EIA for the Airport Development Project at Haa Dhaal Kulhudhuffushi

Prepared for:

Regional Airports

Consultant:

Zahid (EIA P20/2012)

October 2017

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Consultants Declaration

I certify that to best of my knowledge that the information provided in the Environmental Impact Assessment report for the proposed Airport Development Project at Kulhudhuffushi are true, complete and correct. I also certify that the information provided and statements made in the report was gathered through field survey (primary data), secondary data, from the literature and interpretation of these information.

Name: Dr. Zahid

EIA Consultant Registration Number: EIA P20/2012

October 2017

Proponents Declaration

بسم الله الرحمن الرحيم

ދިވެހިރާއްޖެ ޓޫރިޒަމް ދާއިރާ - ދިގު ހިލަނޑި ހަވާލާ ކުރެވުނު

ދިވެހިރާއްޖެ ކުޑަ ދަތުރުތަކުގެ ދާއިރާ

Regional Airports

ޓޫރިޒަމްގެ ވަޒާރާ

Ministry of Tourism

Ref: 448/203/2017/13

Date: 18th October 2017

Mr. Ibrahim Naeem,
Director General
Environmental Protection Agency
Ministry of Environment and Energy,
Green Building,
Ameenee Magu, Maafanny,
Male' 203092, Maldives

Proponent's Declaration and Commitment: EIA for the Proposed Airport Development Project at Kulhudhuffushi

This is to confirm as the proponent of the proposed Airport Development Project at Kulhudhuffushi, that the following activities will be carried out as scheduled below:

Activities to be carried out:	Schedule of activities
1. Relocation of endangered species to another area (approved by relevant authorities) with similar environmental conditions if endangered species exists in the project area. If it is required, monitoring plan will be provided (approved by EPA) to monitor the wellbeing of the species once they are relocated to the new area	3-4 months from EIA approval
2. Make arrangements to declare and manage a new protect area with similar environmental features, under the guidance of EPA	2-3 months from EIA approval
3. Propose an appropriate drainage system to control flood water and for the implementation of the drainage system	1-2 months from EIA approval

	(Tel)	(Fax)	E-mail address/ ލ.ޕ.ދ	(ފެކްސް)	(ފޯން)	
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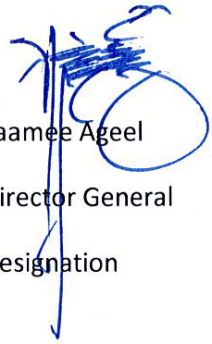
We also confirm that we have read the report and to the best of our knowledge that the information provided in the report in relation to the proposed project (project description activities, operation of the facility) are accurate and complete.

We hereby confirm our commitment to finance all mitigation measures and monitoring recommended and specified in the report.

Thanking you,

Sincerely yours,



Saamee Ageel

Director General

Designation

	(Tel)	(Fax)	E-mail address/	(ދިވެހި)	(ފެކްސް)	
Regional Airports Office	332 3776	332 0911	regional@airports.gov.mv	332 0911	332 3776	ދިވެހިރާއްޖެ ތަނަވަސް ދަތުރުގަ
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1. Non-technical Summary

This environmental impact assessment was undertaken by Dr. Zahid, contracted by Maldives Transport and Contracting Company for the development of a domestic airport at Haa Dhaal Kulhudhuffushi, Maldives. According to Regional Airports, allocated budget for the project is about USD11.4 million.

Kulhudhuffushi is an inhabited island located on the south of Haa Dhaal atoll. Kulhudhuffushi is one of the most populous island in the north with a population more than 9000 people. The length of the island is approximately 2.5 km and 0.89 km in width. The most significant natural feature of the island is existence of two wetland areas (Kulhi). The larger one is in the northern end and small one in the south end of the island. Most dense vegetation exists near the wetland area and eastern side of the island. Due to the high population compared to the land size, already there is pressure on the limited available land area.

The project involves the development of a domestic airport with runway length of 1220m by 30m width, taxiway with length of 90m and width of 15m and an apron with length 150m and width 45m. In addition to this, a passenger terminal, a control tower and safety buildings will constructed at the Kulhuduffushi airport. Under the project, other related services also will be established at the domestic airport. According to Regional Airports, the proposed runway to be constructed to ICAO standards and will be approved by the Civil Aviation Authority of Maldives.

The proposed airport development involves the clearing of about 6 Ha area of the island. In addition to this, the domestic Airport at Kulhudhuffushi is proposed to be built by reclaiming part of Kulhi and wetland area, located at the northern end of the island. This wetland area has been listed as a "environment sensitive area" due to the unique environmental features of the area. In addition to reclaiming wetland area, for building the airstrip, two areas are proposed to be reclaimed from the sea area as well (two ends of the runway will be built by reclaiming the sea area). Dredging and reclamation will be undertaken by a Trailer Suction Hopper Dredger and borrow area will be from the deep sea . Kulhudhuffushi airport development project activities (construction phase) will have considerable negative impacts on the environment and will have some positive and negative impacts during operational phase.

During construction phase, the wetland area will be highly modified and vegetation will be removed from a large area. Environmental values of the environmental sensitive area will be reduced due to the vegetation clearance and reclamation. The main impact is the permanent loss of habitat for the flora and fauna and loss of terrestrial vegetation and deforestation of part of the area allocated for runway and other facilities development. Reclamation of Kulhi also will have impacts due to sedimentation and fish around Kulhi will be impacted from sedimentation. The wetland area surrounding the Kulhi acts as a

natural catchment area for flood mitigation. If proper drainage system is not established, the area will experience flood impacts.

Associated with reclamation of the sea area for airstrip development, main negative impact would be that of sedimentation on the nearby reef areas. Already the marine environment of the project area is not in very healthy condition. Hence, any additional activity will have far damaging impact on the marine environment. Sedimentation impact associated reclamation is considered to be direct and limited to the construction phase but can have lasting impact. The impact will be quite significant if sand bunds are built around the periphery of the reclamation area as currently proposed, as due to the conditions in the area, it is very likely the sand will get eroded on to the reef.

The island might experience some socio- economic benefits through employment opportunities and minimising the cost of transport to Male'. Associated with the operational phase of the project, noise pollution will be elevated, aesthetic value of the environment will be reduced, restriction on the construction of multi-story buildings near the airport and generation of waste. Due to the existence of an airport (Hanimaadhoo) near Kulhudhuffushi may not outweigh the negative impacts of the project on the physical environment of the island compared to the limited positive impacts from the project. There are some among the Kulhudhuffushi island community which oppose the airport development by reclaiming the Kulhi area. Instead of Kulhi area, they had suggested to develop the airport on the eastern side of the island. However, due to space limitations, it was informed that this was not practical. Other major alternatives include developing the airport in a different nearby island without such sensitive areas. This would mean Kulhudhufushi community will have to travel by sea to access the airport and has thus been rejected by the concerned Government agencies and a decision has been made to develop an airport by reclaiming Kulhudhuffushi Kulhi area, as airport development project has been a presidential pledge.

Mitigation measures for negative impacts associated with the project has been identified. The most important mitigation measure for the reclamation of the Kulhi area is creation of similar environment in another location as outlined in the regulation. This also has been pointed out in the regulation that if developmental activities to be carried out at a sensitive area, similar environment needs to be created in another location in consultation with concerned authorities. A more practical alternative is to ensure the developer undertake a program to protect, maintain and preserve an existing wetland area in the same region. In order to minimize the sedimentation due to reclamation of Kulhi and sea area, it is recommended to use of silt or sediment screens and bund walls as silt screens to cordon the reclamation area. Sheet piles, concrete blocks or geobags can be used as bunds rather than sand. To minimize impacts associated with vegetation clearance, it is recommended to remove the mature trees and coconut palms and replant in another location in the island.

As some of the impacts are based on assumptions, it is important to carryout monitoring environmental monitoring during construction and operation. The proponent commits to undertake mitigation measures and monitoring program outlined in this EIA report. Monitoring will help to identify the effectiveness of the mitigation measures and take

precautions to minimize any damage to the environment that may arise in the future. Baseline data collected during the compilation of this EIA report can be used for comparing data collected during monitoring period to identify any changes to the environment including changes to wetland habitat, terrestrial environment, hydrodynamics, reef structure and water quality including groundwater and sea water. Although, due to the nature of the project (proposed reclamation of the sensitive area, reclamation of the sea areas, borrow areas for reclamation and huge cost), the project is undesirable from a purely environmental perspective especially due to the impacts on the kulhi. However, considering the existing condition of the kulhi and given the obligation to better protect and preserve a similar environment in the region with a strict conservation program, the impact can be offset to an extent. Moreover, due to lack of land, the reclamation of the wetland area in Kulhudhufushi seems to be a question of when rather than if. There is political will to proceed with the project along with the backing and need of a vocal majority in the island. As this is a project that has long been delayed resulting in significant community issues, it does not seem the project will be delayed any further. Therefore, if the project is to proceed, it has to be ensured that all mitigation measures proposed in this report, especially regarding conservation of a similar environment in addition to the regular monitoring proposed should be undertaken. This is highly important to fully determine the impacts of the project, which will also be a reference for such future endeavours and plans by government and communities.

ޚުލާޞާ

މިރިޕޯޓަކީ ހދ. ކުޅުދުއްފުށީގައި ހުޅުމަން ހަމަޖެހިފައިވާ ޖެޓްސްބިޔާ އެއާރ ޕޯޓް ތަރައްޤީ ކުރުމުގެ މަޝްރޫޢު އާއި ގެނެވޭނެ ތިމާވެއްޓަށް ކުރާއަސަރު ދެނެގަތުމަށް ހެދިފައިވާ ރިޕޯޓެކެވެ. މި ޕްރޮޖެކްޓްގެ ބިންހިއްކުމުގެ އަމަލީ މަސައްކަތް ކުރުމަން ދިވެހި ސަރުކާރުން ހަވާލު ކޮށްފައިވަނީ މޯލްޑިވްސް ޓްރާންސްޕޯޓް އެންޑް ކޮންޓްރެކްޓިންގ ކޮމްޕެނީ (އެމް.ޓީ.ސީ.ސީ)އަށެވެ. ޕްރޮޖެކްޓްގެ މަސްއޫލު ފަރާތަކީ ރީޖަނަލް އެއާރ ޕޯޓްސް އެވެ. މިމަސްއޫލިއްޔަތު ކަނޑައަޅާފައިވާ ބަޖެޓަކީ ގާތްގަނޑަކަށް އެގާރަ މިލިއަން ޑޮލަރެވެ.

މަޝްރޫޢު ހިންގުމަން ހަމަޖެހިފައިވާ ބިން ކަމުގައިވާ ކުޅުދުއްފުށީ އުތުރުގެ ބަނޑަރަކަން ބަހާއިރު އާބާދީގެ ގޮތުން އެންމެ ބޮޑު ރަށެވެ. މިރަށުގައި 9000 މީހުންނަށްވުރެ ގިނަ މީހުން ދިރިއުޅެއެވެ. އަދި ރަށުގެ ދިގުމިނުގައި 2.5 ކިލޯމީޓަރު ހުންނަ އިރު ފުޅާމިނުގައި ގާތްގަނޑަކަށް 900 މީޓަރު ހުރެއެވެ. ކުޅުދުއްފުށީ ބިމުގެ ދަތިކަން މިހާރުވެސް އިހުސާސް ކުރަންޖެހިފައިވާ ކަމެކެވެ. ތިމާވެށީގެ ގޮތުން މިރަށުގެ އެންމެ މުހިންމު ސިފައަކީ ގޮތުގެ ގެއްލުން ހުރިގޮތުން ކުޅި އެވެ. މިގޮތުން ރަށުގެ އުތުރު ކުޅުދުއްފުށީ ހުރިފަޅު ބޮޑު ކުޅިއަކީ މިތާފުށީގެ ގޮތުން "ސެންސިޓިވް އޭރިއާ" އެއްގެ ގޮތުގައި ތިމާވެށީގެ ގޮތުން ވަރަށް މުހިންމު ސަރަހައްދެކެވެ. ގަސްގަހާގެހި ސަރަހައްދު ބަލާއިރު ކުޅި ސަރަހައްދުގެ ތަފާތު

ސަރަހައްދު ހިމެނޭ ރަށުގެ އެންމެ ގިނަ އަދަދަކަށް ގަސްގަހާގެހި އާއްމުސަރަހައްދުގެ ގޭ ގޯތިތަކުގައެވެ. ދެވަނައަށް އެންމެ ގިނައިން ދެއްކެނީ ހިކިފައިވާ ސަރަހައްދުގެ ގޯތިތަކުގައި ފާހަގަކޮށްފައިވާ ރަށުގެ އިރުމަތީ ފަރާތެވެ.

