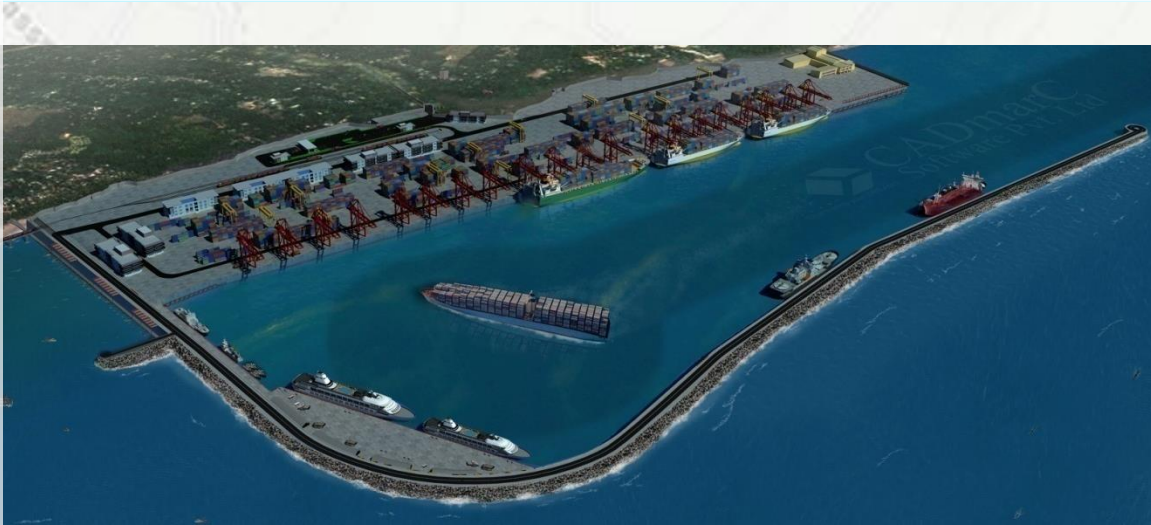




VIZHINJAM INTERNATIONAL SEAPORT LIMITED

GOVERNMENT OF KERALA, THIRUVANANTHAPURAM

MONITORING PLAN FOR VIZHINJAM INTERNATIONAL DEEPWATER MULTIPURPOSE SEAPORT



Comprehensive Long-term Shoreline Monitoring Program

November 2014

Prepared for:
Vizhinjam International Seaport Limited

By:



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TABLE OF CONTENTS

TABLE OF CONTENTS

1	Introduction.....	1
2	Comprehensive Shoreline Monitoring Program.....	1
2.1	Background.....	1
2.2	Study Area	2
2.3	Methodology.....	3
2.3.1	Shoreline monitoring through a combination of (i) beach profiling, (ii) satellite imagery (iii) photography and (iv) bathymetric survey, siltation monitoring & beach sediment analysis	4
2.3.2	Bathymetric survey, siltation monitoring & beach sediment analysis	5
3	Integrated Modelling Study	6
3.1	Data Needs for Integrated Modelling Study	6
4	Scope of Work for Field Data Collection	7
5	Conclusion	7

LIST OF FIGURES

Figure 2-1: Study area showing location of proposed Vizhinjam port (Inverted colour)	3
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1 Introduction

Government of Kerala is planning to develop a Greenfield deep water multipurpose seaport at Vizhinjam (8°22'00"N, 77°00'00"N) in Thiruvananthapuram District of Kerala State. The proposed port will be located to south-east of existing fishing harbour at Vizhinjam. Vizhinjam International Seaport Limited (VISL), which is a fully owned company of the Government of Kerala, has been entrusted with the task of developing the seaport.

Environmental and CRZ clearance for the development of port was issued by the Ministry of Environment and Forest (MoEF) on 3rd January 2014. One of the conditions in the environmental clearance is to carry out intense monitoring with regulatory reporting on shoreline changes due to the development of port. Accordingly VISL has entered into a Memorandum of Understanding (MoU) with National Institute of Ocean Technology (NIOT, Chennai under the Ministry of Earth Sciences, Government of India), to design a Comprehensive Shoreline Monitoring Programme (CSMP) and to provide the guidance and assistance in collection and analysis of field data so as to bring out periodic shoreline reports, (including suggestion of mitigatory measures, if any required) to be submitted to the MoEF. Further with the technical advice of NIOT, the LNTIEL (Formerly L&T-RAMBØLL Consulting Engineering services Limited) has been asked to prepare the proposal and submit for approval. Accordingly this proposal has been prepared and submitted to VISL for taking it forward for implementation.

The following sections give a comprehensive programme for intense long term shoreline monitoring to address the intent of shoreline change monitoring.

2 Comprehensive Shoreline Monitoring Program

2.1 Background

As required under the terms of reference of the Environmental Impact Assessment (EIA) study for the project, VISL conducted a study and prepared a report titled "*Assessment of long term shoreline changes in and around proposed Vizhinjam Port, Kerala*", August 2013. The report prepared in association with Indian National Centre for Ocean Information Sciences (INCOIS, Hyderabad, under the Ministry of Earth Sciences, Government of India) and LNTIEL (Formerly L&T-RAMBØLL Consulting Engineers Ltd) has analysed shore line changes around 15 km on either side (total 30 km stretch) of the proposed Vizhinjam port site using Digital Shoreline Analysis System (DSAS version 3.2) tool with historical satellite images for a period of 20 years from 1992 to 2011. The study concluded that the net changes in the shoreline rate during 1992-2011 period reveals dominantly stable to accreting tendency except a few stretches around Poonthura in the northern part of the study area. It was also reported that the shoreline change rate obtained from the above study correlates well with the observations made in 'Shoreline change assessment of Kerala coast' prepared by National Centre for Sustainable Coastal Management (NCSCM), under the MoEF and the Institute for Ocean Management, Anna University, Chennai.

Further, as required under the terms of reference of the EIA study, VISL through LNTIEL (Formerly L&T-RAMBØLL Consulting Engineers Ltd.) conducted a modelling study and prepared a report titled "*Vizhinjam Model Study*", August 2013". The scope of study also included assessment of shoreline evolution (other scope of study being tranquillity of the fishing harbour & port, hydrodynamics, sedimentation pattern, dredge spoil disposal etc.) due to the development of the project. GENESIS shoreline evolution model was used for the study. The study (of 30 km stretch) concluded that the effect of proposed port on the

shoreline evolution to the north-west of the proposed port is negligible. This is reported to be attributed to the Kovalam headlands having distinct sediment cells (pocket beaches) with cross shore sediment transport and low long shore sediment transport. However, the study projected minor accretion for about 2.6 km to the south east of the port, which will get stabilised within a period of 10 years with cumulative accreted width of about 27 m at the near side of port's outer boundary stabilising to near zero at 2.6 km towards south. The study also recommended monitoring shoreline change during the project development.

MoEF evaluated the above studies and accorded environmental clearance to the project, with a condition for intense monitoring of the shoreline changes and periodic reporting. It is in this context, that VISL entered into an MoU with NIOT to design a Comprehensive Shoreline Monitoring Programme (CSMP) and to provide the guidance and assistance in collection and analysis of field data so as to bring out periodic shoreline reports, (including suggestion of mitigatory measures, if any required) to be submitted to the MoEF.

2.2 Study Area

Considering that the modelling study as part of the EIA has considered 30 km of the shoreline stretch for assessment of the shoreline evolution, the study area for data collection and monitoring has been defined as a unit stretching 30 km with 15 km on either side of the project site (Figure 1). It is noted that two rivers; Karamana (7 km in the North) and Neyyar (10 km in the South) are debouching to the sea within the study area. Considering that there are proposals for fishing harbours at Valiyathura & Poonthura and construction of groins at the Veli river mouth (all on the northern stretch), it would be ideal to extend the data collection of the present monitoring programme to cover this stretch as well, so as to have an integrated modelling study of all these developmental projects to study the effect on the shoreline evolution.

