SCHEDULE 2 – ANNEX A

STATEMENT OF TECHNICAL REQUIREMENTS (SOTR)

SURVEY OF THE WRECK OF HMS CASSANDRA

Reference NO.	REQUIREMENT	PERFORMANCE MEASURE	INFORMATION
1	HMS CASSANDRA (1) The Contractor shall undertake an on-site survey and assessment of the wreck of the World War I cruiser HMS CASSANDRA lying in the Exclusive Economic Zone (EEZ) of Estonia. (2) The on-site survey shall be completed by no later than 30th September 2025, all deliverables shall be completed and supplied to the sole satisfaction of the Authority by no later than forty (40) Business Days following completion of the on-site survey. (3) The Contractor shall provide an on-site manager to supervise all task activities. (4) The Contractor shall accommodate up to five (5) representatives of the Authority, the Estonian government or other personnel as specified by the Authority onboard the selected vessel for the duration of the CASSANDRA survey cruise in addition to the operating crew and Tenderer's personnel.	(1) The on-site survey shall be completed by no later than 30th September 2025. (2) It is essential that all deliverables shall be completed and supplied to the Authority by no later than forty (40) Business Days following completion of the on-site survey.	HMS CASSANDRA lies in the Baltic on its starboard side in 95m of water, approximately 19.5NM west of Vilsandi island in position: 58 28,676'N 021 13,679'E (WGS84). Note – the Estonian government have advised that they will treat the work on HMS CASSANDRA as an underwater archaeological survey. In accordance with this the Contractor shall submit a research plan and report to the Estonian National Heritage Board. The plan and report can only be submitted by a certified marine archaeologist holding the approval of the National Heritage Board (note also that this cannot be done by the Authority). Early engagement with the National Heritage Board to determine research plan/reporting standards and timeframes is therefore strongly encouraged (register.muinas.ee).

2	<u>Multibeam Sonar Survey, Recorded Visual Survey, Photogrammetric Survey</u> (1) The Contractor shall undertake a multibeam sonar, photogrammetric and recorded visual (video and stills) survey of the wreck and the surrounding seabed comprising two parts. Both parts shall be conducted using a suitable Remote Operated Vehicle (ROV). In addition, hull thickness measurements of the wreck shall be taken. (2) The first part of the survey shall cover an area within a radius of 300m around the wreck to map the debris field, identify debris that may impact safe operations, and to ascertain seabed topography. As part of this survey all objects lying on the seabed within the 300m zone that are larger than $1m^3$ shall be identified. (3) The second part of the survey shall be a close in/non-intrusive survey of the wreck itself in order to produce high-quality data, necessary to inform a condition assessment and an assessment of oil volumes remaining on the wreck. The second part shall also include the following: a). A full photogrammetric survey of the wreck shall be conducted. b). Hull thickness measurements shall be taken and shall be used to inform the survey report. (4) Once the multibeam sonar and recorded visual survey data have been	(1) All activities shall be completed to the sole satisfaction of the Authority's representative(s) in attendance. (2) The Contractor shall demonstrate prior relevant experience. (3) The Contractor shall ensure that all personnel have the required qualifications, experience, and certifications to undertake tasked activities. (4) With regards to Requirement 3.a (photogrammetric survey via ROV) and 3.b (hull thickness measurements) the strategy is left to the Contractor to propose. The Contractor shall provide a fully reasoned justification for why they have selected a chosen strategy (full photogrammetry, hull thickness measurement methodology and sampling intervals) which shall demonstrate how it will help to achieve the overarching aim of the survey. Namely, to determine the condition of the wreck, the pollutants remaining on it and to inform a subsequent intervention to address these risks should this be required.	The Contractor shall obtain any and all approvals and licences necessary to deliver the requirement and shall arrange and pay for all port fees. The Contractor shall adhere to the Annex of the 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage and any archaeological standards/requirements stipulated by the Estonian National Heritage Board.

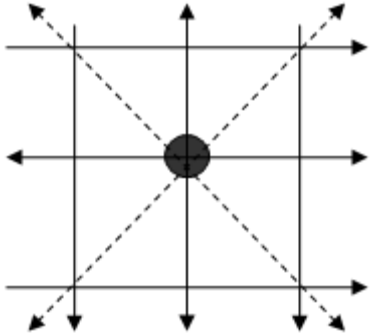
	collected on-site, processing of the data shall be carried out to create a 3D digital model of the wreck. The 3D digital model shall integrate the ship plans of HMS CASSANDRA supplied by the Authority. The 3D digital model shall inform the assessment of oil volumes. Comparison with any previously acquired data on the wreck shall be made to highlight any changes over time and to identify areas of deterioration. (5) The 3D digital model shall be provided to the Authority with a suitable viewer and operating instructions by no later than forty (40) Business Days following completion of the on-site survey. **See Annex A: Required Survey Standard – HMS CASSANDRA** for more detailed survey standards.		
3	Report (1) The Contractor shall provide a comprehensive written report covering all activities undertaken. The report shall include, but not be limited to, the following: a. An expert assessment of the structural condition of the wreck, the likely oil volume remaining and its distribution throughout the wreck. The report shall include a comparison with any previously collected data.	(1) It is essential that the report is provided by no later than forty (40) Business Days following completion of the on-site survey.	