ކުޅުދުއްފުށީގައި ހިންގާ އެއަރ ޕޯޓް މަޝްރޫޢުން ބަލާއިރު 1220 މީޓަރު ދިގު 30 މީޓަރު ފުޅާ ރަންވޭ އަކާއި 45 މީޓަރު ދިގު 15 މީޓަރު ފުޅާ "ޓެކްސީވޭ" އަކާއި 130 މީޓަރު ދިގު 45 މީޓަރު ފުޅާ އޭޕްރަން އެރިޔާ އެއް ހެދުމަށް ހަމަޖެހިފައިވެއެވެ. އެއަރ ޕޯޓުގައި އެޅޭ ރަންވޭ ގާއިމުކުރުމުގެ ގޮތުން ދޫނި ބައިނަލްއަގުވާމީ މިންގަނޑުތަކަށެވެ. މަޝްރޫޢުގެ ދަށުން އެއާރ ޕޯޓަށް ބޭނުންވާނެ ޓާމިނަލް ބިލްޑިންގ އާއި ޓްރާފިކް ކޮންޓްރޯލް ޓަވަރު އިމާރާތްކޮށް ޑްރެއިނޭޖް ސިސްޓަމް (ސްޓޯމް ވޯޓަރ ސިސްޓަމް) އެޅުމަށް ހަމަޖެހިފައިވެއެވެ. މީގެ އިތުރުންވެސް، މަޝްރޫޢުގެ ދަށުން އެއަރ ޕޯޓަށް ބޭނުން ވާނެ ހިދުމަތް ކުރުމާއި ފެނާއި ނަރުދަމާ، ކަރަންޓާއި ފޯނާއި މި ހިދުމަތް ދޭން އިންތިޒާމު ގާއިމު ކުރެވިގެންދާނެއެވެ.

އެއަރ ޕޯޓް ގެ ބިން އެޅުމަށް ހަމަޖެހިފައިވާ އުސޫލު ކޮށްގައި ހުރިހާ ކުރެވޭ ބަދަލުތަކުގެ ތަފުސީލް ސަރަހައްދުގެ ބައެއް ހިއްސާގައިން ނެވެ. މީގެ އިތުރުން، ބިން އެޅުމަށް ބޭނުންވާ ދިގުމިނުގެ ވެލި މިސަރަހައްދުން ލިބިފައިނުވުން، ބިމަށް އެޅުމަށް ބޭނުންވާ ވެލި ބިންވަނީ ދުރުގައިވާ ގޮނޑު ފަށަލަ ސަރަހައްދުން ހިއްކަން ޖެހޭނެއެވެ. އަދި މިޕްރޮޖެކްޓް ހިންގުމަށް ހަމަޖެހިފައިވާ ސަރަހައްދުގައި ހިމެނޭ ގިނަ ގަސްގަހާގެހި ބިމަށް އެޅުމާއި އެހެނިހެން ހިދުމަތްތަކަށް ގާއިމުކުރުމަށް ކަޑަން ޖެހޭނެއެވެ.

ކުރީގައި ރަސްމީ ސަރަހައްދު ހިއްކުމާއި ގުޅޭ ސަރަހައްދު ހިއްކުމަށް ބޭނުންވާ ވެލިނެގުމަށް ހަމަޖެހިފައިވާ ޖެނެރޭޓަރ ސަބްސްޓޭޝަން ހޮޓަލުގެ ޖޭގައި ބޭނުންކުރާނީ އެތައް އަހަރެއް ކުރިން ހިއްކާފައިވާ ބިމެވެ.

ކުޅުދުއްފުށީގައި ހިންގާ ގަސްގަހާގެހި ހުރި ސަރަހައްދުތަކާއި ގުޅޭގޮތުން ކުރެވިފައިވާ ދިރާސާގެ ނަތީޖާއިން ދައްކައިދެނީ ނާދިރު ގަސްގަހާގެހި އާއި މުހިއްމު ސަރަހައްދުތައް ބިމުގައި ނެތްކަމެވެ. އެގޮތުން ރަށުގެ އުތުރު ސަރަހައްދުގައި ހުރި ގެދޮރު ގޯތިތަކާއި ކުޑަ ވަލުގެ ސަރަހައްދު ހިމެނޭގޮތަށް ފަޅުތަކެއް ކަނޑައި ނުލެވޭ ވަރަށް ގިނަ ގަސްތަކެއް ހިމެނެއެވެ. މި ސަރަހައްދުގެ ގަސްގަހާގެހި ގިނަ ބައެއް ވަނީ ބިން ހިއްކުމުގެ ތެރޭގައި ނައްތާލަން ޖެހޭނެ ގޮތަށެވެ. އަދި މިސަރަހައްދު ގެ ތިމާވެށި ހިމާޔަތްކުރުމުގެ ގޮތުން ފަރު ސަރަހައްދުގެ ދިރުމަށް ގެއްލުން ނުވާނެ ގޮތަށް ކަންތައް ކުރަންޖެހޭނެއެވެ. ރަށު ސަރަހައްދުގެ ތިމާވެށި ދިރާސާކުރުމުގައި ފެނުނު ފަރުގެ ދުރު ފާސްޓް ލެގޫނަށް ފައިބާނެ ގޮތްތައް، ދުރުގައި ހުރި ބޮޑެތި ގަސްތައް ފިޔަވައި ގިނަ ބަޔަކީ އާންމު ގަސްތަކެވެ. ބިމުގެ ސަރަހައްދު ނައްތާލުމުން ރަށުގެ ތިމާވެށީގެ ސަރަހައްދު ފާހަގަ ކުރެވުނު ކޮށް ސަރަހައްދުތަކަށް ގެއްލުން ނުވާނެ ގޮތުގެ ތަފާތު ކަންތައްތަކުގެ ހުށަހެޅުން ހުށަހަޅާފައިވެއެވެ. ކުޅުދުއްފުށީ ރަށުގެ އެކި ސަރަހައްދުތަކުގެ ފަރުގެ ދިރުމާއި ދެމެހެއްޓުމަށް ތަފާތު ސަރަހައްދުތަކުން ފެތުރިފައިވާ ސަރަހައްދު ތަކެއް ހިމެނެއެވެ. މީގެ އިތުރުން، މުޅި ސަރަހައްދު ހިމާޔަތްކުރުމުގެ ގޮތުން ފަރުގެ ސަރަހައްދު ބެލެހެއްޓުމަށް ފެތުރިފައިވާ ގޮތް ހަމަޖެހިފައިވެއެވެ.

އިޖްތިމާޢީ އަދި އިގްތިޞާދީ ގޮތުން މިމަޝްރޫޢުގެ ސަބަބުން ރަށުގެ އަސަރު ކުރާނެ ކަމަށް ލަފާކުރެވެއެވެ. މިގޮތުން ކުޅުދުއްފުށީ ސަރަހައްދުގެ ހިތަދޫ ބިދޭސީ ފަތުރުވެރިޔާގެ ދިރިއުޅުމުގެ ފުރުސަތު ހަރުދަނާވުމާއި ކުރީގައި ބޭނުން ވެފައިވާ ގޮތްތަކަށް ބަދަލު

ފާޚާނާގެން ރޯނުހަދައި ވިއްކައިގެން ރަށުގެ ގިނަބަޔަކު ހޯދަމުންދާ އާމްދަނީ ނުލިބިގެންދާނެކަން ފާހަގަކުރެވެއެވެ. އެހެންނަމަވެސް، އެއާރޕޯޓް ހިންގާ ދުވަސްވަރުގައި އިތުރު ވަޒީފާތަކެއް އުފެދިގެން ދިރުމުގެ އިތުރުން މިރަށުގެ ރައްޔިތުންގެ ދަތުރު ފަތުރު ކުރުމަށް ބޮޑު ފަސޭހަތައް ލިބޭނެކަމަށް ބެލެވެއެވެ. އަދި ދަތުރުގެ ޚަރަދު ކުޑަވާނެއެވެ. އެހެންނަމަވެސް، މަތިންދާ ބޯޓުގެ އަޑުނާއި އެއަރ ޕޯޓް ކައިރީގައި އުޅޭ އިމާރާތްތަކުގެ އުސްމިން ވަކިވަރެއްގައި ބަޔަކަށް ޖެހުމުގެ ސަބަބުން އެއަރ ޕޯޓް ހިންގާ ދުވަސް ވަރުގައި ވެސް މަސްއޫލުގެ ސަބަބުން ނުރައްކާ މަދު އަސަރު ކުރާނެ ކަމަށް ފާހަގަކުރެވިފައެވެ.

ކޮންސްޓްރަކްޝަން ދުވަސްވަރު ގައި ލިބިދާނެ ގެއްލުން ކުޑަކުރުމަށާއި މަޝްރޫޢުގެ ސަބަބުން އަންނަ ބަދަލުތަކަށް ދެނެގަނެ، އެކަށީގެންވާ ހައްލުތަކުގެ ޖީނުގާނަގެން ކަމުގެ ފުރިހަމަ ރޭވުންތައް މަޝްރޫޢުގެ ބަޖެޓުގައި ހިމެނުމަށް ރިޢާޔަތް އެއަރޕޯޓުގެ ހިން ދާއެވެ.

މަޝްރޫޢުގެ ގޮތުން (ތިމާވެށީގެ ގޮތުންނާއި، އިޖްތިމާޢީ އަދި މާލީގޮތުން ބޭނުން ހަދާ ކުރަންޖެހޭކަމުން) ނާއި، ކާރި ރަނގަޅުކަމުގައި ވާ ހަރުމާލުގައި އެއަރޕޯޓުގެ ތަރައްޤީގެ ސަބަބުން މަޝްރޫއިން ލިބޭ ފައިދާއަށްވުރެ ތިމާވެށީގެ ގޮތުން ލިބޭގެއްލުން ބޮޑުވާނަމަކަމަށްވާތީއެވެ. ފިޔަވަޅު ލިބޭ ގެއްލުން އަދި ބޮޑުކަން ކުޑަކުރެވޭ މަޝްރޫޢު މިހުށަހަޅައިވާގޮތަށް ކުރިއަށް ނުގެންދިއުމުން، ނަމަވެސް މަޝްރޫޢަކީ ގިނަ ރައްޔިތުންގެ ބޭނުމަށްކަމުގައިވާ، މިގޮތުން އެތައްގޮތަކުން ފަރާތު ކުރިއަށް ނުގެންދިޔުމަށް ވަސްގުވާލުމަށް މަޝްރޫޢު ބާތިލުކުރުމުން ރައްޔިތުންނަށް އަސަރުކުރާ ކުރިއަށްދާކަމަށް ބެލެވެއެވެ. އެހެންނަމަވެސް، މިމަސައްކަތް ކުރިއަށް ގެންދިއުމުގައި ދިރުނަދަނުކަމަށް ބެލުމަށް މިރިޕޯޓުގައި ހުށަހަޅައިފައެވެ. މިގޮތުން މިރިޕޯޓުގައި ހުށަހަޅައިވާ ކަންކަން މަޝްރޫޢުގެ ތެރޭގައި އެކުލަވާލުމުން، ފިޔަވަޅު ލިބޭ ގެއްލުން ކުޑަކުރެވޭނެއެވެ. އަދި ހަމައެއާއެކު މިރިޕޯޓުގައި ހުށަހަޅާފައިވާ އެންވަޔަރަމަންޓަލް މޮނިޓަރިންގ ޕްލޭން ކުރިއަށް ގެންދިއުމަކީ މިފަދަ މަޝްރޫޢުތަކުން ފިޔަވަޅު ލިބިދާނެ ގެއްލުން ދަނެގަނެ ފަރުވާކޮށްދެވޭނެ ވަށަން ދެނެގަނެވޭނެ ބޮޑު ގޮތުގައި ފާހަގަކުރަމެވެ.

2. Project Description

2.1 Introduction

This section will describe the project in terms of the need and justification of the project, location and boundaries of the project, project schedule, main inputs, project mobilization as well as project construction activities. In addition, this section presents materials and resources that will be used as well as the main output of the project.

2.2 Project Overview

The proposed project is to develop a domestic airport by reclaiming 6.27 hectares (Ha) of land from the northwest side and east of Kulhudhuffushi island and 12.04 Ha will be reclaimed from the wetland area (sensitive area) of the island. As part of the proposed domestic airport development project, a length of 1220m by 30m width runway, taxiway with length of 45 and width of 15m and an apron with length 130m and width 45m will be developed along with a passenger terminal, a control tower, safety building and revetment for the coastal protection of the reclaimed land.

2.3 Project Proponent

This project is proposed by Regional Airports department under the Ministry of Tourism of Maldives. Regional Airports is the regulator for all domestic airports in Maldives.

2.4 Project justification

During the Presidency Election in year 2013, considering the scattered nature of islands of Maldives, the distance between the closest airport at HDh. Hanimaadhoo and the increasing population of HDh.Kulhudhuffushi His Excellency President Abdullah Yamin Abdul Qayyoom, pledged the residents of HDh. Kulhudhuffushi that an airport will be developed on the island in his regime.

Maldives being an island nation, majority of its people depend on sea based transport to travel between the islands. This mode of transport is considered risky, unreliable

and economically challenging. Kulhudhuffushi has always been an important link between the islands of Northern Province and capital city Malé,

Kulhudhuffushi is the provincial capital containing all the essential amenities and therefore, the hub of the region.