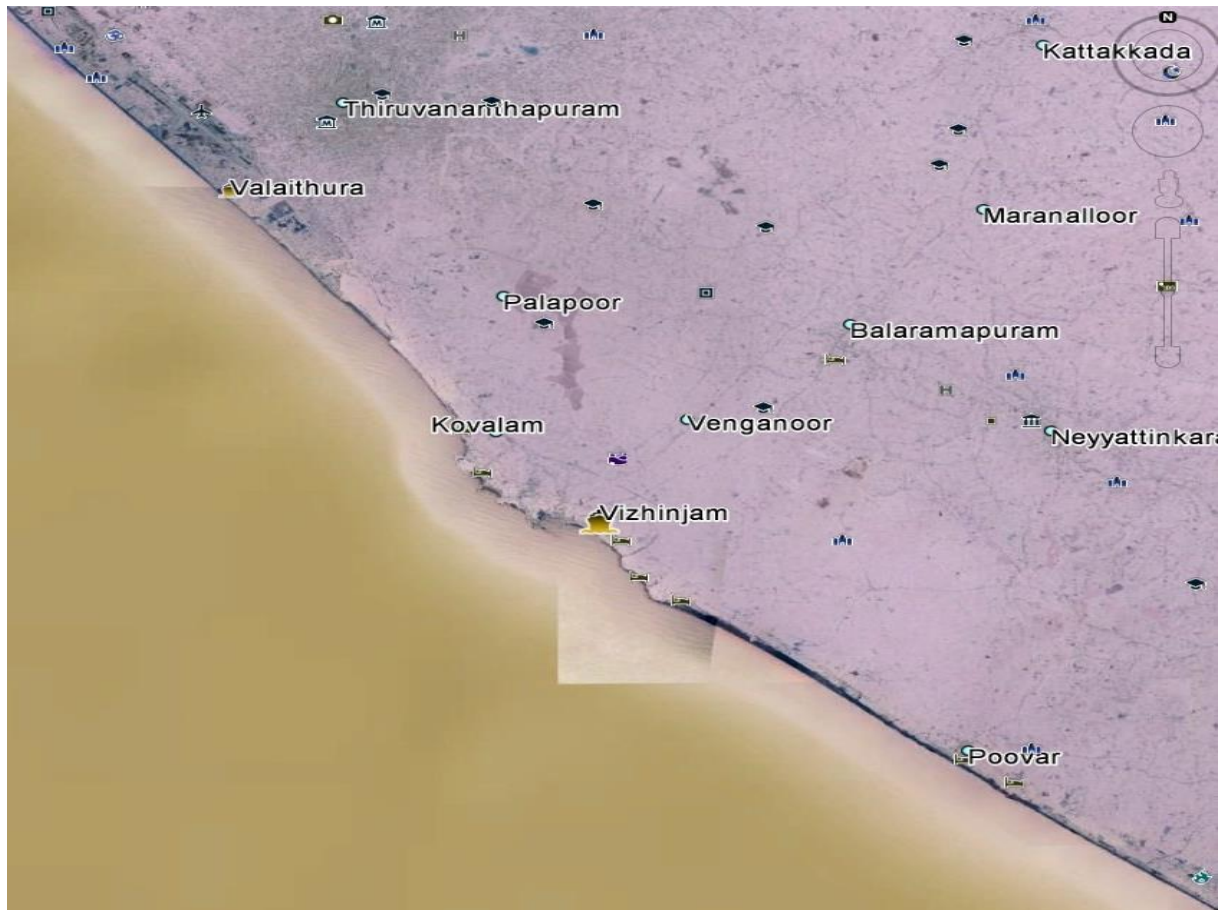


Figure 2-1: Study Area showing location of proposed Vizhinjam Port (Inverted colour)

2.3 Methodology

NIOT will act as the Nodal Agency to provide the guidance for the monitoring programme and also to provide an independent review of the monitoring schemes and findings. All oceanographic and meteorological data required to be collected as per this programme shall be collected by VISL or its port concessionaire under the guidance of NIOT by engaging an experienced marine survey agency. NIOT shall endeavour to procure the required satellite imageries of appropriate resolution of the region and deploy available monitoring equipment [initially a Wave Rider Buoy (WRB) will be deployed] as required under the programme. However VISL or its port concessionaire shall ensure the security and upkeep of the NIOT equipments including data collection through the marine survey agency. Based on the comprehensive baseline data collected for the first year (i.e. pre-construction stage), the modelling study done earlier through LNTIEL (Formerly L&T-RAMBØLL Consulting Engineers Ltd) as part of the EIA study shall be updated. This updation may even consider the other proposed project developments in the region (i.e. fishing harbours at Valiyathura & Poonthura and Construction of groins at the Veli river mouth etc.). NIOT shall provide guidance to VISL and/or its port concessionaire or consultants in collecting and collating the oceanographic & bathymetric data with the modelling results and inter alia with the satellite imagery, so as to bring out periodic shoreline reports, (including suggestion of mitigatory measures, if any required) to be submitted to the MoEF.

2.3.1 Shoreline monitoring through a combination of (i) beach profiling, (ii) satellite imagery (iii) photography and (iv) bathymetric survey, siltation monitoring & beach sediment analysis

Monitoring of shoreline includes monitoring of plan-form changes of shoreline as well as monitoring of changes in the beach profile. Beach profile monitoring is proposed to be carried out by means of a combination of land and bathymetric surveys at regular intervals. Plan-form monitoring is proposed to be carried out by means of satellite imagery and photography. Beach profiling will also provide data on plan-form changes of shorelines. For comparison of the changes the monitoring shall be carried out during the pre-construction, construction and operation stages.

2.3.1.1 Beach profiling

Cross-shore beach profiling shall be carried out perpendicular to the shore from 100m landward of HWL to (-) 10 m CD contour using appropriate methodology for land portion and sea portion. The interval between successive profiles along the shore should be 500 m and the profiling should cover 15 km on the either side of the proposed port (total- 30 km, which may be reviewed as mentioned in 2.2 above). The cross shore beach profile elevation shall be taken at every 5 m interval on the land side using RTK or Total Station. The profile on the sea side shall be obtained from a near shore bathymetry survey using shallow draft boats, sled or any other suitable technique up to (-)10 m CD. The landward and seaward surveys should have continuity to produce a seamless profile.

The beach profiling shall be carried out at specified locations once in a month during the pre-construction, construction and operation stages.

Reference stations are required to provide local bench mark for beach profiling. Reference station shall be established at suitable interval alongshore on a concrete pillar or similar permanent marks and shall be connected to the GTS bench mark. The pillar shall be installed such that same cannot be disturbed easily. The pillar shall be located sufficiently away from the HWL. If required, existing established pillar, rock surface etc., can also be used.

As part of the cross-shore beach profiling, the survey agency shall also carry out monitoring of littoral zone to know the prevailing littoral transport direction and alongshore current speed by means of appropriate drogue observations [using Littoral Environmental Observation (LEO) plates or the like] and visual observations of wave characteristics. These observations shall be carried out at every profile at the time of survey and the frequency shall be same as that of beach profiling.

2.3.1.2 Satellite imagery

Long term shoreline change monitoring shall be carried out using satellite imagery. The interval of monitoring shall be quarterly during pre-construction & construction stages. After port construction, the monitoring shall be carried out for pre and post monsoon satellite imagery. Depending on the availability of monthly satellite data the study methodology shall be reviewed. The requirement to use pre and post monsoon satellite data is to extract maximum accretion and erosion rate prevailing at the project site. Subsequently the monitoring interval can be reviewed and revised depending on the requirement. NIOT shall endeavour to procure the required satellite imageries of appropriate resolution of the region and perform the analysis.

2.3.1.3 Photography

Monitoring shall also include photographic documentation of geo-morphological changes namely the erosion, accretion, seawall failure etc for aiding in impact analysis later. This shall be done at least along with the beach profiling and at every profile. The photographs should be taken from same location with same angle of view and focal lengths during successive surveys for easy comparison of photographs.

2.3.2 Bathymetric survey, siltation monitoring & beach sediment analysis

Bathymetric survey: Bathymetric survey shall be carried out to study the change in seabed level. The baseline survey should commence before the start of port construction. Baseline bathymetry survey shall cover 40 km alongshore (20 km on North and South side of the port) and 15 km offshore. The bathymetric survey lines shall be spaced at 25 m interval up to 20 m water depth (so as to generate contours at 0.5m interval, using multi beam echo sounder) and at 300 m interval for the water depth greater than 20 m,(so as to generate contours at 1.0 m interval, using single beam echo sounder) This shall be carried out just after the monsoon and just prior to the commencement of monsoon to map the variation of seabed profile and to map the line of closure (i.e. location of underwater sand bar).

