EXECUTIVE SUMMARY

1. Introduction

The Government of Maharashtra intends to establish a memorial and statue of Chhatrapati Shivaji Maharaj, the revered king and founder of Maratha Kingdom off Nariman Point, Mumbai. The memorial is aimed at not only providing a place for the people to visit, but also create an internationally acclaimed landmark of our country. With the above concept in mind, it is proposed to erect a 190 m high statue of Chhatrapati Shivaji Maharaj. The identified location is an oval shaped rocky outcrop (latitude: 18° 55' 33.8" N and longitude: 72° 47' 25.0" E) of approximately 650 m x 325 m in size, and it measures 159600 m^2 during the lowest tide. The identified location is 1.2 km southwest of Raj Bhavan, 3.6 km southwest of Girgaon jetty and 2.6 km west of Nariman Point. The proposed project area comes under the jurisdiction of the Port of Mumbai.

CSIR-National Institute of Oceanography (CSIR-NIO) received a request letter from the Public Works Department, Govt. of Maharashtra that a comprehensive EIA may be done by CSIR-NEERI, Nagpur and CSIR-NIO, Goa to delineate all the study components related to marine EIA associated with the above project. Accordingly CSIR-NIO submitted the project proposal for the marine EIA, and the work was awarded on 30 May 2013. This marine EIA report is based on the site-specific base-line studies carried out encompassing the project domain for two seasons.

The studies that were carried out for marine EIA by CSIR-NIO are: i) description of the project activities, ii) baseline studies to establish pre-project environmental status, iii) prediction of potential impacts of the project on marine environment, iv) Environmental Management Plans to reduce environmental impacts, particularly focussed on mitigating significant environmental impacts to acceptable levels and v) Propose a Post-Project Environmental Monitoring Plan for evaluation of the effectiveness of the implemented environmental protection measures.

2. Project Description

The information related to the proposed development as provided by the Public Works Department, Govt. of Maharashtra has been described. The objectives of the proposed developmental activity are i) to establish a memorial of the most revered king of Maratha Empire in India, with a view to give national and international tourism an unique attraction, ii) to provide a facility to learn and experience the history of Maharashtra and also of India with allied facilities such as marine biodiversity sensitization centre, digital library, laser show, light and sound show in theatre. It is expected that about 10000 persons will be visiting the memorial every day. The implementation of the said project expected to bring in socio-cultural awareness and well planned facilities for recreation, education and cross-cultural exchange, ideas interchange etc.

Extensive reconnaissance surveys were carried out to identify a suitable site for the erection of Statue of Chhatrapati Shivaji Maharaj in the Back Bay area of the Arabian Sea near Mumbai during January 2013. Initially three sites, Site I, 500 m away from Girgaon Beach, in the intertidal zone: Site II, 2 km south west of H2O just beyond LTL and Site III, the rocky outcrop, 3.6 km towards the sea from H2O Jetty at Girgaon were evaluated for the establishment of the facility. The Site I was rejected due to its proximity to the land and is in the intertidal zone where reclamation is envisaged. The Site II falls in the CRZ IV and through this site internet and telecommunication cables are passing though and substantial reclamation is required and hence this site was rejected. The Site III which falls under CRZ IV was selected as suitable site due to the presence of the rocky outcrop and no major reclamation would be required.

It is proposed to fortify the rocky outcrop with RCC sea wall/curtain wall. In addition to the establishment of a statue of Chhatrapati Shivaji Maharaj, the other facilities planned at the rocky outcrop are; i) art museum exhibiting various aspects of Shivaji Maharaja's kingdom era records, ii) amphitheatre and auditoria of various sizes, iii) exhibition gallery, iv) marine aquarium, v) coastal and marine resources interpretation and sensitization centre, vi) landscaping and open space of viewing and galleries, vii) common facilities such as cafeteria, lavatories, medical facilities (first-aid), stalls and offices, viii) security installations for safety and disaster management system, ix) wastewater treatment and environmental safeguards facilities and x) berthing jetty for embarkation and disembarkation of tourists. The total estimated cost for the project is Rs. 1400 crores. The total construction period for the proposed development would be approximately 5 Years.

As per the proposed traffic plan, the boats carrying the visitors will be operating from the Nariman Point and Gateway of India. From the Gateway of India, the sea route distance is 12 km and that from Nariman Point is 3.5 km.

3. Description of Environment –Off Coast

The baseline data for assessing the environmental impact include data collected by CSIR-NIO under this EIA project during pre-monsoon and post-monsoon seasons and the secondary data. For assessing the baseline environmental status, an area of ~30 km^2 encompassing the project site was covered. Seawater samples were collected from 13 locations (stations M1-M13) in the coastal waters and five transects (TR-I to TR-V) in the inter-tidal region for chemical and biological studies during 3-6 June 2013 (pre-monsoon season) and 20-26 October 2013 (post-monsoon season).

3.1 Geological Setting of the Study Area

The entire Greater Mumbai area is occupied by Deccan basalt flows and their acid and basic variants were poured out between the late Cretaceous and early Eocene times. The lavas of the Mumbai area are believed to represent a much younger phase in the eruptive sequence of the Deccan Volcanic

Province. The gently shelving seabed platform to the west of Mumbai comprises a varied sequence of tuffs, volcanic breccias and carbonaceous shales that overly the Malabar Hill lava flow. These younger deposits are of considerable lateral extent, beneath a thin seabed veneer of recent marine sediments and some completely weathered lava surfaces. In consequence, the strata present at the project site comprise the lower remnants of the Malabar Hill flow beneath which lie a considerable thickness of intertrappean rocks.

Coastal protection measures are provided along the Marine Drive (Nariman Point to Girgaon Chowpati) and hence the shoreline change along this stretch is negligible.

3.2 Climatology

The climatology is based on the data of the nearest observatory of India Meteorological Department (IMD) at Colaba. The average air temperature data of 30 years reveals that the highest monthly mean temperature of 33.4 ºC is recorded in May and the lowest monthly mean temperature of 19.3 ºC in January. The monthly mean of relative humidity varies from the lowest of 61% in January and February to 87% in July and August. The highest value of atmospheric pressure was 1013.2 hPa in January and the lowest of 1001.5 hPa was in July. The thirty year monthly mean of visibility showed that the morning visibility varied between 4 and 10 km for about 162 days in a year. The region receives on an average about 215 cm rainfall annually, and around 98% of rainfall occurs during southwest monsoon period (June to September). The number of rainy days in a year is estimated to be 76.

The Joint Typhoon Warning Center Tropical Cyclone Best-Tracks data show that during 1945 to 2012, 7 cyclones crossed within 1° radius of the project site and the maximum wind speed of these cyclones is 25.7 m/s and can have storm surges upto 2.1 m. The 1945 tsunami, generated due to Makran Earthquake in the Arabian Sea, was the most devastating tsunami in the history of the Arabian Sea and the tsunami height in Mumbai was 2 m. The estimated arrival time of the tsunami generated at Makran subduction zone (which is 1060 km from Mumbai) is around 180 minutes. The 2004 Indian Ocean Tsunami was one of the most devastating disasters in modern history and it affected the southern coasts of India. The influence of the 2004 Indian Ocean tsunami along the Mumbai coast was not significant.

3.3 Physical Processes

Surface waves are generated by the winds blowing over the surface of the sea and are high during the southwest monsoon period (June to August). The surface waves were recorded continuously at 1.28 Hz using a Datawell waverider buoy, deployed at latitude 18º 55.6’ N; longitude 72º 46.1’ E during June to August 2013 in 10 m water depth off the project location. During June to August 2013, the significant wave height varied between 0.8 and 2.7 m with a mean value of 1.5 m and the

maximum wave height varied from 1.1 to 5.1 m with an average value of 2.4 m. The mean wave period varied from 3.7 to 7.9 s with an average value of 5.2 s and the spectral peak period varied from 4 to 16.7 s with an average value of 11.1 s. During the measurement period, waves are predominantly from the southwest with direction varying from 225 to 284º. Waves were also measured during the post-monsoon season (October-November 2013) and found that the significant wave height was less than 0.7 m with a mean value of 0.4 m and the maximum wave height varied from 0.3 to 1.2 m with an average value of 0.6 m during this period. During the post-monsoon period, waves were from 200 to 350º. The estimated significant wave height during 1979 to 2012 based on the model data at 15 m water depth shows that the maximum significant wave height is 5.3 m in 2007. The estimated significant wave height with 100 year return period at 15 m water depth is 6 m.

The variation of water level during 2013 based on the predicted tide at Mumbai (Apollo Bunder) shows that the highest high water level is 5.1 m above the chart datum and the mean sea level is 2.51 m. The estimates of mean sea level rise based on the past sea level data (1878-1994) for Mumbai is 0.78 mm/year.

Currents were measured at one location (Latitude 18º 55.9’ N; Longitude 72º 47.4’ E) using an Aanderaa Seaguard Current meter which was deployed at 6 m water depth at 10 minutes interval during 5 June to 22 August 2013. The currents varied upto 0.5 m/s with an average current speed of 0.1 m/s and the currents were predominantly towards northwest. Currents during the post-monsoon season (Oct-Nov) were measured at Latitude 18º 55.4’ N; Longitude 72º 47.1’ E using an Aanderaa Seaguard Current meter which was deployed at 7 m water depth. During this period, currents varied upto 0.6 m/s with an average current speed of 0.2 m/s. Current direction was varying with tide and was predominantly towards south. During both spring and neap phases of the tide, the flood and ebb currents constitute an anticlockwise circulation within the Back Bay. As the flood tide enters the bay from the west, the current vectors show strong northeasterly currents all along the open bay. However, during ebb tide the outflow mainly occurs near the northern half off Malabar Hill.

