 438 | 6.6 | 756 631.1 | 2 670 474.6 | 756 628.8 | 2 670 476.3 | |
| 16/05/2020 | 07:04:26 | R1_ENV_006 | VV | NS | 439 | 6.6 | 756 631.1 | 2 670 474.6 | 756 614.1 | 2 670 467.4 | |
| 16/05/2020 | 07:18:51 | R1_ENV_007 | VV | NS | 440 | 6.6 | 757 597.3 | 2 670 732.2 | 757 582.6 | 2 670 742.1 | |
| 16/05/2020 | 07:23:37 | R1_ENV_007 | VV | NS | 441 | 6.5 | 757 597.3 | 2 670 732.2 | 757 592.0 | 2 670 733.2 | |
| 16/05/2020 | 07:30:11 | R1_ENV_007 | VV | NS | 442 | 6.5 | 757 597.3 | 2 670 732.2 | 757 602.5 | 2 670 722.1 | |
| 16/05/2020 | 07:43:08 | R1_ENV_008 | VV | NS | 443 | 6.7 | 758 565.9 | 2 670 981.4 | 758 562.8 | 2 670 969.3 | |
| 16/05/2020 | 07:49:49 | R1_ENV_008 | VV | NS | 444 | 6.8 | 758 565.9 | 2 670 981.4 | 758 562.9 | 2 670 991.2 | |
| 16/05/2020 | 07:55:59 | R1_ENV_008 | VV | NS | 445 | 6.7 | 758 565.9 | 2 670 981.4 | 758 565.1 | 2 670 982.2 | |
| 16/05/2020 | 08:00:17 | SO_R1_001 | VV | NS | 446 | 6.8 | 758 565.9 | 2 670 981.4 | 758 576.5 | 2 670 992.4 | |
| 16/05/2020 | 08:12:49 | R1_ENV_009 | VV | NS | 447 | 6.9 | 759 529.8 | 2 671 247.5 | 759 515.6 | 2 671 249.6 | |
| 16/05/2020 | 08:17:32 | R1_ENV_009 | VV | NS | 448 | 7.0 | 759 529.8 | 2 671 247.5 | 759 527.7 | 2 671 258.5 | |
| 16/05/2020 | 08:25:02 | R1_ENV_009 | VV | NS | 449 | 6.9 | 759 529.8 | 2 671 247.5 | 759 529.0 | 2 671 243.4 | |
| 16/05/2020 | 08:38:05 | R1_ENV_010 | VV | NS | 450 | 4.8 | 760 496.1 | 2 671 505.1 | 760 490.2 | 2 671 490.7 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 16/05/2020 | 08:42:58 | R1_ENV_010 | VV | NS | 451 | 5.0 | 760 496.1 | 2 671 505.1 | 760 487.7 | 2 671 508.8 | |
| 16/05/2020 | 08:47:44 | R1_ENV_010 | VV | NS | 452 | 5.0 | 760 496.1 | 2 671 505.1 | 760 508.6 | 2 671 495.0 | |
| 16/05/2020 | 09:05:43 | R1_ENV_012 | VV | NS | 453 | 3.9 | 762 431.8 | 2 672 008.6 | 762 438.6 | 2 672 006.6 | |
| 16/05/2020 | 09:09:53 | R1_ENV_012 | VV | NS | 454 | 3.6 | 762 431.8 | 2 672 008.6 | 762 419.4 | 2 672 001.4 | |
| 16/05/2020 | 09:15:31 | R1_ENV_012 | VV | NS | 455 | 3.5 | 762 431.8 | 2 672 008.6 | 762 431.2 | 2 672 023.3 | |
| 16/05/2020 | 09:26:08 | R1_ENV_013 | VV | NS | 456 | 4.0 | 763 402.3 | 2 672 259.4 | 763 400.0 | 2 672 262.6 | |
| 16/05/2020 | 09:30:16 | R1_ENV_013 | VV | NS | 457 | 3.8 | 763 402.3 | 2 672 259.4 | 763 414.1 | 2 672 267.8 | |
| 16/05/2020 | 09:34:41 | R1_ENV_013 | VV | NS | 458 | 3.9 | 763 402.3 | 2 672 259.4 | 763 403.5 | 2 672 250.8 | |
| 16/05/2020 | 09:46:40 | R1_ENV_014 | VV | NS | 459 | 5.9 | 764 370.7 | 2 672 508.5 | 764 372.5 | 2 672 495.9 | |
| 16/05/2020 | 09:54:09 | R1_ENV_014 | VV | PC | 460 | 6.1 | 764 370.7 | 2 672 508.5 | 764 373.4 | 2 672 513.5 | |
| 16/05/2020 | 10:13:40 | R1_ENV_015 | VV | NS | 461 | 7.1 | 764 666.3 | 2 673 463.8 | 764 654.5 | 2 673 479.1 | |
| 16/05/2020 | 10:23:05 | R1_ENV_015 | VV | NS | 462 | 7.0 | 764 666.3 | 2 673 463.8 | 764 679.8 | 2 673 470.7 | |
| 16/05/2020 | 10:30:39 | R1_ENV_015 | VV | NS | 463 | 6.9 | 764 666.3 | 2 673 463.8 | 764 665.0 | 2 673 460.1 | |
| 16/05/2020 | 13:55:03 | R1_ENV_036 | WP | YSI Exo2 | 319 | 12.6 | 773 423.4 | 2 692 546.8 | 773 421.1 | 2 692 547.7 | |
| 16/05/2020 | 14:34:27 | R1_ENV_036 | WS | BOT | 320 | 12.8 | 773 423.4 | 2 692 546.8 | 773 423.4 | 2 692 546.5 | |
| 16/05/2020 | 14:43:34 | R1_ENV_036 | WS | MID | 321 | 12.8 | 773 423.4 | 2 692 546.8 | 773 425.4 | 2 692 548.0 | |
| 16/05/2020 | 14:50:29 | R1_ENV_036 | WS | TOP | 322 | 12.8 | 773 423.4 | 2 692 546.8 | 773 423.7 | 2 692 547.7 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 16/05/2020 | 15:00:05 | R1_ENV_036 | VV | NS | 323 | 12.9 | 773 423.4 | 2 692 546.8 | 773 423.8 | 2 692 547.0 | |
| 16/05/2020 | 15:05:48 | R1_ENV_036 | VV | NS | 324 | 13.0 | 773 423.4 | 2 692 546.8 | 773 426.0 | 2 692 538.3 | |
| 16/05/2020 | 15:09:50 | R1_ENV_036 | VV | NS | 325 | 13.0 | 773 423.4 | 2 692 546.8 | 773 420.8 | 2 692 556.2 | |
| 16/05/2020 | 17:06:28 | R1_ENV_037 | VV | NS | 326 | 12.6 | 772 795.6 | 2 693 814.0 | 772 795.9 | 2 693 813.5 | |
| 16/05/2020 | 17:12:04 | R1_ENV_037 | VV | NS | 327 | 12.6 | 772 795.6 | 2 693 814.0 | 772 792.6 | 2 693 823.2 | |
| 16/05/2020 | 17:15:19 | R1_ENV_037 | VV | NS | 328 | 12.6 | 772 795.6 | 2 693 814.0 | 772 799.4 | 2 693 805.3 | |
| 16/05/2020 | 17:19:56 | R1_ENV_037 | WS | BOT | 329 | 12.6 | 772 795.6 | 2 693 814.0 | 772 795.4 | 2 693 814.0 | |
| 16/05/2020 | 17:27:46 | R1_ENV_037 | WS | MID | 330 | 12.6 | 772 795.6 | 2 693 814.0 | 772 795.3 | 2 693 813.5 | |
| 16/05/2020 | 17:34:34 | R1_ENV_037 | WS | TOP | 331 | 12.6 | 772 795.6 | 2 693 814.0 | 772 795.3 | 2 693 813.0 | |
| 16/05/2020 | 17:44:26 | R1_ENV_037 | WP | YSI Exo2 | 332 | 12.6 | 772 795.6 | 2 693 814.0 | 772 792.8 | 2 693 813.7 | |
| 22/05/2020 | 03:50:17 | R1_ENV_114 | WP | YSI Exo2 | 691 | 17.4 | 783 859.2 | 2 761 244.2 | 783 859.9 | 2 761 245.0 | |
| 22/05/2020 | 04:20:57 | R1_ENV_114 | WS | BOT | 692 | 17.5 | 783 859.2 | 2 761 244.2 | 783 859.1 | 2 761 249.7 | |
| 22/05/2020 | 05:16:27 | R1_ENV_114 | WS | MID | 693 | 17.6 | 783 859.2 | 2 761 244.2 | 783 858.7 | 2 761 244.0 | |
| 22/05/2020 | 05:30:09 | R1_ENV_114 | WS | TOP | 694 | 17.6 | 783 859.2 | 2 761 244.2 | 783 861.7 | 2 761 245.3 | |
| 22/05/2020 | 05:49:17 | R1_ENV_114 | VV | NS | 695 | 17.6 | 783 859.2 | 2 761 244.2 | 783 859.1 | 2 761 243.9 | |
| 22/05/2020 | 05:54:47 | R1_ENV_114 | VV | NS | 696 | 17.6 | 783 859.2 | 2 761 244.2 | 783 848.8 | 2 761 246.0 | |
| 22/05/2020 | 06:01:15 | R1_ENV_114 | VV | NS | 697 | 17.8 | 783 859.2 | 2 761 244.2 | 783 867.9 | 2 761 246.8 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 22/05/2020 | 06:36:22 | R1_ENV_115 | WP | YSI Exo2 | 698 | 18.1 | 782 782.9 | 2 760 393.0 | 782 784.3 | 2 760 390.6 | |
| 22/05/2020 | 06:55:46 | R1_ENV_115 | VV | NS | 699 | 18.1 | 782 782.9 | 2 760 393.0 | 782 784.4 | 2 760 393.8 | |
| 22/05/2020 | 07:01:25 | R1_ENV_115 | VV | NS | 700 | 18.1 | 782 782.9 | 2 760 393.0 | 782 791.1 | 2 760 388.4 | |
| 22/05/2020 | 07:07:41 | R1_ENV_115 | VV | NS | 701 | 18.2 | 782 782.9 | 2 760 393.0 | 782 777.3 | 2 760 401.7 | |
| 22/05/2020 | 07:25:07 | R1_ENV_115 | WS | BOT | 702 | 18.2 | 782 782.9 | 2 760 393.0 | 782 789.8 | 2 760 392.3 | |
| 22/05/2020 | 07:34:07 | R1_ENV_115 | WS | MID | 703 | 18.2 | 782 782.9 | 2 760 393.0 | 782 790.4 | 2 760 392.6 | |
| 22/05/2020 | 07:50:02 | R1_ENV_115 | WS | TOP | 704 | 18.4 | 782 782.9 | 2 760 393.0 | 782 789.4 | 2 760 391.2 | |
| 22/05/2020 | 08:31:03 | R1_ENV_116 | WP | YSI Exo2 | 705 | 18.1 | 781 863.5 | 2 761 380.8 | 781 861.8 | 2 761 381.2 | |
| 22/05/2020 | 08:59:21 | R1_ENV_116 | WS | BOT | 706 | 18.2 | 781 863.5 | 2 761 380.8 | 781 863.4 | 2 761 381.3 | |
| 22/05/2020 | 09:08:09 | R1_ENV_116 | WS | MID | 707 | 18.2 | 781 863.5 | 2 761 380.8 | 781 863.7 | 2 761 381.8 | |
| 22/05/2020 | 09:22:07 | R1_ENV_116 | WS | TOP | 708 | 18.1 | 781 863.5 | 2 761 380.8 | 781 863.2 | 2 761 381.1 | |
| 22/05/2020 | 09:35:15 | R1_ENV_116 | VV | NS | 709 | 18.2 | 781 863.5 | 2 761 380.8 | 781 864.5 | 2 761 381.8 | |
| 22/05/2020 | 09:42:06 | R1_ENV_116 | VV | NS | 710 | 18.2 | 781 863.5 | 2 761 380.8 | 781 862.6 | 2 761 393.9 | |
| 22/05/2020 | 09:46:50 | R1_ENV_116 | VV | NS | 711 | 18.2 | 781 863.5 | 2 761 380.8 | 781 863.8 | 2 761 370.9 | |
| 22/05/2020 | 10:11:09 | R1_ENV_117 | VV | NS | 712 | 17.5 | 780 793.3 | 2 760 600.4 | 780 793.2 | 2 760 600.7 | |
| 22/05/2020 | 10:18:26 | R1_ENV_117 | VV | NS | 713 | 17.5 | 780 793.3 | 2 760 600.4 | 780 794.4 | 2 760 611.8 | |
| 22/05/2020 | 10:24:16 | R1_ENV_117 | VV | NS | 714 | 17.6 | 780 793.3 | 2 760 600.4 | 780 793.1 | 2 760 589.6 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 22/05/2020 | 10:32:28 | R1_ENV_117 | WS | BOT | 715 | 17.5 | 780 793.3 | 2 760 600.4 | 780 794.6 | 2 760 600.7 | |
| 22/05/2020 | 10:50:20 | R1_ENV_117 | WS | MID | 716 | 17.4 | 780 793.3 | 2 760 600.4 | 780 793.7 | 2 760 601.0 | |
| 22/05/2020 | 10:59:09 | R1_ENV_117 | WS | TOP | 717 | 17.3 | 780 793.3 | 2 760 600.4 | 780 793.7 | 2 760 600.3 | |
| 22/05/2020 | 11:19:47 | R1_ENV_117 | WP | YSI Exo2 | 718 | 17.2 | 780 793.3 | 2 760 600.4 | 780 791.8 | 2 760 601.0 | |
| 22/05/2020 | 12:05:28 | R1_ENV_118 | WP | YSI Exo2 | 719 | 17.3 | 779 867.9 | 2 761 517.3 | 779 868.2 | 2 761 519.8 | |
| 22/05/2020 | 12:22:10 | R1_ENV_118 | WS | BOT | 720 | 17.2 | 779 867.9 | 2 761 517.3 | 779 867.8 | 2 761 517.6 | |
| 22/05/2020 | 12:30:57 | R1_ENV_118 | WS | MID | 721 | 17.2 | 779 867.9 | 2 761 517.3 | 779 868.2 | 2 761 516.7 | |
| 22/05/2020 | 12:39:05 | R1_ENV_118 | WS | TOP | 722 | 17.1 | 779 867.9 | 2 761 517.3 | 779 868.1 | 2 761 516.2 | |
| 22/05/2020 | 12:51:32 | R1_ENV_118 | VV | NS | 723 | 17.0 | 779 867.9 | 2 761 517.3 | 779 868.9 | 2 761 516.4 | |
| 22/05/2020 | 12:58:22 | R1_ENV_118 | VV | NS | 724 | 17.3 | 779 867.9 | 2 761 517.3 | 779 879.2 | 2 761 517.6 | |
| 22/05/2020 | 13:02:48 | R1_ENV_118 | VV | NS | 725 | 17.3 | 779 867.9 | 2 761 517.3 | 779 856.1 | 2 761 517.2 | |
| 23/05/2020 | 04:51:05 | R1_ENV_119 | WS | TOP | 765 | 16.9 | 778 769.3 | 2 760 811.4 | 778 772.9 | 2 760 807.0 | |
| 23/05/2020 | 05:42:26 | R1_ENV_119 | WP | YSI Exo2 | 768 | 16.9 | 778 769.3 | 2 760 811.4 | 778 760.2 | 2 760 816.0 | |
| 23/05/2020 | 06:02:26 | R1_ENV_119 | WS | BOT | 769 | 17.0 | 778 769.3 | 2 760 811.4 | 778 776.2 | 2 760 801.3 | |
| 23/05/2020 | 06:15:02 | R1_ENV_119 | WS | MID | 770 | 17.3 | 778 769.3 | 2 760 811.4 | 778 766.0 | 2 760 816.6 | |
| 23/05/2020 | 06:23:53 | R1_ENV_119 | VV | NS | 771 | 17.4 | 778 769.3 | 2 760 811.4 | 778 770.3 | 2 760 814.1 | |
| 23/05/2020 | 06:29:10 | R1_ENV_119 | VV | NS | 772 | 17.6 | 778 769.3 | 2 760 811.4 | 778 784.3 | 2 760 815.1 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 23/05/2020 | 06:35:22 | R1_ENV_119 | VV | NS | 773 | 17.2 | 778 769.3 | 2 760 811.4 | 778 758.5 | 2 760 816.9 | |
| 23/05/2020 | 07:02:04 | R1_ENV_120 | VV | NS | 774 | 18.8 | 777 872.3 | 2 761 653.9 | 777 874.1 | 2 761 652.9 | |
| 23/05/2020 | 07:05:10 | R1_ENV_120 | VV | NS | 775 | 18.7 | 777 872.3 | 2 761 653.9 | 777 886.1 | 2 761 652.1 | |
| 23/05/2020 | 07:15:19 | R1_ENV_120 | VV | NS | 776 | 18.9 | 777 872.3 | 2 761 653.9 | 777 862.1 | 2 761 657.1 | |
| 23/05/2020 | 07:19:14 | SO_R1_015 | VV | NS | 777 | 18.9 | 777 872.3 | 2 761 653.9 | 777 876.4 | 2 761 653.5 | |
| 23/05/2020 | 07:25:33 | R1_ENV_120 | WS | BOT | 778 | 18.8 | 777 872.3 | 2 761 653.9 | 777 875.4 | 2 761 655.0 | |
| 23/05/2020 | 07:35:34 | R1_ENV_120 | WS | MID | 779 | 18.8 | 777 872.3 | 2 761 653.9 | 777 873.9 | 2 761 653.9 | |
| 23/05/2020 | 07:43:12 | R1_ENV_120 | WS | TOP | 780 | 18.8 | 777 872.3 | 2 761 653.9 | 777 872.8 | 2 761 654.9 | |
| 23/05/2020 | 08:02:33 | R1_ENV_120 | WP | YSI Exo2 | 781 | 18.9 | 777 872.3 | 2 761 653.9 | 777 872.1 | 2 761 651.7 | |
| 23/05/2020 | 08:47:53 | R1_ENV_121 | WS | BOT | 782 | 20.4 | 776 814.1 | 2 761 015.2 | 776 817.0 | 2 761 013.2 | |
| 23/05/2020 | 08:58:56 | R1_ENV_121 | WS | MID | 783 | 20.4 | 776 814.1 | 2 761 015.2 | 776 814.5 | 2 761 012.5 | |
| 23/05/2020 | 09:06:16 | R1_ENV_121 | WS | TOP | 784 | 20.3 | 776 814.1 | 2 761 015.2 | 776 814.6 | 2 761 015.8 | |
| 23/05/2020 | 09:13:35 | R1_ENV_121 | VV | NS | 785 | 20.4 | 776 814.1 | 2 761 015.2 | 776 814.0 | 2 761 013.9 | |
| 23/05/2020 | 09:15:57 | R1_ENV_121 | VV | NS | 786 | 20.4 | 776 814.1 | 2 761 015.2 | 776 820.3 | 2 761 006.9 | |
| 23/05/2020 | 09:21:33 | R1_ENV_121 | VV | NS | 787 | 20.3 | 776 814.1 | 2 761 015.2 | 776 802.3 | 2 761 024.4 | |
| 23/05/2020 | 09:36:57 | R1_ENV_121 | WP | YSI Exo2 | 788 | 20.4 | 776 814.1 | 2 761 015.2 | 776 818.6 | 2 761 013.7 | |
| 23/05/2020 | 10:18:46 | R1_ENV_122 | WP | YSI Exo2 | 789 | 21.5 | 775 876.6 | 2 761 790.4 | 775 872.4 | 2 761 792.5 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 23/05/2020 | 10:38:21 | R1_ENV_122 | VV | PC | 790 | 21.5 | 775 876.6 | 2 761 790.4 | 775 873.8 | 2 761 791.0 | |
| 23/05/2020 | 11:08:32 | R1_ENV_122 | WS | BOT | 792 | 21.4 | 775 876.6 | 2 761 790.4 | 775 879.4 | 2 761 789.9 | |
| 23/05/2020 | 11:23:43 | R1_ENV_122 | WS | MID | 793 | 21.3 | 775 876.6 | 2 761 790.4 | 775 878.7 | 2 761 787.1 | |
| 23/05/2020 | 11:32:02 | R1_ENV_122 | WS | TOP | 794 | 21.4 | 775 876.6 | 2 761 790.4 | 775 874.3 | 2 761 790.1 | |
| 23/05/2020 | 12:01:42 | R1_ENV_123 | WS | BOT | 795 | 21.1 | 775 086.9 | 2 760 965.0 | 775 087.2 | 2 760 961.7 | |
| 23/05/2020 | 12:18:01 | R1_ENV_123 | WS | MID | 796 | 21.1 | 775 086.9 | 2 760 965.0 | 775 086.9 | 2 760 964.0 | |
| 23/05/2020 | 12:28:37 | R1_ENV_123 | WS | TOP | 797 | 21.2 | 775 086.9 | 2 760 965.0 | 775 085.3 | 2 760 966.9 | |
| 23/05/2020 | 12:40:10 | R1_ENV_123 | VV | NS | 798 | 21.1 | 775 086.9 | 2 760 965.0 | 775 088.5 | 2 760 965.7 | |
| 23/05/2020 | 12:48:44 | R1_ENV_123 | VV | NS | 799 | 21.0 | 775 086.9 | 2 760 965.0 | 775 077.0 | 2 760 963.4 | |
| 23/05/2020 | 12:52:07 | R1_ENV_123 | VV | NS | 800 | 21.0 | 775 086.9 | 2 760 965.0 | 775 092.8 | 2 760 953.6 | |
| 23/05/2020 | 13:32:26 | R1_ENV_123 | WP | YSI Exo2 | 802 | 21.0 | 775 086.9 | 2 760 965.0 | 775 082.7 | 2 760 968.7 | |
| 23/05/2020 | 14:13:03 | R1_ENV_124 | WP | YSI Exo2 | 803 | 22.8 | 773 137.2 | 2 761 211.9 | 773 136.1 | 2 761 211.4 | |
| 28/05/2020 | 11:35:28 | R1_ENV_107 | WS | BOT | 1055 | 15.0 | 785 725.6 | 2 755 221.2 | 785 724.8 | 2 755 220.2 | |
| 28/05/2020 | 11:55:40 | R1_ENV_107 | WS | MID | 1056 | 15.1 | 785 725.6 | 2 755 221.2 | 785 726.5 | 2 755 223.2 | |
| 28/05/2020 | 12:03:49 | R1_ENV_107 | WS | TOP | 1057 | 15.2 | 785 725.6 | 2 755 221.2 | 785 723.7 | 2 755 221.9 | |
| 28/05/2020 | 12:26:05 | R1_ENV_107 | WP | YSI Exo2 | 1058 | 15.2 | 785 725.6 | 2 755 221.2 | 785 721.0 | 2 755 222.3 | |
| 28/05/2020 | 12:56:33 | R1_ENV_107 | VV | NS | 1059 | 15.3 | 785 725.6 | 2 755 221.2 | 785 727.2 | 2 755 222.8 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 28/05/2020 | 13:16:49 | R1_ENV_107 | VV | NS | 1060 | 15.2 | 785 725.6 | 2 755 221.2 | 785 727.6 | 2 755 210.0 | |
| 28/05/2020 | 13:26:47 | R1_ENV_107 | VV | NS | 1061 | 15.3 | 785 725.6 | 2 755 221.2 | 785 731.3 | 2 755 224.7 | |
| 28/05/2020 | 13:49:57 | R1_ENV_106 | WP | YSI Exo2 | 1062 | 14.9 | 786 864.4 | 2 754 382.3 | 786 862.7 | 2 754 382.0 | |
| 28/05/2020 | 14:38:42 | R1_ENV_106 | VV | NS | 1063 | 14.9 | 786 864.4 | 2 754 382.3 | 786 864.6 | 2 754 383.5 | |
| 28/05/2020 | 14:42:59 | R1_ENV_106 | VV | NS | 1064 | 14.8 | 786 864.4 | 2 754 382.3 | 786 867.8 | 2 754 374.4 | |
| 28/05/2020 | 14:45:35 | R1_ENV_106 | VV | NS | 1065 | 14.9 | 786 864.4 | 2 754 382.3 | 786 862.8 | 2 754 391.9 | |
| 28/05/2020 | 16:23:11 | R1_ENV_094 | VV | PC | 1066 | 20.4 | 787 261.2 | 2 742 544.4 | 787 262.7 | 2 742 542.1 | |
| 28/05/2020 | 16:36:32 | R1_ENV_094 | WS | BOT | 1067 | 20.4 | 787 261.2 | 2 742 544.4 | 787 259.2 | 2 742 546.3 | |
| 28/05/2020 | 16:47:40 | R1_ENV_094 | WS | MID | 1068 | 20.2 | 787 261.2 | 2 742 544.4 | 787 259.6 | 2 742 544.4 | |
| 28/05/2020 | 16:56:07 | R1_ENV_094 | WS | TOP | 1069 | 20.3 | 787 261.2 | 2 742 544.4 | 787 261.1 | 2 742 546.8 | |
| 28/05/2020 | 17:10:57 | R1_ENV_094 | WP | YSI Exo2 | 1070 | 20.3 | 787 261.2 | 2 742 544.4 | 787 252.3 | 2 742 541.8 | |
| 28/05/2020 | 17:41:28 | R1_ENV_093 | VV | PC | 1071 | 22.0 | 786 603.1 | 2 741 292.6 | 786 603.9 | 2 741 292.2 | |
| 28/05/2020 | 18:05:12 | R1_ENV_093 | WS | BOT | 1072 | 22.0 | 786 603.1 | 2 741 292.6 | 786 602.9 | 2 741 292.7 | |
| 28/05/2020 | 18:16:44 | R1_ENV_093 | WS | MID | 1073 | 22.0 | 786 603.1 | 2 741 292.6 | 786 602.2 | 2 741 292.4 | |
| 28/05/2020 | 18:32:36 | R1_ENV_093 | WS | TOP | 1074 | 22.1 | 786 603.1 | 2 741 292.6 | 786 603.6 | 2 741 292.8 | |
| 28/05/2020 | 18:46:14 | R1_ENV_093 | WP | YSI Exo2 | 1075 | 22.1 | 786 603.1 | 2 741 292.6 | 786 599.6 | 2 741 295.7 | |
| 28/05/2020 | 19:54:25 | R1_ENV_092 | VV | NS | 1076 | 20.9 | 787 854.8 | 2 740 634.5 | 787 856.2 | 2 740 635.5 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 28/05/2020 | 19:59:04 | R1_ENV_092 | VV | NS | 1077 | 21.0 | 787 854.8 | 2 740 634.5 | 787 858.2 | 2 740 626.8 | |
| 28/05/2020 | 20:03:14 | R1_ENV_092 | VV | PC | 1078 | 21.0 | 787 854.8 | 2 740 634.5 | 787 853.1 | 2 740 641.4 | |
| 28/05/2020 | 20:21:58 | R1_ENV_092 | WS | BOT | 1079 | 21.0 | 787 854.8 | 2 740 634.5 | 787 855.8 | 2 740 635.4 | |
| 28/05/2020 | 20:35:41 | R1_ENV_092 | WS | MID | 1080 | 21.1 | 787 854.8 | 2 740 634.5 | 787 855.9 | 2 740 634.1 | |
| 28/05/2020 | 20:47:21 | R1_ENV_092 | WS | TOP | 1081 | 21.2 | 787 854.8 | 2 740 634.5 | 787 855.7 | 2 740 635.3 | |
| 28/05/2020 | 21:15:06 | R1_ENV_092 | WP | YSI Exo2 | 1082 | 21.1 | 787 854.8 | 2 740 634.5 | 787 853.1 | 2 740 637.2 | |
| 28/05/2020 | 21:50:36 | R1_ENV_091 | VV | PC | 1083 | 19.4 | 787 196.7 | 2 739 382.7 | 787 198.1 | 2 739 382.2 | |
| 28/05/2020 | 22:16:03 | R1_ENV_091 | WS | BOT | 1084 | 19.4 | 787 196.7 | 2 739 382.7 | 787 197.4 | 2 739 383.7 | |
| 28/05/2020 | 22:26:27 | R1_ENV_091 | WS | MID | 1085 | 19.6 | 787 196.7 | 2 739 382.7 | 787 197.1 | 2 739 382.3 | |
| 28/05/2020 | 22:37:30 | R1_ENV_091 | WS | TOP | 1086 | 19.5 | 787 196.7 | 2 739 382.7 | 787 196.4 | 2 739 382.6 | |
| 28/05/2020 | 22:51:09 | R1_ENV_091 | WP | YSI Exo2 | 1087 | 19.6 | 787 196.7 | 2 739 382.7 | 787 198.5 | 2 739 381.8 | |
| 28/05/2020 | 23:37:46 | R1_ENV_090 | VV | NS | 1088 | 20.7 | 788 448.5 | 2 738 724.6 | 788 447.9 | 2 738 724.3 | |
| 28/05/2020 | 23:42:02 | R1_ENV_090 | VV | NS | 1089 | 20.7 | 788 448.5 | 2 738 724.6 | 788 448.5 | 2 738 733.4 | |
| 28/05/2020 | 23:46:39 | R1_ENV_090 | VV | NS | 1090 | 20.8 | 788 448.5 | 2 738 724.6 | 788 441.2 | 2 738 717.4 | |
| 29/05/2020 | 00:01:10 | R1_ENV_090 | WS | BOT | 1091 | 20.7 | 788 448.5 | 2 738 724.6 | 788 447.3 | 2 738 724.0 | |
| 29/05/2020 | 00:14:01 | R1_ENV_090 | WS | MID | 1092 | 20.8 | 788 448.5 | 2 738 724.6 | 788 448.1 | 2 738 724.7 | |
| 29/05/2020 | 00:26:40 | R1_ENV_090 | WS | TOP | 1093 | 20.9 | 788 448.5 | 2 738 724.6 | 788 448.4 | 2 738 724.3 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 29/05/2020 | 00:52:48 | R1_ENV_090 | WP | YSI Exo2 | 1094 | 20.7 | 788 448.5 | 2 738 724.6 | 788 450.4 | 2 738 725.4 | |
| 29/05/2020 | 03:42:55 | R1_ENV_112 | WS | BOT | 1095 | 18.1 | 785 966.0 | 2 760 314.7 | 785 966.3 | 2 760 315.0 | |
| 29/05/2020 | 03:50:04 | R1_ENV_112 | WS | MID | 1096 | 18.2 | 785 966.0 | 2 760 314.7 | 785 964.8 | 2 760 316.1 | |
| 29/05/2020 | 03:56:48 | R1_ENV_112 | WS | TOP | 1097 | 18.0 | 785 966.0 | 2 760 314.7 | 785 964.5 | 2 760 316.4 | |
| 29/05/2020 | 04:38:55 | R1_ENV_112 | WP | YSI Exo2 | 1099 | 17.8 | 785 966.0 | 2 760 314.7 | 785 968.0 | 2 760 314.8 | |
| 29/05/2020 | 04:58:56 | R1_ENV_112 | VV | NS | 1100 | 17.8 | 785 966.0 | 2 760 314.7 | 785 967.8 | 2 760 315.0 | |
| 29/05/2020 | 05:03:11 | R1_ENV_112 | VV | NS | 1101 | 17.7 | 785 966.0 | 2 760 314.7 | 785 968.6 | 2 760 315.4 | |
| 29/05/2020 | 05:09:01 | R1_ENV_112 | VV | NS | 1102 | 17.7 | 785 966.0 | 2 760 314.7 | 785 966.9 | 2 760 322.1 | |
| 29/05/2020 | 05:12:48 | SO_R1_014 | VV | NS | 1103 | 17.7 | 785 966.0 | 2 760 314.7 | 785 965.2 | 2 760 313.4 | |
| 29/05/2020 | 05:37:29 | R1_ENV_113 | VV | NS | 1104 | 17.7 | 784 772.4 | 2 760 185.6 | 784 770.9 | 2 760 186.4 | |
| 29/05/2020 | 05:41:05 | R1_ENV_113 | VV | NS | 1105 | 17.7 | 784 772.4 | 2 760 185.6 | 784 776.9 | 2 760 193.3 | |
| 29/05/2020 | 05:45:04 | R1_ENV_113 | VV | NS | 1106 | 17.7 | 784 772.4 | 2 760 185.6 | 784 772.9 | 2 760 177.1 | |
| 29/05/2020 | 05:54:43 | R1_ENV_113 | WP | YSI Exo2 | 1107 | 17.7 | 784 772.4 | 2 760 185.6 | 784 774.4 | 2 760 188.1 | |
| 29/05/2020 | 06:12:44 | R1_ENV_113 | WS | BOT | 1108 | 17.6 | 784 772.4 | 2 760 185.6 | 784 773.5 | 2 760 185.6 | |
| 29/05/2020 | 06:20:21 | R1_ENV_113 | WS | MID | 1109 | 17.6 | 784 772.4 | 2 760 185.6 | 784 772.9 | 2 760 186.0 | |
| 29/05/2020 | 06:28:50 | R1_ENV_113 | WS | TOP | 1110 | 17.6 | 784 772.4 | 2 760 185.6 | 784 772.7 | 2 760 186.3 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 29/05/2020 | 08:30:50 | R1_ENV_129 | VV | NS | 1111 | 13.5 | 772 016.8 | 2 756 312.8 | 771 972.4 | 2 756 202.2 | Station moved as proposed location was within 200 m of infrastructure |
| 29/05/2020 | 08:38:12 | R1_ENV_129 | VV | NS | 1112 | 13.4 | 772 016.8 | 2 756 312.8 | 771 964.0 | 2 756 201.8 | |
| 29/05/2020 | 08:40:18 | R1_ENV_129 | VV | NS | 1113 | 13.4 | 772 016.8 | 2 756 312.8 | 771 982.0 | 2 756 201.0 | |
| 29/05/2020 | 08:48:02 | R1_ENV_129 | WP | YSI Exo2 | 1114 | 13.4 | 772 016.8 | 2 756 312.8 | 771 973.7 | 2 756 198.0 | |
| 29/05/2020 | 08:59:08 | R1_ENV_129 | WS | BOT | 1115 | 13.5 | 772 016.8 | 2 756 312.8 | 771 972.9 | 2 756 199.9 | |
| 29/05/2020 | 09:10:32 | R1_ENV_129 | WS | MID | 1116 | 13.5 | 772 016.8 | 2 756 312.8 | 771 973.7 | 2 756 198.6 | |
| 29/05/2020 | 09:17:52 | R1_ENV_129 | WS | TOP | 1117 | 13.5 | 772 016.8 | 2 756 312.8 | 771 973.7 | 2 756 200.9 | |
| 29/05/2020 | 09:45:56 | R1_ENV_128 | WS | BOT | 1118 | 15.5 | 772 093.6 | 2 757 483.3 | 772 192.6 | 2 757 600.9 | Station moved as proposed location was within 200 m of infrastructure |
| 29/05/2020 | 09:53:20 | R1_ENV_128 | WS | MID | 1119 | 15.5 | 772 093.6 | 2 757 483.3 | 772 193.2 | 2 757 601.7 | |
| 29/05/2020 | 10:01:44 | R1_ENV_128 | WS | TOP | 1120 | 15.6 | 772 093.6 | 2 757 483.3 | 772 192.9 | 2 757 601.8 | |
| 29/05/2020 | 10:13:51 | R1_ENV_128 | WP | YSI Exo2 | 1121 | 15.6 | 772 093.6 | 2 757 483.3 | 772 192.6 | 2 757 600.8 | |
| 29/05/2020 | 10:34:35 | R1_ENV_128 | VV | NS | 1122 | 15.6 | 772 093.6 | 2 757 483.3 | 772 192.6 | 2 757 603.8 | |
| 29/05/2020 | 10:39:41 | R1_ENV_128 | VV | NS | 1123 | 15.7 | 772 093.6 | 2 757 483.3 | 772 202.1 | 2 757 600.1 | |
| 29/05/2020 | 10:42:25 | R1_ENV_128 | VV | NS | 1124 | 15.7 | 772 093.6 | 2 757 483.3 | 772 185.2 | 2 757 606.9 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 29/05/2020 | 10:45:20 | SO_R1_016 | VV | NS | 1125 | 15.7 | 772 093.6 | 2 757 483.3 | 772 198.4 | 2 757 599.9 | Moved as proposed location was within 200 m of infrastructure |
| 29/05/2020 | 11:21:45 | R1_ENV_127 | VV | NS | 1126 | 17.5 | 773 006.5 | 2 758 130.4 | 773 005.1 | 2 758 131.5 | |
| 29/05/2020 | 11:24:17 | R1_ENV_127 | VV | NS | 1127 | 17.5 | 773 006.5 | 2 758 130.4 | 773 013.4 | 2 758 126.2 | |
| 29/05/2020 | 11:28:26 | R1_ENV_127 | VV | NS | 1128 | 17.6 | 773 006.5 | 2 758 130.4 | 772 998.0 | 2 758 135.2 | |
| 29/05/2020 | 11:41:10 | R1_ENV_127 | WP | YSI Exo2 | 1129 | 17.5 | 773 006.5 | 2 758 130.4 | 773 005.5 | 2 758 130.0 | |
| 29/05/2020 | 11:57:43 | R1_ENV_127 | WS | BOT | 1130 | 17.6 | 773 006.5 | 2 758 130.4 | 773 007.0 | 2 758 131.3 | |
| 29/05/2020 | 12:06:23 | R1_ENV_127 | WS | MID | 1131 | 17.6 | 773 006.5 | 2 758 130.4 | 773 006.3 | 2 758 131.3 | |
| 29/05/2020 | 12:13:18 | R1_ENV_127 | WS | TOP | 1132 | 17.7 | 773 006.5 | 2 758 130.4 | 773 007.4 | 2 758 130.5 | |
| 29/05/2020 | 12:42:23 | R1_ENV_126 | WS | BOT | 1133 | 21.1 | 772 466.7 | 2 759 400.9 | 772 467.4 | 2 759 400.9 | |
| 29/05/2020 | 12:53:50 | R1_ENV_126 | WS | MID | 1134 | 21.1 | 772 466.7 | 2 759 400.9 | 772 467.5 | 2 759 402.0 | |
| 29/05/2020 | 13:04:29 | R1_ENV_126 | WS | TOP | 1135 | 21.2 | 772 466.7 | 2 759 400.9 | 772 467.5 | 2 759 401.5 | |
| 29/05/2020 | 13:17:17 | R1_ENV_126 | VV | Partial Sample | 1137 | 21.1 | 772 466.7 | 2 759 400.9 | 772 462.1 | 2 759 408.7 | PSD only |
| 29/05/2020 | 13:21:14 | R1_ENV_126 | VV | NS | 1138 | 21.1 | 772 466.7 | 2 759 400.9 | 772 468.2 | 2 759 399.4 | |
| 29/05/2020 | 13:24:27 | R1_ENV_126 | VV | NS | 1139 | 21.1 | 772 466.7 | 2 759 400.9 | 772 470.7 | 2 759 392.6 | |
| 29/05/2020 | 13:40:09 | R1_ENV_126 | WP | YSI Exo2 | 1140 | 21.3 | 772 466.7 | 2 759 400.9 | 772 465.2 | 2 759 400.7 | |
| 29/05/2020 | 18:00:05 | R1_ENV_089 | VV | NS | 1141 | 19.8 | 787 790.3 | 2 737 472.9 | 787 790.3 | 2 737 475.1 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 29/05/2020 | 18:04:32 | R1_ENV_089 | VV | PC | 1142 | 19.9 | 787 790.3 | 2 737 472.9 | 787 783.0 | 2 737 467.4 | |
| 29/05/2020 | 18:22:24 | R1_ENV_089 | WS | BOT | 1143 | 19.7 | 787 790.3 | 2 737 472.9 | 787 790.1 | 2 737 471.1 | |
| 29/05/2020 | 18:33:10 | R1_ENV_089 | WS | MID | 1144 | 19.8 | 787 790.3 | 2 737 472.9 | 787 790.0 | 2 737 473.9 | |
| 29/05/2020 | 18:42:23 | R1_ENV_089 | WS | TOP | 1145 | 19.8 | 787 790.3 | 2 737 472.9 | 787 790.5 | 2 737 472.8 | |
| 29/05/2020 | 19:02:37 | R1_ENV_089 | WP | YSI Exo2 | 1146 | 19.7 | 787 790.3 | 2 737 472.9 | 787 790.1 | 2 737 474.3 | |
| 29/05/2020 | 19:50:54 | SO_R1_011 | VV | SOIL | 1147 | 24.8 | 789 042.1 | 2 736 814.8 | 789 042.6 | 2 736 816.0 | |
| 29/05/2020 | 20:08:38 | R1_ENV_088 | VV | PC | 1148 | 24.9 | 789 042.1 | 2 736 814.8 | 789 042.8 | 2 736 815.3 | |
| 29/05/2020 | 20:36:17 | R1_ENV_088 | WS | NT | 1149 | 24.9 | 789 042.1 | 2 736 814.8 | 789 042.3 | 2 736 814.9 | |
| 29/05/2020 | 20:56:13 | R1_ENV_088 | WS | BOT | 1150 | 24.9 | 789 042.1 | 2 736 814.8 | 789 042.0 | 2 736 813.8 | |
| 29/05/2020 | 21:09:29 | R1_ENV_088 | WS | MID | 1151 | 24.9 | 789 042.1 | 2 736 814.8 | 789 042.8 | 2 736 814.4 | |
| 29/05/2020 | 21:20:41 | R1_ENV_088 | WS | TOP | 1152 | 24.9 | 789 042.1 | 2 736 814.8 | 789 042.3 | 2 736 813.9 | |
| 29/05/2020 | 21:33:23 | R1_ENV_088 | WP | YSI Exo2 | 1153 | 25.0 | 789 042.1 | 2 736 814.8 | 789 040.6 | 2 736 815.4 | |
| 29/05/2020 | 22:16:20 | R1_ENV_087 | VV | NS | 1154 | 20.7 | 788 384.0 | 2 735 563.0 | 788 384.6 | 2 735 562.9 | |
| 29/05/2020 | 22:20:47 | R1_ENV_087 | VV | PC | 1155 | 20.8 | 788 384.0 | 2 735 563.0 | 788 391.8 | 2 735 568.2 | |
| 29/05/2020 | 22:45:39 | R1_ENV_087 | WS | BOT | 1156 | 20.8 | 788 384.0 | 2 735 563.0 | 788 384.5 | 2 735 560.4 | |
| 29/05/2020 | 22:57:56 | R1_ENV_087 | WS | MID | 1157 | 20.8 | 788 384.0 | 2 735 563.0 | 788 387.4 | 2 735 564.2 | |
| 29/05/2020 | 23:42:13 | R1_ENV_085 | WP | YSI Exo2 | 1158 | 18.5 | 788 881.5 | 2 733 962.3 | 788 880.3 | 2 733 964.5 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 30/05/2020 | 00:00:00 | R1_ENV_085 | WS | BOT | 1159 | 18.6 | 788 881.5 | 2 733 962.3 | 788 882.1 | 2 733 962.4 | |
| 30/05/2020 | 00:09:51 | R1_ENV_085 | WS | MID | 1160 | 18.5 | 788 881.5 | 2 733 962.3 | 788 882.7 | 2 733 962.8 | |
| 30/05/2020 | 00:20:48 | R1_ENV_085 | WS | TOP | 1161 | 18.6 | 788 881.5 | 2 733 962.3 | 788 882.0 | 2 733 961.8 | |
| 30/05/2020 | 00:31:48 | R1_ENV_085 | VV | NS | 1162 | 18.4 | 788 881.5 | 2 733 962.3 | 788 881.7 | 2 733 961.8 | |
| 30/05/2020 | 00:36:25 | R1_ENV_085 | VV | NS | 1163 | 18.6 | 788 881.5 | 2 733 962.3 | 788 890.6 | 2 733 959.9 | |
| 30/05/2020 | 00:40:02 | R1_ENV_085 | VV | NS | 1164 | 18.5 | 788 881.5 | 2 733 962.3 | 788 874.7 | 2 733 967.6 | |
| 30/05/2020 | 00:58:23 | R1_ENV_087 | WS | TOP | 1165 | 21.0 | 788 384.0 | 2 735 563.0 | 788 384.0 | 2 735 564.2 | |
| 30/05/2020 | 01:01:07 | R1_ENV_087 | WP | YSI Exo2 | 1166 | 21.0 | 788 384.0 | 2 735 563.0 | 788 385.7 | 2 735 564.3 | |
| 30/05/2020 | 04:38:56 | R1_ENV_125 | WS | BOT | 1167 | 21.5 | 774 141.5 | 2 759 676.9 | 774 141.4 | 2 759 677.8 | |
| 30/05/2020 | 04:51:20 | R1_ENV_125 | WS | MID | 1168 | 21.4 | 774 141.5 | 2 759 676.9 | 774 141.6 | 2 759 677.1 | |
| 30/05/2020 | 05:02:57 | R1_ENV_125 | WS | TOP | 1169 | 21.3 | 774 141.5 | 2 759 676.9 | 774 141.2 | 2 759 676.9 | |
| 30/05/2020 | 05:42:10 | R1_ENV_125 | WP | YSI Exo2 | 1171 | 21.3 | 774 141.5 | 2 759 676.9 | 774 144.4 | 2 759 677.7 | |
| 30/05/2020 | 06:02:11 | R1_ENV_125 | VV | NS | 1172 | 21.1 | 774 141.5 | 2 759 676.9 | 774 141.5 | 2 759 676.4 | |
| 30/05/2020 | 06:09:14 | R1_ENV_125 | VV | Partial Sample | 1173 | 21.1 | 774 141.5 | 2 759 676.9 | 774 147.8 | 2 759 683.1 | PSD only |
| 30/05/2020 | 06:16:19 | R1_ENV_125 | VV | NS | 1174 | 21.1 | 774 141.5 | 2 759 676.9 | 774 144.1 | 2 759 668.5 | |
| 30/05/2020 | 06:46:07 | R1_ENV_124 | VV | NS | 1176 | 22.3 | 773 137.2 | 2 761 211.9 | 773 136.2 | 2 761 212.5 | |
| 30/05/2020 | 06:47:48 | R1_ENV_124 | VV | Partial Sample | 1177 | 22.2 | 773 137.2 | 2 761 211.9 | 773 137.0 | 2 761 220.8 | PSD only |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 30/05/2020 | 06:52:58 | R1_ENV_124 | VV | NS | 1178 | 22.2 | 773 137.2 | 2 761 211.9 | 773 133.2 | 2 761 203.8 | |
| 30/05/2020 | 07:03:02 | R1_ENV_124 | WS | BOT | 1179 | 22.2 | 773 137.2 | 2 761 211.9 | 773 137.1 | 2 761 208.5 | |
| 30/05/2020 | 07:14:09 | R1_ENV_124 | WS | MID | 1180 | 22.2 | 773 137.2 | 2 761 211.9 | 773 136.9 | 2 761 210.5 | |
| 30/05/2020 | 07:21:47 | R1_ENV_124 | WS | TOP | 1181 | 22.2 | 773 137.2 | 2 761 211.9 | 773 136.4 | 2 761 209.7 | |
| 30/05/2020 | 08:56:03 | R1_TR10 | Video | SOL | 1182 | 16.1 | 779 346.7 | 2 761 563.9 | 779 340.6 | 2 761 566.1 | |
| 30/05/2020 | 08:56:16 | R1_TR10 | Still | R1_TR10_001 | 1183 | 16.4 | - | - | 779 345.1 | 2 761 564.4 | |
| 30/05/2020 | 08:56:28 | R1_TR10 | Still | R1_TR10_002 | 1184 | 16.5 | - | - | 779 349.1 | 2 761 562.4 | |
| 30/05/2020 | 08:56:34 | R1_TR10 | Still | R1_TR10_003 | 1185 | 16.5 | - | - | 779 351.3 | 2 761 562.1 | |
| 30/05/2020 | 08:56:52 | R1_TR10 | Still | R1_TR10_004 | 1186 | 16.3 | - | - | 779 358.2 | 2 761 563.8 | |
| 30/05/2020 | 08:57:37 | R1_TR10 | Still | R1_TR10_005 | 1187 | 16.7 | - | - | 779 373.4 | 2 761 560.6 | |
| 30/05/2020 | 08:58:12 | R1_TR10 | Still | R1_TR10_006 | 1188 | 16.6 | - | - | 779 385.7 | 2 761 558.4 | |
| 30/05/2020 | 08:59:02 | R1_TR10 | Still | R1_TR10_007 | 1189 | 16.7 | - | - | 779 403.5 | 2 761 554.9 | |
| 30/05/2020 | 08:59:19 | R1_TR10 | Still | R1_TR10_008 | 1190 | 16.5 | - | - | 779 409.5 | 2 761 554.5 | |
| 30/05/2020 | 09:00:07 | R1_TR10 | Still | R1_TR10_009 | 1191 | 16.5 | - | - | 779 426.4 | 2 761 551.0 | |
| 30/05/2020 | 09:00:36 | R1_TR10 | Still | R1_TR10_010 | 1192 | 16.8 | - | - | 779 438.5 | 2 761 549.5 | |
| 30/05/2020 | 09:00:42 | R1_TR10 | Still | R1_TR10_011 | 1193 | 16.8 | - | - | 779 439.9 | 2 761 549.4 | |
| 30/05/2020 | 09:01:01 | R1_TR10 | Still | R1_TR10_012 | 1194 | 16.6 | - | - | 779 445.6 | 2 761 548.8 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 30/05/2020 | 09:01:51 | R1_TR10 | Video | EOL | 1195 | 16.4 | 779 443.5 | 2 761 547.3 | 779 465.0 | 2 761 544.1 | |
| 30/05/2020 | 10:02:58 | R1_ENV_111 | WP | YSI Exo2 | 1196 | 16.9 | 785 125.7 | 2 759 176.0 | 785 126.6 | 2 759 173.9 | |
| 30/05/2020 | 10:34:26 | R1_ENV_111 | VV | NS | 1197 | 17.0 | 785 125.7 | 2 759 176.0 | 785 125.1 | 2 759 175.2 | |
| 30/05/2020 | 10:48:04 | R1_ENV_111 | WS | BOT | 1198 | 17.0 | 785 125.7 | 2 759 176.0 | 785 125.2 | 2 759 176.6 | |
| 30/05/2020 | 10:57:11 | R1_ENV_111 | WS | MID | 1199 | 17.0 | 785 125.7 | 2 759 176.0 | 785 125.7 | 2 759 176.2 | |
| 30/05/2020 | 11:15:15 | R1_ENV_111 | WS | TOP | 1200 | 17.1 | 785 125.7 | 2 759 176.0 | 785 125.0 | 2 759 174.6 | |
| 30/05/2020 | 12:00:51 | R1_ENV_111 | VV | NS | 1201 | 17.2 | 785 125.7 | 2 759 176.0 | 785 120.3 | 2 759 182.9 | |
| 30/05/2020 | 12:03:28 | R1_ENV_111 | VV | NS | 1202 | 17.2 | 785 125.7 | 2 759 176.0 | 785 133.3 | 2 759 171.2 | |
| 30/05/2020 | 12:27:27 | R1_ENV_110 | VV | NS | 1203 | 16.5 | 786 265.5 | 2 758 337.2 | 786 265.4 | 2 758 338.4 | |
| 30/05/2020 | 12:35:03 | R1_ENV_110 | VV | NS | 1204 | 16.5 | 786 265.5 | 2 758 337.2 | 786 263.4 | 2 758 332.3 | |
| 30/05/2020 | 12:36:49 | R1_ENV_110 | VV | NS | 1205 | 16.5 | 786 265.5 | 2 758 337.2 | 786 260.0 | 2 758 345.4 | |
| 30/05/2020 | 12:49:18 | R1_ENV_110 | WP | YSI Exo2 | 1206 | 16.6 | 786 265.5 | 2 758 337.2 | 786 263.9 | 2 758 335.5 | |
| 30/05/2020 | 13:06:46 | R1_ENV_110 | WS | BOT | 1207 | 16.6 | 786 265.5 | 2 758 337.2 | 786 266.5 | 2 758 337.1 | |
| 30/05/2020 | 13:14:59 | R1_ENV_110 | WS | MID | 1208 | 16.7 | 786 265.5 | 2 758 337.2 | 786 265.3 | 2 758 337.3 | |
| 30/05/2020 | 13:21:54 | R1_ENV_110 | WS | TOP | 1209 | 16.7 | 786 265.5 | 2 758 337.2 | 786 265.9 | 2 758 336.0 | |
| 30/05/2020 | 13:52:37 | R1_ENV_109 | WP | YSI Exo2 | 1210 | 17.1 | 785 425.7 | 2 757 198.6 | 785 424.3 | 2 757 197.7 | |
| 30/05/2020 | 14:15:46 | R1_ENV_109 | WS | BOT | 1211 | 17.2 | 785 425.7 | 2 757 198.6 | 785 426.3 | 2 757 198.6 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 30/05/2020 | 14:23:33 | R1_ENV_109 | WS | MID | 1212 | 17.3 | 785 425.7 | 2 757 198.6 | 785 427.0 | 2 757 198.5 | |
| 30/05/2020 | 14:30:18 | R1_ENV_109 | WS | TOP | 1213 | 17.3 | 785 425.7 | 2 757 198.6 | 785 426.3 | 2 757 198.1 | |
| 30/05/2020 | 14:36:45 | R1_ENV_109 | VV | NS | 1214 | 17.3 | 785 425.7 | 2 757 198.6 | 785 427.9 | 2 757 197.9 | |
| 30/05/2020 | 14:40:04 | R1_ENV_109 | VV | Partial Sample | 1215 | 17.3 | 785 425.7 | 2 757 198.6 | 785 428.8 | 2 757 191.4 | |
| 30/05/2020 | 14:46:13 | R1_ENV_109 | VV | Partial Sample | 1216 | 17.3 | 785 425.7 | 2 757 198.6 | 785 424.2 | 2 757 205.9 | |
| 30/05/2020 | 17:30:12 | R1_ENV_086 | VV | PC | 1217 | 18.7 | 789 635.7 | 2 734 904.9 | 789 635.0 | 2 734 905.0 | |
| 30/05/2020 | 17:47:53 | R1_ENV_086 | WS | BOT | 1218 | 18.8 | 789 635.7 | 2 734 904.9 | 789 635.1 | 2 734 903.7 | |
| 30/05/2020 | 17:57:17 | R1_ENV_086 | WS | MID | 1219 | 18.7 | 789 635.7 | 2 734 904.9 | 789 635.5 | 2 734 907.2 | |
| 30/05/2020 | 18:07:56 | R1_ENV_086 | WS | TOP | 1220 | 18.7 | 789 635.7 | 2 734 904.9 | 789 635.5 | 2 734 905.4 | |
| 30/05/2020 | 18:24:12 | R1_ENV_086 | WP | YSI Exo2 | 1221 | 18.7 | 789 635.7 | 2 734 904.9 | 789 632.9 | 2 734 905.2 | |
| 30/05/2020 | 19:15:46 | R1_ENV_084 | WS | BOT | 1222 | 18.2 | 790 229.4 | 2 732 995.0 | 790 229.4 | 2 732 995.1 | |
| 30/05/2020 | 19:29:13 | R1_ENV_084 | WS | MID | 1223 | 18.3 | 790 229.4 | 2 732 995.0 | 790 228.5 | 2 732 995.6 | |
| 30/05/2020 | 19:40:05 | R1_ENV_084 | WS | TOP | 1224 | 18.2 | 790 229.4 | 2 732 995.0 | 790 229.8 | 2 732 993.8 | |
| 30/05/2020 | 19:52:23 | R1_ENV_084 | VV | PC | 1225 | 18.3 | 790 229.4 | 2 732 995.0 | 790 229.5 | 2 732 994.6 | |
| 30/05/2020 | 20:15:42 | R1_ENV_084 | WP | YSI Exo2 | 1226 | 18.3 | 790 229.4 | 2 732 995.0 | 790 228.2 | 2 732 996.8 | |
| 30/05/2020 | 20:52:50 | R1_ENV_083 | VV | PC | 1227 | 19.2 | 789 571.2 | 2 731 743.3 | 789 396.8 | 2 732 329.4 | Station moved as proposed location was within 200 m of infrastructure |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 30/05/2020 | 21:29:09 | R1_ENV_083 | WS | BOT | 1228 | 19.3 | 789 571.2 | 2 731 743.3 | 789 397.1 | 2 732 329.7 | |
| 30/05/2020 | 21:40:43 | R1_ENV_083 | WS | MID | 1229 | 19.3 | 789 571.2 | 2 731 743.3 | 789 396.3 | 2 732 329.7 | |
| 30/05/2020 | 21:53:00 | R1_ENV_083 | WS | TOP | 1230 | 19.3 | 789 571.2 | 2 731 743.3 | 789 396.4 | 2 732 329.6 | |
| 30/05/2020 | 22:10:12 | R1_ENV_083 | WP | YSI Exo2 | 1231 | 19.2 | 789 571.2 | 2 731 743.3 | 789 396.7 | 2 732 328.2 | |
| 30/05/2020 | 22:56:47 | R1_ENV_082 | WS | BOT | 1232 | 17.9 | 790 823.0 | 2 731 085.2 | 790 822.9 | 2 731 084.7 | |
| 30/05/2020 | 23:07:57 | R1_ENV_082 | WS | MID | 1233 | 17.7 | 790 823.0 | 2 731 085.2 | 790 823.3 | 2 731 086.3 | |
| 30/05/2020 | 23:19:59 | R1_ENV_082 | WS | TOP | 1234 | 17.6 | 790 823.0 | 2 731 085.2 | 790 823.0 | 2 731 085.3 | |
| 30/05/2020 | 23:29:30 | R1_ENV_082 | VV | NS | 1235 | 17.8 | 790 823.0 | 2 731 085.2 | 790 821.9 | 2 731 085.0 | |
| 30/05/2020 | 23:34:28 | R1_ENV_082 | VV | NS | 1236 | 17.7 | 790 823.0 | 2 731 085.2 | 790 830.0 | 2 731 077.9 | |
| 30/05/2020 | 23:43:33 | R1_ENV_082 | VV | PC | 1237 | 17.7 | 790 823.0 | 2 731 085.2 | 790 816.1 | 2 731 090.5 | |
| 31/05/2020 | 00:22:35 | R1_ENV_082 | WP | YSI Exo2 | 1238 | 17.7 | 790 823.0 | 2 731 085.2 | 790 823.9 | 2 731 086.0 | |
| 31/05/2020 | 00:54:58 | R1_ENV_081 | WS | BOT | 1239 | 15.4 | 790 164.9 | 2 729 833.4 | 790 164.9 | 2 729 832.5 | |
| 31/05/2020 | 01:07:56 | R1_ENV_081 | WS | MID | 1240 | 15.5 | 790 164.9 | 2 729 833.4 | 790 165.1 | 2 729 832.8 | |
| 31/05/2020 | 01:20:52 | R1_ENV_081 | WS | TOP | 1241 | 15.5 | 790 164.9 | 2 729 833.4 | 790 165.8 | 2 729 832.8 | |
| 31/05/2020 | 01:30:28 | R1_ENV_081 | VV | PC | 1242 | 15.4 | 790 164.9 | 2 729 833.4 | 790 164.9 | 2 729 832.1 | |
| 31/05/2020 | 03:58:38 | R1_ENV_097 | VV | PC | 1243 | 10.2 | 785 770.7 | 2 745 324.1 | 785 768.5 | 2 745 325.7 | |
| 31/05/2020 | 04:29:35 | R1_ENV_097 | WS | BOT | 1244 | 10.1 | 785 770.7 | 2 745 324.1 | 785 770.8 | 2 745 324.3 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 31/05/2020 | 04:36:07 | R1_ENV_097 | WS | MID | 1245 | 10.1 | 785 770.7 | 2 745 324.1 | 785 770.1 | 2 745 324.0 | |
| 31/05/2020 | 04:43:23 | R1_ENV_097 | WS | TOP | 1246 | 10.0 | 785 770.7 | 2 745 324.1 | 785 770.1 | 2 745 323.7 | |
| 31/05/2020 | 05:00:45 | R1_ENV_097 | WP | YSI Exo2 | 1247 | 10.0 | 785 770.7 | 2 745 324.1 | 785 772.0 | 2 745 323.5 | |
| 31/05/2020 | 09:10:14 | R1_ENV_098 | WS | BOT | 1248 | 9.7 | 786 790.2 | 2 746 304.2 | 786 790.3 | 2 746 304.6 | |
| 31/05/2020 | 09:20:37 | R1_ENV_098 | WS | TOP | 1249 | 9.7 | 786 790.2 | 2 746 304.2 | 786 791.1 | 2 746 304.2 | |
| 31/05/2020 | 09:38:09 | R1_ENV_098 | WP | YSI Exo2 | 1250 | 9.7 | 786 790.2 | 2 746 304.2 | 786 789.2 | 2 746 303.3 | |
| 31/05/2020 | 09:48:00 | R1_ENV_098 | VV | NS | 1251 | 9.7 | 786 790.2 | 2 746 304.2 | 786 789.3 | 2 746 305.6 | |
| 31/05/2020 | 09:54:20 | R1_ENV_098 | VV | NS | 1252 | 9.6 | 786 790.2 | 2 746 304.2 | 786 782.9 | 2 746 297.5 | |
| 31/05/2020 | 09:57:30 | R1_ENV_098 | VV | NS | 1253 | 9.7 | 786 790.2 | 2 746 304.2 | 786 794.0 | 2 746 312.5 | |
| 31/05/2020 | 10:26:46 | R1_ENV_099 | VV | PC | 1254 | 8.9 | 785 810.1 | 2 747 323.7 | 785 809.0 | 2 747 324.1 | |
| 31/05/2020 | 10:51:53 | R1_ENV_099 | WS | BOT | 1255 | 9.0 | 785 810.1 | 2 747 323.7 | 785 811.1 | 2 747 323.5 | |
| 31/05/2020 | 10:59:41 | R1_ENV_099 | WS | TOP | 1256 | 9.0 | 785 810.1 | 2 747 323.7 | 785 810.2 | 2 747 324.1 | |
| 31/05/2020 | 11:36:17 | R1_ENV_099 | WP | YSI Exo2 | 1258 | 9.2 | 785 810.1 | 2 747 323.7 | 785 809.0 | 2 747 321.4 | |
| 31/05/2020 | 12:17:18 | R1_ENV_101 | WS | BOT | 1259 | 10.2 | 785 849.5 | 2 749 323.3 | 785 849.1 | 2 749 323.1 | |
| 31/05/2020 | 12:28:07 | R1_ENV_101 | WS | MID | 1260 | 10.3 | 785 849.5 | 2 749 323.3 | 785 847.8 | 2 749 322.1 | |
| 31/05/2020 | 12:37:31 | R1_ENV_101 | WS | TOP | 1261 | 10.3 | 785 849.5 | 2 749 323.3 | 785 849.1 | 2 749 323.2 | |
| 31/05/2020 | 12:58:55 | R1_ENV_101 | WP | YSI Exo2 | 1262 | 10.3 | 785 849.5 | 2 749 323.3 | 785 848.3 | 2 749 323.5 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 31/05/2020 | 13:11:48 | R1_ENV_101 | VV | NS | 1263 | 10.3 | 785 849.5 | 2 749 323.3 | 785 851.4 | 2 749 324.7 | |
| 31/05/2020 | 13:19:10 | R1_ENV_101 | VV | NS | 1264 | 10.4 | 785 849.5 | 2 749 323.3 | 785 844.9 | 2 749 331.6 | |
| 31/05/2020 | 13:23:15 | R1_ENV_101 | VV | NS | 1265 | 10.4 | 785 849.5 | 2 749 323.3 | 785 852.0 | 2 749 315.1 | |
| 31/05/2020 | 14:52:04 | R1_ENV_095 | VV | PC | 1266 | 16.6 | 786 009.4 | 2 743 202.5 | 786 009.9 | 2 743 200.7 | |
| 31/05/2020 | 14:56:21 | R1_ENV_095 | WS | BOT | 1267 | 16.6 | 786 009.4 | 2 743 202.5 | 786 009.1 | 2 743 199.9 | |
| 31/05/2020 | 15:09:07 | R1_ENV_095 | WS | MID | 1268 | 16.6 | 786 009.4 | 2 743 202.5 | 786 009.6 | 2 743 201.1 | |
| 31/05/2020 | 21:31:00 | R1_ENV_081 | WP | YSI Exo2 | 1269 | 14.9 | 790 164.9 | 2 729 833.4 | 790 167.0 | 2 729 833.9 | |
| 31/05/2020 | 22:03:17 | SO_R1_010 | VV | NS | 1270 | 20.4 | 791 416.6 | 2 729 175.3 | 791 415.3 | 2 729 176.5 | |
| 31/05/2020 | 22:08:03 | SO_R1_010 | VV | SOIL | 1271 | 20.5 | 791 416.6 | 2 729 175.3 | 791 412.5 | 2 729 165.9 | |
| 31/05/2020 | 22:23:02 | R1_ENV_080 | VV | PC | 1272 | 20.4 | 791 416.6 | 2 729 175.3 | 791 415.2 | 2 729 175.1 | |
| 31/05/2020 | 22:45:05 | R1_ENV_080 | WS | BOT | 1273 | 20.4 | 791 416.6 | 2 729 175.3 | 791 415.9 | 2 729 175.3 | |
| 31/05/2020 | 22:58:18 | R1_ENV_080 | WS | MID | 1274 | 20.5 | 791 416.6 | 2 729 175.3 | 791 415.3 | 2 729 175.2 | |
| 31/05/2020 | 23:11:49 | R1_ENV_080 | WS | TOP | 1275 | 20.4 | 791 416.6 | 2 729 175.3 | 791 415.8 | 2 729 176.1 | |
| 31/05/2020 | 23:23:47 | R1_ENV_080 | WP | YSI Exo2 | 1276 | 20.5 | 791 416.6 | 2 729 175.3 | 791 417.5 | 2 729 173.6 | |
| 01/06/2020 | 00:05:37 | R1_ENV_079 | VV | PC | 1277 | 19.9 | 790 758.5 | 2 727 923.5 | 790 757.8 | 2 727 923.5 | |
| 01/06/2020 | 00:22:38 | R1_ENV_079 | WS | BOT | 1278 | 19.9 | 790 758.5 | 2 727 923.5 | 790 757.9 | 2 727 924.6 | |
| 01/06/2020 | 00:32:31 | R1_ENV_079 | WS | MID | 1279 | 19.9 | 790 758.5 | 2 727 923.5 | 790 758.2 | 2 727 923.5 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 01/06/2020 | 00:43:12 | R1_ENV_079 | WS | TOP | 1280 | 19.9 | 790 758.5 | 2 727 923.5 | 790 757.6 | 2 727 923.6 | |
| 01/06/2020 | 02:52:13 | R1_ENV_095 | WS | TOP | 1281 | 16.6 | 786 009.4 | 2 743 202.5 | 786 010.0 | 2 743 203.2 | |
| 01/06/2020 | 03:44:01 | R1_ENV_095 | WP | YSI Exo2 | 1283 | 16.7 | 786 009.4 | 2 743 202.5 | 786 012.0 | 2 743 206.2 | |
| 01/06/2020 | 04:32:35 | R1_TR09 | Video | SOL | 1284 | 12.7 | 786 713.4 | 2 744 250.3 | 786 709.7 | 2 744 249.1 | |
| 01/06/2020 | 04:32:49 | R1_TR09 | Still | R1_TR09_001 | 1285 | 12.6 | - | - | 786 711.7 | 2 744 251.7 | |
| 01/06/2020 | 04:33:34 | R1_TR09 | Still | R1_TR09_002 | 1286 | 12.6 | - | - | 786 722.0 | 2 744 256.0 | |
| 01/06/2020 | 04:33:40 | R1_TR09 | Still | R1_TR09_003 | 1287 | 12.7 | - | - | 786 723.0 | 2 744 256.5 | |
| 01/06/2020 | 04:33:41 | R1_TR09 | Still | R1_TR09_004 | 1288 | 12.7 | - | - | 786 723.7 | 2 744 257.0 | |
| 01/06/2020 | 04:33:48 | R1_TR09 | Still | R1_TR09_005 | 1289 | 12.6 | - | - | 786 725.4 | 2 744 258.1 | |
| 01/06/2020 | 04:33:55 | R1_TR09 | Still | R1_TR09_006 | 1290 | 12.7 | - | - | 786 727.0 | 2 744 259.5 | |
| 01/06/2020 | 04:34:21 | R1_TR09 | Still | R1_TR09_007 | 1291 | 12.6 | - | - | 786 735.7 | 2 744 263.4 | |
| 01/06/2020 | 04:34:27 | R1_TR09 | Still | R1_TR09_008 | 1292 | 12.6 | - | - | 786 736.5 | 2 744 263.7 | |
| 01/06/2020 | 04:34:49 | R1_TR09 | Still | R1_TR09_009 | 1293 | 12.6 | - | - | 786 740.6 | 2 744 266.7 | |
| 01/06/2020 | 04:35:13 | R1_TR09 | Still | R1_TR09_010 | 1294 | 12.6 | - | - | 786 745.0 | 2 744 270.1 | |
| 01/06/2020 | 04:35:20 | R1_TR09 | Still | R1_TR09_011 | 1295 | 12.6 | - | - | 786 746.3 | 2 744 277.4 | |
| 01/06/2020 | 04:35:58 | R1_TR09 | Still | R1_TR09_012 | 1296 | 12.6 | - | - | 786 754.7 | 2 744 274.7 | |
| 01/06/2020 | 04:36:37 | R1_TR09 | Still | R1_TR09_013 | 1297 | 12.6 | - | - | 786 762.3 | 2 744 278.7 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 01/06/2020 | 04:36:42 | R1_TR09 | Still | R1_TR09_014 | 1298 | 12.6 | - | - | 786 763.5 | 2 744 279.6 | |
| 01/06/2020 | 04:37:01 | R1_TR09 | Still | R1_TR09_015 | 1299 | 12.6 | - | - | 786 768.3 | 2 744 283.1 | |
| 01/06/2020 | 04:37:05 | R1_TR09 | Still | R1_TR09_016 | 1300 | 12.6 | - | - | 786 769.5 | 2 744 283.4 | |
| 01/06/2020 | 04:37:33 | R1_TR09 | Still | R1_TR09_017 | 1301 | 12.6 | - | - | 786 776.8 | 2 744 288.2 | |
| 01/06/2020 | 04:37:38 | R1_TR09 | Still | R1_TR09_018 | 1302 | 12.6 | - | - | 786 777.4 | 2 744 288.9 | |
| 01/06/2020 | 04:37:54 | R1_TR09 | Still | R1_TR09_019 | 1303 | 12.6 | - | - | 786 782.2 | 2 744 289.8 | |
| 01/06/2020 | 04:38:27 | R1_TR09 | Still | R1_TR09_020 | 1304 | 12.6 | - | - | 786 788.4 | 2 744 294.5 | |
| 01/06/2020 | 04:38:56 | R1_TR09 | Still | R1_TR09_021 | 1305 | 12.5 | - | - | 786 794.7 | 2 744 298.3 | |
| 01/06/2020 | 04:38:59 | R1_TR09 | Still | R1_TR09_022 | 1306 | 12.5 | - | - | 786 795.4 | 2 744 298.6 | |
| 01/06/2020 | 04:39:06 | R1_TR09 | Still | R1_TR09_023 | 1307 | 12.6 | - | - | 786 797.2 | 2 744 299.3 | |
| 01/06/2020 | 04:39:59 | R1_TR09 | Still | R1_TR09_024 | 1308 | 12.3 | - | - | 786 809.4 | 2 744 306.0 | |
| 01/06/2020 | 04:40:05 | R1_TR09 | Video | EOL | 1309 | 12.5 | 786 810.6 | 2 744 305.3 | 786 810.8 | 2 744 306.9 | |
| 01/06/2020 | 04:59:31 | R1_ENV_096 | WS | BOT | 1310 | 12.1 | 786 750.8 | 2 744 304.6 | 786 749.7 | 2 744 305.5 | |
| 01/06/2020 | 05:06:05 | R1_ENV_096 | WS | MID | 1311 | 12.2 | 786 750.8 | 2 744 304.6 | 786 747.0 | 2 744 301.8 | |
| 01/06/2020 | 05:12:09 | R1_ENV_096 | WS | TOP | 1312 | 12.2 | 786 750.8 | 2 744 304.6 | 786 748.3 | 2 744 302.9 | |
| 01/06/2020 | 05:26:00 | R1_ENV_096 | WP | YSI Exo2 | 1313 | 12.0 | 786 750.8 | 2 744 304.6 | 786 749.3 | 2 744 302.9 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 01/06/2020 | 05:44:28 | R1_ENV_096 | VV | PC | 1314 | 11.3 | 786 750.8 | 2 744 304.6 | 786 757.9 | 2 744 407.7 | Moved due to seabed gas seeps |
| 01/06/2020 | 10:53:35 | R1_ENV_108 | VV | NS | 1315 | 14.7 | 786 565.0 | 2 756 359.7 | 786 566.4 | 2 756 361.7 | |
| 01/06/2020 | 10:57:10 | R1_ENV_108 | VV | NS | 1316 | 14.9 | 786 565.0 | 2 756 359.7 | 786 558.6 | 2 756 366.6 | |
| 01/06/2020 | 11:01:27 | R1_ENV_108 | VV | NS | 1317 | 14.6 | 786 565.0 | 2 756 359.7 | 786 572.6 | 2 756 355.4 | |
| 01/06/2020 | 11:12:20 | R1_ENV_108 | WP | YSI Exo2 | 1318 | 14.7 | 786 565.0 | 2 756 359.7 | 786 565.4 | 2 756 359.3 | |
| 01/06/2020 | 11:27:27 | R1_ENV_108 | WS | BOT | 1319 | 14.7 | 786 565.0 | 2 756 359.7 | 786 565.4 | 2 756 359.6 | |
| 01/06/2020 | 11:38:07 | R1_ENV_108 | WS | MID | 1320 | 14.8 | 786 565.0 | 2 756 359.7 | 786 566.4 | 2 756 359.8 | |
| 01/06/2020 | 11:49:04 | R1_ENV_108 | WS | TOP | 1321 | 14.7 | 786 565.0 | 2 756 359.7 | 786 567.0 | 2 756 359.2 | |
| 01/06/2020 | 12:19:44 | R1_ENV_106 | WS | BOT | 1322 | 14.2 | 786 864.4 | 2 754 382.3 | 786 864.1 | 2 754 382.9 | |
| 01/06/2020 | 12:26:45 | R1_ENV_106 | WS | MID | 1323 | 13.9 | 786 864.4 | 2 754 382.3 | 786 866.0 | 2 754 382.6 | |
| 01/06/2020 | 12:36:46 | R1_ENV_106 | WS | TOP | 1324 | 14.0 | 786 864.4 | 2 754 382.3 | 786 865.2 | 2 754 382.0 | |
| 01/06/2020 | 13:00:48 | R1_ENV_105 | WS | BOT | 1325 | 13.5 | 785 928.2 | 2 753 314.2 | 785 929.1 | 2 753 313.6 | |
| 01/06/2020 | 13:06:57 | R1_ENV_105 | WS | MID | 1326 | 13.5 | 785 928.2 | 2 753 314.2 | 785 927.9 | 2 753 313.8 | |
| 01/06/2020 | 13:12:57 | R1_ENV_105 | WS | TOP | 1327 | 13.5 | 785 928.2 | 2 753 314.2 | 785 927.8 | 2 753 315.1 | |
| 01/06/2020 | 13:20:53 | R1_ENV_105 | VV | NS | 1328 | 13.4 | 785 928.2 | 2 753 314.2 | 785 927.8 | 2 753 316.1 | |
| 01/06/2020 | 13:22:48 | R1_ENV_105 | VV | NS | 1329 | 13.4 | 785 928.2 | 2 753 314.2 | 785 923.2 | 2 753 322.5 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 01/06/2020 | 13:28:00 | R1_ENV_105 | VV | NS | 1330 | 13.5 | 785 928.2 | 2 753 314.2 | 785 931.4 | 2 753 306.7 | |
| 01/06/2020 | 13:42:52 | R1_ENV_105 | WP | YSI Exo2 | 1331 | 13.6 | 785 928.2 | 2 753 314.2 | 785 926.6 | 2 753 312.4 | |
| 01/06/2020 | 14:43:58 | R1_ENV_104 | WS | BOT | 1332 | 15.2 | 786 908.3 | 2 752 303.1 | 786 908.8 | 2 752 302.9 | |
| 01/06/2020 | 14:55:56 | R1_ENV_104 | WS | MID | 1333 | 15.1 | 786 908.3 | 2 752 303.1 | 786 910.4 | 2 752 301.5 | |
| 01/06/2020 | 17:58:16 | R1_ENV_079 | WP | YSI Exo2 | 1334 | 20.2 | 790 758.5 | 2 727 923.5 | 790 760.1 | 2 727 922.4 | Data not accepted |
| 01/06/2020 | 18:24:13 | R1_ENV_079a | WP | YSI Exo2 | 1335 | 20.2 | 790 758.5 | 2 727 923.5 | 790 761.1 | 2 727 921.7 | |
| 01/06/2020 | 19:02:57 | R1_ENV_078 | WS | BOT | 1336 | 20.1 | 792 010.3 | 2 727 265.4 | 792 012.1 | 2 727 266.5 | |
| 01/06/2020 | 19:11:16 | R1_ENV_078 | WS | MID | 1337 | 20.1 | 792 010.3 | 2 727 265.4 | 792 013.8 | 2 727 264.6 | |
| 01/06/2020 | 19:19:08 | R1_ENV_078 | WS | TOP | 1338 | 20.1 | 792 010.3 | 2 727 265.4 | 792 009.7 | 2 727 264.2 | |
| 01/06/2020 | 19:27:29 | R1_ENV_078 | VV | NS | 1339 | 20.2 | 792 010.3 | 2 727 265.4 | 792 009.5 | 2 727 264.3 | |
| 01/06/2020 | 19:35:47 | R1_ENV_078 | VV | PC | 1340 | 20.0 | 792 010.3 | 2 727 265.4 | 792 019.0 | 2 727 262.8 | |
| 01/06/2020 | 19:57:36 | R1_ENV_078 | WP | YSI Exo2 | 1341 | 20.0 | 792 010.3 | 2 727 265.4 | 792 010.2 | 2 727 268.4 | |
| 01/06/2020 | 20:41:57 | R1_ENV_077 | VV | Partial Sample | 1342 | 18.2 | 791 352.1 | 2 726 013.7 | 791 351.9 | 2 726 012.6 | PSD only |
| 01/06/2020 | 20:47:21 | R1_ENV_077 | VV | NS | 1343 | 18.2 | 791 352.1 | 2 726 013.7 | 791 345.3 | 2 726 019.7 | |
| 01/06/2020 | 20:50:24 | R1_ENV_077 | VV | Partial Sample | 1344 | 18.2 | 791 352.1 | 2 726 013.7 | 791 357.8 | 2 726 005.4 | PSD only |
| 01/06/2020 | 21:02:02 | R1_ENV_077 | WS | BOT | 1345 | 18.1 | 791 352.1 | 2 726 013.7 | 791 351.3 | 2 726 012.6 | |
| 01/06/2020 | 21:13:26 | R1_ENV_077 | WS | MID | 1346 | 18.1 | 791 352.1 | 2 726 013.7 | 791 352.0 | 2 726 013.8 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 01/06/2020 | 21:25:41 | R1_ENV_077 | WS | TOP | 1347 | 18.1 | 791 352.1 | 2 726 013.7 | 791 352.2 | 2 726 013.4 | |
| 01/06/2020 | 21:39:22 | R1_ENV_077 | WP | YSI Exo2 | 1348 | 18.1 | 791 352.1 | 2 726 013.7 | 791 353.2 | 2 726 014.0 | |
| 01/06/2020 | 22:20:41 | R1_ENV_076 | VV | PC | 1349 | 22.1 | 792 603.9 | 2 725 355.5 | 792 603.9 | 2 725 355.0 | |
| 01/06/2020 | 22:43:01 | R1_ENV_076 | WS | BOT | 1350 | 22.1 | 792 603.9 | 2 725 355.5 | 792 604.1 | 2 725 355.4 | |
| 01/06/2020 | 22:56:51 | R1_ENV_076 | WS | MID | 1351 | 22.1 | 792 603.9 | 2 725 355.5 | 792 604.0 | 2 725 355.0 | |
| 01/06/2020 | 23:06:01 | R1_ENV_076 | WS | TOP | 1352 | 22.0 | 792 603.9 | 2 725 355.5 | 792 604.0 | 2 725 355.3 | |
| 01/06/2020 | 23:18:46 | R1_ENV_076 | WP | YSI Exo2 | 1353 | 22.0 | 792 603.9 | 2 725 355.5 | 792 603.7 | 2 725 355.2 | |
| 01/06/2020 | 23:59:09 | R1_ENV_075 | VV | PC | 1354 | 23.1 | 791 945.8 | 2 724 103.8 | 791 945.4 | 2 724 102.9 | |
| 02/06/2020 | 00:26:12 | R1_ENV_075 | WS | BOT | 1355 | 23.1 | 791 945.8 | 2 724 103.8 | 791 946.6 | 2 724 103.1 | |
| 02/06/2020 | 00:42:18 | R1_ENV_075 | WS | MID | 1356 | 23.2 | 791 945.8 | 2 724 103.8 | 791 946.0 | 2 724 103.2 | |
| 02/06/2020 | 00:55:08 | R1_ENV_075 | WS | TOP | 1357 | 23.1 | 791 945.8 | 2 724 103.8 | 791 945.9 | 2 724 103.0 | |
| 02/06/2020 | 01:07:03 | R1_ENV_075 | WP | YSI Exo2 | 1358 | 23.3 | 791 945.8 | 2 724 103.8 | 791 947.3 | 2 724 104.9 | |
| 02/06/2020 | 01:42:24 | R1_ENV_074 | WP | YSI Exo2 | 1359 | 24.4 | 793 197.5 | 2 723 445.7 | 793 199.8 | 2 723 444.9 | |
| 02/06/2020 | 02:34:41 | R1_ENV_074 | WS | BOT | 1360 | 24.5 | 793 197.5 | 2 723 445.7 | 793 196.8 | 2 723 445.3 | |
| 02/06/2020 | 02:44:29 | R1_ENV_074 | WS | MID | 1361 | 24.5 | 793 197.5 | 2 723 445.7 | 793 197.5 | 2 723 448.2 | |
| 02/06/2020 | 02:55:37 | R1_ENV_074 | WS | TOP | 1362 | 24.6 | 793 197.5 | 2 723 445.7 | 793 196.7 | 2 723 444.9 | |
| 02/06/2020 | 03:09:32 | R1_ENV_074 | VV | PC | 1363 | 24.5 | 793 197.5 | 2 723 445.7 | 793 197.0 | 2 723 444.5 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 02/06/2020 | 03:51:36 | R1_ENV_073 | VV | PC | 1364 | 23.8 | 792 073.9 | 2 722 461.2 | 792 073.3 | 2 722 462.6 | |
| 02/06/2020 | 09:57:47 | R1_ENV_073 | WP | YSI Exo2 | 1365 | 23.1 | 792 073.9 | 2 722 461.2 | 792 073.8 | 2 722 459.7 | Data not accepted |
| 02/06/2020 | 11:14:21 | R1_ENV_073a | WP | YSI Exo2 | 1366 | 23.2 | 792 073.9 | 2 722 461.2 | 792 072.3 | 2 722 461.1 | Data not accepted |
| 02/06/2020 | 12:14:28 | R1_ENV_073b | WP | YSI Exo2 | 1367 | 23.1 | 792 073.9 | 2 722 461.2 | 792 073.1 | 2 722 459.3 | Data not accepted |
| 02/06/2020 | 12:34:05 | R1_ENV_073c | WP | YSI Exo2 | 1368 | 23.1 | 792 073.9 | 2 722 461.2 | 792 072.4 | 2 722 459.7 | Data not accepted |
| 02/06/2020 | 12:54:51 | R1_ENV_073d | WP | YSI Exo2 | 1369 | 23.1 | 792 073.9 | 2 722 461.2 | 792 071.4 | 2 722 462.8 | |
| 02/06/2020 | 13:22:21 | R1_ENV_073 | WS | BOT | 1370 | 23.3 | 792 073.9 | 2 722 461.2 | 792 075.0 | 2 722 460.8 | |
| 02/06/2020 | 13:30:32 | R1_ENV_073 | WS | MID | 1371 | 23.3 | 792 073.9 | 2 722 461.2 | 792 075.0 | 2 722 459.9 | |
| 02/06/2020 | 13:37:56 | R1_ENV_073 | WS | TOP | 1372 | 23.4 | 792 073.9 | 2 722 461.2 | 792 073.5 | 2 722 461.1 | |
| 02/06/2020 | 14:47:40 | R1_ENV_072 | VV | PC | 1373 | 25.4 | 792 783.6 | 2 721 237.9 | 792 783.9 | 2 721 238.6 | |
| 02/06/2020 | 15:12:22 | SO_R1_009 | VV | SOIL | 1374 | 25.4 | 792 783.6 | 2 721 237.9 | 792 783.7 | 2 721 238.9 | |
| 02/06/2020 | 15:36:02 | R1_ENV_072 | WS | BOT | 1375 | 25.5 | 792 783.6 | 2 721 237.9 | 792 783.6 | 2 721 239.0 | |
| 02/06/2020 | 15:47:34 | R1_ENV_072 | WS | MID | 1376 | 25.5 | 792 783.6 | 2 721 237.9 | 792 783.2 | 2 721 238.3 | |
| 02/06/2020 | 15:58:05 | R1_ENV_072 | WS | TOP | 1377 | 25.5 | 792 783.6 | 2 721 237.9 | 792 783.7 | 2 721 237.7 | |
| 02/06/2020 | 16:21:41 | R1_ENV_072 | WP | YSI Exo2 | 1378 | 25.6 | 792 783.6 | 2 721 237.9 | 792 781.5 | 2 721 238.2 | |
| 02/06/2020 | 17:07:38 | R1_ENV_071 | VV | NS | 1379 | 23.3 | 791 560.3 | 2 720 528.3 | 791 558.9 | 2 720 528.1 | |
| 02/06/2020 | 17:14:03 | R1_ENV_071 | VV | PC | 1380 | 23.4 | 791 560.3 | 2 720 528.3 | 791 561.8 | 2 720 521.1 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 02/06/2020 | 17:38:11 | R1_ENV_071 | WS | BOT | 1381 | 23.4 | 791 560.3 | 2 720 528.3 | 791 560.0 | 2 720 529.0 | |
| 02/06/2020 | 17:46:57 | R1_ENV_071 | WS | MID | 1382 | 23.4 | 791 560.3 | 2 720 528.3 | 791 560.4 | 2 720 528.6 | |
| 02/06/2020 | 17:54:57 | R1_ENV_071 | WS | TOP | 1383 | 23.5 | 791 560.3 | 2 720 528.3 | 791 561.3 | 2 720 528.0 | |
| 02/06/2020 | 18:08:19 | R1_ENV_071 | WP | YSI Exo2 | 1384 | 23.5 | 791 560.3 | 2 720 528.3 | 791 558.4 | 2 720 529.3 | |
| 02/06/2020 | 19:05:19 | R1_ENV_070 | VV | NS | 1385 | 24.1 | 792 269.9 | 2 719 305.0 | 792 270.2 | 2 719 304.6 | |
| 02/06/2020 | 19:08:46 | R1_ENV_070 | VV | PC | 1386 | 24.1 | 792 269.9 | 2 719 305.0 | 792 262.3 | 2 719 300.8 | |
| 02/06/2020 | 19:29:45 | R1_ENV_070 | WS | BOT | 1387 | 24.0 | 792 269.9 | 2 719 305.0 | 792 269.4 | 2 719 304.7 | |
| 02/06/2020 | 19:39:24 | R1_ENV_070 | WS | MID | 1388 | 24.0 | 792 269.9 | 2 719 305.0 | 792 270.1 | 2 719 304.3 | |
| 02/06/2020 | 19:49:18 | R1_ENV_070 | WS | TOP | 1389 | 24.0 | 792 269.9 | 2 719 305.0 | 792 269.2 | 2 719 304.0 | |
| 02/06/2020 | 20:02:00 | R1_ENV_070 | WP | YSI Exo2 | 1390 | 24.0 | 792 269.9 | 2 719 305.0 | 792 268.5 | 2 719 304.2 | Data not accepted |
| 02/06/2020 | 20:24:08 | R1_ENV_070a | WP | YSI Exo2 | 1391 | 23.9 | 792 269.9 | 2 719 305.0 | 792 271.1 | 2 719 307.3 | |
| 02/06/2020 | 21:06:01 | R1_ENV_069 | VV | NS | 1392 | 20.8 | 791 046.6 | 2 718 595.3 | 791 046.0 | 2 718 594.1 | |
| 02/06/2020 | 21:10:03 | R1_ENV_069 | VV | PC | 1393 | 20.9 | 791 046.6 | 2 718 595.3 | 791 038.4 | 2 718 601.0 | |
| 02/06/2020 | 21:32:13 | R1_ENV_069 | WS | BOT | 1394 | 20.7 | 791 046.6 | 2 718 595.3 | 791 046.3 | 2 718 594.4 | One bottle open |
| 02/06/2020 | 21:42:36 | R1_ENV_069 | WS | BOT | 1395 | 20.7 | 791 046.6 | 2 718 595.3 | 791 046.5 | 2 718 595.2 | |
| 02/06/2020 | 21:50:49 | R1_ENV_069 | WS | MID | 1396 | 20.6 | 791 046.6 | 2 718 595.3 | 791 046.9 | 2 718 594.9 | |
| 02/06/2020 | 21:58:33 | R1_ENV_069 | WS | TOP | 1397 | 20.5 | 791 046.6 | 2 718 595.3 | 791 047.1 | 2 718 595.2 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 02/06/2020 | 22:11:52 | R1_ENV_069 | WP | YSI Exo2 | 1398 | 20.6 | 791 046.6 | 2 718 595.3 | 791 048.0 | 2 718 595.3 | |
| 02/06/2020 | 22:54:32 | R1_ENV_068 | VV | NS | 1399 | 22.4 | 791 756.3 | 2 717 372.1 | 791 755.8 | 2 717 371.0 | |
| 02/06/2020 | 22:58:13 | R1_ENV_068 | VV | PC | 1400 | 22.5 | 791 756.3 | 2 717 372.1 | 791 751.4 | 2 717 380.0 | |
| 02/06/2020 | 23:27:01 | R1_ENV_068 | WS | BOT | 1401 | 22.3 | 791 756.3 | 2 717 372.1 | 791 756.0 | 2 717 371.1 | |
| 02/06/2020 | 23:37:06 | R1_ENV_068 | WS | MID | 1402 | 22.3 | 791 756.3 | 2 717 372.1 | 791 755.4 | 2 717 371.5 | |
| 02/06/2020 | 23:45:55 | R1_ENV_068 | WS | TOP | 1403 | 22.2 | 791 756.3 | 2 717 372.1 | 791 755.7 | 2 717 370.6 | |
| 02/06/2020 | 23:58:49 | R1_ENV_068 | WP | YSI Exo2 | 1404 | 22.1 | 791 756.3 | 2 717 372.1 | 791 759.1 | 2 717 372.2 | |
| 03/06/2020 | 00:45:17 | R1_ENV_067 | VV | NS | 1405 | 19.4 | 790 533.0 | 2 716 662.4 | 790 532.1 | 2 716 661.1 | |
| 03/06/2020 | 00:48:46 | R1_ENV_067 | VV | PC | 1406 | 19.4 | 790 533.0 | 2 716 662.4 | 790 533.9 | 2 716 672.0 | |
| 03/06/2020 | 01:09:05 | R1_ENV_067 | WS | BOT | 1407 | 19.5 | 790 533.0 | 2 716 662.4 | 790 531.9 | 2 716 662.9 | |
| 03/06/2020 | 01:21:20 | R1_ENV_067 | WS | MID | 1408 | 19.3 | 790 533.0 | 2 716 662.4 | 790 530.2 | 2 716 662.0 | |
| 03/06/2020 | 01:28:52 | R1_ENV_067 | WS | TOP | 1409 | 19.4 | 790 533.0 | 2 716 662.4 | 790 532.6 | 2 716 663.1 | |
| 03/06/2020 | 01:41:08 | R1_ENV_067 | WP | YSI Exo2 | 1410 | 19.4 | 790 533.0 | 2 716 662.4 | 790 533.6 | 2 716 660.6 | |
| 03/06/2020 | 03:04:47 | R1_ENV_066 | VV | NS | 1411 | 21.9 | 791 242.6 | 2 715 439.1 | 791 241.9 | 2 715 438.2 | |
| 03/06/2020 | 03:08:07 | R1_ENV_066 | VV | NS | 1412 | 22.0 | 791 242.6 | 2 715 439.1 | 791 238.8 | 2 715 430.2 | |
| 03/06/2020 | 03:12:38 | R1_ENV_066 | VV | PC | 1413 | 21.9 | 791 242.6 | 2 715 439.1 | 791 246.4 | 2 715 446.9 | |
| 03/06/2020 | 03:40:17 | R1_ENV_066 | WS | BOT | 1414 | 22.1 | 791 242.6 | 2 715 439.1 | 791 241.3 | 2 715 439.8 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 03/06/2020 | 03:48:04 | R1_ENV_066 | WS | MID | 1415 | 22.1 | 791 242.6 | 2 715 439.1 | 791 242.3 | 2 715 439.1 | |
| 03/06/2020 | 03:56:13 | R1_ENV_066 | WS | TOP | 1416 | 22.1 | 791 242.6 | 2 715 439.1 | 791 242.1 | 2 715 439.1 | |
| 03/06/2020 | 04:12:57 | R1_ENV_066 | WP | YSI Exo2 | 1417 | 22.1 | 791 242.6 | 2 715 439.1 | 791 244.3 | 2 715 437.4 | Data not accepted |
| 03/06/2020 | 04:37:09 | R1_ENV_066a | WP | YSI Exo2 | 1418 | 22.2 | 791 242.6 | 2 715 439.1 | 791 242.4 | 2 715 437.2 | |
| 03/06/2020 | 05:25:51 | R1_ENV_065 | WS | BOT | 1419 | 20.1 | 790 019.3 | 2 714 729.5 | 790 020.0 | 2 714 730.2 | |
| 03/06/2020 | 05:33:15 | R1_ENV_065 | WS | MID | 1420 | 20.2 | 790 019.3 | 2 714 729.5 | 790 019.6 | 2 714 731.9 | |
| 03/06/2020 | 05:38:56 | R1_ENV_065 | WS | TOP | 1421 | 20.3 | 790 019.3 | 2 714 729.5 | 790 017.3 | 2 714 731.9 | |
| 03/06/2020 | 05:50:00 | R1_ENV_065 | VV | NS | 1422 | 20.2 | 790 019.3 | 2 714 729.5 | 790 017.3 | 2 714 727.3 | |
| 03/06/2020 | 05:51:59 | R1_ENV_065 | VV | PC | 1423 | 20.2 | 790 019.3 | 2 714 729.5 | 790 026.1 | 2 714 734.2 | |
| 03/06/2020 | 06:45:55 | R1_ENV_065 | WP | YSI Exo2 | 1424 | 20.3 | 790 019.3 | 2 714 729.5 | 790 019.8 | 2 714 727.6 | Data not accepted |
| 03/06/2020 | 13:04:09 | R1_ENV_065a | WP | YSI Exo2 | 1425 | 19.3 | 790 019.3 | 2 714 729.5 | 790 017.6 | 2 714 728.2 | |
| 03/06/2020 | 13:53:33 | R1_ENV_064 | VV | PC | 1426 | 20.6 | 790 729.0 | 2 713 506.2 | 790 729.1 | 2 713 506.2 | |
| 03/06/2020 | 14:50:31 | SO_R1_008 | VV | NS | 1427 | 20.8 | 790 729.0 | 2 713 506.2 | 790 727.7 | 2 713 503.3 | |
| 03/06/2020 | 14:55:35 | SO_R1_008 | VV | NS | 1428 | 20.8 | 790 729.0 | 2 713 506.2 | 790 737.2 | 2 713 500.9 | |
| 03/06/2020 | 15:06:18 | SO_R1_008 | VV | SOIL | 1429 | 20.6 | 790 729.0 | 2 713 506.2 | 790 722.2 | 2 713 510.2 | |
| 03/06/2020 | 15:32:44 | R1_ENV_064 | WS | BOT | 1430 | 20.7 | 790 729.0 | 2 713 506.2 | 790 728.9 | 2 713 505.9 | |
| 03/06/2020 | 15:41:01 | R1_ENV_064 | WS | MID | 1431 | 20.8 | 790 729.0 | 2 713 506.2 | 790 730.1 | 2 713 505.7 | |