Among the key sectors that contribute to the economic structure of the island are fishing, agriculture, wholesale and retail trade, construction, transport and civil service and public enterprises. Small- medium industries include rope making, weaving, cake baking and decorations. In addition to this, businesses involved in the service sector include the bank, tailors, saloons and guesthouses (Detailed risk and vulnerability assessment HDh. Kulhudhuffushi, 2013).

Apart from the above, tourism is a budding industry in the northern Province and expected to grow rapidly in the northern region. The Ministry of Tourism announced that five Islands from this region have been included in the list of islands to be leased for the development of tourist resorts in year 2016 and another one island from north province have been included to list in 2017 (Tourism Ministry's announcement dated 16 October 2016 (IUL) 88-LS/88/2016/37 and 9 January 2017 (IUL) 88-LS/88/2017/02). For this reason major improvement in tourist arrivals and tourism related industries is expected. As a result of the tourism boost, related economic sectors including fisheries, agriculture and handicrafts industry would grow. There will be several knock-on or multiplier effects to the local economy as a result of better and efficient transport of encouraging local businesses to enhance.

Therefore due to its rapid growth, speed in development and also promising tourism industry Kulhudhuffushi needs to have better connectivity for tourists and locals alike to visit the region. At present, seaplane is the primary mode of transfer of tourists with increasing demand from the local populace. However, lack of the cost-prohibitive nature of this has implications on tourism and it is often difficult for locals to fly on seaplanes due to the high cost or unavailability of seats. Developing an airport would help to reduce the cost of travel, provide greater access and freedom of choice as well as create additional business ventures in intra-island transport.

As the Regional Hospital for the northern region of Maldives resides in Kulhudhuffushi, residents from Kulhudhuffushi and neighbouring islands (in Haa Alif, Haa Dhaal, Shaviyani and Noonu atoll) seek medical services from the regional hospital. In the past many have lost lives due to delays in transferring patients from Regional hospital to HDh. Hanimaadhoo in due to bad weather conditions or lack of affordability to pay extravagant fares of speed boats.

Hence to considering all of the above reasons and to accomplish the presidential pledge, the policy of interconnecting the islands of Maldives via air network was formulated by the Regional Airports department under the Ministry of Tourism. A master plan of Kulhudhuffushi Airport project was incorporated into their scope of work for the year 2017. The development of the proposed airport will create a connectivity point within the atoll where intra-island transportation will be enhanced.

2.5 Project Boundaries

The proposed project to develop a domestic airport in Kulhudhuffushi will take place on the northwest and northeast of Kulhudhuffushi. Kulhudhuffushi is located on the eastern side of Haa Dhaalu (Thiladhunmathi Dhekunuburi) Atoll on geographic coordinates of 6°37'0"North and 73°3'0"East (Figure 2-1 and Figure 2-2)and is 275km north of Male'. At present, the island has a land area of 235 Hectares (ha). The total airport boundary has been identified to be 6.12 ha. This area will be achieved after reclaiming part of the wetland (12.04 ha) and from the northwest side and east of Kulhudhuffushi island (6.27 ha).

Figure 2-1: Haa Dhaal Atoll

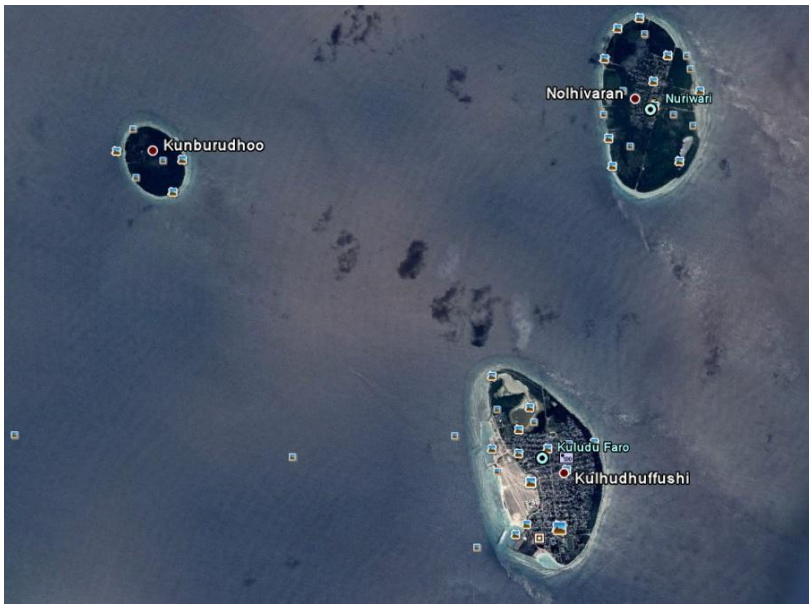


Figure 2-2: Satellite image of Kulhudhuffushi (on the left bottom)

The project study area is shown in the following image

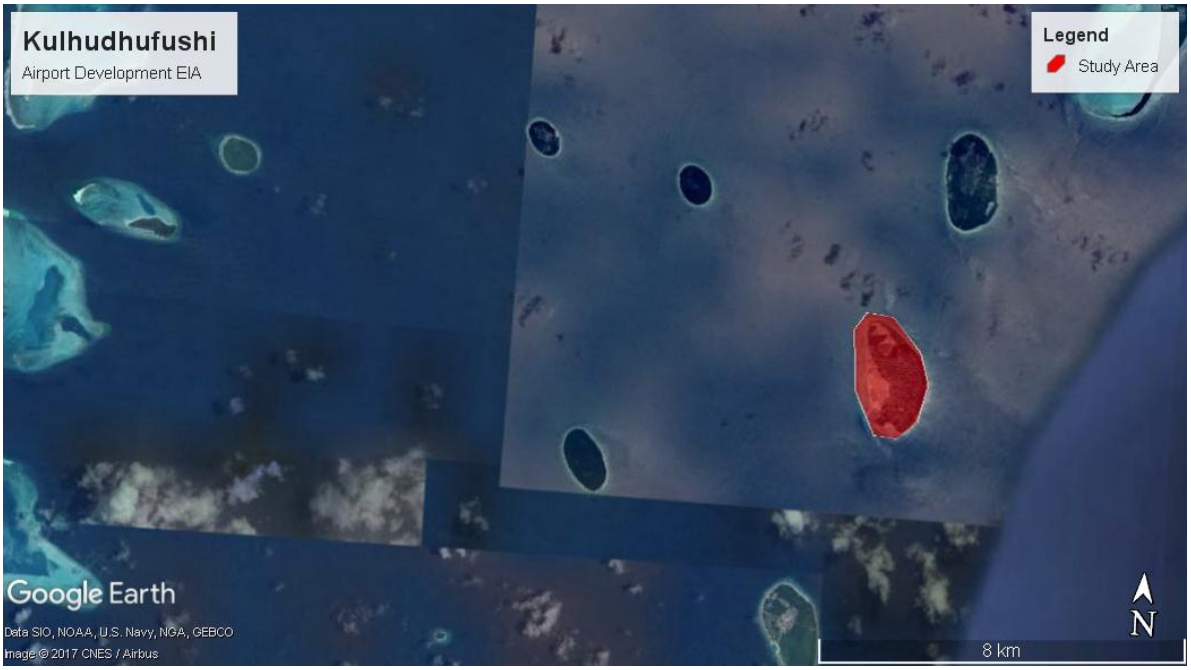


Figure 3 Project Study Area

2.6 Project Duration

The proposed project is expected to be completed within a period of 26 months. This involves mobilization, setting out (clearing of site and preparation of reclamation works) and dredging and reclamation works, construction of the airstrip including levelling, compaction and runway development will take place. Construction and development of the terminal, tower and other supporting facilities and services will be undertaken during subsequent months and will go on till the end of the project.

A tentative project work schedule is given in the Appendix 1.

2.7 Project Details

2.7.1 Dredging and Reclamation

The project involves reclaiming a total of 18.31ha of land partly from the wetland and from the northwest side and east of Kulhudhuffushi. Assuming an average depth of about -2.20m from MSL in the reclamation area and reclaiming land to about +1.4m from MSL to attain +1.2m of finished level upon possible settlement, a total volume of approximately 144,586.20 cubic metres of sand is estimated for the filling of the proposed area in the northwest side and east of Kulhudhuffushi. Reclamation in the

wetland area is expected to consume 240,790.00 cubic metres of sand. That is assuming an average depth of about -2.0m from MSL in the wetland area and reclaiming land to about +1.4m from MSL to attain +1.2m of finished level upon any possible settlement.

Deep sea dredging will be undertaken to obtain sand. Therefore, borrow area can only be determined once geotechnical studies are completed. An EIA addendum will be prepared then to get environmental clearance to dredge from the particular borrow area.

2.7.2 Airport Development

2.7.2.1 Concept Design

The concept design for this project is in Figure 2-4.

Figure 2-4: Concept design for the project.

2.7.2.2 Specifications of the Proposed Airport

The following are specific details of the project

Physical requirements for aerodrome		
1	Runway Length:	1220 m
2	Runway Width:	30 m
3	Strip Length:	60m from each end of runway
4	Strip Width:	75 m from each side of runway
5	Taxiway Length:	90 m
6	Taxiway Width:	15 m
7	Apron Length:	150 m
8	Apron Width:	50 m
9	Stop way Length:	60 m from Runway end
10	Stopway Width:	60 m
11	Runway End Safety Area (RESA) Length:	90 m from stopway end
12	Runway End Safety Area (RESA)	60 m

	Width:	
13	Transverse gradient:	1.5% from Runway & 0.5% Taxiway for Apron
14	Transitional surface:	1:5 slope
15	Approach slope:	3.33%
16	Divergence angle:	15%
17	Take off Climb Slope:	4%
18	Pavement Classification (PCN)	15 estimated (proposed critical aircraft is ATR 72-600)
19	Aerodrome Reference Code	2C

2.7.2.3 Graded Areas

The areas of runway shoulder and air strip will be graded areas. Approximately 60.5 square meters will be graded.

2.7.2.4 Basic Elements

Power Supply to the airport will be provided by the local service provider although back-up power generation will be available. The service provider to the island Fenaka Corporation has agreed to provide power supply to airport.

Water supply to airport will be provided by the local service provider and sewage disposal will be via local sewage outflow pipe. The proponent confirms that this also has been agreed by service provider Male Water and sewerage Company

Drainage system for runway and apron will be designed to accommodate the estimated storm water. This system will ensure that the runway is dried within 10 minutes of heavy rainfall.

The airport boundary will be fenced properly to block any trespassing.

An administrative office will be built to execute all the necessary administrative works of airport.

2.7.2.5 Airside

The Airside of the airport will include, runway, taxiway, apron, passenger terminal, tower, means of weighing baggage, baggage carousel for arrival and departure with adequate security, means to screen the baggage, and security check points.

2.7.2.6 Passenger Amenities

Waiting areas and toilets will be available as passenger amenities.

2.7.2.7 Navigational and Meteorological Information

A visual aid system to cater for night operation, to control/approach aerodrome, equipment used in gauging wind and to receive meteorological information will be established.

2.7.2.8 Aircraft Fuel Facilities

Fuel will be stored on site in appropriately bonded storage tanks and distributed when required using a pipeline. If any waste oil is built up it will be collected and will be incinerated.

2.7.2.9 Airport Emergency

The airport will be designed to facilitate any emergency movement. An Airport emergency plan will be formulated and equipment used in fire fighting, Search and rescue will be established.

2.7.2.10 Ground Support Equipment

To support the operations of aircraft whilst on the ground equipment such as Tow trucks and Carts and dollies will be available

2.8 Construction Methodology

This section discusses about the construction methodologies that will be undertaken in this project. The construction of the airport involves three major components. They are:

(1) Dredging and reclamation,

(2) Levelling and construction of runway and apron area,

(3) Construction of airport buildings including tower, terminal and other facilities.

These are discussed below.

2.8.1 Mobilization and temporary facilities

As mobilization may strain the environmental conditions due to site access, transportation and workforce activities, allocation of space for storage of materials and site access and services for the workforce on site will be planned beforehand. Extreme effort will be made to properly manage the mobilization and construction activities and workforce will be made aware of the fragile environment and need to manage their daily activities so as to minimize their footprint on the environment.

The first step in the development process of the project would be mobilization of equipment and material. Since the project consists of 3 components, mobilization will be undertaken in stages. The first stage would involve mobilization for dredging and reclamation works.

This will involve mobilization of excavators, lorries, loaders along with the hopper dredger, the delivery of construction materials, machinery, equipment as well as workforce to the island. This machinery will be kept at a suitable location within the

boundary set for the airport development. Materials required for shore protection will be mobilized upon completion of the dredging and reclamation works, for this would give adequate space for setting up the rock boulders for revetments. Workforce for the dredging and reclamation works will be accommodated in a rented facility from the residential area. Adequate facilities for entertainment, waste management and safety will be provided to workforce.