MIKE21 Flow Model of Danish Hydraulic Institute (DHI), Denmark has been used to model the hydrodynamics of Mumbai Back Bay. MIKE21 HD Flow model, a hydrodynamic modeling system for 2D free surface flows, has been used to simulate currents and to study the circulation of coastal waters off Mumbai and within the Back Bay region from Malabar Hill to Nariman Point. The model simulation showed good comparison with the measurements and the currents are predominantly tide driven with reversal associated with tidal phases.

3.4 Water Quality

During the pre-monsoon season, the water temperature in the coastal waters of Mumbai varied between 31.2 and 33.4 °C and the variation in water temperature between the sampled stations is not discernible. During post-monsoon season, the water temperature ranged from 26.5 to 29.8°C and the variations in temperature between surface and bottom were minor, suggesting well mixed water mass.

Salinity recorded during pre-monsoon and post-monsoon seasons in the coastal waters of Mumbai varied narrowly between 34.4 and 36.1 psu. The salinity at intertidal stations during pre-monsoon season transects, TR-I and TR-II was relatively lower (33.0-33.7 psu) compared to other transects indicating some freshwater input. pH was in the range 8.0-8.3 during pre-monsoon. However, the surface waters in the intertidal locations sustained lower pH values, indicating some anthropogenic perturbation. During post-monsoon season, pH varied between 7.8 and 8.0. In pre-monsoon season, the variation in the concentration of TSS was from 18 to 169 mg/I. There was no marked spatial and vertical variation in the distribution of TSS at sub-tidal stations indicating well mixed environmental conditions prevailing in the study region. High concentration of TSS (102-1253 mg/l) at intertidal stations may be attributed to the churning out of sediments due to wave action. During post-monsoon season, the concentration of TSS in the coastal waters of Mumbai ranged from 23 to 166 mg/l.

During pre-monsoon, the DO varied from 5.1 to 7.0 mg/l indicating good oxidizing condition. During temporal variation, there was no substantial variation in the concentration of DO, which can affect the biotic life. But during post-monsoon season, a substantial decrease in DO levels in the coastal waters of Mumbai was observed. BOD values, which showed a moderate variation between 0.6 and 4.4 mg/l during pre-monsoon showed an increment during post-monsoon and ranged between 1.0 and 9.8 mg/l. The observed values of turbidity are within the expected limits and are not high enough to restrict light penetration. Phosphate-phosphorous in the water column during pre-monsoon and post-monsoon seasons ranged from 0.2 to 2.1 µmol/l. Nitrate-nitrogen ranged between 0.5 and 14.2 µmol/l, which is low when compared to the concentration generally recorded in coastal waters. However, significantly low concentration of NO_3^--N was observed during low tide. During post-monsoon season, concentrations of NO_3^--N varied between 6.8 and 13.5 µmol/l. During pre-monsoon and post-monsoon seasons, NO_2^--N ranged from 0.1 to 1.1 µmol/l and from 0.2 to 3.0 µmol/l respectively. NH_4^+-N in the water column during pre-monsoon season ranged from 0.6 to 5.2 µmol/l. Relatively lower concentrations of Ammonia-nitrogen ranging from 0.5 to 3.8 µmol/l were observed during the post-monsoon season. Higher concentrations of NH_4^+-N observed during Pre-monsoon season indicates some sources of anthropogenic inputs mostly in the form of domestic sewage. Overall, the area showed some addition of urea to the coastal region**.** Insignificant differences in the urea concentrations between surface and bottom waters during temporal study

indicated well-mixed condition. The distribution of TN though showed higher values in the bottom relative to surface in the coastal waters of Mumbai, they did not follow any characteristic trend. The recorded concentrations of TN indicate anthropogenic input of inorganic nitrogenous compounds (fertilizers) into the coastal environment.

In general, the values of silicate concentrations were found to be well within the limits expected for coastal waters. The concentrations of PHc during pre-monsoon season ranged from 3.6 to 32.0 µg/l and during post-monsoon season, the range was between 2.1 and 37.0 µg/l and were in the range generally observed in the nearshore coastal waters. However, enhanced values recorded in the water of intertidal area, may be due to land based source. Enhanced concentration of phenol may be due to the cumulative effect of external additions and the release of phenols from humic substances. The average Overall Index of Pollution (OIP) value of all the stations calculated for the all the stations gave a value of 3.17 suggesting a slightly polluted water quality in the study region as per the classification based on OIP values.

3.5 Sediment Quality

Sub-tidal stations sustained maximum fraction of silt (86.5-93.9%) except stations M12 and M13, which contained maximum fraction of sand (77.2-96.0%). The sediments at intertidal locations contain maximum sand (89.4-93.6%). All the metals varied in the range generally recorded in the lithogenic form. Hence, there is no accumulation of heavy metals in the sediments. These values may be considered as base line concentration and can be used while assessing post-project monitoring. Wide variation in the concentration of C_{org} was observed, which is due to variation in the texture of the sediment. Phosphorous was of the order generally encountered in the fine-grained coastal sediment off Mumbai. The observed levels of C_{org} and phosphorous represent baseline concentration and there was no evidence for anthropogenic contamination. The concentrations of PHc were low and revealed uncontaminated status of the sediment with respect to pollution from petroleum hydrocarbons in the study area. The profile of measured concentrations of trace metals and PHc in commercially important finfish and shellfish species inhabiting the coastal marine waters represent the baseline values.

3.6 Biological Productivity and Ecology

The biological parameters considered for the assessment of ecological status in the present study are total bacterial counts, phytoplankton pigments and cell counts, zooplankton standing stock and population, macrobenthic biomass and population and fishery status. Status of marine vegetation in the vicinity of the proposed site of development has also been investigated as these are considered as unique ecosystems.

Microbiological Aspects: The microbial status of the study area was assessed through enumeration of the abundance of aerobic- and anaerobic-heterotrohic and health indicator bacteria in seawater and sediment samples were enumerated during Pre-monsoon and Post-monsoon seasons. No consistency in the distribution of hetertrophic bacterial between stations was discernible. In general, post-monsoon season recorded higher bacterial productivity compared to the pre-monsoon season. In general, the variability in bacterial counts obtained from the study area for two season fall within the normal values recorded for similar coastal waters along the west coast of India. Counts of heterotrophic and functional bacterial groups in the sediments were 1-2 orders magnitude higher than recorded from water column.

Phytoplankton & Productivity: During pre-monsoon season, the concentrations of Chl *a* ranged from 0.55 to 16.92 mg/m^3 in surface waters and from 0.49 to 5.34 mg/m^3 in bottom waters. The concentrations of Chl *a* remained high at all sampled stations with large variability between stations. The content of phaeophytin in surface waters ranged from 0.23 to 5.85 mg/m^3 and from 0.12 to 1.51 mg/m^3 in bottom waters. The measured concentrations of Chl *a* and Phaeophytin show moderately elevated levels in surface waters as compared to the bottom waters which could be due to natural biological variability inherent to such dynamic ecosystems. A highly diverse phytoplankton population with 58 species belonging to 30 genera were identified from the study area. Diatoms with 24 genera dominated the phytoplankton composition, while Dinoflagellates were represented by 7 genera. Major genera that contributed to the total phytoplankton abundance were *Chaetoceros*, *Coscinodiscus, Navicula, Rhizosolenia*, *Amphipora* and *Thallasiothrix*, while species belonging to other genera such as *Nitzschia, Thalassiosira* and *Peridinium* also made significant contributions to the total abundance at few stations. Amongst Dinoflagellates, *Procentrum micans*, *Peridinium elegans* and *Ceratium* spp. were dominant at most of the sampled stations. Concentrations of POC were quite high (mean±SD, 2291±356 mg C/m^3) in surface and bottom waters. In surface and bottom waters, the concentrations varied from 1731.51 to 2745.93 mg C/m^3 and from 1842.28 to 3060 mg C/m^3. In general, bottom waters recorded marginally higher concentrations of POC compared to surface waters and this may be due to the re-suspension of bottom sediments in the shallow coastal waters.

During post-monsoon season, the concentrations of Chl *a* ranged from 6.59 to 17.39 mg/m^3 in surface waters and from 2.31 to 11.84 mg/m^3 in bottom waters. The concentrations of Chl *a* remained high at all sampled stations with large variability between stations. Surface waters sustained significantly higher concentrations compared to the bottom waters. The content of phaeophytin in surface waters ranged from 4.36 to 53.68 mg/m^3 and from 4.14 to 17.11 mg/m^3 in the bottom waters. The measured concentrations of Chl *a* and Phaeophytin recorded during post-monsoon season showed significantly higher values compared to those recorded during pre-monsoon season. A large variation in Chl *a* and Phaeophytin values between stations and sampled depths

indicate the natural biological variability inherent to such dynamic ecosystems and nutrient availability. Total phytoplankton abundance in surface waters varied from 5.2 x 10^2 cells/l (Stn. M10) to 269.4 x10^2 cells/l (Stn. M4) and from 6.0 x10^2 cells/l (Stn. M6) to 46.40 x10^2 cells/l (Stn. M11) in bottom waters. Surface waters sustained relatively higher phytoplankton abundance compared to bottom waters. Analysis of the phytoplankton composition revealed that the study area sustains high generic diversity. A highly diverse phytoplankton population with 42 species belonging to 26 genera were identified from the study area during post-monsoon season (October, 2013). Diatoms with 13 genera dominated the phytoplankton composition, while Dinoflagellates were represented by 13 genera. Major genera that contributed to the total phytoplankton abundance were *Chaetoceros, Gyrosigma, Coscinodiscus, Navicula, Rhizosolenia, Amphipora* and *Thallasiothrix,* while species belonging to other genera such as *Nitzschia, Thalassiosira* and *Peridinium* also made significant contributions to the total abundance at few stations. Amongst Dinoflagellates, *Amphidoma nanum, Amylax triachantha, Gonyaulax* spp., *Protoperidinium sternii* and *Ceratium* spp. were dominant at most of the sampled stations. A comparison of data on the abundance and diversity of phytoplankton collected during pre-monsoon and post-monsoon seasons showed striking differences. A relatively lower abundance and diversity was observed during post-monsoon season reflecting the influence of anthropogenic inputs into the coastal ecosystem. Furthermore, the contribution of dinoflagellates both in terms of qualitatively and quantitatively is relatively high when compared to the pre-monsoon season data. Therefore, there is a need to closely monitor the changes in the species succession of dinoflagellates for preventing the development of large-scale harmful algal blooms. In general, the concentrations of POC recorded during the post-monsoon season (October, 2013) were relatively lower than the values recorded during the Pre-monsoon Season. Such differences in POC may be attributable to the variability in the phytoplankton biomass and suspended solids. POC/Chl *a* ratios provides an indication on the health status of the environment and contribution of autotrophs to the organic production in the study area. In the present study, the presence of high and variable content of POC not co-varying with Chl *a* was reflected in the lack of or low correlation coefficient found for POC on Chl *a*.