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 03/06/2020 | 15:47:07 | R1_ENV_064 | WS | TOP | 1432 | 20.8 | 790 729.0 | 2 713 506.2 | 790 728.3 | 2 713 505.3 | |
| 03/06/2020 | 16:05:49 | R1_ENV_064 | WP | YSI Exo2 | 1433 | 20.9 | 790 729.0 | 2 713 506.2 | 790 730.9 | 2 713 506.5 | |
| 03/06/2020 | 17:30:39 | R1_ENV_063 | WS | BOT | 1434 | 19.4 | 789 224.5 | 2 713 318.9 | 789 222.5 | 2 713 319.4 | |
| 03/06/2020 | 17:38:20 | R1_ENV_063 | WS | MID | 1435 | 19.4 | 789 224.5 | 2 713 318.9 | 789 223.3 | 2 713 318.4 | |
| 03/06/2020 | 17:48:41 | R1_ENV_063 | WS | TOP | 1436 | 19.4 | 789 224.5 | 2 713 318.9 | 789 224.7 | 2 713 317.8 | |
| 03/06/2020 | 17:57:39 | R1_ENV_063 | VV | NS | 1437 | 19.4 | 789 224.5 | 2 713 318.9 | 789 224.4 | 2 713 320.5 | |
| 03/06/2020 | 18:06:56 | R1_ENV_063 | VV | NS | 1438 | 19.4 | 789 224.5 | 2 713 318.9 | 789 214.3 | 2 713 313.0 | |
| 03/06/2020 | 18:11:11 | R1_ENV_063 | VV | NS | 1439 | 19.7 | 789 224.5 | 2 713 318.9 | 789 231.0 | 2 713 324.1 | |
| 03/06/2020 | 18:19:13 | R1_ENV_063 | VV | NS | 1440 | 19.7 | 789 224.5 | 2 713 318.9 | 789 225.9 | 2 713 320.3 | |
| 03/06/2020 | 18:33:28 | R1_ENV_063 | WP | YSI Exo2 | 1441 | 19.7 | 789 224.5 | 2 713 318.9 | 789 222.6 | 2 713 316.1 | |
| 03/06/2020 | 19:30:59 | R1_ENV_062 | WS | BOT | 1442 | 14.6 | 789 123.8 | 2 711 908.3 | 789 125.0 | 2 711 908.4 | |
| 03/06/2020 | 19:40:55 | R1_ENV_062 | WS | MID | 1443 | 14.6 | 789 123.8 | 2 711 908.3 | 789 124.0 | 2 711 908.3 | |
| 03/06/2020 | 19:48:18 | R1_ENV_062 | WS | TOP | 1444 | 14.6 | 789 123.8 | 2 711 908.3 | 789 122.7 | 2 711 909.5 | |
| 05/06/2020 | 00:12:00 | R1_ENV_060 | WS | BOT | 1445 | 19.4 | 787 612.4 | 2 710 598.3 | 787 612.1 | 2 710 599.3 | |
| 05/06/2020 | 00:20:12 | R1_ENV_060 | WS | MID | 1446 | 19.3 | 787 612.4 | 2 710 598.3 | 787 611.7 | 2 710 599.3 | |
| 05/06/2020 | 00:30:12 | R1_ENV_060 | WS | TOP | 1447 | 19.4 | 787 612.4 | 2 710 598.3 | 787 612.7 | 2 710 599.4 | |
| 05/06/2020 | 00:39:39 | R1_ENV_060 | VV | PC | 1448 | 19.4 | 787 612.4 | 2 710 598.3 | 787 611.7 | 2 710 598.3 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 05/06/2020 | 01:03:34 | R1_ENV_060 | WP | YSI Exo2 | 1449 | 19.1 | 787 612.4 | 2 710 598.3 | 787 613.0 | 2 710 595.8 | |
| 05/06/2020 | 01:35:03 | R1_ENV_062 | WP | YSI Exo2 | 1450 | 12.5 | 789 123.8 | 2 711 908.3 | 789 124.4 | 2 711 907.0 | |
| 05/06/2020 | 01:48:08 | R1_ENV_062 | VV | Partial Sample | 1451 | 12.9 | 789 123.8 | 2 711 908.3 | 789 124.0 | 2 711 909.4 | PSD only |
| 05/06/2020 | 01:53:26 | R1_ENV_062 | VV | NS | 1452 | 12.8 | 789 123.8 | 2 711 908.3 | 789 133.6 | 2 711 909.0 | |
| 05/06/2020 | 01:56:58 | R1_ENV_062 | VV | NS | 1453 | 12.9 | 789 123.8 | 2 711 908.3 | 789 114.2 | 2 711 908.4 | |
| 05/06/2020 | 02:38:49 | R1_ENV_061 | VV | Partial Sample | 1454 | 18.6 | 787 713.1 | 2 712 009.0 | 787 713.6 | 2 712 013.0 | HC and HM |
| 05/06/2020 | 03:03:12 | R1_ENV_061 | VV | Partial Sample | 1455 | 18.8 | 787 713.1 | 2 712 009.0 | 787 712.8 | 2 712 011.0 | PSD only |
| 05/06/2020 | 03:17:10 | R1_ENV_061 | WS | BOT | 1456 | 18.7 | 787 713.1 | 2 712 009.0 | 787 715.5 | 2 712 013.1 | |
| 05/06/2020 | 03:23:57 | R1_ENV_061 | WS | MID | 1457 | 18.8 | 787 713.1 | 2 712 009.0 | 787 713.2 | 2 712 011.5 | |
| 05/06/2020 | 03:30:42 | R1_ENV_061 | WS | TOP | 1458 | 18.7 | 787 713.1 | 2 712 009.0 | 787 712.9 | 2 712 009.3 | |
| 05/06/2020 | 03:51:53 | R1_ENV_061 | WP | YSI Exo2 | 1459 | 18.6 | 787 713.1 | 2 712 009.0 | 787 713.8 | 2 712 008.3 | |
| 05/06/2020 | 04:46:24 | R1_ENV_059 | WS | BOT | 1460 | 18.5 | 786 201.8 | 2 710 699.0 | 786 201.7 | 2 710 699.6 | |
| 05/06/2020 | 04:53:02 | R1_ENV_059 | WS | MID | 1461 | 18.6 | 786 201.8 | 2 710 699.0 | 786 202.0 | 2 710 699.4 | |
| 05/06/2020 | 05:00:49 | R1_ENV_059 | WS | TOP | 1462 | 18.6 | 786 201.8 | 2 710 699.0 | 786 201.8 | 2 710 699.1 | |
| 05/06/2020 | 05:07:34 | R1_ENV_059 | VV | PC | 1463 | 18.5 | 786 201.8 | 2 710 699.0 | 786 201.3 | 2 710 700.1 | |
| 05/06/2020 | 05:41:17 | R1_ENV_059 | WP | YSI Exo2 | 1464 | 18.7 | 786 201.8 | 2 710 699.0 | 786 201.8 | 2 710 696.2 | |
| 05/06/2020 | 06:29:42 | R1_ENV_058 | VV | Partial Sample | 1465 | 18.7 | 786 101.1 | 2 709 288.4 | 786 103.8 | 2 709 289.1 | HC only |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 05/06/2020 | 06:38:47 | R1_ENV_058 | VV | Partial Sample | 1466 | 18.6 | 786 101.1 | 2 709 288.4 | 786 109.8 | 2 709 286.6 | HM and PSD |
| 05/06/2020 | 06:48:27 | R1_ENV_058 | VV | NS | 1467 | 18.7 | 786 101.1 | 2 709 288.4 | 786 095.5 | 2 709 295.1 | |
| 05/06/2020 | 06:58:14 | R1_ENV_058 | WS | BOT | 1468 | 18.8 | 786 101.1 | 2 709 288.4 | 786 103.3 | 2 709 289.4 | |
| 05/06/2020 | 07:04:06 | R1_ENV_058 | WS | MID | 1469 | 18.7 | 786 101.1 | 2 709 288.4 | 786 103.3 | 2 709 288.6 | |
| 05/06/2020 | 07:10:33 | R1_ENV_058 | WS | TOP | 1470 | 18.7 | 786 101.1 | 2 709 288.4 | 786 100.5 | 2 709 288.7 | |
| 05/06/2020 | 07:25:07 | R1_ENV_058 | WP | YSI Exo2 | 1471 | 19.0 | 786 101.1 | 2 709 288.4 | 786 099.0 | 2 709 286.9 | |
| 05/06/2020 | 08:29:12 | R1_ENV_057 | WS | BOT | 1472 | 19.1 | 784 690.5 | 2 709 389.1 | 784 689.8 | 2 709 388.3 | |
| 05/06/2020 | 08:35:56 | R1_ENV_057 | WS | MID | 1473 | 19.1 | 784 690.5 | 2 709 389.1 | 784 688.7 | 2 709 390.1 | |
| 05/06/2020 | 08:42:30 | R1_ENV_057 | WS | TOP | 1474 | 19.1 | 784 690.5 | 2 709 389.1 | 784 689.7 | 2 709 390.2 | |
| 05/06/2020 | 08:56:19 | R1_ENV_057 | VV | Partial Sample | 1475 | 19.1 | 784 690.5 | 2 709 389.1 | 784 689.4 | 2 709 390.7 | HC only |
| 05/06/2020 | 09:05:01 | R1_ENV_057 | VV | Partial Sample | 1476 | 19.2 | 784 690.5 | 2 709 389.1 | 784 696.3 | 2 709 382.9 | HM only |
| 05/06/2020 | 09:15:37 | R1_ENV_057 | VV | Partial Sample | 1477 | 19.0 | 784 690.5 | 2 709 389.1 | 784 683.4 | 2 709 395.5 | PSD only |
| 05/06/2020 | 09:29:55 | R1_ENV_057 | WP | YSI Exo2 | 1478 | 19.0 | 784 690.5 | 2 709 389.1 | 784 689.5 | 2 709 387.6 | |
| 05/06/2020 | 10:08:40 | R1_ENV_056 | VV | PC | 1479 | 18.6 | 784 589.8 | 2 707 978.5 | 784 591.0 | 2 707 980.0 | |
| 05/06/2020 | 10:24:47 | SO_R1_007 | VV | NS | 1480 | 18.5 | 784 589.8 | 2 707 978.5 | 784 589.7 | 2 707 978.8 | |
| 05/06/2020 | 10:28:09 | SO_R1_007 | VV | SOIL | 1481 | 18.7 | 784 589.8 | 2 707 978.5 | 784 582.9 | 2 707 985.5 | |
| 05/06/2020 | 10:42:59 | R1_ENV_056 | WS | BOT | 1482 | 18.6 | 784 589.8 | 2 707 978.5 | 784 589.8 | 2 707 977.4 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 05/06/2020 | 10:49:52 | R1_ENV_056 | WS | MID | 1483 | 18.8 | 784 589.8 | 2 707 978.5 | 784 589.8 | 2 707 976.7 | |
| 05/06/2020 | 10:58:09 | R1_ENV_056 | WS | TOP | 1484 | 18.6 | 784 589.8 | 2 707 978.5 | 784 589.6 | 2 707 977.0 | |
| 05/06/2020 | 11:13:34 | R1_ENV_056 | WP | YSI Exo2 | 1485 | 18.6 | 784 589.8 | 2 707 978.5 | 784 590.9 | 2 707 979.8 | |
| 05/06/2020 | 12:03:40 | R1_ENV_055 | WS | BOT | 1486 | 19.5 | 783 179.2 | 2 708 079.2 | 783 177.4 | 2 708 079.6 | |
| 05/06/2020 | 12:12:19 | R1_ENV_055 | WS | MID | 1487 | 19.6 | 783 179.2 | 2 708 079.2 | 783 178.3 | 2 708 077.7 | |
| 05/06/2020 | 12:18:09 | R1_ENV_055 | WS | TOP | 1488 | 19.4 | 783 179.2 | 2 708 079.2 | 783 178.8 | 2 708 079.5 | |
| 05/06/2020 | 12:23:53 | R1_ENV_055 | VV | PC | 1489 | 19.4 | 783 179.2 | 2 708 079.2 | 783 178.6 | 2 708 079.3 | |
| 05/06/2020 | 12:46:46 | R1_ENV_055 | WP | YSI Exo2 | 1490 | 19.4 | 783 179.2 | 2 708 079.2 | 783 181.2 | 2 708 080.5 | |
| 06/06/2020 | 05:25:38 | R1_ENV_054 | VV | NS | 1491 | 16.8 | 783 078.5 | 2 706 668.6 | 783 079.4 | 2 706 670.3 | |
| 06/06/2020 | 05:31:11 | R1_ENV_054 | VV | Partial Sample | 1492 | 16.9 | 783 078.5 | 2 706 668.6 | 783 071.0 | 2 706 673.9 | HC and HM |
| 06/06/2020 | 05:46:37 | R1_ENV_054 | VV | Partial Sample | 1493 | 17.7 | 783 078.5 | 2 706 668.6 | 783 087.9 | 2 706 666.4 | PSD only |
| 06/06/2020 | 06:02:55 | R1_ENV_054 | WS | BOT | 1494 | 17.2 | 783 078.5 | 2 706 668.6 | 783 081.6 | 2 706 670.9 | |
| 06/06/2020 | 06:09:55 | R1_ENV_054 | WS | MID | 1495 | 17.1 | 783 078.5 | 2 706 668.6 | 783 079.1 | 2 706 668.7 | |
| 06/06/2020 | 06:16:29 | R1_ENV_054 | WS | TOP | 1496 | 17.2 | 783 078.5 | 2 706 668.6 | 783 078.4 | 2 706 667.6 | |
| 06/06/2020 | 06:48:29 | R1_ENV_054 | WP | YSI Exo2 | 1497 | 17.6 | 783 078.5 | 2 706 668.6 | 783 077.6 | 2 706 667.1 | |
| 06/06/2020 | 07:45:35 | R1_ENV_053 | WS | BOT | 1498 | 18.3 | 781 667.8 | 2 706 769.3 | 781 670.1 | 2 706 769.2 | |
| 06/06/2020 | 07:50:36 | R1_ENV_053 | WS | MID | 1499 | 18.3 | 781 667.8 | 2 706 769.3 | 781 671.1 | 2 706 768.4 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 06/06/2020 | 07:57:36 | R1_ENV_053 | WS | TOP | 1500 | 18.4 | 781 667.8 | 2 706 769.3 | 781 666.7 | 2 706 770.3 | |
| 06/06/2020 | 08:03:55 | R1_ENV_053 | VV | Partial Sample | 1501 | 18.3 | 781 667.8 | 2 706 769.3 | 781 665.7 | 2 706 771.1 | PSD only |
| 06/06/2020 | 08:12:06 | R1_ENV_053 | VV | Partial Sample | 1502 | 18.3 | 781 667.8 | 2 706 769.3 | 781 659.5 | 2 706 773.2 | HC and HM |
| 06/06/2020 | 08:23:39 | R1_ENV_053 | VV | NS | 1503 | 18.2 | 781 667.8 | 2 706 769.3 | 781 675.5 | 2 706 764.9 | |
| 06/06/2020 | 08:40:34 | R1_ENV_053 | WP | YSI Exo2 | 1504 | 18.4 | 781 667.8 | 2 706 769.3 | 781 666.6 | 2 706 768.7 | |
| 06/06/2020 | 09:26:43 | R1_ENV_052 | VV | Partial Sample | 1505 | 18.6 | 781 567.1 | 2 705 358.7 | 781 567.6 | 2 705 358.4 | PSD only |
| 06/06/2020 | 09:35:49 | R1_ENV_052 | VV | Partial Sample | 1506 | 18.7 | 781 567.1 | 2 705 358.7 | 781 562.2 | 2 705 364.4 | HC and HM |
| 06/06/2020 | 09:47:43 | R1_ENV_052 | VV | NS | 1507 | 18.7 | 781 567.1 | 2 705 358.7 | 781 573.1 | 2 705 351.1 | |
| 06/06/2020 | 09:51:50 | R1_ENV_052 | WS | BOT | 1508 | 18.6 | 781 567.1 | 2 705 358.7 | 781 566.7 | 2 705 359.2 | |
| 06/06/2020 | 09:59:18 | R1_ENV_052 | WS | MID | 1509 | 18.6 | 781 567.1 | 2 705 358.7 | 781 566.8 | 2 705 358.7 | |
| 06/06/2020 | 10:05:12 | R1_ENV_052 | WS | TOP | 1510 | 18.6 | 781 567.1 | 2 705 358.7 | 781 567.2 | 2 705 358.6 | |
| 06/06/2020 | 10:19:06 | R1_ENV_052 | WP | YSI Exo2 | 1511 | 18.6 | 781 567.1 | 2 705 358.7 | 781 564.8 | 2 705 358.1 | |
| 06/06/2020 | 11:09:55 | R1_ENV_051 | WS | BOT | 1512 | 13.7 | 780 156.5 | 2 705 459.4 | 780 156.5 | 2 705 459.5 | |
| 06/06/2020 | 11:16:35 | R1_ENV_051 | WS | MID | 1513 | 13.6 | 780 156.5 | 2 705 459.4 | 780 156.9 | 2 705 458.7 | |
| 06/06/2020 | 11:24:21 | R1_ENV_051 | WS | TOP | 1514 | 13.6 | 780 156.5 | 2 705 459.4 | 780 156.6 | 2 705 459.4 | |
| 06/06/2020 | 11:30:43 | R1_ENV_051 | VV | NS | 1515 | 13.5 | 780 156.5 | 2 705 459.4 | 780 156.2 | 2 705 460.4 | |
| 06/06/2020 | 11:38:12 | R1_ENV_051 | VV | NS | 1516 | 13.6 | 780 156.5 | 2 705 459.4 | 780 150.6 | 2 705 466.8 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 06/06/2020 | 11:41:36 | R1_ENV_051 | VV | NS | 1517 | 13.6 | 780 156.5 | 2 705 459.4 | 780 162.0 | 2 705 453.1 | |
| 06/06/2020 | 11:57:42 | R1_ENV_051 | WP | YSI Exo2 | 1518 | 13.6 | 780 156.5 | 2 705 459.4 | 780 154.6 | 2 705 457.5 | |
| 06/06/2020 | 12:31:38 | R1_ENV_050 | VV | NS | 1519 | 17.3 | 780 062.6 | 2 704 040.9 | 780 062.0 | 2 704 042.0 | |
| 06/06/2020 | 12:35:56 | R1_ENV_050 | VV | PC | 1520 | 17.2 | 780 062.6 | 2 704 040.9 | 780 056.3 | 2 704 048.2 | |
| 06/06/2020 | 13:04:43 | R1_ENV_050 | WS | BOT | 1521 | 17.3 | 780 062.6 | 2 704 040.9 | 780 062.8 | 2 704 041.3 | |
| 06/06/2020 | 13:10:50 | R1_ENV_050 | WS | MID | 1522 | 17.3 | 780 062.6 | 2 704 040.9 | 780 062.4 | 2 704 041.6 | |
| 06/06/2020 | 13:19:03 | R1_ENV_050 | WS | TOP | 1523 | 17.2 | 780 062.6 | 2 704 040.9 | 780 062.2 | 2 704 042.3 | |
| 06/06/2020 | 13:33:32 | R1_ENV_050 | WP | YSI Exo2 | 1524 | 17.1 | 780 062.6 | 2 704 040.9 | 780 060.8 | 2 704 040.8 | |
| 06/06/2020 | 14:41:06 | R1_ENV_049 | VV | NS | 1525 | 17.2 | 778 638.4 | 2 704 157.3 | 778 642.3 | 2 704 155.7 | |
| 06/06/2020 | 14:50:33 | R1_ENV_049 | VV | PC | 1526 | 17.3 | 778 638.4 | 2 704 157.3 | 778 645.1 | 2 704 149.8 | |
| 06/06/2020 | 15:14:07 | R1_ENV_049 | WS | BOT | 1527 | 17.3 | 778 638.4 | 2 704 157.3 | 778 639.3 | 2 704 157.3 | |
| 06/06/2020 | 15:23:27 | R1_ENV_049 | WS | MID | 1528 | 17.1 | 778 638.4 | 2 704 157.3 | 778 638.5 | 2 704 157.9 | |
| 06/06/2020 | 15:31:39 | R1_ENV_049 | WS | TOP | 1529 | 17.2 | 778 638.4 | 2 704 157.3 | 778 637.5 | 2 704 156.1 | |
| 06/06/2020 | 16:04:38 | R1_ENV_049 | WP | YSI Exo2 | 1530 | 17.2 | 778 638.4 | 2 704 157.3 | 778 639.9 | 2 704 154.8 | |
| 06/06/2020 | 17:02:35 | R1_ENV_048 | WP | YSI Exo2 | 1531 | 16.8 | 778 544.5 | 2 702 738.8 | 778 548.1 | 2 702 734.8 | |
| 08/06/2020 | 21:33:20 | SO_R1_006 | VV | SOIL | 1532 | 17.4 | 778 544.5 | 2 702 738.8 | 778 545.0 | 2 702 736.6 | |
| 08/06/2020 | 21:43:44 | R1_ENV_048 | VV | PC | 1533 | 17.6 | 778 544.5 | 2 702 738.8 | 778 544.1 | 2 702 738.6 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 08/06/2020 | 21:57:28 | R1_ENV_048 | WS | BOT | 1534 | 17.5 | 778 544.5 | 2 702 738.8 | 778 545.6 | 2 702 738.2 | |
| 08/06/2020 | 22:09:10 | R1_ENV_048 | WS | MID | 1535 | 17.6 | 778 544.5 | 2 702 738.8 | 778 544.0 | 2 702 739.9 | |
| 08/06/2020 | 22:16:28 | R1_ENV_048 | WS | TOP | 1536 | 17.6 | 778 544.5 | 2 702 738.8 | 778 544.4 | 2 702 738.9 | |
| 08/06/2020 | 22:40:01 | R1_ENV_047 | WS | BOT | 1537 | 15.9 | 777 133.9 | 2 702 839.5 | 777 135.0 | 2 702 837.8 | |
| 08/06/2020 | 22:46:56 | R1_ENV_047 | WS | MID | 1538 | 15.9 | 777 133.9 | 2 702 839.5 | 777 133.4 | 2 702 841.1 | |
| 08/06/2020 | 22:53:03 | R1_ENV_047 | WS | TOP | 1539 | 15.9 | 777 133.9 | 2 702 839.5 | 777 133.8 | 2 702 840.1 | |
| 08/06/2020 | 23:01:04 | R1_ENV_047 | VV | NS | 1540 | 15.9 | 777 133.9 | 2 702 839.5 | 777 133.4 | 2 702 840.3 | |
| 08/06/2020 | 23:05:21 | R1_ENV_047 | VV | Partial Sample | 1541 | 16.2 | 777 133.9 | 2 702 839.5 | 777 128.9 | 2 702 846.7 | |
| 08/06/2020 | 23:09:32 | R1_ENV_047 | VV | NS | 1542 | 16.2 | 777 133.9 | 2 702 839.5 | 777 138.8 | 2 702 831.1 | |
| 08/06/2020 | 23:20:43 | R1_ENV_047 | WP | YSI Exo2 | 1543 | 16.0 | 777 133.9 | 2 702 839.5 | 777 135.8 | 2 702 840.1 | |
| 08/06/2020 | 23:50:26 | R1_ENV_046 | VV | PC | 1544 | 19.0 | 777 033.2 | 2 701 428.9 | 777 033.2 | 2 701 429.0 | |
| 09/06/2020 | 00:02:29 | R1_ENV_046 | WS | BOT | 1545 | 18.9 | 777 033.2 | 2 701 428.9 | 777 033.1 | 2 701 428.9 | |
| 09/06/2020 | 00:09:37 | R1_ENV_046 | WS | MID | 1546 | 18.9 | 777 033.2 | 2 701 428.9 | 777 033.0 | 2 701 428.4 | |
| 09/06/2020 | 00:15:54 | R1_ENV_046 | WS | TOP | 1547 | 18.9 | 777 033.2 | 2 701 428.9 | 777 033.4 | 2 701 428.5 | |
| 09/06/2020 | 00:28:28 | R1_ENV_046 | WP | YSI Exo2 | 1548 | 18.9 | 777 033.2 | 2 701 428.9 | 777 031.8 | 2 701 428.7 | |
| 09/06/2020 | 00:59:32 | R1_ENV_045 | VV | NS | 1549 | 17.1 | 775 622.5 | 2 701 529.6 | 775 622.5 | 2 701 528.3 | |
| 09/06/2020 | 01:02:58 | R1_ENV_045 | VV | PC | 1550 | 17.1 | 775 622.5 | 2 701 529.6 | 775 614.5 | 2 701 524.1 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 09/06/2020 | 01:19:30 | R1_ENV_045 | WS | BOT | 1551 | 17.0 | 775 622.5 | 2 701 529.6 | 775 622.4 | 2 701 530.2 | |
| 09/06/2020 | 01:25:59 | R1_ENV_045 | WS | MID | 1552 | 17.0 | 775 622.5 | 2 701 529.6 | 775 622.4 | 2 701 529.8 | |
| 09/06/2020 | 01:32:46 | R1_ENV_045 | WS | TOP | 1553 | 17.0 | 775 622.5 | 2 701 529.6 | 775 622.7 | 2 701 529.3 | |
| 09/06/2020 | 02:38:15 | R1_ENV_045 | WP | YSI Exo2 | 1554 | 16.3 | 775 622.5 | 2 701 529.6 | 775 622.4 | 2 701 530.0 | |
| 09/06/2020 | 03:18:29 | R1_ENV_044 | WS | BOT | 1555 | 14.8 | 775 981.1 | 2 700 126.9 | 775 981.1 | 2 700 127.3 | |
| 09/06/2020 | 03:24:37 | R1_ENV_044 | WS | MID | 1556 | 14.7 | 775 981.1 | 2 700 126.9 | 775 980.1 | 2 700 127.9 | |
| 09/06/2020 | 03:30:30 | R1_ENV_044 | WS | TOP | 1557 | 14.8 | 775 981.1 | 2 700 126.9 | 775 978.7 | 2 700 127.2 | |
| 09/06/2020 | 03:36:27 | R1_ENV_044 | VV | NS | 1558 | 14.7 | 775 981.1 | 2 700 126.9 | 775 980.2 | 2 700 128.2 | |
| 09/06/2020 | 03:45:42 | R1_ENV_044 | VV | Partial Sample | 1559 | 14.7 | 775 981.1 | 2 700 126.9 | 775 972.8 | 2 700 121.8 | HC only |
| 09/06/2020 | 04:00:49 | R1_ENV_044 | VV | Partial Sample | 1560 | 14.4 | 775 981.1 | 2 700 126.9 | 775 987.3 | 2 700 134.1 | HM and PSD |
| 09/06/2020 | 04:21:58 | R1_ENV_044 | WP | YSI Exo2 | 1561 | 14.3 | 775 981.1 | 2 700 126.9 | 775 980.8 | 2 700 125.8 | |
| 09/06/2020 | 04:59:57 | R1_ENV_043 | VV | PC | 1562 | 14.6 | 774 713.9 | 2 699 499.1 | 774 713.7 | 2 699 499.7 | |
| 09/06/2020 | 05:19:33 | R1_ENV_043 | WS | BOT | 1563 | 14.6 | 774 713.9 | 2 699 499.1 | 774 714.2 | 2 699 499.2 | |
| 09/06/2020 | 05:31:31 | R1_ENV_043 | WS | MID | 1564 | 14.6 | 774 713.9 | 2 699 499.1 | 774 713.1 | 2 699 500.0 | |
| 09/06/2020 | 05:39:56 | R1_ENV_043 | WS | TOP | 1565 | 14.6 | 774 713.9 | 2 699 499.1 | 774 713.8 | 2 699 500.0 | |
| 09/06/2020 | 05:59:01 | R1_ENV_043 | WP | YSI Exo2 | 1566 | 14.6 | 774 713.9 | 2 699 499.1 | 774 711.6 | 2 699 498.3 | |
| 09/06/2020 | 06:33:32 | R1_ENV_042 | WS | BOT | 1567 | 12.6 | 775 341.7 | 2 698 231.9 | 775 343.2 | 2 698 231.5 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 09/06/2020 | 06:44:01 | R1_ENV_042 | WS | MID | 1568 | 12.7 | 775 341.7 | 2 698 231.9 | 775 341.2 | 2 698 232.9 | |
| 09/06/2020 | 06:49:31 | R1_ENV_042 | WS | TOP | 1569 | 12.6 | 775 341.7 | 2 698 231.9 | 775 341.7 | 2 698 232.7 | |
| 09/06/2020 | 07:01:21 | R1_ENV_042 | VV | NS | 1570 | 12.7 | 775 341.7 | 2 698 231.9 | 775 342.7 | 2 698 234.5 | |
| 09/06/2020 | 07:05:41 | R1_ENV_042 | VV | NS | 1571 | 12.6 | 775 341.7 | 2 698 231.9 | 775 337.7 | 2 698 241.2 | |
| 09/06/2020 | 07:09:57 | R1_ENV_042 | VV | NS | 1572 | 12.8 | 775 341.7 | 2 698 231.9 | 775 347.5 | 2 698 224.1 | |
| 09/06/2020 | 07:24:06 | R1_ENV_042 | WP | YSI Exo2 | 1573 | 12.8 | 775 341.7 | 2 698 231.9 | 775 340.5 | 2 698 231.9 | |
| 09/06/2020 | 08:12:34 | R1_ENV_041 | VV | PC | 1574 | 14.4 | 774 074.4 | 2 697 604.1 | 774 074.8 | 2 697 605.5 | |
| 09/06/2020 | 08:34:08 | R1_ENV_041 | WS | BOT | 1575 | 14.5 | 774 074.4 | 2 697 604.1 | 774 075.3 | 2 697 603.7 | |
| 09/06/2020 | 08:41:07 | R1_ENV_041 | WS | MID | 1576 | 14.5 | 774 074.4 | 2 697 604.1 | 774 074.7 | 2 697 604.7 | |
| 09/06/2020 | 08:46:32 | R1_ENV_041 | WS | TOP | 1577 | 14.5 | 774 074.4 | 2 697 604.1 | 774 075.1 | 2 697 603.9 | |
| 09/06/2020 | 09:05:29 | R1_ENV_041 | WP | YSI Exo2 | 1578 | 14.6 | 774 074.4 | 2 697 604.1 | 774 072.7 | 2 697 603.8 | |
| 09/06/2020 | 09:40:54 | R1_ENV_040 | WS | BOT | 1579 | 15.2 | 774 702.2 | 2 696 336.8 | 774 703.1 | 2 696 337.4 | |
| 09/06/2020 | 09:47:51 | R1_ENV_040 | WS | MID | 1580 | 15.2 | 774 702.2 | 2 696 336.8 | 774 703.1 | 2 696 337.3 | |
| 09/06/2020 | 09:54:00 | R1_ENV_040 | WS | TOP | 1581 | 15.2 | 774 702.2 | 2 696 336.8 | 774 702.4 | 2 696 337.6 | |
| 09/06/2020 | 10:03:09 | SO_R1_005 | VV | Partial Sample | 1582 | 15.3 | 774 702.2 | 2 696 336.8 | 774 702.9 | 2 696 337.3 | |
| 09/06/2020 | 10:15:30 | SO_R1_005 | VV | Partial Sample | 1583 | 15.3 | 774 702.2 | 2 696 336.8 | 774 710.7 | 2 696 343.2 | |
| 09/06/2020 | 10:25:39 | R1_ENV_040 | VV | Partial Sample | 1585 | 15.4 | 774 702.2 | 2 696 336.8 | 774 703.5 | 2 696 337.3 | HC only |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 09/06/2020 | 10:34:37 | R1_ENV_040 | VV | Partial Sample | 1586 | 15.4 | 774 702.2 | 2 696 336.8 | 774 707.1 | 2 696 329.5 | HM and PSD |
| 09/06/2020 | 10:48:47 | R1_ENV_040 | VV | NS | 1587 | 15.5 | 774 702.2 | 2 696 336.8 | 774 699.3 | 2 696 346.7 | |
| 09/06/2020 | 11:00:07 | R1_ENV_040 | WP | YSI Exo2 | 1588 | 15.5 | 774 702.2 | 2 696 336.8 | 774 700.6 | 2 696 335.9 | |
| 09/06/2020 | 11:42:11 | R1_ENV_039 | VV | PC | 1589 | 15.3 | 773 435.0 | 2 695 709.0 | 773 435.0 | 2 695 709.8 | |
| 09/06/2020 | 12:00:24 | R1_ENV_039 | WS | BOT | 1590 | 15.4 | 773 435.0 | 2 695 709.0 | 773 435.2 | 2 695 708.8 | |
| 09/06/2020 | 12:16:45 | R1_ENV_039 | WS | MID | 1591 | 15.4 | 773 435.0 | 2 695 709.0 | 773 435.5 | 2 695 709.4 | |
| 09/06/2020 | 12:32:11 | R1_ENV_039 | WS | TOP | 1592 | 15.4 | 773 435.0 | 2 695 709.0 | 773 433.0 | 2 695 708.5 | |
| 09/06/2020 | 12:36:24 | R1_ENV_039 | WP | YSI Exo2 | 1593 | 15.5 | 773 435.0 | 2 695 709.0 | 773 432.2 | 2 695 709.7 | |
| 09/06/2020 | 13:45:44 | R1_ENV_030 | WS | MID | 1594 | 12.4 | 771 505.1 | 2 686 861.7 | 771 505.2 | 2 686 861.3 | |
| 09/06/2020 | 17:23:23 | R1_TR05 | Video | SOL | 1595 | 12.6 | 771 193.4 | 2 689 055.8 | 771 189.9 | 2 689 043.3 | |
| 09/06/2020 | 17:24:11 | R1_TR05 | Still | R1_TR05_001 | 1596 | 12.7 | - | - | 771 193.2 | 2 689 057.9 | |
| 09/06/2020 | 17:24:35 | R1_TR05 | Still | R1_TR05_002 | - | 12.7 | - | - | 771 194.8 | 2 689 066.0 | |
| 09/06/2020 | 17:24:45 | R1_TR05 | Still | R1_TR05_003 | 1597 | 12.7 | - | - | 771 195.6 | 2 689 068.9 | |
| 09/06/2020 | 17:25:08 | R1_TR05 | Still | R1_TR05_004 | 1598 | 12.6 | - | - | 771 197.1 | 2 689 075.9 | |
| 09/06/2020 | 17:25:28 | R1_TR05 | Still | R1_TR05_005 | 1599 | 12.6 | - | - | 771 198.0 | 2 689 081.7 | |
| 09/06/2020 | 17:25:44 | R1_TR05 | Still | R1_TR05_006 | 1600 | 12.6 | - | - | 771 199.0 | 2 689 086.2 | |
| 09/06/2020 | 17:25:55 | R1_TR05 | Still | R1_TR05_007 | 1601 | 12.7 | - | - | 771 199.4 | 2 689 089.3 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 09/06/2020 | 17:26:23 | R1_TR05 | Still | R1_TR05_008 | 1602 | 12.7 | - | - | 771 201.2 | 2 689 097.0 | |
| 09/06/2020 | 17:26:39 | R1_TR05 | Still | R1_TR05_009 | 1603 | 12.7 | - | - | 771 202.1 | 2 689 101.1 | |
| 09/06/2020 | 17:27:05 | R1_TR05 | Still | R1_TR05_010 | 1604 | 12.7 | - | - | 771 203.3 | 2 689 107.6 | |
| 09/06/2020 | 17:27:29 | R1_TR05 | Still | R1_TR05_011 | 1605 | 12.7 | - | - | 771 204.3 | 2 689 113.6 | |
| 09/06/2020 | 17:27:50 | R1_TR05 | Still | R1_TR05_012 | 1606 | 12.7 | - | - | 771 205.0 | 2 689 118.8 | |
| 09/06/2020 | 17:28:08 | R1_TR05 | Still | R1_TR05_013 | 1607 | 12.7 | - | - | 771 206.4 | 2 689 123.3 | |
| 09/06/2020 | 17:28:33 | R1_TR05 | Still | R1_TR05_014 | 1608 | 12.7 | - | - | 771 207.6 | 2 689 130.3 | |
| 09/06/2020 | 17:29:08 | R1_TR05 | Still | R1_TR05_015 | 1609 | 12.7 | - | - | 771 210.2 | 2 689 140.7 | |
| 09/06/2020 | 17:29:30 | R1_TR05 | Still | R1_TR05_016 | 1610 | 12.8 | - | - | 771 211.5 | 2 689 147.2 | |
| 09/06/2020 | 17:30:03 | R1_TR05 | Still | R1_TR05_017 | 1611 | 12.8 | - | - | 771 214.4 | 2 689 157.0 | |
| 09/06/2020 | 17:30:32 | R1_TR05 | Still | R1_TR05_018 | 1612 | 12.8 | - | - | 771 215.9 | 2 689 165.9 | |
| 09/06/2020 | 17:31:01 | R1_TR05 | Video | EOL | 1613 | 12.8 | 771 217.7 | 2 689 171.2 | 771 218.2 | 2 689 174.7 | |
| 10/06/2020 | 07:53:05 | R1_ENV_038 | VV | Partial Sample | 469 | 9.1 | 774 062.8 | 2 694 441.8 | 774 060.2 | 2 694 439.4 | HC only |
| 10/06/2020 | 08:23:21 | R1_ENV_038 | VV | Partial Sample | 470 | 9.4 | 774 062.8 | 2 694 441.8 | 774 058.1 | 2 694 441.7 | HM and PSD |
| 10/06/2020 | 08:43:25 | R1_ENV_038 | VV | NS | 471 | 9.3 | 774 062.8 | 2 694 441.8 | 774 057.4 | 2 694 442.0 | |
| 10/06/2020 | 10:10:11 | R1_ENV_038 | WS | BOT | 472 | 9.6 | 774 062.8 | 2 694 441.8 | 774 064.2 | 2 694 441.0 | |
| 10/06/2020 | 10:26:01 | R1_ENV_038 | WS | TOP | 473 | 9.7 | 774 062.8 | 2 694 441.8 | 774 066.1 | 2 694 441.8 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 10/06/2020 | 10:33:35 | R1_ENV_038 | WP | YSI Exo2 | 474 | 9.7 | 774 062.8 | 2 694 441.8 | 774 064.9 | 2 694 438.5 | |
| 10/06/2020 | 11:53:35 | R1_ENV_028 | WS | BOT | 475 | 10.0 | 770 865.6 | 2 684 966.7 | 770 862.5 | 2 684 956.8 | |
| 10/06/2020 | 11:53:35 | R1_ENV_028 | WP | YSI Exo2 | 475 | 10.0 | 770 865.6 | 2 684 966.7 | 770 862.5 | 2 684 956.8 | |
| 10/06/2020 | 12:14:29 | R1_ENV_028 | WS | TOP | 476 | 10.0 | 770 865.6 | 2 684 966.7 | 770 875.8 | 2 684 958.6 | |
| 10/06/2020 | 12:44:03 | R1_ENV_026 | WS | BOT | 477 | 11.0 | 770 226.2 | 2 683 071.7 | 770 223.0 | 2 683 068.2 | |
| 10/06/2020 | 12:44:03 | R1_ENV_026 | WP | YSI Exo2 | 477 | 11.0 | 770 226.2 | 2 683 071.7 | 770 223.0 | 2 683 068.2 | |
| 10/06/2020 | 13:08:15 | R1_ENV_026 | VV | NS | 478 | 10.9 | 770 226.2 | 2 683 071.7 | 770 226.3 | 2 683 065.2 | |
| 10/06/2020 | 13:24:22 | R1_ENV_026 | VV | NS | 479 | 11.0 | 770 226.2 | 2 683 071.7 | 770 232.2 | 2 683 069.0 | |
| 10/06/2020 | 13:32:55 | R1_ENV_026 | VV | NS | 480 | 11.1 | 770 226.2 | 2 683 071.7 | 770 221.4 | 2 683 064.6 | |
| 10/06/2020 | 19:30:27 | R1_TR08 | Video | SOL | 1614 | 19.8 | 791 736.9 | 2 713 316.5 | 791 742.9 | 2 713 308.7 | |
| 10/06/2020 | 19:30:44 | R1_TR08 | Still | R1_TR08_001 | 1615 | 19.6 | - | - | 791 739.5 | 2 713 311.6 | |
| 10/06/2020 | 19:31:14 | R1_TR08 | Still | R1_TR08_002 | 1616 | 19.6 | - | - | 791 734.3 | 2 713 317.1 | |
| 10/06/2020 | 19:31:27 | R1_TR08 | Still | R1_TR08_003 | 1617 | 19.6 | - | - | 791 731.4 | 2 713 319.3 | |
| 10/06/2020 | 19:31:47 | R1_TR08 | Still | R1_TR08_004 | 1618 | 19.7 | - | - | 791 728.7 | 2 713 324.2 | |
| 10/06/2020 | 19:32:08 | R1_TR08 | Still | R1_TR08_005 | 1619 | 19.6 | - | - | 791 725.8 | 2 713 329.4 | |
| 10/06/2020 | 19:32:28 | R1_TR08 | Still | R1_TR08_006 | 1620 | 19.6 | - | - | 791 722.1 | 2 713 333.8 | |
| 10/06/2020 | 19:32:49 | R1_TR08 | Still | R1_TR08_007 | 1621 | 19.6 | - | - | 791 717.9 | 2 713 338.4 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 10/06/2020 | 19:33:25 | R1_TR08 | Still | R1_TR08_008 | 1622 | 19.6 | - | - | 791 710.8 | 2 713 345.1 | |
| 10/06/2020 | 19:33:57 | R1_TR08 | Still | R1_TR08_009 | 1623 | 19.6 | - | - | 791 706.3 | 2 713 351.3 | |
| 10/06/2020 | 19:34:16 | R1_TR08 | Still | R1_TR08_010 | 1624 | 19.6 | - | - | 791 704.5 | 2 713 356.0 | |
| 10/06/2020 | 19:34:50 | R1_TR08 | Still | R1_TR08_011 | 1625 | 19.6 | - | - | 791 698.2 | 2 713 361.7 | |
| 10/06/2020 | 19:35:30 | R1_TR08 | Still | R1_TR08_012 | 1626 | 19.4 | - | - | 791 690.0 | 2 713 368.7 | |
| 10/06/2020 | 19:35:57 | R1_TR08 | Still | R1_TR08_013 | 1627 | 19.4 | - | - | 791 685.0 | 2 713 374.6 | |
| 10/06/2020 | 19:36:30 | R1_TR08 | Still | R1_TR08_014 | 1628 | 19.5 | - | - | 791 677.1 | 2 713 381.9 | |
| 10/06/2020 | 19:36:52 | R1_TR08 | Still | R1_TR08_015 | 1629 | 19.5 | - | - | 791 673.5 | 2 713 387.5 | |
| 10/06/2020 | 19:37:37 | R1_TR08 | Still | R1_TR08_016 | 1630 | 19.6 | - | - | 791 668.6 | 2 713 397.3 | |
| 10/06/2020 | 19:38:12 | R1_TR08 | Still | R1_TR08_017 | 1631 | 19.6 | - | - | 791 664.8 | 2 713 401.9 | |
| 10/06/2020 | 19:38:48 | R1_TR08 | Still | R1_TR08_018 | 1632 | 19.6 | - | - | 791 648.4 | 2 713 415.4 | |
| 10/06/2020 | 19:39:38 | R1_TR08 | Still | R1_TR08_019 | 1633 | 19.6 | - | - | 791 647.9 | 2 713 416.0 | |
| 10/06/2020 | 19:40:11 | R1_TR08 | Still | R1_TR08_020 | 1634 | 19.7 | - | - | 791 644.5 | 2 713 422.1 | |
| 10/06/2020 | 19:40:46 | R1_TR08 | Video | EOL | 1635 | 19.7 | 791 645.3 | 2 713 424.6 | 791 638.0 | 2 713 427.6 | |
| 10/06/2020 | 20:14:32 | R1_TR08A | Video | SOL | 1636 | 19.8 | 791 645.3 | 2 713 424.6 | 791 639.0 | 2 713 431.6 | |
| 10/06/2020 | 20:14:49 | R1_TR08A | Still | R1_TR08A_001 | 1637 | 19.9 | - | - | 791 640.8 | 2 713 428.9 | |
| 10/06/2020 | 20:15:16 | R1_TR08A | Still | R1_TR08A_002 | 1638 | 19.8 | - | - | 791 644.2 | 2 713 424.8 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 10/06/2020 | 20:15:45 | R1_TR08A | Still | R1_TR08A_003 | 1639 | 19.8 | - | - | 791 648.3 | 2 713 420.1 | |
| 10/06/2020 | 20:16:29 | R1_TR08A | Still | R1_TR08A_004 | 1640 | 19.7 | - | - | 791 654.4 | 2 713 412.8 | |
| 10/06/2020 | 20:16:58 | R1_TR08A | Still | R1_TR08A_005 | 1641 | 19.7 | - | - | 791 660.4 | 2 713 408.3 | |
| 10/06/2020 | 20:17:50 | R1_TR08A | Still | R1_TR08A_006 | 1642 | 19.8 | - | - | 791 666.4 | 2 713 400.0 | |
| 10/06/2020 | 20:18:16 | R1_TR08A | Still | R1_TR08A_007 | 1643 | 19.7 | - | - | 791 668.9 | 2 713 395.9 | |
| 10/06/2020 | 20:18:42 | R1_TR08A | Still | R1_TR08A_008 | 1644 | 19.8 | - | - | 791 672.7 | 2 713 392.4 | |
| 10/06/2020 | 20:19:31 | R1_TR08A | Still | R1_TR08A_009 | 1645 | 19.8 | - | - | 791 679.4 | 2 713 384.1 | |
| 10/06/2020 | 20:20:24 | R1_TR08A | Still | R1_TR08A_010 | 1646 | 19.8 | - | - | 791 688.2 | 2 713 374.3 | |
| 10/06/2020 | 20:20:48 | R1_TR08A | Still | R1_TR08A_011 | 1647 | 19.8 | - | - | 791 692.0 | 2 713 370.5 | |
| 10/06/2020 | 20:21:26 | R1_TR08A | Still | R1_TR08A_012 | 1648 | 20.0 | - | - | 791 696.5 | 2 713 365.0 | |
| 10/06/2020 | 20:22:04 | R1_TR08A | Still | R1_TR08A_013 | 1649 | 19.8 | - | - | 791 700.9 | 2 713 360.6 | |
| 10/06/2020 | 20:22:34 | R1_TR08A | Still | R1_TR08A_014 | 1650 | 19.8 | - | - | 791 702.3 | 2 713 355.4 | |
| 10/06/2020 | 20:23:22 | R1_TR08A | Still | R1_TR08A_015 | 1651 | 19.8 | - | - | 791 710.1 | 2 713 349.2 | |
| 10/06/2020 | 20:24:25 | R1_TR08A | Still | R1_TR08A_016 | 1652 | 19.9 | - | - | 791 718.7 | 2 713 336.4 | |
| 10/06/2020 | 20:24:53 | R1_TR08A | Still | R1_TR08A_017 | 1653 | 19.8 | - | - | 791 723.5 | 2 713 331.7 | |
| 10/06/2020 | 20:25:43 | R1_TR08A | Still | R1_TR08A_018 | 1654 | 19.9 | - | - | 791 729.3 | 2 713 325.5 | |
| 10/06/2020 | 20:26:18 | R1_TR08A | Still | R1_TR08A_019 | 1655 | 19.9 | - | - | 791 732.2 | 2 713 321.4 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 10/06/2020 | 20:27:07 | R1_TR08A | Video | EOL | 1656 | 19.9 | 791 736.9 | 2 713 316.5 | 791 738.5 | 2 713 314.5 | |
| 10/06/2020 | 21:21:27 | R1_ENV_REF | VV | Partial Sample | 1657 | 20.1 | 791 692.6 | 2 713 369.3 | 791 693.4 | 2 713 369.5 | |
| 10/06/2020 | 21:27:36 | R1_ENV_REF | VV | Partial Sample | 1658 | 19.9 | 791 692.6 | 2 713 369.3 | 791 695.5 | 2 713 360.3 | |
| 10/06/2020 | 21:32:08 | R1_ENV_REF | VV | NS | 1659 | 19.9 | 791 692.6 | 2 713 369.3 | 791 692.4 | 2 713 379.2 | |
| 10/06/2020 | 21:35:49 | SO_R1_REF | VV | NS | 1660 | 20.0 | 791 692.6 | 2 713 369.3 | 791 694.9 | 2 713 361.0 | |
| 10/06/2020 | 22:04:17 | R1_ENV_REF | WP | YSI Exo2 | 1661 | 20.0 | 791 692.6 | 2 713 369.3 | 791 692.8 | 2 713 369.7 | |
| 11/06/2020 | 05:41:51 | R1_ENV_001 | WS | MID | 482 | 9.9 | 751 800.5 | 2 669 184.1 | 751 797.8 | 2 669 184.1 | |
| 11/06/2020 | 05:41:51 | R1_ENV_001a | WP | YSI Exo2 | 482 | 9.9 | 751 800.5 | 2 669 184.1 | 751 797.8 | 2 669 184.1 | |
| 11/06/2020 | 05:59:16 | R1_ENV_001 | VV | PC | 483 | 9.7 | 751 800.5 | 2 669 184.1 | 751 795.0 | 2 669 186.9 | |
| 11/06/2020 | 06:31:45 | R1_ENV_002 | VV | PC | 484 | 11.0 | 752 765.9 | 2 669 444.8 | 752 759.6 | 2 669 445.5 | |
| 11/06/2020 | 07:11:46 | R1_ENV_002a | WP | YSI Exo2 | 485 | 10.7 | 752 765.9 | 2 669 444.8 | 752 759.8 | 2 669 448.3 | |
| 11/06/2020 | 07:28:07 | R1_ENV_003 | VV | NS | 486 | 5.4 | 753 732.2 | 2 669 702.4 | 753 729.0 | 2 669 706.1 | |
| 11/06/2020 | 07:35:05 | R1_ENV_003 | VV | NS | 487 | 5.3 | 753 732.2 | 2 669 702.4 | 753 730.1 | 2 669 700.9 | |
| 11/06/2020 | 07:39:00 | R1_ENV_003 | VV | NS | 488 | 5.6 | 753 732.2 | 2 669 702.4 | 753 727.9 | 2 669 698.4 | |
| 11/06/2020 | 07:49:57 | R1_ENV_004 | VV | NS | 489 | 5.7 | 754 698.0 | 2 669 961.5 | 754 693.8 | 2 669 961.6 | |
| 11/06/2020 | 07:54:20 | R1_ENV_004 | VV | NS | 490 | 5.8 | 754 698.0 | 2 669 961.5 | 754 691.9 | 2 669 955.1 | |
| 11/06/2020 | 08:00:05 | R1_ENV_004 | VV | NS | 491 | 5.6 | 754 698.0 | 2 669 961.5 | 754 693.3 | 2 669 965.7 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 11/06/2020 | 08:09:40 | R1_ENV_005 | VV | NS | 492 | 6.0 | 755 664.9 | 2 670 216.9 | 755 664.4 | 2 670 218.0 | |
| 11/06/2020 | 08:17:33 | R1_ENV_005 | VV | NS | 493 | 6.0 | 755 664.9 | 2 670 216.9 | 755 661.7 | 2 670 225.2 | |
| 11/06/2020 | 08:22:05 | R1_ENV_005 | VV | NS | 494 | 6.0 | 755 664.9 | 2 670 216.9 | 755 666.8 | 2 670 211.9 | |
| 11/06/2020 | 09:28:45 | R1_ENV_011 | VV | NS | 495 | 4.3 | 761 468.0 | 2 671 740.2 | 761 460.5 | 2 671 736.9 | |
| 11/06/2020 | 09:32:57 | R1_ENV_011 | VV | NS | 496 | 4.3 | 761 468.0 | 2 671 740.2 | 761 467.9 | 2 671 741.2 | |
| 11/06/2020 | 09:37:20 | R1_ENV_011 | VV | NS | 497 | 4.4 | 761 468.0 | 2 671 740.2 | 761 465.2 | 2 671 732.8 | |
| 11/06/2020 | 10:32:08 | R1_TR04 | Video | SOL | 500 | 5.0 | 764 987.8 | 2 675 363.7 | 764 971.1 | 2 675 367.4 | |
| 11/06/2020 | 10:32:14 | R1_TR04 | Still | R1_TR04_001 | 501 | 2.8 | - | - | 764 982.3 | 2 675 359.2 | |
| 11/06/2020 | 10:32:47 | R1_TR04 | Still | R1_TR04_002 | 502 | 6.7 | - | - | 765 009.5 | 2 675 356.6 | |
| 11/06/2020 | 10:33:05 | R1_TR04 | Still | R1_TR04_003 | 503 | 7.0 | - | - | 765 031.1 | 2 675 358.8 | |
| 11/06/2020 | 10:33:12 | R1_TR04 | Still | R1_TR04_004 | 504 | 6.8 | - | - | 765 039.9 | 2 675 360.2 | |
| 11/06/2020 | 10:33:18 | R1_TR04 | Still | R1_TR04_005 | 505 | 6.8 | - | - | 765 047.5 | 2 675 360.1 | |
| 11/06/2020 | 10:33:28 | R1_TR04 | Still | R1_TR04_006 | 506 | 6.7 | - | - | 765 057.6 | 2 675 356.1 | |
| 11/06/2020 | 10:33:41 | R1_TR04 | Still | R1_TR04_007 | 507 | 6.7 | - | - | 765 067.2 | 2 675 350.7 | |
| 11/06/2020 | 10:33:45 | R1_TR04 | Still | R1_TR04_008 | 508 | 6.8 | - | - | 765 069.1 | 2 675 349.7 | |
| 11/06/2020 | 10:33:52 | R1_TR04 | Still | R1_TR04_009 | 509 | 6.8 | - | - | 765 071.9 | 2 675 347.9 | |
| 11/06/2020 | 10:33:59 | R1_TR04 | Still | R1_TR04_010 | 510 | 6.8 | - | - | 765 074.4 | 2 675 346.4 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 11/06/2020 | 10:34:19 | R1_TR04 | Still | R1_TR04_011 | 511 | 6.8 | - | - | 765 083.8 | 2 675 348.7 | |
| 11/06/2020 | 10:34:21 | R1_TR04 | Video | EOL | 512 | 6.7 | 765 082.0 | 2 675 363.3 | 765 085.6 | 2 675 349.1 | |
| 11/06/2020 | 10:55:19 | R1_ENV_019 | WP | YSI Exo2 | 513 | 3.5 | 765 502.2 | 2 677 375.5 | 765 499.6 | 2 677 367.7 | |
| 11/06/2020 | 11:52:13 | R1_ENV_026 | WS | MID | 514 | 10.5 | 770 226.2 | 2 683 071.7 | 770 227.1 | 2 683 066.5 | |
| 11/06/2020 | 12:06:41 | R1_ENV_026 | WS | TOP | 515 | 10.6 | 770 226.2 | 2 683 071.7 | 770 224.3 | 2 683 070.8 | |
| 11/06/2020 | 12:31:27 | R1_ENV_028 | VV | NS | 516 | 9.9 | 770 865.6 | 2 684 966.7 | 770 858.9 | 2 684 964.9 | |
| 11/06/2020 | 12:42:00 | R1_ENV_028 | VV | NS | 517 | 9.9 | 770 865.6 | 2 684 966.7 | 770 862.8 | 2 684 962.4 | |
| 11/06/2020 | 12:48:17 | R1_ENV_028 | VV | NS | 518 | 9.9 | 770 865.6 | 2 684 966.7 | 770 863.8 | 2 684 969.8 | |
| 11/06/2020 | 15:39:10 | R1_TR05A | Video | SOL | 1662 | 12.8 | 771 193.4 | 2 689 055.8 | 771 190.9 | 2 689 048.2 | |
| 11/06/2020 | 15:39:26 | R1_TR05A | Still | R1_TR05A_001 | 1663 | 12.8 | - | - | 771 191.3 | 2 689 051.4 | |
| 11/06/2020 | 15:40:05 | R1_TR05A | Still | R1_TR05A_002 | 1664 | 12.8 | - | - | 771 192.9 | 2 689 059.1 | |
| 11/06/2020 | 15:40:24 | R1_TR05A | Still | R1_TR05A_003 | 1665 | 12.8 | - | - | 771 194.0 | 2 689 062.9 | |
| 11/06/2020 | 15:41:01 | R1_TR05A | Still | R1_TR05A_004 | 1666 | 12.8 | - | - | 771 195.7 | 2 689 070.0 | |
| 11/06/2020 | 15:41:21 | R1_TR05A | Still | R1_TR05A_005 | 1667 | 12.8 | - | - | 771 196.2 | 2 689 074.2 | |
| 11/06/2020 | 15:42:06 | R1_TR05A | Still | R1_TR05A_006 | 1668 | 12.9 | - | - | 771 197.9 | 2 689 083.3 | |
| 11/06/2020 | 15:42:51 | R1_TR05A | Still | R1_TR05A_007 | 1669 | 12.8 | - | - | 771 199.4 | 2 689 092.2 | |
| 11/06/2020 | 15:43:11 | R1_TR05A | Still | R1_TR05A_008 | 1670 | 12.9 | - | - | 771 200.3 | 2 689 096.1 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 11/06/2020 | 15:43:59 | R1_TR05A | Still | R1_TR05A_009 | 1671 | 12.9 | - | - | 771 202.9 | 2 689 105.8 | |
| 11/06/2020 | 15:44:39 | R1_TR05A | Still | R1_TR05A_010 | 1672 | 12.8 | - | - | 771 204.4 | 2 689 113.7 | |
| 11/06/2020 | 15:45:32 | R1_TR05A | Still | R1_TR05A_011 | 1673 | 12.8 | - | - | 771 206.5 | 2 689 124.6 | |
| 11/06/2020 | 15:46:36 | R1_TR05A | Still | R1_TR05A_012 | 1674 | 12.9 | - | - | 771 209.7 | 2 689 137.1 | |
| 11/06/2020 | 15:47:20 | R1_TR05A | Still | R1_TR05A_013 | 1675 | 12.9 | - | - | 771 211.4 | 2 689 146.0 | |
| 11/06/2020 | 15:48:24 | R1_TR05A | Still | R1_TR05A_014 | 1676 | 12.9 | - | - | 771 213.7 | 2 689 158.9 | |
| 11/06/2020 | 15:49:40 | R1_TR05A | Video | EOL | 1677 | 12.8 | 771 217.7 | 2 689 171.2 | 771 217.1 | 2 689 174.4 | |
| 11/06/2020 | 17:37:20 | R1_TR06 | Video | SOL | 1678 | 14.4 | 777 340.1 | 2 701 657.1 | 777 336.0 | 2 701 650.7 | |
| 11/06/2020 | 17:37:37 | R1_TR06 | Still | R1_TR06_001 | 1679 | 14.5 | - | - | 777 337.9 | 2 701 653.7 | |
| 11/06/2020 | 17:38:04 | R1_TR06 | Still | R1_TR06_002 | 1680 | 14.4 | - | - | 777 341.2 | 2 701 358.9 | |
| 11/06/2020 | 17:38:27 | R1_TR06 | Still | R1_TR06_003 | 1681 | 14.5 | - | - | 777 342.9 | 2 701 663.8 | |
| 11/06/2020 | 17:39:16 | R1_TR06 | Still | R1_TR06_004 | 1682 | 14.7 | - | - | 777 347.7 | 2 701 673.7 | |
| 11/06/2020 | 17:40:10 | R1_TR06 | Still | R1_TR06_005 | 1683 | 15.3 | - | - | 777 353.0 | 2 701 685.1 | |
| 11/06/2020 | 17:40:59 | R1_TR06 | Still | R1_TR06_006 | 1684 | 15.9 | - | - | 777 357.7 | 2 701 694..1 | |
| 11/06/2020 | 17:41:27 | R1_TR06 | Still | R1_TR06_007 | 1685 | 16.1 | - | - | 777 360.1 | 2 701 698.8 | |
| 11/06/2020 | 17:41:59 | R1_TR06 | Still | R1_TR06_008 | 1686 | 16.2 | - | - | 777 363.0 | 2 701 704.4 | |
| 11/06/2020 | 17:42:50 | R1_TR06 | Still | R1_TR06_009 | 1687 | 16.1 | - | - | 777 368.0 | 2 701 714.1 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 11/06/2020 | 17:43:24 | R1_TR06 | Still | R1_TR06_010 | 1688 | 16.1 | - | - | 777 371.6 | 2 701 720.9 | |
| 11/06/2020 | 17:44:14 | R1_TR06 | Still | R1_TR06_011 | 1689 | 16.1 | - | - | 777 376.5 | 2 701 731.7 | |
| 11/06/2020 | 17:45:09 | R1_TR06 | Still | R1_TR06_012 | 1690 | 16.0 | - | - | 777 381.9 | 2 701 742.5 | |
| 11/06/2020 | 17:45:32 | R1_TR06 | Still | R1_TR06_013 | 1691 | 16.0 | - | - | 777 383.3 | 2 701 746.1 | |
| 11/06/2020 | 17:46:20 | R1_TR06 | Still | R1_TR06_014 | 1692 | 16.1 | - | - | 777 387.7 | 2 701 752.6 | |
| 11/06/2020 | 17:47:02 | R1_TR06 | Still | R1_TR06_015 | 1693 | 16.2 | - | - | 777 391.3 | 2 701 760.4 | |
| 11/06/2020 | 17:47:58 | R1_TR06 | Still | R1_TR06_016 | 1694 | 16.3 | - | - | 777 396.6 | 2 701 772.3 | |
| 11/06/2020 | 17:48:30 | R1_TR06 | Still | R1_TR06_017 | 1695 | 16.4 | - | - | 777 399.3 | 2 701 778.9 | |
| 11/06/2020 | 17:48:53 | R1_TR06 | Video | EOL | 1696 | 16.4 | 777 401.5 | 2 701 779.7 | 777 401.6 | 2 701 783.0 | |
| 15/06/2020 | 08:59:39 | SO_R1_012 | VV | SOIL | 1697 | 10.5 | 786 750.8 | 2 744 304.6 | 786 759.1 | 2 744 406.9 | Moved due to potential presence of shallow gas |
| 15/06/2020 | 09:37:27 | R1_ENV_100 | VV | NS | 1698 | 9.4 | 786 829.6 | 2 748 303.8 | 786 828.6 | 2 748 302.7 | |
| 15/06/2020 | 09:41:10 | R1_ENV_100 | VV | NS | 1699 | 9.5 | 786 829.6 | 2 748 303.8 | 786 829.5 | 2 748 302.1 | |
| 15/06/2020 | 09:44:35 | R1_ENV_100 | VV | NS | 1700 | 9.6 | 786 829.6 | 2 748 303.8 | 786 822.0 | 2 748 308.7 | |
| 15/06/2020 | 09:48:27 | R1_ENV_100 | WS | BOT | 1701 | 9.6 | 786 829.6 | 2 748 303.8 | 786 828.9 | 2 748 303.3 | |
| 15/06/2020 | 09:59:20 | R1_ENV_100 | WS | TOP | 1702 | 9.5 | 786 829.6 | 2 748 303.8 | 786 829.1 | 2 748 304.6 | |
| 15/06/2020 | 10:12:18 | R1_ENV_100 | WP | YSI Exo2 | 1703 | 9.5 | 786 829.6 | 2 748 303.8 | 786 831.3 | 2 748 305.5 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 15/06/2020 | 10:50:37 | R1_ENV_102 | VV | NS | 1704 | 12.0 | 786 868.9 | 2 750 303.4 | 786 870.6 | 2 750 301.9 | |
| 15/06/2020 | 10:56:01 | R1_ENV_102 | VV | NS | 1705 | 11.9 | 786 868.9 | 2 750 303.4 | 786 863.9 | 2 750 310.7 | |
| 15/06/2020 | 11:00:33 | R1_ENV_102 | VV | NS | 1706 | 12.1 | 786 868.9 | 2 750 303.4 | 786 875.7 | 2 750 296.2 | |
| 15/06/2020 | 11:03:49 | R1_ENV_102 | WS | BOT | 1707 | 11.9 | 786 868.9 | 2 750 303.4 | 786 870.7 | 2 750 302.6 | |
| 15/06/2020 | 11:09:53 | R1_ENV_102 | WS | MID | 1708 | 12.1 | 786 868.9 | 2 750 303.4 | 786 869.4 | 2 750 302.1 | |
| 15/06/2020 | 11:15:43 | R1_ENV_102 | WS | TOP | 1709 | 12.0 | 786 868.9 | 2 750 303.4 | 786 869.8 | 2 750 301.9 | |
| 15/06/2020 | 11:23:45 | R1_ENV_102 | WP | YSI Exo2 | 1710 | 11.9 | 786 868.9 | 2 750 303.4 | 786 871.4 | 2 750 303.6 | |
| 15/06/2020 | 11:54:50 | R1_ENV_103 | WS | BOT | 1711 | 12.1 | 785 888.8 | 2 751 322.9 | 785 889.2 | 2 751 322.1 | |
| 15/06/2020 | 11:56:33 | R1_ENV_103 | WP | YSI Exo2 | 1712 | 12.3 | 785 888.8 | 2 751 322.9 | 785 891.1 | 2 751 322.5 | |
| 15/06/2020 | 12:00:35 | R1_ENV_103 | WS | MID | 1713 | 12.3 | 785 888.8 | 2 751 322.9 | 785 889.6 | 2 751 322.1 | |
| 15/06/2020 | 12:06:53 | R1_ENV_103 | WS | TOP | 1714 | 12.3 | 785 888.8 | 2 751 322.9 | 785 888.8 | 2 751 323.0 | |
| 15/06/2020 | 12:12:47 | R1_ENV_103 | VV | NS | 1715 | 12.3 | 785 888.8 | 2 751 322.9 | 785 888.1 | 2 751 322.5 | |
| 15/06/2020 | 12:17:31 | R1_ENV_103 | VV | NS | 1716 | 12.4 | 785 888.8 | 2 751 322.9 | 785 880.0 | 2 751 325.8 | |
| 15/06/2020 | 12:19:13 | R1_ENV_103 | VV | NS | 1717 | 12.3 | 785 888.8 | 2 751 322.9 | 785 895.7 | 2 751 315.4 | |
| 15/06/2020 | 13:00:09 | SO_R1_013 | VV | SOIL | 1718 | 14.5 | 786 908.3 | 2 752 303.1 | 786 910.1 | 2 752 301.8 | |
| 15/06/2020 | 13:02:23 | R1_ENV_104 | VV | Partial Sample | 1719 | 14.6 | 786 908.3 | 2 752 303.1 | 786 910.7 | 2 752 302.1 | HM only |
| 15/06/2020 | 13:10:29 | R1_ENV_104 | VV | Partial Sample | 1720 | 14.4 | 786 908.3 | 2 752 303.1 | 786 902.0 | 2 752 308.9 | HC only |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 15/06/2020 | 13:13:41 | R1_ENV_104 | VV | NS | 1721 | 14.5 | 786 908.3 | 2 752 303.1 | 786 916.2 | 2 752 295.9 | |
| 15/06/2020 | 13:19:16 | R1_ENV_104 | WS | TOP | 1722 | 14.3 | 786 908.3 | 2 752 303.1 | 786 907.2 | 2 752 302.1 | |
| 15/06/2020 | 13:28:54 | R1_ENV_104 | WP | YSI Exo2 | 1723 | 14.6 | 786 908.3 | 2 752 303.1 | 786 908.6 | 2 752 305.1 | |
| 15/06/2020 | 18:55:17 | R1_ENV_REF | WS | BOT | 1724 | 19.3 | 791 692.6 | 2 713 369.3 | 791 694.0 | 2 713 367.7 | |
| 15/06/2020 | 19:04:55 | R1_ENV_REF | WS | MID | 1725 | 19.2 | 791 692.6 | 2 713 369.3 | 791 692.3 | 2 713 368.7 | |
| 15/06/2020 | 19:13:30 | R1_ENV_REF | WS | TOP | 1726 | 19.3 | 791 692.6 | 2 713 369.3 | 791 693.6 | 2 713 368.4 | |
| 15/06/2020 | 21:07:26 | R1_TR04B | Video | SOL | 1727 | 16.5 | 788 932.0 | 2 711 776.1 | 788 940.4 | 2 711 779.3 | |
| 15/06/2020 | 21:08:23 | R1_TR04B | Still | R1_TR04B_001 | 1728 | 16.3 | - | - | 788 935.5 | 2 711 767.5 | |
| 15/06/2020 | 21:08:34 | R1_TR04B | Still | R1_TR04B_002 | 1729 | 16.3 | - | - | 788 933.3 | 2 711 767.6 | |
| 15/06/2020 | 21:08:57 | R1_TR04B | Still | R1_TR04B_003 | 1730 | 16.4 | - | - | 788 929.1 | 2 711 766.9 | |
| 15/06/2020 | 21:09:30 | R1_TR04B | Still | R1_TR04B_004 | 1731 | 16.1 | - | - | 788 927.4 | 2 711 761.6 | |
| 15/06/2020 | 21:09:56 | R1_TR04B | Still | R1_TR04B_005 | 1732 | 16.1 | - | - | 788 923.8 | 2 711 760.7 | |
| 15/06/2020 | 21:10:50 | R1_TR04B | Still | R1_TR04B_006 | 1733 | 16.0 | - | - | 788 920.3 | 2 711 754.7 | |
| 15/06/2020 | 21:11:29 | R1_TR04B | Still | R1_TR04B_007 | 1734 | 15.9 | - | - | 788 918.4 | 2 711 749.3 | |
| 15/06/2020 | 21:12:02 | R1_TR04B | Still | R1_TR04B_008 | 1735 | 15.9 | - | - | 788 913.5 | 2 711 749.5 | |
| 15/06/2020 | 21:12:31 | R1_TR04B | Still | R1_TR04B_009 | 1736 | 15.7 | - | - | 788 911.6 | 2 711 746.4 | |
| 15/06/2020 | 21:13:58 | R1_TR04B | Still | R1_TR04B_010 | 1737 | 15.2 | - | - | 788 898.6 | 2 711 739.2 | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 15/06/2020 | 21:15:22 | R1_TR04B | Still | R1_TR04B_011 | 1738 | 15.3 | - | - | 788 892.8 | 2 711 732.3 | |
| 15/06/2020 | 21:15:40 | R1_TR04B | Still | R1_TR04B_012 | 1739 | 15.4 | - | - | 788 890.7 | 2 711 730.4 | |
| 15/06/2020 | 21:17:23 | R1_TR04B | Still | R1_TR04B_013 | 1740 | 15.9 | - | - | 788 873.6 | 2 711 712.3 | |
| 15/06/2020 | 21:18:17 | R1_TR04B | Still | R1_TR04B_014 | 1741 | 16.1 | - | - | 788 863.6 | 2 711 700.7 | |
| 15/06/2020 | 21:19:10 | R1_TR04B | Still | R1_TR04B_015 | 1742 | 16.3 | - | - | 788 855.9 | 2 711 690.6 | |
| 15/06/2020 | 21:20:49 | R1_TR04B | Still | R1_TR04B_016 | 1743 | 16.5 | - | - | 788 837.3 | 2 711 679.2 | |
| 15/06/2020 | 21:21:04 | R1_TR04B | Still | R1_TR04B_017 | 1744 | 16.5 | - | - | 788 834.6 | 2 711 677.3 | |
| 15/06/2020 | 21:22:04 | R1_TR04B | Still | R1_TR04B_018 | 1745 | 16.5 | - | - | 788 825.6 | 2 711 667.9 | |
| 15/06/2020 | 21:22:53 | R1_TR04B | Video | EOL | 1746 | 16.5 | 788 820.3 | 2 711 668.3 | 788 817.7 | 2 711 661.5 | |
| 15/06/2020 | 22:57:27 | R1_TR07 | Video | SOL | 1747 | 22.6 | 793 049.3 | 2 722 052.6 | 793 050.8 | 2 722 048.5 | |
| 15/06/2020 | 22:57:41 | R1_TR07 | Still | R1_TR07_001 | - | 22.7 | - | - | 793 047.5 | 2 722 051.2 | |
| 15/06/2020 | 22:57:47 | R1_TR07 | Still | R1_TR07_002 | - | 22.7 | - | - | 793 047.0 | 2 722 052.6 | |
| 15/06/2020 | 22:57:52 | R1_TR07 | Still | R1_TR07_003 | - | 22.6 | - | - | 793 046.8 | 2 722 053.9 | |
| 15/06/2020 | 22:57:53 | R1_TR07 | Still | R1_TR07_004 | - | 22.8 | - | - | 793 047.0 | 2 722 054.2 | |
| 15/06/2020 | 22:57:59 | R1_TR07 | Still | R1_TR07_005 | - | 22.7 | - | - | 793 046.8 | 2 272 055.7 | |
| 15/06/2020 | 22:58:00 | R1_TR07 | Still | R1_TR07_006 | 1748 | 22.7 | - | - | 793 046.7 | 2 722 055.7 | |
| 15/06/2020 | 22:58:06 | R1_TR07 | Still | R1_TR07_007 | - | 22.7 | - | - | 793 046.1 | 2 722 057.1 | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |
| 15/06/2020 | 22:58:17 | R1_TR07 | Still | R1_TR07_008 | - | 22.6 | - | - | 793 044.8 | 2 722 059.0 | |
| 15/06/2020 | 22:58:21 | R1_TR07 | Still | R1_TR07_009 | - | 22.7 | - | - | 793 044.5 | 2 722 059.9 | |
| 15/06/2020 | 22:58:24 | R1_TR07 | Still | R1_TR07_010 | - | 22.6 | - | - | 793 044.4 | 2 722 060.1 | |
| 15/06/2020 | 22:58:35 | R1_TR07 | Still | R1_TR07_011 | - | 22.6 | - | - | 793 044.1 | 2 722 062.0 | |
| 15/06/2020 | 23:59:09 | R1_TR07 | Still | R1_TR07_012 | - | 22.7 | - | - | 793 043.9 | 2 722 067.6 | |
| 15/06/2020 | 23:00:42 | R1_TR07 | Still | R1_TR07_013 | - | 22.9 | - | - | 793 034.9 | 2 722 084.1 | |
| 15/06/2020 | 23:01:10 | R1_TR07 | Still | R1_TR07_014 | - | 23.1 | - | - | 793 033.1 | 2 722 088.9 | |
| 15/06/2020 | 23:02:33 | R1_TR07 | Still | R1_TR07_015 | 1754 | 23.3 | - | - | 793 026.8 | 2 722 102.7 | |
| 15/06/2020 | 23:05:10 | R1_TR07 | Still | R1_TR07_016 | - | 25.2 | - | - | 793 015.4 | 2 722 132.9 | |
| 15/06/2020 | 23:05:31 | R1_TR07 | Still | R1_TR07_017 | 1756 | 25.3 | - | - | 793 013.6 | 2 722 137.0 | |
| 15/06/2020 | 23:06:00 | R1_TR07 | Still | R1_TR07_018 | 1757 | 25.5 | - | - | 793 011.8 | 2 722 142.6 | |
| 15/06/2020 | 23:08:33 | R1_TR07 | Still | R1_TR07_019 | 1758 | 26.0 | - | - | 792 995.7 | 2 722 176.1 | |
| 15/06/2020 | 23:09:26 | R1_TR07 | Video | EOL | 1759 | 26.0 | 792 993.1 | 2 722 185.5 | 792 992.7 | 2 722 187.8 | |