The second stage of would involve mobilization for the construction of runway and apron area. At this stage additional heavy machinery such asphalt laying machine, concrete machine, loaders and trucks will be mobilized with material such as cement, asphalt, aggregate, sand, steel and others.

The third Stage of mobilization will involve mobilizing the equipment and materials required for construction of airport buildings including tower, terminal and other facilities.

Temporary facilities and structures such as road would be constructed as the project mobilization starts. These structures would be operational until the point of demobilization, thereafter it will be removed from the site if not instructed otherwise. Any technical specification provided by the Regional Airports will be followed during all stages of construction works.

2.8.2 Dredging and Reclamation

An area of 6.57 ha will be reclaimed from the northwest side and northeast of the island with an elevation of 1.2meters above mean sea level after possible settlement. In addition 12.04 Ha will be reclaimed from the wetland area with the same elevation proposed above. Throughout the dredging and Reclamation the technical specifications for the constructions works of the project will be followed.

2.8.2.1 Dredging

It is now decided that filling materials will be obtained from deep sea and the dredging process will be carried out by the use of a trailer suction hopper dredger as shown in Figure 2-5. Trailer suction hopper dredgers (TSHD) are hydraulic dredgers which transports, by self propelling, dredged materials by raising material out of the water and

horizontally transporting them to another site while storing them in its hopper. TSHD is commonly used for large dredging projects.

In the Maldives such dredgers have been used to reclaim large amounts of land, and is usually undertaken at a national level. Coarse sand is preferable for the project as it would create the optimal land conditions and would result in minimum sedimentation.

The material would be discharged using a floating pipeline. Discharge through bottom doors is not an option as the TSHD cannot enter the lagoon area under any circumstances. Rain bowing is also not an option, as the sedimentation it creates is too high.

The TSHD will reach the project site either from the ocean ward side or atoll ward side to dispose the material for the reclamation as its important to have as small distance as possible from the hopper to the reclamation site. The ship will be positioned using high precision GPS system and positioning systems

There are two spud poles on the back of the vessel. The one called the auxiliary spud pole passes through the vessel. While the other spud pole is mounted on a mobile spud carriage, which can be moved length wise along the vessel. These spud poles are used to manoeuvre the dredger and the operation itself (Van Oord Marine Ingenuity 2013). It is believed that this type of dredgers would minimize time-related environmental impacts as well as costs. The dredging vessels (Maha Jarraafu) for the project is a brand new vessel and expected to have a minimal impact

Figure 2-5: Dredger Maha Jahraaf of MTCC will be used for the Project.

Figure 2-6: Suction pipe with cutter head

2.8.2.2 Reclamation

The dredged material from deep sea will be pumped directly onto the proposed reclamation area. If any material is in excess they will be spread using excavators, lorries and loaders. Pumping will be undertaken minimizing the need for creating a bund by using excavators so that sedimentation can be minimized. In addition, extreme precautions will be taken to avoid putting on extra pressure on the pipelines that run beneath the airport boundary.

It is currently proposed to create a sand bund using excavators to contain the reclamation area as in normally undertaken in such projects. The bund will be up to the reclamation height or about 0.1 – 0.5m lower. It will be undertaken by excavating along the inside of the boundary of the reclamation site. There are alternatives proposed for this under the Alternatives section.

2.8.3 Shore Protection Measures

The shore protection measure for the proposed reclamation is the 800m of revetments protecting the reclaimed area. The shore protection measures are essential for the sustainability of the airport project, since land will be reclaimed to develop this project and the location of the project site is already experiencing erosional activities. A revetment with rock boulders (250-500kg) Armour rocks in two layers will be constructed because rock boulder revetment would provide better wave energy absorption hence protecting the reclaimed area. However, geotextile tubes would be cheaper and may be considered in some areas such as the western periphery of the

reclaimed land. Geotextile of strength 600gms/m2 (5.0m x 50m) will be layed beneath the rock boulder layer to prevent erosion.

Alternatives are recommended for this component of the project as well under the Alternatives section.

2.8.4 Ground Truth

The concept design of the proposed airport will be physically checked for ground truth (Factual data as ascertainable through direct observation and surveying the study area on ground with a systematic routing and recording all ecological resources) before any activities will be undertaken. A permanent bench mark indicating its height above MSL will be established. Areas of the reclaimed land will be levelled with respect to this permanent benchmark.

2.8.5 Levelling and Compaction

As the ground condition of the area where the airport is to be developed consists of muddy silt type soil and most of the area is currently a wetland, approximately 600mm of the top soil layer of will need to be excavated and removed before backfilling. Once backfilled with materials in layers not more than 300 - 600mm levelling will be done to an acceptable standard. Once the levelling is completed, site grading and compaction will be done to 98% Maximum Dry Density (MDD). All of infrastructural facilities of the airport will be constructed after levelling and compaction of ground for good stability.

2.8.6 Drainage System

The proponent has proposed to have a well suitable drainage system for Kulhudhuffushi airport, as the location proposed for the construction airport is on the downstream of the island during rainy season and is prone to flooding. In addition due to shallow water table it is predicted that flooding may occur immediately after raining. It is recommended to have drainage system with 1.5% transverse gradient from runway and taxiway on either sides of the airstrip in order to ensure an effective drainage as the airstrip surfaces will be subject to collection of storm-water from rain. A series of gutters running parallel to the runway on either side, embankments and

cuts will be laid on either side of the runway and water drained at the feet of the embankments and flowing over cuts will be collected and conveyed safely away from the structures into the sea.

2.8.7 Sewerage System

Being the capital of the atoll and regional hub, Kulhudhuffushi has a comprehensive sewerage system. Given that the proposed airport is a domestic one, it is believed that sewage and wastewater from the airport operations would be significantly small. For this reason, wastewater from the airport will be disposed to the island sewerage system. The existing wastewater outfall pipeline is lies on the south east end of the island therefore if any blockage or failure arises, there will be no discontinuity in airport services. In the unlikely event of expansion of the airport or upgrading it to an international airport, the sewerage facility of airport could be managed by the local service provider Male' Water and Sewerage Company (MWSC).

2.8.8 Project inputs and outputs

Following table shows the main inputs of the proposed project

Input resource(s)	**Estimated quantities**	**How to obtain resources**
Construction and Operation Staff		
Construction workers	Over 50 staff	Contractor's staff
Management, operations and maintenance staff	About 100 staff	Appointed by proponent/operator
Machinery and equipment		
Trailer Suction Hopper Dredger	1	Contractors own equipment.
Bull dozer	3	Contractor's equipment
Excavator 350	3	Contractor's equipment

Excavator 200 & 300	3	Contractor's equipment
Showel loader at site	2	Contractor's equipment
Soil compactor at site	3	Contractor's equipment
Dump truck	4	Contractor's equipment
Motor Grader	2	Contractor's equipment
Water bowser with Tractor	3	Contractor's equipment
5 Hp diesel enginer (water pump)	2	Contractor's equipment
Asphalt Bin	1	Contractor's equipment
Asphalt Dum	1	Contractor's equipment
Asphalt delivery conveyer	1	Contractor's equipment
Bin to drum conveyer	1	Contractor's equipment
Bitument tank	1	Contractor's equipment
Fuel tank	1	Contractor's equipment
Panelboard	1	Contractor's equipment
125kv genset	1	Contractor's equipment
Set spares and other accesorries	1	Contractor's equipment
Double drum roller	2	Contractor's equipment
Asphalt paver	1	Contractor's equipment
Backhoe loader	1	Contractor's equipment
Pneumatic tyre roller	1	Contractor's equipment

Bitument Sprayer	1	Contractor's equipment
Concrete cutting machine	1	Contractor's equipment
Air compressor	1	Contractor's equipment
Asphalt core cutting machine	1	Contractor's equipment
Construction Materials and utilities		
Construction materials:- timber, cement, electrical cables, reinforcing steel bars, river sand, aggregates, PVC pipes, fuel, etc.	Varying quantities	Import and purchased where locally available at competitive prices
100mm PVC duct pipes, 100mm PVC Cap, 100mm PVC Elbow, 100mm PVC HP Pipe, 50mm PVC HP Pipe	Varying quantities	Import and purchased where locally available at competitive prices
Iron bars, welding rods, Plywood. Timber, Nails, Formoil, Power cables	Varying quantities	Import and purchased where locally available at competitive prices
Construction tools (crow bar, flashlight, cutter bolt, chisel, hack saw, hook, hammer, axe, screw driver, power saw, nozzle, forcing tools, ladder, ropes, pliers, etc)	Varying quantities	Procured locally
Water (during construction)	6 ton RO plant	Groundwater extracted for construction, bottled & rain water for consumption for workers
Water tanks	12 2500 L tank	Procured locally
Wells	2 1800mm dia well	Constructed on land
Septic tank system	3	Procured locally
Inspection chambers	20	Constructed on land
Electricity/Energy	100 KW/125 KVA cummins	Imported from supplier

	prime power open generator 62.5KVA cummins diesel generator 62.5KVA cummins diesel generator (standby)	
Distribution boxes, attenuator, transformer	Varying	Imported from supplier
Fuel (e.g. diesel, petrol)	300 cbm	Locally purchased
Security		
Walk through detectors	2 nos	Imported from supplier
Hand held metal detectors	3nos	Imported from supplier
Boundary Fence	1233m	Imported from supplier
X Ray Machine (checked baggage and hand luggage)	2	Imported from supplier
CCTV Cameras	21	Imported from supplier
Fire Services (Category 4)		
Fire fighting equipment's	Varying quantities 13 – 15 sets	Imported from supplier
Water tank capacity	5,400L	Constructed on land
Foam liquid tank capacity	450 L	Imported from supplier
Dry powder system capacity	235kg	Imported from supplier
Fire Pond	3000 L	Constructed on land
Fire extinguishers	12-20	Imported from supplier
Fire Truck	1-2	Imported from manufacturer

Foam FFFP (barrel)	14	Imported from supplier
Dry chemical powder	720	Imported from supplier
Fuel Services		
Storage tank with filter	Varying quantiies	Imported from supplier
4500 litre capacity pump laid to apron	1	Imported from supplier
Ground handling equipment		
Baggage Cart	4	Imported from supplier
Baggage Trolley	85	Imported from supplier
Ground power unit	01	Imported from supplier
Passenger Bus	1	Imported from supplier
Inspection and Operations		
4 wheel vehicle for runway inspection	1	Imported from supplier
4 wheel vehicle for general maintenance	1	Imported from supplier
Navigation Aids		
VHF Main, VHF standby, VHF Emergency frequency 121.5 Hz	1 each	Imported from supplier
Handheld handset GP 328 or equivalanet	6	Imported from supplier
Digital clock with temperature guage	1	Imported from supplier
Binoculars	2	Imported from supplier
Anemometer and wind direction indicator	1	Imported from supplier

Provision of crash alarm system	1	Imported from supplier
Safety		
Lightening protection system	1	Imported from supplier
First aid kits	2-5	Imported from supplier
Vehicle for first aid use	1	Imported from supplier
Safety flourecent vests, Safety shoes, Ear muffs, safety hats, life jackets	Varying quantities	Imported from supplier

The following table is a matrix of major outputs

By products and waste materials	**Anticipated quantities**	**Method of disposal**
Waste oils from machinery	Minute	Re-used to other applications mostly as lubricants. Also used for incineration
Waste silt	Moderate	Silt will get settled in the settlement ponds, and less dense material will be flushed out
Green waste from site clearance (mostly coastal vegetation)	Moderate	Burnt and mulched on site and used for landscaping needs or buried.
Timber, cardboard, gunny bags and scrap metals (construction site waste)	Moderate	Recovered, reused , recycled. Most are stockpiled on land and transported to R. Vandhoo at project completion to be recycled.
Solid waste (kitchen waste, waste from workers)	Moderate/minor	Taken for disposal through island SW system
Hazardous wastes (batteries, filters)	Small quantities	Stored in specific sealed containers and transported to R. Vandhoo quarterly.

3. Description of the Existing Environment

3.1 General Setting

The Maldives lies in the Indian Ocean and consists of a double chain of natural 26 coral atolls. These 26 natural atolls consist of about 1192 islands but only 200 islands are inhabited. Both atolls and islands vary greatly in shape and size. Although, the Maldives is about 840km long (stretching from Northern to Southern atoll) and width varies between 80-120km from east-west, total land area is about 300km2 and about 99% is sea area. About 80% of Maldives land area is less than 1m above mean sea level (with highest point of about 3m) (UNEP, 2005), making Maldives one of the most low-lying nations in the world.

The Island Kulhudhuffushi is located in the second most northern atoll, Haa Dhaal, latitude 6°37'28.2" N and longitude 73°04'12.0"E, covering an area of about 200 hectares. Two phases of reclamation added a total of 37 hectares to the land area of Kulhudhuffushi Island (http://www.environment.gov.mv/v1/news/reclamation-works-in-haa-dhaalu-atoll-kulhudhuffushi-island-completed/).The Kulhudhuffushi is located on the south of Haa Dhaal atoll. As most of the islands of the Maldives are geographically isolated by large bodies of sea water, the Kulhudhuffushi is also separated from other islands by sea. The closest neighboring inhabited island is, Haa Dhaal Nolhivaran (4.5 Km to the north) and Kumundhoo, 6km to the south from Kulhudhuffushi (See Figure 3-1). The island itself measures about 2.5 km in length and 0.89 km in width (Figure 3-2). The most significant natural feature of the island is existence of two wetland areas (Kulhi). The larger one is in the northern end and small one in the south end of the island.