Mesozooplankton Biomass & Abundance: During pre-monson season, the meso-zooplankton biomass ranged between 3.51 and 22.06 ml/100 m^3. The total meso-zooplankton density varied from 1238 to 53078 Nos./100 m^3. The zooplankton population comprised of 16 faunal groups. In general, copepoda was the most dominant group and Calanoida, Cyclopodia and Harpacticoida are the major group observed under Copepoda, which on an average constituted 73.62% of total zooplankton density in all the stations. Fish and shrimp eggs, Decapod larvae and Brachyuran/ Anomuran larvae were the other dominant groups in the zooplankton samples from the study area. Lucifer and Chaetognaths which is major food items for fish, contribute to about 0.78% and 0.06%, respectively. Fish and shrimp eggs contribution is 1.91% to total zooplankton density. Anomuran crab larvae (eg. Hermit crabs) and Brachyuran crab larvae (eg. Portunid crabs) have noticeable share in zooplankton.

Meso-zooplankton biomass ranged between 5.91 and 234.24 ml/100 m^3 in the study area during post-monsoon season (October 2013). Maximum biomass (234.24 ml/100 m^3) was observed at Stn. M10, while the minimum at Stn. M7 (5.91 ml/100 m^3). The total meso-zooplankton density varied from 1961 to 77429 Nos./100 m^3. The zooplankton population comprised of 15 faunal groups during post-monsoon season. In general, Copepoda was the most dominant group and Calanoida, Cyclopodia and Harpacticoida are the major group observed under Copepoda, which on an average constituted 47.0.2% of total zooplankton density in all the stations. Higher abundance of important live food organisms such as copepods, lucifers, chaetognaths at study area of Mumbai coastal waters can be correlated with high abundance and density of phytoplankton and chlorophyll content. Abundance of copepods, lucifers, chaetognaths, (major contribution) and other zooplankton like cladecerons, ostracods (minor contribution) and occurrence of decapods and fish larvae/eggs in zooplankton samples suggest that the study area has high production potentials for live food organism's resources for fish and shellfishes during post-monsoon season.

3.7 Benthic Studies

During Pre-monsoon season, the macrobenthic community in the subtidal sediments of Mumbai was comprised of 5 major invertebrate groups viz. Polychaeta, Bivalvia, Crustacea and Nemertina. Polycheata dominated the faunal density with 51% of the total benthic abundance. This was followed by crustaceans (41%), bivalves (4%), nemertins (2%) and echinoderms (1%) and other miscellaneous groups contributed to the rest 4% of the total abundance. Macrofaunal diversity as estimated by Shannaon and Simpsion diversity indices showed higher macrofaunal diversity (H=>2.50). Macrofaunal density (Ind./m^2) in the study region ranged from 266 to 15339 with a mean density of 4286 Ind/m^2. Higher percentage of crustaceans at few stations could be due to the coarser grain size at these stations. Macrofaunal biomass (wet wt.) varied from 0.09 to 21.9 g/m^2 with a mean biomass of 7.17 g/m^2.

During Post-monsoon season, 26 macrofaunal groups were recorded at subtidal stations. The abundance of macrofauna ranged from 178 to 8066 ind/m^2 (mean, 2165 ind/m^2). Macrofauna was dominated by groups such as Cossura (23%) followed by Amphipoda (22%), Tanaidacea sp (12%), *Trichochaetidae* sp. (8.3%), Mediomastus Sp. (7.8%) and others. Shannaon and Simpson diversity indices were used to estimate the diversity of the macrofuna in the study region showed higher macrofaunal diversity indices.

Macrobenthic abundance-Biomass Curve (ABC) generally used for assessing the pollution status of a given habitat/area showed indicate dominance of biomass over faunal abundance. Intertidal macrofauna was represented only by three major groups: Crustaceans (91.03%), Bivalve (7.04%) and Polycheates (1.89%). Amongst the most dominant group was the Isopoda with single species

Euridice pulchra contributing 63.20% followed by *Emerita* sp. 25.76%, *Donax* 7.04% and *Scoloplos* sp. 1.89%.

Amongst subtidal meiofauna, nematodes consistently recorded at all stations with a dominance. Highest density of nematodes was recorded at Stn. M12; with a density of 527 ind./10 cm^2. The other groups recorded were polychaetes, harpacticoids, oligochaetes and foraminifera. Stn. M7 and M12 depicted the highest diversity with 3 groups while lowest diversity was at Stn. M3. Considerable differences in macrofaunal standing stock and abundance between different water levels were discernible at intertidal stations. Mean values of standing stock of macrobenthos in terms of population density and biomass were in the order: LTL>HTL>MTL.

Fish and Fisheries: The status of fisheries in the study domain has been assessed both based on information available with Department of Fisheries. Govt. of Maharashtra (landings, fishermen population, craft and gear etc.) and the data obtained through experimental trawling in the study area.The study area falls under Mumbai fishing district. There are 1085 non-motorised boats, 397 outboard engines boats. Mechanized boats comprising of various types viz., 228 no. of purse-seine boats, 2849 of Trawlers, 551 of Gill netters, 1236 of Dol netters and 26 other mechanized boats engaged in harvesting different species of Fish, Prawns, Squids etc. by using various types of gears (Fishing nets). As per the Fish landing data of Department of Fisheries, Govt. of Maharashtra, the total marine fish landings from Mumbai fishing district during the last 10 years fluctuate between 180, 285 MT (2001-02) to 184,6789 MT (2007-08). Due to increase in fishing effort, there has been an increase in the fish landings in the recent past. Ribbon fishes dominate the marine fish landings accounting for ~ 8% of total finfish and shellfish species. Bombay duck (6.75%), Anchovies (5.53%), Goat fishes (5.39%), *Otholithes* sp. (5.05%), Indian Mackeral (2.60%), are other major groups that constitute the marine fish landings.

For assessment of fishery resources, experimental fishing was carried out at three transects encompassing the project domain. Overall 8016 fish and shellfish individuals belonging to 49 species, 45 genera and 35 families were collected from sampling station. The fish assemblage in terms of abundance was dominated by the members of the families Sergistidae (30.96%), Penaeidae (24%), Squillidae (20.95%), Hipplytidae (4.50%), Palaemonidae (4.85%), Solenoceridae (3.68%), Sciaenidae (1.05%) Cynoglossidae (0.76%), Gobiidae (0.73%) and Sepiidae (0.78%). Families such as Hemiscyllidae, Clupeidae, Plotosidae, Synodontidae, Harpadontidae, Terapontidae, Serranidae, Lactaridae, Apogonidae, Carangidae, Portunidae, Sphyraenidae, Loliginidae and typical of inshore fish and shellfish community, contributed about 2.43%. Based on the average biomass obtained during the three experimental trawls (714 kg/km^2), the fishery potential of the study area (30 km^2) in terms of potential biomass has been worked out to be 21.42 MT (metric tonnes). The estimated marine fishery potential of the study area is moderately low compared to the rich fishing grounds

along the west coast of India. The fishing grounds encompassing the project domain are under the influence of intense fishing pressure.

The length-weight analysis, maturity and spawning behaviour of fishes collected indicated that the fishes off Mumbai belong to 1 or <1 year-classes. Thus, based on the limited data, it appears that Mumbai coast having rich ichthyoplankton may act as a good nursery ground for the commercially important fishes for a limited period.

Coastal Marine Vegetation: The study area was surveyed extensively for the occurrence of mangroves and is devoid of mangroves. Qualitative and quantitative assessment of marine macroalgae was investigated from the intertidal zones from two sites: Site 1: near Raj Bhavan and site 2: Colaba behind the Tata Institute of Fundamental Research consists of rocky laterite and granite boulders. Rocky area extends downwards to the level of MLWS below which the bottom of the area consists of soft muddy sand. The area has gradual slop with emerging rocks enclosing several small rock pools. This area gets completely exposed during low tide. In all, 16 macroalgal species have been recorded from the study area. Rhodophyta dominates followed by Chlorophyta and Phaeophyta. The pattern of seaweed distribution in the study area was not uniform and showed varied combination depending on the substratum and topography of the study area.