Notes
UTC = Coordinated Universal Time
BSL = Below sea level
VV = Single van Veen grab
NS = No sample
PC = Physico-chemical sample
HM = Heavy metal sample
HC = Hydrocarbon sample

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time [UTC] | Transect/ Station | Type | Sample Rep/ Still No. | Fix No. | Water Depth [m BSL] | Proposed Location | | Actual Location | | Notes |
| | | | | | | | Easting [m] | Northing [m] | Easting [m] | Northing [m] | |

PSD = Particle size distribution
SOL = Start of line
EOL = End of line
TOP = Surface water sample
MID = Mid water depth water sample
BOT = Near seabed water sample
WP = Water profile
WS = Water sample

## C.2 Grab Log

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [°C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 14/05/2020 | 17:15 | R1_ENV_030 | PC | 266 | 8 | - | - | - | gS | Gravelly coarse sand with shell fragments | Grey | |
| 14/05/2020 | 17:54 | R1_ENV_031 | PC | 267 | 7 | - | - | - | gS | Gravelly coarse sand with shell fragments | Grey | |
| 14/05/2020 | 21:23 | SO_R1_004 | NS | 276 | 4 | - | - | - | gS | Gravelly coarse sand | Grey | |
| 14/05/2020 | 21:35 | R1_ENV_032 | NS | 277 | 4 | - | - | - | gS | Gravelly coarse sand | Grey | |
| 14/05/2020 | 21:42 | R1_ENV_032 | NS | 278 | 2 | - | - | - | gS | Gravelly coarse sand | Grey | |
| 14/05/2020 | 21:50 | R1_ENV_032 | NS | 279 | 2 | - | - | - | gS | Gravelly coarse sand | Grey | |
| 14/05/2020 | 22:16 | R1_ENV_033 | NS | 280 | < 1 | - | - | - | gS | Gravelly coarse sand | Grey | |
| 14/05/2020 | 22:21 | R1_ENV_033 | NS | 281 | < 1 | - | - | - | gS | Gravelly coarse sand | Grey | Bryozoa |
| 14/05/2020 | 22:26 | R1_ENV_033 | NS | 282 | 2 | - | - | - | gS | Gravelly coarse sand | Grey | |
| 15/05/2020 | 05:12 | R1_ENV_025 | NS | 365 | < 2 | - | - | - | gS | Gravelly coarse sand with shell fragments | Pale yellow (2.5Y 8/6) | |
| 15/05/2020 | 05:32 | R1_ENV_025 | NS | 367 | < 2 | - | - | - | gS | Gravelly coarse sand with shell fragments | Pale yellow (2.5Y 8/6) | |
| 15/05/2020 | 05:43 | R1_ENV_025 | NS | 368 | < 2 | - | - | - | gS | Gravelly coarse sand with shell fragments | Pale yellow (2.5Y 8/6) | |
| 15/05/2020 | 06:03 | R1_ENV_024 | NS | 369 | 4 | 32 | 233 | 8 | mS | Muddy coarse sand with shell fragments | Pale yellow (2.5Y 8/4) | |
| 15/05/2020 | 06:27 | R1_ENV_024 | NS | 370 | < 2 | - | - | - | S | Sand | Pale yellow | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [°C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 15/05/2020 | 06:35 | R1_ENV_024 | NS | 371 | < 1 | - | - | - | S | Sand | Pale yellow | |
| 15/05/2020 | 06:42 | SO_R1_003 | PC | 372 | < 1 | - | - | - | S | Sand | Pale yellow | |
| 15/05/2020 | 07:01 | R1_ENV_023 | NS | 373 | < 1 | - | - | - | S | Sand | Pale yellow | |
| 15/05/2020 | 07:07 | R1_ENV_023 | NS | 374 | < 1 | - | - | - | S | Sand | Pale yellow | |
| 15/05/2020 | 07:13 | R1_ENV_023 | NS | 375 | < 1 | - | - | - | S | Sand | Pale yellow | |
| 15/05/2020 | 07:27 | R1_ENV_022 | NS | 376 | < 1 | - | - | - | S | Sand | Pale yellow | Seagrass |
| 15/05/2020 | 07:33 | R1_ENV_022 | NS | 377 | 0 | - | - | - | | | | |
| 15/05/2020 | 07:38 | R1_ENV_022 | NS | 378 | 2 | - | - | - | S | Sand | Pale yellow | Algae in jaws |
| 15/05/2020 | 07:57 | R1_ENV_021 | NS | 379 | 3 | - | - | - | S | Sand | Pale yellow | Seagrass and algae |
| 15/05/2020 | 08:03 | R1_ENV_021 | NS | 380 | < 1 | - | - | - | S | Sand | Pale yellow | |
| 15/05/2020 | 08:12 | R1_ENV_021 | NS | 381 | < 1 | - | - | - | S | Sand | Pale yellow | |
| 15/05/2020 | 08:28 | R1_ENV_020 | NS | 382 | < 1 | - | - | - | mS | Sand with coral rubble | Pale yellow | |
| 15/05/2020 | 08:34 | R1_ENV_020 | NS | 383 | < 1 | - | - | - | S | Sand | Pale yellow | |
| 15/05/2020 | 08:39 | R1_ENV_020 | NS | 384 | 2 | - | - | - | S | Sand | Pale yellow | |
| 15/05/2020 | 08:52 | R1_ENV_019 | NS | 385 | 0 | - | - | - | | | | |
| 15/05/2020 | 09:02 | R1_ENV_019 | NS | 386 | 0 | - | - | - | | | | |
| 15/05/2020 | 09:10 | R1_ENV_019 | NS | 387 | 2 | - | - | - | gS | Coarse sand and gravel, coral rubble | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [°C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 15/05/2020 | 09:24 | R1_ENV_018 | NS | 388 | 0 | - | - | - | | | | |
| 15/05/2020 | 09:27 | R1_ENV_018 | NS | 389 | 0 | - | - | - | | | | |
| 15/05/2020 | 09:35 | R1_ENV_018 | NS | 390 | 0 | - | - | - | | | | |
| 15/05/2020 | 09:53 | R1_ENV_017 | NS | 391 | < 1 | - | - | - | S | Coarse sand and shell fragments | Yellow | |
| 15/05/2020 | 09:57 | R1_ENV_017 | NS | 392 | | - | - | - | | | | |
| 15/05/2020 | 10:01 | R1_ENV_017 | NS | 393 | 0 | - | - | - | | | | |
| 15/05/2020 | 10:13 | R1_ENV_016 | NS | 394 | 0 | - | - | - | | | | |
| 15/05/2020 | 10:20 | R1_ENV_016 | NS | 395 | < 1 | - | - | - | S | Coral rubble and fine sand | | |
| 15/05/2020 | 10:27 | R1_ENV_016 | NS | 396 | 0 | - | - | - | | | | |
| 15/05/2020 | 10:43 | SO_R1_002 | NS | 397 | < 1 | - | - | - | S | Sand | Yellow | |
| 15/05/2020 | 20:30 | R1_ENV_027 | NS | 295 | < 2 | - | - | - | S | Coarse sand with shell fragments | | |
| 15/05/2020 | 20:37 | R1_ENV_027 | NS | 296 | < 2 | - | - | - | S | Coarse sand with shell fragments | | |
| 15/05/2020 | 20:43 | R1_ENV_027 | NS | 297 | 0 | - | - | - | | | | |
| 15/05/2020 | 21:16 | R1_ENV_029 | PC | 298 | 8 | - | - | - | | Coarse sand with shell fragments | | - |
| 15/05/2020 | 23:46 | R1_ENV_034 | NS | 307 | 1 | - | - | - | gS | Gravelly sand | | Echinoidea |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 15/05/2020 | 23:51 | R1_ENV_034 | NS | 308 | 2 | - | - | - | gS | Gravelly sand | | |
| 15/05/2020 | 23:55 | R1_ENV_034 | NS | 309 | 3 | - | - | - | gS | Gravelly sand | | |
| 16/05/2020 | 00:18 | R1_ENV_035 | NS | 310 | 1 | - | - | - | gS | Gravelly sand | | |
| 16/05/2020 | 00:23 | R1_ENV_035 | NS | 311 | 1 | - | - | - | gS | Gravelly sand | | |
| 16/05/2020 | 00:28 | R1_ENV_035 | NS | 312 | 2 | - | - | - | gS | Sandy gravel | | |
| 16/05/2020 | 06:14 | R1_ENV_006 | NS | 437 | < 1 | - | - | - | S | Sand | | Seagrass |
| 16/05/2020 | 06:54 | R1_ENV_006 | NS | 438 | < 1 | - | - | - | S | Sand | | |
| 16/05/2020 | 07:04 | R1_ENV_006 | NS | 439 | < 1 | - | - | - | | | | |
| 16/05/2020 | 07:18 | R1_ENV_007 | NS | 440 | < 1 | - | - | - | S | Coarse sand | | Seagrass |
| 16/05/2020 | 07:23 | R1_ENV_007 | NS | 441 | < 1 | - | - | - | S | Coarse sand | | |
| 16/05/2020 | 07:30 | R1_ENV_007 | NS | 442 | < 1 | - | - | - | | | | |
| 16/05/2020 | 07:43 | R1_ENV_008 | NS | 443 | 0 | - | - | - | | | | |
| 16/05/2020 | 07:49 | R1_ENV_008 | NS | 444 | 0 | - | - | - | | | | |
| 16/05/2020 | 07:55 | R1_ENV_008 | NS | 445 | 0 | - | - | - | | | | |
| 16/05/2020 | 08:00 | SO_R1_001 | NS | 446 | 0 | - | - | - | | | | |
| 16/05/2020 | 08:12 | R1_ENV_009 | NS | 447 | 0 | - | - | - | | | | |
| 16/05/2020 | 08:17 | R1_ENV_009 | NS | 448 | 0 | - | - | - | | | | |
| 16/05/2020 | 08:25 | R1_ENV_009 | NS | 449 | < 1 | - | - | - | S | Sand | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 16/05/2020 | 08:38 | R1_ENV_010 | NS | 450 | < 1 | - | - | - | S | Coarse sand | | |
| 16/05/2020 | 08:42 | R1_ENV_010 | NS | 451 | < 1 | - | - | - | S | Coarse sand | | |
| 16/05/2020 | 08:47 | R1_ENV_010 | NS | 452 | < 1 | - | - | - | S | Coarse sand | | |
| 16/05/2020 | 09:05 | R1_ENV_012 | NS | 453 | < 1 | - | - | - | S | Coarse sand | | |
| 16/05/2020 | 09:09 | R1_ENV_012 | NS | 454 | < 1 | - | - | - | | | | |
| 16/05/2020 | 09:15 | R1_ENV_012 | NS | 455 | < 1 | - | - | - | S | Sand | | |
| 16/05/2020 | 09:26 | R1_ENV_013 | NS | 456 | < 1 | - | - | - | S | Sand | | |
| 16/05/2020 | 09:30 | R1_ENV_013 | NS | 457 | < 1 | - | - | - | S | Sand | | |
| 16/05/2020 | 09:34 | R1_ENV_013 | NS | 458 | < 1 | - | - | - | S | Sand | | |
| 16/05/2020 | 09:46 | R1_ENV_014 | NS | 459 | 3 | - | - | - | mS | Muddy coarse sand | | |
| 16/05/2020 | 09:54 | R1_ENV_014 | PC | 460 | 9 | 29 | 233 | 8 | mS | Muddy coarse sand | | |
| 16/05/2020 | 10:13 | R1_ENV_015 | NS | 461 | 0 | - | - | - | | | | |
| 16/05/2020 | 10:23 | R1_ENV_015 | NS | 462 | 0 | - | - | - | S | Coarse sand | | |
| 16/05/2020 | 10:30 | R1_ENV_015 | NS | 463 | 0 | - | - | - | S | Coarse sand | | |
| 16/05/2020 | 15:00 | R1_ENV_036 | NS | 323 | 2 | - | - | - | gS | Gravelly sand with shell fragments | | |
| 16/05/2020 | 15:05 | R1_ENV_036 | NS | 324 | 1 | - | - | - | gS | Gravelly sand with shell fragments | | Brittlestar (Ophiuroidea) |
| 16/05/2020 | 15:09 | R1_ENV_036 | NS | 325 | 3 | - | - | - | gS | Gravelly sand | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 16/05/2020 | 17:06 | R1_ENV_037 | NS | 326 | 3 | - | - | - | gS | Gravelly sand | | |
| 16/05/2020 | 17:12 | R1_ENV_037 | NS | 327 | 3 | - | - | - | gS | Gravelly sand | | |
| 16/05/2020 | 17:15 | R1_ENV_037 | NS | 328 | < 1 | - | - | - | S | Sand | | |
| 22/05/2020 | 05:49 | R1_ENV_114 | NS | 695 | 0 | - | - | - | S | Coarse sand | | Starfish (Asteroidea) |
| 22/05/2020 | 05:54 | R1_ENV_114 | NS | 696 | 0 | - | - | - | | | | |
| 22/05/2020 | 06:01 | R1_ENV_114 | NS | 697 | 0 | - | - | - | | | | |
| 22/05/2020 | 06:55 | R1_ENV_115 | NS | 699 | 0 | - | - | - | | Large shell fragments and coral rubble | | |
| 22/05/2020 | 07:01 | R1_ENV_115 | NS | 700 | 2 | - | - | - | S | Sand with shell fragments and coral rubble | Olive yellow (5Y 6/6) | |
| 22/05/2020 | 07:07 | R1_ENV_115 | NS | 701 | < 1 | - | - | - | | | | |
| 22/05/2020 | 09:35 | R1_ENV_116 | NS | 709 | 0 | - | - | - | | | | |
| 22/05/2020 | 09:42 | R1_ENV_116 | NS | 710 | 0 | - | - | - | | | | |
| 22/05/2020 | 09:46 | R1_ENV_116 | NS | 711 | 0 | - | - | - | | | | |
| 22/05/2020 | 10:11 | R1_ENV_117 | NS | 712 | 0 | - | - | - | | | | |
| 22/05/2020 | 10:18 | R1_ENV_117 | NS | 713 | 0 | - | - | - | | | | |
| 22/05/2020 | 10:24 | R1_ENV_117 | NS | 714 | 0 | - | - | - | | | | |
| 22/05/2020 | 10:24 | R1_ENV_117 | NS | 714 | 0 | - | - | - | | | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 22/05/2020 | 12:51 | R1_ENV_118 | NS | 723 | 0 | - | - | - | | | | |
| 22/05/2020 | 12:58 | R1_ENV_118 | NS | 724 | < 1 | - | - | - | | | | |
| 22/05/2020 | 13:02 | R1_ENV_118 | NS | 725 | 0 | - | - | - | | | | |
| 23/05/2020 | 06:23 | R1_ENV_119 | NS | 771 | 0 | - | - | - | | | | |
| 23/05/2020 | 06:29 | R1_ENV_119 | NS | 772 | < 1 | - | - | - | gS | Coarse sand and gravels with coral rubble | | |
| 23/05/2020 | 06:35 | R1_ENV_119 | NS | 773 | 0 | - | - | - | | | | |
| 23/05/2020 | 07:02 | R1_ENV_120 | NS | 774 | < 1 | - | - | - | | Coarse sand and gravels with coral rubble | | |
| 23/05/2020 | 07:05 | R1_ENV_120 | NS | 775 | 0 | - | - | - | | | | |
| 23/05/2020 | 07:15 | R1_ENV_120 | NS | 776 | 0 | - | - | - | | | | |
| 23/05/2020 | 07:19 | SO_R1_015 | NS | 777 | 0 | - | - | - | | | | |
| 23/05/2020 | 09:13 | R1_ENV_121 | NS | 785 | 0 | - | - | - | | | | |
| 23/05/2020 | 09:15 | R1_ENV_121 | NS | 786 | 0 | - | - | - | | | | |
| 23/05/2020 | 09:21 | R1_ENV_121 | NS | 787 | 2 | - | - | - | S | Coarse sand | Olive yellow (2.5Y 6/8) | |
| 23/05/2020 | 10:38 | R1_ENV_122 | PC | 790 | 5 | 27 | 277 | 8 | S | Coarse sand | Olive yellow (2.5Y 6/8) | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [°C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 23/05/2020 | 12:40 | R1_ENV_123 | NS | 798 | 1 | - | - | - | gS | Coarse sand with gravel and infrequent shell fragments | | Hermit crab (Paguridae) |
| 23/05/2020 | 12:48 | R1_ENV_123 | NS | 799 | 0 | - | - | - | S | Coarse and shell fragments | Yellow | |
| 23/05/2020 | 12:52 | R1_ENV_123 | NS | 800 | 0 | - | - | - | S | Coarse and shell fragments | | |
| 28/05/2020 | 12:56 | R1_ENV_107 | NS | 1059 | < 1 | - | - | - | S | Sand | | |
| 28/05/2020 | 13:16 | R1_ENV_107 | NS | 1060 | < 1 | - | - | - | S | Sand | | Sea urchin (Echinoidea) |
| 28/05/2020 | 13:26 | R1_ENV_107 | NS | 1061 | < 1 | - | - | - | S | Sand | | |
| 28/05/2020 | 14:38 | R1_ENV_106 | NS | 1062 | 0 | - | - | - | | | | |
| 28/05/2020 | 14:42 | R1_ENV_106 | NS | 1063 | 0 | - | - | - | | | | |
| 28/05/2020 | 14:45 | R1_ENV_106 | NS | 1064 | 0 | - | - | - | | | | |
| 28/05/2020 | 16:23 | R1_ENV_094 | PC | 1065 | 11 | - | - | - | M | Mud/clay | | |
| 28/05/2020 | 17:41 | R1_ENV_093 | PC | 1071 | 16 | - | - | - | M | Mud/clay | | |
| 28/05/2020 | 19:54 | R1_ENV_092 | NS | 1076 | < 1 | - | - | - | mS | Muddy sand | | |
| 28/05/2020 | 19:59 | R1_ENV_092 | NS | 1077 | 0 | - | - | - | | | | |
| 28/05/2020 | 20:03 | R1_ENV_092 | PC | 1078 | 6 | - | - | - | (g)mS | Gravelly muddy sand | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 28/05/2020 | 21:50 | R1_ENV_091 | PC | 1083 | 5 | - | - | - | (g)mS | Gravelly muddy sand | | Crab (Brachyura) |
| 28/05/2020 | 23:37 | R1_ENV_090 | NS | 1088 | 0 | - | - | - | | | | |
| 28/05/2020 | 23:42 | R1_ENV_090 | NS | 1089 | 4 | - | - | - | (g)mS | Gravelly muddy sand | | |
| 28/05/2020 | 23:46 | R1_ENV_090 | NS | 1090 | 4 | - | - | - | (g)mS | Gravelly muddy sand | | |
| 29/05/2020 | 04:58 | R1_ENV_112 | NS | 1100 | < 1 | - | - | - | S | Sand | | |
| 29/05/2020 | 05:03 | R1_ENV_112 | NS | 1101 | < 1 | - | - | - | S | Sand | | Bivalvia and sea urchin (Echinoidea) |
| 29/05/2020 | 05:09 | R1_ENV_112 | NS | 1102 | 0 | - | - | - | | | | Coral rubble |
| 29/05/2020 | 05:12 | SO_R1_014 | NS | 1103 | < 1 | - | - | - | | | | Soft coral |
| 29/05/2020 | 05:37 | R1_ENV_113 | NS | 1104 | < 1 | - | - | - | S | Sand | | |
| 29/05/2020 | 05:41 | R1_ENV_113 | NS | 1105 | < 1 | - | - | - | S | Sand | | Sea urchin (Echinoidea) |
| 29/05/2020 | 05:45 | R1_ENV_113 | NS | 1106 | < 1 | - | - | - | S | Sand | | Sea snail (Gastropoda) |
| 29/05/2020 | 08:30 | R1_ENV_129 | NS | 1111 | < 1 | - | - | - | S | Coarse sand | | |
| 29/05/2020 | 08:38 | R1_ENV_129 | NS | 1112 | < 1 | - | - | - | | | | |
| 29/05/2020 | 08:40 | R1_ENV_129 | NS | 1113 | < 1 | - | - | - | | | | |
| 29/05/2020 | 10:34 | R1_ENV_128 | NS | 1122 | 0 | - | - | - | | | | |
| 29/05/2020 | 10:39 | R1_ENV_128 | NS | 1123 | 0 | - | - | - | | | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 29/05/2020 | 10:42 | R1_ENV_128 | NS | 1124 | 0 | - | - | - | | | | |
| 29/05/2020 | 10:45 | SO_R1_016 | NS | 1125 | 0 | - | - | - | | | | |
| 29/05/2020 | 11:21 | R1_ENV_127 | NS | 1126 | < 1 | - | - | - | S | Sand with shell fragments | | Hermit crab (Paguridae) |
| 29/05/2020 | 11:24 | R1_ENV_127 | NS | 1127 | < 1 | - | - | - | S | Sand | | |
| 29/05/2020 | 11:28 | R1_ENV_127 | NS | 1128 | < 1 | - | - | - | S | Sand | | |
| 29/05/2020 | 13:17 | R1_ENV_126 | PC | 1137 | 2 | - | - | - | S | Coarse sand | | |
| 29/05/2020 | 13:21 | R1_ENV_126 | NS | 1138 | 1 | - | - | - | S | Coarse sand with shell fragments | | |
| 29/05/2020 | 13:24 | R1_ENV_126 | NS | 1139 | < 1 | - | - | - | S | Coarse sand | | |
| 29/05/2020 | 18:00 | R1_ENV_089 | NS | 1141 | 0 | - | - | - | S | | | |
| 29/05/2020 | 18:04 | R1_ENV_089 | PC | 1142 | 4.5 | 29 | 130 | 4 | (g)mS | Gravelly muddy sand | | |
| 29/05/2020 | 19:50 | SO_R1_011 | PC | 1147 | 17 | - | - | - | M | Mud/clay | | |
| 29/05/2020 | 20:08 | R1_ENV_088 | PC | 1148 | 19 | 29 | 65 | 6 | M | Mud/clay | | |
| 29/05/2020 | 22:16 | R1_ENV_087 | NS | 1154 | < 1 | - | - | - | gS | Gravelly coarse sand | | |
| 29/05/2020 | 22:20 | R1_ENV_087 | PC | 1155 | 5 | 29 | 225 | 4 | gS | Gravelly coarse sand with shell fragments | | |
| 30/05/2020 | 00:31 | R1_ENV_085 | NS | 1162 | < 1 | - | - | - | S | Coarse sand and coral rubble | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [°C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 30/05/2020 | 00:36 | R1_ENV_085 | NS | 1163 | < 1 | - | - | - | S | Coarse sand | | |
| 30/05/2020 | 00:40 | R1_ENV_085 | NS | 1164 | < 1 | - | - | - | S | Coarse sand and coral rubble | | |
| 30/05/2020 | 06:02 | R1_ENV_125 | NS | 1172 | < 1 | - | - | - | | | | |
| 30/05/2020 | 06:09 | R1_ENV_125 | NS | 1173 | 2 | - | - | - | gS | Gravelly coarse sand with occasional large shell fragments | | |
| 30/05/2020 | 06:16 | R1_ENV_125 | NS | 1174 | 2 | - | - | - | S | Coarse sand | | |
| 30/05/2020 | 06:46 | R1_ENV_124 | NS | 1176 | 0 | - | - | - | | | | |
| 30/05/2020 | 06:47 | R1_ENV_124 | NS | 1177 | < 1 | - | - | - | gS | Gravelly coarse sand with shell fragments | | |
| 30/05/2020 | 06:52 | R1_ENV_124 | NS | 1178 | < 1 | - | - | - | | | | |
| 30/05/2020 | 10:34 | R1_ENV_111 | NS | 1197 | < 1 | - | - | - | S | Coarse sand and shell | | |
| 30/05/2020 | 12:00 | R1_ENV_111 | NS | 1201 | < 1 | - | - | - | S | Sand and shell | | |
| 30/05/2020 | 12:03 | R1_ENV_111 | NS | 1202 | < 1 | - | - | - | S | Coarse sand and shell | | |
| 30/05/2020 | 12:27 | R1_ENV_110 | NS | 1203 | < 1 | - | - | - | S | Sand | | |
| 30/05/2020 | 12:35 | R1_ENV_110 | NS | 1204 | < 1 | - | - | - | S | Sand | | Sea urchin (Echinoidea) |
| 30/05/2020 | 12:36 | R1_ENV_110 | NS | 1205 | 0 | - | - | - | | | | Coral in jaws |
| 30/05/2020 | 14:36 | R1_ENV_109 | NS | 1214 | 0 | - | - | - | | | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 30/05/2020 | 14:40 | R1_ENV_109 | NS | 1215 | 2 | - | - | - | S | Sand | | Sea urchin (Echinoidea) |
| 30/05/2020 | 14:46 | R1_ENV_109 | NS | 1216 | 2 | - | - | - | gS | Gravelly sand with shell fragments | | Bivalvia |
| 30/05/2020 | 17:30 | R1_ENV_086 | PC | 1217 | 5 | 30 | 120 | 7 | S | Coarse sand | | |
| 30/05/2020 | 20:52 | R1_ENV_083 | PC | 1227 | 4.5 | 29.3 | 169 | 6.1 | gS | Gravelly coarse sand | | |
| 30/05/2020 | 21:52 | R1_ENV_084 | PC | 1225 | 4 | 29.3 | 158 | 6.3 | gS | Gravelly coarse sand with shell fragments | | |
| 30/05/2020 | 23:29 | R1_ENV_082 | NS | 1235 | 0 | - | - | - | | | | |
| 30/05/2020 | 23:34 | R1_ENV_082 | NS | 1236 | 3 | - | - | - | S | Coarse sand with shell fragments | | |
| 30/05/2020 | 23:43 | R1_ENV_082 | PC | 1237 | 4 | 29.7 | 234 | 6.3 | S | Coarse sand with shell fragments | | |
| 31/05/2020 | 01:30 | R1_ENV_081 | PC | 1242 | 9 | 29.9 | 262 | 6.1 | S | Coarse sand | | |
| 31/05/2020 | 03:58 | R1_ENV_097 | PC | 1243 | 8 | 27.1 | 432 | 6.3 | S | Very coarse sand with shell fragments | Light grey (10YR 7/2) | |
| 31/05/2020 | 09:48 | R1_ENV_098 | NS | 1251 | < 1 | - | - | - | S | Sand | | |
| 31/05/2020 | 09:54 | R1_ENV_098 | NS | 1252 | 2 | - | - | - | S | Sand with shell | | |
| 31/05/2020 | 09:57 | R1_ENV_098 | NS | 1253 | 3 | - | - | - | S | Sand | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [°C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 31/05/2020 | 10:26 | R1_ENV_099 | PC | 1254 | 7 | 32.2 | 256 | 6.1 | S | Coarse sand with shell fragments | Pale brown (2.5Y 8/9) | |
| 31/05/2020 | 13:11 | R1_ENV_101 | NS | 1263 | < 1 | - | - | - | S | Coarse sand | | |
| 31/05/2020 | 13:19 | R1_ENV_101 | NS | 1264 | 0 | - | - | - | | | | |
| 31/05/2020 | 13:23 | R1_ENV_101 | NS | 1265 | 0 | - | - | - | | | | |
| 31/05/2020 | 14:52 | R1_ENV_095 | PC | 1266 | 9 | 30.0 | -210 | 7.1 | sM | Sandy mud | | |
| 31/05/2020 | 22:03 | SO_R1_010 | NS | 1270 | 0 | - | - | - | | | | |
| 31/05/2020 | 22:08 | SO_R1_010 | PC | 1271 | 12 | - | - | - | M | Mud/clay | | |
| 31/05/2020 | 22:23 | R1_ENV_080 | PC | 1272 | 11 | 29.9 | -147 | 6.9 | M | Mud/clay | | |
| 01/06/2020 | 00:05 | R1_ENV_079 | PC | 1277 | 7 | 29.1 | -180 | 6.9 | gM | Gravelly mud | | |
| 01/06/2020 | 05:44 | R1_ENV_096 | PC | 1314 | 9.5 | 25.8 | 111 | 7.6 | S | Sand with occasional shell fragments | Grey | |
| 01/06/2020 | 10:53 | R1_ENV_108 | NS | 1315 | < 1 | - | - | - | S | Coarse sand | | |
| 01/06/2020 | 10:57 | R1_ENV_108 | NS | 1316 | < 1 | - | - | - | S | Coarse sand | | |
| 01/06/2020 | 11:01 | R1_ENV_108 | NS | 1317 | < 1 | - | - | - | S | Coarse sand | | |
| 01/06/2020 | 13:20 | R1_ENV_105 | NS | 1328 | < 1 | - | - | - | S | Coarse sand | | |
| 01/06/2020 | 13:22 | R1_ENV_105 | NS | 1329 | 0 | - | - | - | | | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 01/06/2020 | 13:28 | R1_ENV_105 | NS | 1330 | < 1 | - | - | - | S | Coarse sand | | |
| 01/06/2020 | 19:27 | R1_ENV_078 | NS | 1339 | 3 | - | - | - | (g)sM | Gravelly sandy mud | | |
| 01/06/2020 | 19:35 | R1_ENV_078 | PC | 1340 | 4.5 | 30.0 | 125 | 6.1 | (g)sM | Gravelly sandy mud | | |
| 01/06/2020 | 20:41 | R1_ENV_077 | NS | 1342 | < 1 | - | - | - | gS | Gravelly sand | | |
| 01/06/2020 | 20:47 | R1_ENV_077 | NS | 1343 | 0 | - | - | - | | | | |
| 01/06/2020 | 20:50 | R1_ENV_077 | NS | 1344 | | - | - | - | gS | Gravelly sand | | |
| 01/06/2020 | 22:20 | R1_ENV_076 | PC | 1349 | 16 | 30.0 | -80 | 6.9 | M | Very soft mud/clay | | |
| 01/06/2020 | 23:59 | R1_ENV_075 | PC | 1354 | 18 | 30.0 | -140 | 5.6 | M | Very soft mud/clay | | |
| 02/06/2020 | 03:09 | R1_ENV_074 | PC | 1363 | 18 | 28.9 | -120 | 5.7 | M | Slightly sandy mud | Gley 2 5/5PB (Bluish gray) | Anoxic smell |
| 02/06/2020 | 03:51 | R1_ENV_073 | PC | 1364 | 18 | 29.8 | -156 | 6.0 | sM | Sandy mud | Gley 2 5/5PB (Bluish gray) | |
| 02/06/2020 | 14:47 | R1_ENV_072 | PC | 1373 | 14 | 30.0 | -130 | 4.8 | M | Soft mud/clay | | |
| 02/06/2020 | 15:12 | SO_R1_009 | PC | 1374 | 15 | - | - | - | (g)M | Gravelly soft mud/clay | | |
| 02/06/2020 | 17:07 | R1_ENV_071 | NS | 1379 | 0 | - | - | - | | | | |
| 02/06/2020 | 17:14 | R1_ENV_071 | PC | 1380 | 17 | 29.9 | -240 | 6.9 | M | Very soft mud/clay | | |
| 02/06/2020 | 19:05 | R1_ENV_070 | NS | 1385 | 0 | - | - | - | | | | |
| 02/06/2020 | 19:08 | R1_ENV_070 | PC | 1386 | 18 | 29.5 | -110 | 5.6 | M | Very soft mud/clay | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 02/06/2020 | 21:06 | R1_ENV_069 | NS | 1392 | 0 | - | - | - | | | | |
| 02/06/2020 | 21:10 | R1_ENV_069 | PC | 1393 | 5 | 29.4 | -158 | 5.7 | gM | Gravelly mud | | |
| 02/06/2020 | 22:54 | R1_ENV_068 | NS | 1399 | 0 | - | - | - | | | | |
| 02/06/2020 | 22:58 | R1_ENV_068 | PC | 1400 | 19 | 30.0 | -20 | 5.9 | M | Very soft mud/clay | | |
| 03/06/2020 | 00:45 | R1_ENV_067 | NS | 1405 | 0 | - | - | - | | | | |
| 03/06/2020 | 00:48 | R1_ENV_067 | PC | 1406 | 6 | 29.9 | -147 | 6.9 | (g)sM | Gravelly sandy mud with shell fragments | | |
| 03/06/2020 | 03:04 | R1_ENV_066 | NS | 1411 | < 1 | - | - | - | sM | Sandy mud | | |
| 03/06/2020 | 03:08 | R1_ENV_066 | NS | 1412 | < 1 | - | - | - | | | | |
| 03/06/2020 | 03:12 | R1_ENV_066 | PC | 1413 | 10.6 | 30.1 | -21 | 6.7 | sM | Sandy mud/clay | Grey (10YR 5/1) | |
| 03/06/2020 | 05:50 | R1_ENV_065 | NS | 1422 | 0 | - | - | - | | | | |
| 03/06/2020 | 05:51 | R1_ENV_065 | PC | 1423 | 7.5 | 29.7 | 93 | 7.2 | (g)sM | Gravelly sandy mud | Grey 10YR 5/1 | |
| 03/06/2020 | 13:53 | R1_ENV_064 | PC | 1426 | 7 | 29.6 | 423 | 2.3 | | | | |
| 03/06/2020 | 14:50 | SO_R1_008 | NS | 1427 | 0 | - | - | - | | | | |
| 03/06/2020 | 14:55 | SO_R1_008 | NS | 1428 | 0 | - | - | - | | | | |
| 03/06/2020 | 15:06 | SO_R1_008 | PC | 1429 | 6 | - | - | - | (g)sM | Gravelly sandy mud | | |
| 03/06/2020 | 17:57 | R1_ENV_063 | NS | 1437 | < 1 | - | - | - | S | Sand | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [°C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 03/06/2020 | 18:06 | R1_ENV_063 | NS | 1438 | < 1 | - | - | - | S | Sand | | |
| 03/06/2020 | 18:11 | R1_ENV_063 | NS | 1439 | 1 | - | - | - | S | Sand | | |
| 03/06/2020 | 18:19 | R1_ENV_063 | NS | 1440 | 0 | - | - | - | S | | | |
| 05/06/2020 | 00:39 | R1_ENV_060 | PC | 1448 | 8 | 32.1 | -77 | 6.8 | (g)mS | Gravelly muddy sand | | |
| 05/06/2020 | 01:48 | R1_ENV_062 | NS | 1451 | 1 | - | - | - | S | Sand | | |
| 05/06/2020 | 01:53 | R1_ENV_062 | NS | 1452 | 0 | - | - | - | | | | Coral rubble in jaws |
| 05/06/2020 | 01:56 | R1_ENV_062 | NS | 1453 | 0 | - | - | - | | | | |
| 05/06/2020 | 02:38 | R1_ENV_061 | Partial sample | 1454 | 4.5 | 27.7 | 277 | 7.2 | (g)sM | Gravelly muddy sand | Reddish gray (7.5R 5/1) | |
| 05/06/2020 | 03:03 | R1_ENV_061 | Partial sample | 1455 | 3 | 27.9 | 22 | 7.1 | (g)sM | Gravelly muddy sand | Reddish gray (7.5R 5/1) | |
| 05/06/2020 | 05:07 | R1_ENV_059 | PC | 1463 | 8.5 | 30.5 | 59 | 6.0 | (g)sM | Sandy slightly gravelly mud | Blue gray (5Y 5/2) | |
| 05/06/2020 | 06:29 | R1_ENV_058 | Partial sample | 1465 | 3 | 32.3 | 2 | 6.4 | (g)sM | Gravelly sandy mud | Gray (2.5Y 6/1) | |
| 05/06/2020 | 06:38 | R1_ENV_058 | Partial sample | 1466 | 4 | 32.1 | 17 | 6.6 | (g)sM | Gravelly sandy mud | Gray (2.5Y 6/1) | |
| 05/06/2020 | 06:48 | R1_ENV_058 | NS | 1467 | 3 | - | - | - | (g)sM | Gravelly sandy mud | Gray (2.5Y 6/1) | |
| 05/06/2020 | 08:56 | R1_ENV_057 | Partial sample | 1475 | 4 | 32.2 | 126 | 6.8 | (g)sM | Muddy gravelly sand | Gray (2.5Y 5/1) | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 05/06/2020 | 09:05 | R1_ENV_057 | Partial sample | 1476 | 4 | 32.3 | 118 | 6.7 | (g)sM | Muddy gravelly sand | Gray (2.5Y 5/1) | |
| 05/06/2020 | 09:15 | R1_ENV_057 | Partial sample | 1477 | 3 | 32.2 | 233 | 6.2 | (g)sM | Muddy gravelly sand | Gray (2.5Y 5/1) | |
| 05/06/2020 | 10:08 | R1_ENV_056 | PC | 1479 | 6.5 | 32.7 | 180 | 7.2 | gS | Gravelly muddy sand with shell fragments | Gray (2.5Y 6/1) | |
| 05/06/2020 | 10:24 | SO_R1_03 | NS | 1480 | 0 | - | - | - | | | | |
| 05/06/2020 | 10:28 | SO_R1_03 | PC | 1481 | 6.5 | 32.7 | 207 | 7.0 | gS | Gravelly muddy sand with shell fragments | Gray (2.5Y 6/1) | |
| 05/06/2020 | 12:23 | R1_ENV_055 | PC | 1489 | 7 | 31.6 | 39 | 6.8 | (g)sM | Sandy gravelly mud with infrequent shell fragments | Grayish brown (2.5Y 5/2) | |
| 06/06/2020 | 05:25 | R1_ENV_054 | NS | 1491 | 0 | - | - | - | | | | |
| 06/06/2020 | 05:31 | R1_ENV_054 | Partial sample | 1492 | 4 | 29.9 | 44 | 7.3 | (g)sM | Gravelly sandy mud with shell fragments | Pale brown (2.5Y 8/3) | |
| 06/06/2020 | 05:46 | R1_ENV_054 | Partial sample | 1493 | 4 | 32.1 | 47 | 7.2 | (g)sM | Gravelly sandy mud with shell fragments | Pale brown (2.5Y 8/3) | |
| 06/06/2020 | 08:03 | R1_ENV_053 | Partial sample | 1501 | 3.5 | 32.7 | -32 | 6.5 | (g)sM | Sandy gravelly mud with infrequent shell fragments | Light brownish gray (2.5Y 6/2) | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 06/06/2020 | 08:12 | R1_ENV_053 | Partial sample | 1502 | 4 | 31.6 | 203 | 6 | (g)sM | Sandy gravelly mud with infrequent shell fragments | Light brownish gray (2.5Y 6/2) | |
| 06/06/2020 | 08:23 | R1_ENV_053 | NS | 1503 | 4 | - | - | - | | | | |
| 06/06/2020 | 09:26 | R1_ENV_052 | Partial sample | 1505 | 3 | 32.8 | 26 | 6.5 | mS | Muddy sand | Light brownish gray (2.5Y 6/2) | |
| 06/06/2020 | 09:35 | R1_ENV_052 | Partial sample | 1506 | 4 | 32.7 | 94 | 5.8 | mS | Muddy sand | Light brownish gray (2.5Y 6/2) | |
| 06/06/2020 | 09:47 | R1_ENV_052 | NS | 1507 | 4 | - | - | - | | | | |
| 06/06/2020 | 11:30 | R1_ENV_051 | NS | 1515 | < 1 | - | - | - | gS | Gravelly sand with shell fragments | Very pale brown (10YR 8/3) | |
| 06/06/2020 | 11:38 | R1_ENV_051 | NS | 1516 | < 1 | - | - | - | gS | Gravelly sand with shell fragments | Very pale brown (10YR 8/3) | |
| 06/06/2020 | 11:41 | R1_ENV_051 | NS | 1517 | < 1 | - | - | - | gS | Gravelly sand with shell fragments | Very pale brown (10YR 8/3) | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 06/06/2020 | 12:31 | R1_ENV_050 | NS | 1519 | 4 | 33.6 | 170 | 6.8 | mS | Muddy coarse sand | Pale brown (2.5Y 8/2) | |
| 06/06/2020 | 12:35 | R1_ENV_050 | PC | 1520 | 7 | 32.9 | 159 | 6.7 | mS | Muddy coarse sand | Pale brown (2.5Y 8/2) | |
| 06/06/2020 | 14:41 | R1_ENV_049 | NS | 1525 | 0 | - | - | - | | | | |
| 06/06/2020 | 14:50 | R1_ENV_049 | NS | 1526 | 5 | 32.1 | -82 | 5.1 | (g)mS | Gravelly muddy sand | Gray (2.5Y 6/1) | |
| 06/06/2020 | 21:33 | SO_R1_006 | SO | 1532 | 5 | - | - | - | (g)mS | Muddy gravelly sand | Gley 1 (6/10Y) | |
| 08/06/2020 | 21:43 | R1_ENV_048 | PC | 1533 | 6 | 31.9 | 40 | 6.9 | (g)mS | Muddy gravelly sand | Gley 1 (6/10Y) | |
| 08/06/2020 | 23:01 | R1_ENV_047 | NS | 1540 | < 1 | - | - | - | S | Sand | | |
| 08/06/2020 | 23:05 | R1_ENV_047 | NS | 1541 | < 1 | - | - | - | S | Sand | Pale yellow (2.5Y 7/3) | |
| 08/06/2020 | 23:09 | R1_ENV_047 | NS | 1542 | < 1 | - | - | - | S | Sand | | |
| 08/06/2020 | 23:50 | R1_ENV_046 | PC | 1544 | 8 | 31.9 | 100 | 6.9 | (g)mS | Gravelly muddy sand | Gley 1 (5/10Y) | |
| 09/06/2020 | 00:59 | R1_ENV_045 | NS | 1549 | 2 | - | - | - | (g)mS | Gravelly muddy sand | | |
| 09/06/2020 | 01:02 | R1_ENV_045 | PC | 1550 | 6 | 31.9 | 100 | 6.9 | (g)mS | Gravelly muddy sand | Reddish gray (2.5Y 6/1) | |
| 09/06/2020 | 03:36 | R1_ENV_044 | NS | 1558 | 1.5 | 26.1 | 12 | 7.3 | (g)sM | Muddy gravelly sand | Gray (2.5Y 5/1) | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 09/06/2020 | 03:45 | R1_ENV_044 | Partial sample | 1559 | 3.5 | 31.4 | -3 | 7.3 | (g)sM | Muddy gravelly sand | Gray (2.5Y 5/1) | |
| 09/06/2020 | 04:00 | R1_ENV_044 | Partial sample | 1560 | 4 | 31.9 | 31 | 6.8 | (g)sM | Muddy gravelly sand | Gray (2.5Y 5/1) | |
| 09/06/2020 | 04:59 | R1_ENV_043 | PC | 1562 | 6 | 32.6 | 128 | 7.2 | mS | Muddy coarse sand | Dark grey (2.5Y 4/1) | |
| 09/06/2020 | 07:01 | R1_ENV_042 | NS | 1570 | < 1 | - | - | - | S | Coarse sand | Light yellow brown (2.5Y 6/4) | |
| 09/06/2020 | 07:05 | R1_ENV_042 | NS | 1571 | < 1 | - | - | - | S | Coarse sand | Light yellow brown (2.5Y 6/4) | |
| 09/06/2020 | 07:09 | R1_ENV_042 | NS | 1572 | < 1 | - | - | - | S | Coarse sand | Light yellow brown (2.5Y 6/4) | |
| 09/06/2020 | 08:12 | R1_ENV_041 | PC | 1574 | 5.5 | 30.5 | 109 | 7.2 | mS | Muddy coarse sand with shell fragments | Light brownish gray (2.5Y 6/2) | |
| 09/06/2020 | 10:03 | SO_R1_005 | Partial sample | 1582 | 3 | 30.1 | 138 | 8.6 | mS | Muddy coarse sand with shell fragments | Olive yellow (5Y 6/6) | |
| 09/06/2020 | 10:15 | SO_R1_005 | Partial sample | 1583 | 5.5 | 30.9 | 124 | 8.1 | mS | Muddy coarse sand with shell fragments | Olive yellow (5Y 6/6) | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 09/06/2020 | 10:25 | R1_ENV_040 | PC | 1585 | 2 | 30.7 | 119 | 7.8 | mS | Muddy coarse sand with shell fragments | Olive yellow (5Y 6/6) | |
| 09/06/2020 | 10:34 | R1_ENV_040 | PC | 1586 | 4 | 30.9 | 79 | 8.5 | mS | Muddy coarse sand with shell fragments | Olive yellow (5Y 6/6) | |
| 09/06/2020 | 10:48 | R1_ENV_040 | NS | 1587 | 3 | - | - | - | mS | Muddy coarse sand with shell fragments | Olive yellow (5Y 6/6) | |
| 09/06/2020 | 11:42 | R1_ENV_039 | PC | 1589 | 5 | 31.2 | 163 | 7.9 | gS | Gravelly sand with frequent shell fragments | Light yellow brown (2.5Y 6/4) | |
| 10/06/2020 | 07:53 | R1_ENV_038 | Partial sample | 469 | 3.5 | 32.8 | 169 | 7.4 | gS | Gravelly coarse sand | Light yellow brown (2.5Y 6/4) | |
| 10/06/2020 | 08:23 | R1_ENV_038 | Partial sample | 470 | 3 | 32.8 | 171 | 7.2 | gS | Gravelly coarse sand | Light yellow brown (2.5Y 6/4) | |
| 10/06/2020 | 08:43 | R1_ENV_038 | NS | 471 | 1 | - | - | - | gS | Gravelly coarse sand | Light yellow brown (2.5Y 6/4) | |
| 10/06/2020 | 13:08 | R1_ENV_026 | NS | 478 | 0 | - | - | - | | | | |
| 10/06/2020 | 13:24 | R1_ENV_026 | NS | 479 | < 1 | - | - | - | | Coarse sand | | Seagrass |
| 10/06/2020 | 13:32 | R1_ENV_026 | NS | 480 | < 1 | - | - | - | | Coarse sand | | Seagrass |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 10/06/2020 | 21:21 | R1_ENV_REF | NS | 1657 | < 1 | - | - | - | | Sand | Light gray (2.5Y 7/2) | |
| 10/06/2020 | 21:27 | R1_ENV_REF | NS | 1658 | 2 | - | - | - | | Sand | Light gray (2.5Y 7/2) | |
| 10/06/2020 | 21:32 | R1_ENV_REF | NS | 1659 | 0 | - | - | - | | Sand | Light gray (2.5Y 7/2) | |
| 10/06/2020 | 21:35 | R1_ENV_REF | NS | 1660 | 0 | - | - | - | | Sand | Light gray (2.5Y 7/2) | |
| 11/06/2020 | 05:59 | R1_ENV_001 | PC | 483 | 8 | 32.3 | 114 | 7.7 | sM | Sandy mud with occasional small shell fragments | Light brown (7.5YR 6/3) | |
| 11/06/2020 | 06:31 | R1_ENV_002 | PC | 484 | 8 | 33.6 | -109 | 7.6 | sM | Very fine sandy mud with occasional small shell fragments | Light brown (7.5YR 6/3) | |
| 11/06/2020 | 07:28 | R1_ENV_003 | NS | 486 | < 1 | - | - | - | mS | Muddy sand | | Seagrass |
| 11/06/2020 | 07:35 | R1_ENV_003 | NS | 487 | 0 | - | - | - | | | | |
| 11/06/2020 | 07:39 | R1_ENV_003 | NS | 488 | 0 | - | - | - | | | | |
| 11/06/2020 | 07:49 | R1_ENV_004 | NS | 489 | 0 | - | - | - | | | | |
| 11/06/2020 | 07:54 | R1_ENV_004 | NS | 490 | < 1 | - | - | - | mS | Muddy sand | | |
| 11/06/2020 | 08:00 | R1_ENV_004 | NS | 491 | 0 | - | - | - | mS | Muddy sand | | |
| 11/06/2020 | 08:09 | R1_ENV_005 | NS | 492 | 0 | - | - | - | | | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [˚C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 11/06/2020 | 08:17 | R1_ENV_005 | NS | 493 | 0 | - | - | - | | | | |
| 11/06/2020 | 08:22 | R1_ENV_005 | NS | 494 | 0 | - | - | - | | | | |
| 11/06/2020 | 09:28 | R1_ENV_011 | NS | 495 | < 1 | - | - | - | S | Muddy sand | | Seagrass |
| 11/06/2020 | 09:32 | R1_ENV_011 | NS | 496 | < 2 | - | - | - | S | Muddy sand | | Seagrass |
| 11/06/2020 | 09:37 | R1_ENV_011 | NS | 497 | < 1 | - | - | - | S | Muddy sand | | Seagrass |
| 11/06/2020 | 12:31 | R1_ENV_028 | NS | 516 | < 1 | - | - | - | S | Coarse sand | | |
| 11/06/2020 | 12:42 | R1_ENV_028 | NS | 517 | < 1 | - | - | - | S | Coarse sand | | |
| 11/06/2020 | 12:48 | R1_ENV_028 | NS | 518 | 0 | - | - | - | | | | |
| 15/06/2020 | 08:59 | SO_R1_012 | PC | 1697 | 0 | 27.8 | 110 | 7.2 | S | Sand | Very pale brown (2.5Y 8/4) | |
| 15/06/2020 | 09:37 | R1_ENV_100 | NS | 1698 | 0 | - | - | - | | | | |
| 15/06/2020 | 09:41 | R1_ENV_100 | NS | 1699 | < 1 | - | - | - | S | Coarse sand | | |
| 15/06/2020 | 09:44 | R1_ENV_100 | NS | 1700 | < 1 | - | - | - | S | Coarse sand | | |
| 15/06/2020 | 10:50 | R1_ENV_102 | NS | 1704 | < 1 | - | - | - | S | Coarse sand | | |
| 15/06/2020 | 10:56 | R1_ENV_102 | NS | 1705 | < 1 | - | - | - | S | Coarse sand and coral rubble | | |
| 15/06/2020 | 11:00 | R1_ENV_102 | NS | 1706 | < 1 | - | - | - | S | Coarse sand | | |
| 15/06/2020 | 12:12 | R1_ENV_103 | NS | 1715 | 0 | - | - | - | S | Coarse sand | | |