	b. An assessment of the quantity and location of any mercury that may remain on the wreck. c. An assessment of the feasibility of removing any oil and mercury and an evaluation of the options for doing this including full costings. The evaluation shall take account of any challenges posed to the removal of oil/mercury by the provisions in the Annex to the 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage. d. Recommendations for the future management of the wreck. e. An overall appraisal of the survey operation including lessons identified and recommendations for future work of a similar nature. (2) The Contractor shall provide the written report to the Authority by no later than forty (40) Business Days following completion of the on-site survey.		

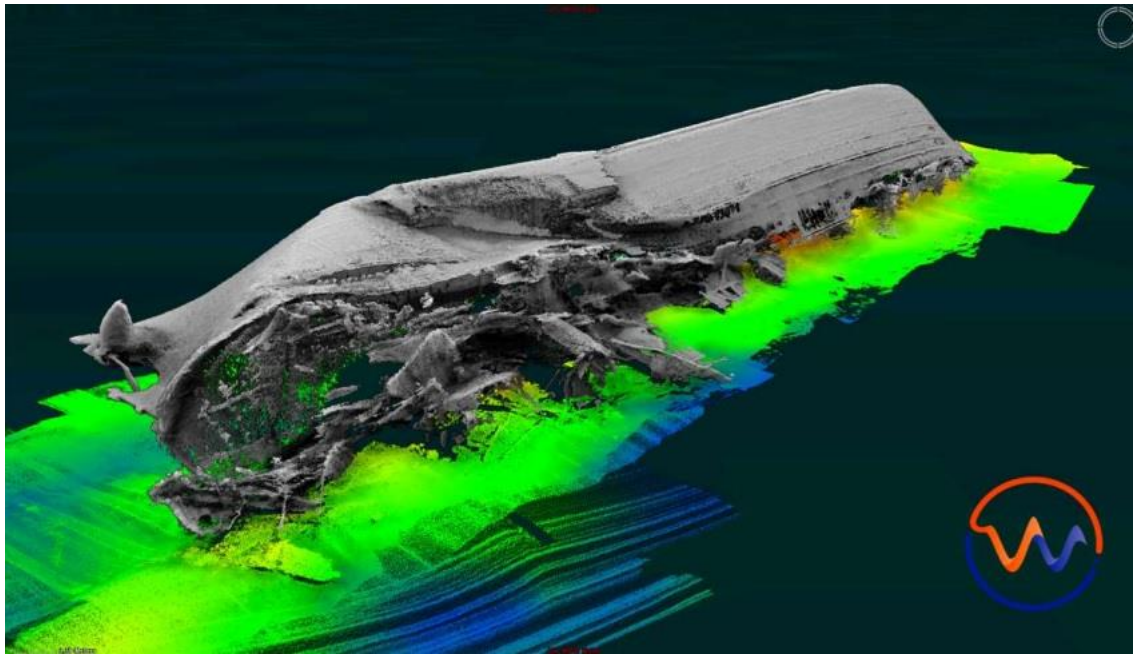
Annex A: Required Survey Standard – HMS CASSANDRA

The primary objective of the multibeam survey element of the requirement is to provide a dense point cloud dataset of the wreck of HMS CASSANDRA from all angles to show as much detail as possible. The survey standard / 3D visualisation requirement is detailed in the table below and illustrated, following the table, by a multibeam echosounder screenshot of a similar wreck obtained using a similar methodology.

1. MULTIBEAM BATHYMETRY		
1.1	**Primary Depth Sensor**	Depth will be measured throughout the survey area using a multibeam bathymetry system capable of meeting all requirements stated below.
1.2	**Uncertainty**	Sounding uncertainty (in three dimensions) shall be in accordance with IHO Order Special Order as defined in IHO S44 Edition 5. Total Horizontal Uncertainty (THU) and Total Vertical Uncertainty (TVU) values must be calculated at / for each valid sounding and be representative of the spread of data. These values must be inclusive of but not limited to the following components: temporal and spatial effects, equipment, systematic and random errors in survey system and platform configurations. The Contractor shall provide a fully developed uncertainty model to the Authority prior to survey operations commencing. The model shall state all component uncertainties, as well as the combined Total Propagated Uncertainty (TPU).
1.3	**Sounding Density**	See Sections 3.5 to 3.7 for details.
1.4	**Acoustic Coverage**	See sections 3.5 to 3.7 for details.
1.5	**Depth Data Precision**	Soundings shall be logged to at least two decimal places of a meter and presented as depths below Chart Datum.
1.6	**Data Cleaning**	All accepted soundings within the final bathymetric dataset shall fall within the IHO Special Order uncertainty allowance or better. All systematic errors and obvious outliers shall be rejected from the bathymetric data. Data points falling within the Special-Order depth requirements but still numerically distant from the main dataset will still be regarded as outliers and should be rejected, but not deleted, from the dataset.
2. GEODESY AND POSITIONING		
2.1	**Survey Geodesy**	Unless otherwise stated, the survey shall be rendered using the following geodetic parameters: Datum: ETRS89 Projection: UTM Grid Zone 34 North All rendered positions shall be quoted as geographical co-ordinates (i.e. in terms of Lat / Long) as degrees and decimal minutes.
2.2	**Horizontal Accuracy**	The Horizontal Accuracy of all depths and positions shall be in accordance with IHO S44 Special Order (5th Edition) or better.
2.3	**Positioning**	Soundings are to be positioned by using dual frequency carrier phase GNSS. Post processed positions should ideally be integrated with the vessel attitude data to avoid bias associated with vessel motion. The Contractor shall demonstrate that the method chosen for sounding positioning results in the overall horizontal uncertainty requirements being met.