Endangered Sea Animals: The occurrence of endangered sea animals such as Whales, Dolphins, Turtles, Porpoises etc. in the project domain was investigated through actual sightings and from the published literature. There are isolated reports of dolphins inhabiting the coastal marine environs of Mumbai. There are few reports of stranding and accidentally capture of Bottlenose Dolphin and other species of Dolphins (locally called 'Gada') along the Mumbai coast. However, no sightings of dolphins, whales and other marine mammals were observed during the period of field studies. The nearest turtle nesting localities reported to the proposed project site are Versova and Gorai. However, the distance between the project domain and these localities is > 8 km.

3.8 Anticipated Environmental Impacts

The anticipated environmental impacts due to the activities related to the construction, operation and post operational phases of the project are highlighted below.

The Effect of Seawater on Reinforced Concrete Structures: The marine environment is highly corrosive. Hence the concrete structures have to be designed for extreme environment as per IS 456:2000 and nominal concrete cover of not less than 75 mm is to be provided to the steel bars and the minimum grade of concrete is to be M40. In view of the corrosive environment, it is proposed to use M60 grade concrete for the project and hence the impact of the marine environment on concrete structures will be minimum.

Impact of Cyclone and Storm Surge: In the last 67 years, 7 cyclones crossed within 1° radius of the project site and the maximum wind speed during the cyclone was 26 m/s. The structure will be designed as per IS875:1987. The basic wind speed, i.e. 3 s gust wind speed, for the Mumbai region as per IS 875: 1987 is 44 m/s and the wind speed observed during the cyclone is less than this value.

The significant wave height for 100 years return period near the project site at 15 m water depth is 6 m. The corresponding maximum wave height will be around 10 m. Storm surge due to cyclone will be around 2.1 m. The average highest high tide for the Mumbai area is 4.42 m and the highest high tide is 5.2 m. Since the water depth around the project site is less than 5 m, during the highest high tide under cyclone condition, the maximum wave height which can be present is 7.9 m. Considering these factors, the ground level of the project site is to be at 10.5 m above the Chart Datum, which is 8.01 m above the Mean Sea Level. A fortified wall is proposed around the project site with the top level of the wall at 13 m above the Chart Datum. Considering the average annual rainfall of around 3 m in Mumbai, the project site ground level below the high tide line will lead to floods for brief period. The tide level reaches up to 5.2 m. Hence the top level of the project site is to be above 5.2 m to have good drainage. The proposed ground level of the project site is 8 m above the chart datum and hence the impact due to storm surge and monsoon will be negligible.

Impact due to raising the ground level on the rocky outcrop: At present the rocky outcrop over which the construction is planned gets exposes during the low tide time and the top level of the rocky outcrop is at 1.6 m above chart datum. During the high tide, the rocky outcrop gets completely submerged. The proposed project is on this rocky outcrop and it is proposed to raise the ground level of the rocky outcrop to 8 m above Mean Sea Level. Once the project is executed, an area of 159600 m^2 will be exposed even during the high tide and will block the flow of water during the high tide and hence can change the waves, currents and the shoreline.

Change in wave characteristics: The change in wave height close to the coast are studied using MIKE21 SW model. The changes in significant wave height due to the proposed project is not significant (<0.1 m) off Malabar Hill, off Nariman Point and Colaba.

Change in currents and surface elevation: MIKE21 HD Flow model, a hydrodynamic modeling system for 2D free surface flows, is used to carry out model simulation of currents and to study the circulation of coastal waters within the Back Bay region. The comparison of the surface elevation with and without the project facilities shows that there is no chage in the surface elevation due to the project activities. However, change in current speed is obseved between the rocky outcrop and the Malabar Hill. The u-component of current increase by 3-10 cm/s during flood and 12-14 cm/s during the ebb. The change in currents near the coastal locations off Nariman Point and Malabar Hill are negligible. No significant change in the ebb/flood currents and surface elevations are noticed when the reclamation area over the rocky outcrop is reduced to 75% or 50%.

Change in bed level near the project area: Sediment transport within the Back Bay has been studied using the results obtained from model simulations using MIKE21 ST. The model results indicate very mild erosion, within the bay at location between Malabar Hill and the rocky outcrop under exisitng conditions, driven by the tidal currents (ebb and flood currents). After inclusion of the project facilities, the erosion at this location shows increase as a result of the increase in currents through the channel. There are no other significant change in the sediment transport pattern within the bay, or at the project site as a consequence of the reclamation.

Change in shoreline: Since the rocky outcrop is 1.2 km south-southwest of Raj Bhavan, 3.6 km south west of Girgaon jetty, 2.6 km west of Nariman Point and 2.1 km north from the shoreline and the length of the rocky outcrop is 0.65 km, the construction of the facility on the rocky outcrop will not have significant influence on the shoreline.

Impacts on fisheries: The proposed project site falls under the area prohibited for anchoring and trawling due to the existence of submarine cable in the nearby location. Due to the shallow depth and the rocky bottom, large scale mechanized fishing are not carried out. Fishing through country crafts are carried out in and around the project site in the Back Bay area. Large-scale hindrance to the fishing activities are not envisaged due to the proposed establishment of the facility. However, the routes of the tourist ferry boats from Nariman Point and the Gateway of India will be through the fishing areas and hence these boats interfere with the local fishing activities.

Construction Phase: During the installation of sheet piles, breakwater, jetty and seawater intake system, a temporary increase in suspended solids in the water column will result. The berthing jetty will be on piles and the piling operations will also disturb the bottom sediments and make the water turbid. Turbidity can lower light penetration in the water column. The data on primary water quality parameters viz. DO, BOD and nutrients, which are responsible for causing an impact on the environment, indicate that the oxygen content of the water in the study area is sufficiently high. The water column from surface to bottom is well oxygenated with good mixing at most of the stations in the study area. The pH observed is that of the normal seawater pH. Therefore, it is unlikely that the temporary increase in the suspended sediment and turbidity during the installation of the project facilities is expected to bring about large changes in the baseline levels.

Permanent loss of benthic community in 162000 m^2 area is expected during the reclamation of the rocky outcrop and construction of breakwater and would be negligible considering the vast availability of such a habitat in the nearby areas. Although no sightings of dolphin, turtles and other endangered animals were observed during the baseline studies, proper care should be exercised not to disturb these animals if spotted during the construction activity.

Solid Waste Disposal*:* Solid waste -(packaging materials such as food wrappers, plastics etc) may be generated at the site due to the presence of construction machinery and materials, make-shift huts for labour force, cabins etc. Solid waste may find their way into the sea following rainfall and strong winds, and/or intentional disposed off into the sea. Left over solid waste generated during construction would be a source of nuisance if not cleared from the site. These may alter the aesthetic beauty of the environment if not well managed. Further, it may influence the water quality and the biotic communities within the project domain. The extent of impact on the coastal ecology would also depend on the duration of the construction phase. If the construction is prolonged due to time-overruns or improper planning, the adverse influence would increase accordingly.

Any negative impacts on underwater historic/cultural heritage appear to be absent.

3.9 Operational Phase

Seawater intake: Sea water intake will be provided with velocity cap, trash bars and low intake velocity to minimize the entry of debris and fish. The screen, which consists of a mesh, is designed to prevent entrainment of all but small fish. However, there will be instances that fish eggs, larvae, small fishes, plants and zooplankton pass through the water intake screen. These organisms are drawn in pumps and they may be subject to mechanical and chemical effects. Mechanical damage can arise from abrasions, shear, impact and rapid change in pressure in passing through the pumps. Entrained organisms may also be effected by chemicals especially chlorine, added to intake water. Even though the entrained organisms are not killed, young fishes that undergo physical damage may become prey to predators.

Seawater intake system is proposed within the coastal waters of Mumbai and is liable for intense fouling activities, thereby affecting flow characteristics. To control the fouling, biocides will be used. During the passage of intake water various small organisms tend to grow as slimy deposits on the interior walls of the pipelines. Chlorination of water will kill the fouling organisms. This is eventually done by slug of chlorine or sodium hypochlorite solution to condenser intake water either continuously or intermittently. Addition of chlorine may exert effects on the receiving water body.

Emergency release of untreated or partially treated sewage-: It is proposed to re-use the wastewater generated from STP for gardening and other domestic purposes. Due to malfunctioning and plant failures, there may be occasions prompting the emergency release of untreated and or partially treated wastewater. This will lead to the deterioration in the water quality of the treated wastewater which may end up with high levels of BOD, SS, Bacteria counts etc.

Bioinvasion: As an allied facility, it is proposed to establish a marine aquarium. Such marine aquariums tend to exhibit exotic flora and fauna for improving the aesthetics and attraction.

Accidental escape of exotic species may lead to bioinvasion and may adversely affect the genetic pool of the local fauna if proper care is not exercised.

Movement of passenger boats: The impacts due to boat traffic will be due to exhaust emissions, garbage disposal, sewage discharge, hazardous waste release, boat noise emission, grounding/collision of boats, oil spills and bilge water release.

Corrosion: The marine environment is highly corrosive and suitable coating systems are to be used for protection of the structures. Maintenance is difficult and hence coatings are to be applied correctly and under the right conditions. Corrosion in the marine environment is 0.2 to 0.5 mm per year. Considering a design life of 300 years, additional material thickness of minimum 150 mm shall be provided as corrosion allowance for structural members and other components.