| Date | Time [UTC] | Station | Sample | Fix No. | Sample Depth [cm] | Temp [°C] | Redox [mV] | pH | Sediment Description (including stratigraphy) | | | Comments (fauna, smell, bioturbation, debris) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Sediment Type | Sediment Description | Munsell colour | |
| 15/06/2020 | 12:17 | R1_ENV_103 | NS | 1716 | 0 | - | - | - | S | Coral rubble | | |
| 15/06/2020 | 12:19 | R1_ENV_103 | NS | 1717 | < 1 | - | - | - | S | Sand and shell fragments | | |
| 15/06/2020 | 13:00 | SO_R1_013 | PC | 1718 | < 2 | - | - | - | S | Coarse sand and shell fragments | | |
| 15/06/2020 | 13:02 | R1_ENV_104 | NS | 1719 | < 2 | 31.6 | 97 | 6.8 | S | Coarse gravelly sand | Pale brown (2.5Y 8/2) | |
| 15/06/2020 | 13:10 | R1_ENV_104 | NS | 1720 | 3 | 31.2 | 89 | 6.4 | S | Coarse gravelly sand | Pale brown (2.5Y 8/2) | |
| 15/06/2020 | 13:13 | R1_ENV_104 | NS | 1721 | < 1 | - | - | - | S | Coarse gravelly sand | Pale brown (2.5Y 8/2) | |

Notes
UTC = Coordinated Universal Time
PC = Physico-chemical sample
NS = No sample

## C.3 Video and Photographic Log

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Data | Transect | Video File | Time [UTC] | Video Coordinates | | Length [m] | Still Nos. | Sediment Description | Fauna/Bioturbation/Debris | Soft Coral Cover | Hard Coral Cover | Seagrass |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Easting [m] | Northing [m] | | | | | | | |
| 16/05/2020 | TR01 | E0395_R1_TR01 | 09:50:12 | 760 298.4 | 2 671 461.1 | 137 | 13 | Sand | Seagrass (*Halodule uninervis*, possible *Halophila stipulacea* and *Halophila ovalis* complex), macroalgae, red algae (Rhodophyta, ?*Chondria dasyphylla*) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 09:52:36 | 760 172.1 | 2 671 406.8 | | | | | | | |
| 16/05/2020 | TR02 | E0395_R1_TR02 | 09:27:48 | 762 923.0 | 2 672 225.9 | 47 | 2 | Sand | Seagrass (*Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis* complex), peacock weed (*Padina boergesenil*), red algae (Rhodophyta, ?*Chondria dasyphylla*), sponges (Porifera), ascidians (Ascidiacaea, including ?*Didemnum* sp.) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 09:28:52 | 762 878.9 | 2 672 209.2 | | | | | | | |
| | | | 09:28:52 | 762 878.9 | 2 672 209.2 | 9 | - | Sand | Low density patches of seagrass (*Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis* complex), peacock weed (?*Padina boergesenil*) | No coral (< 1 %) | No coral (< 1 %) | Low seagrass cover (1 to 10 % ) |
| | | | 09:29:04 | 762 870.4 | 2 672 205.5 | | | | | | | |
| | | | 09:29:04 | 762 870.4 | 2 672 205.5 | 95 | 9 | Sand | Seagrass (*Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis* complex), ascidian (Ascidiacea), sponge (Porifera), macroalgae, red algae (Rhodophyta, ?*Chondria dasyphylla*), peacock weed (*Padina boergesenil*) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 09:31:09 | 762 779.9 | 2 672 177.4 | | | | | | | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Transect | Video File | Time [UTC] | Video Coordinates Easting [m] | Video Coordinates Northing [m] | Length [m] | Still Nos. | Sediment Description | Fauna/Bioturbation/Debris | Soft Coral Cover | Hard Coral Cover | Seagrass |
| 15/05/2020 | TR03 | E0395_R1_TR03 | 15:28:58 | 764 720.1 | 2 673 924.0 | 23 | 1 | Sand | Seagrass (*Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis* complex), sponges (Porifera), epiphytic branching sponges/ascidians (Porifera/Ascidiacea), peacock weed (*Padina boergesenil*), red algae (Rhodophyta, ?*Chondria dasyphylla*) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 15:29:28 | 764 742.7 | 2 673 924.8 | | | | | | | |
| | | | 15:29:28 | 764 742.7 | 2 673 924.8 | 13 | 2 | Sand with shell and coral rubble fragments | Low density patches of seagrass (possible *Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis* complex), red algae (Rhodophyta), algal turf, fish (Pisces) | No coral (< 1 %) | No coral (< 1 %) | Low seagrass cover (1 to 10 %) |
| | | | 15:29:51 | 764 755.5 | 2 673 926.8 | | | | | | | |
| | | | 15:29:51 | 764 755.5 | 2 673 926.8 | 41 | 3 | Sand with shell and coral rubble fragments | Seagrass (*Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis* complex), faunal burrows, fish (Pisces) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 15:31:04 | 764 793.0 | 2 673 942.1 | | | | | | | |
| | | | 15:31:04 | 764 793.0 | 2 673 942.1 | 42 | 3 | Rippled sand with shell and coral rubble fragments | Low density patches of seagrass (possible *Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis* complex), peacock weed (*Padina boergesenil*), red algae (Rhodophyta, ?*Chondria dasyphylla*), goby (*Cryptocentrus* sp.), fish (Pisces) | No coral (< 1 %) | No coral (< 1 %) | Low seagrass cover (1 to 10 %) |
| | | | 15:32:09 | 764 834.7 | 2 673 947.4 | | | | | | | |
| | | | 15:32:09 | 764 834.7 | 2 673 947.4 | 13 | 1 | Sand with shell and coral rubble fragments | Seagrass (possible *Halodule uninervis*, *Halophila stipulacea* and *Halophila ovalis* complex), peacock weed (*Padina boergesenil*), red algae (Rhodophyta, ?*Chondria dasyphylla*) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 15:32:32 | 764 847.7 | 2 673 949.4 | | | | | | | |

Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Transect | Video File | Time [UTC] | Video Coordinates Easting [m] | Video Coordinates Northing [m] | Length [m] | Still Nos. | Sediment Description | Fauna/Bioturbation/Debris | Soft Coral Cover | Hard Coral Cover | Seagrass |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16/06/2020 | TR04B | E0395_R1_TR04b | 01:07:26 | 788 940.4 | 2 711 779.3 | 69 | 11 | Gravelly sand with shell fragments and coral rubble veneer overlying calcarenite. Occasional calcarenite outcrops | Finger corals (*Porites* sp.), sea urchins (*Echinometra mathei*), sponge (Porifera), ascidian (Phallusia nigra), faunal turf (Bryozoa/Hydrozoa), hermit crab (Paguroidea), pearl oyster (*Pinctada* sp.), hammer oysters (*Malleus* sp.), shrimps (Caridea), sea snails (Gastropoda), sand dollar (Clypeasteroidea inc.?*Echinodiscus* sp.), peacock weed (*Padina boergesenii*), algal turf, emperor fish (*Lethrinus* sp.), unidentified fish (Pisces) | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 01:15:36 | 788 891.3 | 2 711 730.7 | | | | | | | |
| | | | 01:15:36 | 788 891.3 | 2 711 730.7 | 9 | 1 | Gravelly sand with shell fragments and coral rubble veneer overlying calcarenite. Occasional calcarenite outcrops | Boulder corals (Faviidae), plate coral (*Turbinaria* sp.), finger corals (*Porites* sp.), sea urchins (*Echinometra mathei*), sponge (Porifera), hammer oysters (*Malleus* sp.), starfish (Asteroidea) | No coral (< 1 %) | Low coral (1 10 %) | No seagrass (< 1 %) |
| | | | 01:16:16 | 788 885.1 | 2 711 724.6 | | | | | | | |
| | | | 01:16:16 | 788 885.1 | 2 711 724.6 | 57 | 3 | Gravelly sand with shell fragments and coral rubble veneer overlying calcarenite. Occasional calcarenite outcrops | Boulder corals (Faviidae), finger corals (*Porites* sp.), sea urchins (*Echinometra mathei*), sponge (Porifera), ascidian (*Phallusia nigra*), faunal turf (Bryozoa/Hydrozoa), hermit crab (Paguroidea), crab (Decapoda), pearl oyster (*Pinctada* sp.), hammer oysters (*Malleus* sp.), shrimps (Caridea), unidentified fish (Pisces) | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 01:20:07 | 788 844.9 | 2 711 684.7 | | | | | | | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Transect | Video File | Time [UTC] | Video Coordinates | | Length [m] | Still Nos. | Sediment Description | Fauna/Bioturbation/Debris | Soft Coral Cover | Hard Coral Cover | Seagrass |
| | | | | Easting [m] | Northing [m] | | | | | | | |
| 16/06/2020 | TR04B | E0395_R1_TR04b | 01:20:07 | 788 844.9 | 2 711 684.7 | 10 | 1 | Gravelly sand with shell fragments and coral rubble veneer overlying calcarenite | Boulder corals (Faviidae), finger corals (Porites sp.), sea urchins (*Echinometra mathei*), sponge (Porifera), ascidian (*Phallusia nigra*), faunal turf (Bryozoa/Hydrozoa), hammer oysters (*Malleus* sp.) | No coral (< 1 %) | Low coral (1-10 %) | No seagrass (< 1 %) |
| | | | 01:20:54 | 788 836.4 | 2 711 678.6 | | | | | | | |
| | | | 01:20:54 | 788 836.4 | 2 711 678.6 | 25 | 2 | Gravelly sand with shell fragments and coral rubble veneer overlying calcarenite | Boulder corals (Faviidae), sea urchins (*Echinometra mathei*), sponge (Porifera), ascidian (*Phallusia nigra*), pearl oyster (*Pinctada* sp.), hammer oysters (*Malleus* sp.), sand dollar (Clypeasteroidea), pearly goatfish (*Parupeneus margaritatus*), unidentified fish (Pisces) | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 01:22:53 | 788 817.8 | 2 711 661.5 | | | | | | | |
| 11/06/2020 | TR05A | E0395_R1_TR05a | 19:39:10 | 771 190.9 | 2 689 048.2 | 129 | 14 | Gravelly sand with shell fragment deposits | Seagrass (possible *Halophila stipulacea* and *Halophila ovalis* complex), sponges (Porifera), faunal turf (Hydrozoa/ Bryozoa), sand dollar (Clypeasteroidea), red algae (Rhodophyta), goatfish (Mullidae inc. *Upeneus* sp.), yellowstripe scad (*Selaroides leptolepis*), pink ear emperor (*Lethrinus lentjan*), mojarra fish (Gerreidae) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 19:49:40 | 771 217.1 | 2 689 174.4 | | | | | | | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Transect | Video File | Time [UTC] | Video Coordinates Easting [m] | Video Coordinates Northing [m] | Length [m] | Still Nos. | Sediment Description | Fauna/Bioturbation/Debris | Soft Coral Cover | Hard Coral Cover | Seagrass |
| 11/06/2020 | TR06 | E0395_R1_TR06 | 21:37:20 | 777 336.0 | 2 701 650.7 | 53 | 5 | Calcarenite with a veneer of sand, relict coral and coral rubble | Boulder corals (Faviidae, ?*Cyphastrea* sp.), finger corals (*Porites* sp.), encrusting plate corals (*Turbinaria* sp.), long spined sea urchins (*Diadema* sp.), sea urchins (*Echinometra mathei*), shells (Bivalvia), ascidian (*Phallusia nigra*), starfish (*Astropecten polyacanthus phragmorus*), coralline algae (Corallinales), pink ear emperor fish (*Lethrinus lentjan*), snapper (*Lutjanus* sp.), arabian monocle bream (*Scolopsis ghanam*), black-streaked monocle bream (*Scolopsis taeniatus*) | No coral (< 1 %) | Moderate coral (10 to 50 %) | No seagrass (< 1 %) |
| | | | 21:41:25 | 777 359.9 | 2 701 698.5 | | | | | | | |
| | | | 21:41:25 | 777 359.9 | 2 701 698.5 | 94 | 12 | Calcarenite with gravelly sand veneer, relict coral and coral rubble | Sponge (Porifera), finger corals (*Porites* sp.), fanshell (*Pinna muricata*), hermit crab (Paguroidea), sea urchins (*Echinometra mathei*), brittlestar (Ophiuroidea), hydroids (Hydrozoa), sand dollar (*Clypeaster humilis*), ascidian (*Phallusia nigra*), shrimps (Caridea), yellowstripe scad (*Selaroides leptolepis*), blackspot snapper (*Lutjanus fulviflamma*), goatfish (*Upeneus* sp.), fish (Pisces) | No coral (< 1 %) | Coral rubble (< 1 %) | No seagrass (< 1 %) |
| | | | 21:48:53 | 777 401.6 | 2 701 783.0 | | | | | | | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Transect | Video File | Time [UTC] | Video Coordinates | | Length [m] | Still Nos. | Sediment Description | Fauna/Bioturbation/Debris | Soft Coral Cover | Hard Coral Cover | Seagrass |
| | | | | Easting [m] | Northing [m] | | | | | | | |
| 16/06/2020 | TR07 | E0395_R1_TR07 | 02:57:27 | 793 050.8 | 2 722 048.5 | 151 | 20 | Sand, shell fragments and coral rubble veneer overlying possible calcarenite | Starfish (*Pentaceraster mammillatus*), fanshells (*Pinna muricata*), brittlestars (*Ophiuroidea* possible *Ophiothela* sp.), gorgonian (?*Subergorgia suberosa*), encrusting sponges (Porifera), ascidian (*Phallusia nigra*), blackspot snapper (*Lutjanus fulviflamma*), arabian monocle bream (*Scolopsis ghanam*), orange spot grouper (*Epinephelus coioides*), small scale terapon (*Terapon puta*), scad (Carangidae), unidentified fish (Pisces) | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 03:09:26 | 792 992.7 | 2 722 187.8 | | | | | | | |
| 10/06/2020 | TR08A | E0395_R1_TR08a | 00:14:33 | 791 639.1 | 2 713 431.5 | 153 | 19 | Muddy, gravelly sand with shell fragments and coral rubble veneer overlying calcarenite | Sponges (Porifera), hydroid (Hydrozoa), ascidians (*Phallusia nigra*, *Didemnum* sp.), sea urchin (Echinoidea), hermit crabs (Paguroidea), crab (Decapoda), decorator crab (Majoidea), conid shells (Conidae), shell (Bivalvia), star fish (*Aquilonastra* burtoni), small scale Terapon (*Terapon puta*), yellowstripe goatfish (*Mulloidichthys flavolineatus*), yellowstripe scad (*Selaroides leptolepis*), anchovies (Clupeiformes), mojarra fish (Gerreidae), cardinal fish (Apogonidae), faunal tracks, anthropogenic debris | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 00:27:07 | 791 738.5 | 2 713 314.5 | | | | | | | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Transect | Video File | Time [UTC] | Video Coordinates Easting [m] | Video Coordinates Northing [m] | Length [m] | Still Nos. | Sediment Description | Fauna/Bioturbation/Debris | Soft Coral Cover | Hard Coral Cover | Seagrass |
| 1/06/2020 | TR09 | E0395_R1_TR09 | 08:32:36 | 786 709.8 | 2 744 249.5 | 15 | 2 | Sand | Hermit crabs (Paguroidea), faunal burrows and tracks | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 08:33:37 | 786 722.7 | 2 744 256.4 | | | | | | | |
| | | | 08:33:37 | 786 722.7 | 2 744 256.4 | 7 | 4 | Sand | Seagrass (*Halophila stipulacea* and *Halophila ovalis* complex), hermit crabs (Paguroidea), goatfish (Mullidae) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 08:34:01 | 786 728.5 | 2 744 260.6 | | | | | | | |
| | | | 08:34:01 | 786 728.5 | 2 744 260.6 | 5 | 0 | Sand | Hermit crabs (Paguroidea), faunal burrows and tracks | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 08:34:19 | 786 733.1 | 2 744 263.3 | | | | | | | |
| | | | 08:34:19 | 786 733.1 | 2 744 263.3 | 4 | 1 | Sand | Seagrass (*Halophila stipulacea* and *Halophila ovalis* complex), hermit crabs (Paguroidea) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 08:34:33 | 786 737.4 | 2 744 263.9 | | | | | | | |
| | | | 08:34:33 | 786 737.4 | 2 744 263.9 | 9 | 1 | Sand | Hermit crabs (Paguroidea), faunal burrows and tracks | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 08:35:11 | 786 744.7 | 2 744 269.9 | | | | | | | |
| | | | 08:35:11 | 786 744.7 | 2 744 269.9 | 5 | 1 | Sand | Seagrass (*Halophila stipulacea* and *Halophila ovalis* complex), hermit crabs (Paguroidea) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 08:35:33 | 786 748.8 | 2 744 272.0 | | | | | | | |
| | | | 08:35:33 | 786 748.8 | 2 744 272.0 | 23 | 4 | Sand | Hermit crabs (Paguroidea), faunal burrows and tracks | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 08:37:04 | 786 769.3 | 2 744 283.3 | | | | | | | |
| | | | 08:37:04 | 786 769.3 | 2 744 283.3 | 3 | 1 | Sand | Seagrass (*Halophila stipulacea* and *Halophila ovalis* complex), hermit crabs (Paguroidea) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 08:37:12 | 786 771.8 | 2 744 283.7 | | | | | | | |

| Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Transect | Video File | Time [UTC] | Video Coordinates | | Length [m] | Still Nos. | Sediment Description | Fauna/Bioturbation/Debris | Soft Coral Cover | Hard Coral Cover | Seagrass |
| | | | | Easting [m] | Northing [m] | | | | | | | |
| 01/06/2020 | TR09 | E0395_R1_TR09 | 08:37:12 | 786 771.8 | 2 744 283.7 | 6 | 0 | Sand | Hermit crabs (Paguroidea), faunal burrows and tracks | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 08:37:32 | 786 776.6 | 2 744 288.0 | | | | | | | |
| | | | 08:37:32 | 786 776.6 | 2 744 288.0 | 7 | 3 | Sand | Seagrass (*Halophila stipulacea* and *Halophila ovalis* complex), hermit crabs (Paguroidea) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 08:38:00 | 786 783.3 | 2 744 290.9 | | | | | | | |
| | | | 08:38:00 | 786 783.3 | 2 744 290.9 | 28 | 4 | Sand | Hermit crabs (Paguroidea), faunal burrows and tracks | No coral (< 1 %) | No coral (< 1 %) | No seagrass (< 1 %) |
| | | | 08:39:51 | 786 807.5 | 2 744 305.0 | | | | | | | |
| | | | 08:39:51 | 786 807.5 | 2 744 305.0 | 4 | 1 | Sand | Seagrass (*Halophila stipulacea* and *Halophila ovalis* complex), hermit crabs (Paguroidea) | No coral (< 1 %) | No coral (< 1 %) | Seagrass bed 10 %) |
| | | | 08:40:05 | 786 810.8 | 2 744 306.9 | | | | | | | |

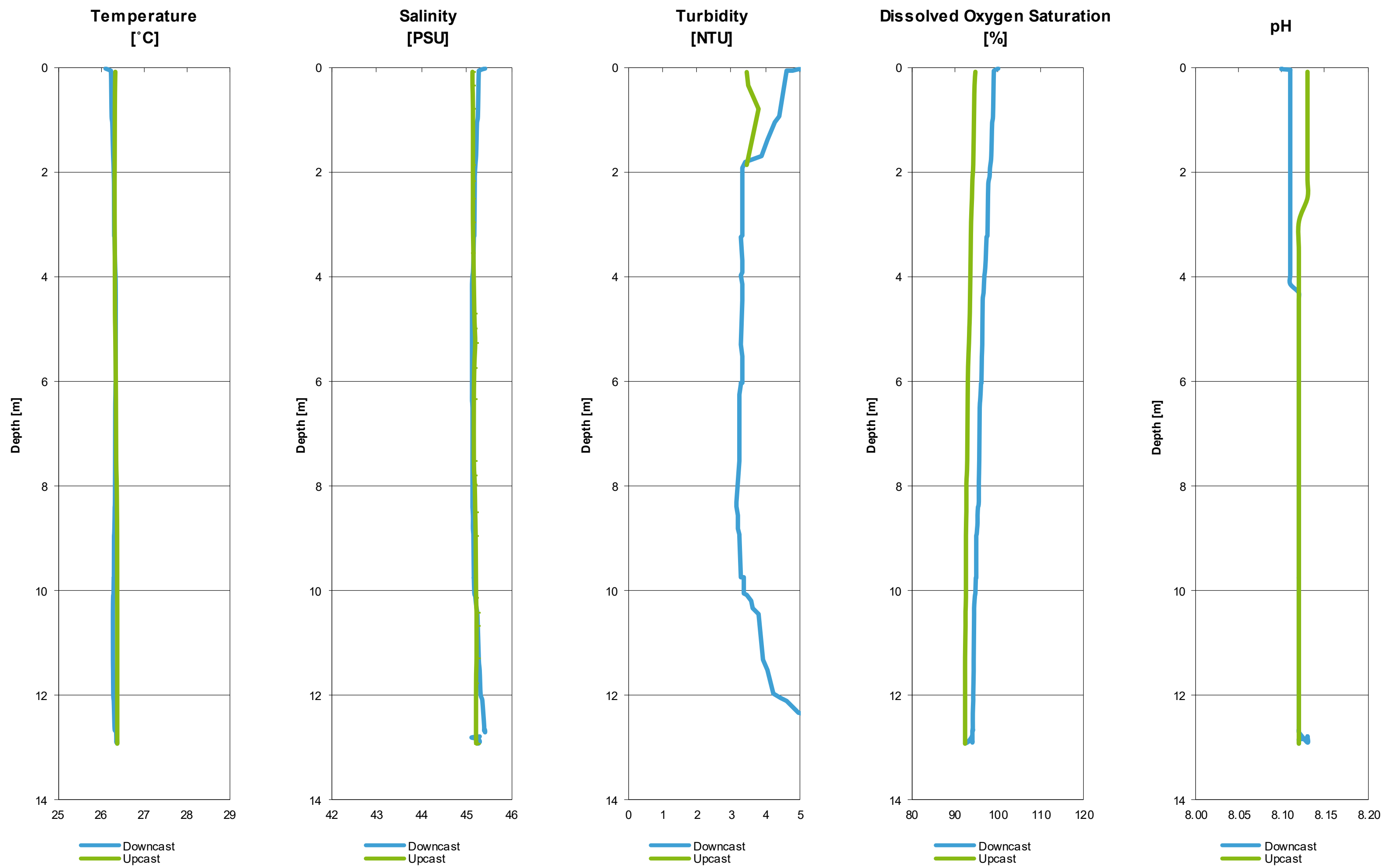
Clarke 1880 (Mod) Spheroid, Nahrwan 1967 Datum, UTM Projection, Zone 39 North, CM 51° East

| Date | Transect | Video File | Time [UTC] | Video Coordinates Easting [m] | Video Coordinates Northing [m] | Length [m] | Still Nos. | Sediment Description | Fauna/Bioturbation/Debris | Soft Coral Cover | Hard Coral Cover | Seagrass |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30/05/2020 | TR10 | E0395_R1_TR10 | 12:56:03<br>13:01:53 | 779 340.6<br>779 465.0 | 2 761 566.1<br>2 761 544.1 | 126 | 13 | Gravelly sand and shell fragments veneer overlying calcarenite, coral rubble. Calcarenite subcrops and calcarenite reef overhangs | Boulder corals (Faviidae), finger corals (*Porites* sp.), plate corals (*Turbinaria* sp.), gorgonians (Alcyonacea), pencil urchins (*Phyllacanthus imperialis*), sea urchin (*Echinometra mathei*), long spined urchin (*Diadema setosum*), starfish (*Linckia* sp.), hydroids (Hydrozoa), turf algae, encrusting sponge (Porifera), coralline algae (Corallinales), pearly goatfish (*Parupeneus margaritatus*), black spot snapper (*Lutjanus* sp.), arabian monacle bream (*Scolopsis ghanam*), parrotfish (*Chlorurus sordidus*), yellowband angel fish (*Pomacanthus maculosus*), blackspotted rubber lip (*Plectorhinchus gaterinus*), double bar bream (*Acanthopagrus bifasciatus*), goby (Gobiidae), unidentified fish (Pisces). Occasional evidence of coral bleaching and/or coral death. | No coral (< 1 %) | Low coral (1-10 %) | No seagrass (< 1 %) |

Notes
UTC = Coordinated Universal Time
? = Identification om taxon not certain

# D. Water Column Profile

Station R1_ENV_001



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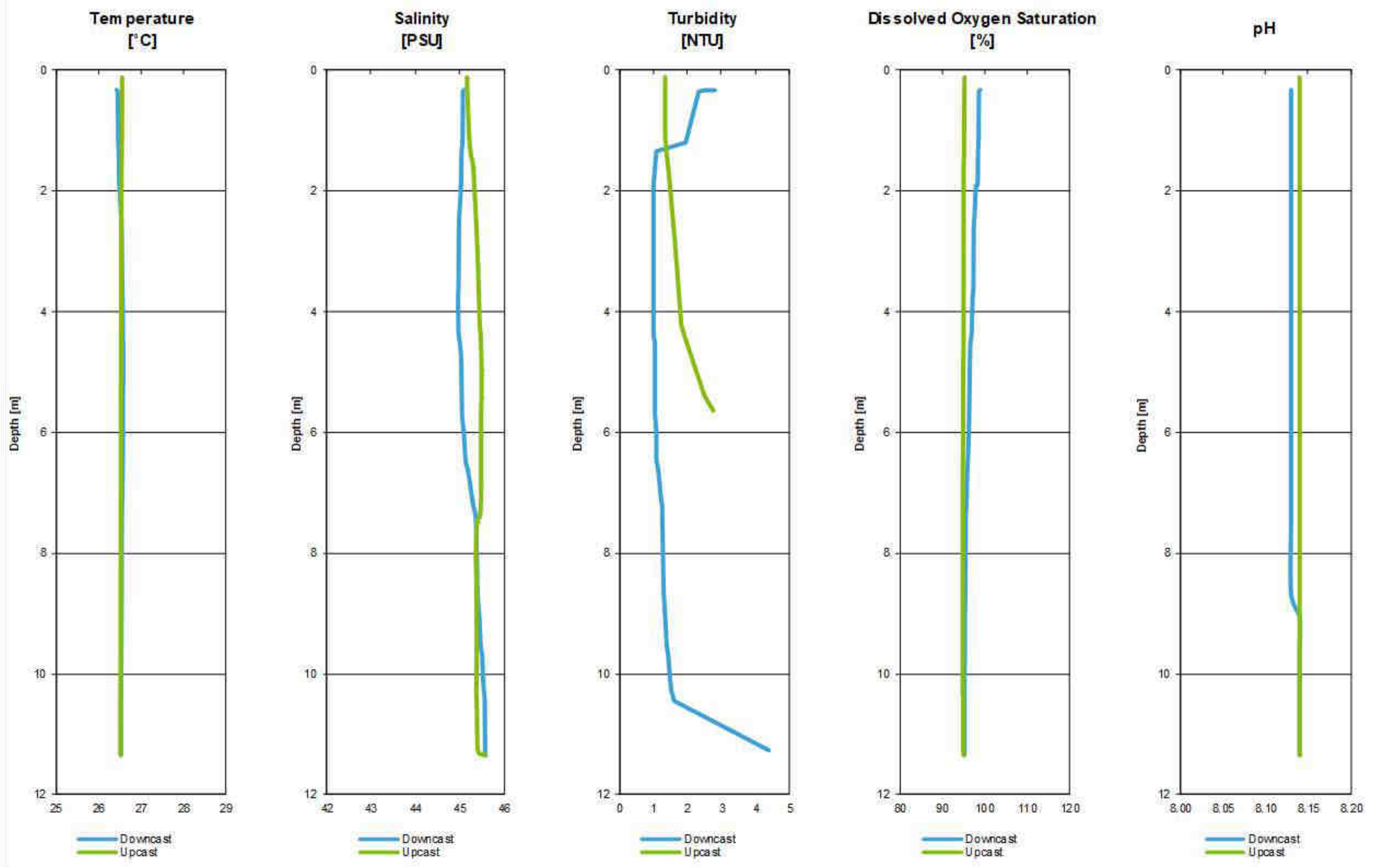

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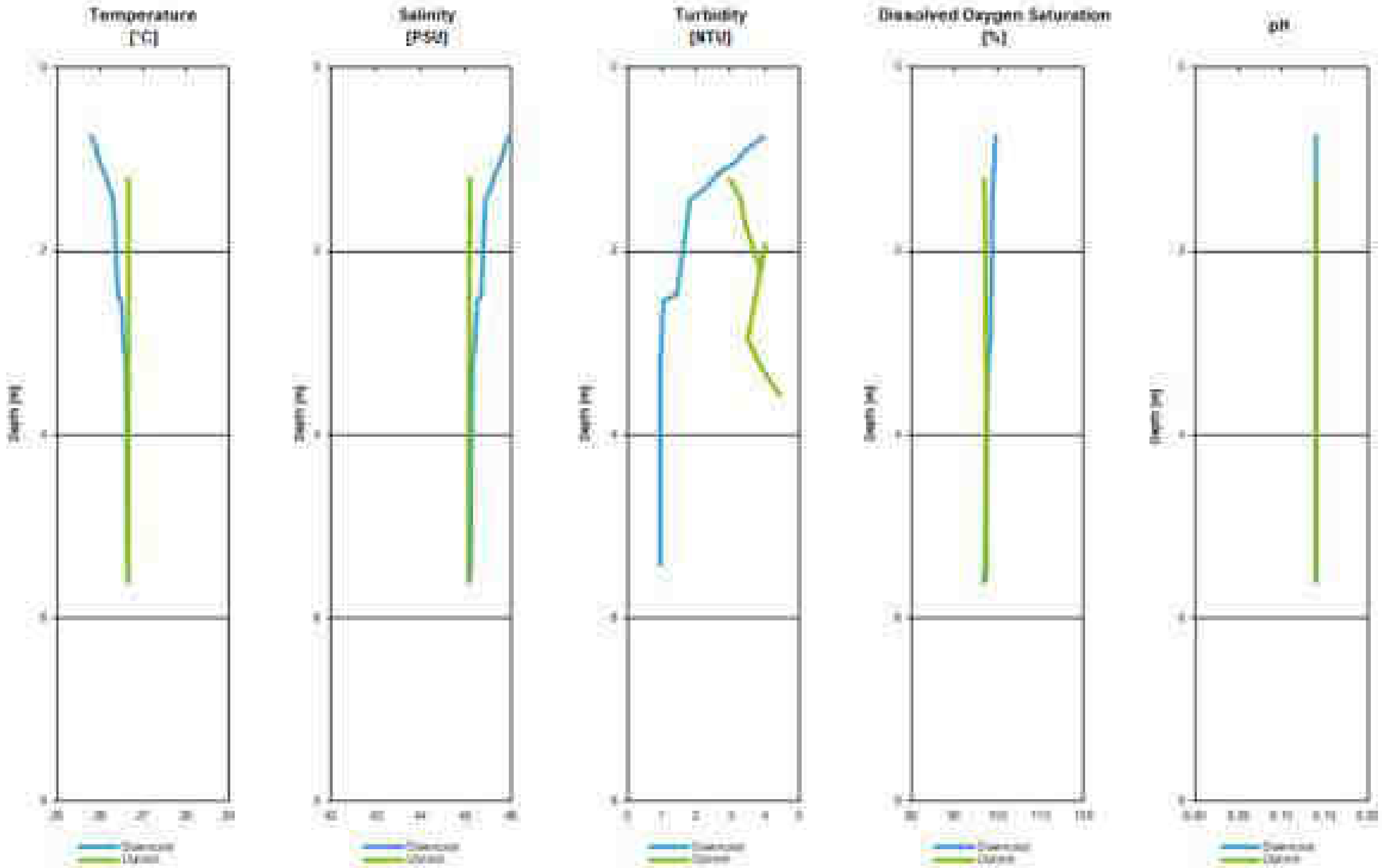

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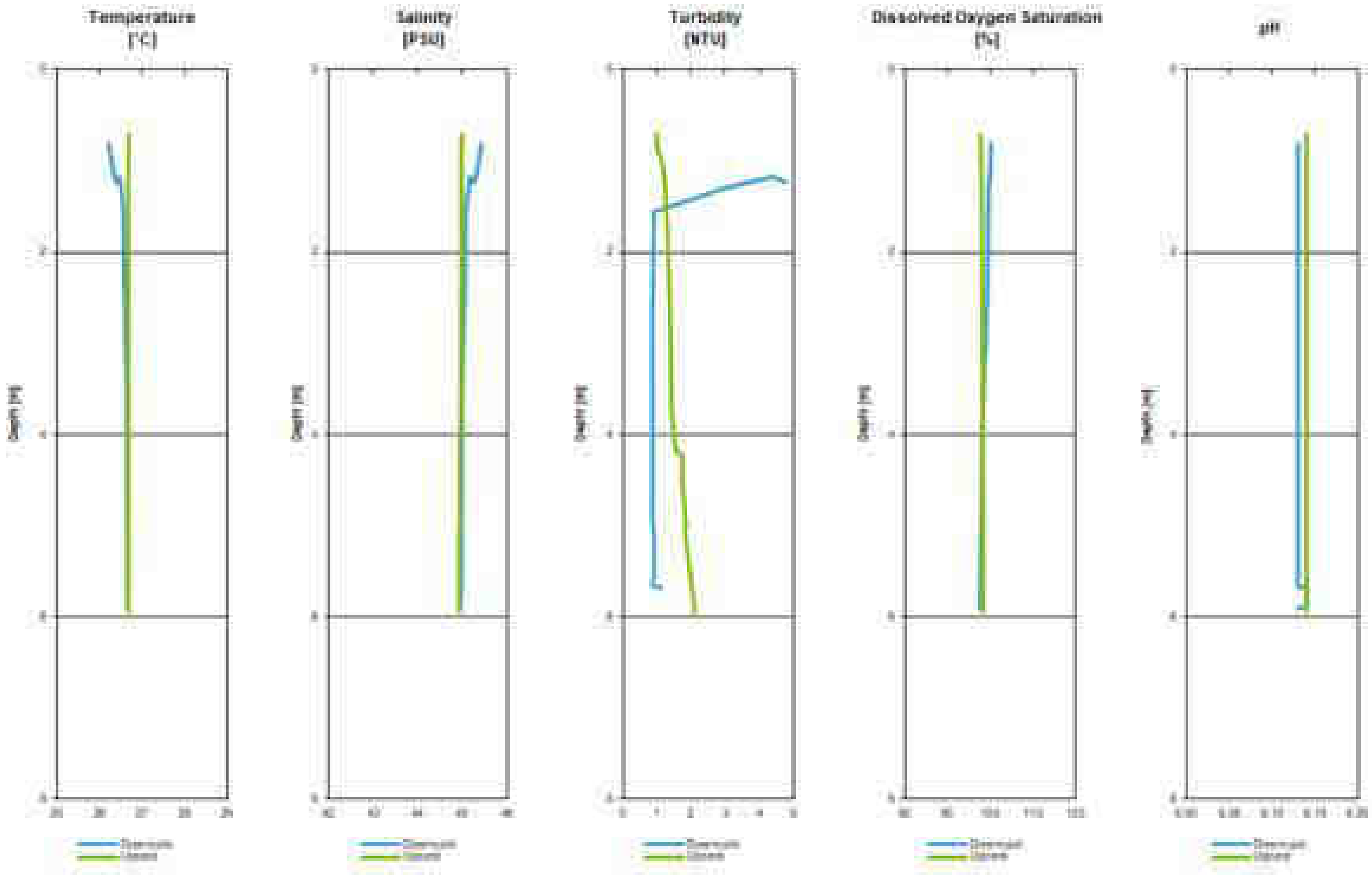

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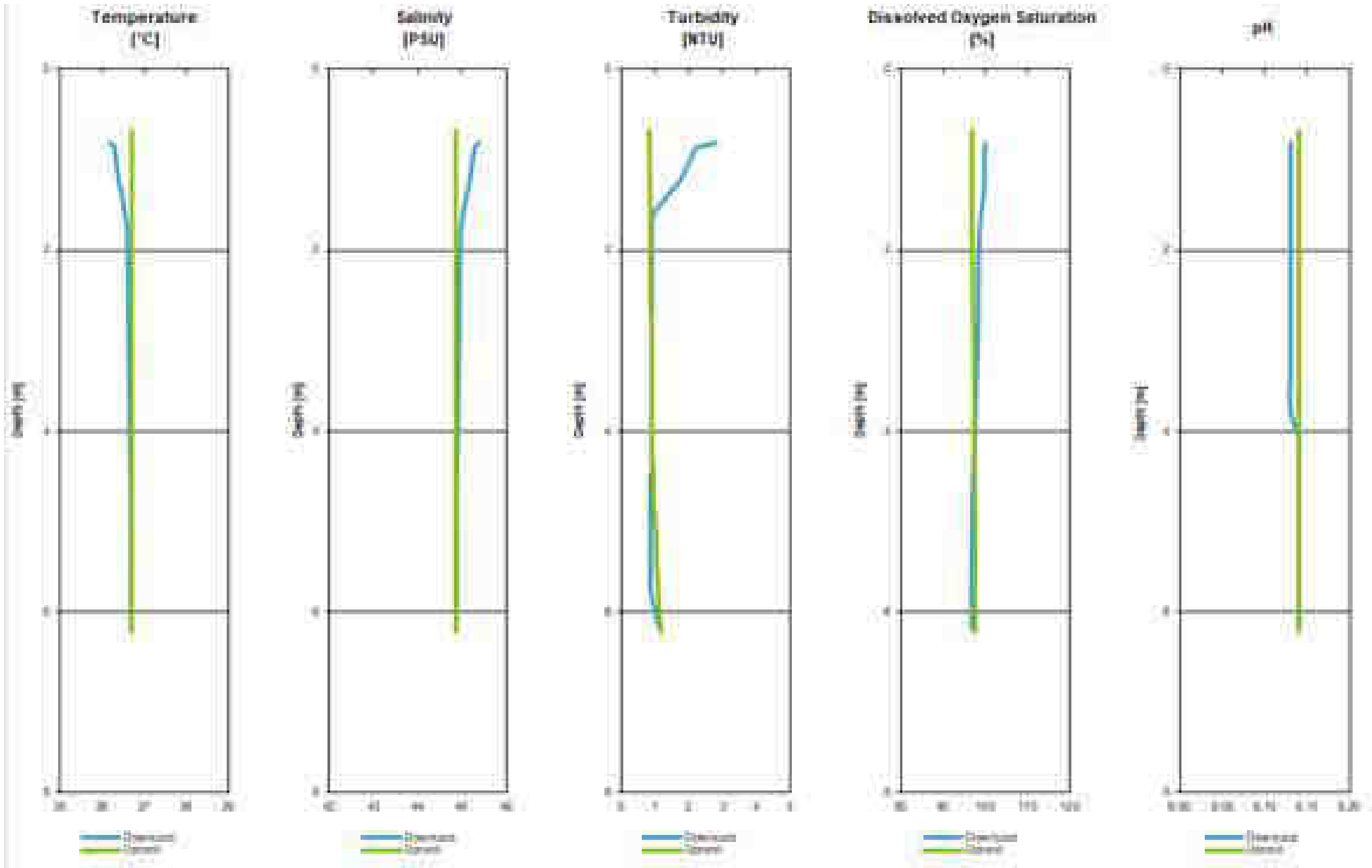

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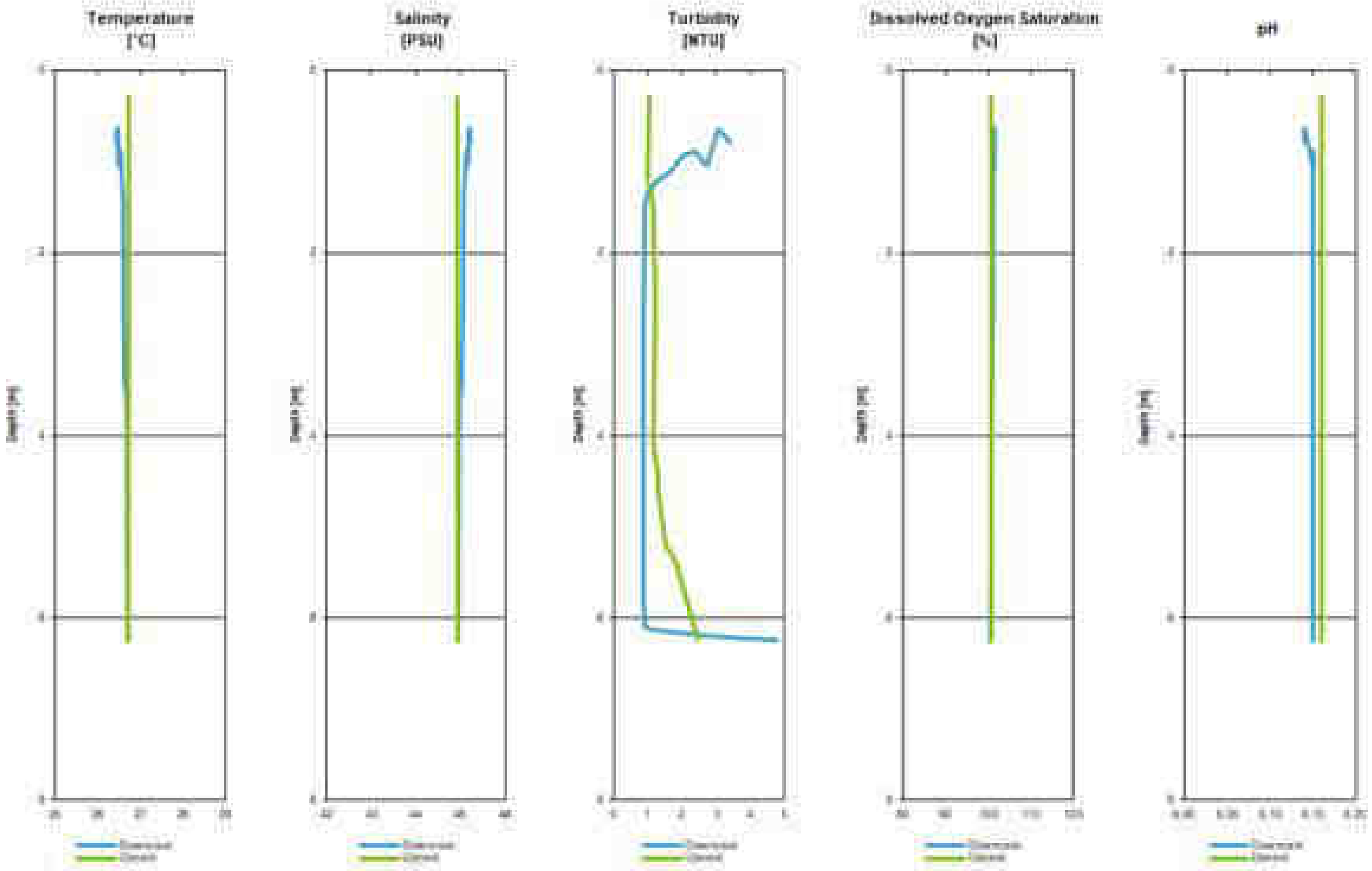

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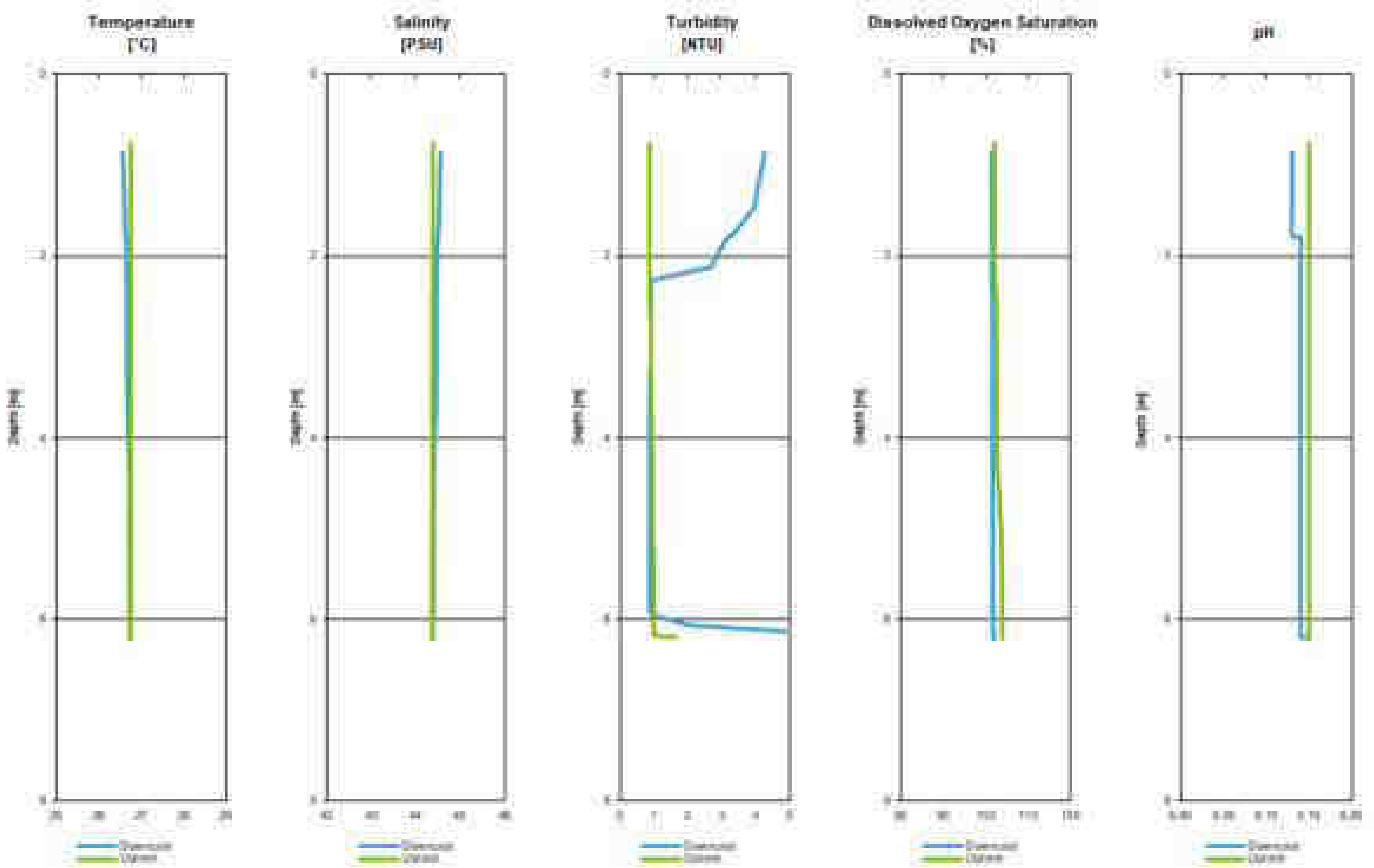

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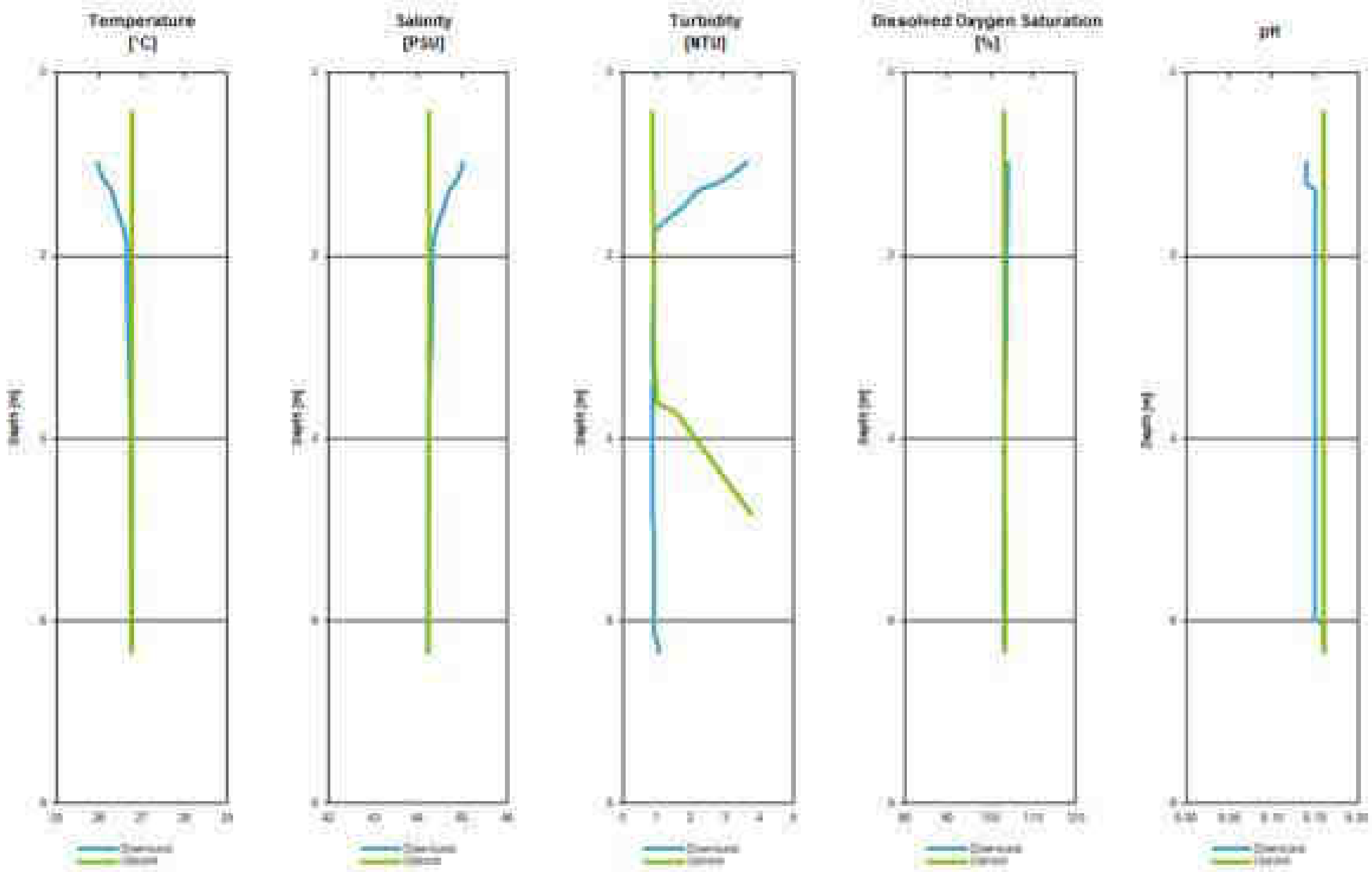

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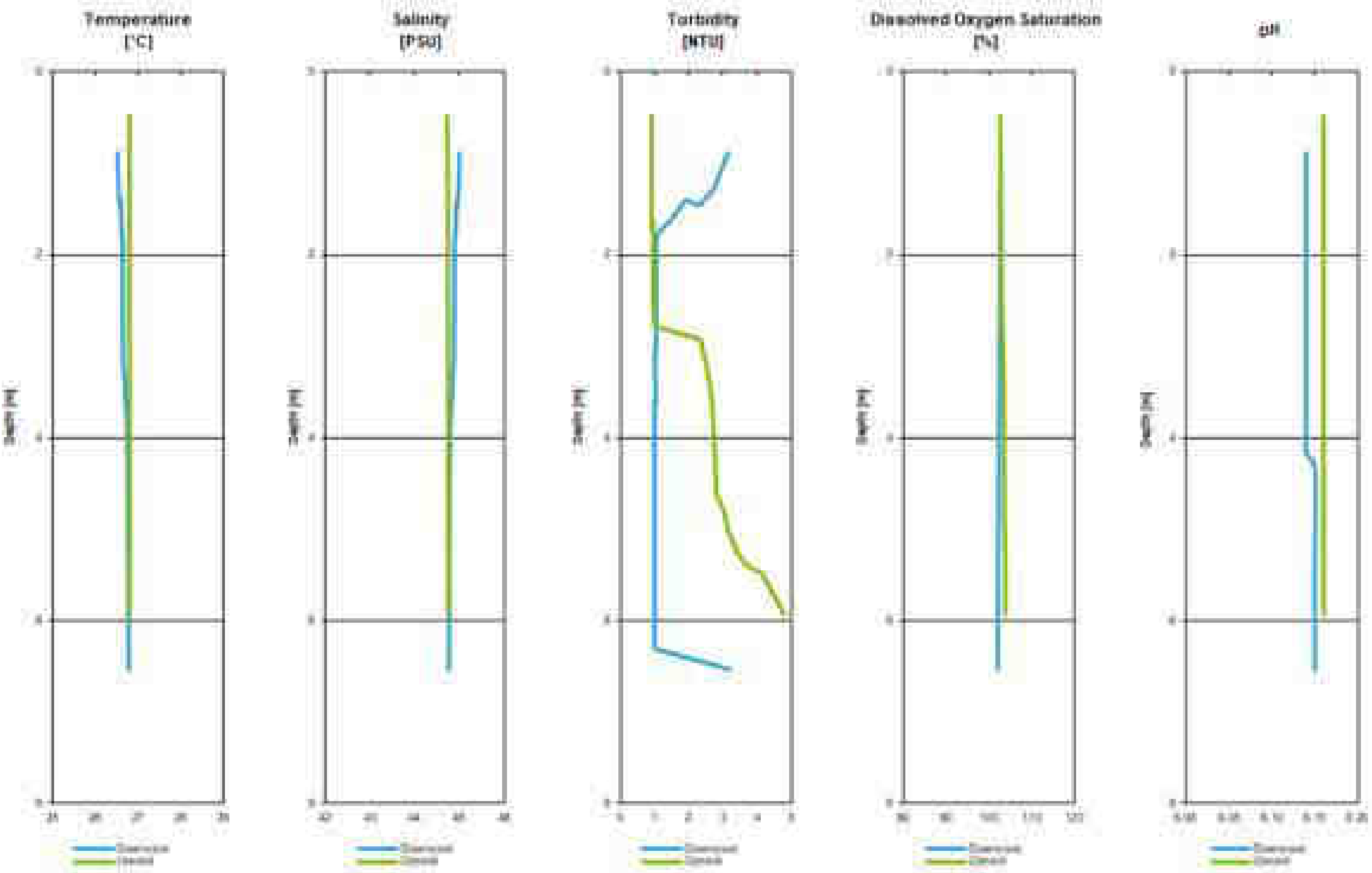