Figure 3-1: Geographical location of Haa Dhaal Kulhudhuffushi in relation to the neighbouring islands and aerial photograph of Kulhudhuffushi (right map: http://isles.egov.mv)

Figure 3-2: General setting of Haa Dhaal Kulhudhuffushi, depicting unique features of the Island. The enclosed areas marked in yellow are water bodies (Kulhi or wetland area). The red lines indicate the length and width of the island.

3.2 Climate

The monsoonal climate experienced by the Maldives is influenced by the Asian Monsoon, which is an annual event caused by the northward advance of the Inter-Tropical Convergence Zone (ITCZ) and the Asian landmass experiences increase in precipitation during the boreal summer (Zahid 2011). The two distinct seasons that the Maldives experiences are the dry season (northeast monsoon) and the wet season (southwest monsoon). Traditionally, the northeast monsoon extends from January to March and the wet season or southwest monsoon runs from May to November (MEC 2004). During the southwest monsoon, the Maldives experiences torrential rain with an average of 1492.2mm of rainfall (Zahid 2011). It should be noted that the rainfall

varies considerably in space and time during the monsoon season (May-November). Spatial patterns of mean annual monsoon rainfall for the Maldives are depicted in Figure 3-3. On average the northern Maldives (where the Kulhudhuffushi is located) and southern parts of the Maldives received less rainfall during the monsoon season (May-November), with two minima occurring at around 4.5° N and 0.7° S (Figure 3-3).

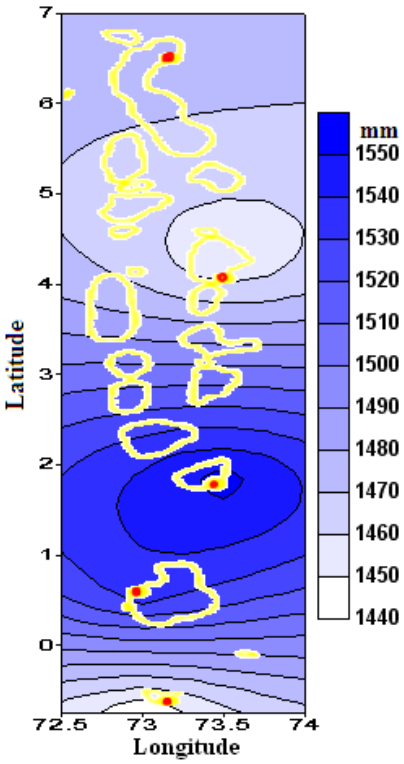


Figure 3-3: Spatial distribution of mean annual monsoon rainfall (May-November total) based on 1994-2006 data. The red dots indicate where the rainfall data were obtained (Taken from Zahid, 2011).

3.2.1 Rainfall

Meteorological data is not available at the project location, Kulhudhuffushi. However, it is noted that the meteorological station Hanimaadhoo (the most northern station and closest station to the Kulhudhuffushi) is geographically located at 6.75° N and 73.17° E. Since the establishment of the Hanimaadhoo meteorological station in 1990, it has been considered that this station would represent the climate of the northern part of the Maldives (Zahid, 2011). The fact that no meteorological data is not available from Kulhudhuffushi and Hanimaadhoo lies very close to Kulhudhuffushi and

represents climate of northern parts of the Maldives, to describe the climate of the Kulhudhuffushi, climate conditions at Hanimaadhoo station is described here.

Although Hanimaadhoo total annual rainfall shows a periodic pattern, the annual precipitation varies from year to year (Figure 3-4), with the minimum, average and maximum annual rainfall of 1346.5, 1785.4 and 2240.5mm respectively (Zahid, 2011). Furthermore, daily rainfall reveals that the Hanimaadhoo experienced on average of 135 rainy days per year (standard deviation of 8.5 days with a minimum number of rainy days 123 days in 1996. The maximum numbers of rainy days for the northern region was observed in 2004, accounting for a total of 154 rainy days for the period 1992-2006. It is noted that there exists strong correlation (CC= 0.98) between number of rainy days and annual rainfall at Hanimaadhoo, indicating that the rainfall amount is determined by the number of rainy days (Zahid, 2011).

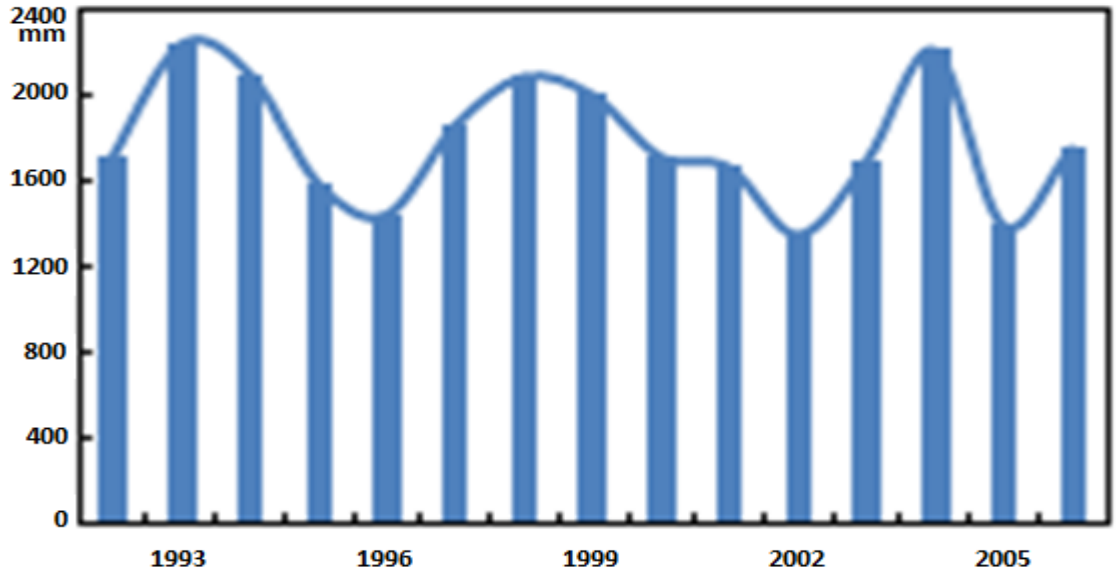


Figure 3-4: Yearly total rainfall for Hanimaadhoo (modified from Zahid, 2011).

Figure 3-5 shows mean annual rainfall for the three regions of Maldives, while Figure 3-6 shows average monthly rainfall and year 2016 rainfall for Hanimaadhoo. On average the southern region receives about 2,218 mm of rainfall per year, while the annual rainfalls over central and north receives about 1,966 and 1,779 mm respectively over a 20-year period (SNC 2016). This shows that the annual rainfall

increases from the North to South as seen in the Figure. On average, the month of May to August, Hanimaadhoo receives more rainfall (Figure 3-5)

Figure 3-5: Spatial distribution of mean annual rainfall (1992-2012) (SNC 2016)

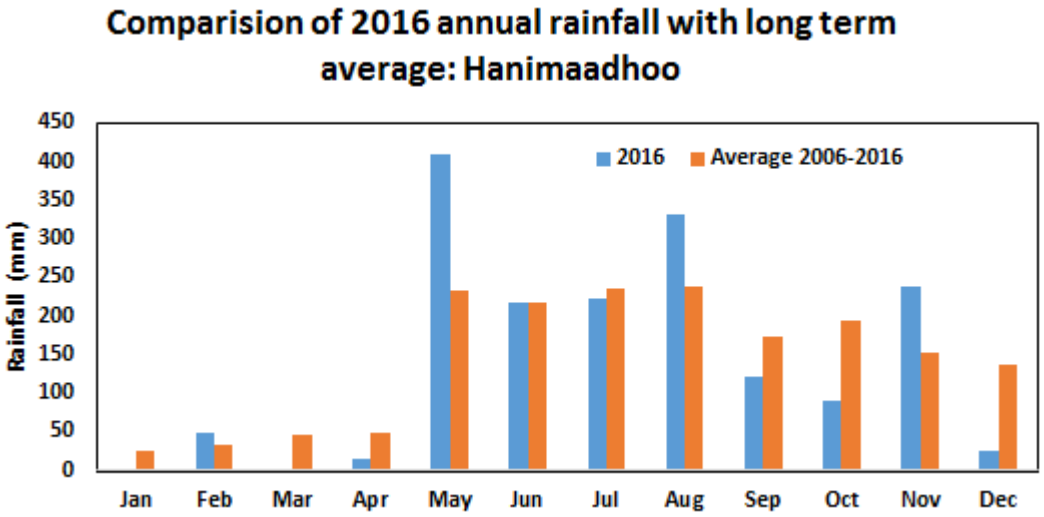


Figure 3-6: Monthly average rainfall and 2016 rainfall for Hanimadhoo (data source: MMS).

Figure 3-7 below shows daily average rainfall for the period 1992-2014 and for the years 2015 and 2016 for the month of April. For Hanimaadhoo, the highest rainfall within 24hrs was 146.9 mm, recorded on 26th May 2008 (MMS, 2016). The highest rainfall within 24 hours for the past year April was 8mm, on 18th April 2016. The days when field surveys were carried out (19-23 April 2017), there was no rain on the island of Kulhudhuffushi.

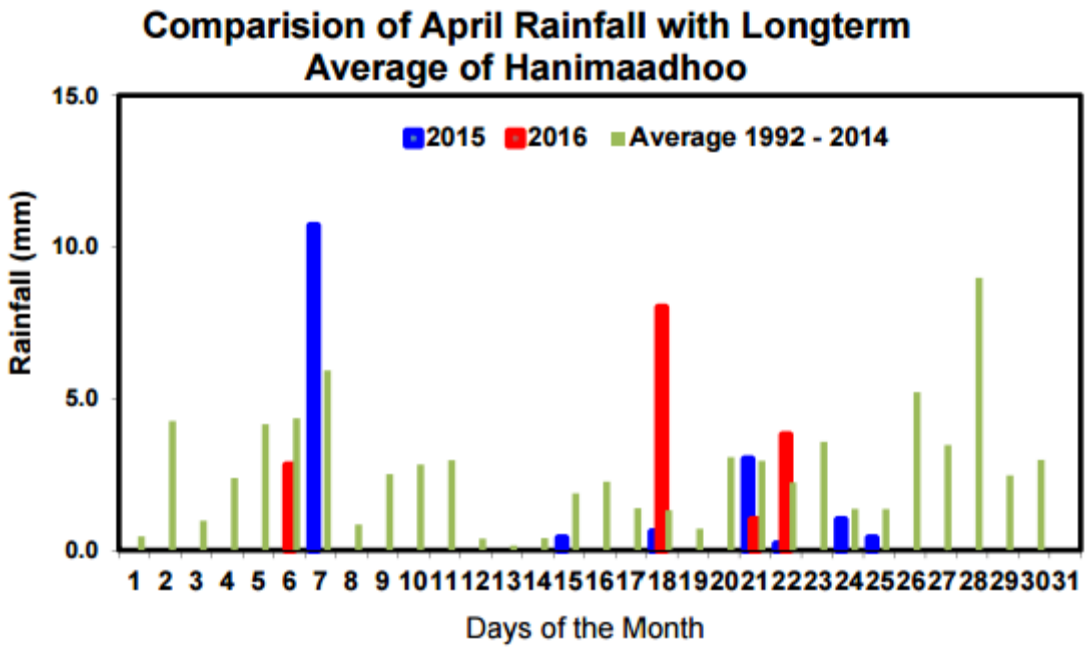


Figure 3-7: Daily rainfall for Hanimaadhoo (MMS, 2016).

3.2.2 Temperature

The Maldives being located around equator, the monthly temperature variation is very small. Although diurnally temperature ranges from around 31 degrees Celsius during daytime to 23 degrees Celsius at night over the Maldives, throughout the year the temperature remains almost the same and seasonally the temperature varies hardly.

Since the Maldives consists of small islands that are surrounded by sea, hot days are often tempered by cooling sea breezes and balmy evening temperatures. Hanimaadhoo temperature indicates that mean daily maximum is about 30.7 degrees Celsius, while mean minimum temperatures is 25.6 degrees Celsius. The highest and lowest temperature recorded for the northern parts of the Maldives are 35.0°C (30 April 2016) and 18.2°C (23 December 2002), respectively. The 35.0°C recorded on 30 April 2016 was the highest temperature ever recorded in the Maldives. Likewise, the minimum temperature ever recorded in the Maldives was 18.2°C, recorded at the Hanimaadhoo. The daily mean, maximum and minimum temperature for Hanimaadhoo for the survey period (19-23 April 2017) were depicted in Table 3-1 (provided by the Maldives Meteorological Service).