3.10 Mitigation Measures

- During the construction phase, the proposed activities will be notified to mariners and the area and the route through which the construction material will be transported will be demarcated by marker buoys. Prior to commencement of construction activity, local residents and fishermen would be advised about the construction, period of construction and associated activities.
- During construction phase, temporary colonies of work force will be established sufficiently away from the High Tide Line and proper sanitation including toilets and bathrooms will be provided to the inhabitants to prevent abuse of the intertidal area. Sewage and other wastes generated in these settlements will not be released to the marine environment.
- Contractors will use equipment, vessels, boats and barges that are in good working order, well maintained, and that have some noise suppression equipment (e.g. mufflers, noise baffles) intact and in working order. This will be achieved by making it a component of contractual agreements with the construction contractors. The noise level during piling, transport and erection of structures etc. will be kept to a minimum through proper lubrication, muffling and modernization of equipment.
- The vessels engaged in transporting the construction materials would implement a hazardous materials management plan that includes specification for proper storage and handling of fuels, oil, wastes, and other potentially hazardous materials as well as a plan for containment and cleanup of accidental spills into marine environment.
- The fortified wall would be designed to withstand the significant wave height with 100 year return period which is 6 m.
- The ground level of the project site is to be designed considering a sea level rise of 0.78 mm/year and the design life of the project.
- The routes of the passenger boats will be identified by markers and will be notified in the Naval Hydrographic charts.

- The passenger boats should be checked for leakages of fuel into the marine environment.
- To meet the situations arising out of cyclone/tsunami, areas would be made available on higher floors for the assembly of large crowds, and vertical transfers (airway) will be made available in situations.
- The berthing jetties will be on piles and hence are not expected to change the hydrodynamics of the area.
- The sea water intake well will be formed from a number of pre-cast units. The yard for construction of pre-cast units is to be selected away from the coastline.
- The top level of the intake structure will be at -3 m with respect to Chart Datum so that a draft of 3 m will be available for the fishing vessel. To avoid net damage due to the intake structure, proper marker buoy with light needs to be installed close to the intake structure. The location of intake well needs to be notified to the mariners.
- A trash rack with spacing of bar around 50 mm is to be installed at the intake. Travelling water screen with mesh opening of 5 mm x 5mm will prevent entry of fish into the intake system.
- During a cyclone warning, all the persons will be evacuated from the project site.

3.11 Environmental Monitoring Program

The monitoring of critical parameters in the project area is required during the operation phase to ensure that the impacts of the project do not exceed the legal standards and implementation of the mitigation measures are in the manner as described in the EIA report. Monitoring parameters and duration is presented in the report**.** Annual monitoring surveys will be undertaken to check the shoreline change along the Malabar Hill and the marine drive.

3.12 Environmental Management Plan

Broad environmental management plan is presented in **Table E1**. The responsibility of EMP action items lies with Public Works Department, Govt. of Maharashtra and construction contractors and the cost could be part of the construction contract.

Table E.1 : Environment Management Plan –Off Coast

Project Activity /Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional Responsibility	Implementation Schedule
Pre-construction						
Sheet pile	Loss of benthos	Use minimum required area while sheet pile	Driving location	Tender document to mention specifications-once	PWD	Part of detailed survey and design
Breakwater design	Change in hydrodynamics	Breakwater alignment to be as proposed	Hydrodynamics	breakwater alignment compliance once	PWD	Part of detailed alignment and design
Noise related	Nuisance to marine life	Design to ensure noise will not be a nuisance	Noise levels	Noise levels to be specified in tender documents –once.	PWD	Part of detailed equipment design
Escape of polluting materials	Environmental pollution	Construction vessels/barges to have oil spill contingency plan	Specifications with respect to oil spill contingency plan	Tender document to mention specifications - once	PWD	Part of detailed design
		Construction vessels/barges should comply with MARPOL convention and other Regulations. Vessels and boats should not be allowed to discharge bilge or waste into marine waters	Specification related to pollution control	Tender document to mention detailed specifications - once	PWD	Part of detailed design

Table E.1 : (Contd..) Environment Management Plan –Off Coast

Project Activity /Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional Responsibility	Implementation Schedule
Construction						
Equipment and installation vessel	Noise and vibrations	Construction techniques and machinery selection seeking to minimize noise	Construction techniques and machinery	Construction techniques and machinery creating minimal noise	PWD (Contractor through contract provisions)	Construction period
Discharge of Polluting material from Machinery/ Installation vessels/barges	Marine pollution	Construction Machinery/Installation vessels/barges to be well maintained	Leakage of oil and other pollutants	Complaint received by local authorities – every 2 weeks	PWD(Contractor through contract provisions)	Construction period
Physical construction	Disturbed fishing activity	Construction activities to be notified and explained to fishing community to avoid fishing activities during construction time	Interaction with fishing community	No. of meeting with from local fishing community – every 2 weeks	PWD (Contractor through contract provisions)	period Construction
Mechanical Construction	Impact to marine ecology	Use of minimum area	Change in turbidity and water quality	Water quality- every 2 weeks	PWD(Contractor through contract provisions)	Construction period

Table E.1 : (Contd..) Environment Management Plan –Off Coast

Project Activity /Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional Responsibility	Implementation Schedule
Construction						
Storage of Chemicals and materials	Contamination of receptors (land, water, air)	Fuel and other hazardous materials securely stored above high water level.	Location of Hazardous Material storage; spill reports (type of material spilled, amount (kg or m^3) and action taken to control and clean up spill)	Fuel storage in Appropriate locations and receptacles – every 2 weeks	PWD (Contractor through contract provisions)	Construction period
Provision of facilities for construction workers	Contamination of receptors (land, water)	Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities	Amenities for Workforce facilities	Presence of Proper sanitation, water supply and waste disposal facilities -once	PWD (Contractor through contract provisions)	Construction period
		Appropriate contact clauses to ensure satisfactory implementation of contractual environmental mitigation measures.	Compliance report related to environmental aspects for the contract	Submission of duly completed checklists of all contracts for each site - once		

Table E.1 : (Contd..) Environment Management Plan –Off Coast

Project Activity /Stage	Potential Impact	Proposed Mitigation Measure	Parameter to be Monitored	Measurement and Frequency	Institutional Responsibility	Implementation Schedule
Operation and Maintenance						
Operations and maintenance staff skills less than acceptable	Unnecessary environmental losses of various types	Adequate training in O&M to all relevant operational staff Preparation and training in the use of O&M manuals and standard operating practices.	Training/ Awareness programs and mock drills for all relevant staff	Number of programs and percent of staff covered - once each year	PWD	Operation
Inadequate periodic environmental monitoring.	Diminished ecological values.	PWD staff to receive training in environmental monitoring of project operations and maintenance activities	Training/ Awareness programs for all relevant staff	Number of programs and percent of staff covered -once each year	PWD	Operation
Water quality monitoring	Damage to marine environment	PWD staff to receive training in environmental monitoring of project operations and maintenance activities	Training/ Awareness programs for all relevant staff	Once in a year	PWD (by third party)	Operation
Shoreline survey to check for the changes	Damage to marine environment	PWD staff to receive training in environmental monitoring of project operations and maintenance activities	Training/ Awareness programs for all relevant staff	Once in a year	PWD	Operation

4. On Land Environment

The scope of work that were carried out for EIA of land environment by **CSIR-NEERI** includes: i) To assess existing status of major environmental components of the project area, viz., water, air, noise, land, biological, socio-economic and cultural aspects as facilities close to place where people would travel from. ii) To identify potential impacts on various environmental components during construction and operation phases. iii) To predict and evaluate significant impacts through calibration and validation of appropriate mathematical simulation models. iv) To prepare Environmental Management Plan (EMP) outlining the control strategies to be adopted for minimizing the adverse impacts.

All the work components contribute towards the general social facilities and tourism enhancement infrastructure without impacting environmental and public health. The implementation of the above project shall bring socio-cultural awareness and well planned facilities for recreation, education and safety/disaster prevention. The purpose of environmental study is to ascertain sustainable tourism development. Tourism carrying capacity is a required concern in Environmental Impact Assessment. It is applied to proposed development projects and programmes in order to evaluate the potential impacts in light of forecasted tourism growth and peak demand.

The data collections on land area for baseline environment were carried out during post monsoon and winter seasons. These sections are based entirely on secondary data and some primary data. Under 10 km radius land area is having municipal corporation boundaries of A, B, C, D, E, F/S, F/N and G/S, population of about 31 million as per census 2011. Vehicle statistics suggest that percentage increase in Mumbai central area 1.22% as against 5.8% for greater Mumbai. On land Monthly relative humidity ranges between 57-87%, city's annual rainfall of 2,200 mm, temperatures range from a high of 38°C to a low of 11°C, morning visibility varies between 4 and 10 km. Highest average wind speed is of 18 km/h.

Air quality was monitored during study period at 11 locations near proximity of the study area for criteria pollutant as per National Ambient Air Quality Standards from October 2013 and will be Monitored till September 2014, which reveals that there is steady increase of percentage in air pollution to the national standards. Past 10 years data for PM and NOx also explain that the air quality has gradually increased in terms of emission loads and thus necessitates the implementation of strict control measures in terms of technology and policy. During this study period the average SO_2, NOx concentration ranges from 6.0-7.5 $\mu g/m^3$ and 8.1 to 66.53 $\mu g/m^3$ respectively; NH_3 ranges from 9.3 to 163.37 $\mu g/m^3$. The average RSPM and $PM_{2.5}$ ranges from 38.2 to 179.57 $\mu g/m^3$and 13.22 to 132.9 $\mu g/m^3$ respectively during monsoon and winter season. The highest observed noise level was at Air India Building is 154.57 dBA. However, at all most all locations the

levels were above the regulatory standard. At Malabar Hill Police Station the levels were much above 45 dBA standard for residential area.

Water quality during post-monsoon, winter and pre-monsoon physico-chemical and microbial analysis of tap and ground water, nallah and drains towards west coast, wastewater treatment facility, chemical analysis data of coastal water during low and high tides, water quality of outfalls and beaches including microbial data was taken from the latest available study, 'Comprehensive EIA for Mumbai Sewage Disposal Project' (2011) report prepared by NEERI for MCGM, 2007. This also included phytplanktonic, zooplanktonic and benthos counts and composition in the coastal waters in the study area.