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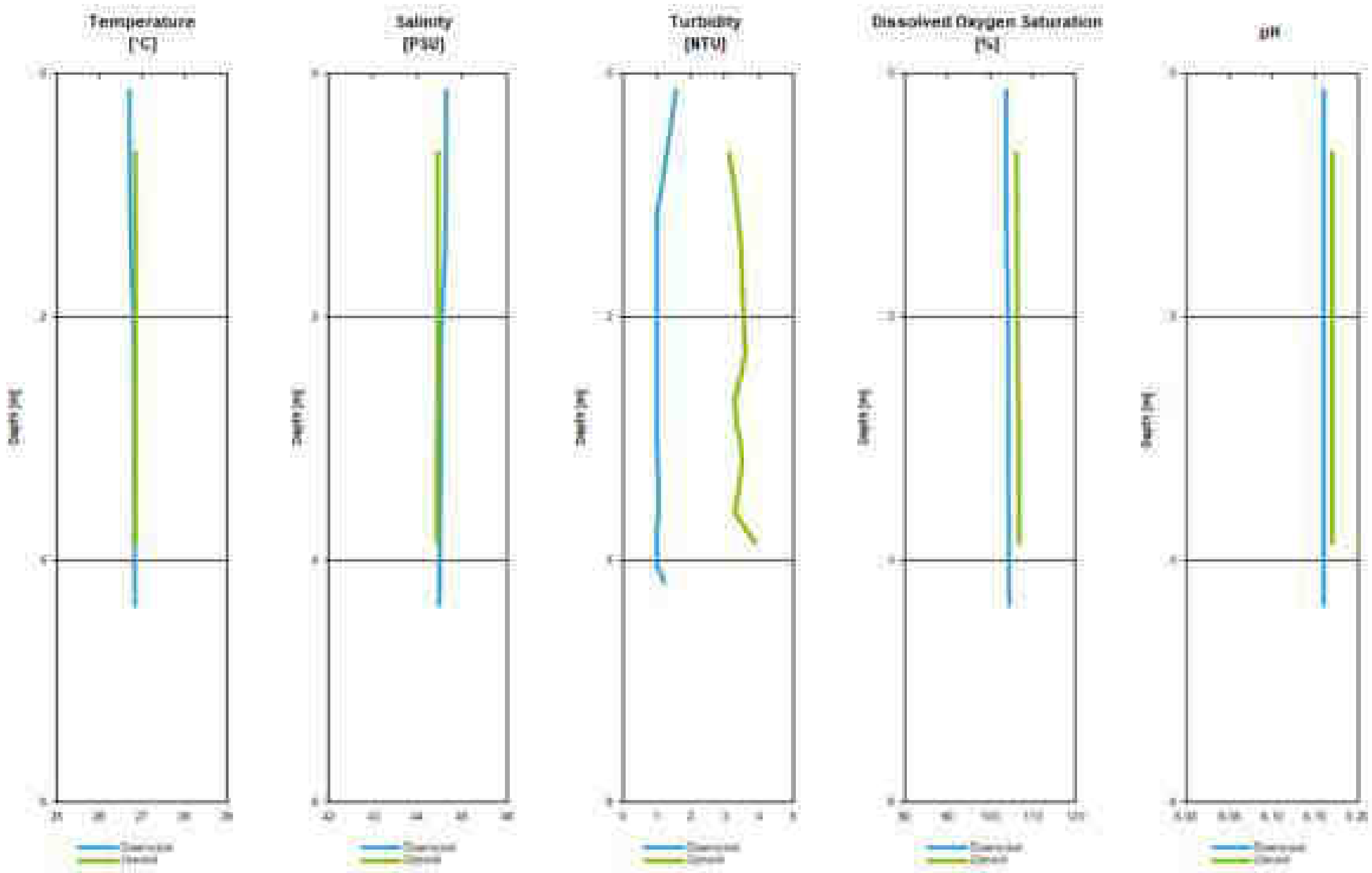

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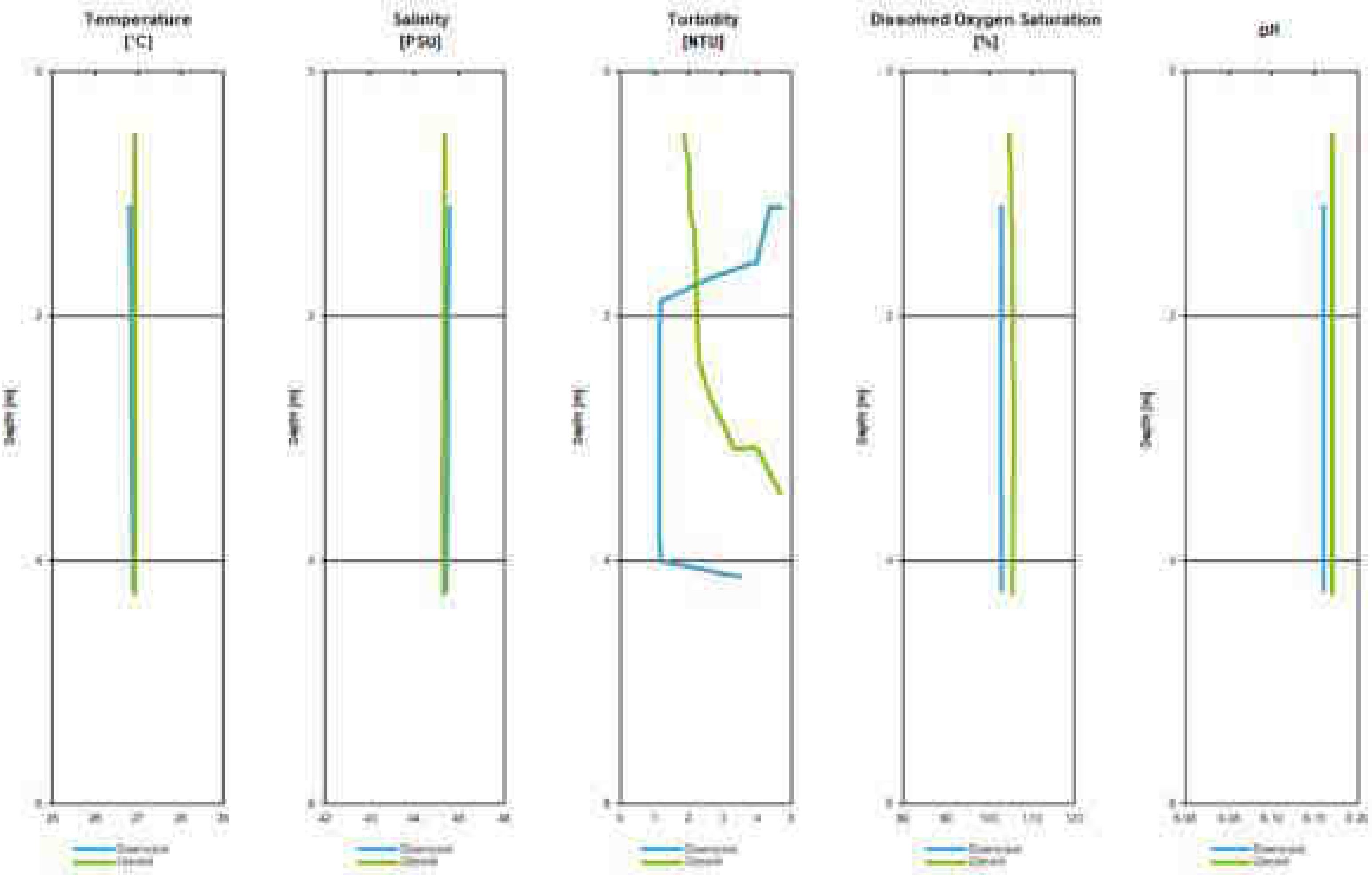

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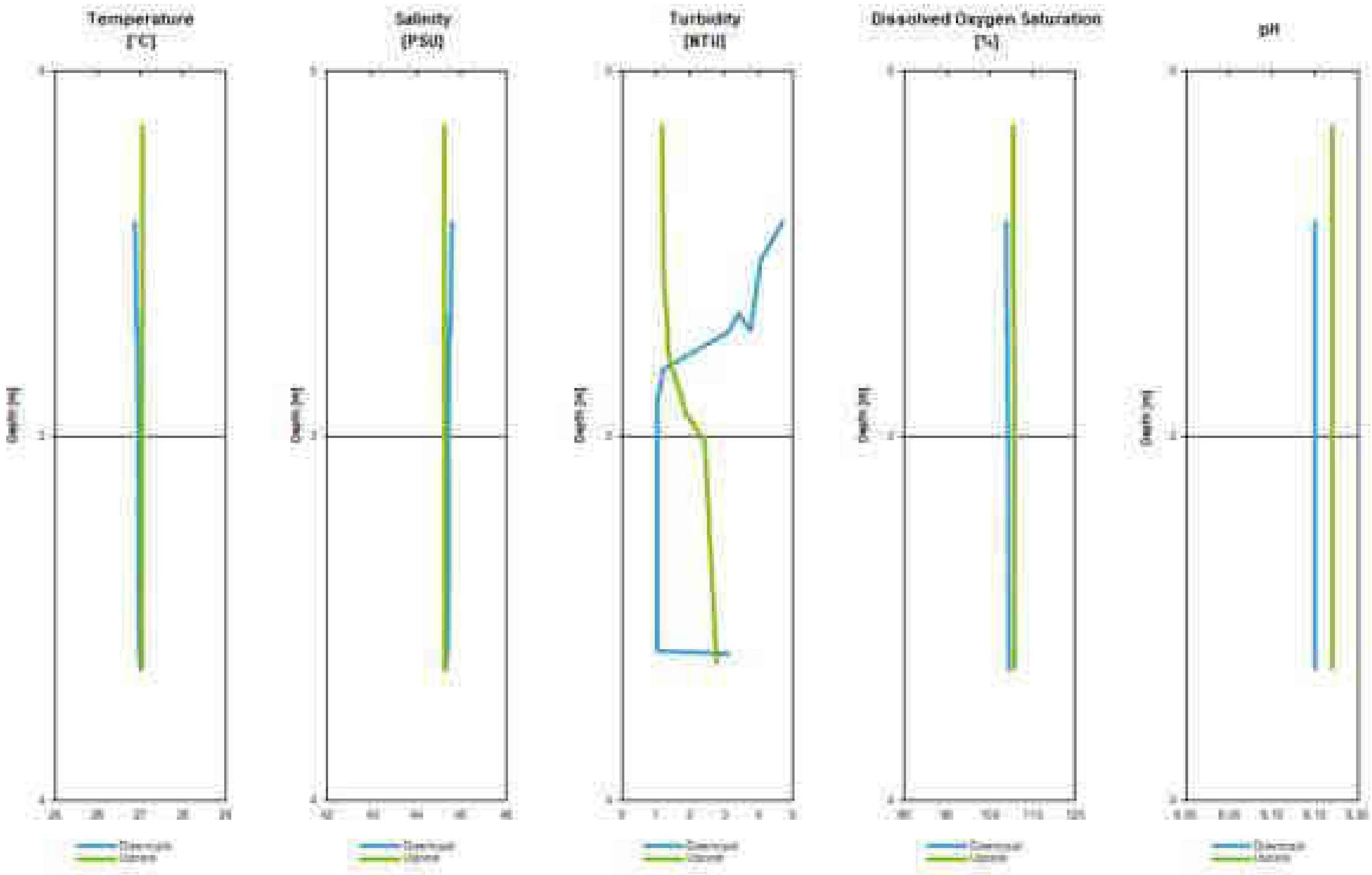

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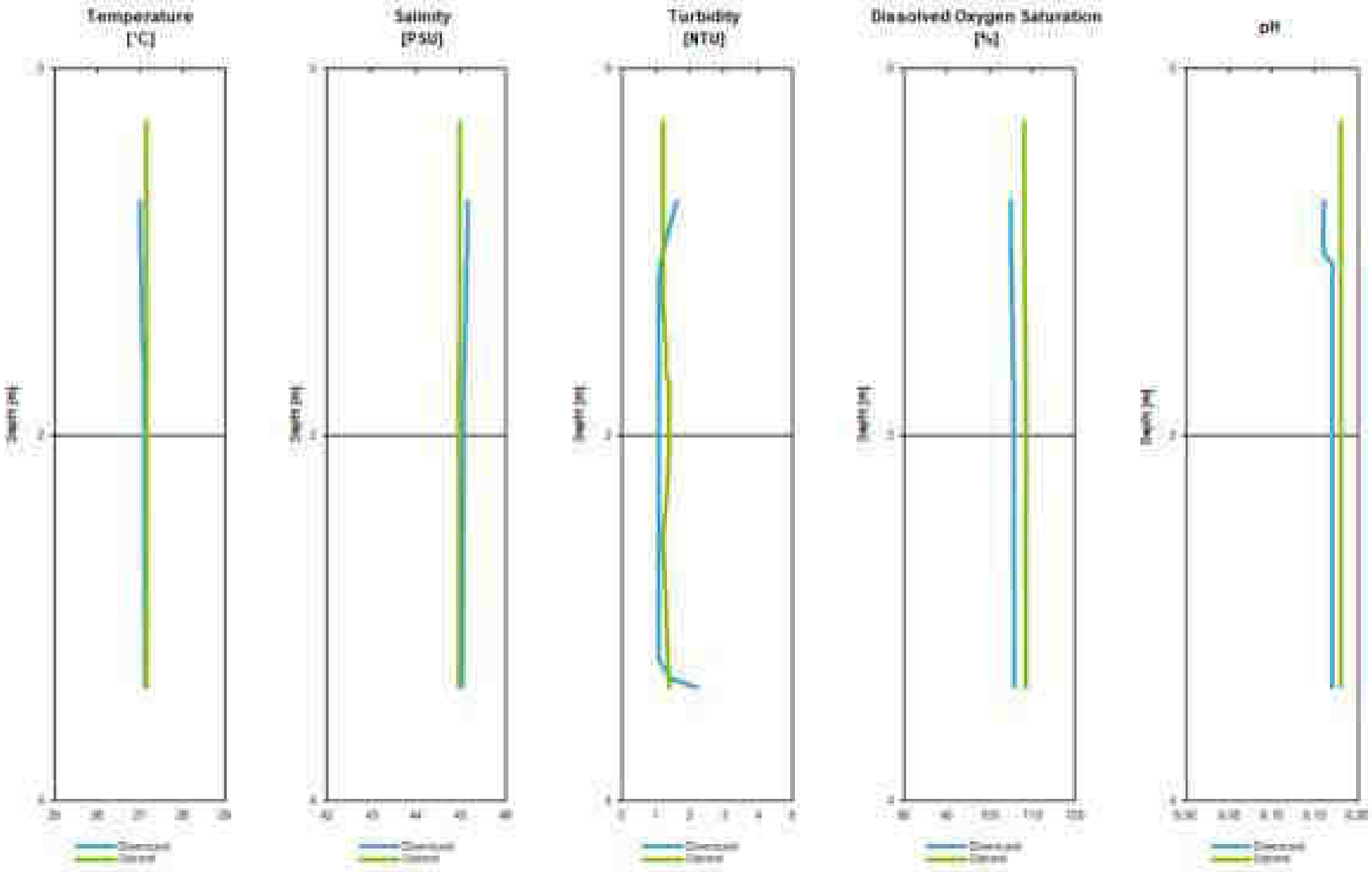

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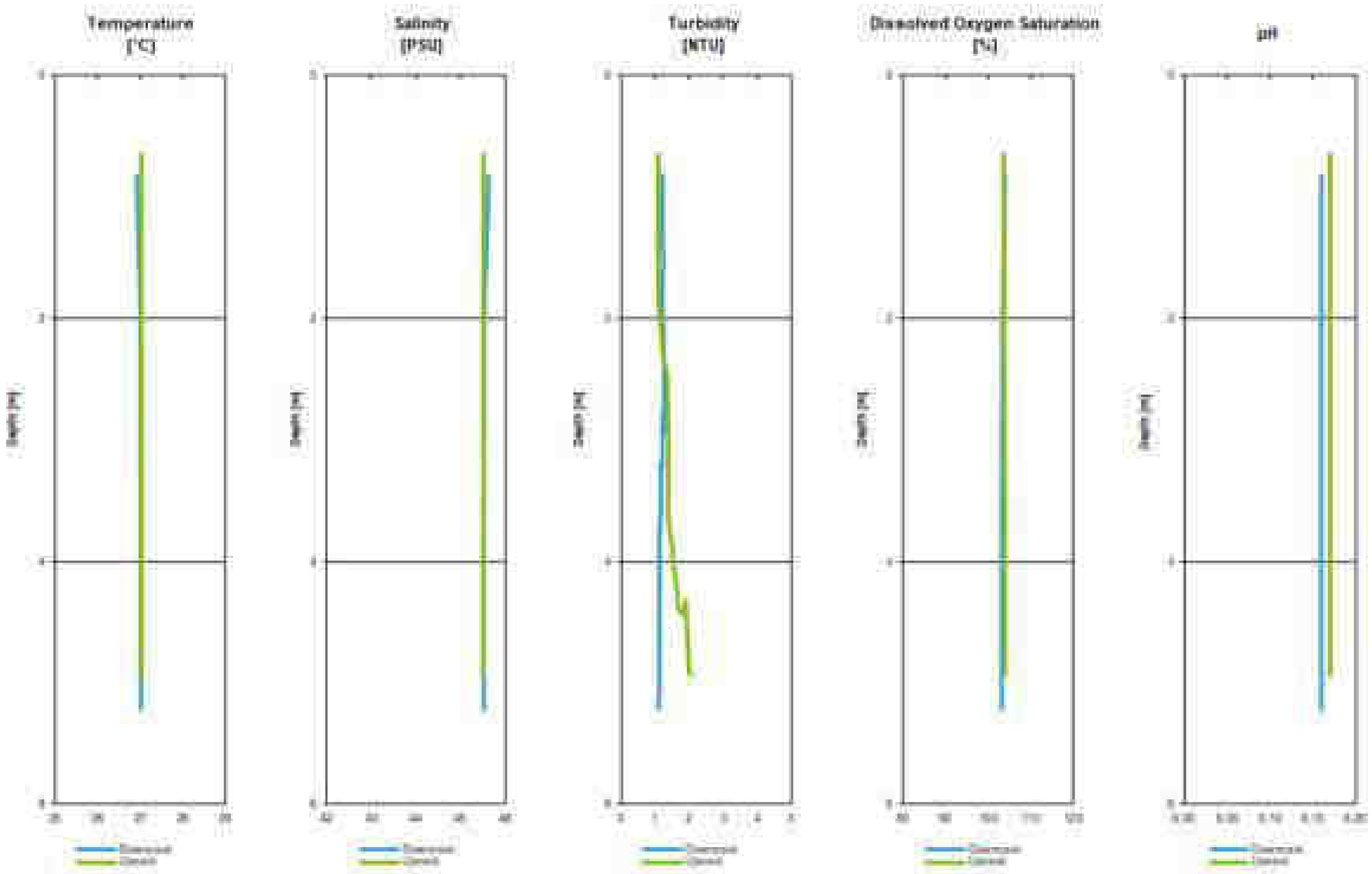

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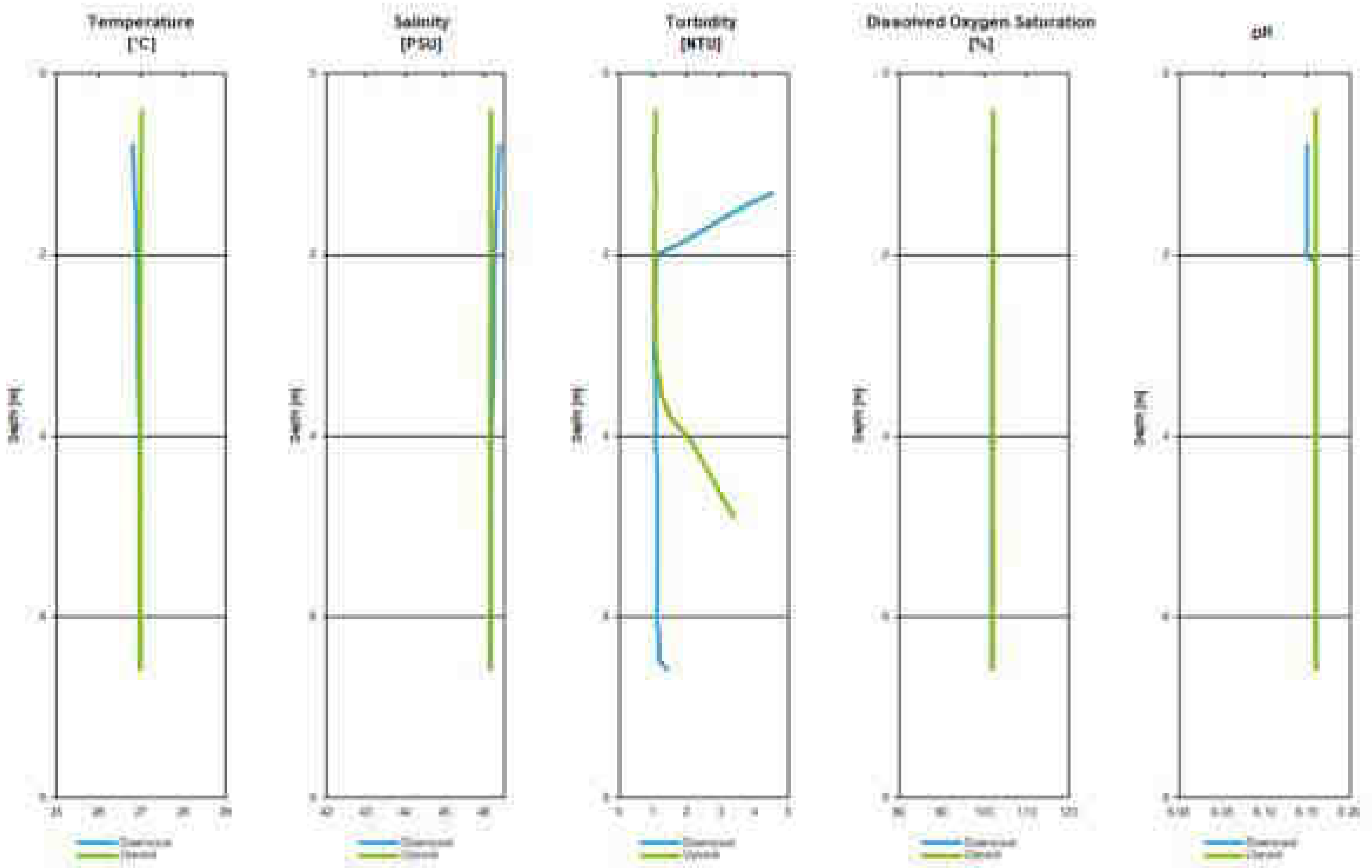

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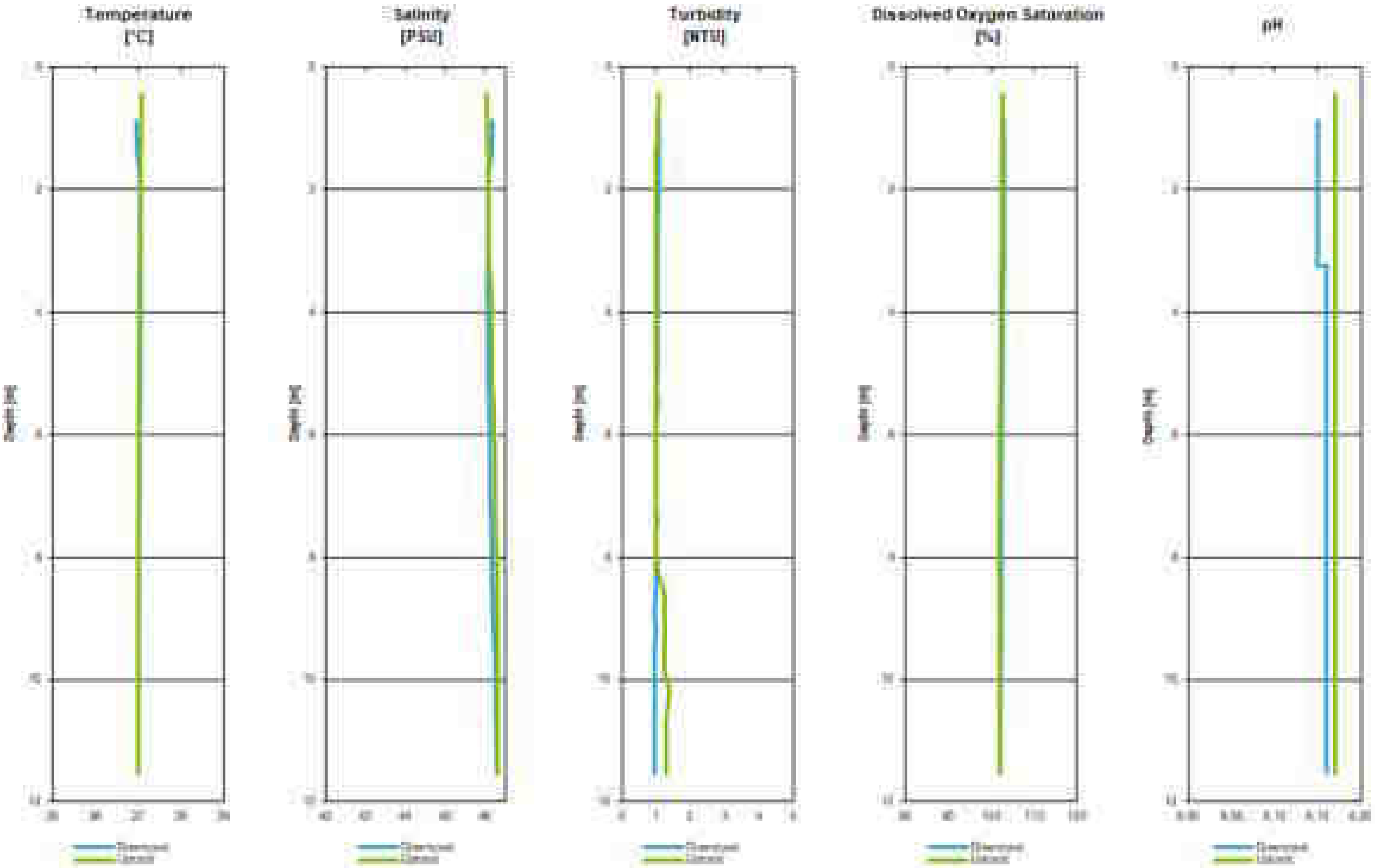

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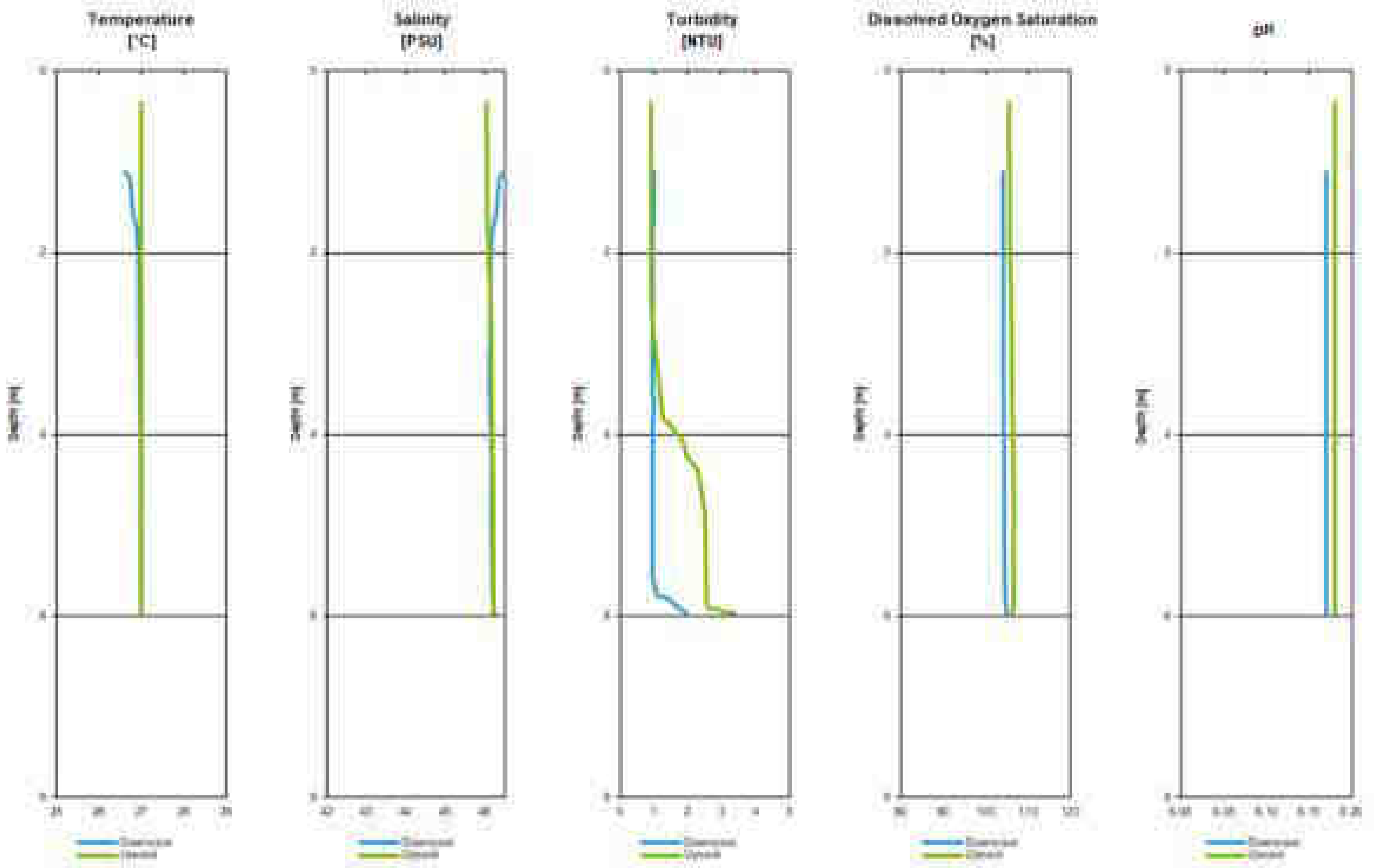

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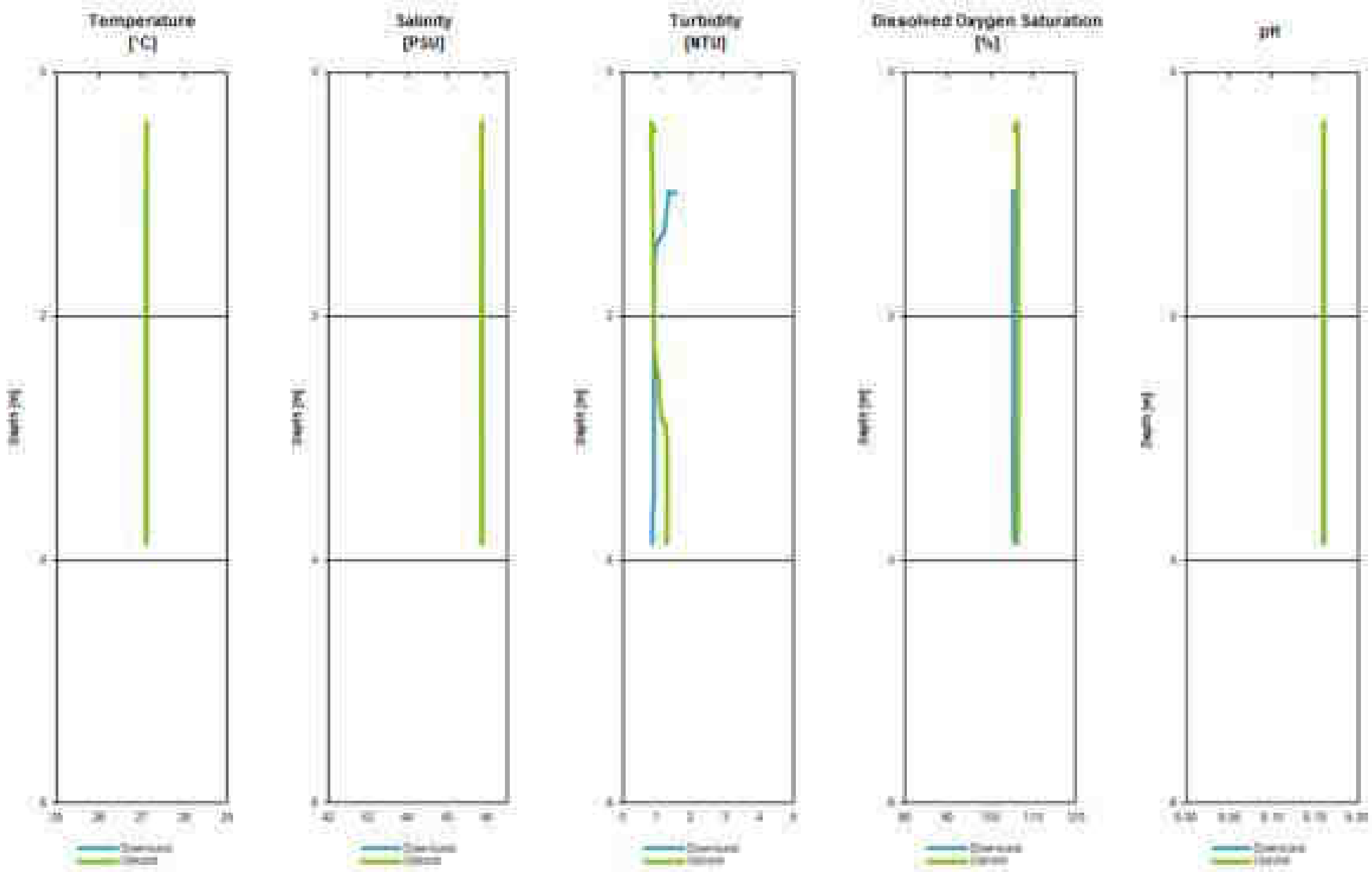

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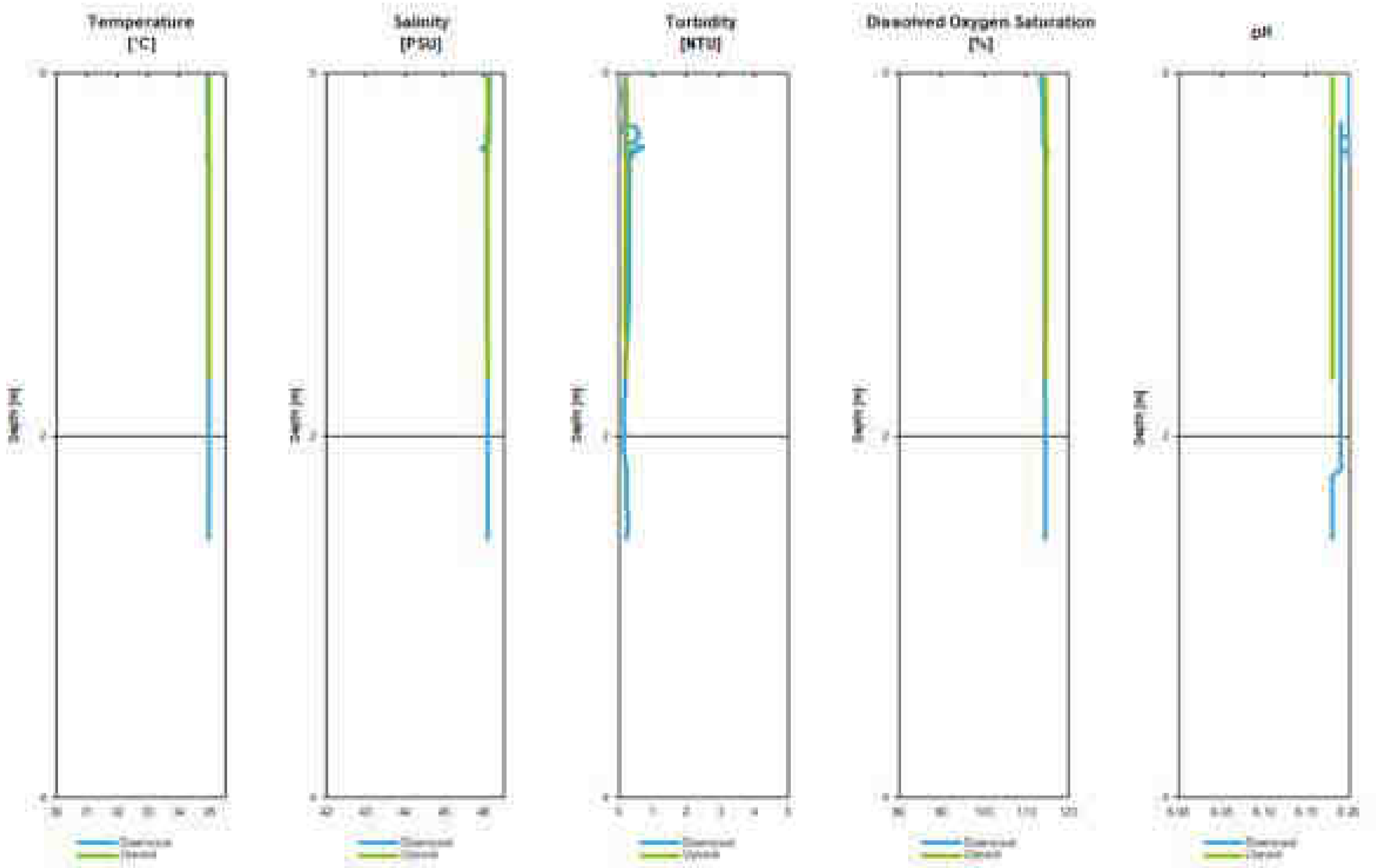

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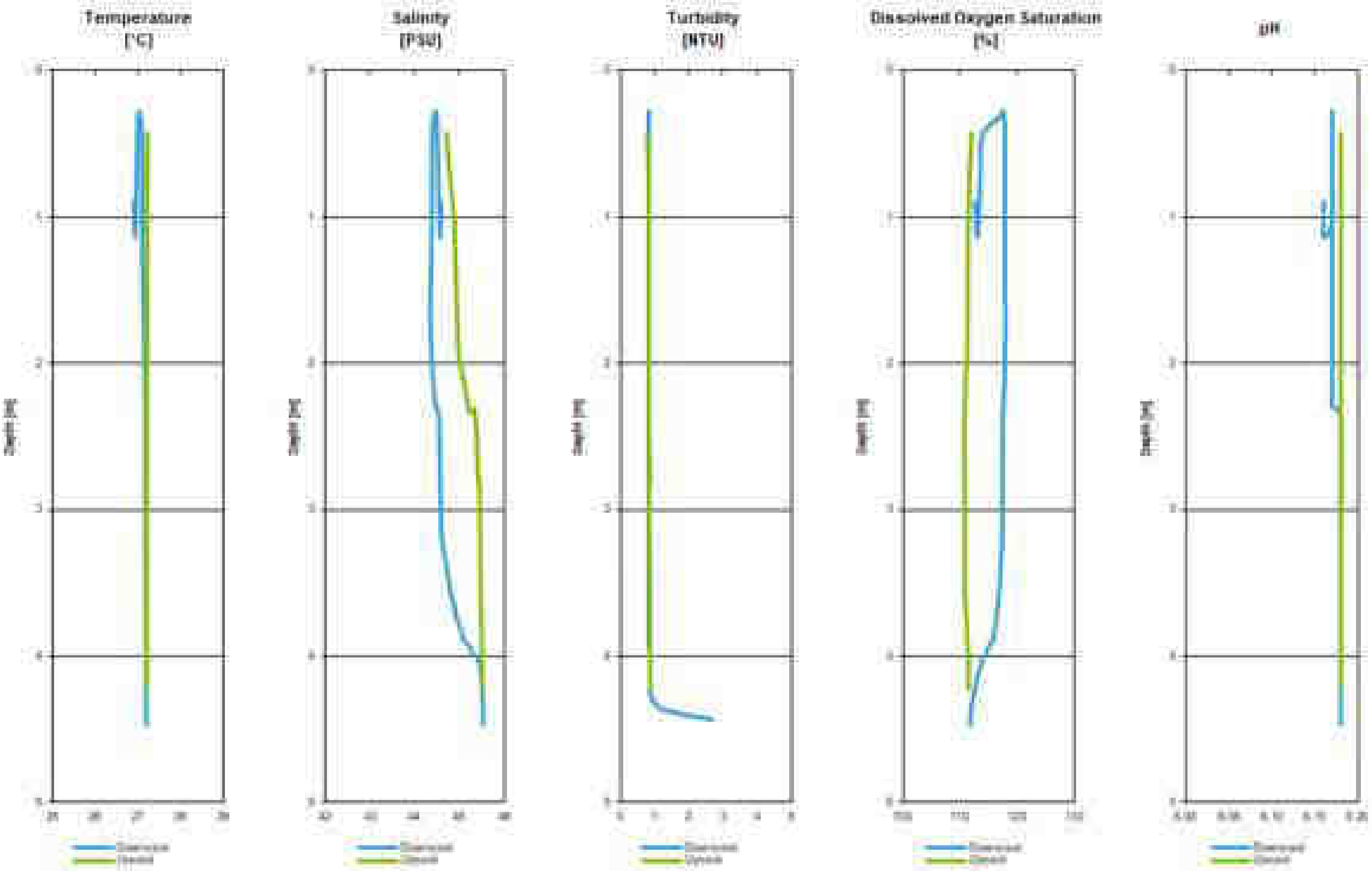

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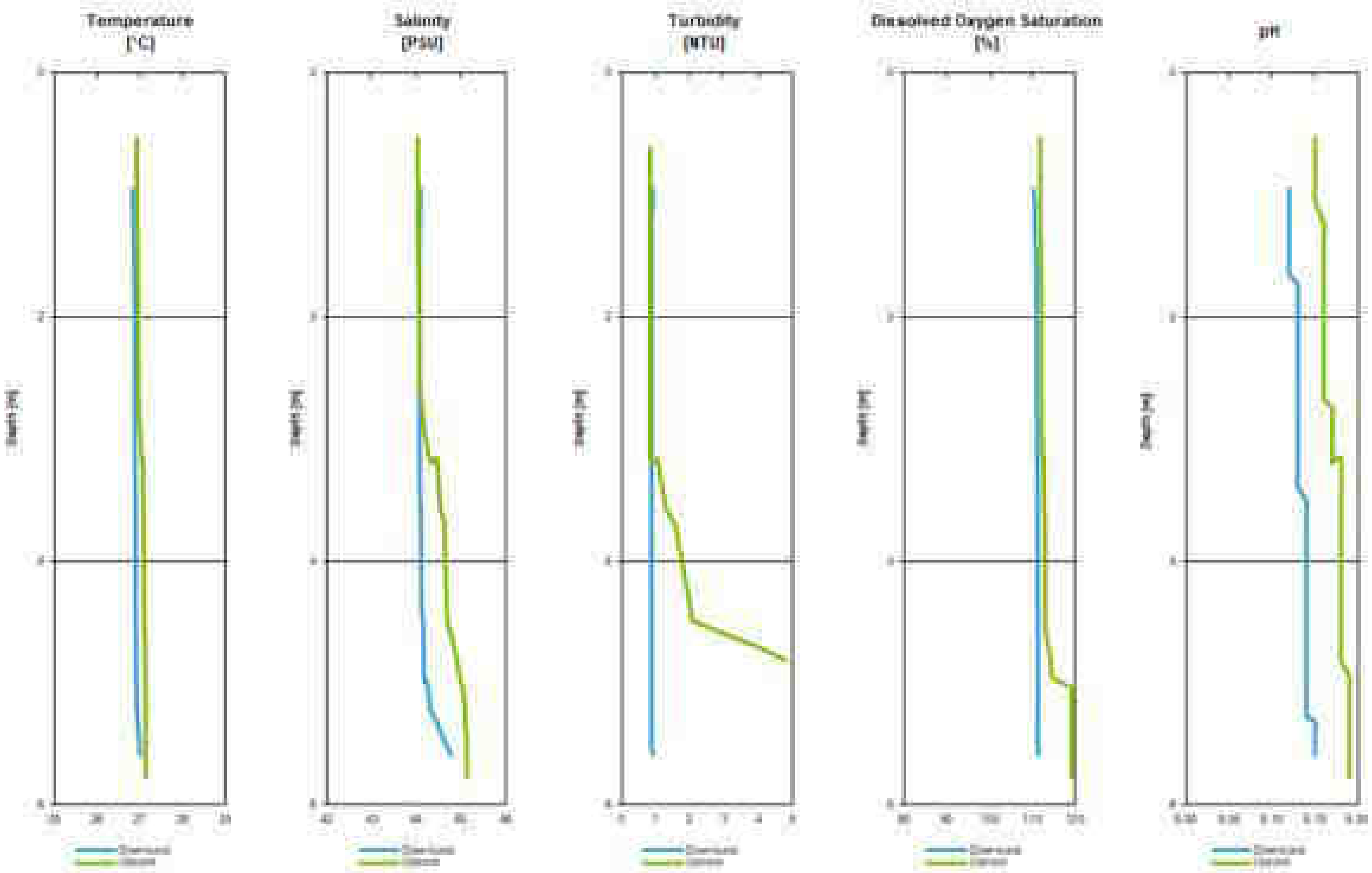

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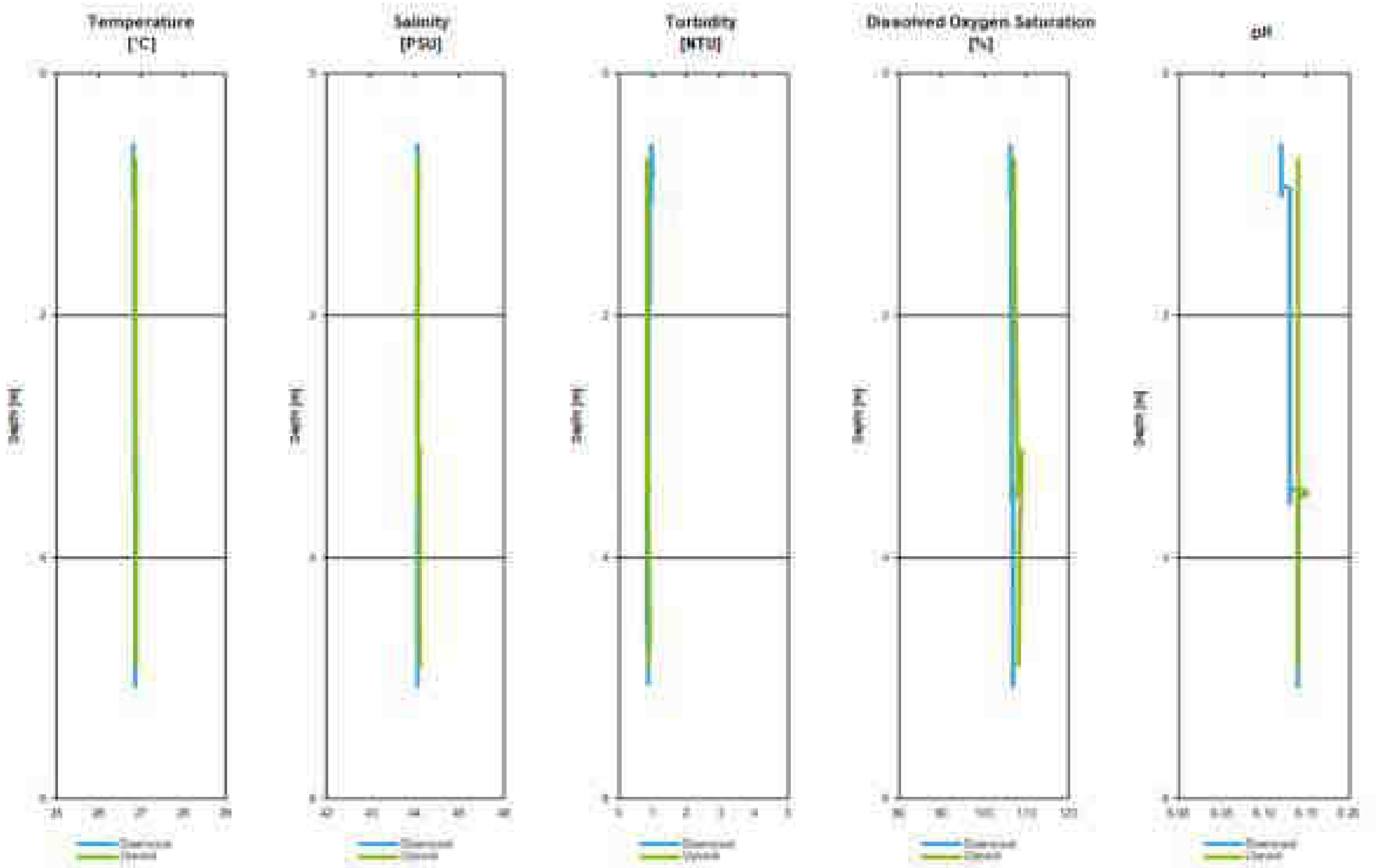

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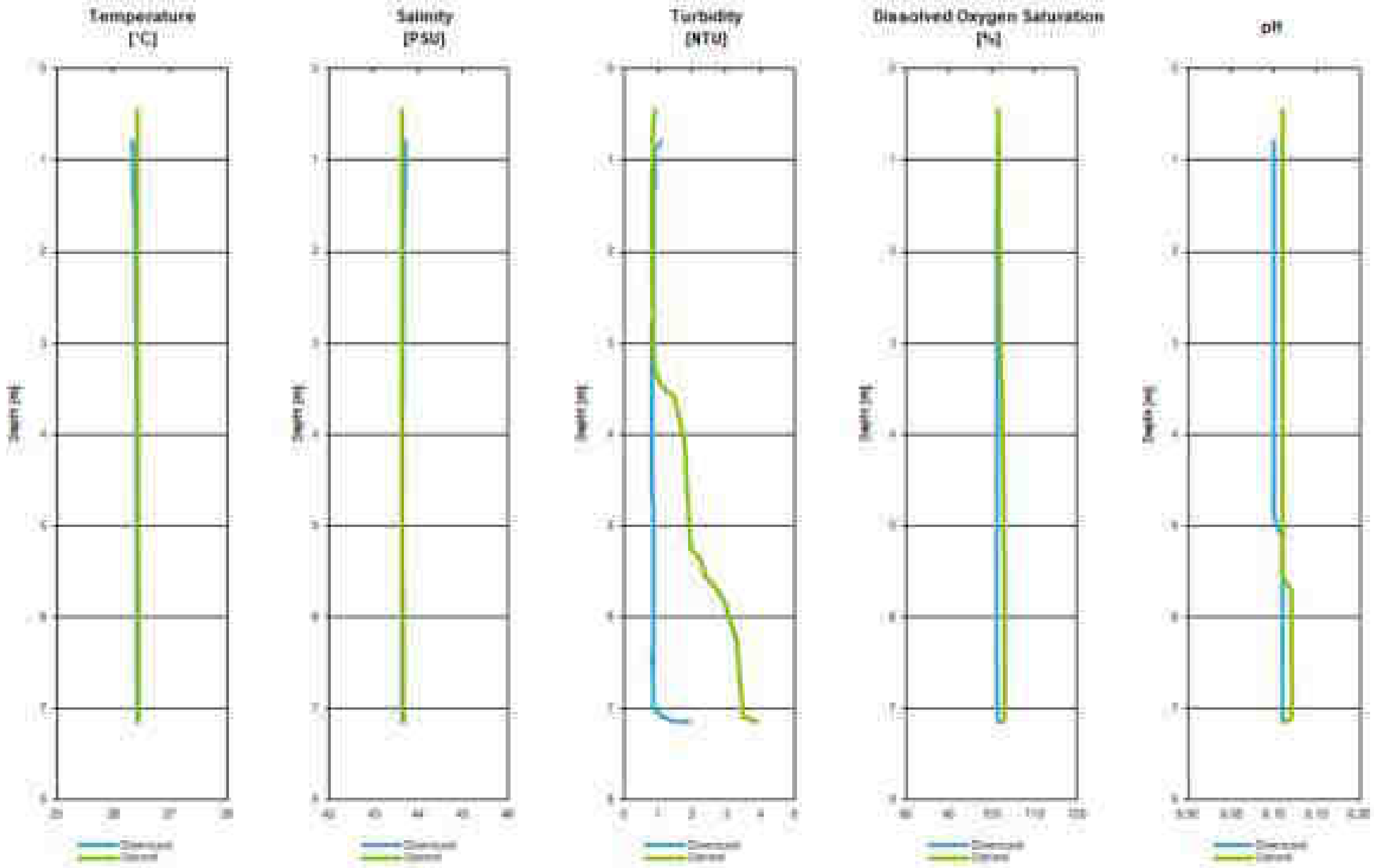

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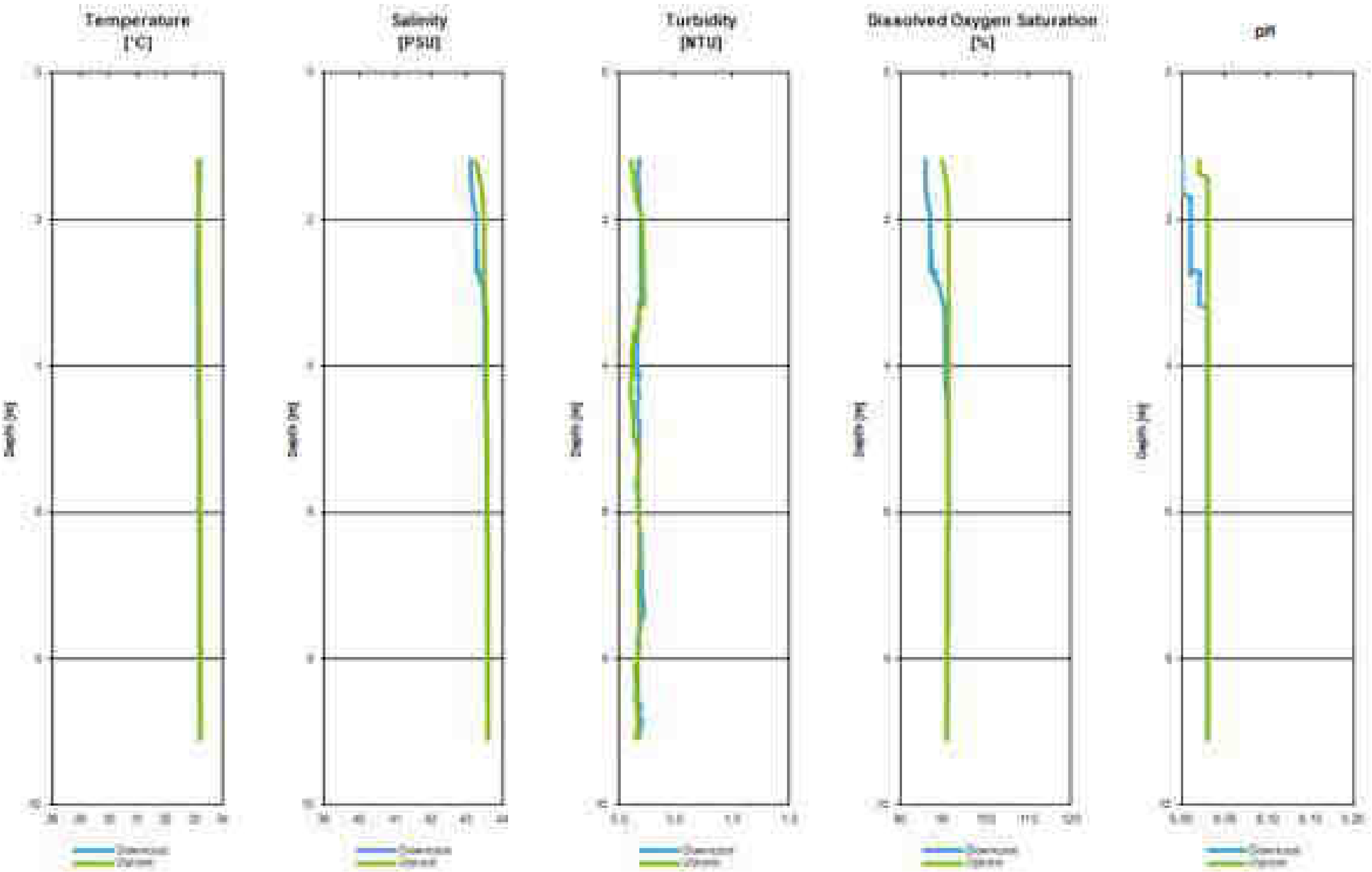

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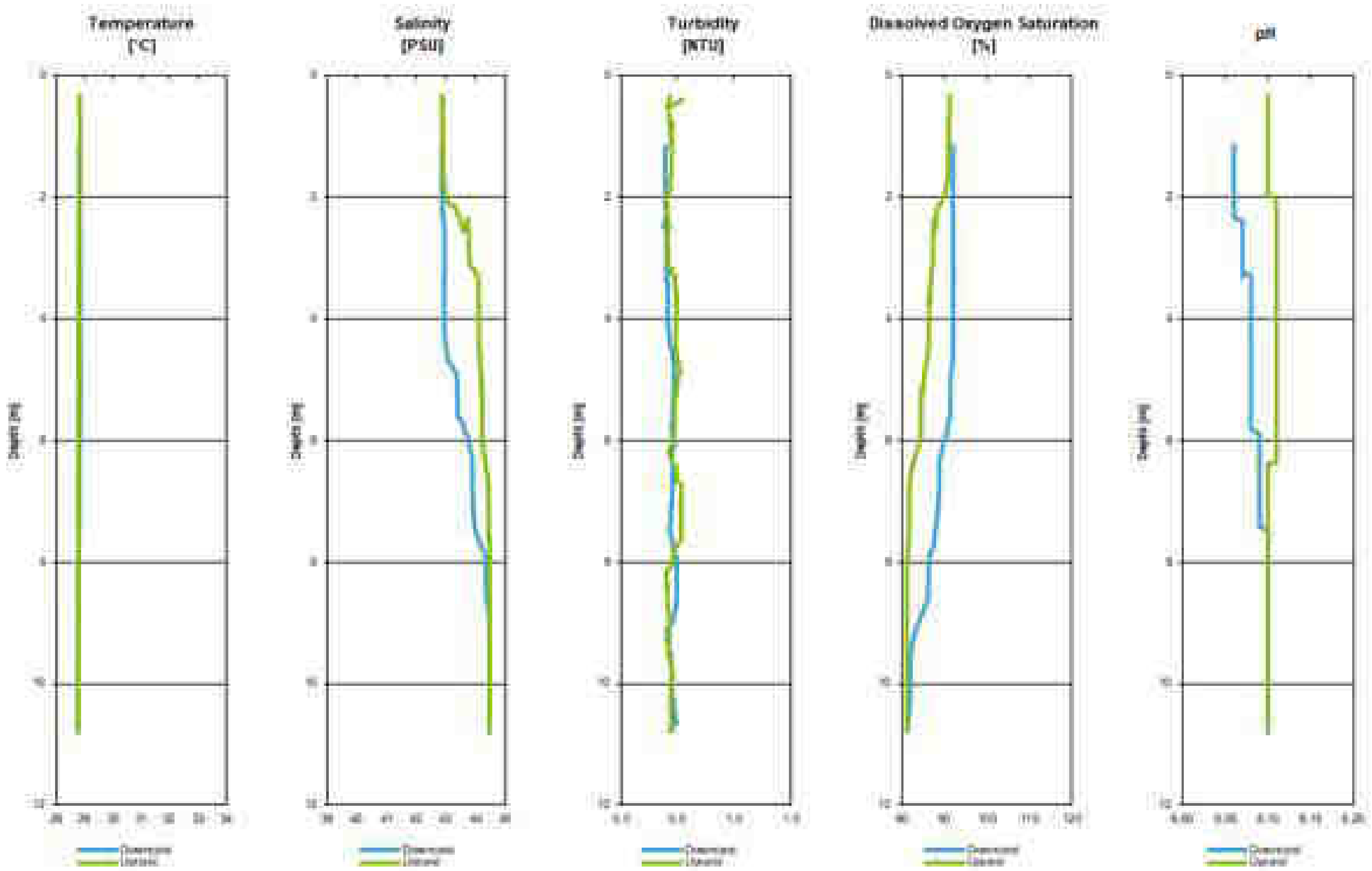

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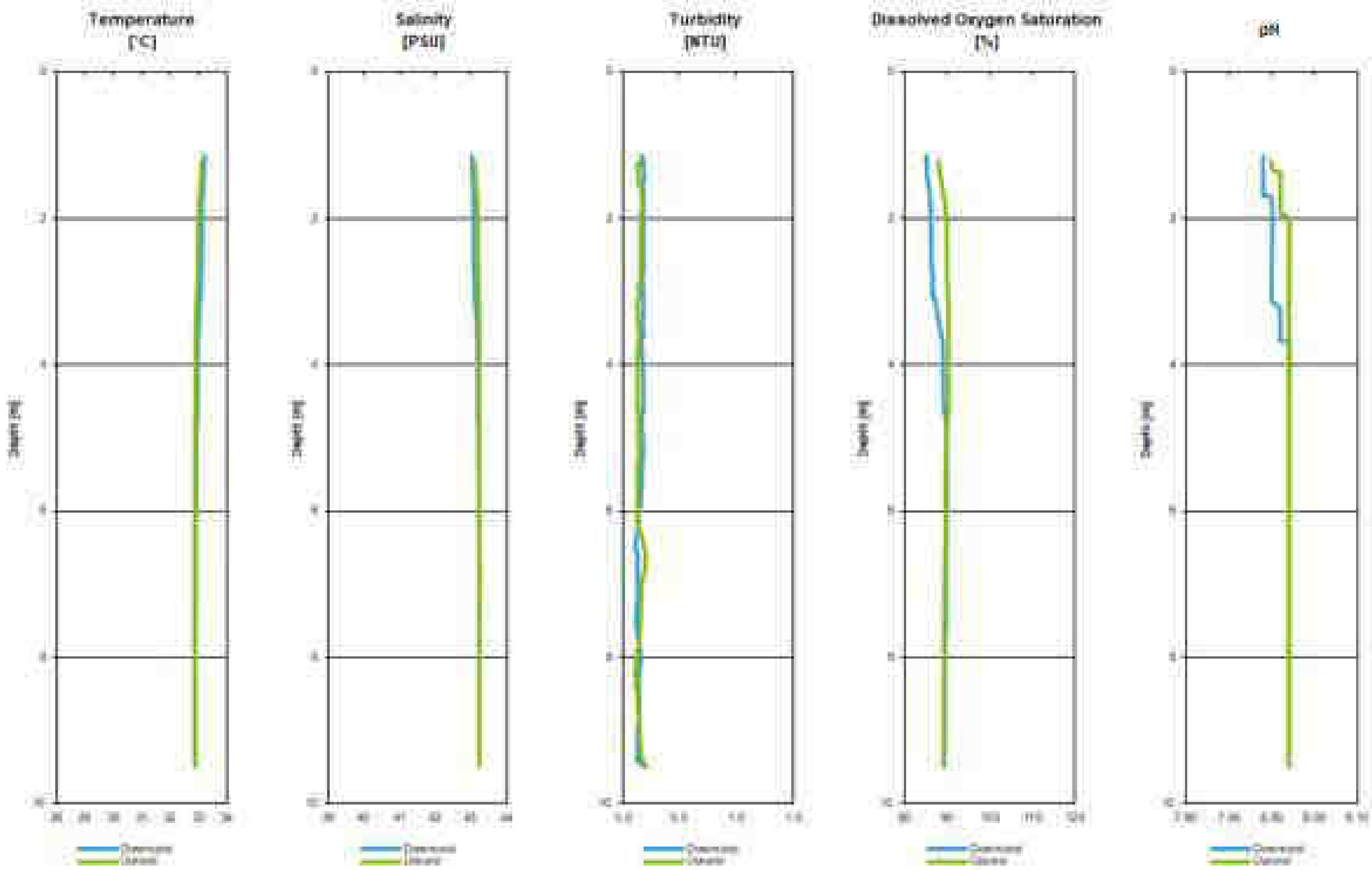

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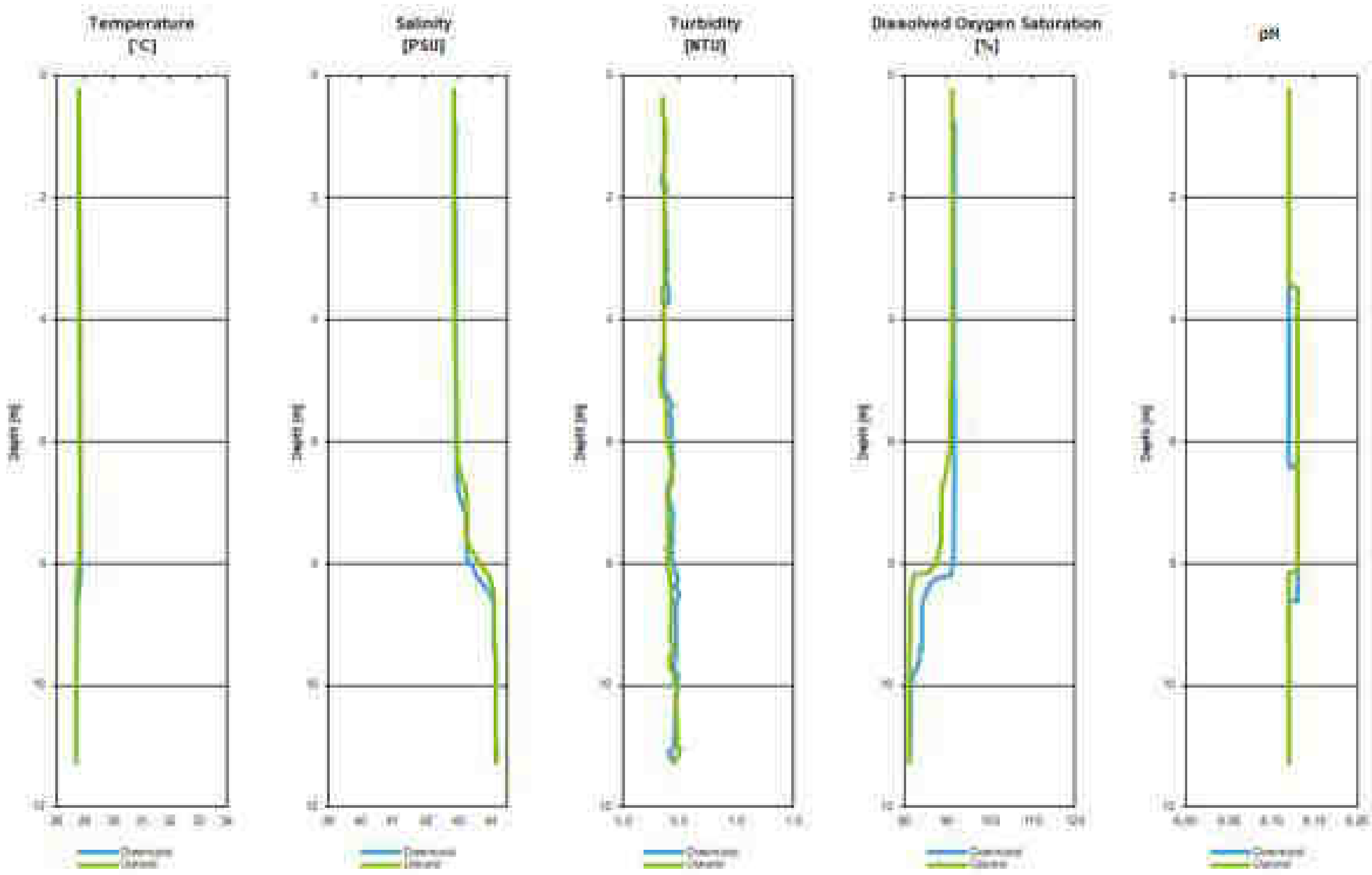