Table 3-1: Daily temperature for the survey period

Days	Mean (°C)	Minimum (°C)	Maximum (°C)
19th April	30.3	28.0	33.1
20th April	30.4	27.4	33.2
21st April	30.4	27.3	33.7
22nd April	30.2	27.9	33.2
23rd April	30.2	26.7	33.6

3.2.3 Wind

The Maldives experience seasonal shifts in monsoon winds from southwest monsoon to northeast monsoon. Winds during northeast monsoon season (from December to March) are mainly dominated by East-north-easterly wind direction (Kench and Brander, 2006). Figure 3-8 shows wind rose (wind speed frequency and direction) for the month of April (monsoon onset month), August (middle of southwest monsoon) and December (start of northeast monsoon season) for Hanimaadhoo for a typical monsoon year (2016). As the wind rose indicates wind speed maintained at a speed of 4-8 mph during the month of April and December. Wind speed for the month of August is generally higher compared to the other two months with a speed of 8-12 mph. The wind prevailed from north westerly during the three months but during December month, the wind direction varied much compared to the other two months.

Wind direction in northern parts of the Maldives changes from southwesterly or northwesterly to a variable or northeasterly direction in late November, indicating cessation of the southwest monsoon from the northern parts of the Maldives, while late May the wind direction in northern parts of the Maldives changes from southeasterly to southwesterly direction indicating establishment of southwest monsoon over the northern Maldives.

Wind speed for Hanimaadhoo for the month of April, August and December 2016 is shown in Figure 3-8 and daily mean wind speed for the survey period is given in Table 3-2. The maximum wind observed for Hanimaadhoo during the survey period is also depicted (provided by the Maldives Meteorological Service).

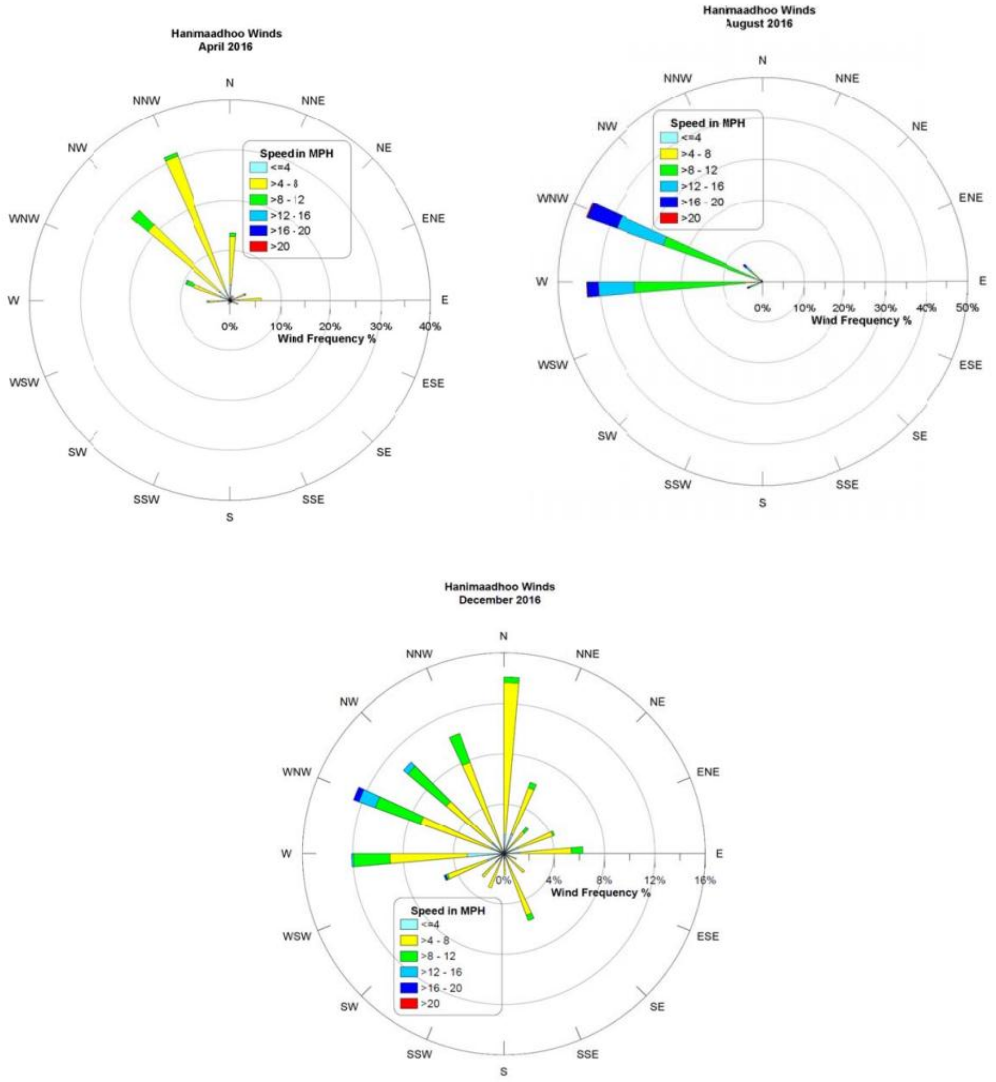


Figure 3-8: Wind speed (mph) and direction for Hanimaadhoo for the month of April, August and December 2016 (MMS, 2016).

Table 3-2: Daily wind for the survey period

Days	daily mean wind speed (mph)	Daily max wind speed (mph)
19th April	W-6	WNW-15
20th April	W-5	W-10
21st April	WSW-5	W-13
22nd April	W-6	W-15
23rd April	W-6	WNW-22

3.2.4 Waves

Information on waves, especially deep-water waves is limited in the Maldives. The wave climate data for the Indian Ocean region surrounding the Maldives based on ten years of data (Figure 3-9) indicates that the dominant swell approaches from southerly quarters (Kench and Brander, 2006). From April to November the swells are mainly from south-southwest with a peak significant wave height (Hs) of 1.8 m in July, while during December to March the swells are dominated from southeast with a minimum mean Hs of 0.75 m in March (Kench and Brander, 2006). These wave height estimates and seasonality in wave height conditions are consistent with independent analysis of a shorter three-year record of satellite altimetry data (Kent et al. 2006).

The wave energy affecting the atoll of the Maldives is considerably greater during the westerly monsoon and the structure of the atolls promotes significant changes in wave energy and wave characteristics across the atolls. In general shorter periods (3–8 s)

generated by monsoon-driven wave energy is significant on windward reefs. The density of lagoonal patch reefs limits development of locally generated wind-wave energy across the lagoon but the longer period swell (8–20 s) propagates through the lagoon to leeward reefs (Kent et al. 2006).

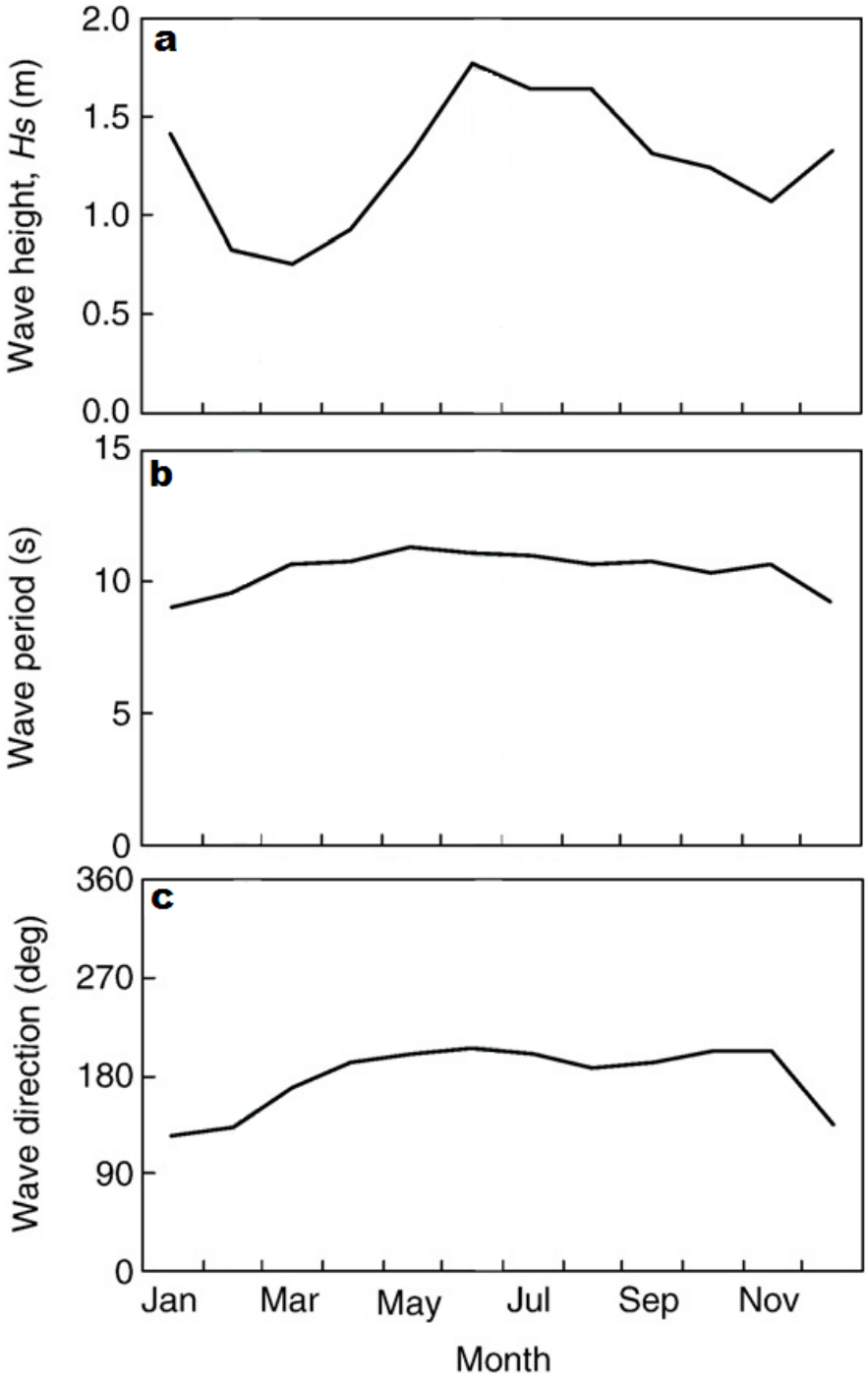


Figure 3-9: (a) Mean monthly significant wave height, (b) mean monthly wave period and (c) mean monthly wave direction based on 10-year ocean swell data derived from satellite data (modified from Kench et al., 2006).

From time to time, Maldives also experiences unusual waves causing damages to properties. For example Male' and Hulhule experienced 3 m high swell waves during 10 - 15th of April 1987 caused by a storm in the south Indian Ocean near Australian region. Since then, tidal waves had become a known phenomenon, especially during the monsoons season.

In 2007, Maldives experienced series of high waves in varying magnitude from 15 to 18 May. In this occasion, the swell which caused the unusual tidal waves were originated from the extra-tropical system in the southern hemisphere, approximately 5630km southwest of Addu Atoll, Maldives. The waves that hit Seenu, Gaafu Dhaalu and other atolls had a wavelength range of 350-433 meters. These waves doubled the wave height when it reached the coastline, thus inundating about 35 islands in 13 Atolls across the country.

The extent of the tidal surge/storm surges which caused inundation of the islands of the Maldives ranges from 20 feet to 2000 feet from the coastline. Discussion held with locals from Kulhudhuffushi indicated that Kulhudhuffushi experienced inundation due to waves during 2017. Locals also indicated that the island experienced 2004 tsunami to some extent but no severe damages occurred to the Island. According to the proposed design, two ends of the runway will lie in an area of reclaimed area (will be reclaimed for the project). Since north east end of runway will be located where the coastal area is exposed to the open sea and the other end of the runway face inside the atoll. However, these two area is likely to be impacted by wind generated waves. From the discussions held with locals, now also the area experience high waves and sometimes experiences inundation or wash over effect. During the days when field surveys were carried out, although no significant wave actions were observed in the project boundary area, signs of wave actions can be seen (Figure 3-10).