The groundwater sources evaluated indicated presence of microbial indicator organisms. Surveillance of the potable water resources, including the distribution system indicated that quality satisfied drinking water BIS standards. BOD in effluent at Colaba and Worli WWTF's was in the range of 140- 316 mg/l, while COD in effluent was in the range of 200-600 mg/l at Colaba and Worli WWTF's. The BOD in nallahs and drains ranged from 35-235 mg/l and COD ranged from 72 – 613 mg/l. The BOD in coastal water low tide ranged from BDL – 4 mg/l and during high tide BOD ranged from BDL to 4.8 mg/l. In the outfall BOD ranged from 1.8 – 5 mg/l and in beach water BOD was 1.8 - 6.8 mg/l. At all the above mentioned locations Fecal coliforms was in the range of 10^3 to 10^7 cfu/ 100ml. Microbial water quality in terms of FC count was poor and found to be in non-compliance of the stipulated standards at any location in the marine water.

Aquatic fauna and flora richness : The aquatic ecosystem of the west coast constitutes of phytoplankton, zooplankton, and benthos. Phytoplankton comprises of 5 groups and 42 genera in west coast. Zooplankton comprises of 15 groups of 34 genera in west coast. Benthos represents an important secondary consumer and decomposers of the marine environment. Total 62 species belongs to 11 groups were observed in the west coast**.**

Terrestrial fauna and flora richness : The study zone comprises of wide variety of flora and fauna, the general composition and character of vegetation in the study area are of same type throughout the area. This includes 69 species of angiosperms, 1 species of Gymnosperms. 27 species of shrubs, 25 species of herbs, climbers and grasses. Nearest Zoo (*Jijamata Udyan)*having4 species of Avifauna, 2 reptile species and 4 mammalian species. None of the faunal and floral species found fall under rare, threatened and endangered category. The study comprises of eight wards A, B, C, D, E, G/S, F/N and F/S. There is no agricultural activity in the area but there are interspersed green areas.

Unbridled development activity has led to ecological changes and in turn diverting the avifauna away from Mumbai Region. Some data available from Mumbai bird race shows decline in bird sightings specifically in Mumbai city region.

The *Current Population* for the entire study are is around 31,07,000 leading to the density of population 47940.13 per sq km compared to the ideal 15000 persons per sq km i.e.3.16 times more than the ideal. As regards to study area population varies from 1.48 million to 6.02 million. 'G/N' ward has highest population density which is 7 times more than the ideal. 'F/N' ward has 3.18 times more population than the ideal. Only Ward 'A' has population density almost equal to the ideal condition, all other wards are highly dense with density more than 37 times than the ideal.

- Study area ideal ***Residential Area*** following the norms of 40% of developed area, 25.93 sq.km is the ideal residential area as per the area of study area, whereas the actual residential for entire study area is 16.654 sq.km, which is 25.70% developed as compared to the 40%.
- For ideal city ***Commercial Area*** following the norms of 5% of developed area, 3.24 sq.km is the ideal commercial area for the study area whereas the actual present commercial area for entire study area is 3.02 sq.km, which is 4.66% of total area.
- Ideally in a city ***Office Area*** following the norms of 16% of developed area, 10.37 sq.km is the ideal area for offices whereas, the actual office area for entire study area is 1.34 sq.km i.e. 2.07% of the total area.
- ***Industrial Area*** following the norms of 14% of total development area, 9.07 sq.kmis the ideal industrial area whereas the actual present industrial area for entire study area is 4.38 sq.km which is 6.76% of the total area.
- For study area ideal ***Natural and Open Area*** following the, norms of 3 sq.m/capita, 9.321 sq.km is the ideal Natural and open area space requirement as per the current city population whereas this requirement may vary to 2.913 sq.km as per the ideal city population. The actual present area for Natural and open spaces in entire study area is 8.24 sq.km, i.e. 12.71% of the total area. It is coming as 2.65 sq.mts per capita.
- For study area ideal ***Education Amenities*** following the, norms of 2sq m/capita for developed area; 6.21sq.km area is required for educational amenities in the present population scenario. But according to the ideal population size in the city; it is 1.942 sq.km, whereas the actual present area for education amenities in entire study area is only 1.57 sq. km, which is 2.42% of the total area. It is coming approximately is 0.51 sq.mts per capita available for the city.
- ***Medical Amenities***: The 0.24 sq.km is the area required for medical amenities in the ideal condition of population whereas this is 0.78 sq.km for the present population scenario. And the actual present area for medical amenities in entire study area is 1.82sq.km which is around two times more than required for the ideal condition.

- For ***Welfare Activities*** following the norms of 0.132, 0.133 (Public Hall) sq.m/capita in developed area 0.13 sq.km is the ideal area for welfare activities in ideal condition whereas 0.41 sq.mts is required according to the present population. The actual present area for welfare activities in entire study area are 0.07 and 0.14 (ph) per sq.km.
- ***Law and Order Facility*** in Wards: The area required for police stations is 0.48 sq.km but the actual area in present condition is 0.07 sq.km only. Similarly the area required for police chowky is 0.93 sq.km whereas the current situation is available area of 0.02 sq.km only. Total 44 numbers of police stations are available in Study area to take care of peace and order.
- ***Public Utilities & Facilities*** in Wards: As for study is concerned total area required for Public Utilities and Facilities is 0.48 sq.km according to the present population condition and it is 0.44 sq.km in present condition which is close to the ideal condition according to the norms.
- ***Fire Stations*** in Wards: As for the overall study are is concerned total area required for the fire station facility is 0.249 sq.km according to the present population condition but it's mere 0.033 sq.km in present condition which is very low as per the norms.
- ***Transportation Facilities*** in Wards: Total area required for transportation facility is 11.67 sq. km as the entire study area is 64.81 sq.km, whereas the present condition is only 6.23 sq.km which is almost half of the ideal condition.

***Water Supply and Wastewater Disposal*:** At present the domestic, commercial and industrial water supply is to the tune of 3450 million litres per day (MLD). **Zone I** Colaba covers an area of 574 ha. This contains six pumping stations and about 32 km of sewers leading to preliminary treatment and the short pipe outfall to Colaba Harbour. **Zone II** Worli covers an area of 3891 ha. This contains sixteen pumping stations and about 339 km of sewers leading to preliminary treatment and 3 km long sea outfall at Worli, discharging to the Arabian Sea.

The total number of ***Tourist visit*** from domestic sector and visit of foreigners in Mumbai City are around 28668587 and 1705016 respectively, however in Mumbai suburban area it is around 4951756 domestic and 56831foreigners respectively. As per the monthly estimates prepared by Ministry of Tourism, FEE from tourism in India in2011 were 77591 crore as compared to 64889 crore in 2010 registering a growth of 19.6% in 2011 over 2010. The foreign tourist visits in Maharashtra is 25% of those visiting India.

4.1 Expected Environmental Impacts

Air quality is likely to be impacted adversely. Levels of NOx, RSPM and $PM_{2.5}$ are expected to rise due to increased vehicular movement. During the day, wind blows from sea to land and during night wind blows from land to sea. Thus sea breeze affects the transfer of pollutants during day and land breeze during night.

Around 10,000 visitors per day and 3000 visitors at peak hours are expected to visit the memorial site. Assuming that all the visitors will travel from Gate way of India and the increase in vehicles in the stretch from regal to Gateway of India during this period will be approximately 1000 vehicles per day assuming both way trip.

It is assumed that the memorial will be open from 10.00 am to 8.00 pm. It is assumed that the vehicles will be four wheelers, 110 diesel private cars, 110 petrol private car, and 100 each taxi (CNG), 90 bus diesel, and 90 bus diesel and CNG. Increase in emission load of CO, HC, NOx, and PM in the area for routes A and C have been estimated. Increased Emission loads are given in **Table E2**.

Table E2 : Vehicle Emission Load from Routes Approach Areas

Route	Emission Load (Kg/year)			
	CO	**HC**	**NOx**	**PM**
Route A : (S P Mukherjee Chowk to Gateway of India)				
Car (Petrol)	129.13	8.15	5.15	0.26
Car (Diesel)	28.32	10.73	26.17	7.72
Taxi (CNG)	23.4	14.04	0.39	0.078
Bus (Diesel)	639.80	87.18	458.80	65.14
Bus (CNG & Diesel)	198.9	12.27	308.30	41.11
Route C : (Girgaum Chowpatty to Gateway of India)				
Car (Petrol)	1112.50	70.22	44.35	2.28
Car (Diesel)	243.94	92.4	225.46	66.53
Taxi (CNG)	201.6	120.96	3.36	0.67
Bus (Diesel)	5512.08	751.13	3952.70	561.20
Bus (CNG & Diesel)	1713.6	105.67	2656.08	354.14

Total Increase in existing emission load from **All Vehicle** types is given below

Route	Emission Load (Kg/year)			
	CO	**HC**	**NOx**	**PM**
Route A : (S P Mukherjee Chowk to Gateway of India)	1019.54	132.37	798.80	114.30
Route C: (Girgaum Chowpatty to Gateway of India)	8783.71	1140.38	6881.95	984.77

In order to ferry 10000 visitors to memorial site 20 motor boats with capacity of 100 persons each is envisaged. This amounts to 5 trips of 20 motor boats up and down during a day. The movement of these boats will cause air pollution and coastal water pollution. Pollution estimates per kilogram of diesel fuel used is given in below **:**

Emissions Due to Motor Boats

Parameters	Emissions in grams per Kilogram of fuel used					
	HC	NO_x	CO	PM	SO_2	VOC
Air	2.4	57.1	50.5	1.2	64.1	--
Water	--	--	--	1.33	--	428.6

**Emission factors based on Reid et al., 2002 (USEPA) and Netherlands National Water Board, 2008*

Especially fine particles contain microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including: premature death in people with heart or lung disease, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, and increased respiratory symptoms, irritation of the airways, coughing or difficulty breathing. People with heart or lung diseases, children and older adults are the most likely to be affected by particle pollution exposure. However, even if you are healthy, you may experience temporary symptoms from exposure to elevated levels of particle pollution.