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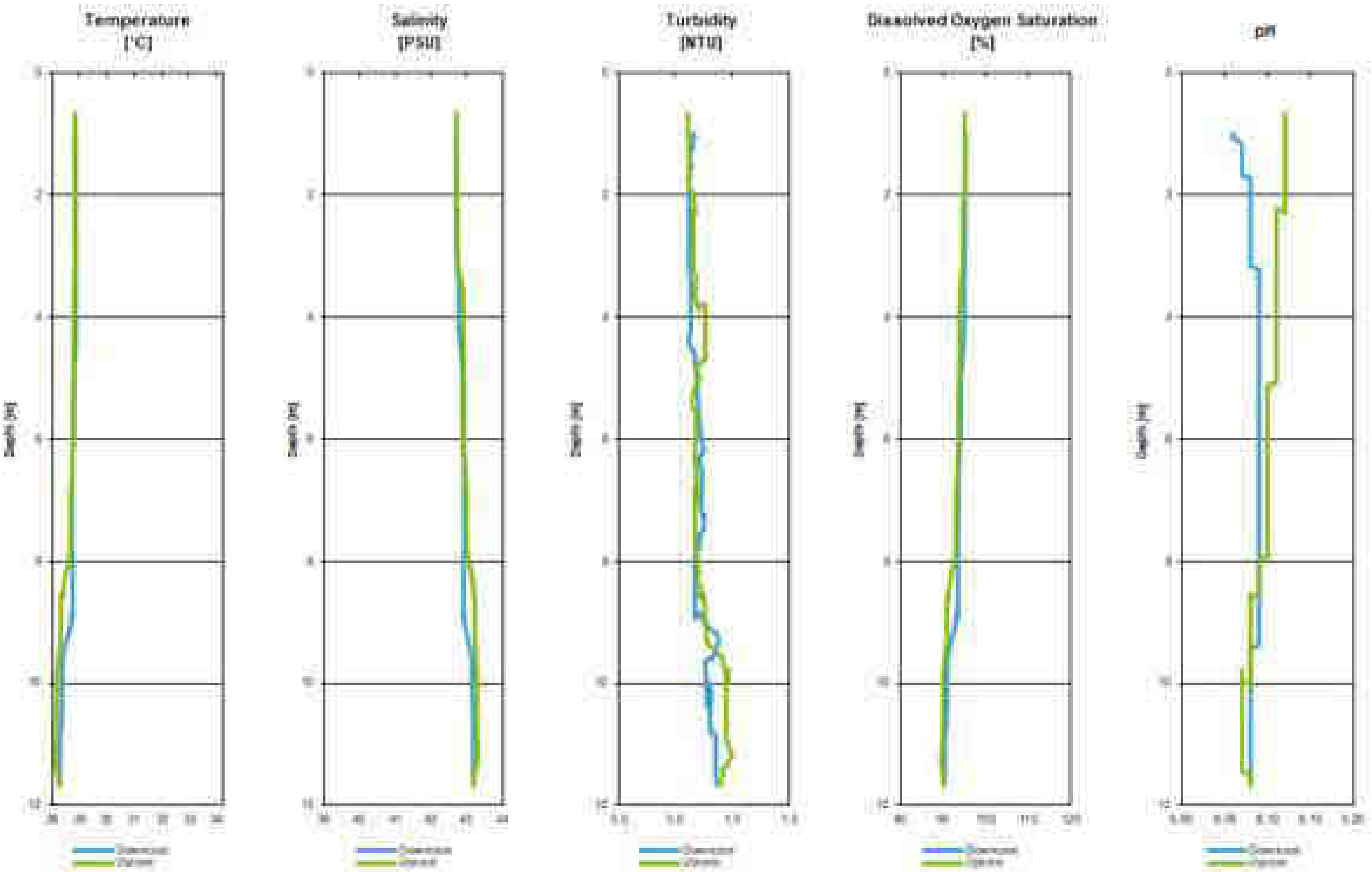

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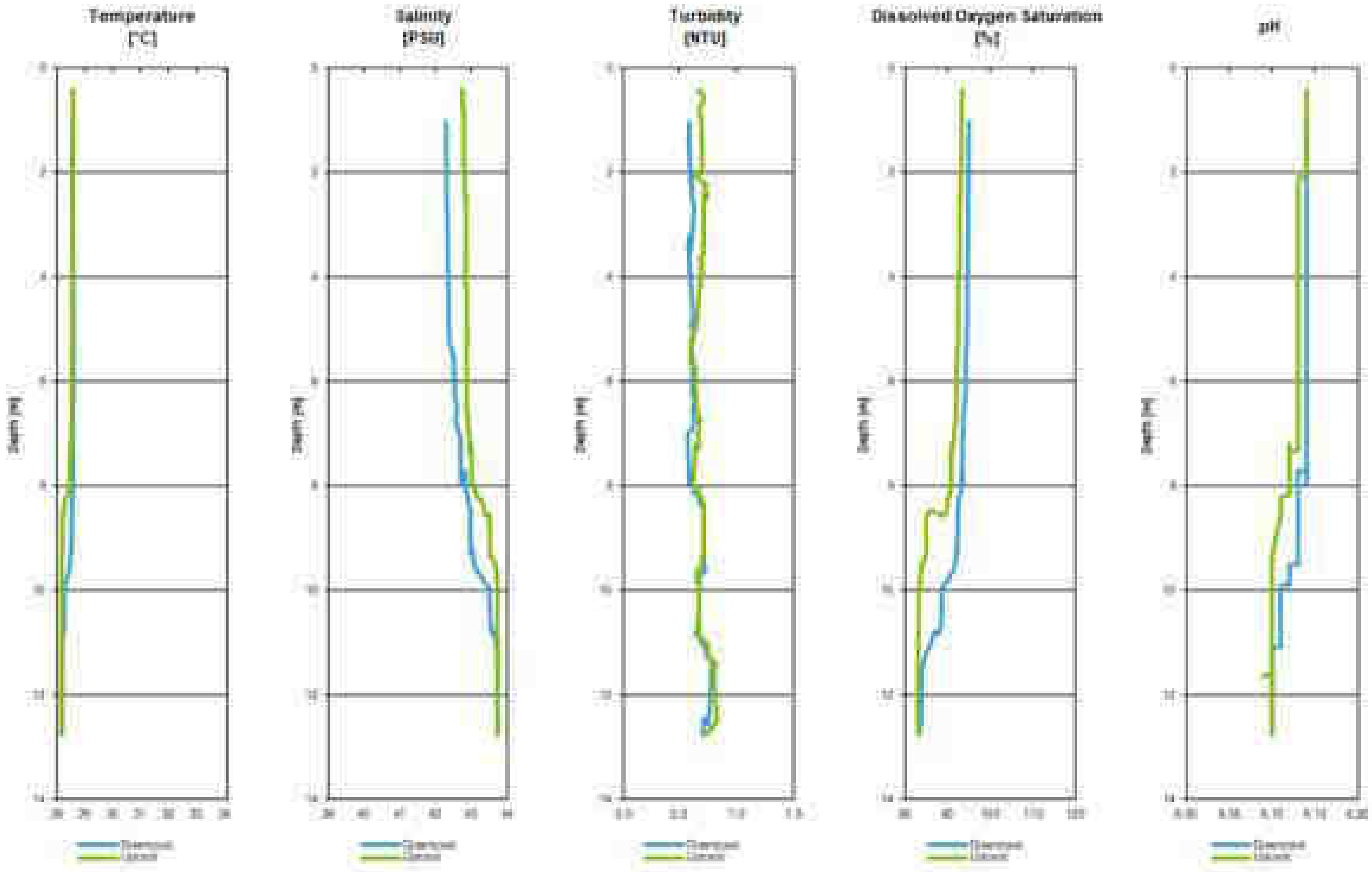

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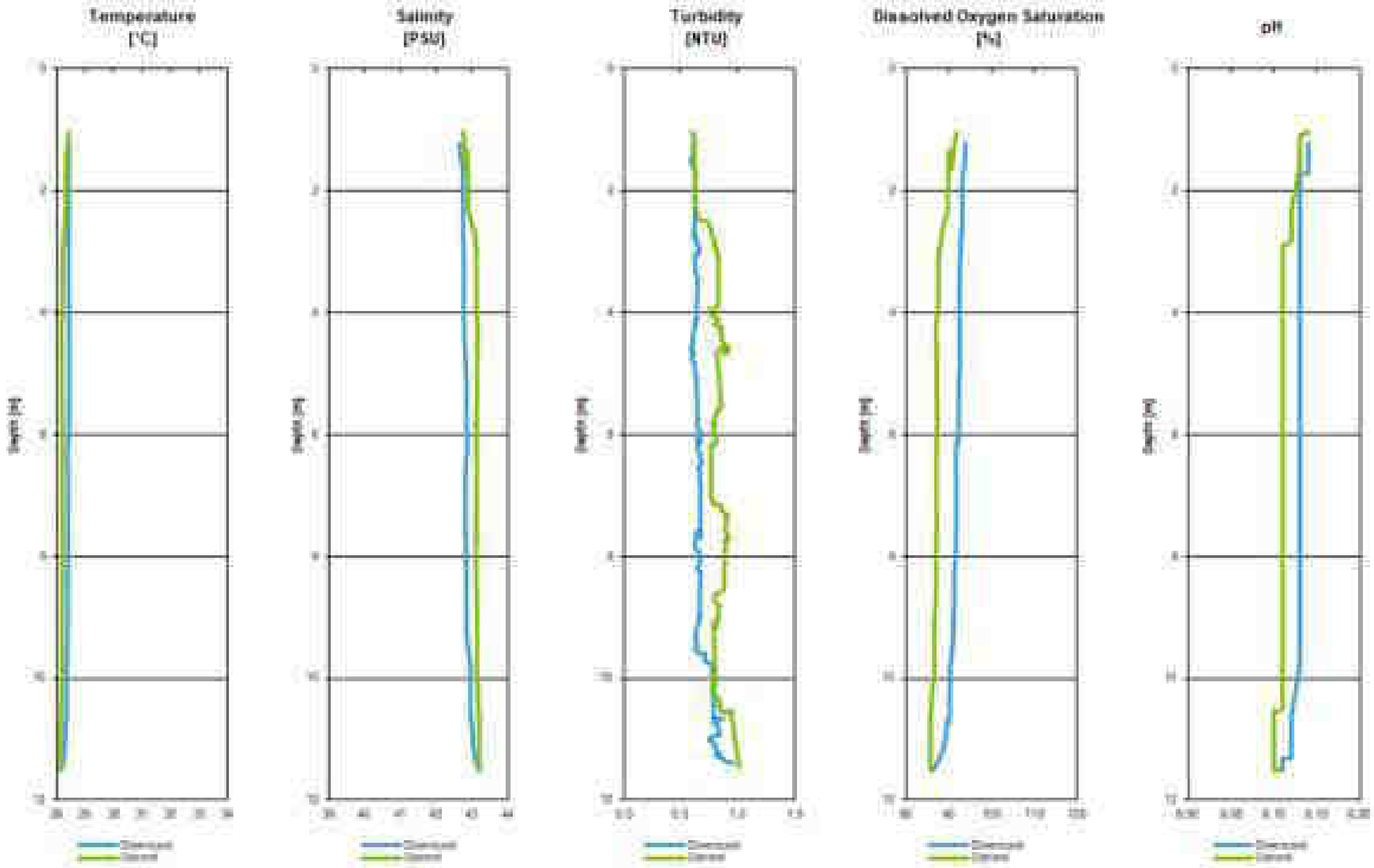

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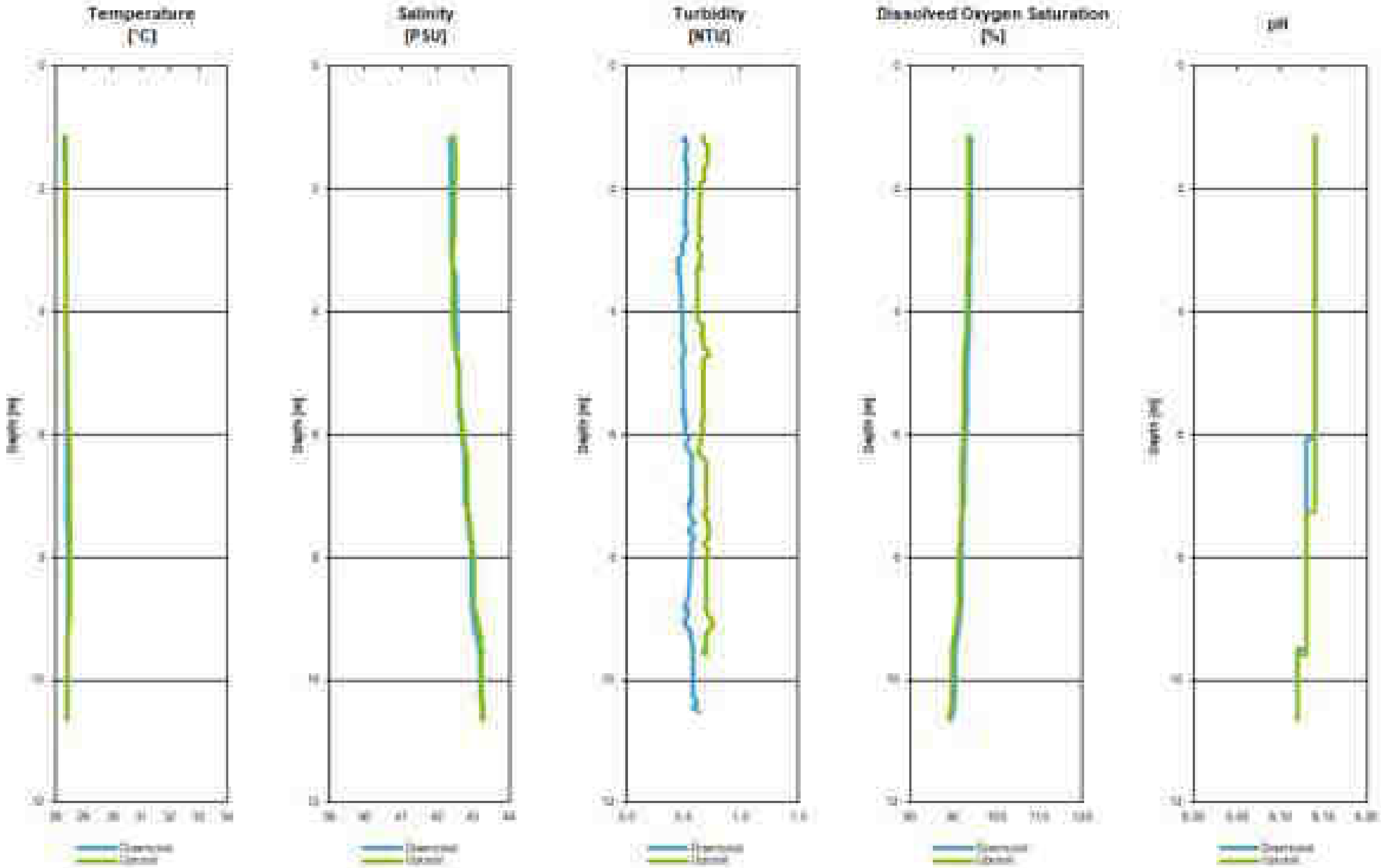

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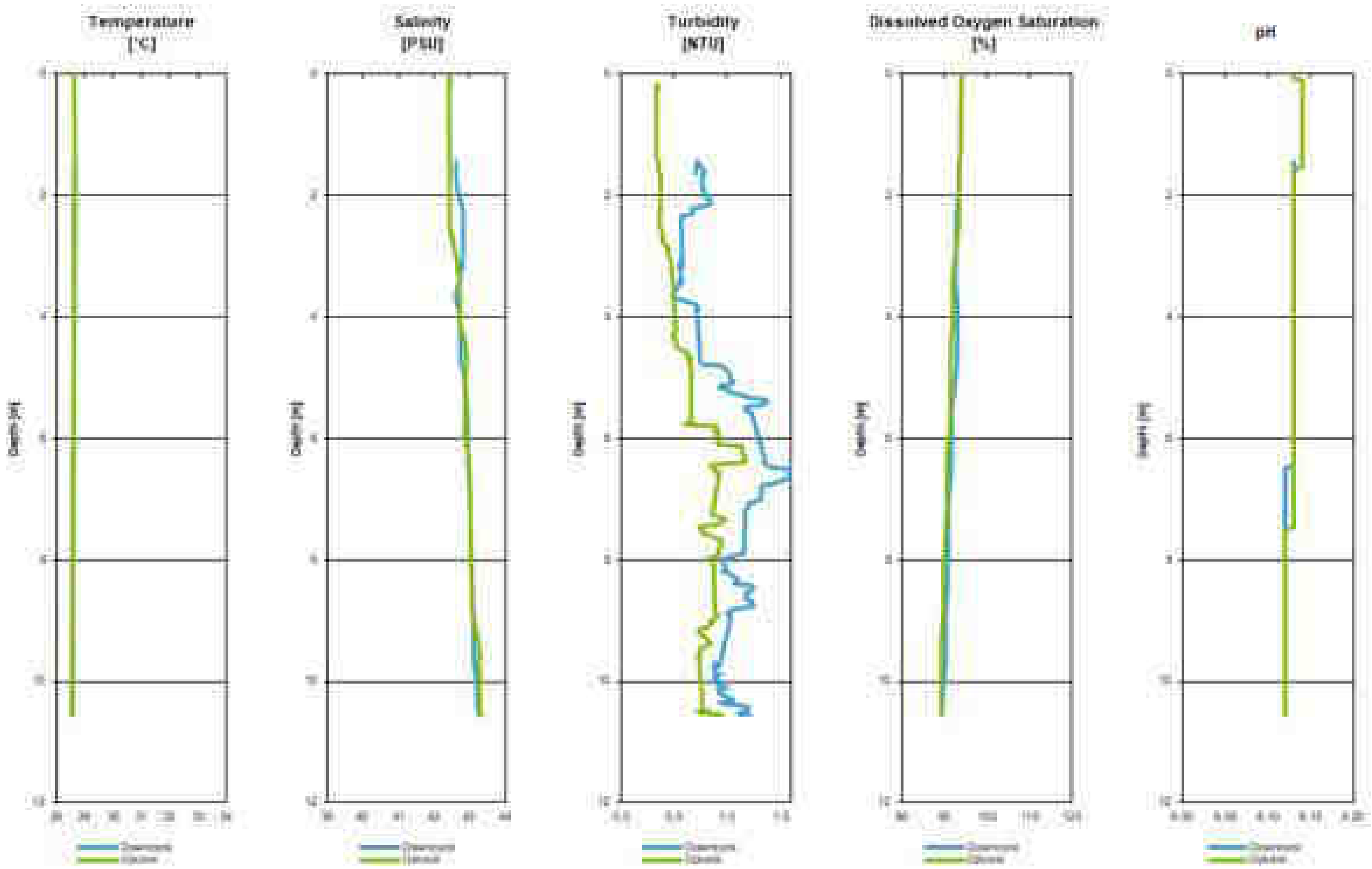

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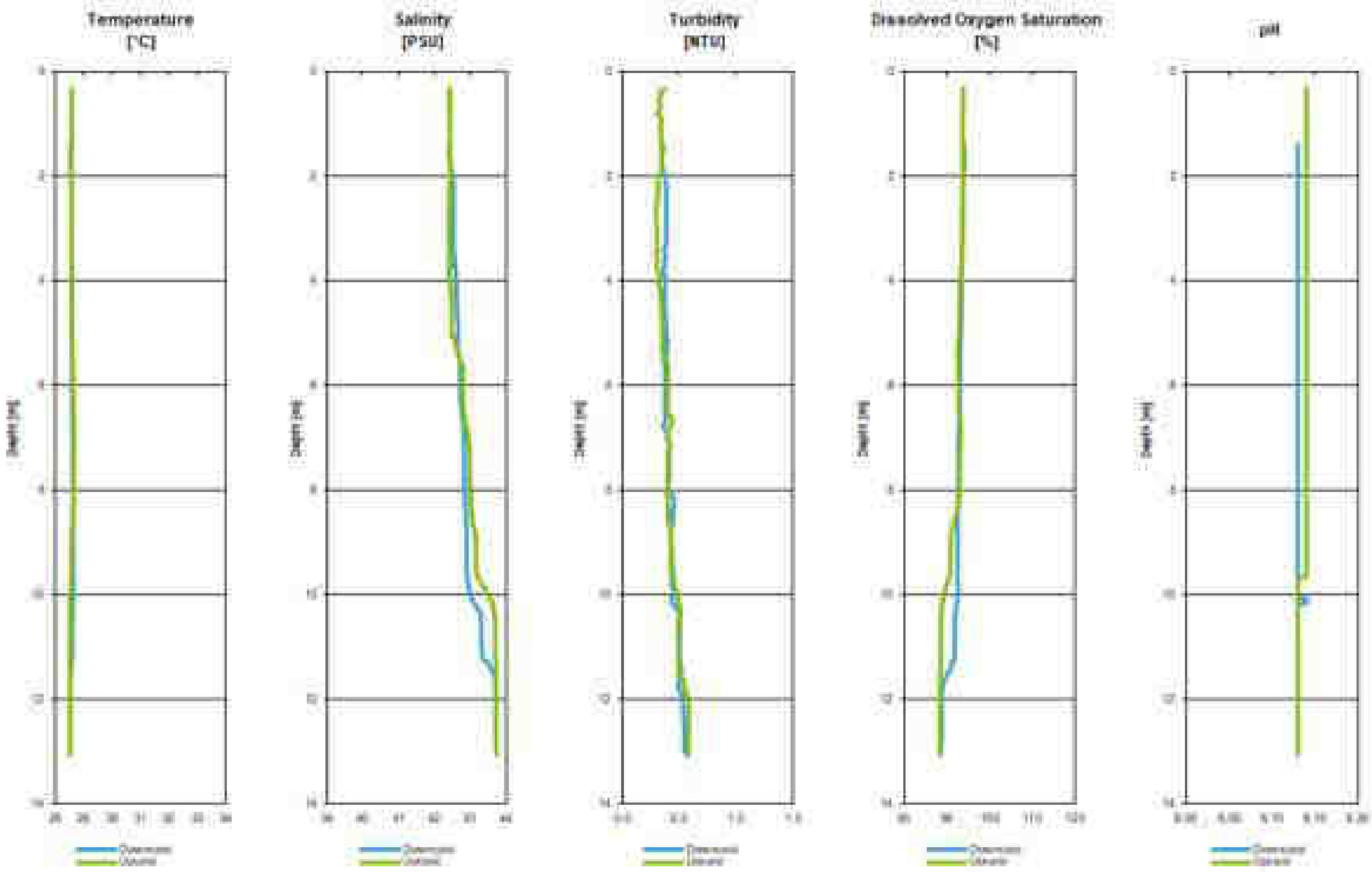

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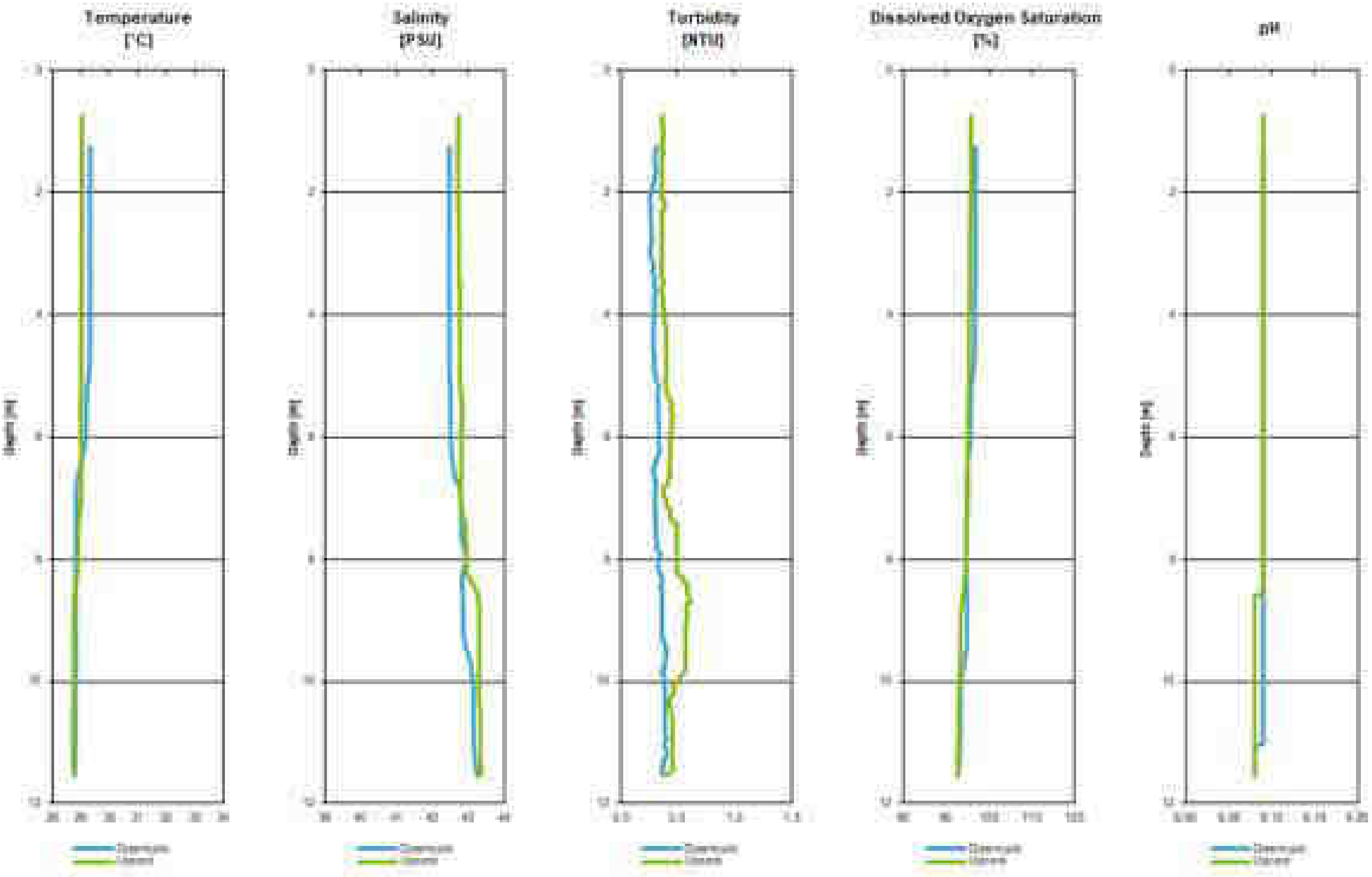

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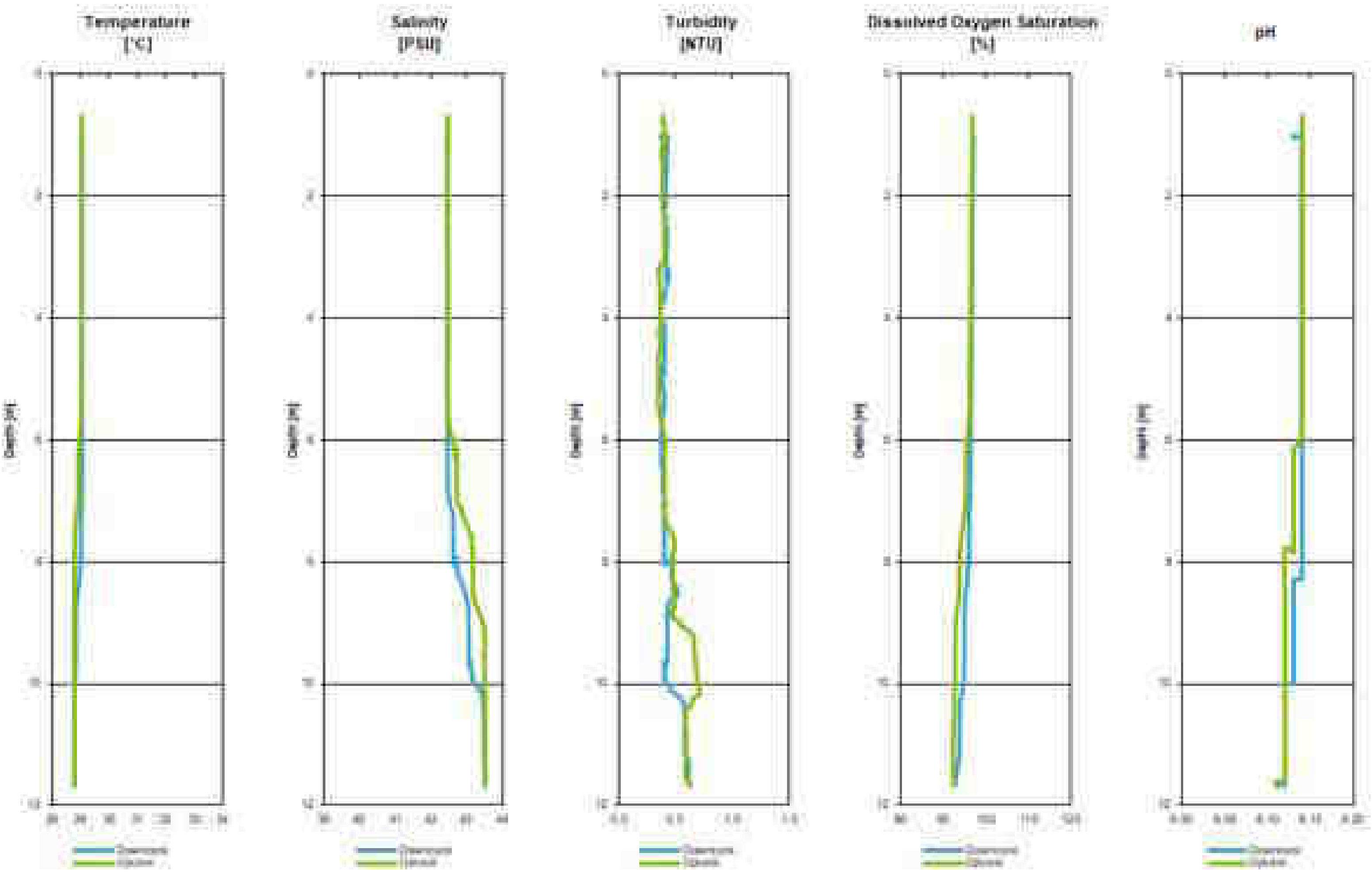

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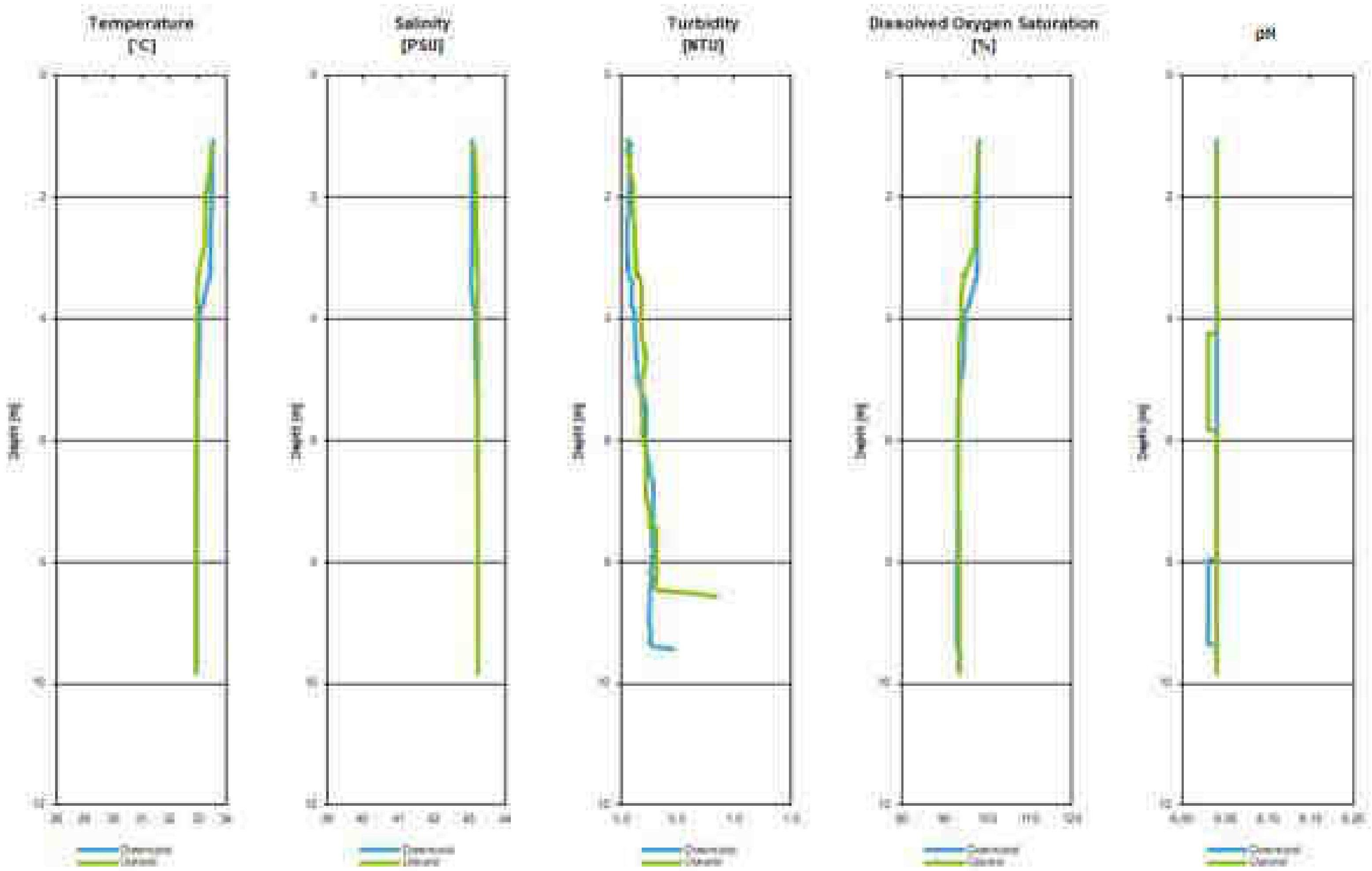

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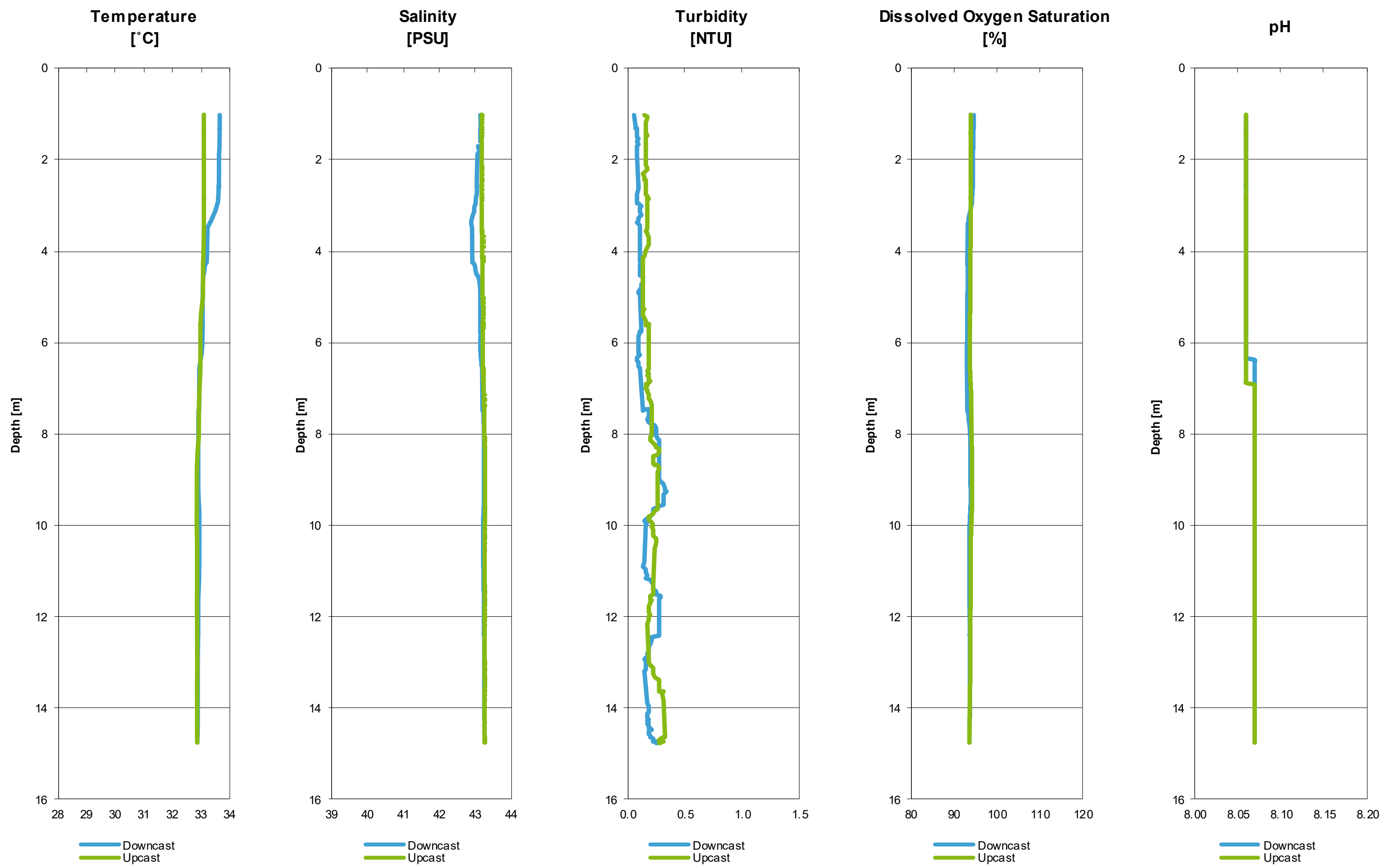

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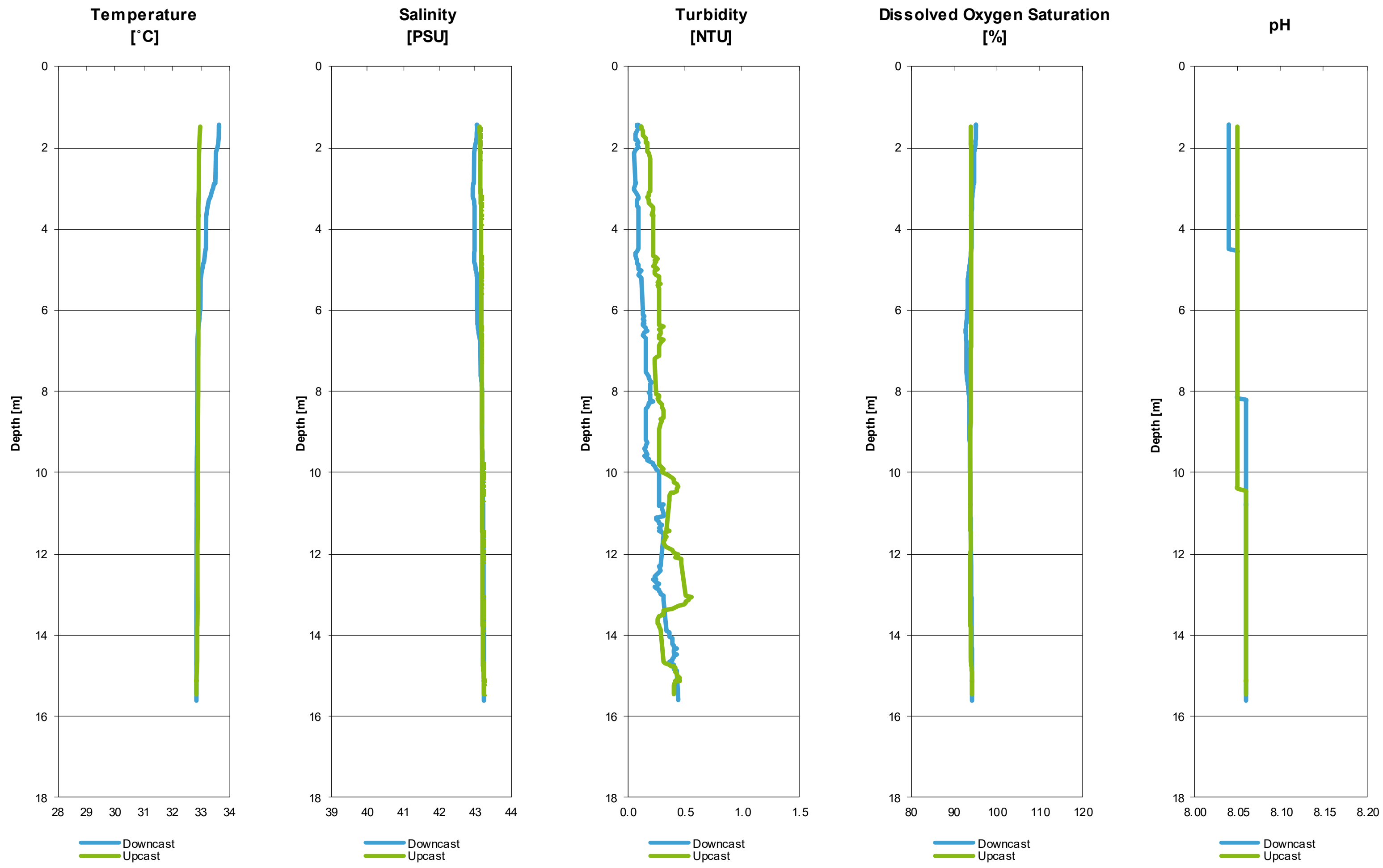

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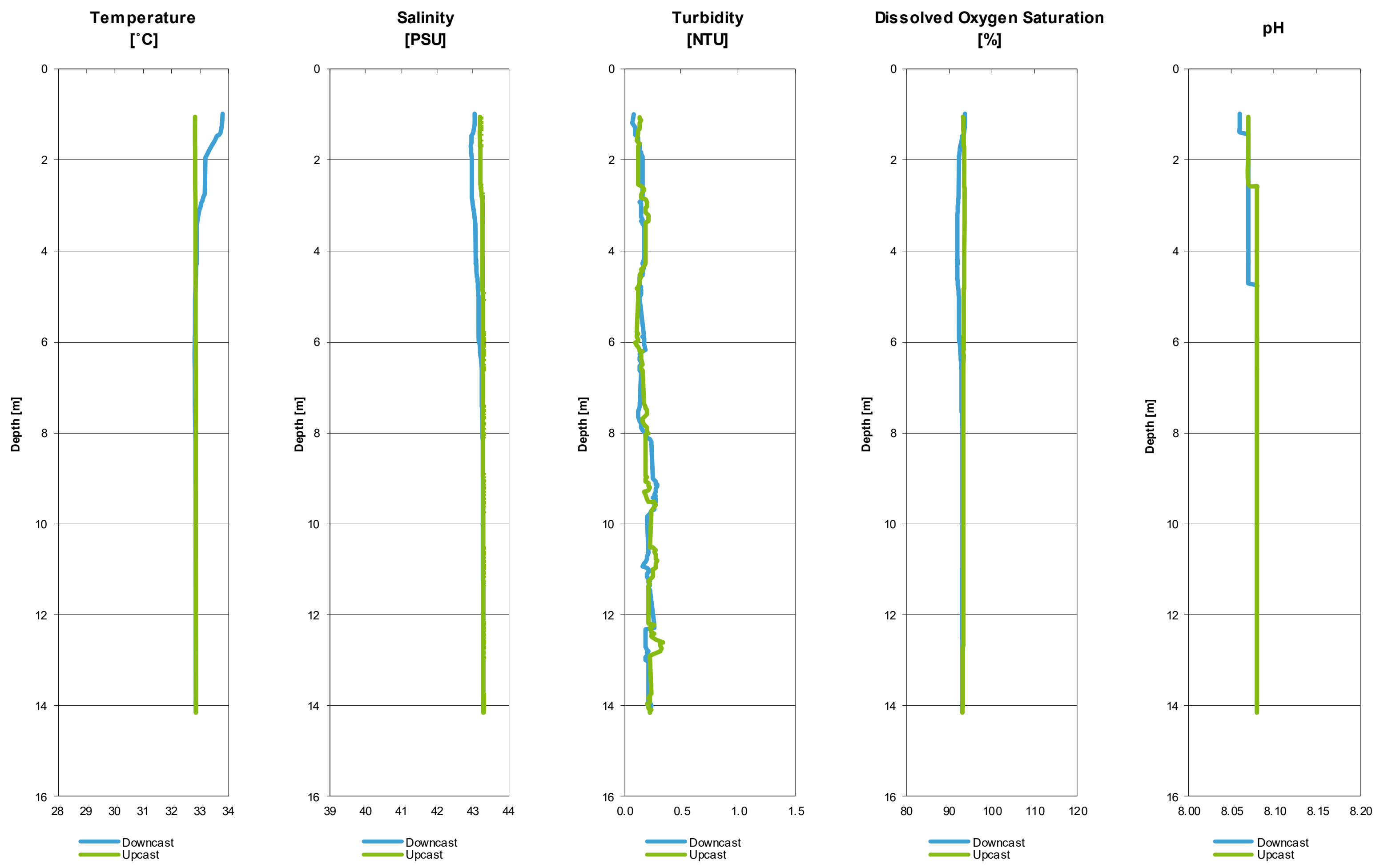

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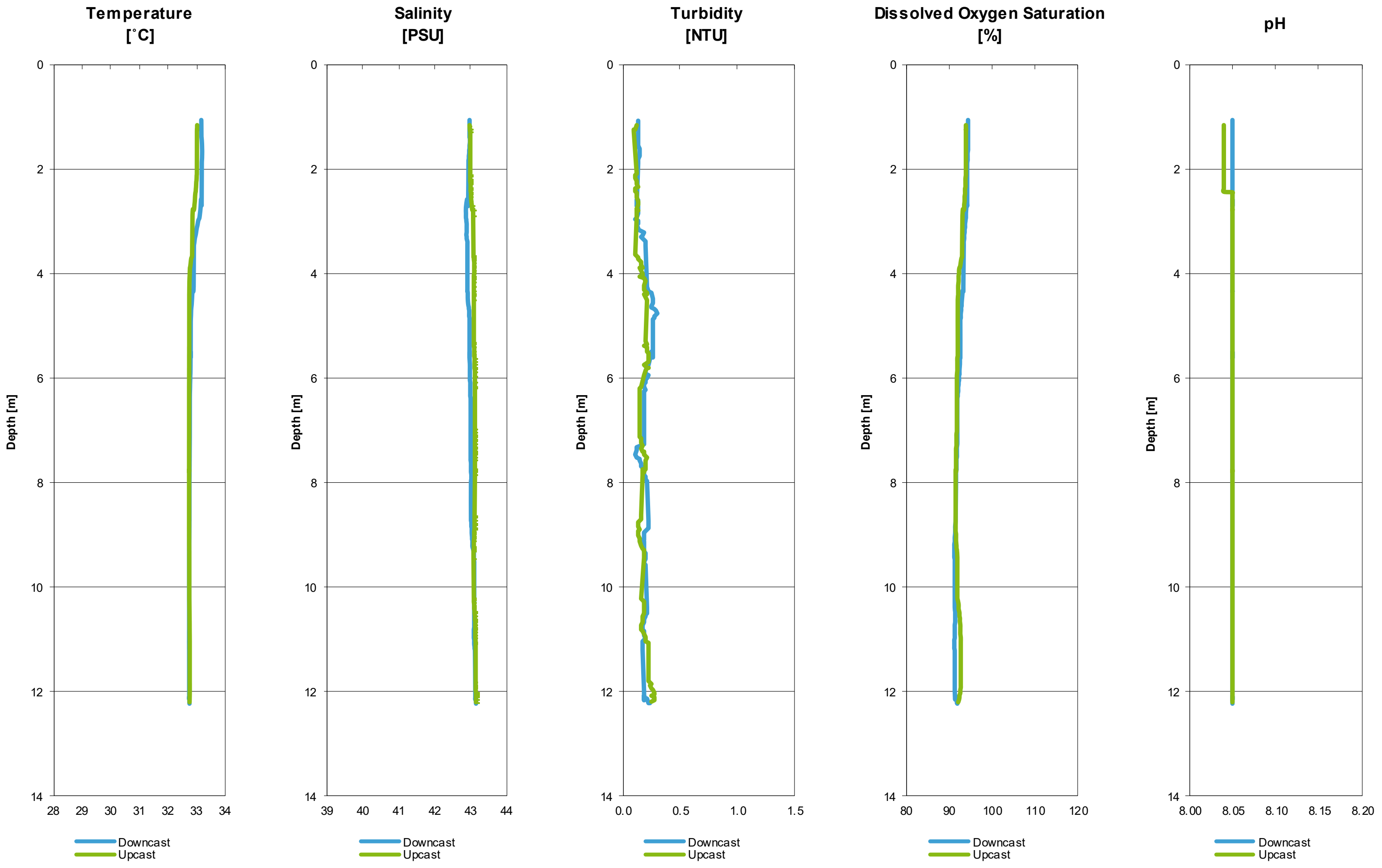

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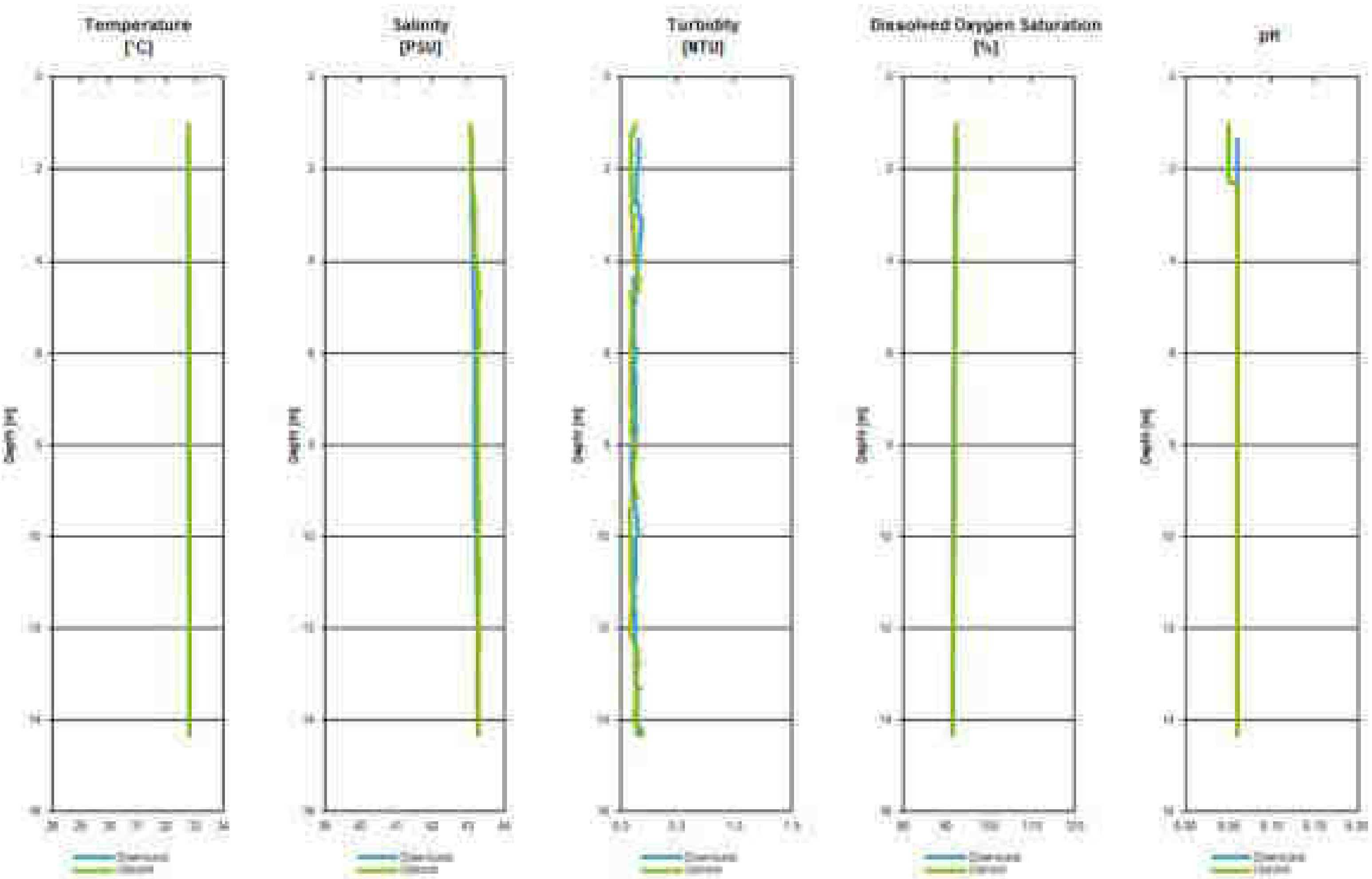

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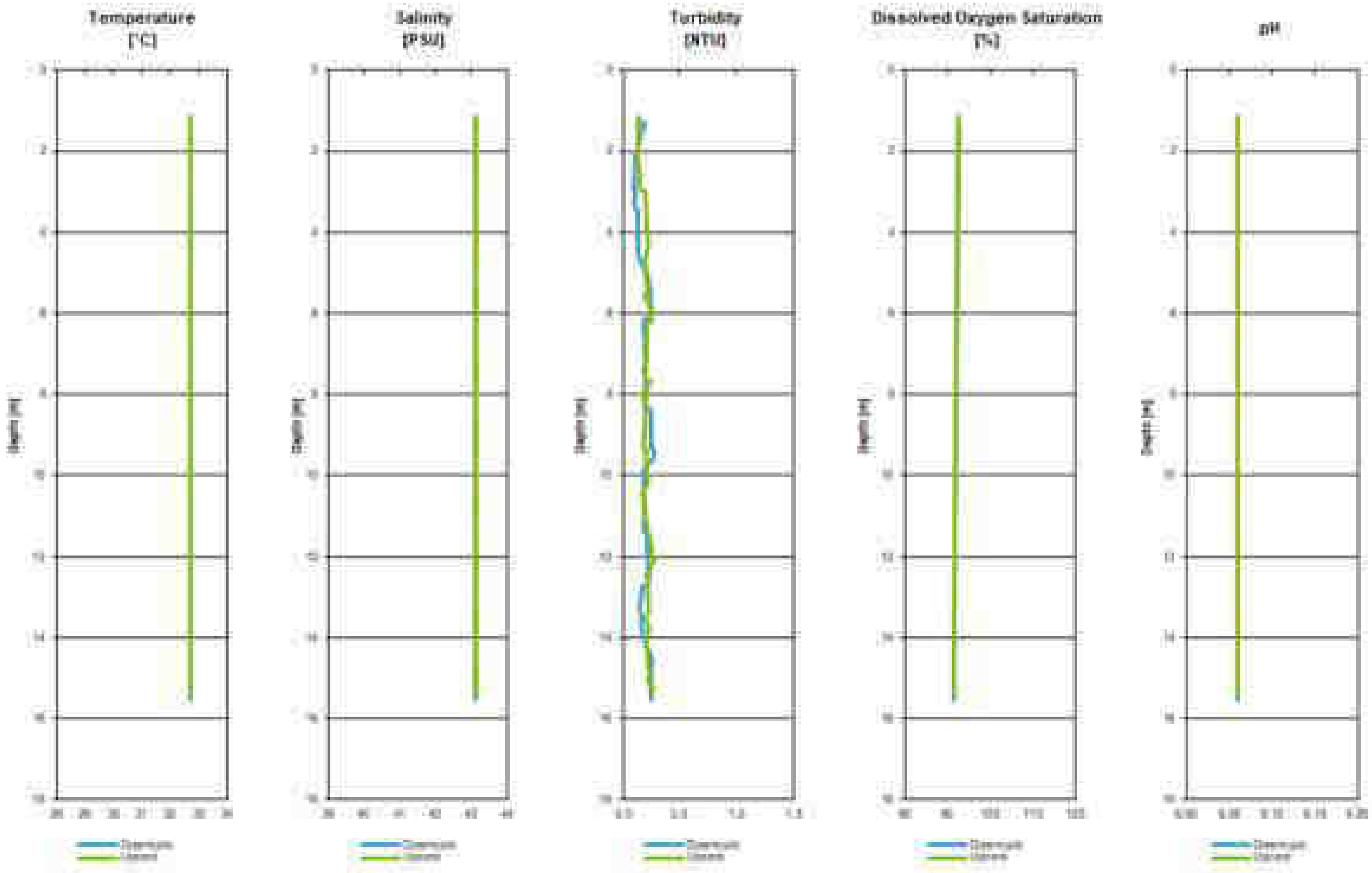

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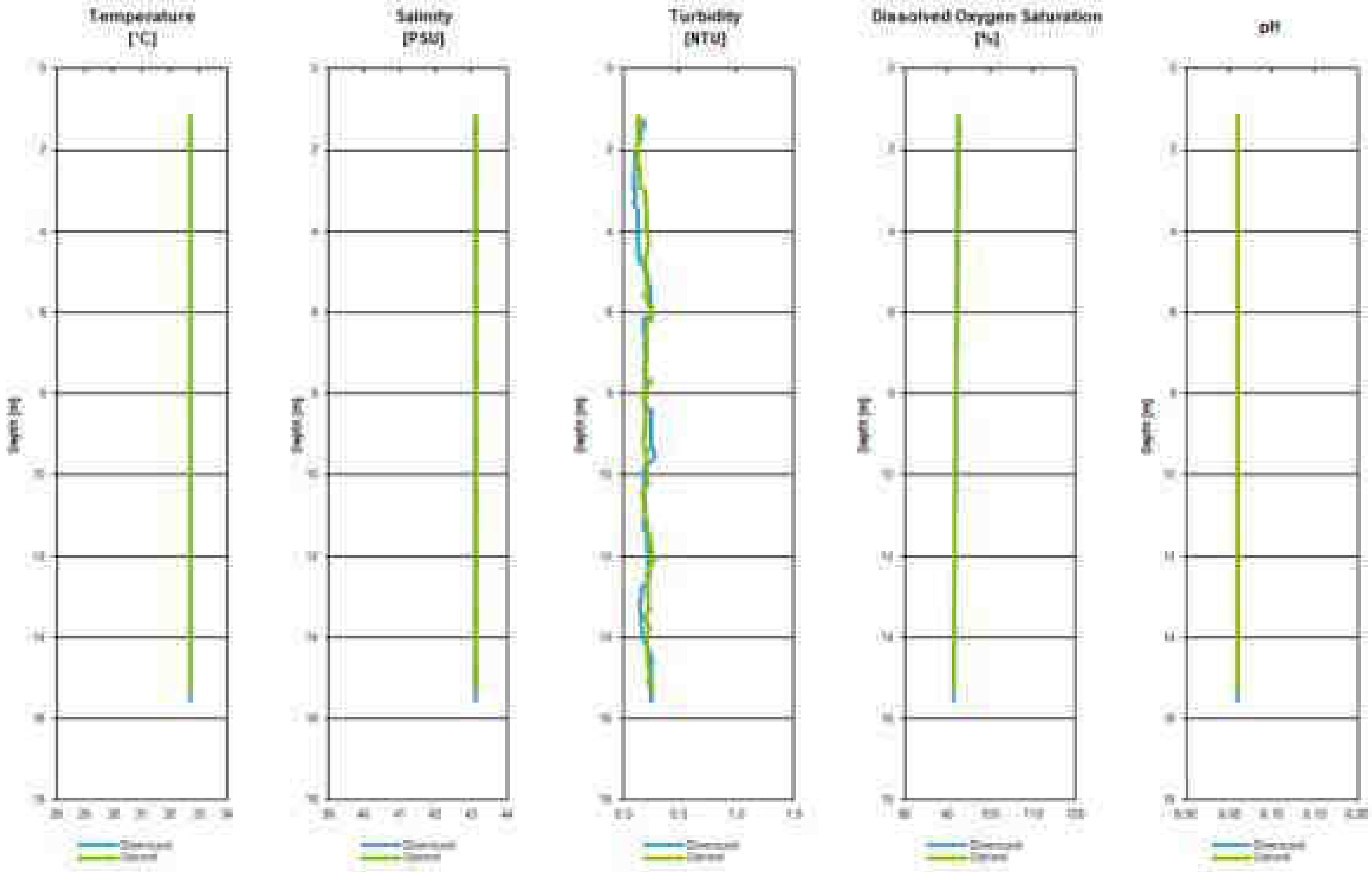

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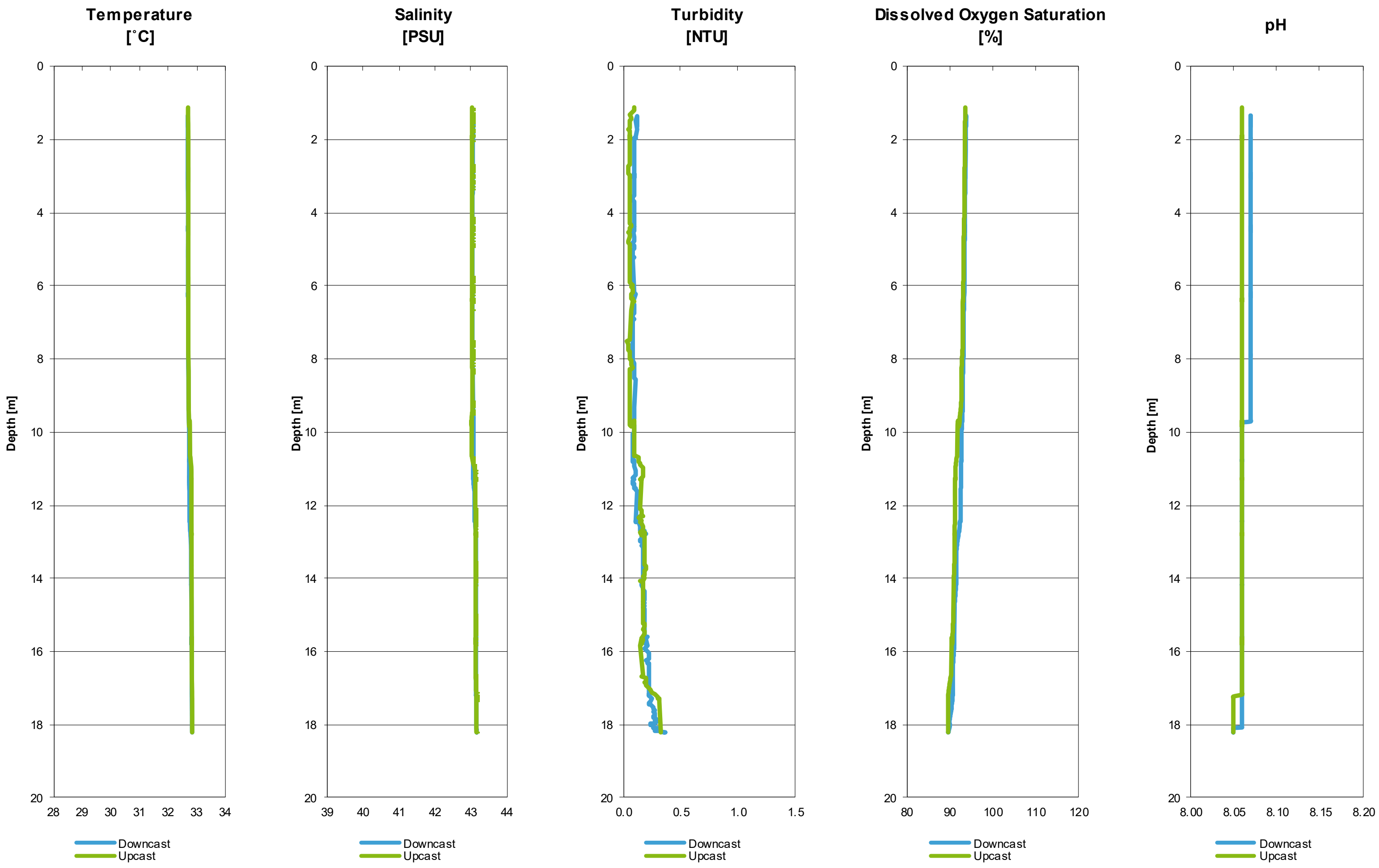

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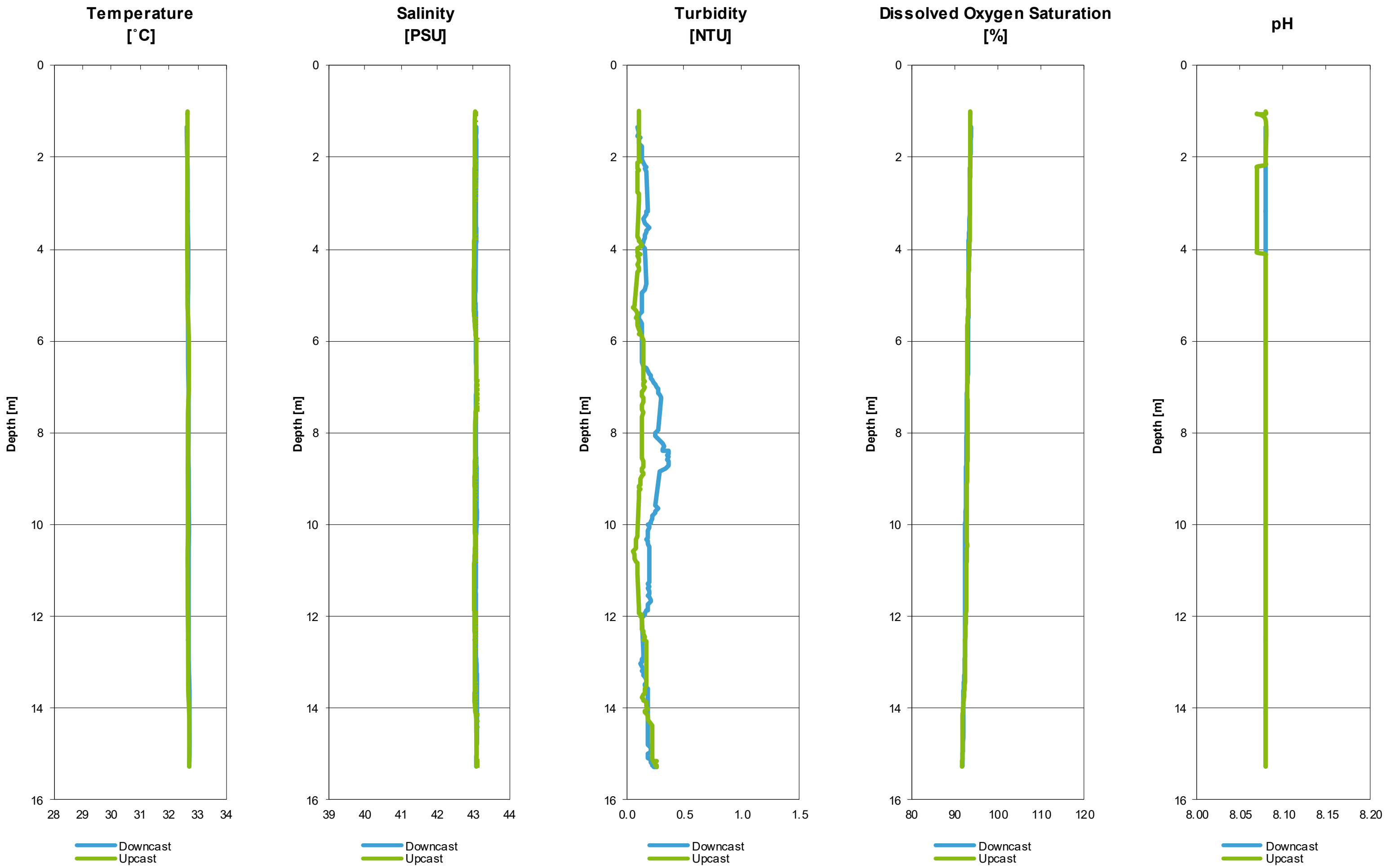