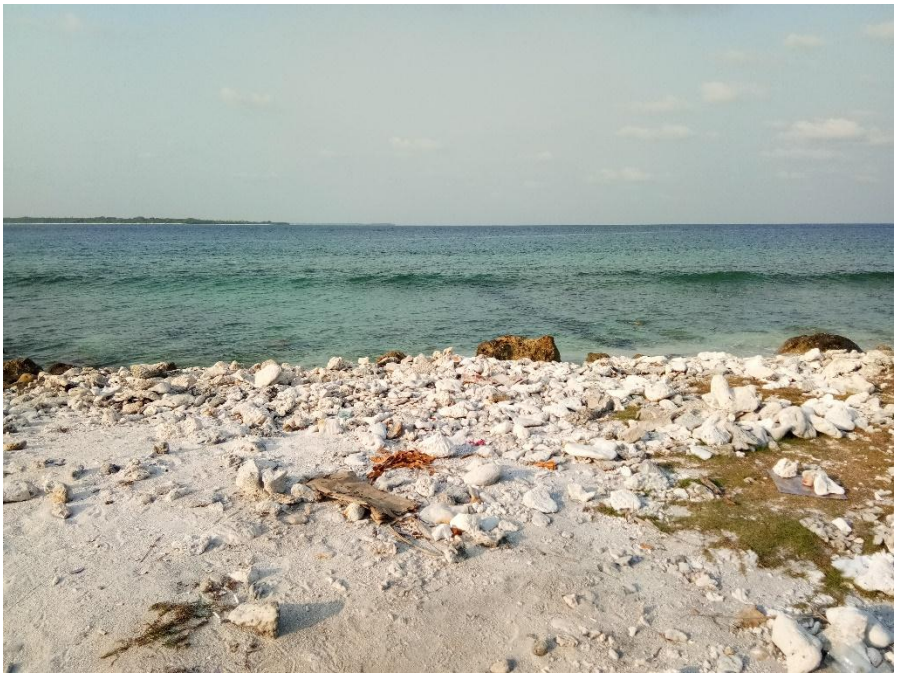


Figure 3-10: Kulhudhuffushi island project boundary, depicting wave conditions.

3.3 Geology and Geomorphology

The islands of the Maldives occupy the central portion of the 3,000km-long Lacadive-Chagos submarine ridge, which is a major feature of the Indian Ocean seafloor and they are low-lying in nature (UNEP 2005). Primarily the islands of the Maldives compose of reef-derived carbonate sediment that has been deposited by waves and currents and this can be seen from the Kulhudhuffushi Island also. The reef foundations have been in existence for millions of years. The islands of the Maldives however, are some of the youngest land surfaces on earth. Because of their unconsolidated nature, the islands should be considered ephemeral from the perspective of geologic timescales.

The western side of the lagoon area has been highly modified (reclaimed and harbor exists) and only limited live corals exist. The reef system around the island gently slopes to Deep Ocean on the eastern side. The west side of the island is exposed to the inner atoll and protected from strong waves. The eastern side is exposed to the open sea and wave action is high on this side (Figure 3-11). Due to high wave energy action on the eastern side of the Island, storm deposits and coral rubbles exists and the

eastern side of Kulhudhuffushi is generally higher compared to the natural area of western side.

Figure 3-11: Wave action on the eastern side of Kulhudhuffushi.

3.3.1 Bathymetry

Bathymetry survey of the proposed project areas were undertaken during the field survey visit, to determine the depth of the area and the results are provided in Appendix 3, together with shoreline and beach profiles. It should be noted that the depth is in meters with reference to mean sea level (MSL). The results of the survey indicates that the average depth of the proposed north western reclamation area is -1.0m from mean sea level, while the maximum depth observed was 2.0m from MSL. On the other hand, average depth of the proposed north eastern reclamation area is -0.86m from mean sea level, while the maximum depth observed was 2.60m from MSL. In addition to these two areas, bathymetry survey of lake (Kulhi) area was also done in areas where it is reachable by a paddling vessel (see photo: Figure 3-12 top panel). The average depth of lake (Kulhi) area is -0.41m from mean sea level, while the maximum depth observed was -0.86m from MSL (see photo: Figure 3-12 bottom panel).

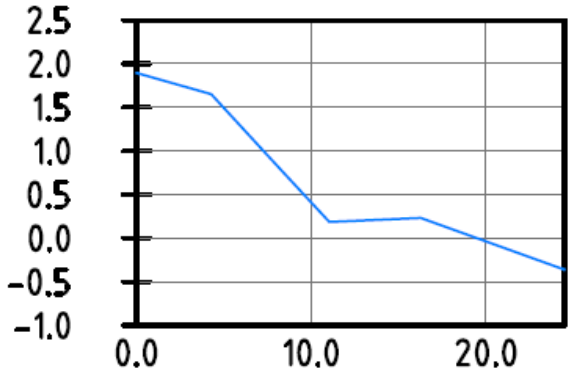
Figure 3-12: Vessel used for the bathymetric survey of Kulhi area (top) and spot height of Kulhi area.

3.3.2 Beach Environment

For the monitoring purpose it is important to establish baseline condition of the beach around the project boundary. In order to establish baseline conditions of the existing beach and shoreline environment, beach profiles were taken around the project boundary area during the field survey. The locations of beach profiles (marked P1-P12) are given in Figure 3-13, while Figure 3-14 depicts beach profiles. These profiles

provide baseline conditions for the future monitoring and can provide information regarding shoreline changes that may occur in the future. Presently also some signs of coastal erosion (not so severe) around project boundary area is observed during field survey, as shown in Figure 3-15. Most of the islands of the Maldives are geomorphologically dynamic in structure, since the sandy beach around the islands are active and undergoes natural erosion in response to reversing monsoon from season to season. Kulhudhuffushi is not an exception to this, as erosion can be seen around the island and rocky beach is seen on the north end and on the eastern side of Kulhudhuffushi (Figure 3-15)

Figure 3-13: Locations of beach profiles (locations of beach profiles are marked P1-P12).



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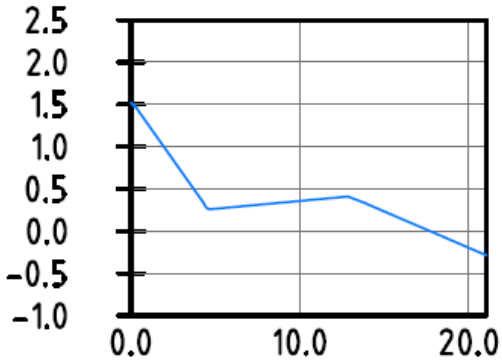

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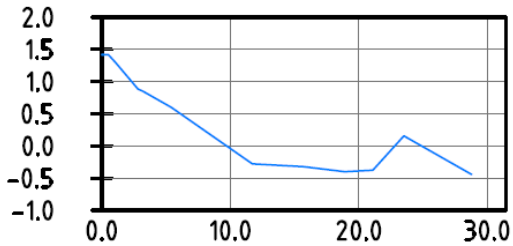

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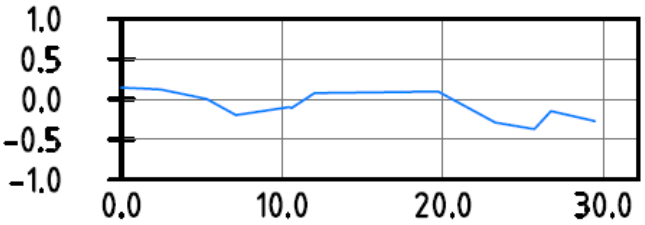
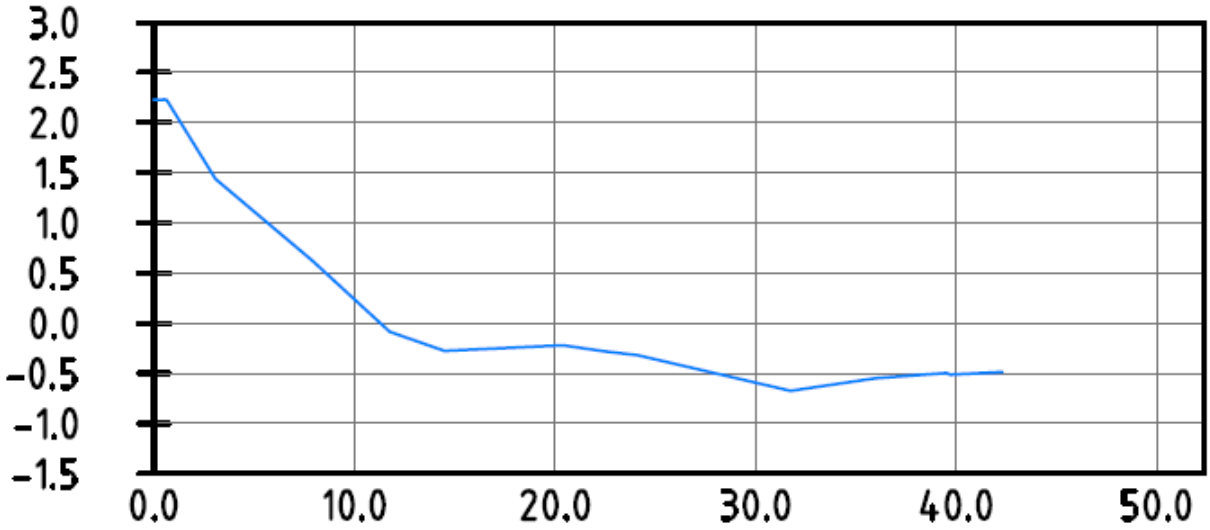


CS 4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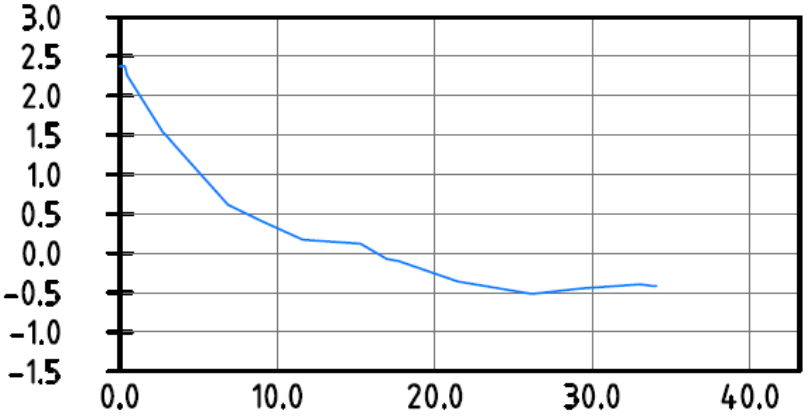
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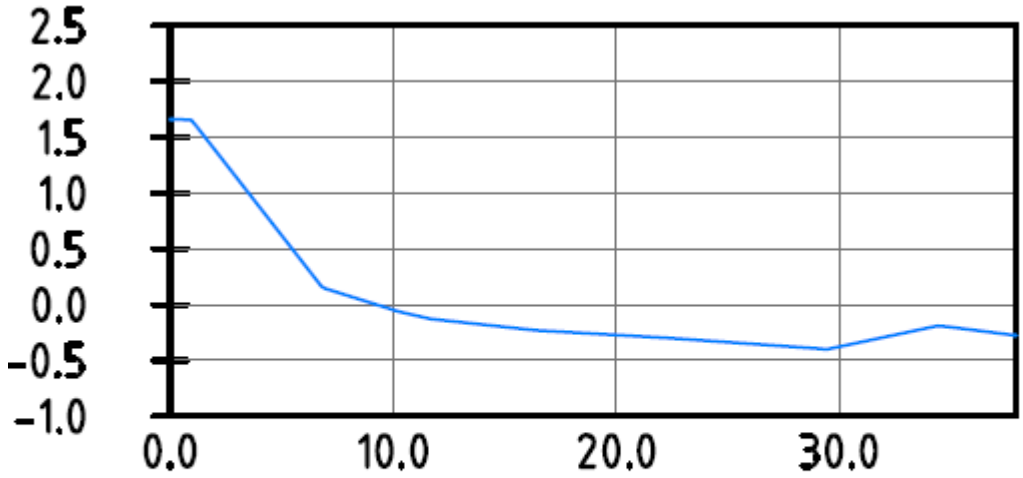
CS 6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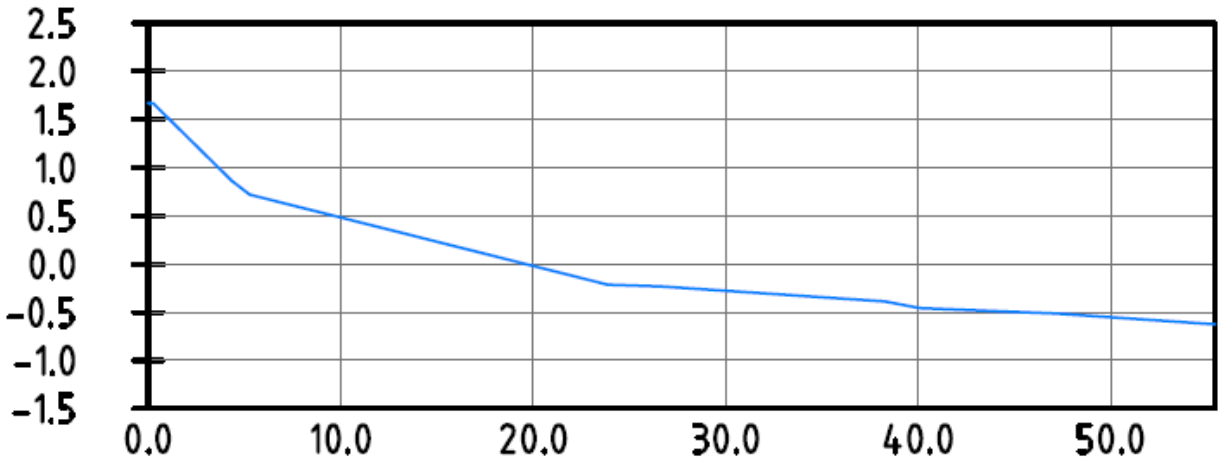
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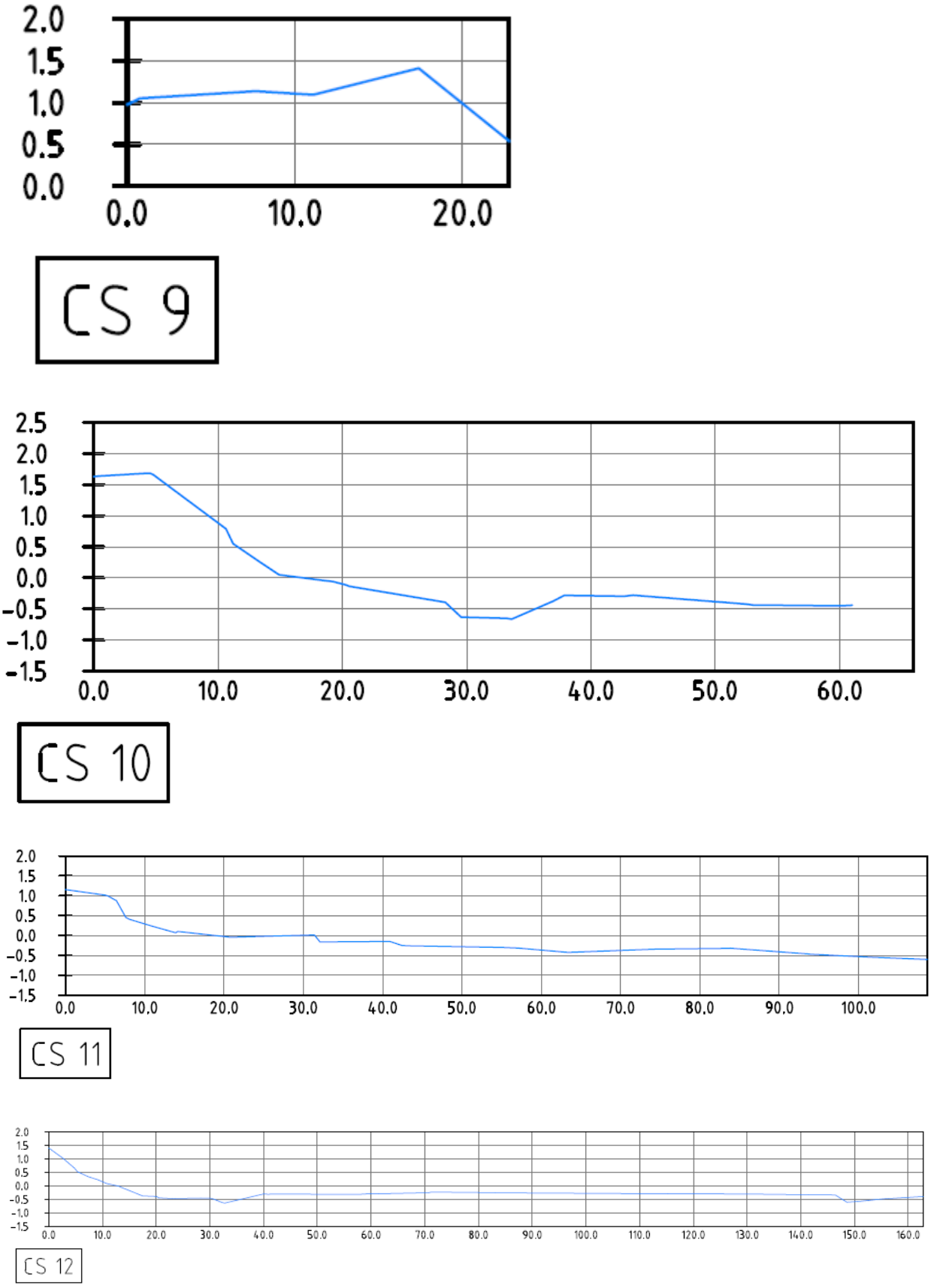