Fine particles ($PM_{2.5}$) are the main cause of reduced visibility (haze). The effects of particulate settling include: making lakes and streams acidic; changing the nutrient balance in coastal waters and large river basins; depleting the nutrients in soil; damaging sensitive forests and farm crops; and affecting the diversity of ecosystems. Particle pollution can stain and damage stone and other materials, including culturally important objects such as statues and monuments.

Congestion: The road widths in the area are not sufficient to accommodate increase of 1000 vehicles per day considering both way trip. Though over all area required for transportation facility is 11.67 sq.km and wards A, B and C have 31.77%, 63.39% and 13.86% for transportation facility respectively, the road stretch from Regal to Gate way of India is not wide enough to take the load. Thus unmanageable traffic jams are anticipated with expected increase in number of vehicles during the day. Additional road space elevated or new sea link from NCPA to Gate way of India will be required to be created backed by transport models on the basis of detailed study of traffic pattern, trip characteristics etc. Alternately another boarding points needs to be explored. Multi-level parking at Gate way of India needs to be provided.

Expected Impact on ***Climate Change*** : Tourism and travel contribute to climate change through emissions of greenhouse gases(GHGs), including in particular CO_2, as well as methane (CH_4), nitrous oxides (N_2O), hydro fluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6). VOCs contribute to global warming. In the study area 60 VOCs have been identified and 35 have been quantified. Amongst these 15 VOCs belong to the list of Hazardous Air Pollutants. VOCs quantified in the study area have global warming potential (GWP) and also ozone forming potential (OFP). Ozone formed at ground level leads to smog formation and thus low visibility. The present activities contribute to global warming equivalent to 4.01 Tonnes of CO_2 per

day. Total ozone being formed in the study area is 500 gms per day. It is expected that VOC and aldehyde emissions will increase nearly two times with influx of 10000 visitors per day.

Water and Wastewater: As the site is away from mainland, it is proposed to have a desalination plant of capacity 6 m^3/hr based on Reverse Osmosis technology for drinking water. The quantity of seawater intake is 432 m^3 per day. The seawater intake location will be at the tip of the breakwater in the northeast direction. Wastewater and brine generated from the facility will be treated and used for domestic purposes and gardening and there will be no discharge into the sea. **(Annexure B).** RO reject is proposed to be disposed at location where proper dilution is available. Assuming complete removal of dissolved solids in permeate, TDS of reject flow would be about 53000 ppm.

The analysis of tourist data shows that 95 percent of visitors in Greater Mumbai are domestic tourist and 5 percent foreign tourist. 64 percent domestic tourists stay in Hotels, whereas 100 percent foreign tourists stay in Hotels. As per the WTO country wise averages water use per tourist per day for India is 150 litres. Assuming 10000 visitors per day number of tourist staying in hotels work out to be 6580. This creates an additional demand of 98700 litres per day. Besides considering a very conservative figure of an average requirement of 30 lit per capita for sanitation and drinking for local tourist another burden of 1026000 litres per day is envisaged. An additional arrangement for supply of 1089600 litres per day will have to be made by MCGM or Memorial Authority.

Assuming that washroom usage by each visitor results in generation of 7 liters of wastewater, there would be 70,000 liters of wastewater generated per day. This would have a BOD load of 17500 g per 70,000 liters (average inlet BOD being 250 mg/l) per day. The additional load of wastewater generated by the visitors will worsen the current situation, where already the discharge standards are not being met. The boarding stations will have to be equipped with amenities which will support such additional load. The domestic sewage generated at the memorial site will be treated using RBC technology, this water is proposed to be used for gardening and other non-potable uses, and hence no discharge is envisaged.

The ***Solid waste*** generated by the tourist's population at the memorial site would include materials from the cafeteria such as empty cans, bottles, tins and glass, left-over food, paper serviettes, coasters, straws etc. In general 112 g/p/visit is the waste produced in a restaurant. Therefore, if a large figure of 10,000 visitors goes to the cafeteria then the total waste produced could be approximately 1.12 tonnes/ day. MCGM will have to arrange for collection and disposal of this additional quantity of waste near Gateway of India.

4.1.1 Expected Biological Impact

Impact of Dust : Effects of particulate matter on vegetation may be associated with the reduction in light required for photosynthesis and an increase in leaf temperature due to changed surface optical properties. This reduces photosynthesis due to reduced light penetration through the leaves and leads to reduced growth rates and plant vigour. Alkaline dust materials may cause leaf surface injury while other materials may be taken up across the cuticle.

Construction activity of the project envisages generation of dust and noise. The extent of the direct impact of the construction activity on the onshore fauna and flora will depend on the wind direction and intensity due to location of the site away from the land. Onsite there is no vegetation and faunal species.

Effects on Birds : Illumination during construction and post construction could adversely affect marine birds. Many birds and animals are affected by stray light intruding into their night world, confusing their natural patterns, deterring them from established foraging areas, and affecting their breeding cycles (causing premature breeding).

Effects on Wind Farms on Birds - particularly raptors like eagles or vultures are likely to come into contact with the turbines. There are deaths through collision or interaction with turbine blades. It's not just the turbine blades that pose a risk to birds; research indicates that wind developments can disrupt migration routes.

4.1.2 Effect on Infrastructure

Facilities will be required to be created for 10000 persons per day in terms of drinking water, eateries and toilets. The existing facility is not enough and hence needs augmentation. There will be added stress on existing facility of toilets, food courts and transportation. Socio economic and metropolitan cultural environment will be impacted severely. Major impacts are on local residing transport with congestion and increased of road side vendors.

It is expected that besides generation of employment at memorial site for up keep, safety, recreation, food court etc. of 200 people, some employment may also get generated at boarding point. Licenses for small road side vendors is not envisaged in DPR, however marginal increase in non-licensed small mobile vendors is foreseen. Sale of packaged drinking water, snacks and souvenirs from existing shops will increase. Government of Maharashtra does not envisage any considerable revenue generation, but contractors of boats, recreation facilities, food court etc. will involve considerable revenue generation. An estimate of the same is not possible presently as details of facilities and pricing have not been fixed.

In general aesthetics, public convenience, sentiments etc. have been addressed at large by the project proponent. However for the sake of wider reach and maintaining transparency authorities may consider obtaining public opinion specifically through public meeting, newspaper, electronic media etc.

***Expected Economic Benefits* :** Tourists visiting Mumbai comprise of non-leisure and leisure tourists. 52.5% tourists are non-leisure tourists and 47.5% are leisure tourists. Amongst the domestic tourists the leisure tourists are 15071400 and non-leisure tourists were 17237418. Amongst the foreign tourists the leisure tourists are 1105716 and non-leisure tourists were 630857. With the erection of the memorial it would attract leisure tourists due to the historical significance of the memorial. The leisure tourists visiting Mumbai would need to stay for an extra day to visit the memorial. The economic gains due to leisure tourists would be Rs 8703.89 crores. The non- leisure tourists would visit the memorial once due to its novelty. Hence, one time economic gains due to non-leisure tourists would be Rs 8754.67 crores.

4.2 Mitigation Measures

Construction Phase : During construction phase pre mixed concrete is proposed to be pumped using 4000hp pump from Raj Bhavan to Memorial site. This concrete will be transported by trucks approximately 50 nos. during night hours to avoid congestion during day time. However, noise and air emissions need to be handled carefully. The trucks chosen for transport should have low noise and low emission compliance. The pump should be rated for low noise and enclosed within noise barriers to reduce the noise level. The observed noise level during night at Malabar Police Station is 80 dBA which is much above the regulatory standard of 45 dBA for residential area.

Operational Phase : Air Quality is expected to deteriorate due to increased vehicular movement. It thus suggested that following control options should be considered.

- Adopting new vehicle standards viz Bharat IV
- Using cleaner fuels like CNG /LPG in some percentage of vehicles
- Implementation of maintenance and inspection schedule
- Synchronization of traffic
- Ban on 8 years old vehicles
- Provision for underground/multi storied parking space at boarding points.
- Restriction on private vehicles and introduction of luxury public transport
- Check on adulteration
- Declaration of silence zones
- Use of cleaner fuel (CNG) in motor boats

Traffic Management

- Provision of alternate route to Gate way of India. Elevated corridor or sea link may be explored based on transport models on the basis of detailed study of traffic pattern, trip characteristics etc.
- Multi-level parking at Gate way of India needs to be provided.
- Alternately another boarding points needs to be explored.

Water Environment -Onland

- Provision for toilet facilities at boarding points
- Boats to be equipped with toilets with collection/treatment facilities
- Toilet, drinking water and eatery facility onshore at boarding points should be as per 3000 persons/ peak hours and for 10,000 visitors/ day.

Water Environment -Off Coast

- STP is proposed to be installed. Effluent complying with CPCB Discharge Standards General Standards for Discharge of Environmental Pollutants Part-A : Effluents for marine coastal areas can be discharged at appropriate location. Alternately it can be used for land irrigation in the garden if meeting the quality according to the above standards. The treatment capacity of the STP should be such that it treats sewage generated by 3000 persons at peak hours and for 10000 tourists per day plus 200 people residing at the memorial site.
- RO reject is proposed to be disposed at location where proper dilution is available. Assuming complete removal of dissolved solids in permeate, TDS of reject flow would be about 53000 ppm.