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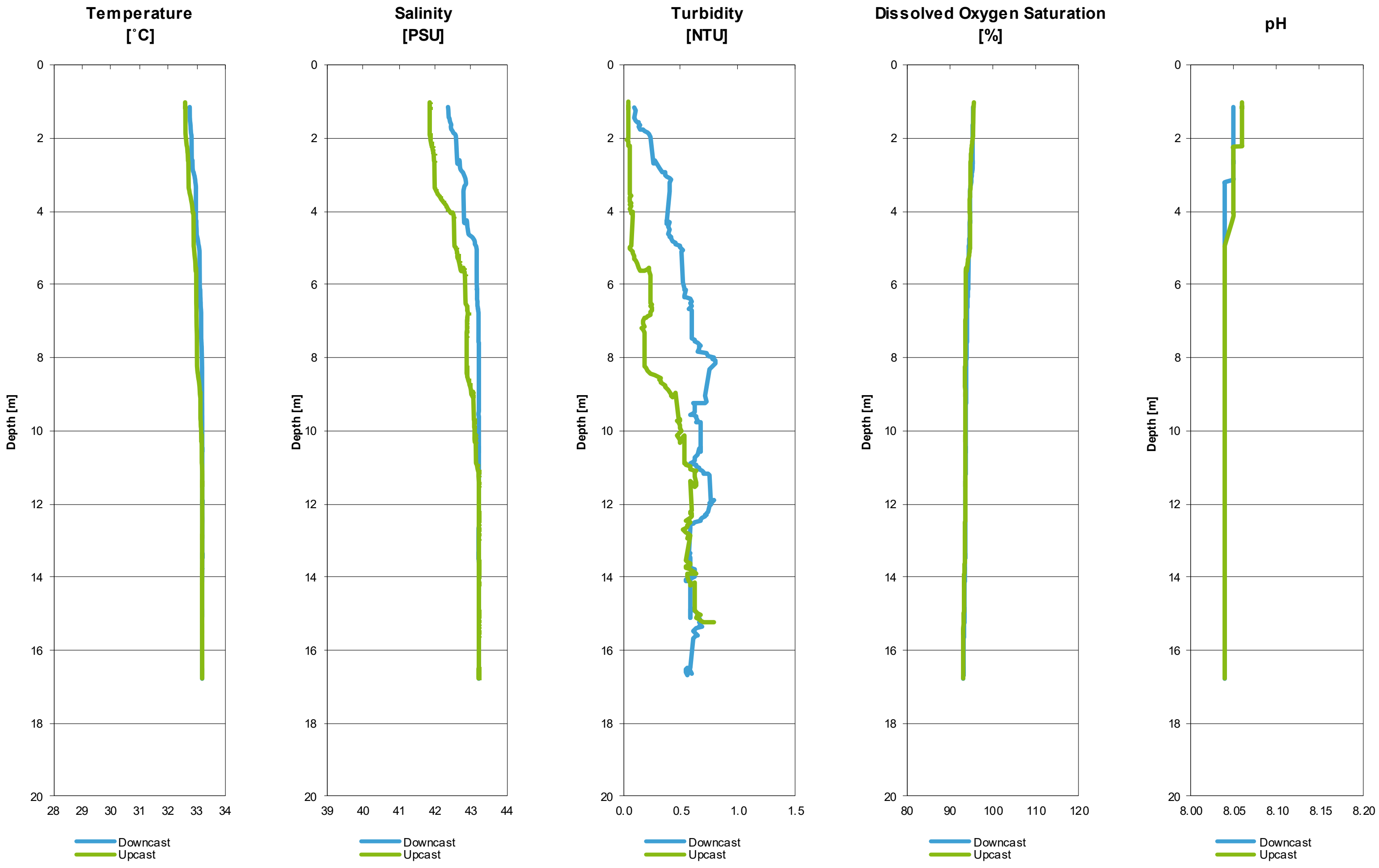

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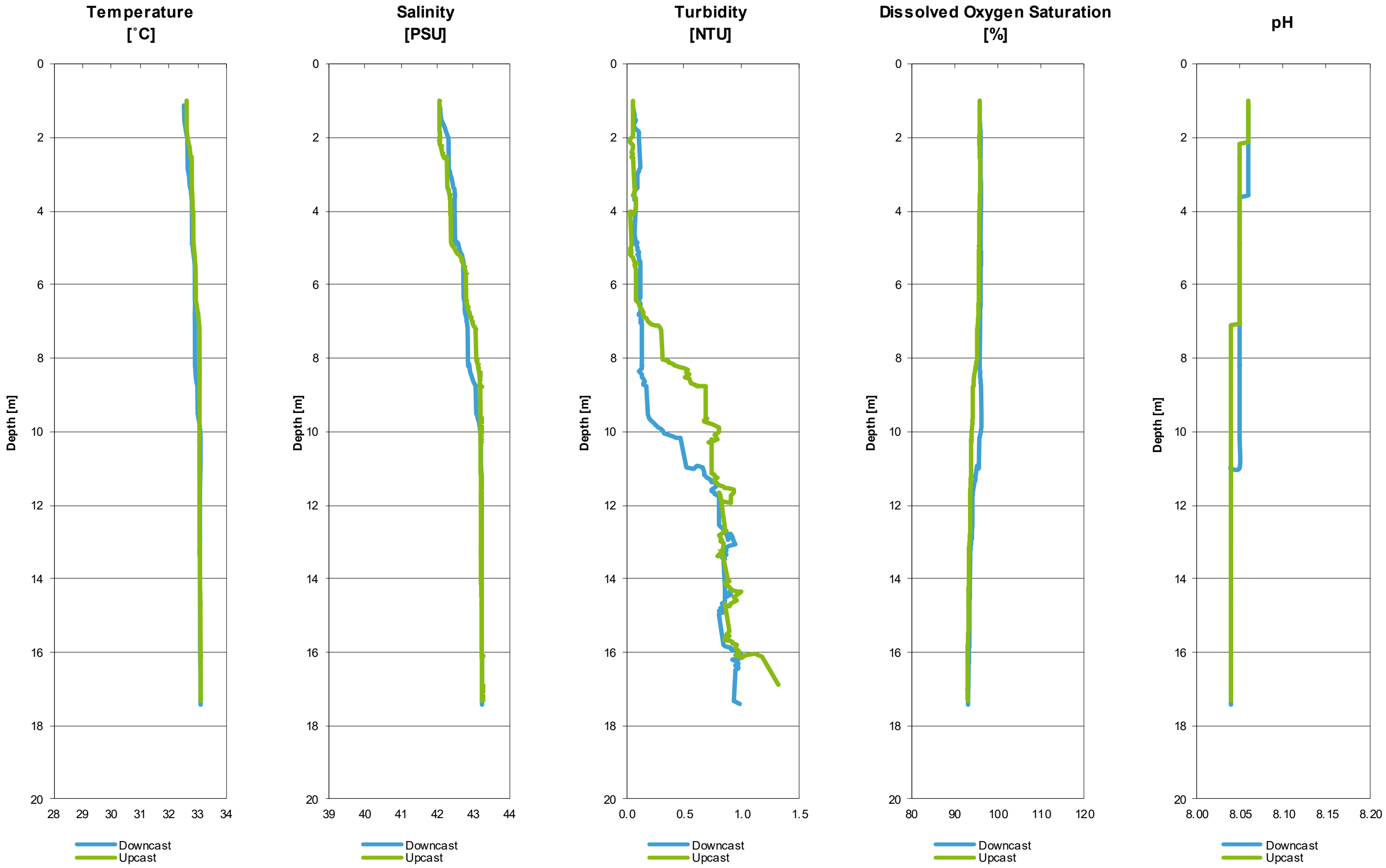

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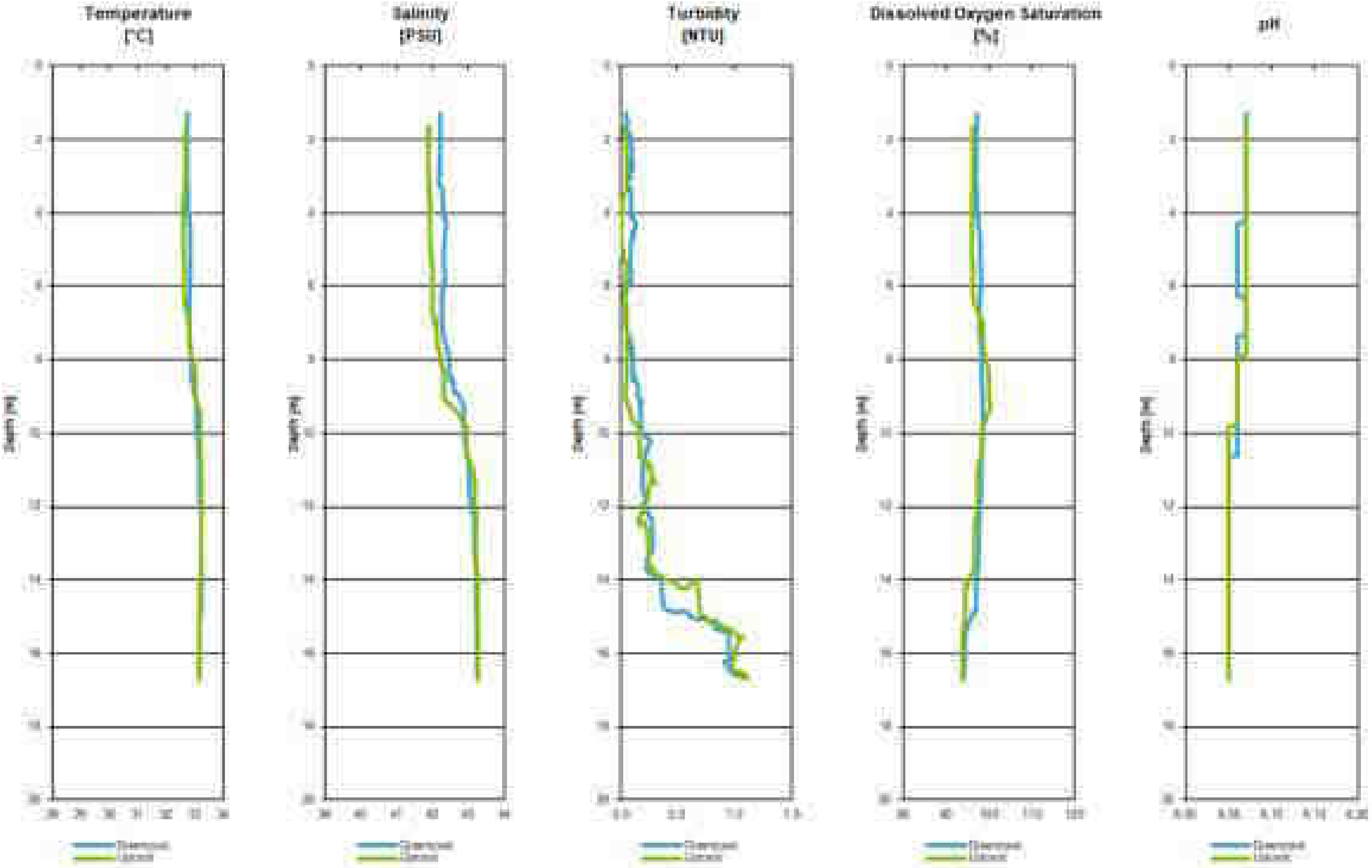

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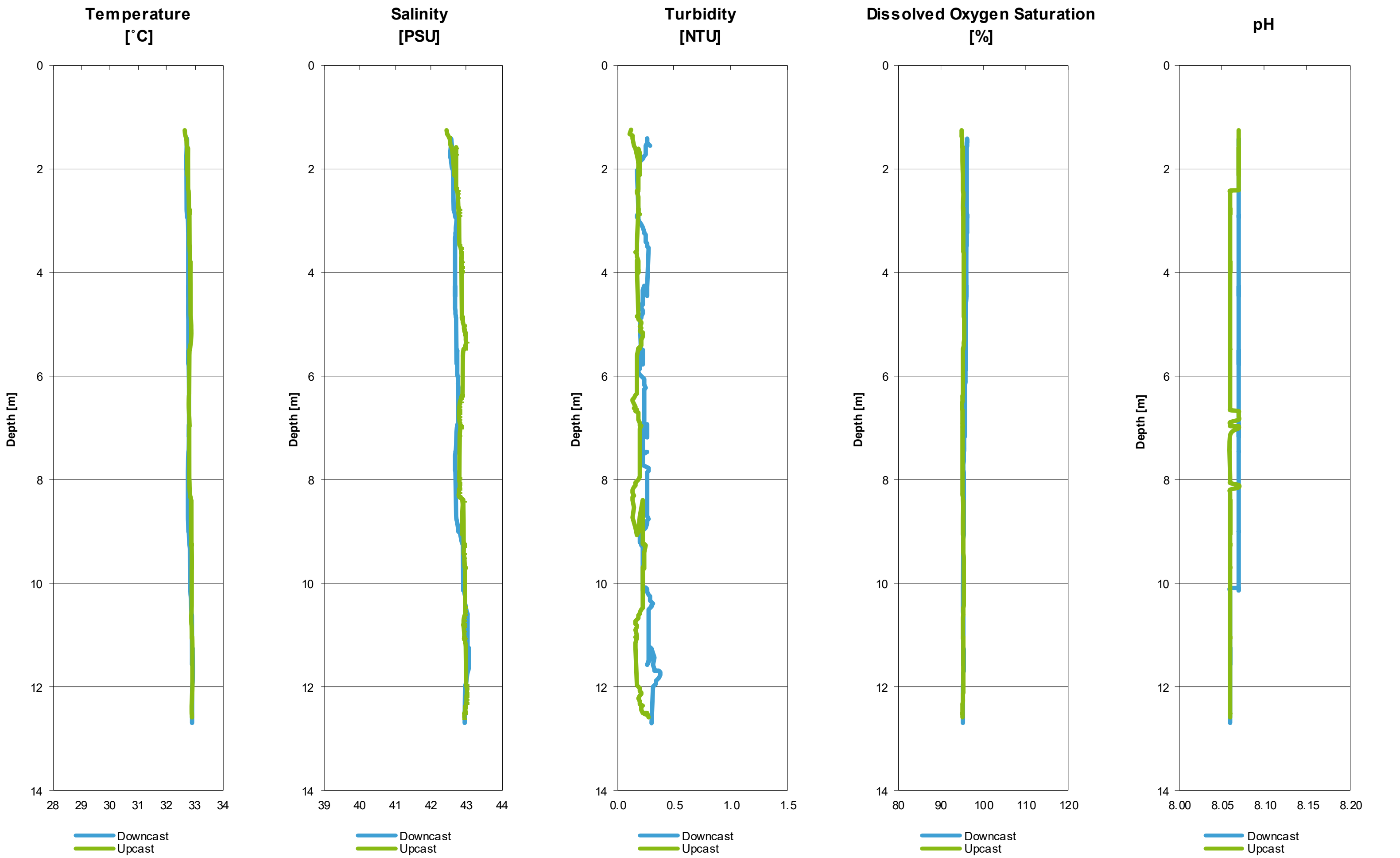

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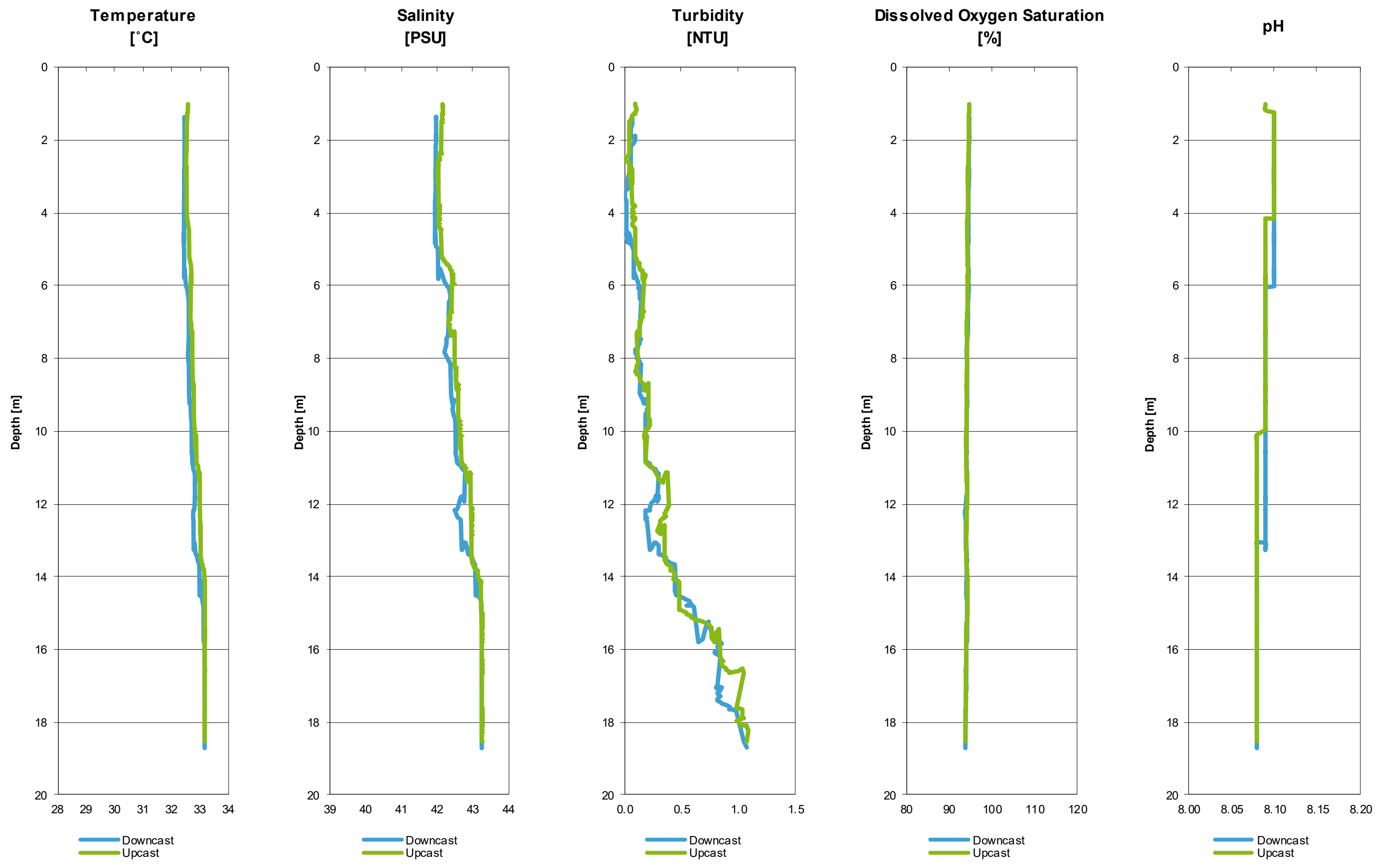

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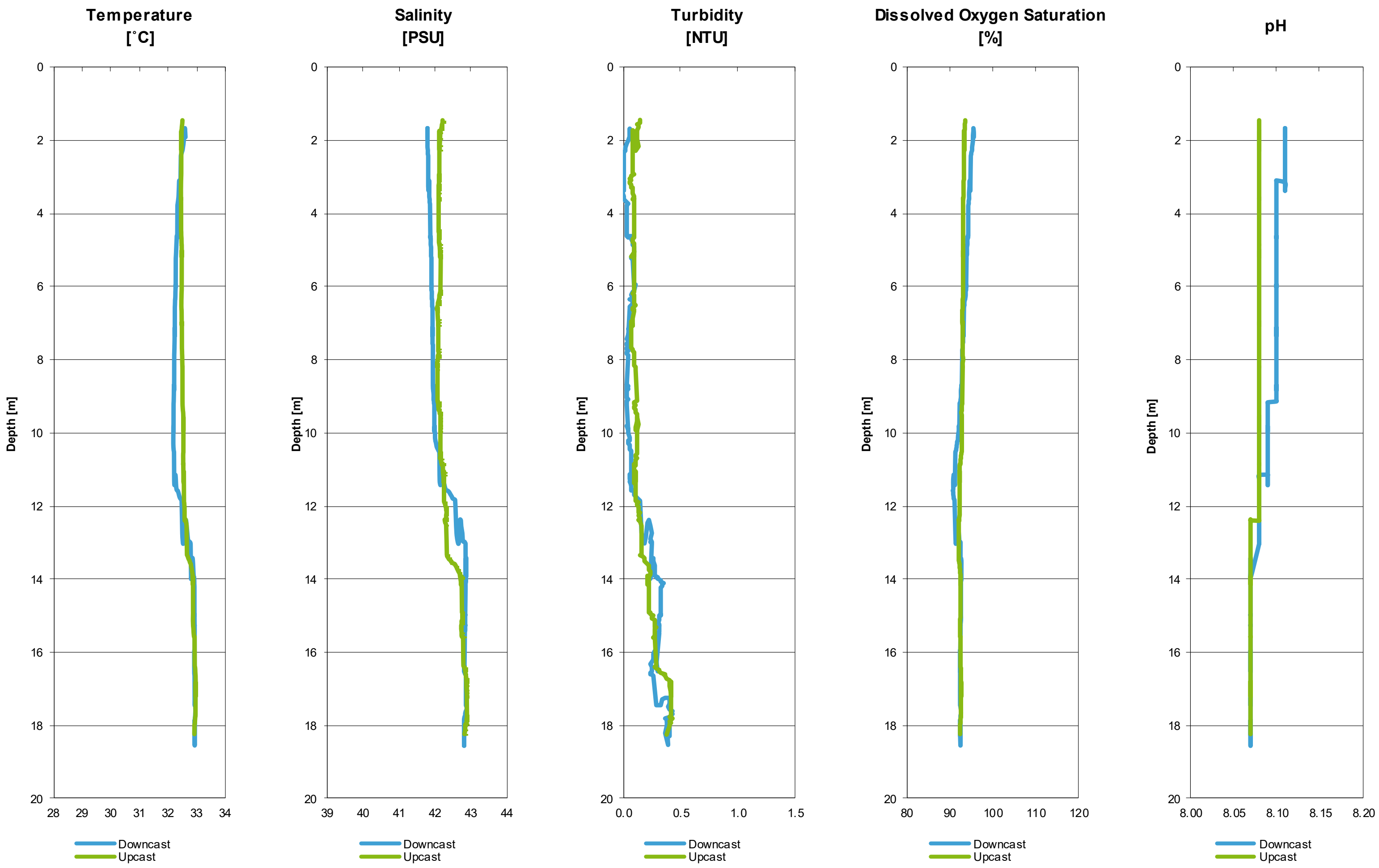

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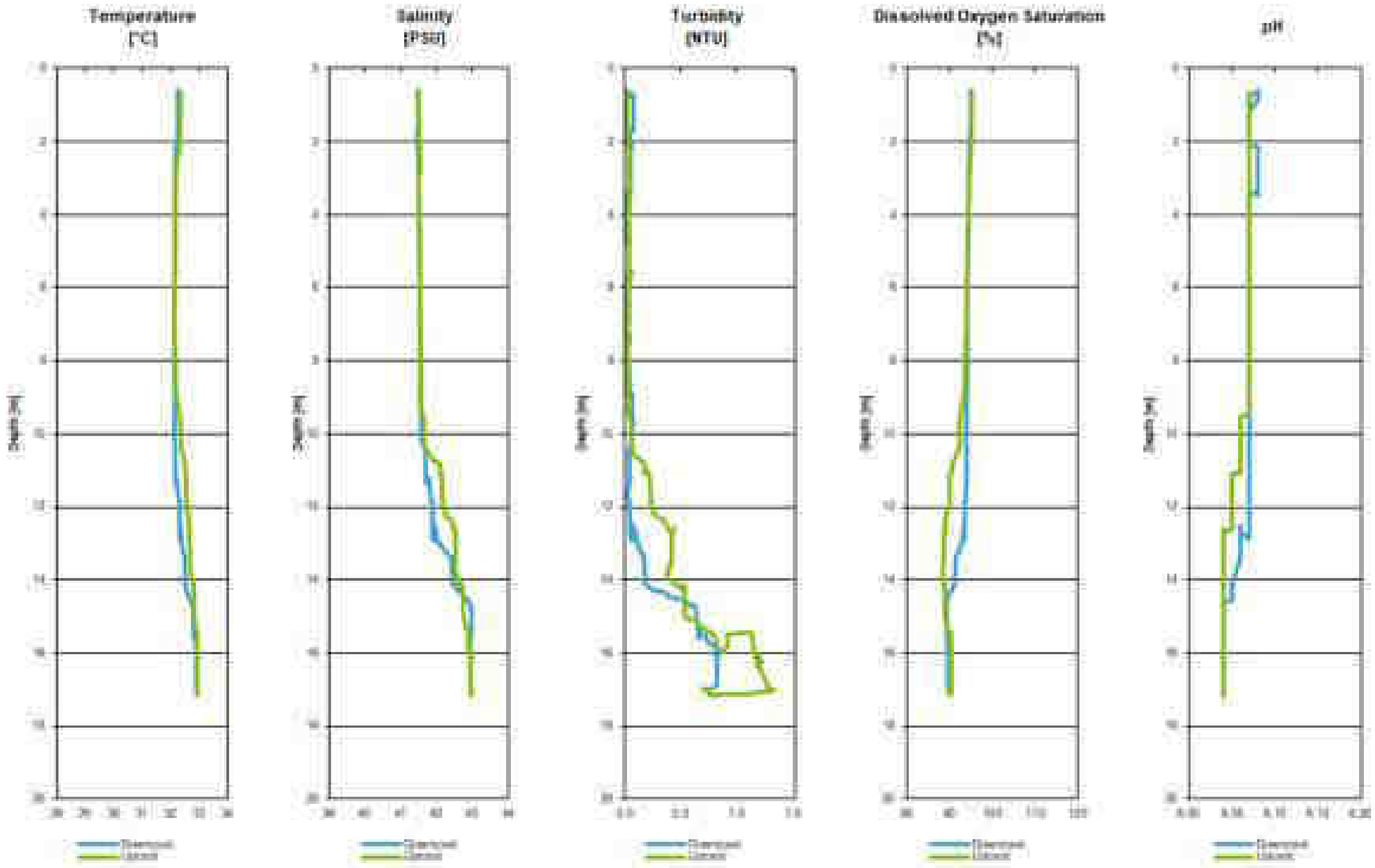

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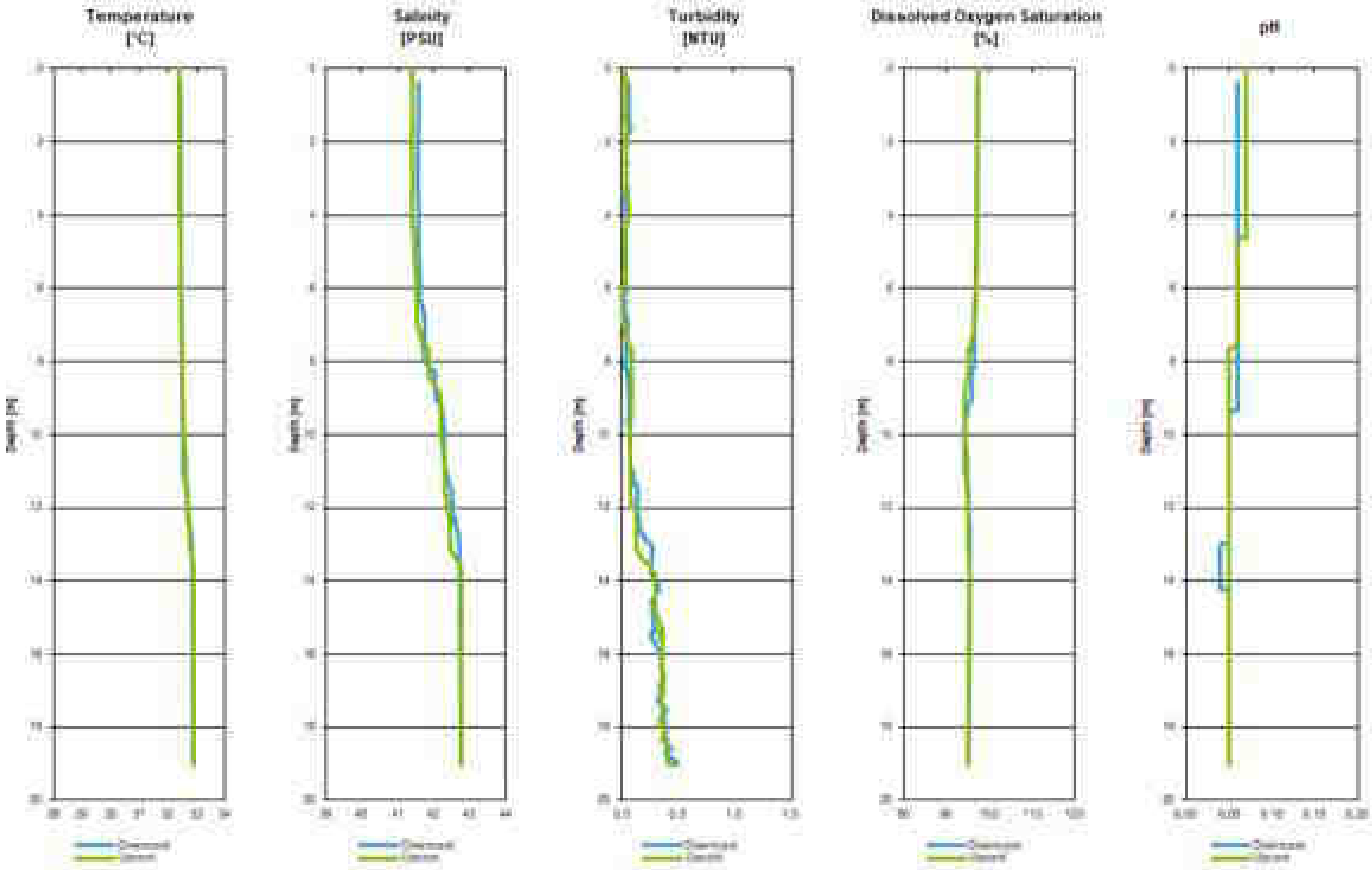

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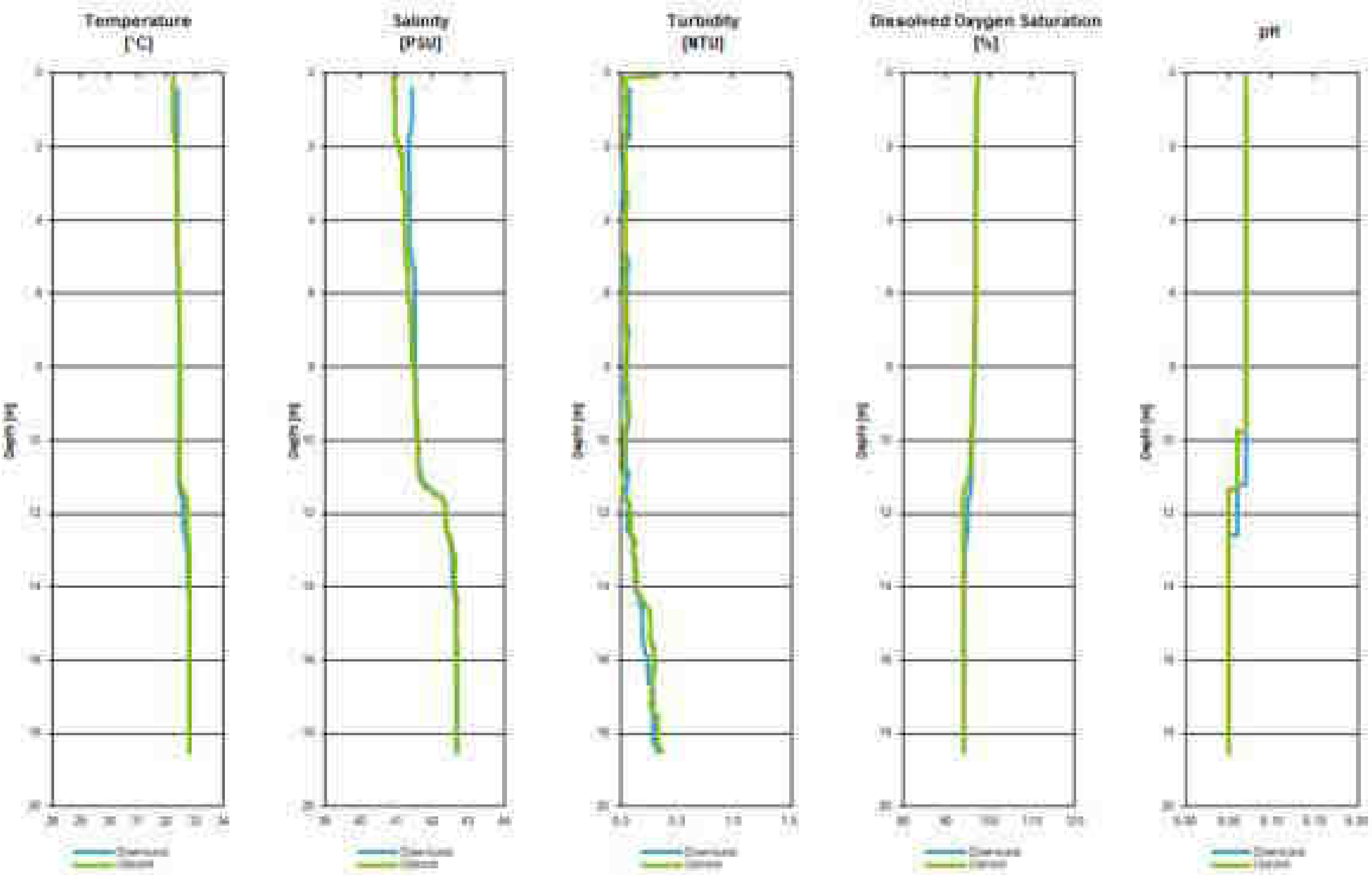

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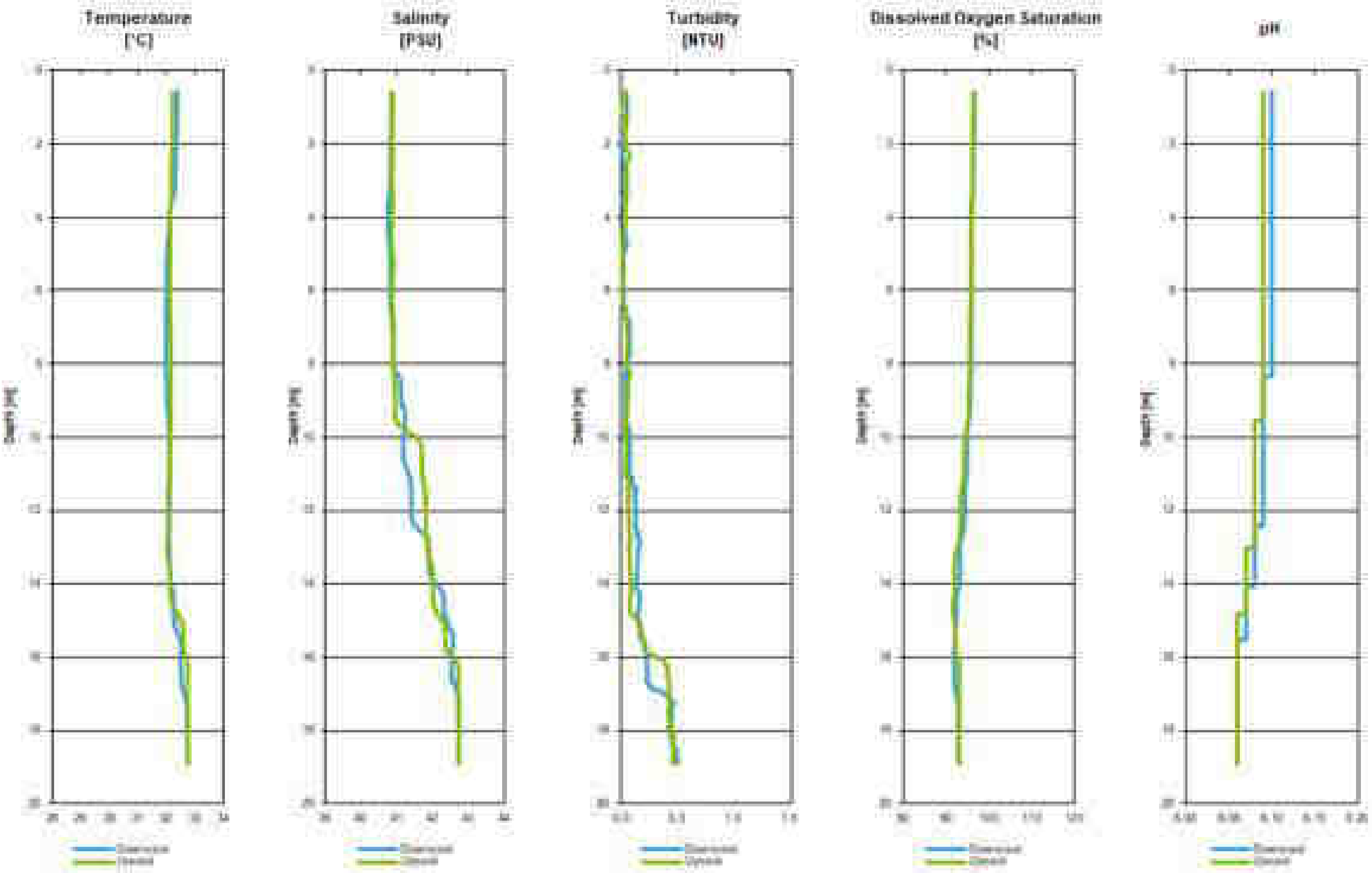

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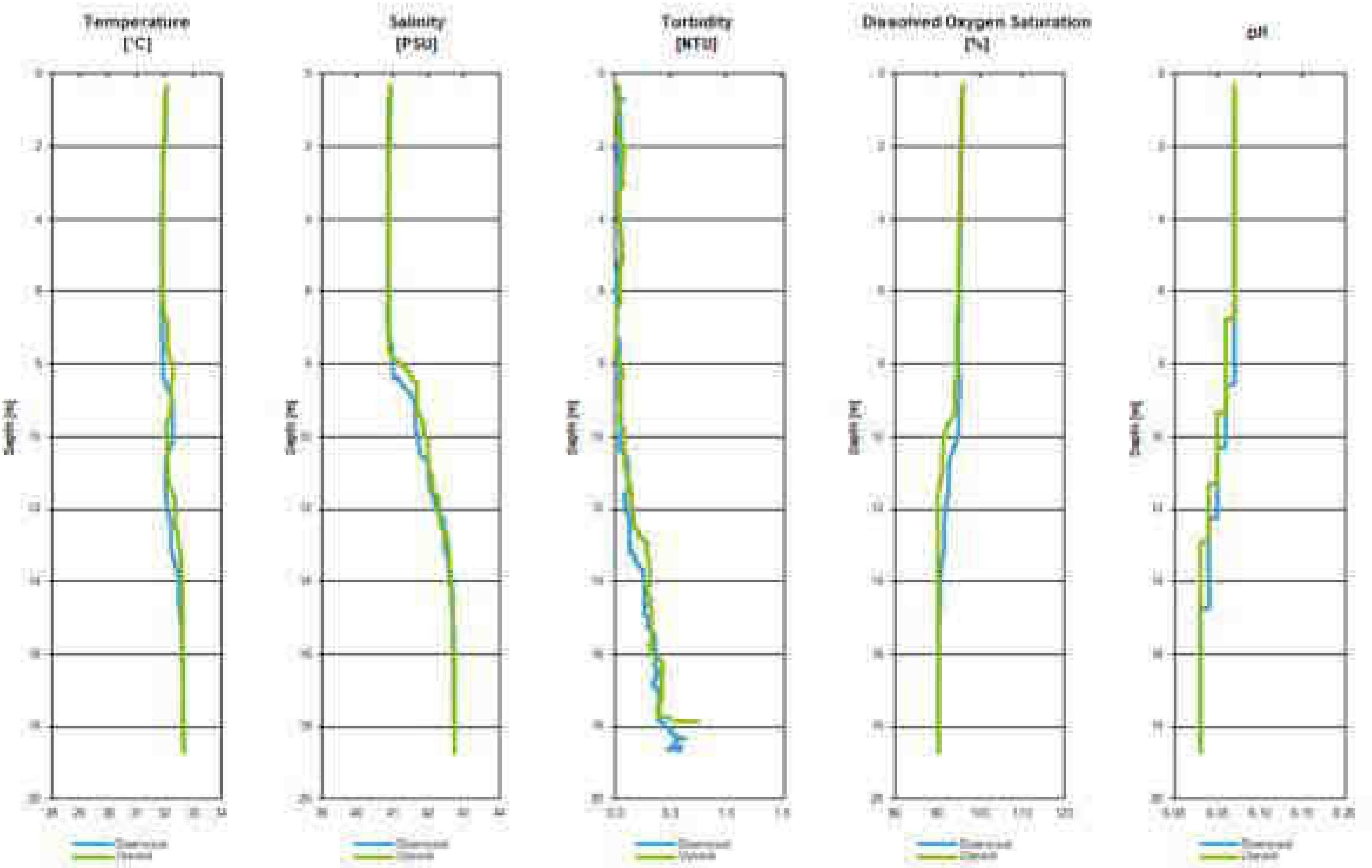

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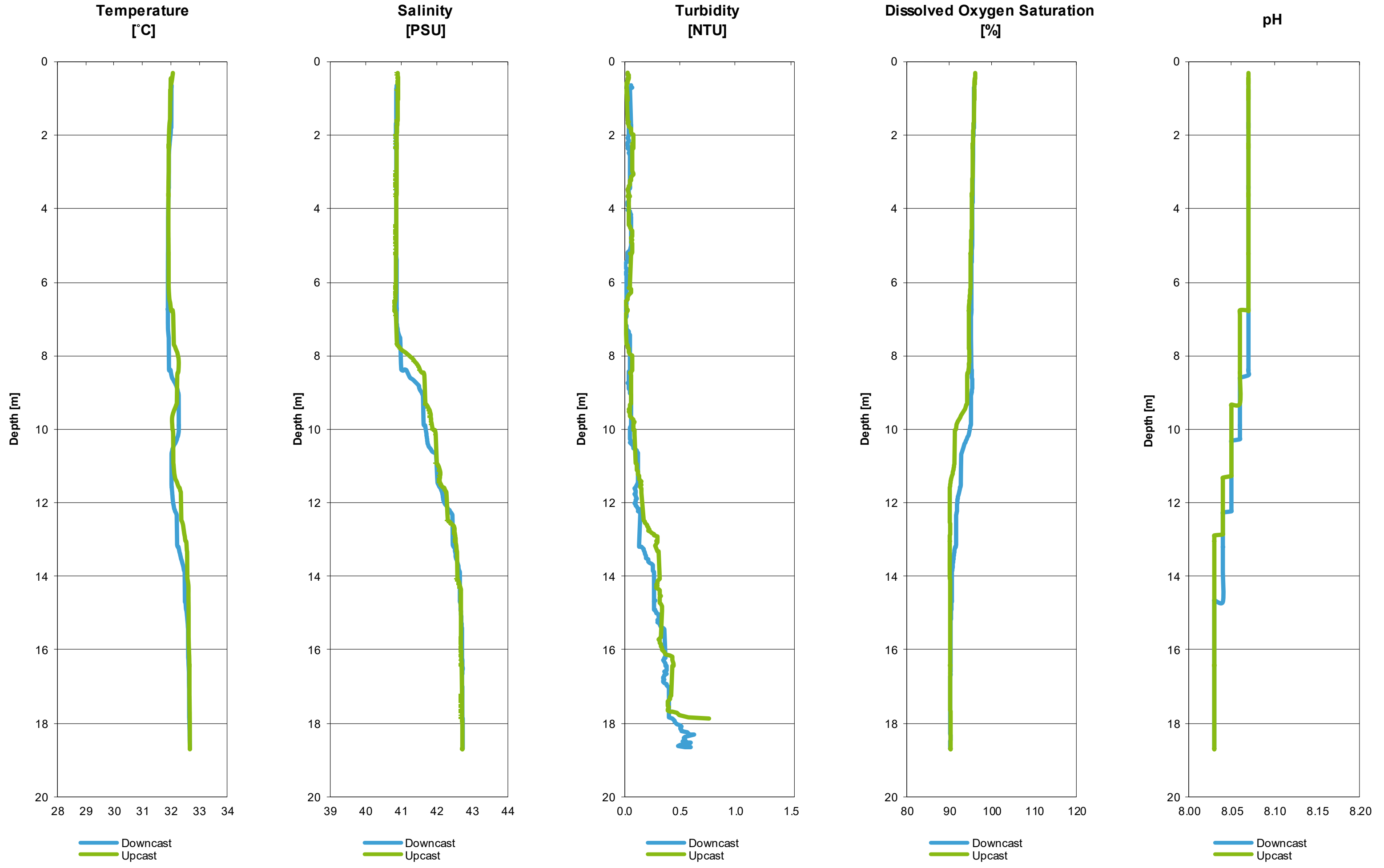

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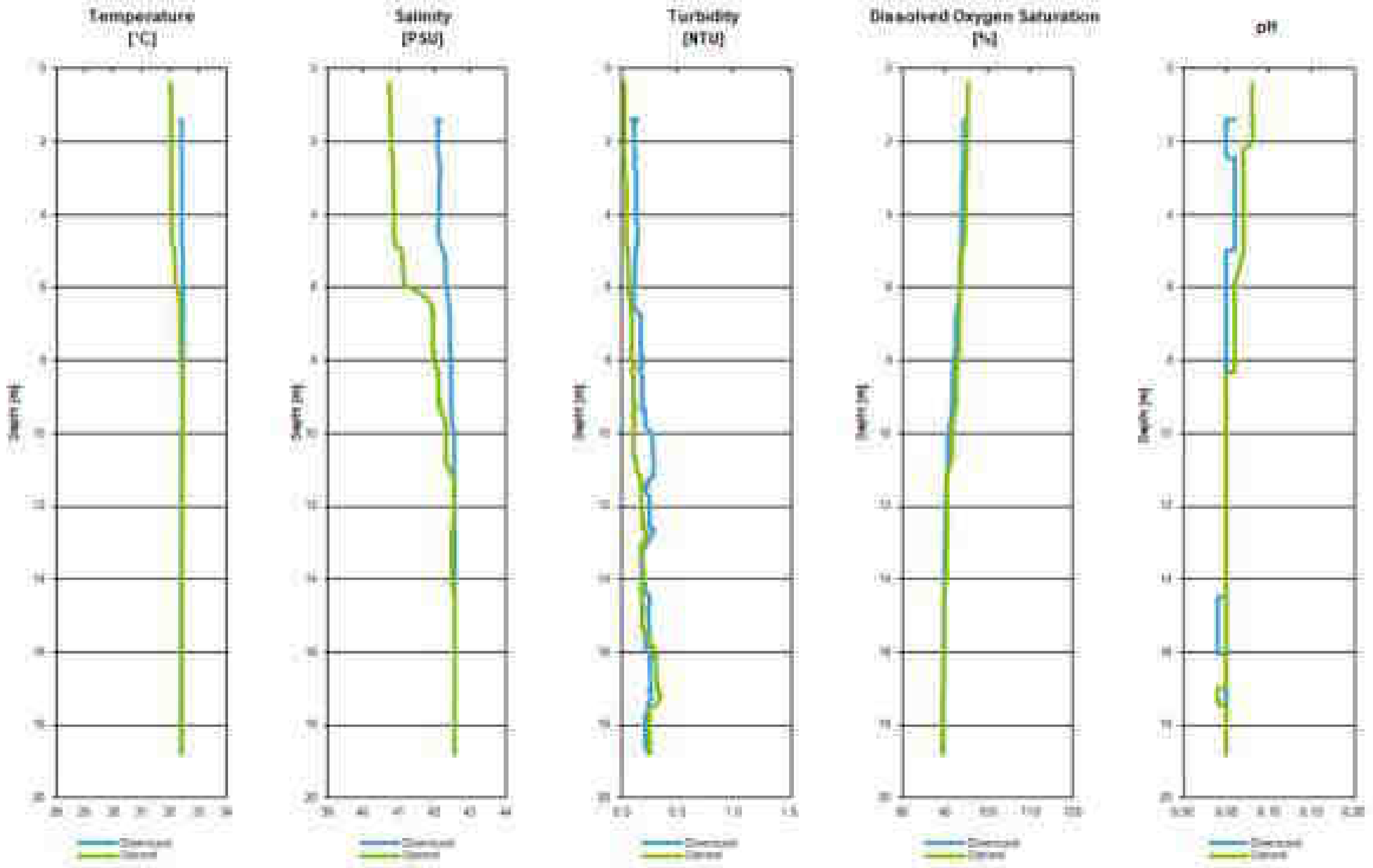
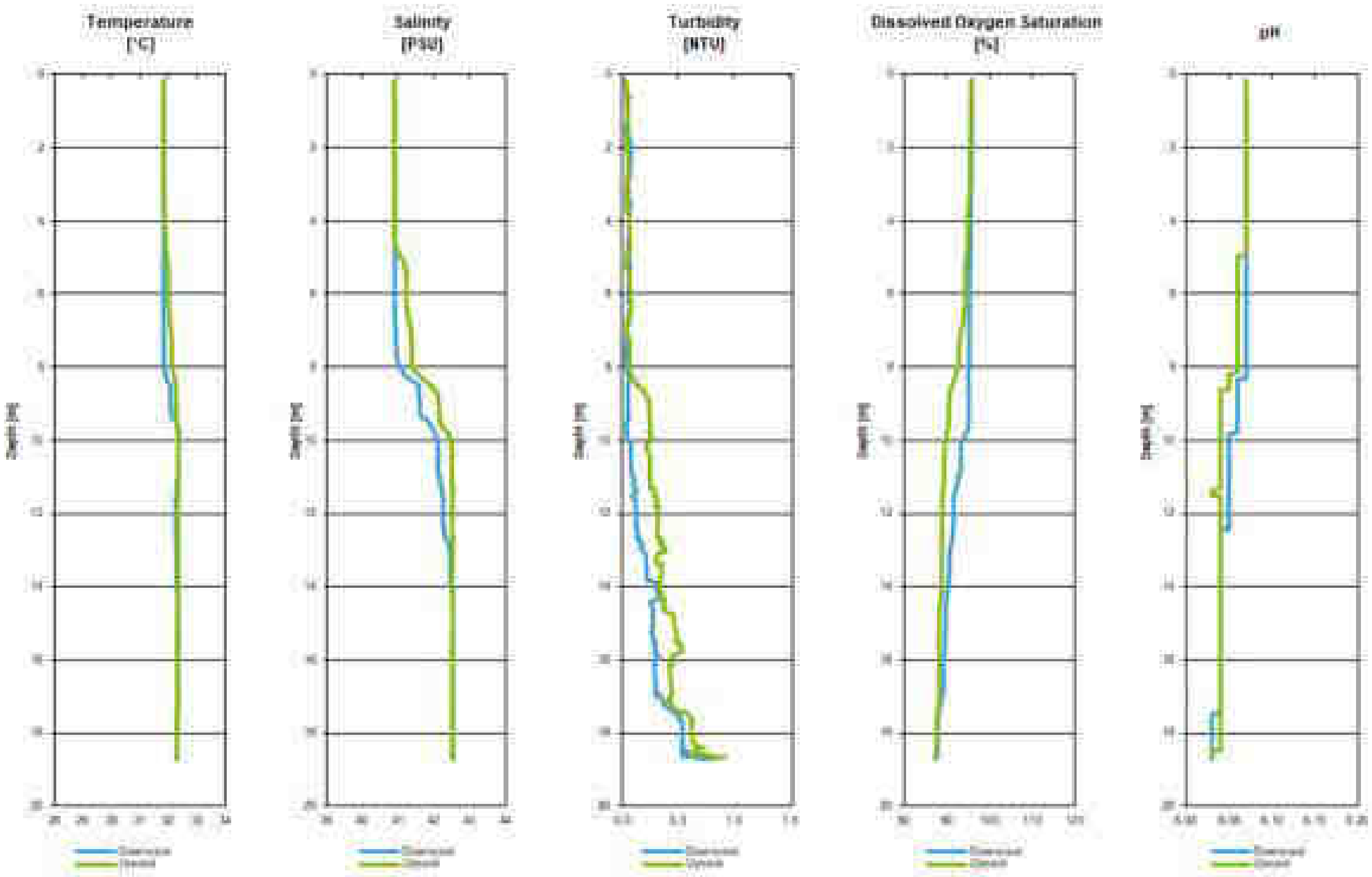


## Station R1_ENV_061



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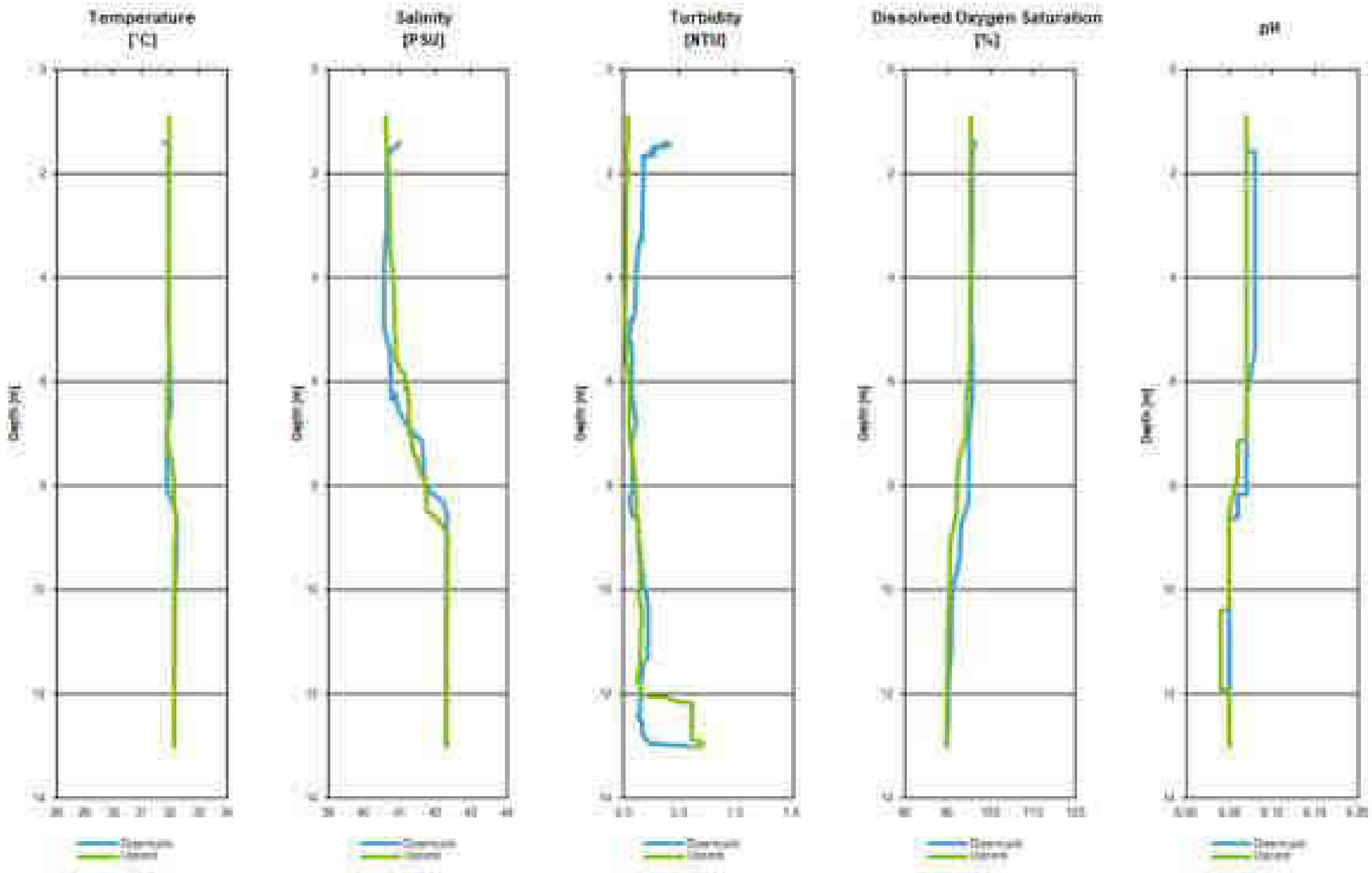

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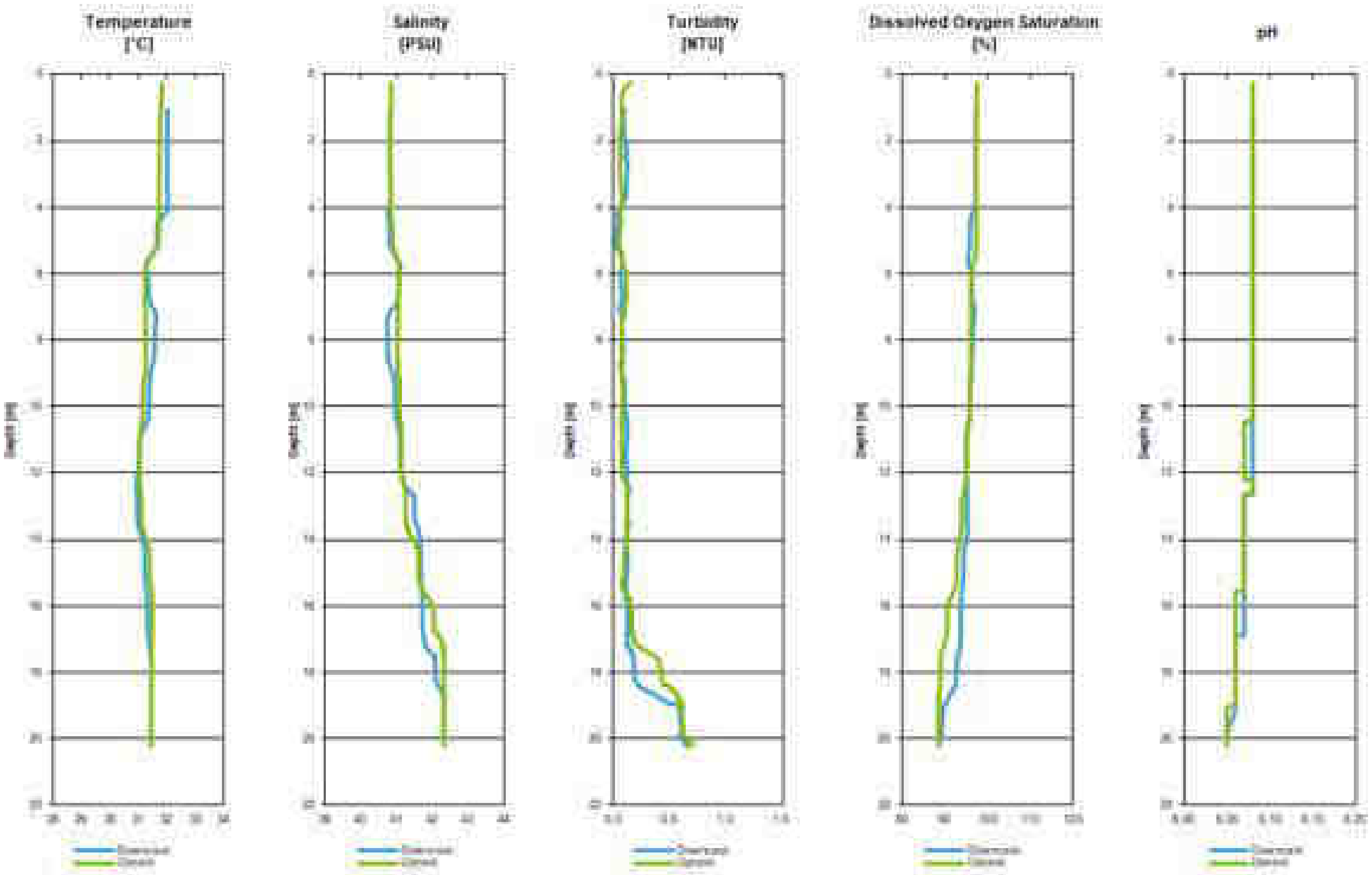
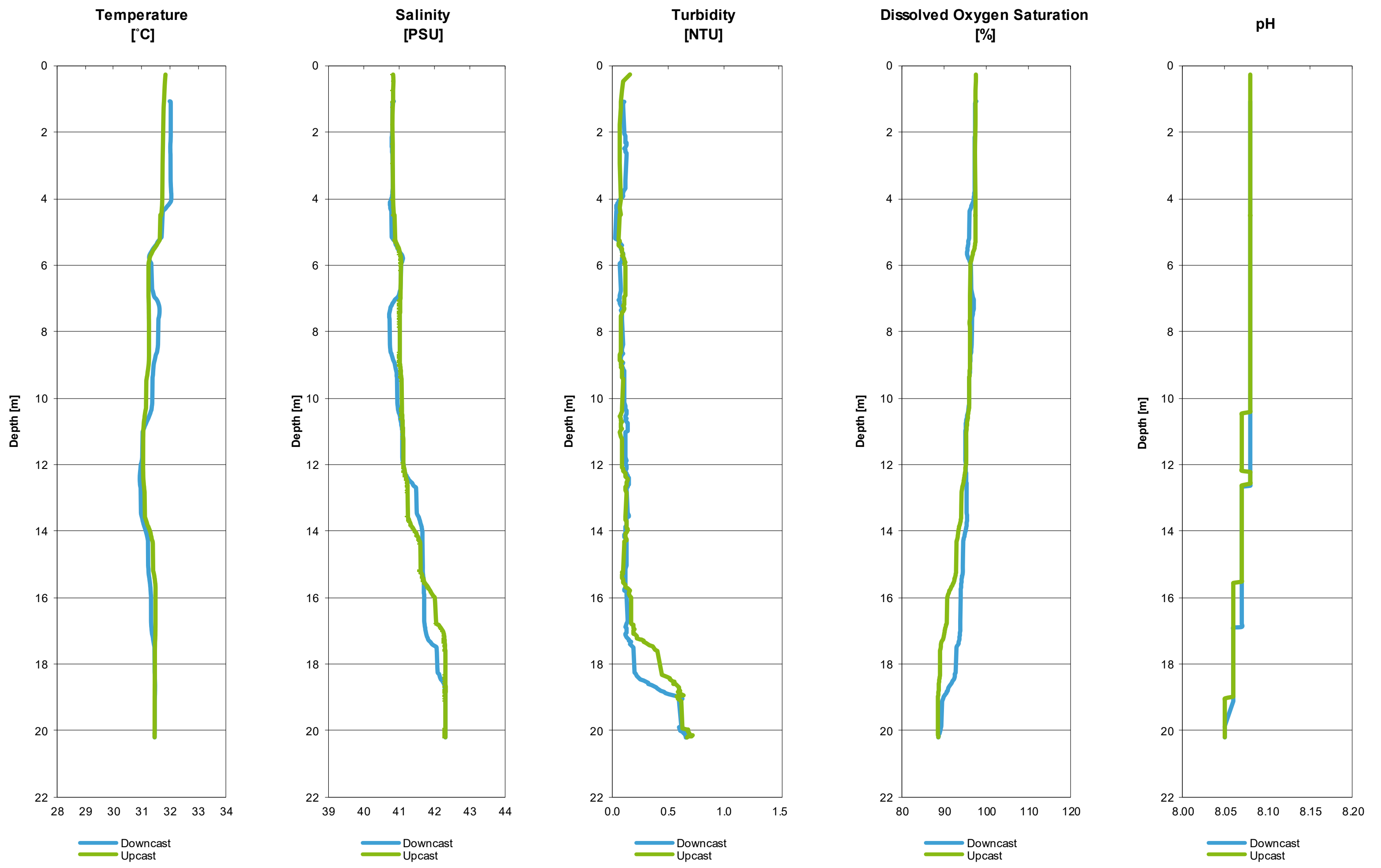
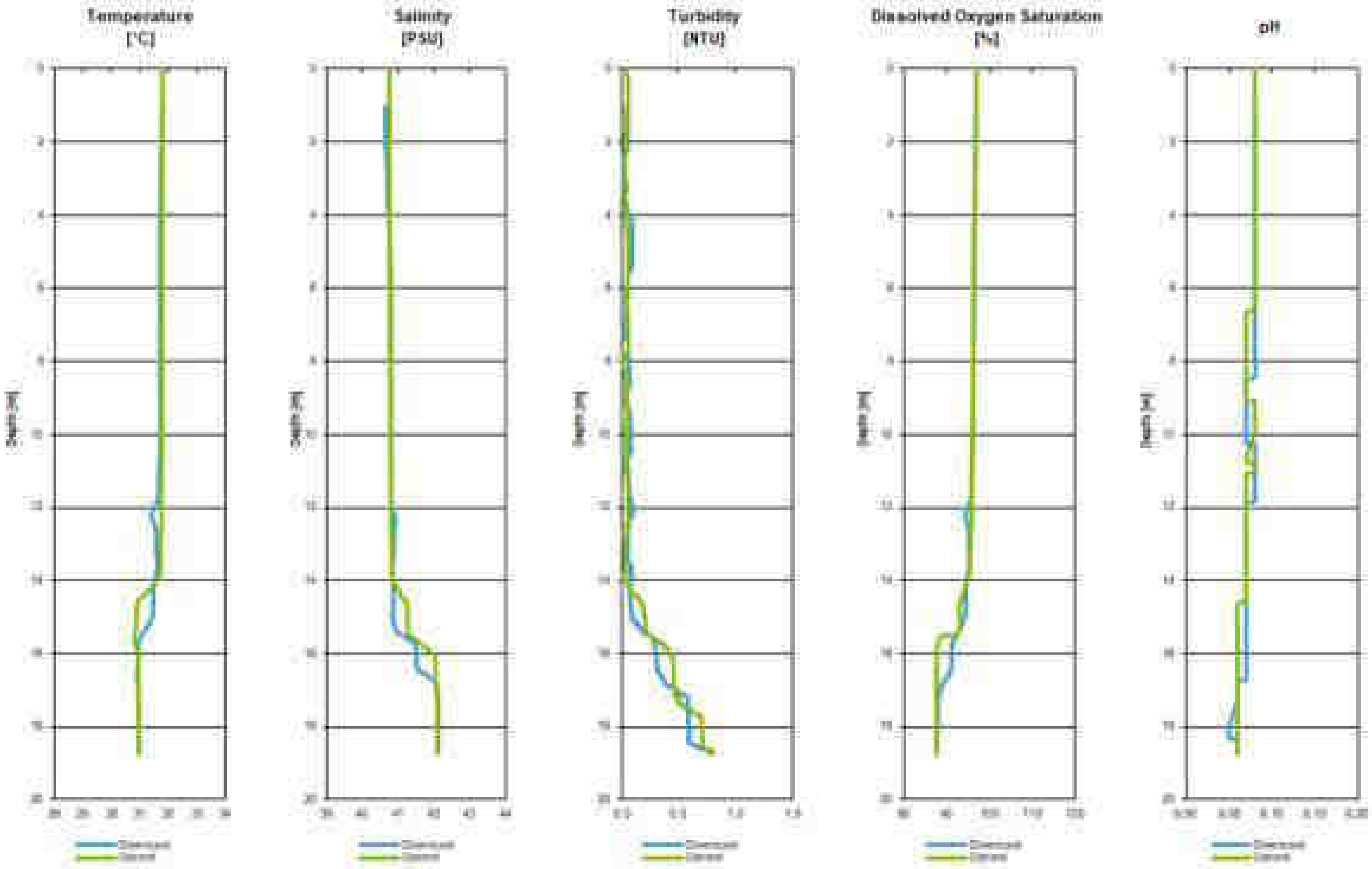


## Station R1_ENV_064



Station R1_ENV_065



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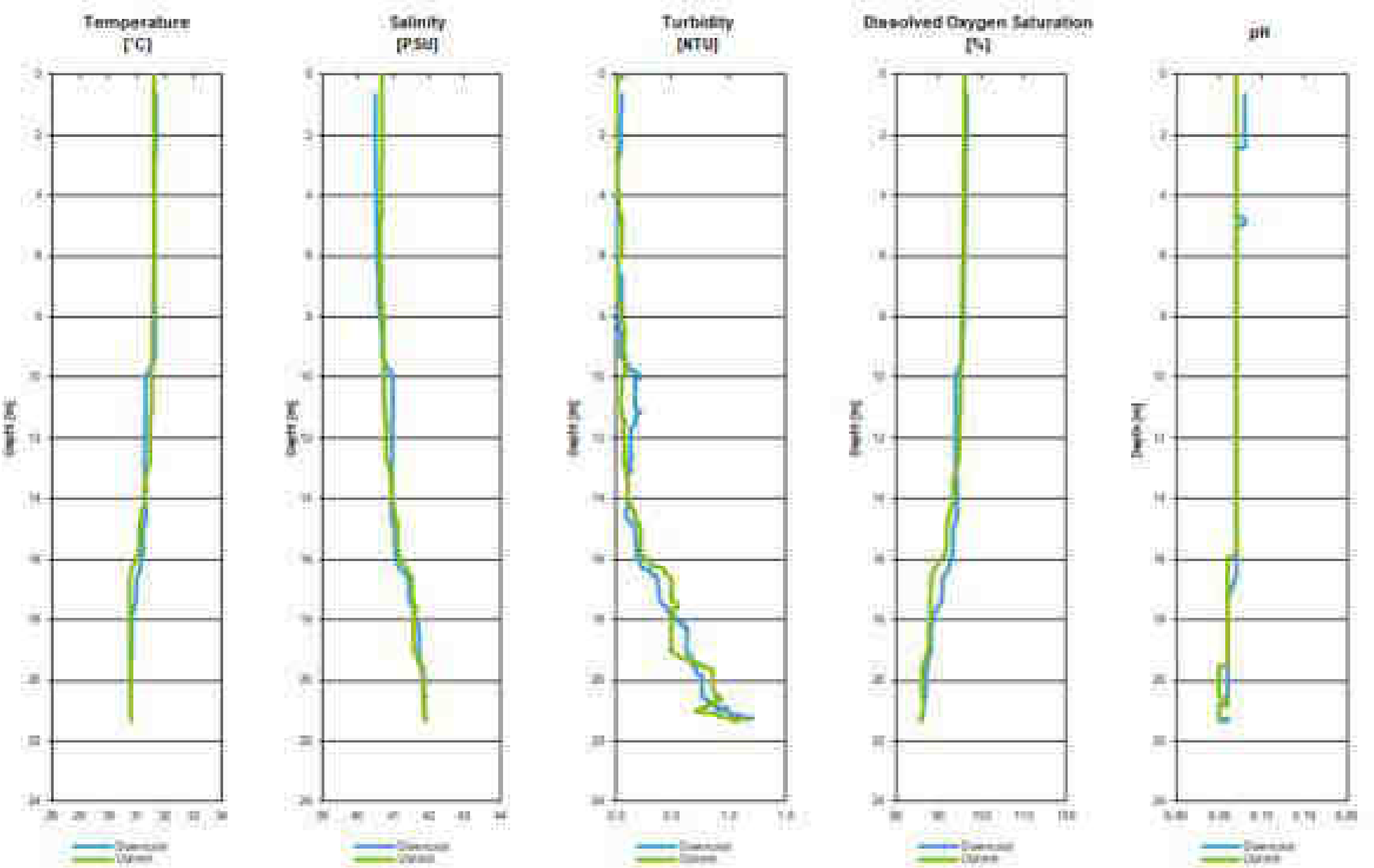