Seasonal (pre and post monsoon) bathymetric survey inside the fishing harbor and in the stretch between the existing fishing harbor and proposed port and the dredge dumping sites shall be carried out with a line spacing of 25 m. This is required to assess the rate of siltation including generation of 0.5 m contours. All the bathymetry data shall be corrected to reference bench mark using measured tide.

The bathymetry survey will also cover survey of river mouths up to 500 m upstream of river at interval of 100 m.

Siltation monitoring: It is also proposed to carry out grab sample collection and analysis of seabed sediment along with the baseline bathymetric survey for seabed sediment mapping. The grab sampling shall be done in a grid pattern with a tentative grid size of 1 km (total 600 Samples in the pre-construction phase). The collected sediment shall be subjected to sieve analysis and grain size distribution graph shall be prepared. Hydrometer analysis of sediment samples will be carried out when percentage of fine sediments (<75 micron) is greater than 15 percent.

Beach sediment analysis: To understand the changes in beach sediment composition, beach sediment sampling shall be carried out at an interval of 500m along the 30 km stretch (61 Samples) coinciding with the beach profile locations. The samples shall be collected from the water line. The frequency between successive sampling should be about four months. The collected beach sediment shall be subjected to sieve analysis. The grain size distribution graph shall be prepared from the sieve analysis. Hydrometer analysis of sediment samples shall be carried out when percentage of fine sediments (<75 micron) is greater than 15 percent. For the purpose of estimation it is considered that 75% of Samples (45 samples) are <75 micron size.

Water sample analysis: This shall be carried out at four locations:

- (i) fishing harbor
- (ii) Kovalam
- (iii) Poovar/Adimalthura &
- (iv) dredge dumping location

from three depths [(i) surface (ii) mid depth (iii) near bottom] once in all the three seasons in an year to analyse the suspended solids (TSS), salinity, temperature and turbidity.

Construction and operation phase: During the construction and operation phase, shore line monitoring through

- (i) beach profiling,
- (ii) satellite imagery and
- (iii) photography shall be continued as such, whereas
- (iv) the bathymetric survey (pre and post monsoon) & siltation analysis shall be limited to the following locations of the study area; viz:(i) near shore area up to water depth (-) 20 m CD to map the annual variation/drift of line of closure (ii) at the dredge disposal dumping area to assess the dispersion and (iii) inside the fishing harbor, port basin and its vicinity to assess the annual siltation pattern. The beach sediment analysis and water sample analysis shall also be continued as such during the construction and operation phases.

The methodology and parameters for the monitoring shall be reviewed every year for appropriate refinement to achieve the desired objectives.

3 Integrated Modelling Study

Analysis of the shoreline data from site as elucidated above will provide estimates of the ongoing processes. This when correlated with the oceanographic & meteorological data (tide, current, wave, wind data etc.) from the site, will aid in better mathematical interpretation (modelling) of real time site conditions. Further this integrated model could be used for root cause analysis of the coastal process (erosion/accretion) in the region, and for taking considered decisions on

- (i) shoreline/beach nourishment programmes,
- (ii) future expansions of the port development project and also for assessing the combined effect of other projects in the region like (i) fishing harbour at Valiyathura & Poonthura and (ii) groins at Veli river mouth.

3.1 Data Needs for Integrated Modelling Study

The modelling study carried out as part of the EIA study through LNTIEL shall be updated and validated to bring out an integrated model for the purposes mentioned above. For the same the following data needs to be collected during the pre-construction, construction and operation periods.

- (i) Current measurements: This shall be collected from four locations [(a) at Vizhinjam project site (b) off Karamana river mouth/Poonthura (c) Fishing harbour entrance (d) south east of the proposed port (Neyyar river mouth)] for 30 days each in all the three seasons of the year.
- (ii) Wave measurements: This shall be collected at one location, i.e. at the project site at Vizhinjam year round (365 days).
- (iii) Tide measurements: This shall be collected at one location, i.e. at the project site at Vizhinjam year round (365 days).
- (iv) Wind speed & direction, atmospheric pressure, humidity and temperature: This shall be collected at one location, i.e. at the project site at Vizhinjam year round (365 days).

4 Scope of Work for Field Data Collection

Based on the methodology discussed in the preceding sections a detailed scope of work including the specifications for field data collection is attached as **Appendix 1**.

5 Conclusion

The whole purpose of the monitoring is to understand the hydrodynamic and shoreline behavior of the project study area during construction and operation phases of the project. The close monitoring will help to pinpoint the cause effect relationship and sustainable management of the coastline on a long term basis, which ultimately can be replicated in other areas where ever required.

APPENDIX

TABLE OF CONTENTS

1	Introduction.....	1
1.1	Project Background.....	1
1.2	Project Site.....	1
2	Scope of Work.....	1
3	Equipment/Methodology.....	3
3.1	Vessel	3
3.2	Positioning.....	3
3.3	Current Meter	3
3.4	Wave Measurement.....	4
3.5	Tide Gauge	4
3.6	Automatic Weather Station	5
3.7	Cross shore beach profiling survey using RTK or Total Station	5
3.8	Littoral environment observations	5
3.9	Beach sediment sampling and analysis.....	5
3.10	Bathymetric survey	6
3.11	Sea bed sediment sampling and analysis	6
3.12	Water sampling and analysis	6
4	Personnel	6
5	Equipment Calibrations	7
6	Previous Experience	7
7	Reports	8
8	Time of Completion	8
9	Schedule of Quantities.....	9

LIST OF FIGURES

Figure 1:	Location of Port Site.....	2
Figure 2:	Tentative Locations of Current Meters (P1, P2, P3) and wave measurement	2
Figure 3:	Tentative locations for Water Sampling	3

1 Introduction

1.1 Project Background

The Government of Kerala (GoK) has decided to set up a Greenfield modern Deepwater multipurpose port at Vizhinjam, near Thiruvananthapuram, the capital city of Kerala. Vizhinjam International Seaport Limited (VISL) (the “Client”) is a special purpose government company (fully owned by Government of Kerala) that acts as an implementing agency for the development of this Greenfield port.

The project obtained Environmental & CRZ Clearance (“EC”) from the Ministry of Environment & Forests (MoEF), Government of India (GoI) on 3rd January 2014, wherein it has been specified to carry out intense monitoring and regulatory reporting of the shoreline changes in the project area. Accordingly VISL intends to collect the baseline data of the shoreline including the seasonal bathymetry to document the present status of shoreline dynamics.

1.2 Project Site

The port location is at Vizhinjam (Lat 8° 22' N, Long 76° 57' E), located 16 km south of Thiruvananthapuram. The location plan of port site is shown in **Figure 1** attached.

Objective

The main objective of the study is to determine:

- Seasonal mapping of shoreline / near shore underwater sand bar including bathymetry
- Beach and sea bed sediment analysis including turbidity
- Current variation in terms of velocity and direction in four locations in the study area (30 days each in three seasons at three locations & year round at one location)
- Wave Observations at one location for the entire year covering all the seasonal variations
- The tidal variation at one location for entire year covering all seasons
- Wind speed & direction, atmospheric pressure, humidity and temperature at one location for one year covering all seasons

2 Scope of Work

Scope of work in general for the survey is given below. More specific details can be found under the section Equipment/ Methodology and Annexure 7-Schedule of Quantities.