		The Contractor shall provide an Ultra short baseline positioning solution (USBL) capable of relaying GNSS position to WROV and of sending and receiving range and bearing measurements to an accuracy of at least 20dB S/N:0,10º and range detection 0.02 m to relate position. This must be fully calibrated and verified (verification to be a required deliverable) before data collection, calibration to be checked pre-acquisition by way of spin check.
3. SURVEY CONTROL AND CALIBRATION		
3.1	**Multibeam Bathymetry Calibration**	A calibration of the multibeam bathymetry system and associated sensors (i.e. "patch test") shall be performed at the start of each survey or after changing out or significantly reconfiguring any survey sensor (methodology shall be detailed in tender). Final post calibration repeatability shall be proven by means of the repeatability test detailed below.
3.2	**Multibeam Bathymetry Repeatability Test**	A multibeam bathymetry repeatability test shall be performed following calibration at the start of each survey or after changing out or significantly reconfiguring any survey sensor (methodology shall be detailed in tender). The test shall monitor the three-dimensional position of a clearly defined small but easily detectable feature on the seabed. The feature should be first surveyed near nadir from multiple directions – as a minimum from north, south, east and west. Secondly the feature should be boxed in, so that it appears in the outer beams on port for 2 lines, and the outer beams on starboard for 2 lines.  The subsequent report should separately state the computed statistical reliability of both the horizontal position and the depth measured for the feature.
3.3	**Vertical Offset Check**	A vertical offset gross error check shall be performed at the start of the survey. The check shall compare the physical measurements of the distance from the primary and secondary GNSS antennas to the USBL head. This shall be performed in one location using a method entirely independent of the vessel's survey systems. These measurements shall be compared to data logged simultaneously in the same location using the vessel's survey system and software.
3.4	**Quality**	The Contractor shall provide a real-time indication of the quality of the 3D position and received augmentation data.
3.5	**Survey Data Coverage**	The survey should utilise multibeam sonar equipment to provide detailed data on the entire wreck structure and surrounding seabed to the full extent of the wreck's debris field.
		The Contractor should maximise data density in order to ensure full and complete ensonification of the wreck to allow assessment to take place. Sufficient data density should be achieved to allow for the production of close, detailed images

		of the wreck structure which will allow for the location, identification, visualisation and quantification of any anomalies including cracks, apertures and collapse.
3.6	**Geo-Referencing**	The wreck and seabed survey must be fully and accurately geo-referenced in a format that will enable detailed analysis and comparisons with previous and future surveys.
3.7	**Seabed Data**	The Contractor should maximise data density in order to ensure full and complete ensonification of the seabed within the full extent of the wreck's debris field to allow assessment and accurate comparisons to take place. This includes the ensonification of loose and isolated wreckage or other objects within the debris field. The seabed data coverage must fully ensonify the level of sediment around the wreck.
4. SURVEY PLATFORM		
4.1	**Remotely Operated Vehicle**	The Contractor should provide a Class 3 WROV that must be capable of holding steady position and heading in currents found in the vicinity of the wreck. The WROV should have a means for managing tether umbilical so that it is does not have any potential of snagging or colliding with the wreck or hampering WROV operations. The WROV must have USBL positioning, accuracy at least 20dB S/N:0,10º and range detection 0.02 m. The WROV must have integrated Doppler Velocity logger (DVL) with Fibre Optic Gyrocompass to provide a velocity bound inertial navigation system. All equipment must be calibrated and is to be verified to the Authority as part of the deliverable. Integration of MBES must be verified and allow for a full swathe of all exposed aspect of the wreck for a comprehensive point cloud.
4.2	**Vessel**	The survey vessel should have appropriate dynamic positioning or other means of maintaining position and heading against current for WROV operations.
4.3	**Survey Planning**	The survey must be planned to gather data in optimal conditions for instance gathering data at slack tides to maintain best position and heading of WROV.



The required 3D visualisation standard of the survey multibeam is illustrated by the screen shot from a previous survey shown above.