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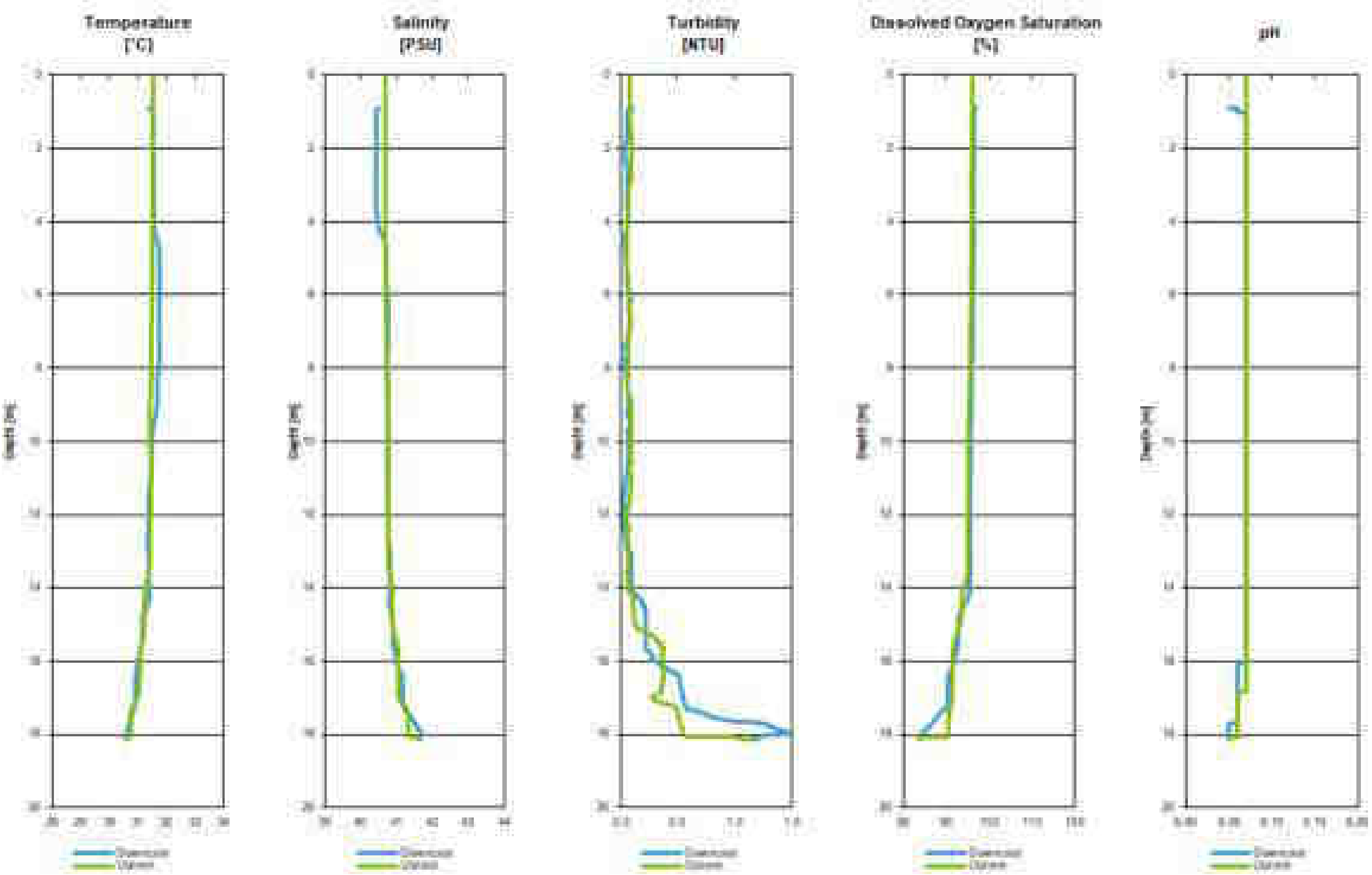

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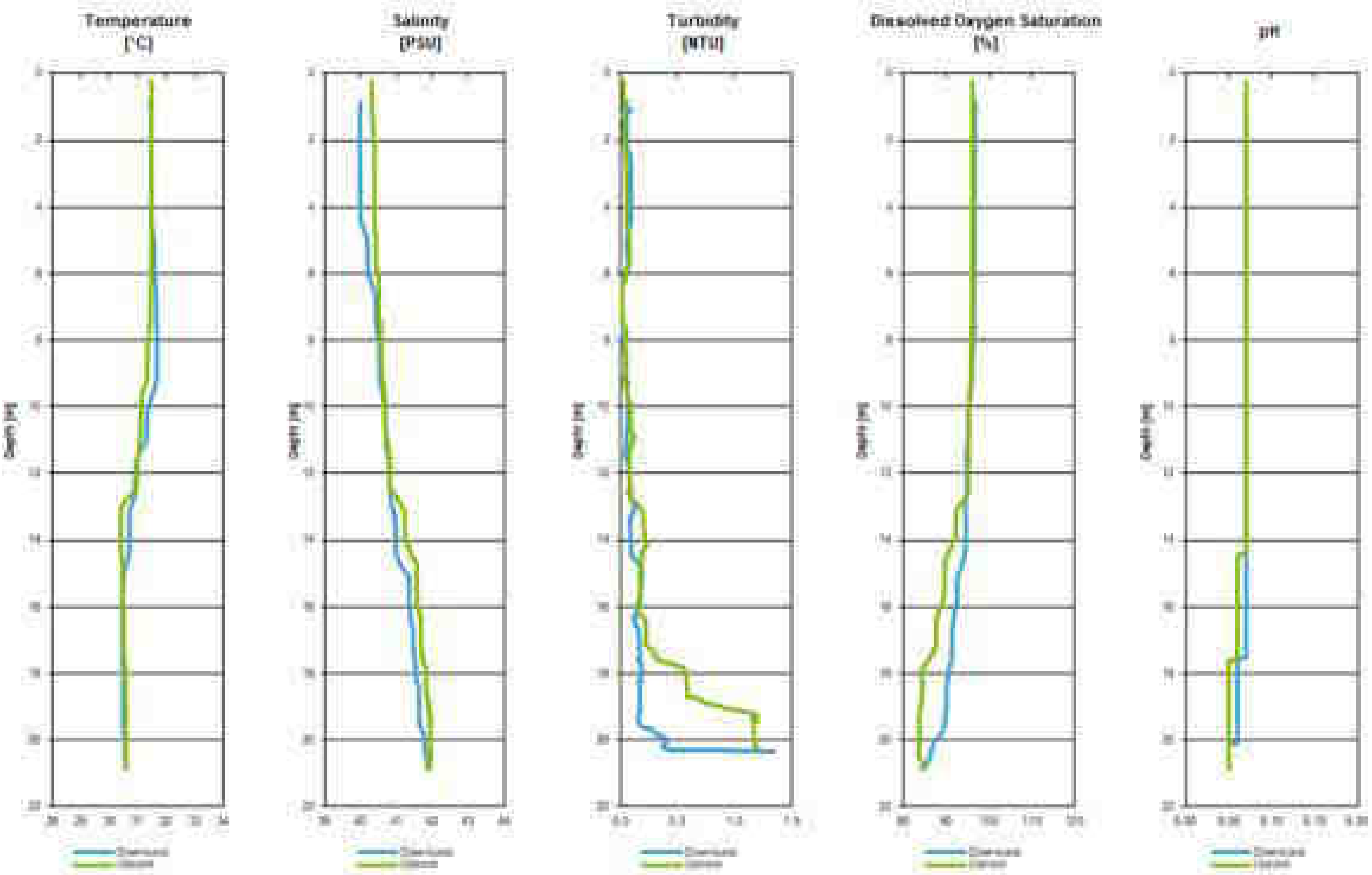

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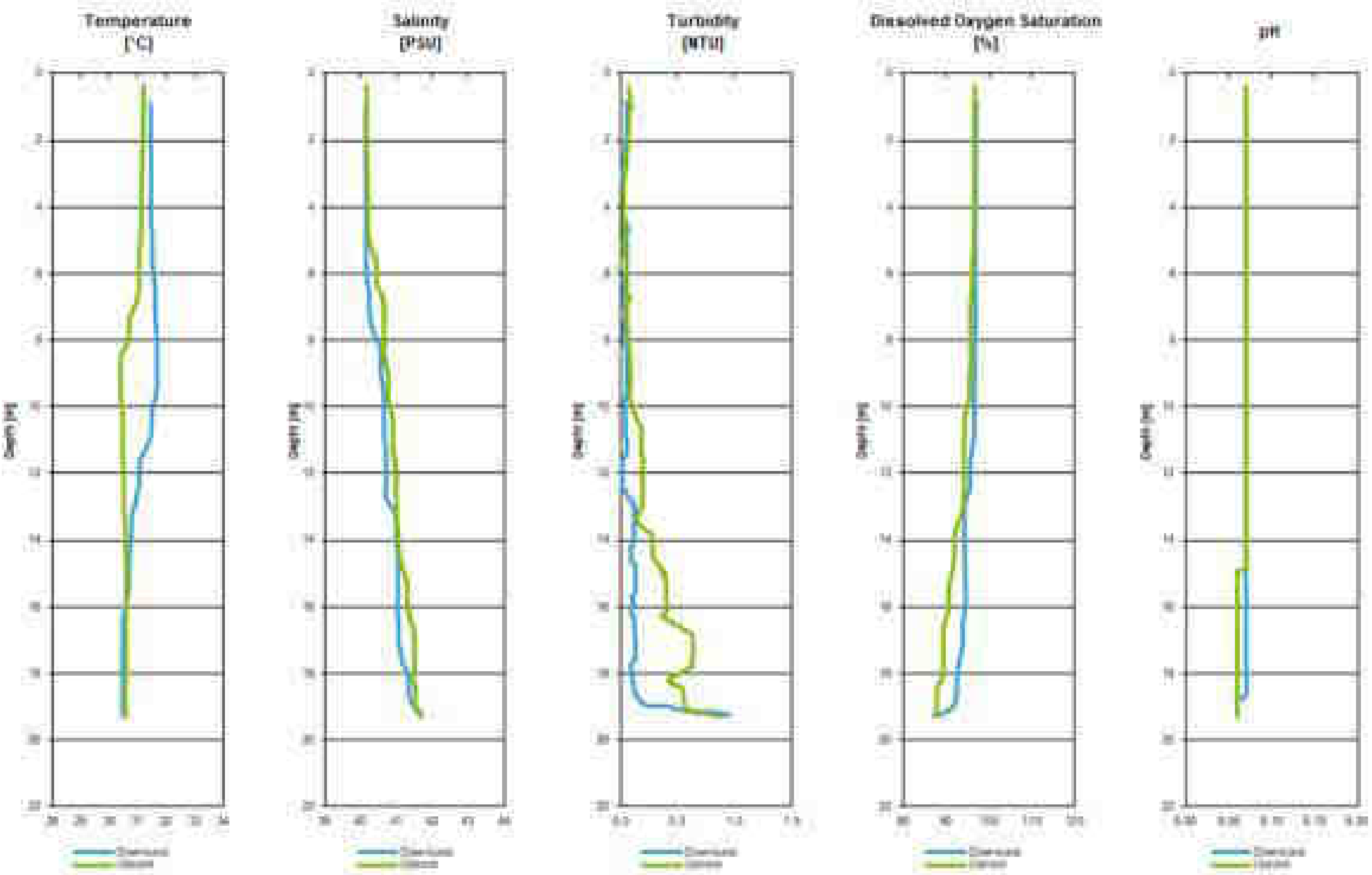

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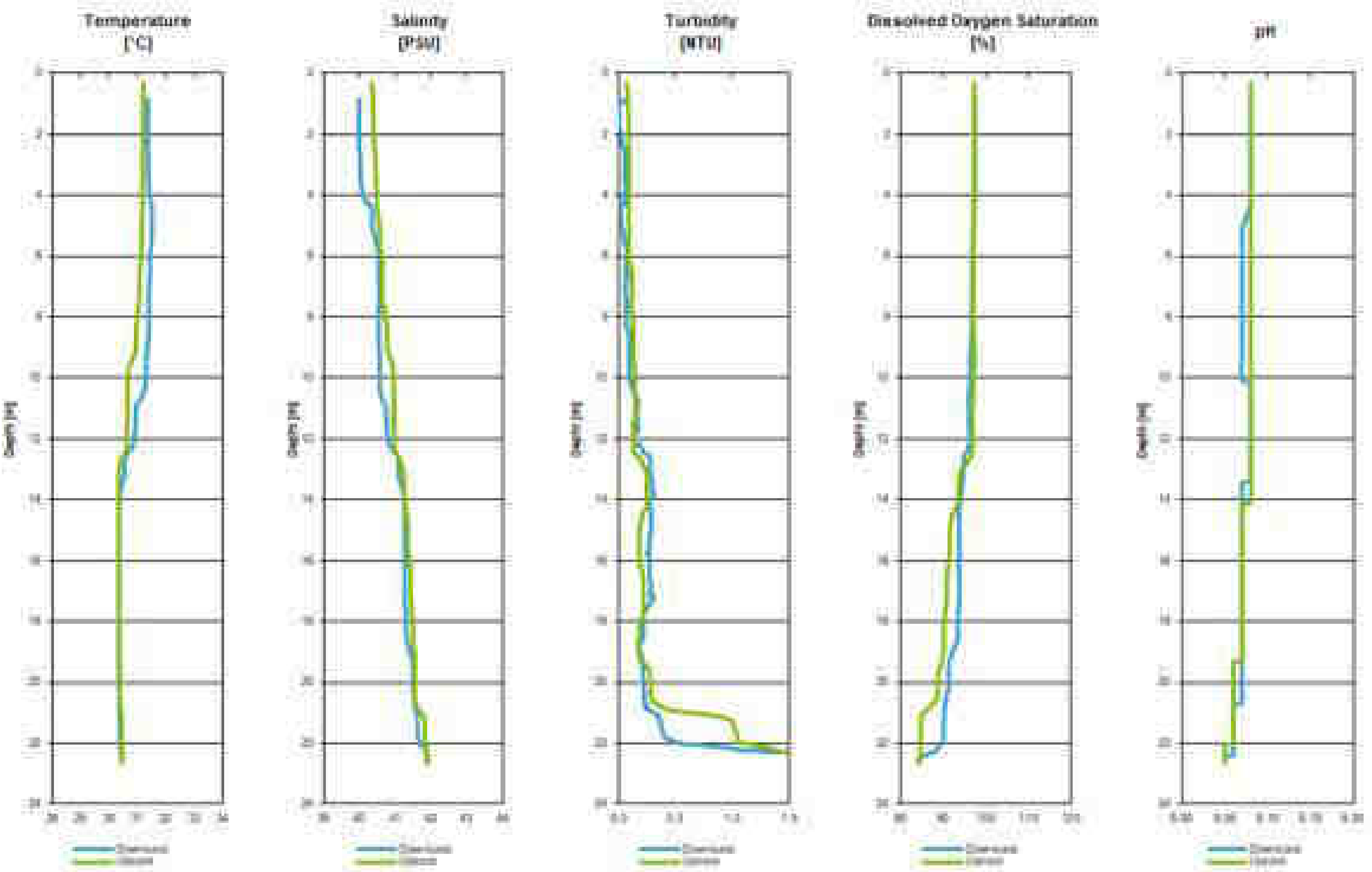

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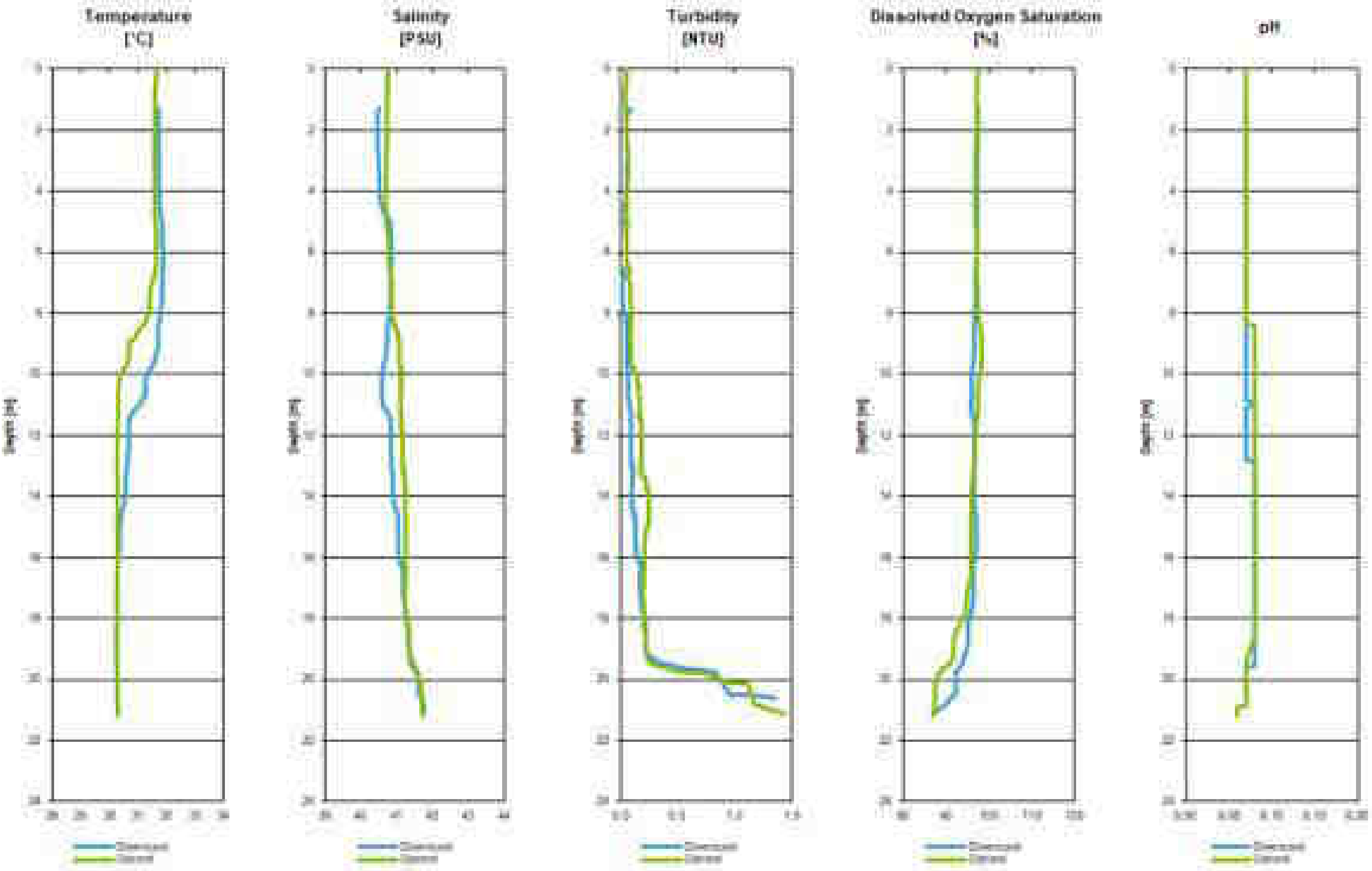

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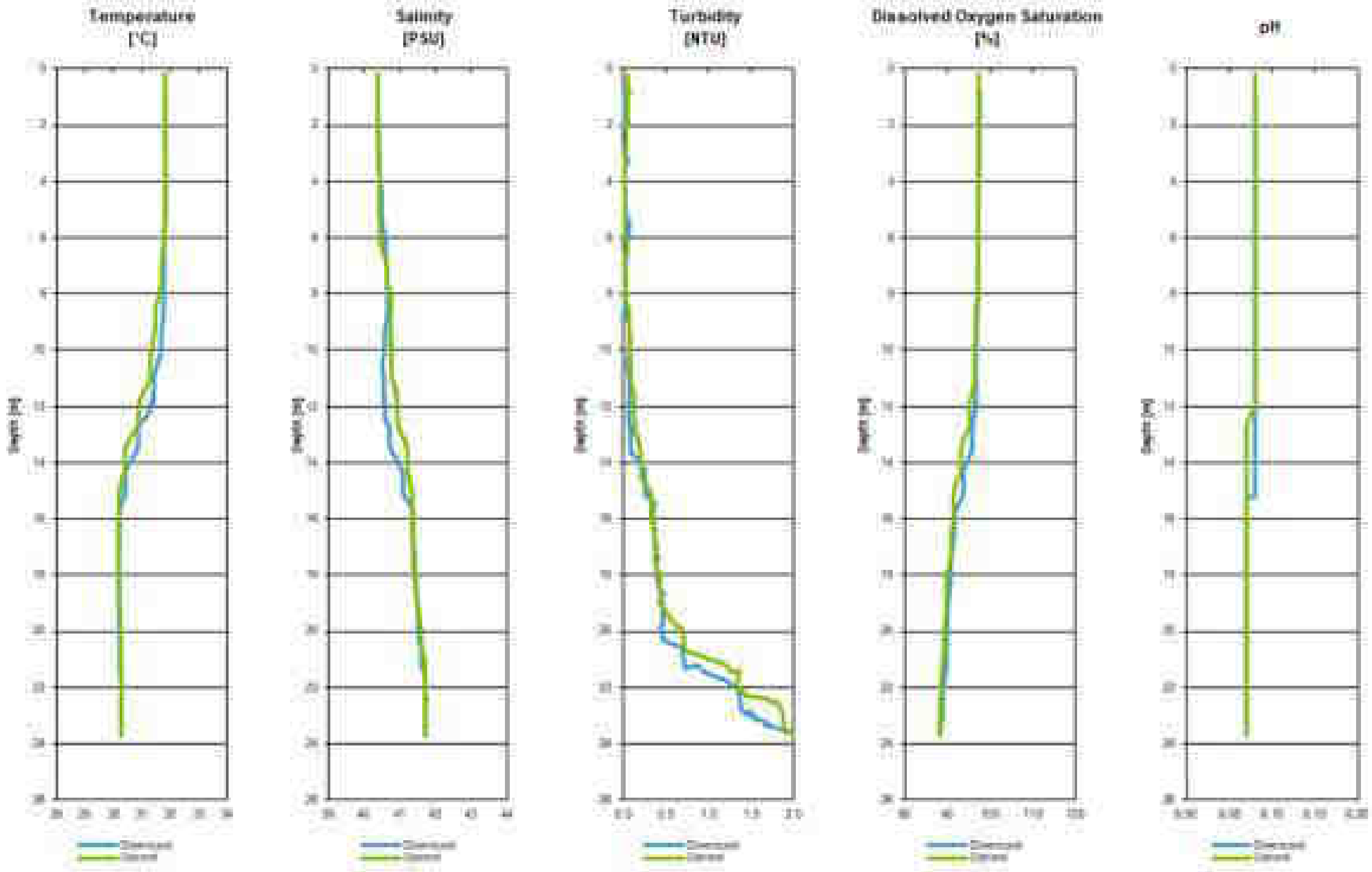

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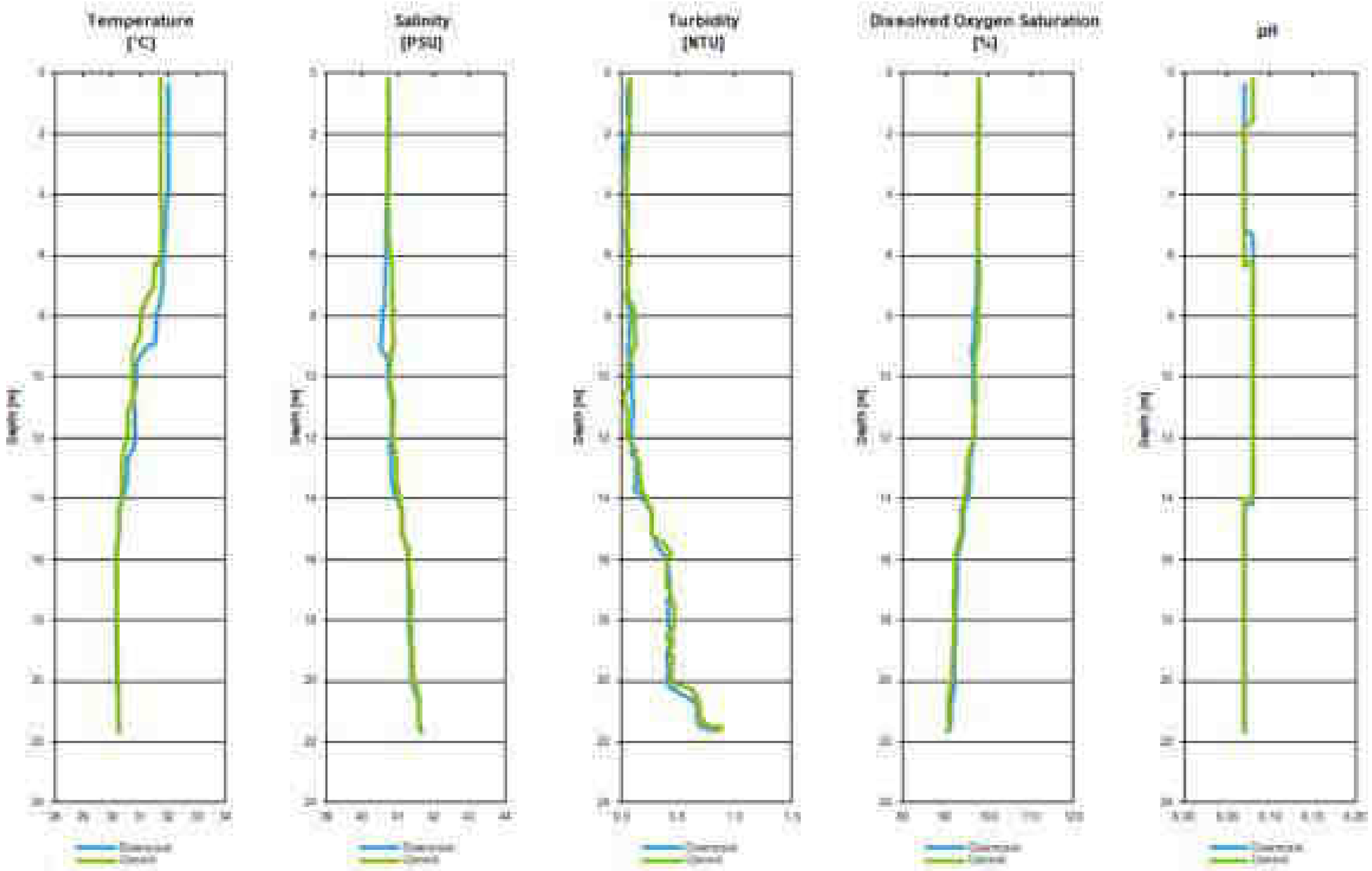

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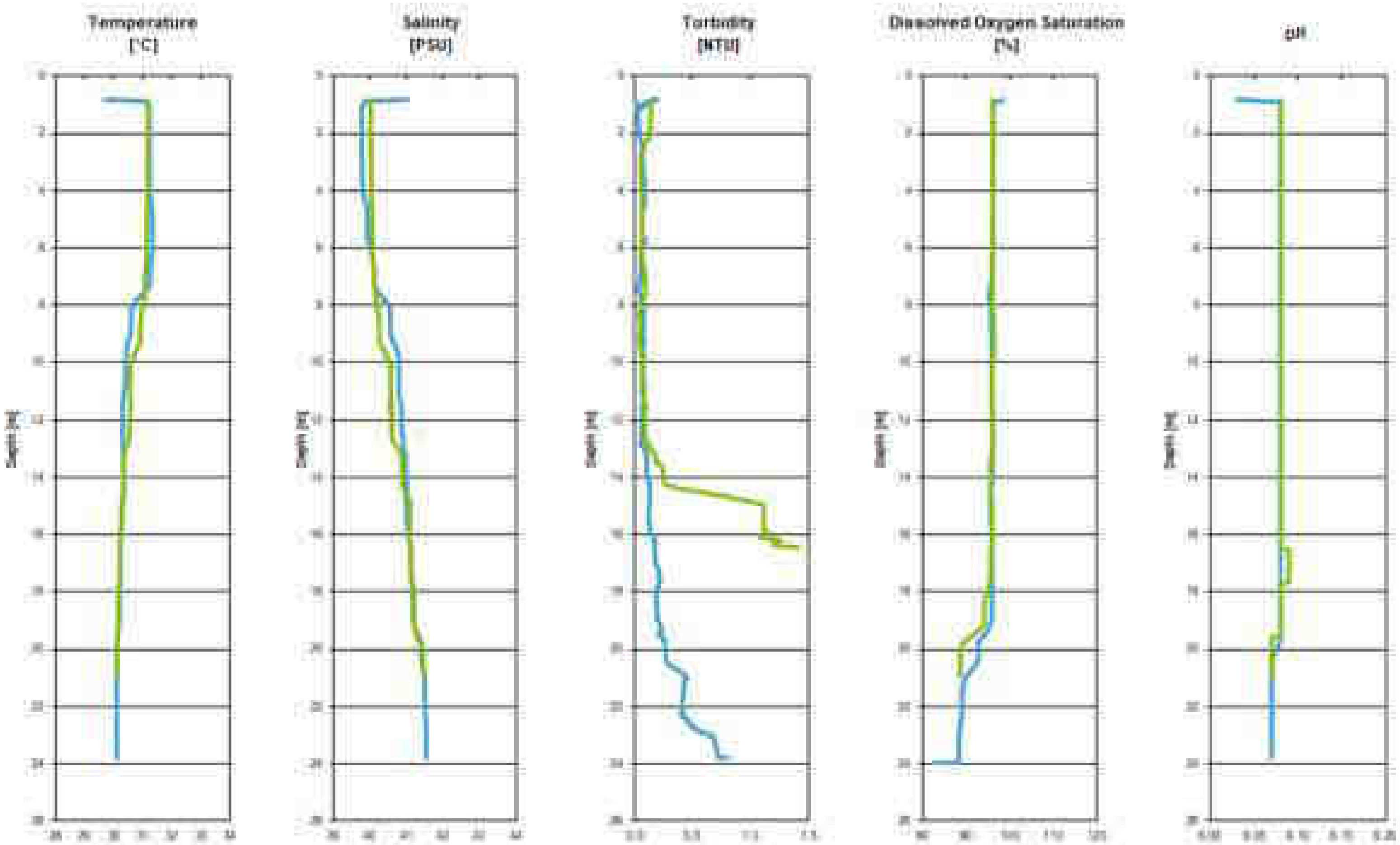

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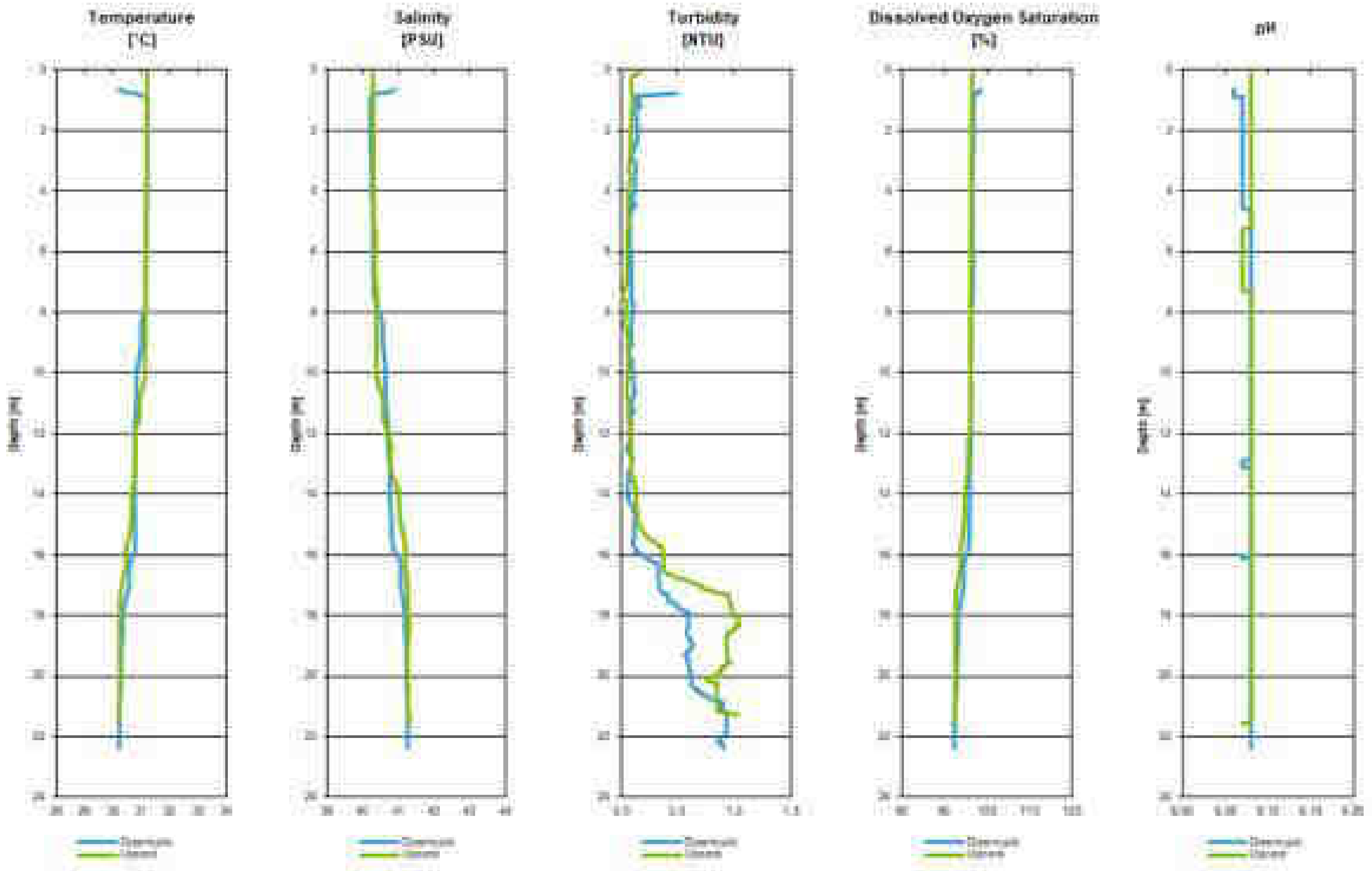

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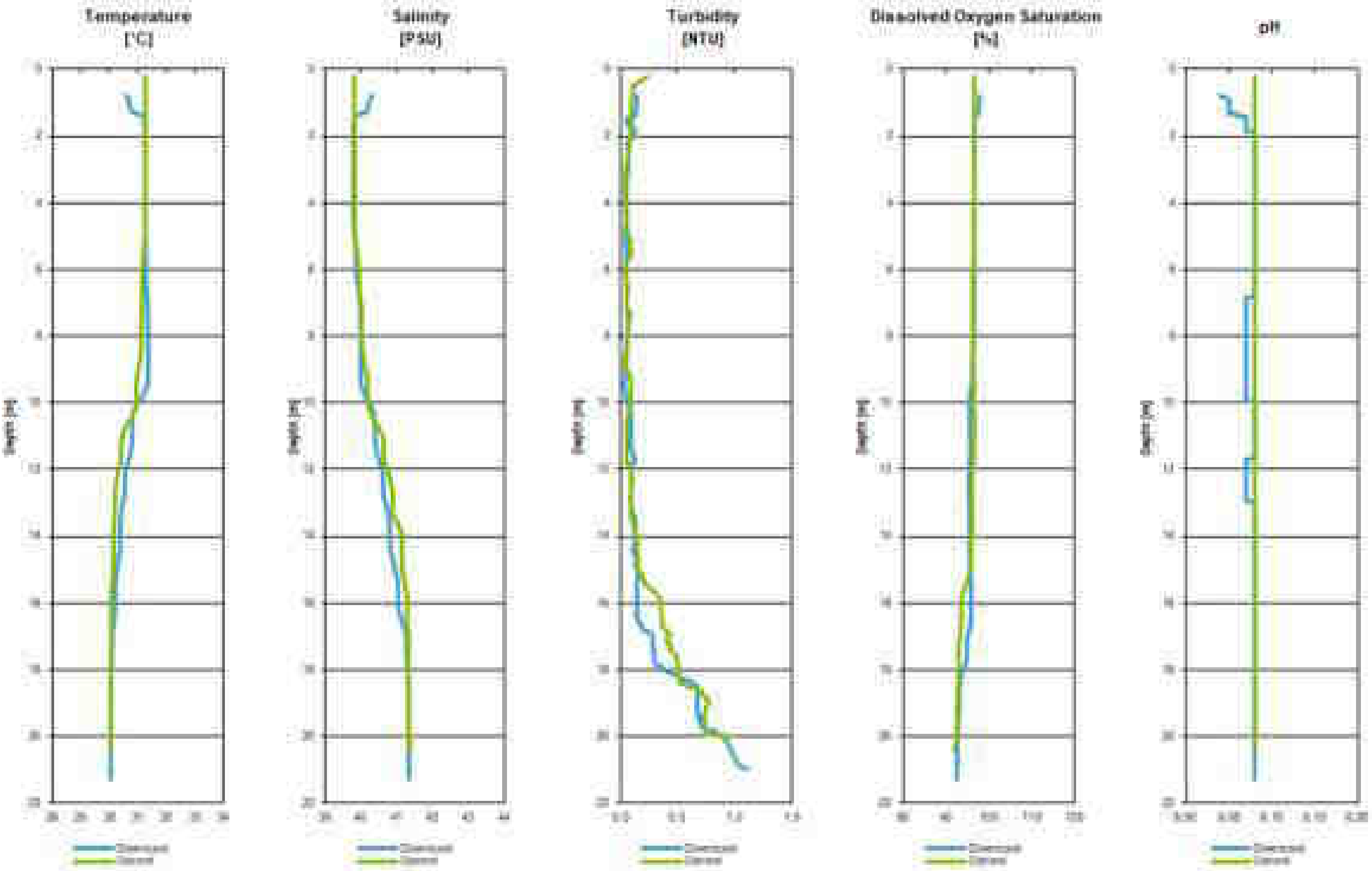

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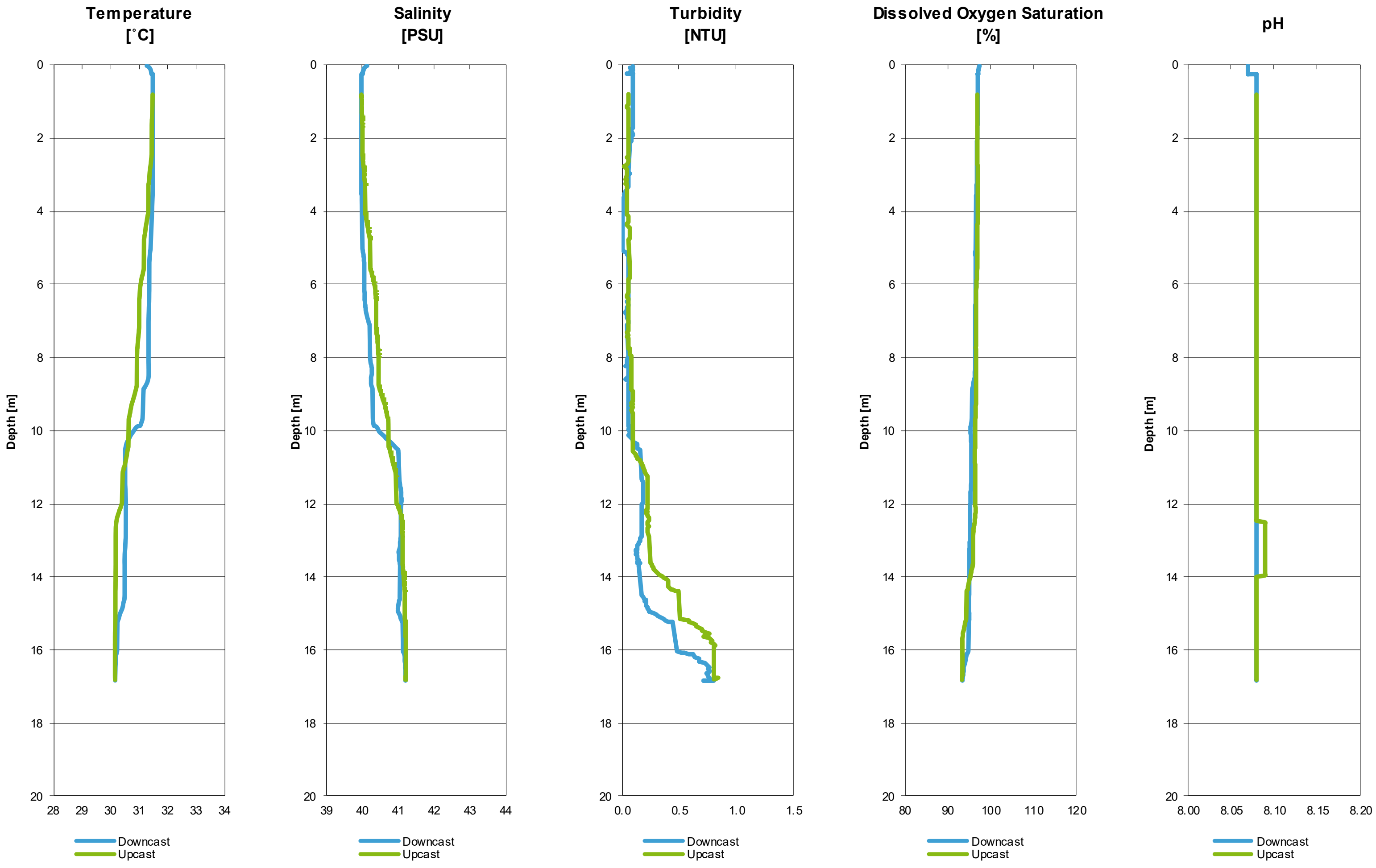

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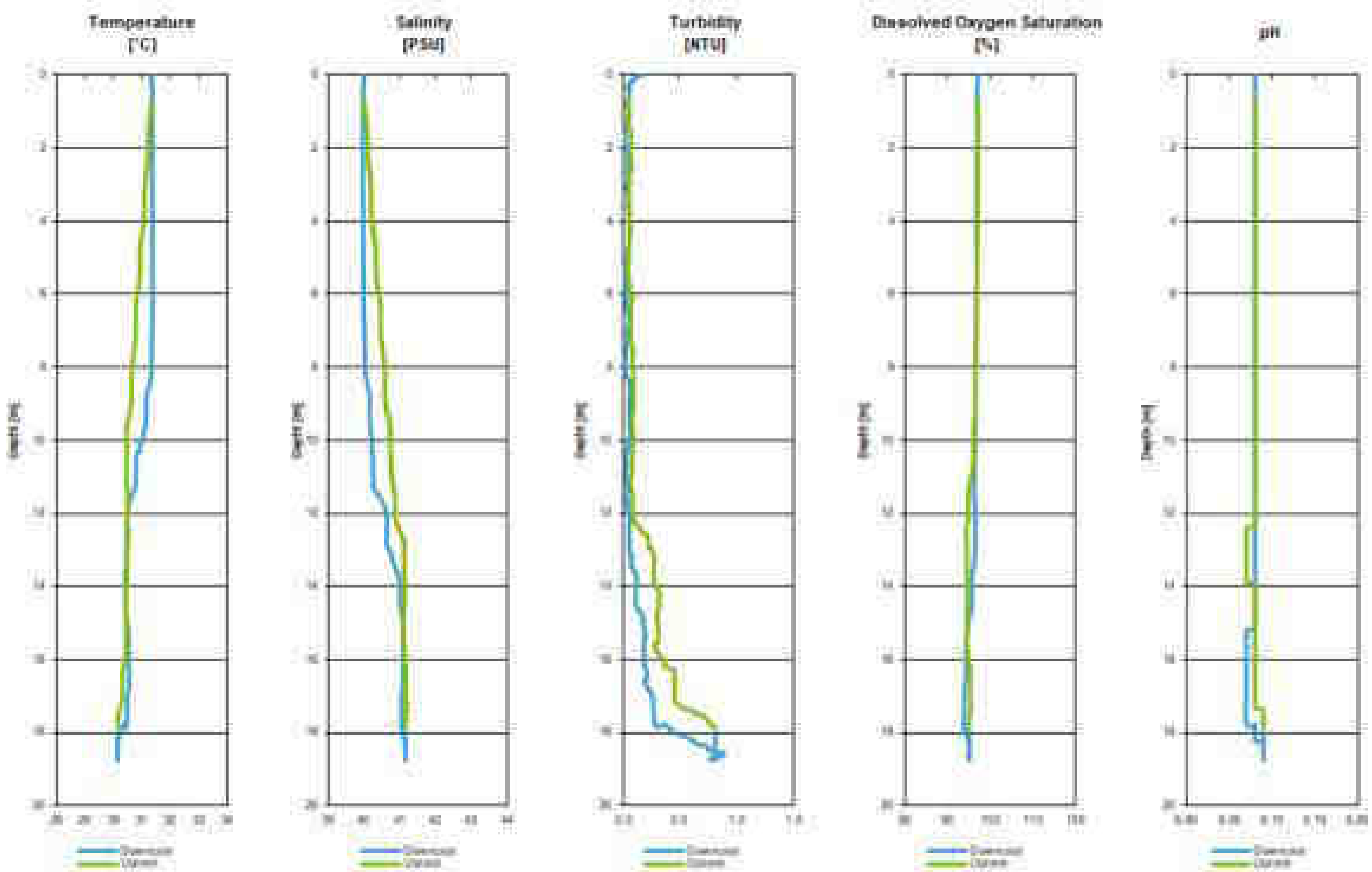

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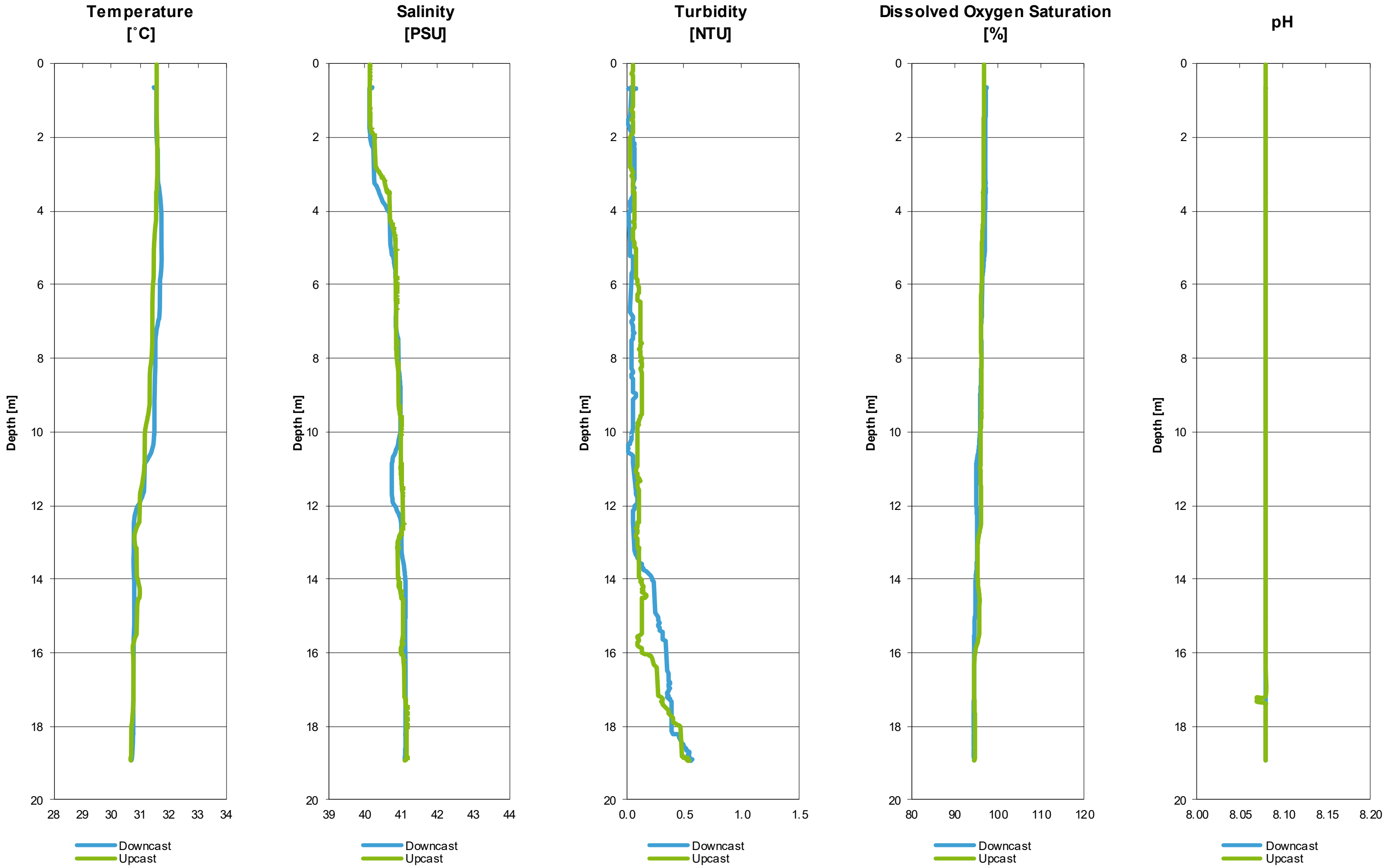

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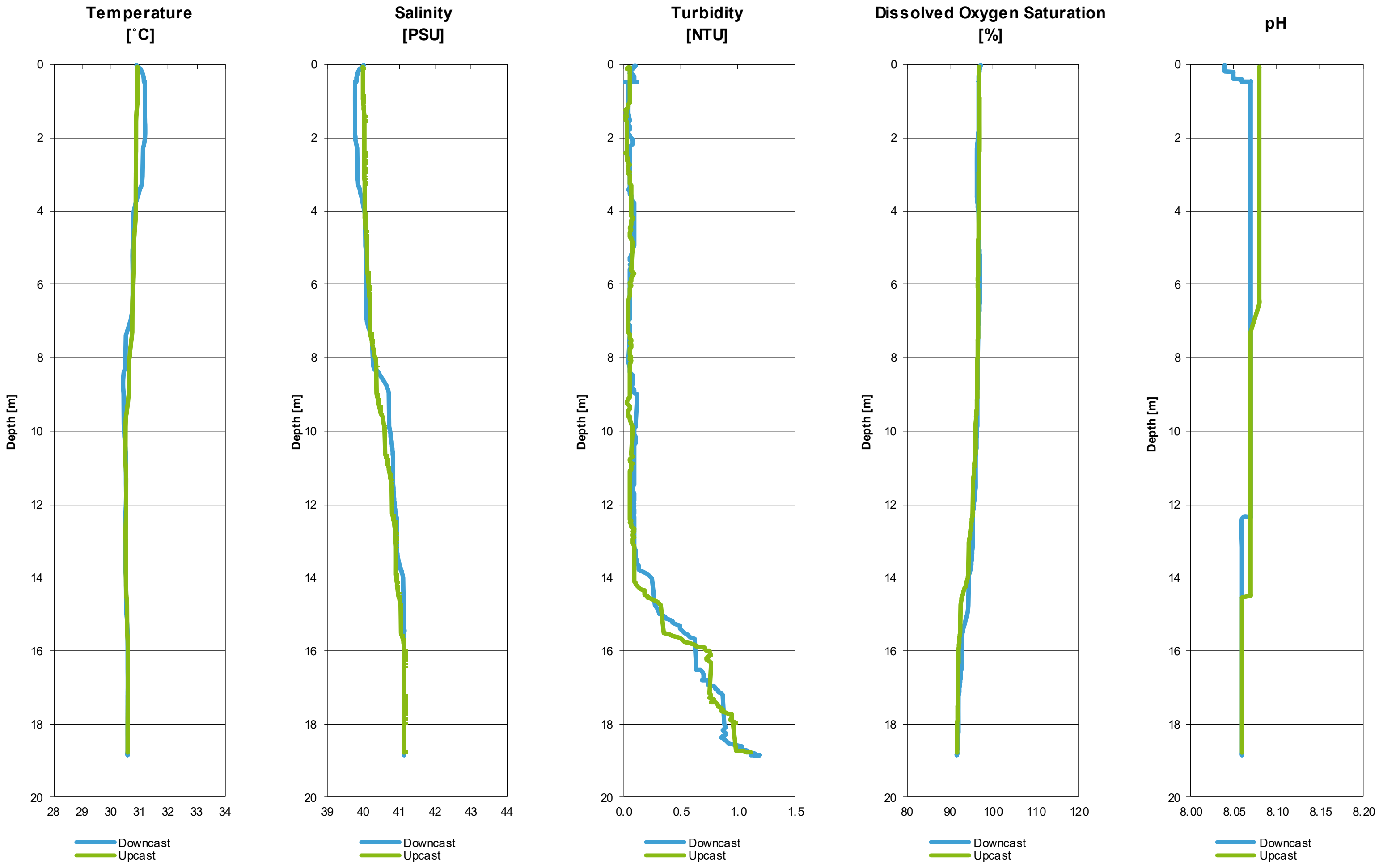

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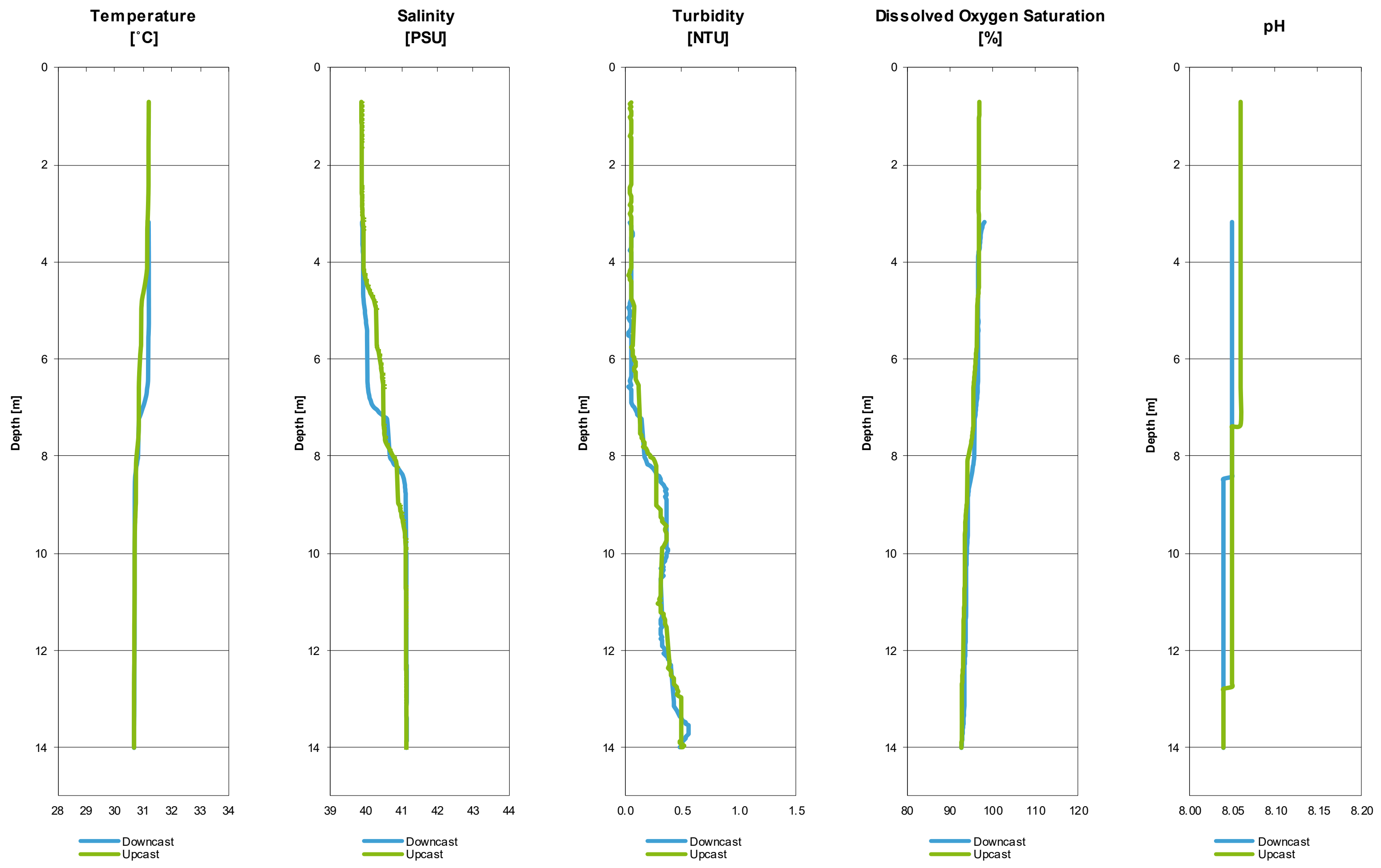
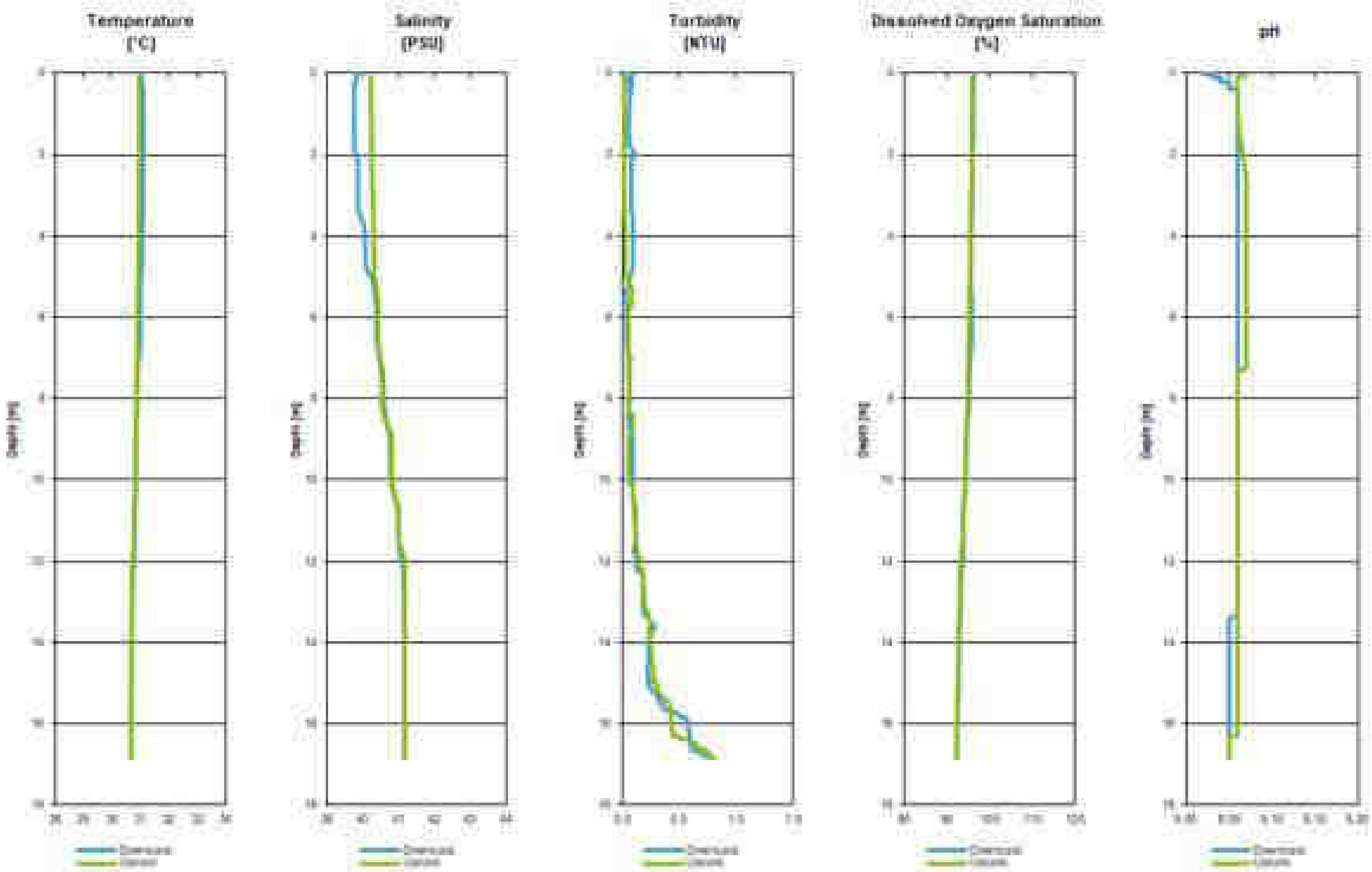


## Station R1_ENV_082



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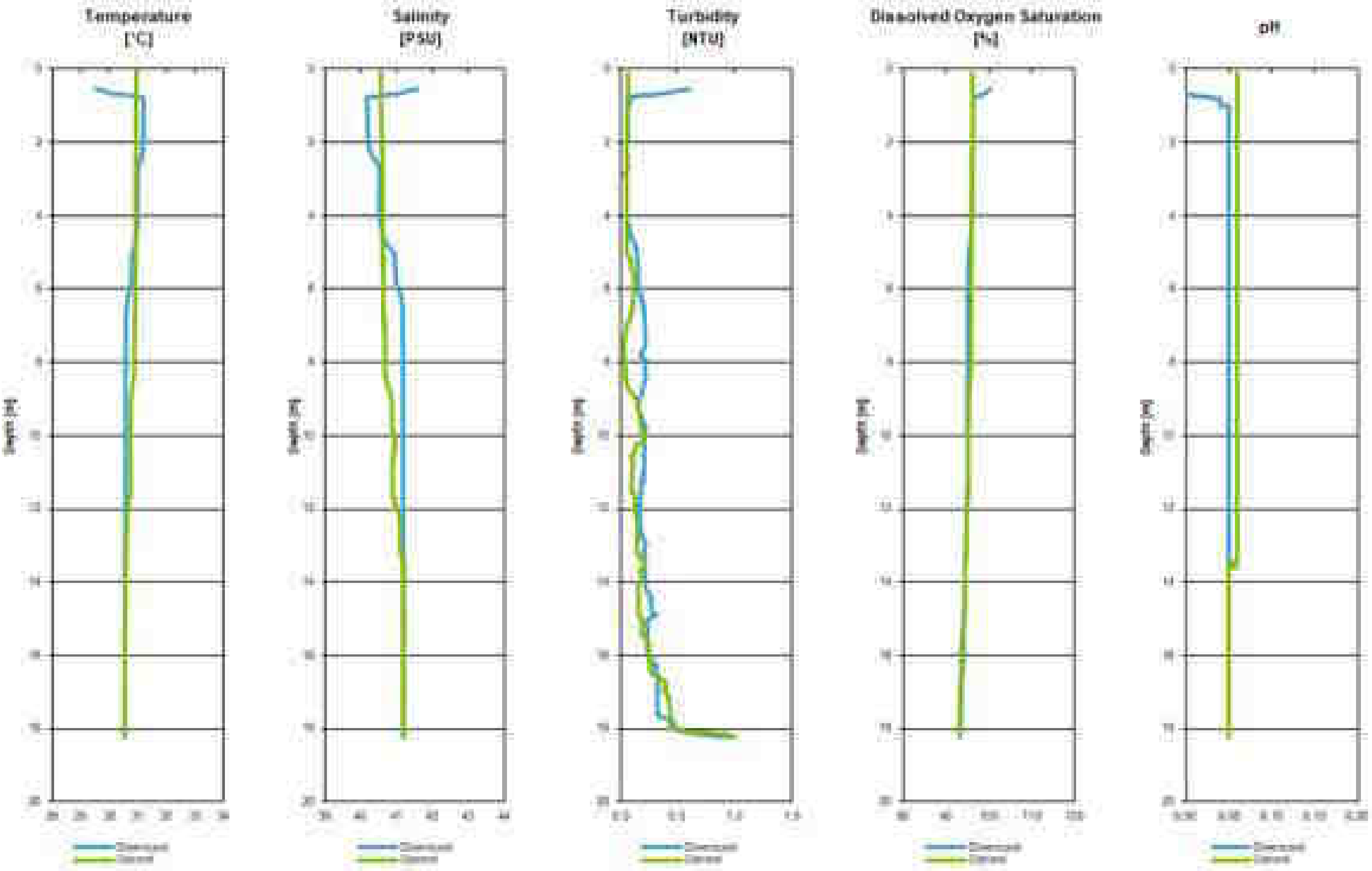

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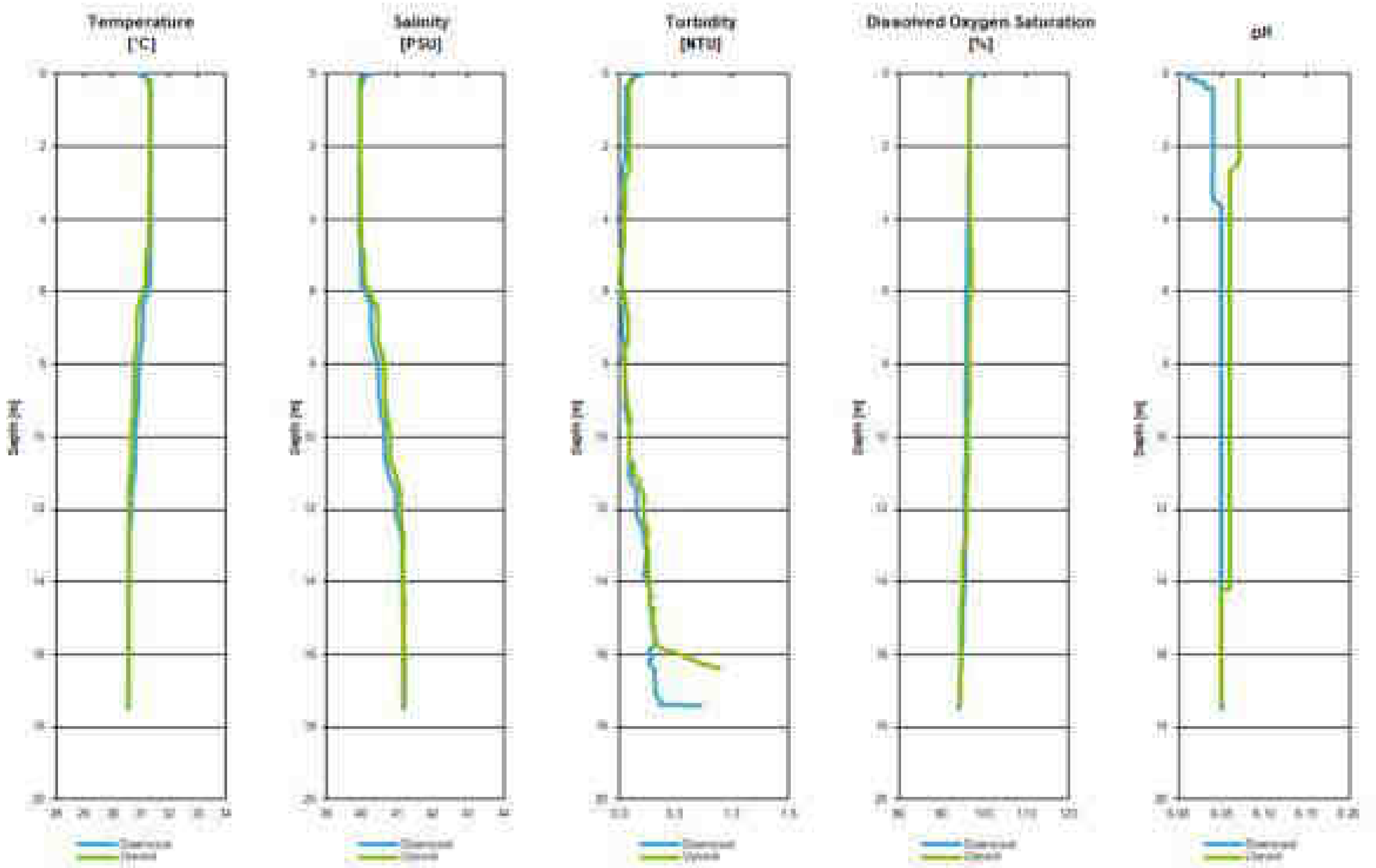

## Station R1_ENV_085