1. Shore line change study area in general is tentatively fixed for a length of 30 Km, with 15 Km each on either side of the proposed port project site, with bathymetry data collection from 600 sqkm area, covering 40 Km alongshore and 15 km offshore.
2. Monthly cross shore beach profiling perpendicular to the shoreline for 30 Km stretch at an interval of 500m, using RTK or total station for land side up to 100m from HWL and using shallow draft boats, sled or any other suitable techniques for sea side up to 10m CD
3. Monthly monitoring of littoral zone (at the cross shore beach profiling locations) to observe the littoral transport direction and alongshore current speed by means of appropriate drogoue observations and visual observations.
4. Monthly photographic documentation of geomorphological changes (at the cross shore beach profiling locations)

5. Seasonal beach sediment sampling and analysis (at the cross shore beach profiling locations)
6. Bathymetry survey in an area of 600 sqkm (40 KmX15 Km) twice in a year i.e. Just after the monsoon season and just prior to the commencement of monsoon to generate 0.5m contours (with bathymetric survey lines spaced at 25 m interval) in areas having depth up to 20m CD using Multibeam echosounder and 1 m contour (with bathymetric survey lines spaced at 300 m interval) in areas having depth greater than 20m CD at a spacing of 300m using single beam echosounder
7. Bathymetry / cross section survey for 500m length of rivers debouching in 40 Km stretch of the sea
8. Seabed sediment sampling and analysis in 600 sq.km with one sample per sq.km
9. Collection and analysis of water samples at specified periods (seasonal) for TSS and turbidity from four specified locations
10. Current measurements (both magnitude and direction) using Acoustic Doppler Current Profiler (ADCP) at four locations, as marked in the attached Figure 002, for the duration of full tidal cycle/30 days each during monsoon (June-Oct), post-monsoon (Nov-Feb) and summer months (Mar-May). ADCP shall be configured to profile the currents throughout the water column. The current meters shall be properly configured/installed and moored in the position stipulated with a watch boat for guarding the same. The exact locations will be indicated by the Engineer In-Charge (EIC) before the commencement of the survey. The Client / EIC reserve the right to specify the location of its choice and also to increase/ curtail the data collection period(s). Current observations shall be recorded and analysed using standard software. In case, the Contractor finds after retrieval of the current meters that no data / faulty data has been recorded, he shall reinstall the current meters and obtain the data properly at no extra cost to the Client.
11. Wave observations using WRB shall be carried out at one location as marked in the attached Figure 002, for one full year including the full South-West and North-East monsoon seasons. The WRB shall be properly configured/installed and moored in the position stipulated with a watch boat for guarding the same. The exact locations will be indicated by the EIC before the commencement of the surveys. The Client / EIC reserve the right to specify the location of its choice and also to increase/ curtail the data collection period(s). Wave observations shall be recorded and analysed using standard software. In case, the Contractor finds after retrieval of the wave observation instrument that no data / faulty data has been recorded, he shall reinstall the instruments and obtain the data properly at no extra cost to the Client.
12. Tide measurements using an automatic tide gauge close to the survey area to observe the tidal variations round the clock at 10 minute intervals or as specified to cover one full year. The Client / EIC reserve the right to specify the location of its choice and also to increase/ curtail the data collection period(s). Data will be analysed for deriving tidal constituents. These tidal corrections shall be applied to reduce the soundings to Chart Datum. The tide gauge shall be connected to the nearest Survey of India Bench Mark. The data shall be used to derive the Harmonic Constituents.
13. Collection of wind speed & direction, atmospheric pressure, humidity and temperature at one location specified by the client/EIC by establishing an Automatic Weather Station to cover one full year.
14. Analysis and processing of the data and submission of periodic reports in soft & hard copies

3 Equipment/Methodology

All the survey equipments proposed to be deployed in the assignment shall have hundred percent back up. All equipments shall be tested and calibrated in accordance with the quality procedures as recommended by the manufacturer to ensure that the equipment provides consistent and reliable data during the course of measurement.

All key equipments shall have necessary spare parts on board to keep the down time during the measurement to the barest minimum.

3.1 Vessel

The Contractor shall mobilise suitable survey vessels capable of operating in the proposed area of survey work and during proposed seasons.

There shall be sufficient clear deck space for preparation, lowering and retrieving / trailing of survey instruments like tide gauge and installation of current meters.

There shall be sufficient covered space to install and operate positioning system.

The survey vessels shall have a boom or other suitable device with necessary winch of sufficient capacity to handle, installation / retrieving current meters.

Propeller noise, electrical noise and generator noise shall not cause any interference with recording equipment and sensors and in turn shall not reflect on quality of the data.

The Contractor shall mention the specifications and the details of the equipment and vessel/small boat to be mobilized.

3.2 Positioning

The Contractor shall mobilize a Differential Global Positioning System (DGPS). The specifications for the system are as follows:

- A mobile DGPS unit of 12 channels/with Radio Beacon receiver shall be mounted on the survey vessel. The mobile unit shall be equipped with a computer / microprocessor with standard navigation software for online navigation, pre & post-plotting on UTM or spherical grid. The DGPS system shall be capable of providing positional accuracy of at least 2m. The position spread shall be demonstrated once by the contractor by installing the DGPS on ground (location to be mutually agreeable for client and contractor) for at least one hour before installing at boat.
- All instruments (Current meters, tide gauges and wave observation systems) shall be synchronized with GPS time using appropriate setup programs supplied with the instruments. The internal clocks of such systems shall be matched within 5 seconds to GPS receiver time.

3.3 Current Meter

The Contractor shall mobilize and install self-recording Acoustic Doppler Current Profiler (ADCP) including mooring materials with sufficient back up / spares to record the current speed and directions, water temperature and conductivity at specified locations.

Current meters shall be moored at observation locations in 'U' mooring configuration or as approved by EIC. Prior to mooring, the instruments shall be set to match with GPS time frame. Data storage units shall be cleared of previous recordings (if any) and annotated with details like station name, current meter identification, location, starting time interval of

observation etc. as per field log sheet. All instruments need to be started simultaneously to align with common observation time marks.

The sampling rates of all the current meters are required to be configured to 2 Hz with burst duration of 1 minute and recording interval of 10 minutes. Thus, a current speed and direction value recorded once in 10 minutes is the average of 120 samples measured during 1 minute period.

The tentative locations of the current meter installation are as below:

Current Meters	Longitude	Latitude
P1	76°58'58.70"E	8°22'6.42"N
P2	77° 3'55.54"E	8°18'0.35"N
P3	76°56'28.57"E	8°25'1.20"N
P4	76°59'25.84"E	8°21'43.12"N

3.4 Wave Measurement

The Contractor shall mobilize and install a self-recording instrument including mooring materials with sufficient back up / for measuring the wave parameters. The wave and current shall be measured by installing a WRB at one location.

The instrument shall be configured to record directional wave data for 20-minute duration once every 3 hours or as instructed. Wave parameters shall be recorded as wave height, wave period, and wave direction.

Data will be retrieved from the monitoring equipment on a monthly basis. The contractor shall submit full detailed deployment logs that include instrument configuration parameters, instrument in water times, and other information specified by the Client/EIC. The recorded data will be submitted to the Client/EIC on a monthly basis in both processed and raw data formats. Data shall be processed as per manufacturer's recommendations using instrument specific software and should exclude effects of tides, swells etc., as the case be.

The tentative location for wave and current is as below:

Wave Observation	Longitude	Latitude
Location	76°59'25.84"E	8°21'43.12"N

3.5 Tide Gauge

The Contractor shall mobilize and install automatic tide gauge including all accessories, etc. This shall be monitored periodically and data downloaded.

It is advised that contractor shall use latest Automatic Tide Gauge (ATG) with self-reporting facilities like Radar Level Sensors/ Valeport 740 pressure gauge or equivalent.

The sampling rates of the all tide gauges are required to be configured to 2 Hz with a burst sampling of 1 minute and 10 minute interval.

All the tide measurements are required to be reduced to Mean Sea level referred to permanent bench marks established by Survey of India (Sol). Hence, the contractor should make one temporary bench mark near the tide gauge locations based on the vertical control survey and connected to the Sol bench mark. The tide gauge sensor levels also to be connected to the established temporary bench marks to measure the accurate water level variation with respect to the mean sea level.

3.6 Automatic Weather Station

The contractor shall mobilise and install an Automatic Weather Station (AWS) with sufficient back up to collect wind speed & direction, atmospheric pressure, humidity and temperature at one location specified by EIC. The AWS shall be configured to 2 Hz with a burst sampling of 1 minute and 10 minute interval. The AWS shall be powered using a solar panel and shall be installed in an area which is free of any obstructions.

Data will be retrieved from the AWS on a monthly basis. The contractor shall submit full detailed deployment logs that include instrument configuration parameters and other information specified by the Client/EIC. The recorded data will be submitted to the Client/EIC on a monthly basis in both processed and raw data formats. Data shall be processed as per manufacturer's recommendations using instrument specific software and should include wind gusts. Height of the instrument above MSL and the local ground level shall also be recorded.