Biological Environment

- **Effect of Light :**In order to avoid impact of light on birds the type of lights used can be adjusted, so that the light waves emitted are less likely to cause severe light pollution is important. This can include replacing older high pressure mercury vapour lights with **high pressure sodium vapour lamps** and combining them with “full cut-off luminaries” to reduce energy waste and glow.
- Different wavelengths of light have different attractiveness to animals. White lights appear to be the worst offenders for bird attraction, with yellow lights performing better in this aspect. **Red and blue lights are the least attractive**. This may be important in the construction of tall buildings with lightson top of them and in the lighting of cranes etc.
- Impact of wind farm can be reduced by some referring preventive measures can help to reduce bird mortality.
  - Create feeding sites away from turbines and shut down turbines at peak flight times.
  - Use maps to identify high risk areas for protected birds.
  - Use radar systems to detect flocks of birds and shut off the wind turbines as they approach
  - may be considered.
  - Study the flight path of local and migratory birds with help from BNHS.

Safety Security Plan

Emergency evacuation during natural and manmade calamity : Emergency may take many forms, including earthquakes, fires, civil unrest, explosions, terroristic activities, flood, storm, utility failures, etc. The primary purpose of this emergency plan is to provide comprehensive guidance on the measure that will be taken to prevent, prepare and implement the actions in response to a broad range of emergencies that could potentially occur at the Shivaji Memorial Statue island and focuses on the concept of prevention and preparedness in minimizing the extent and impact of the emergencies that may arise in association with all phases of Project activities.

The guidance and procedures provided in this plan are designed to uphold policies for minimizing potential hazards to human health, environment and property. Preplanning, preventive measures, training and efficient execution of the procedures outlined in this plan should collectively minimize the potential hazards and reduce the potential impact of hazardous operations within the project's footprint. The security will consult and engage the local emergency responders and will formulate cooperative agreements on all anticipated response scenarios prior to the opening of the center.

4.3 Environmental Management Plan - On Land

Some issues of serious concern have emerged out of the preliminary analysis of environmental and proposed activity data viz. air and coastal water pollution, traffic congestion, size of visitors, and additional load of service utilities on Municipal Corporation etc. Based on interim environmental study and present DPR environment management plan is given in **Table E3.**

5. Project Benefits

The proposed memorial and statue of Chhatrapati Shivaji Maharaj, the revered king and founder of Maratha Kingdom off the Coast of Mumbai in the Arabian Sea is aimed at not only providing a place to visit but also to create an internationally acclaimed landmark for our nation. The implementation of the said project shall bring socio-cultural awareness and well planned facilities for recreation, education and ideas interchange. It will also place Mumbai as a place with unique attraction of tallest statue in the World for people to visit. It will provide a facility to learn and experience the history of Maharashtra and also of India with library, digital library, Marine Biodiversity Sensitisation Centre, Laser Show, light & sound show in theatre.

Table E3 : Environment Management Plan – Onland

	Potential Impact	Proposed Mitigation measure	Parameter to be Monitored	Measurement of frequency	Institutional Responsibility	Implementation Schedule	Remarks
Construction Phase -Onshore Impact							
Transport of construction material to Raj Bhavan site (50 trucks per day from 11 pm to 5 am.)	Increase in Air pollution (RSPM, NOx) Impacting Human Health (asthma, decreased lung function etc). Noise levels would further increase over the current levels which is expected to go above the permissible levels given by CPCB of 45 dBA	Trucks chosen for transport should have low noise and low emissions and comply with the norms. However best maintained trucks would have noise levels between 85 to 95 dBA per truck. Alternate route of transportation should be explored. Transportation by sea route may be considered.	RSPM, $PM_{2.5}$, NOx, Noise levels	Weekly	PWD	Construction period	The area is residential area and the roads are not wide enough for transportation of trucks. Best maintained trucks also will not be able to meet standards for night time in residential area. There is also a religious place a Jain Derasar of historic importance. This can create social conflict
Pumping ready mix concrete from Raj Bhavan (Pump capacity 4000 hp)	Noise levels are expected to increase due to pump operation	Barriers are required to be installed to reduce noise levels	Noise Levels	Daily	PWD	Construction period	--

Table E3 (Contd..) : Environment Management Plan – Onland

	Potential Impact	Proposed Mitigation measure	Parameter to be Monitored	Measurement of frequency	Institutional Responsibility	Implementation Schedule	Remarks
Operational Phase -Onshore Impact							
On land visitors traveling to the boarding points (10,000 visitors/day) From regal to Gateway of India, increase in vehicles in the stretch will be approximately 1000 vehicles per day assuming both way trip 100 boats of capacity 100 persons approximately 5 trips per day, considering 20 boats plying at a time	1) Air pollution due to increase in traffic (RSPM, NOx), increase in noise levels, air pollutants will impact human health adversely; dusts will also have an adverse effect on flora and avifauna. Deterioration in coastal water quality 2) Traffic congestion	1) Adoption of new vehicle standards 2) Additional road space elevated or new sea link to be created backed by transport models on the basis of detailed study of traffic pattern, trip characteristics etc. Alternately another boarding points needs to be explored. Boats to use cleaner fuel such as CNG. Multi storied parking to be created.	RSPM, $PM_{2.5}$, NOx, Noise levels Traffic count and pattern	Weekly Daily	MPCB Traffic Police	On operation	Traffic police and MPCB and MCGM should be consulted for monitoring and traffic management.

Table E3 (Contd..) : Environment Management Plan – Onland

	Potential Impact	**Proposed Mitigation measure**	**Parameter to be Monitored**	**Measurement of frequency**	**Institutional Responsibility**	**Implementation Schedule**	**Remarks**
Stay of tourists in hotels and total of 10000 visitors per day	An additional requirement of 1089600 litres of potable water per day will be there. *(See Chapter 4)* 90000 lit per day of waste water will be generated	MCGM will be required to make arrangements for 1089600 lits of potable water and treatment of 90000 lit of waste water per day.	Wastewater quality parameters like COD, BOD, TDS,PO_4, NH_3, Total nitrogen, turbidity, pH, Total and Ecoli Coliforms	Weekly	MCGM	On operation	Increased burden on Zone I of MCGM
Services at Boarding Point	Additional solid waste generation of 3000 Kg per day is predicted	MCGM will be required to make arrangements for collection and disposal of solid waste generated. Disposal bins for degradable and non-degradable waste must be installed.	Quantity of waste generated	Weekly	MCGM	On operation	Increased burden on Zone I of MCGM

Table E3 (Contd..) : Environment Management Plan – Onland

	Potential Impact	Proposed Mitigation measure	Parameter to be Monitored	Measurement of frequency	Institutional Responsibility	Implementation Schedule	Remarks
Operational Phase -Memorial Site							
Desalination of sea water using RO for drinking. Water Facility for 3000 visitors at peak hour and 10,000 visitors/day at the site.	Increase in Salinity of sea water	RO waste to be disposed seawards at a point, where sufficient dilution is available	Salinity of sea water	Weekly	Memorial maintenance authority	On operation	--
107600 litres per day of waste water generated by visitors	Deterioration in quality of sea water	RBC is proposed to be installed and waste generated to be used onsite for gardening etc.	Water quality around the Island	Monthly	Memorial maintenance authority	On operation	--

Table E3 (Contd..) : Environment Management Plan – Onland

	Potential Impact	Proposed Mitigation measure	Parameter to be Monitored	Measurement of frequency	Institutional Responsibility	Implementation Schedule	Remarks
Operational Phase -Memorial Site							
Approximately 1.5 tonnes of solid waste generated due to food consumption onsite by tourists and solid waste by 200 residents on site and 10000 tourist per day	Deterioration in quality of sea water	Vermi composting has been proposed	Water quality around the island	Monthly	Memorial maintenance authority	On operation	--
Illumination of the site	Load on land power supply Impact on birds	Wind power proposed to be used to reduce pressure on onland power supply companies High pressure sodium vapor lamps. The use of Red and Blue light which are least attractive to the birds can be considered.	Observing bird deaths Identifying changes in migratory paths	Monthly	Memorial maintenance authority	On operation	Commitment for power supplying agencies like MSEB to be obtained for power supply without cut to general public.

Table E3 (Contd..) : Environment Management Plan – Onland

	Potential Impact	Proposed Mitigation measure	Parameter to be Monitored	Measurement of frequency	Institutional Responsibility	Implementation Schedule	Remarks
Operational Phase -Memorial Site							
Power generation (Wind Farms)	Impact on birds. Over all aesthetics of the memorial could be impacted due to view of wind farms. If it is at lower level, it's not likely to give real power inputs. At higher level, it would impact aesthetics. Further, wind in Mumbai is not adequate enough for economical wind energy	Use of maps for identifying routes of birds flying. Use of radars to detect bird flight and shut off wind turbine before they approach. This proposal need not be considered except as an experimental basis. In its place, PV panels can be considered as an alternative.	Observing bird deaths Identifying changes in migratory paths	Monthly	Memorial maintenance authority	On operation	--

Table E3 (Contd..) : Environment Management Plan – Onland

	Potential Impact	Proposed Mitigation measure	Parameter to be Monitored	Measurement of frequency	Institutional Responsibility	Implementation Schedule	Remarks
Operational Phase -Memorial Site							
Safety and Security	Terrorist activity, Natural disaster, stampede etc	Screening scanning of all visitors at boarding point and at entry of island There must be two guards on each boat, preferably traditionally dressed to enhance tourist attraction No boats should to allowed within500m around the island No boats in the area should move with the speed more than that of coast guard boats CCTV cameras to cover whole area	See section 5.3 & 5.4	Daily	Memorial maintenance authority	On operation	