3.7 Cross shore beach profiling survey using RTK or Total Station

Contractor shall mobilize suitable RTK units to carry out the cross shore beach profiling at the specified intervals. The values should be connected to the local reference stations, along the shore which shall be connected to chart datum with an accuracy of $\pm 1\text{cm}$. Cross-shore beach profiling shall be executed perpendicular to the shore from 100m landward of high water line to 10m CD contour using appropriate methodology for land portion and sea portion for a length of 30km (15 km on either side of proposed port), with an interval 500m between successive profiles, to be carried out once in every month for a period of one year. The cross shore beach profile elevation to be taken at every 5m interval on the land side using RTK or Total Station. The profile on the sea side shall be obtained from a near shore bathymetry survey using shallow draft boats, sled or any other suitable technique up to 10m CD. The landward and seaward surveys should have continuity to produce a seamless profile.

3.8 Littoral environment observations

Contractor shall make littoral environment observations at the cross shore beach profiling locations every month at the time of beach profiling. The littoral currents shall be recorded by deploying suitable drogues in the littoral zone and visually observing its direction of travel and distance covered at regular intervals of 5 minutes for 30 minutes. Wave heights, breaker heights, breaker distance from the water line, direction of the waves, wave period, surf zone width etc. during this time shall also be observed and recorded at every beach profiling location.

3.9 Beach sediment sampling and analysis

Beach sediments shall be collected at an interval of 500m along the 30 km stretch coinciding with the beach profile locations (to be taken at the time of cross shore beach profiling but once in 4 months x 3 seasons). The samples shall be collected from the water line. The

frequency between successive sampling should be about four months. The collected beach sediment shall be subjected to sieve analysis. The grain size distribution graph shall be prepared from the sieve analysis. Hydrometer analysis of sediment samples shall be carried out when percentage of fine sediments (<75 micron) is greater than 15 percent. The analysis shall be carried out at reputed lab with accreditation.

3.10 Bathymetric survey

Baseline bathymetry survey using a combination of Multi Beam Echo Sounder (MBES) and Single Beam Echo Sounder (SBES) covering an area of 600 sqkm with 40 km alongshore (20 km on North and South side of the port location) and 15 km offshore shall be carried out as follows:

1. Bathymetric survey using MBES with lines spaced at 25 m interval or appropriate (to get 100% coverage/0.5 metre contours) to cover (a) the entire area within the existing Vizhinjam fishing harbour (b) the area between the existing fishing harbour and the proposed port (c) the area up to 20m contour depth and (d) about 4 sqkm extent of offshore dredge disposal sites (all within the 600 sqkm survey area)
2. Bathymetry and cross section survey of streams/rivers debouching into the sea in 40 Km stretch (20km on North & South side of proposed port location) up to 500 m upstream of river at interval of 100 m.
3. Bathymetric survey using SBES with lines spaced at 300 m interval (to generate 1m contour) for depths greater than 20 m contour.

The works are to be carried out, twice in a year i.e. (i) just after monsoon season and (ii) just before commencement of monsoon season. The objective of carrying out Multibeam survey is to estimate the near shore underwater sand bar formation. The collected data is to be corrected using observed tides and all raw and processed data as per the required format shall be handed over to the EIC. The contractor should submit the planned survey lines prior to the start of the survey and get it approved by EIC.

3.11 Sea bed sediment sampling and analysis

Seabed samples shall be collected using a van veen grab sampler in a grid pattern size of 1km (total 600 Samples) along with bathymetric survey, but only once in the study period. The samples shall be subjected to sieve analysis & preparation of grain size distribution graph and hydrometer analysis of sediment samples when percentage of fine sediments (<75 micron) is greater than 15 percent.

3.12 Water sampling and analysis

Water samples from three levels viz. Near surface, Mid depth and Near bottom shall be collected from 4 locations specified by EIC. ((i) Fishing harbour (ii) Kovalam (iii) Poovar/Adimalathura (iv) Dredge Dumping location) from 0700 hrs to 1700 hrs on a hourly basis. The samples shall be collected using a 5 litre Niskin water sampler. The samples shall be analysed for salinity, turbidity and total suspended solids at a reputed laboratory. The temperature at the time of sampling shall also be recorded.

4 Personnel

The Contractor shall provide necessary experienced personnel for operation of the survey equipment onboard the vessel.

The Contractor shall provide one experienced Oceanographer, during the entire period of the survey, with a Masters degree in Ocean Sciences/ Oceanography and at least 10 years of experience in handling these kinds of projects. He shall be responsible for operation of the positioning system and survey equipment onboard the vessel, and for preparation of observation plan, mooring details, installation at site, data retrieval and processing the data.

Hydrographic Surveyor with relevant experience in acquiring bathymetric data shall also be provided. The Contractor shall provide the necessary personnel / logistic supports for smooth operation of shore stations including local transport, etc.

5 Equipment Calibrations

The Contractor shall carry out calibration / checks / trials of all survey equipment in the field and obtain necessary approvals for the start of operations from the EIC at site. The contractor must provide the calibration certificate from the OEM of each equipment's used for this measurement programme. The contractor shall submit the log sheets in the prescribed format (sample log sheets enclosed as Annexure 1 to 6) describing all activities of calibration, preparation, deployment, retrieval and data processing. The contractor shall prepare a procedure document that covers proposed methodology of fulfilling the requirements (calibrations, deployment, retrieval and data processing). The log sheets may be modified to suit the site conditions and equipment specifications. The procedure document shall be submitted to EIC for approval before deployment.

6 Previous Experience

The contractor should have sufficient experience in executing these kinds of projects in India or abroad.

The contractor is required to submit a comprehensive but concise technical proposal (both as soft copy& hard copy) based on the information presented herein. The proposal should contain, but not be limited to, the following information:

- **Corporate Credentials:** Present the contractor's corporate qualifications and experiences of completing projects similar in type, magnitude, and duration to that being considered under this solicitation. Particular emphasis needs to be placed on describing corporate experience in India and carrying out similar studies.
- **Team Members, Credentials, and Organization:** Identify and present the organization of the proposed team, the location of team members, and qualifications and experience of key team members.
- **Management Approach:** Describe the Agency's proposed management approach for the project, including cost control and procurement strategies and approaches. Also, describe additional data needs of the agency from VISL.
- **Project Approach:** Include a Project Work Plan outline and a rough plan of the study approach for each project task to be studied that describe proposed strategies for achieving the objectives of the efforts.
- **Project Schedule:** Include a project schedule to execute the statement of work presented above.

The survey contractor shall be qualified based on the above and based on the financial capacity of the company. The company shall provide the audited financial accounts for the last 5 years along with the bid. An average turnover for the last 5 years would be at least INR 20 Crores.

7 Reports

Draft and final reports shall be prepared as per specifications / requirements mentioned in section 2.0 in addition to the following specific requirements.

- The Contractor shall process and submit reports on completion of data collection of the respective seasons
- The Contractor shall process and prepare a consolidated final report on completion of the entire studies. The report shall include the details of field surveys for the current, tidal and wave observations. Harmonic analysis of tidal data to be carried out for deriving harmonic constituents. Graphs of cumulative and monthly wave rose are to be prepared. Statistical summary table of all wave parameters are to be provided.
- All log sheets (based on attached samples in annexure) shall be filled, duly signed and enclosed as part of Final Report.
- The contractor should provide the beach profiles, LEO observation details in ASCII or excel format
- The contractor shall provide the time series data in soft copy (Excel format) in the following manner
 - Current data: (time [dd/mmm/yyyyhh:mm], current speed in meter/sec, current direction in degrees w.r.t north)
 - Wave data : (time [dd/mmm/yyyy hh:mm], significant wave height (Hs), peak wave period (Tp), mean wave period (T01 and/or T02), mean wave direction in degrees w.r.t. north(MWD))
 - Tide data : (time [dd/mmm/yyyy hh:mm], tidal level in meter w.r.t MSL or CD)
 - Wind data: (time [dd/mmm/yyyy hh:mm], wind speed, gust & direction)
 - Atmospheric pressure data:(time [dd/mmm/yyyy hh:mm], pressure in mb)
 - Humidity data:(time [dd/mmm/yyyy hh:mm], relative humidity in %)
 - Temperature data:(time [dd/mmm/yyyy hh:mm], temperature in deg C)
- The contractor shall submit 5 hard and one soft copy of the reports and all raw data collected.

8 Time of Completion

Time is essence of the contract. The work shall be executed strictly as per time schedule indicated below:

Mobilization	1 week from LOI
Complete Oceanographic Field work	4 week after mobilization for the respective seasons
Beach profiles	End of every month
Complete first season Bathymetric Survey	8 weeks after mobilization
Draft Analysis and Reports	1 week after field work of respective investigation for the respective seasons
Final survey report	Within 1 week on receipt of comments on the Draft Report for the respective seasons
Consolidated Survey Report	On completion of the all season (1 year) work

The comments on the draft survey report are expected to be furnished within 7 days on receipt.

9 Schedule of Quantities

The schedule of quantities is attached separately as Annexure 7.

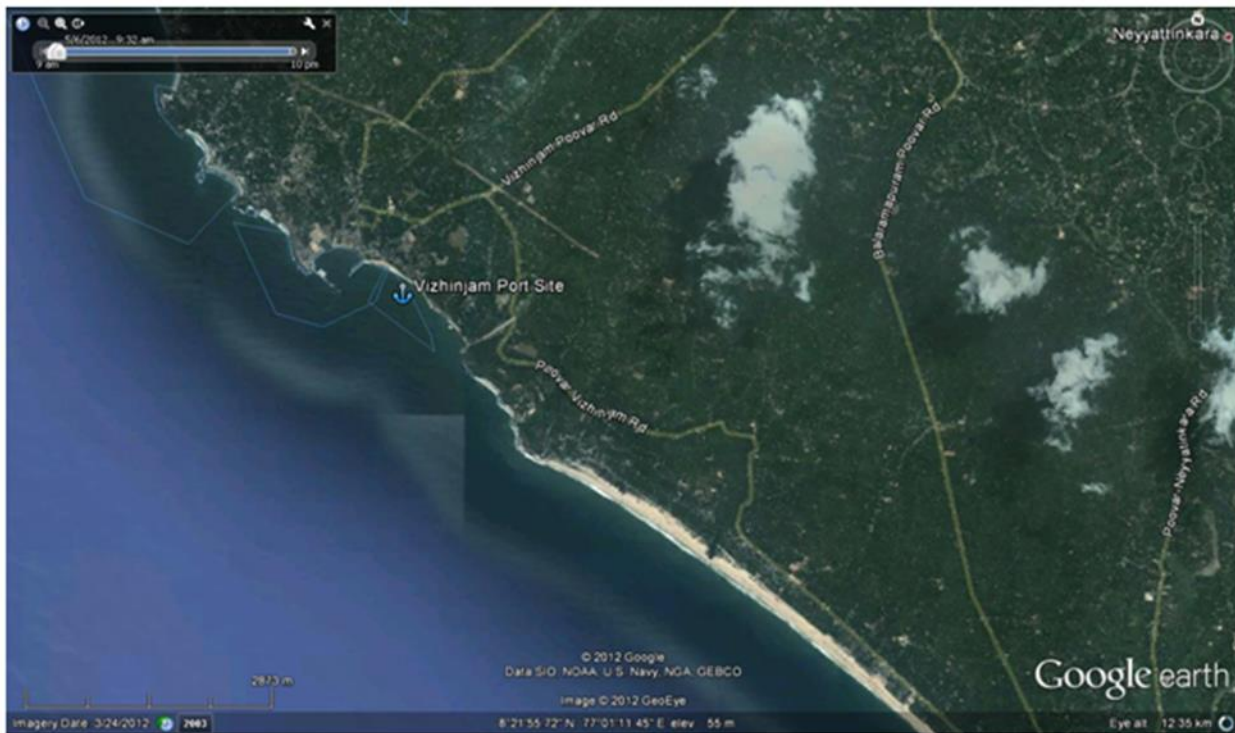


Figure 1: Location of Port Site



Figure 2: Tentative Locations of Current Meters (P1, P2, P3) and wave measurement

- P1- Fishing harbour entrance
- P2- South-East of the proposed port (Neyyar river mouth)
- P3- Off Karamana River mouth/ Poonthura
- P4- Wave and current- Near Project Site



Figure 3: Tentative locations for Water Sampling

- L1- Fishing harbor
- L2- Kovalam
- L3 – Poovar
- L4- Dredge dumping location

ANNEXURE

TABLE OF CONTENTS

Annexure 1	Sample Tide Gauge Functionality Test	1
Annexure 2	Sample Current Meter Functionality test	3
Annexure 4	Sample Field Log for Tidal Observation.....	4
Annexure 5	Sample Checklist for Current Observation (before deployment)	6
Annexure 6	Sample Checklist for Current Meter (During deployment)	7
Annexure 8	Sample Checklist for AWS.....	8
Annexure 9	Schedule of Quantities.....	9

Annexure 1 Sample Tide Gauge Functionality Test

Project:		Functionality test site:		Date:	
Functionality test Leader name					
Pre-installation check/Functionality sheet					
S. No.	Description	Remarks			
1.	Instrument type/Make				
2.	Instrument S/N				
3.	Sensors connected				
4.	Checking of O ring and Starting Plug pin				
5.	Synchronise the Internal memory time with GPS Time (PC/Laptop time) prior to Functionality test				
6.	Battery Voltage (both instrument and internal memory)				
7.	Internal memory status				
8.	Baud rate/sampling interval/sampling time				
9.	Functionality Test (Air and water drum) Reading should be at different levels of water depth(1m, 2m, 5m.... etc)	Instrument actual depth	Atmo. Pressure (dBar)	Total Pressure (dBar)	Difference between Total and Atmo. Pressure (error)
		In Air			
		0 m			
		1 m			
		2 m			
		5 m			
10.	Functionality test report (error is within the acceptable range i.e. <+ 0.1)				
11.	Temperature data at air and water				

12.	Synchronise the Internal memory time with GPS Time (PC/Laptop time) after retrieval and Indicate time at reset and differences	
13.	Store the functionality test results in file name e.gT/G SIno_date.BIN (test raw data for future reference)	

N.B-Attach a Xerox copy of Instrument test certificate issued by the dealer/company along with this sheet.

Signature of Functionality Test Leader:

Project:	Functionality test site:	Date:		
Functionality Test Leader Name				
Pre-installation check/Functionality sheet				
S. No.	Instrument description	Remarks		
1.	Instrument type/Make/S. No.			
2.	Battery type/Voltage			
3.	Data recording interval/format			
4.	Ping number			
5.	Sound speed			
6.	Cell start			
7.	Cell size			
8.	Operation set up Burst mode: Tilt compensation: ZPulse active:			

Signature of Functionality Test Leader(s):

Annexure 3 Sample Field Log for Tidal Observation

Project: Installation site :		Date:		
Party Chief:		Installation Team Leader		
S. No	Description	Yes		Remarks
1.	Pre-installation			
	Site is suitable for observing tidal elevation in an unbiased manner (e.g. Not impounded water)			
	Installation diagram is prepared and enclosed			
	Mounting is rigid			
	Logger is secure from direct sunlight and rain			
	Level transfer from reference bench mark to installation is complete			
	Offsets from local BM to sensor head is measured and verified			
	Final reduced level of sensor (m)			
	Levelling observation, station description, BM description to be enclosed with diagrams where ever needed.			
2.	Installation			
	TG S/N with Model			
	Tide gauge is checked for any transport related damages			
	Lab calibration is complete			
	Site calibration is complete (attach calibration sheet separately)			
	Erase the data from memory			
	Synchronise the Internal clock with GPS Time in IST			Indicate the time of reset and differences
3.	Interval setting for recording/measuring			Indicate interval in minutes
4.	Other Sensor setting if required (burst length, rate, etc)			
5.	Initiate observation (Remove the dummy plug pin)			Indicate time of start
6.	Check for atleast two cycles of measurement			

7.	Switch on [indicate start time – aligned with common time marks with]			
8.	Post Retrieval			
	Retrieval Date and Time			
	Check for damages or external marks and record			
	Record the TG S/N and Model			
	Download the Data from Internal memory			
	Data processing and Analysis and transform to ASCII format			
	Final file name and archive address			
	Functionality Test (using ATF/ water drum)			

Annexure 4 Sample Checklist for Current Observation (before deployment)

S. No	Description	Yes	No	Remarks
1.	Station ID.			
2.	ADCP S/N			
3.	Battery Voltage			
4.	Properly greased			
5.	O ring			
6.	Functionality Test			
7.	Store the functionality test results			
8.	Erase previous data			
9.	Synchronise ADCP time with GPS Time			
10.	Interval setting for recording/measuring			
11.	Other Sensor setting if required			
12.	Switch on [indicate start time – aligned with common time marks with]			

Annexure 5 Sample Checklist for Current Meter (During deployment)

S. No	Description	Yes	No	Remarks
1.	Casing fitting with proper O ring and C-clamps			
2.	Mooring Frame fitted with Equipment			
3.	Proper sinker weight with PP rope			
4.	Deployment type (from floating platform, I-mooring, U-mooring.)			
5.	Watch keeping Boat name			
6.	Planned Coordinates (Latitude, Longitude)			
7.	Deployment Coordinates (Latitude, Longitude)			
8.	Regular check to be made to confirm moorings are in proper place			

Signature [Site-in-charge]

Date:

Annexure 6 Sample Checklist for AWS

Project: Installation site :		Date:		
Party Chief:		Installation Team Leader		
S. No	Description	Yes	No	Remarks
1.	Pre-installation			
	Site is suitable for observing weather parameters			
	Installation diagram is prepared and enclosed			
	Mounting is rigid			
2.	Installation			
	AWS S/N and model			
	AWS is checked for any transport related damages			
	Erase the data from memory & Synchronise the Internal clock with GPS Time in IST			Indicate the time of reset and differences
3.	Interval setting for recording/measuring			Indicate interval in minutes
4.	Other Sensor setting if required (burst length, rate, etc)			
5.	Check for at least two cycles of measurement			
6.	Switch on [indicate start time – aligned with common time marks with]			
7.	Post Retrieval			
	Retrieval Date and Time			
	Check for damages or external marks and record			
	Record the AWS S/N and Model			
	Download the Data from Internal memory			
	Data processing and Analysis and transform to ASCII format			
	Final file name and archive address			

Signature [Site-in-charge]

Date :

Annexure 7 Schedule of Quantities

#	Details	Quantity	Unit
1	Submission of inception report on mobilization of suitable sea going vessel with adequate endurance and fully equipped with positioning system along with deployment of survey/monitoring instruments etc. at Vizhinjamport project site, to complete the survey as per specifications including the cost of personnel, travel, boarding, lodging, clearances, approvals etc. all complete as per the requirements and instructions of the Client/EIC.	1	Lump Sum
2	Cross Shore Profiling		
2.1	Establishment and maintenance of reference stations at an interval of 1km or appropriate along the 30 Km coastline (15km on either side of the proposed project site) on concrete/ stone pillars/ rock surfaces or by other suitable means at suitable interval alongshore required to provide local bench mark for beach profiling and connected to the nearest available GTS bench mark. (The pillar shall be established sufficiently away from the HWL and at locations that cannot be disturbed easily. The levels shall be periodically checked with GTS benchmark for correctness).	31	Reference stations
2.2	Cross-shore beach profiling perpendicular to the shore from 100m landward of HWL to 10m CD contour using appropriate methodology for land portion and sea portion for a length of 30km (15 km on either side of proposed port), with an interval 500m between successive profiles, to be carried out once in every month for a period of one year. The cross shore beach profile elevation to be taken at every 5m interval on the land side using RTK or Total Station. The profile on the sea side shall be obtained from a near shore bathymetry survey using shallow draft boats, sled or any other suitable technique up to 10m CD. The landward and seaward surveys should have continuity to produce a seamless profile. (61 cross sections/month X 12 months= 732)	732	Cross sections
2.3	Monitoring of littoral zone to know the prevailing littoral transport direction and alongshore current speed by means of appropriate drogue observations and visual observations of wave characteristics, to be carried out at each cross shore beach profile at the time of cross shore beach profiling under item (2.2) above. (61 cross section locations X12 months=732)	732	locations
2.4	Photographic documentation of geo-morphological changes like erosion, accretion, seawall failure with date and time at each cross shore profiling locations (to be taken at the time of cross shore beach profiling under item (2.2) above) or at other potential locations of dynamic shoreline. (The photographs to be taken from same location with same angle of	732	locations

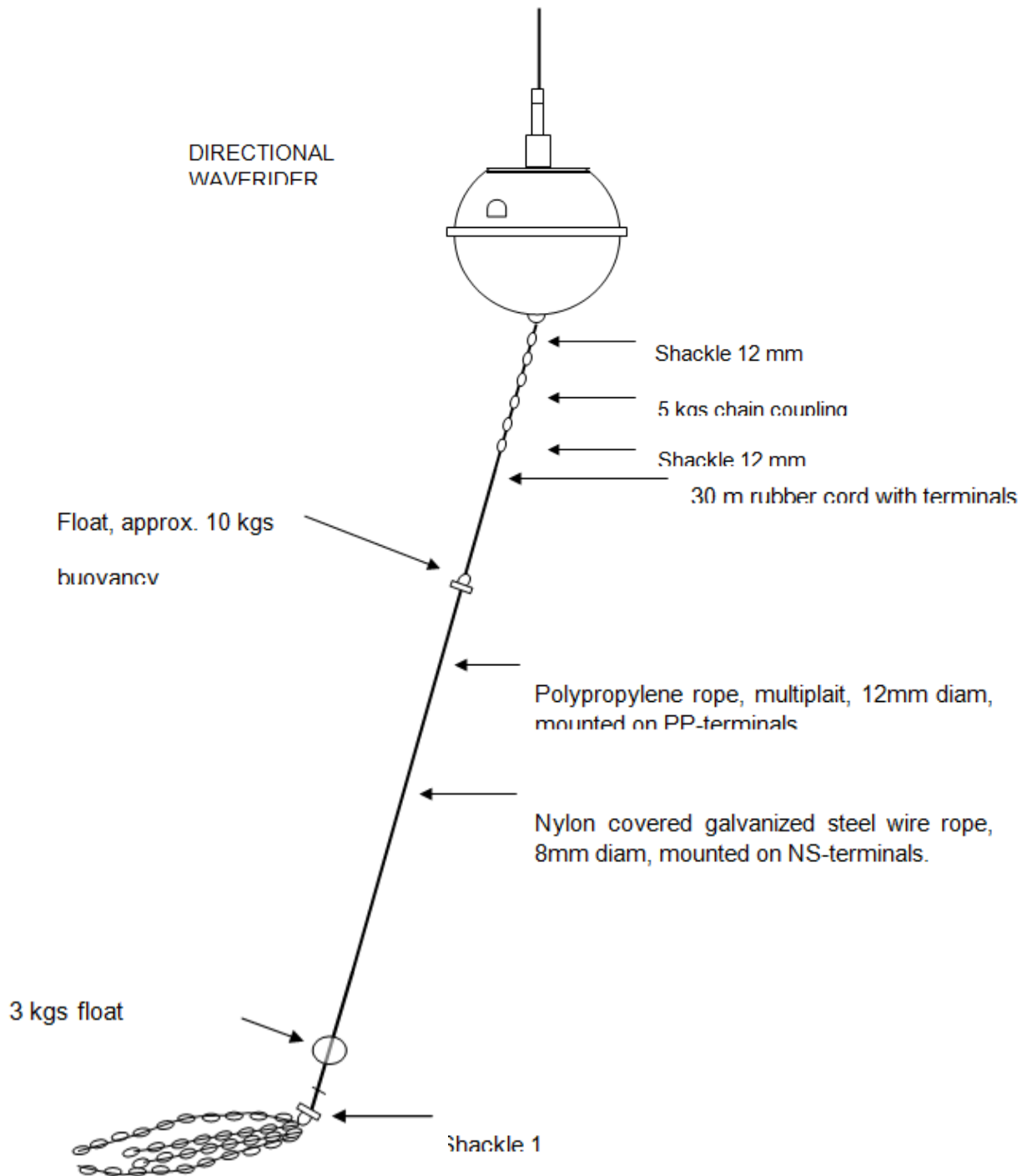
#	Details	Quantity	Unit
	view and focal lengths during successive surveys for easy comparison of photographs. In addition to the above specific events/incidents like seawall failure, High wave activity, Changes in erosion / accretion rates, Changes in hydrodynamics etc. ,if any, which needs to be documented in between the routine beach profiling schedule shall also be captured during the study period) (61 cross sections/month X 12 months=732)		
2.5	Analysis of beach sediment composition, through beach sediment sampling at an interval of 500m along the 30 km stretch coinciding with the beach profile locations (to be taken at the time of cross shore beach profiling under item (2.2) above, but once in 4 months x 3 seasons). The samples shall be collected from the water line. The frequency between successive sampling should be about four months. The collected beach sediment shall be subjected to sieve analysis. The grain size distribution graph shall be prepared from the sieve analysis. Hydrometer analysis of sediment samples shall be carried out when percentage of fine sediments (<75 micron) is greater than 15 percent. (61 samples once in 4 months X 3 seasons=183)	183	samples
3	Bathymetry & Siltation Monitoring		
3.1	Baseline bathymetry survey using multi beam and single beam echo sounder covering an area of 600 sqkm with 40 km alongshore (20 km on North and South side of the port location) and 15 km offshore with (i) bathymetric survey lines spaced at 25 m interval or appropriate (to get 100% coverage/0.5 m contours) to cover (a) the entire area within the existing Vizhinjam fishing harbour (b) the area between the existing fishing harbour and the proposed port (c) the area up to 20m contour depth and (d) about 4 sqkm extent of off shore dredge disposal sites (all within the 600 sqkm survey area) and (ii) bathymetric survey lines spaced at 300 m interval (to generate 1m contour) for depths greater than 20 m contour. The works are to be carried out, twice in a year i.e. (i) just after monsoon season and (ii) just before commencement of monsoon season. (capturing the location/layout of near shore underwater sand bar formation is a primary objective)		
a	Just after monsoon season (October/ November/ December) (40X15 =600 sqkm)		
a1	Multibeam echo sounder survey (up to 20m CD)	1300	Line km
a2	Singlebeam echo sounder survey (Beyond 20m CD)	1900	Line km
b	Just before commencement of monsoon season (March/April/May) (40X15 =600 sqkm)		

#	Details	Quantity	Unit
b1	Multibeam echo sounder survey (up to 20m CD)	1300	Line km
b2	Singlebeam echo sounder survey (Beyond 20m CD)	1900	Line km
3.2	Bathymetry and cross section survey of streams/rivers debouching into the sea in 40 Km stretch (20km on North & South side of proposed port location) up to 500 m upstream of river at interval of 100 m. (6 streams/rivers X 6 cross sections=36)	36	Cross sections
3.3	Collection of seabed sediments by grab sampling in a grid pattern size of 1km (total 600 Samples) along with bathymetric survey under item 3.1(a) above and analysis including (i) sieve analysis and preparation of grain size distribution graph and (ii) hydrometer analysis of sediment samples when percentage of fine sediments (<75 micron) is greater than 15 percent) (600 sqkm/1 sqkm=600 samples)	600	Samples
3.4	Collection and analysis of water samples for Total Suspended Solids (TSS) and Turbidity. The samples shall be collected at one hour interval starting from 7:00 AM to 5:00 PM for a day from three depths viz. (i) surface, (ii) mid-depth and (iii) near bottom using Niskin water sampler at four locations. Namely (i) Fishing harbour (ii) Kovalam (iii) Poovar/Adimalathura (iv) Dredge Dumping location. The salinity, temperature and turbidity of the samples should also be recorded at the time of sample collection. The collected samples should be subjected to laboratory analysis to determine total suspended solids. (11 samplesX 3 depths)/dayX 4 locations X 3 seasons= 396 samples	396	Samples
4	Simultaneous current measurement at four locations [ie. (i) Off Karamana River mouth/Poonthura(ii) Fishing harbour entrance (iii) South-East of the proposed port (Neyyarriver mouth) (iv) near project site] at water depth greater than 10m (tentative) using ADCP.Bottom mounted ADCP with suitable frame and anchoring arrangement to operate reliably under the prevailing environmental and hydraulic conditions shall be deployed. The maximum profiling range of ADCP should be greater than 15m with cell resolution less than 1.0m at the prescribed depth. Current measurements shall be recorded continuously at 10 minutes interval for duration of 30 days for single deployment and should be carried out at the four specified locations simultaneously. The survey shall be repeated during summer, monsoon and winter seasons. (This requires 4ADCP instruments deployed for 30 days continuously for each season x 3 seasons= 360 daily data sets)	360	Daily datasets
5	Collection of wave data at one location (near Vizhinjam Port project site) at water depth greater than 10m (tentative) using Wave Rider Buoy	365	days

#	Details	Quantity	Unit
	(WRB). The WRB (make-Datawell- MK II-having insurance coverage) along with the receiver/software will be provided by VISL (through a reputed Research Agency in the field) at the site office at Vizhinjam. <u>Following are the responsibilities of VISL for wave observation</u> 1.VISL will provide one GPS based Directional wave rider buoy (which is insured for 1 year and it will be renewed thereafter). 2. VISL will provide technical assistance in the Mooring and deployment along with mooring material except sinker weight. 3. VISL will setup the data reception station with real time communication with the buoy. <u>Following are the responsibilities of the Contractor for wave observation</u> 1. Contractor shall arrange 700kg of scrap MS anchor Chain for sinker weight 2. Contractor shall arrange one big boat for deployment and retrieval of wave rider buoy at the nearest port to the deployment site (minimum of a fishing trawler of 40 footer having 1 ton winch capacity will be suitable for this operation) along with qualified manpower to handle the boat and assist client for deployment operations. 3. Contractor shall provide assistance during retrieval of the wave rider buoy using a similar boat and manpower as provided during deployment. 4. Contractor shall arrange round the clock watch keeping at the buoy deployment location for 365 days using a boat.(during the rough sea condition the watch keeping boat may come to the safer location and the crew members may keep a watch from the land with coordination with the data receiving station). 5. Contractor shall be responsible for safe operations during deployment, observation and retrieval. Hence sufficient insurance cover for boat, manpower and material shall be ensured by contractor. 6. Contractor shall be responsible for adhering to all statutory requirements including documentation and certificates for boat and manpower for safe marine operations. 7. Contractor shall maintain regular daily field log on the watch keeping operations. 8. Contractor shall provide transportation of clients personnel (two persons) to visit the wave rider buoy location from nearest port for maintenance work as and when needed. The mooring diagram for the WRB is enclosed. Based on the above, the contractors are requested to quote their		

#	Details	Quantity	Unit
	rates for the following four sub-items. Payments will be as per the actual quantities executed		
5.1	Boat for deployment as described above – unit rate to be quoted per operation that will include loading the material at nearest port, travel, deployment and return. There may more than one deployment during the contract due to maintenance or mooring damages. (Three operations assumed)	3	operations
5.2	Boat for watch keeping as described above. – rate per day shall be quoted. The rate shall include boat, manpower, fuel, insurance and any other expenses related to watch keeping operations described above. (365 days assumed)	365	Days
5.3	Boat transport for client's personnel to visit the observation site for maintenance work. Rate per trip shall be provided.(12 monthsX 2 trips=24 trips assumed)	24	Trips
6	Tide measurement using automatic tide gauge deployed at one location at project site for continuous tide measurement. Tide measurement shall be recorded continuously at 10 minutes interval for duration of one year (365 days).	365	days
7	Collection of wind speed & direction, atmospheric pressure, humidity and temperature at one location with sufficient back up, using an Automatic Weather Station (AWS).	365	days
8	Analysis and processing of all collected data and preparation of reports (hard & soft copies) including printing, compiling and submission of data and drawings. (Reports to be submitted on completion of the respective seasons & on completion of the all season work)		
a	Season 1 (Post Monsoon)	5	Each copy
b	Season 2 (Summer)	5	do
c	Season 3 (Monsoon)	5	do
9	Final Report (on completion of all season work)	5	do

Mooring diagram for shallow water wave observation
(NIOT will provide the WRB, while the Survey agency has to supply sinker weight only)





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