Figure 3-14: Cross sections (CS) of Beach profiles 1-12: Both axis in meters.

Figure 3-15: Some degree of beach erosion is observed during field survey of Kulhudhuffushi.

3.3.3 Sediment characteristics

Physical removal of substratum and associated biota from the seabed, and burial due to subsequent deposition of material are the most likely direct effects of dredging and reclamation projects. The proposed project involved reclamation of the sea area and dredging and reclamation at Kulhi area and it is important to determine sediment characteristics as sediment may impact surrounding habitats. In order to determine the sediment characteristics of the project area, samples from upper surface of the sea bottom were collected and analyzed for grain size. 8 samples were taken perpendicular to the beach from each location where the sea water samples (see Figure 3-16) were collected. Samples collected indicates it consists of gravel, sand, silt and clay.

Furthermore, four soil core samples were collected around the Kulhi area (Figure 3-16) by drilling an iron rod (Figure 3-17) to understand the physical nature of the soil. Figure 3-18 shows Soil samples 2-4. Top few centimetres consist of muddy silt and clay materials. When the water column is disturbed, silt and clay sediments are easily suspended and make the water turbid, as it is observed during the field survey (Figure 3-19). These can impact fish in the lake. From the samples collected around the Kulhi area, some remains of plant materials were found. The bottom layer (about 20cm) consists of white brownish sand.

Figure 3-16: Locations showing where sea water samples (SW1-SW3), sea current measurements (Current 1-3: indicated in yellow square), ground water samples (G1-G5: indicated in red square) and soil samples (Soil 1-4: indicated in red circle) were taken. Water current (speed depicted and direction shown in arrow) GPS coordinates are given in Table below. Water current 1-3 coordinates are same as SW1-SW3 coordinates. Soil 1 coordinates are same as GW1 coordinates. Soil 2-4 GPS coordinates are 6°37'48.7"N, 73°04'10.1"E, 6°37'59.8"N, 73°03'49.9"E and 6°37'54.0"N, 73°03'50.6"E, respectively.

Figure 3-17: Soil sample collection by drilling an iron rod at Kulhudhuffushi Kulhi area.

Soil 2

Soil 3

Soil 4

Figure 3-18: Soil sample (sample 2-4) collected by at Kulhudhuffushi Kulhi area.

Figure 3-19: Observed turbidity due to suspension of clay and silt when the water at the Kulhi was disturbed.

In order to establish baseline condition of groundwater for future monitoring, ground water samples were collected from five (ground water) locations of the island. Figure 3-16 shows the locations where ground water samples were collected to determine water quality and physical characteristics ground water. Samples were sent to MWSC laboratory for chemical and physical testing specified in the TOR. Table 3-3 shows test results of ground water samples (see Appendix 4 for the test result report).

Table 3-3: Ground Water sample test results for the 5 locations

Parameters /Coordinates	**GW1** **6°38'00.1" N, 73°03'56.9 "E**	**GW2** **6°37'36.2" N, 73°04'06.3 "E**	**GW3** **6°37'24.4" N, 73°04'03.3 "E**	**GW4** **6°37'39.9" N, 73°04'19.9 "E**	**GW5** **6°37'13.2" N, 73°04'12.9 "E**

Physical appearance	Pale yellow with particles	Pale yellow with particles	Pale yellow with particles	Pale yellow with particles	Pale yellow with particles
Electronic Conductivity (uS/cm)	40700	2500	2090	1343	1368
pH	8.33	7.21	7.38	7.20	7.35
Salinity (‰)	25.91	1.29	1.07	0.67	0.68
Temperature (°C)	21.1	21.2	21.3	21.4	21.4
Nitrate (mg/L)	0.005	<0.002 (LoQ 0.002 mg/L)	5.18	0.006	6.11
Sulphides (ug/L)	<5 (LoQ 5ug/L)	<5 (LoQ 5ug/L)	5	12	<5 (LoQ 5ug/L)
Phosphates (mg/L)	0.10	0.16	0.6	0.36	0.34
Hydrocarbons	NA	NA	NA	NA	NA

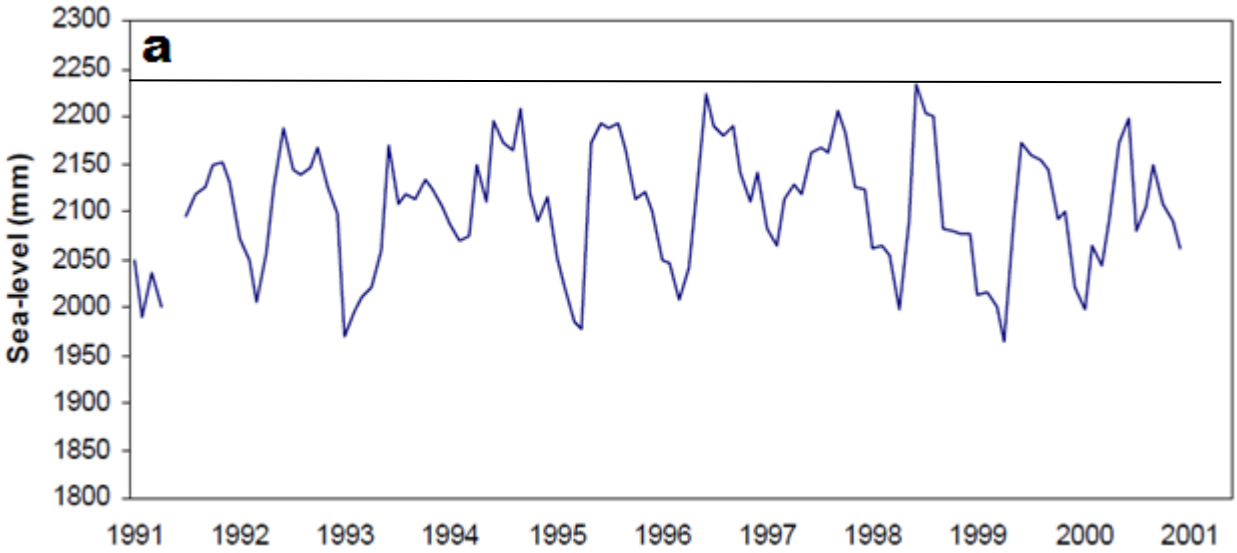
3.4 Hydrography/Hydrodynamics:

3.4.1 Tides

Tides in the Maldives are mixed and semi-diurnal/diurnal in nature. Tide data from north (Hanimaadhoo), Central (Hulhule) and South (Gan) indicates maximum spring tide variation of about 1.1 m. Although tidal range is small in the Maldives, tides may play an important role on the formation, development, and sediment transportation around the islands of the Maldives. Furthermore, tides also may play an important role in lagoon flushing, water circulation within the reef and water residence time within an enclosed reef highly depends on tidal fluctuations. Tide is important as they can determine the strength and direction of currents. Tides are long-period waves that roll around the planet as the ocean is "pulled" back and forth by the gravitational pull of the moon and the sun as these bodies interact with the Earth in their monthly and yearly orbits. During full or new moons, which occur when the Earth, sun, and moon are nearly in alignment, average tidal ranges are slightly larger. This occurs twice each month and called spring tides. Spring tides occur between one and three days after a new or full moon and neap tides occur just after the first and third quarters of the moon. During neap tides, the influence of the sun and moon are working against each other, resulting in a minimal tidal range.

The approximate difference between successive high tides is 12 hours 25 minutes and the interval between spring and neap tides is about 7 1/4 days. During spring tides, the tidal range is between about 88 cm and 110 cm and during neap tides the range can be as little as a few centimeters. Variations of just a few centimeters can make an immense difference to the strength of tidal currents. The height of the tide is also affected by the weather. Winds from different directions influence the raising and lowering of the water level and situations of high sea levels on the outside of the atolls are caused by storm surges and wave set-up. The times of low and high water must not be considered to coincide with the times of slack water and change of current direction. Inside the atolls, water often runs in or out long after the tide has turned. Precise and long term data on tidal range and patterns of flow do not exist.

Inter-annual and seasonal variability of sea level at Hanimaadhoo is shown in Figure 3-20. There exists both inter-annual variability and seasonal variability. In general, higher sea levels are seen during the north east monsoon. This might be due to the formation of low pressure depressions at the south of India during this season. These depressions again cause swells and water to pileup causing higher sea levels at Hanimaadhoo during the north east monsoon (Shareef, 2006). The sea level variations depicted in Figure 3-20 for Hanimaadho would represent sea level conditions at the project area (Kulhudhuffushi). Figure 3-21 and Figure 3-22 shows seasonal mean tidal anomaly for the three regions of the Maldives and diurnal tide for the Maldives, respectively. Seasonal pattern of mean tide pattern for Hanimaadhoo is quite similar to variability of sea level for Hanimaadhoo. The tide observed in the Maldives can be described as mixed diurnal tide as it is seen from Figure 3-22 (SNC, 2016).



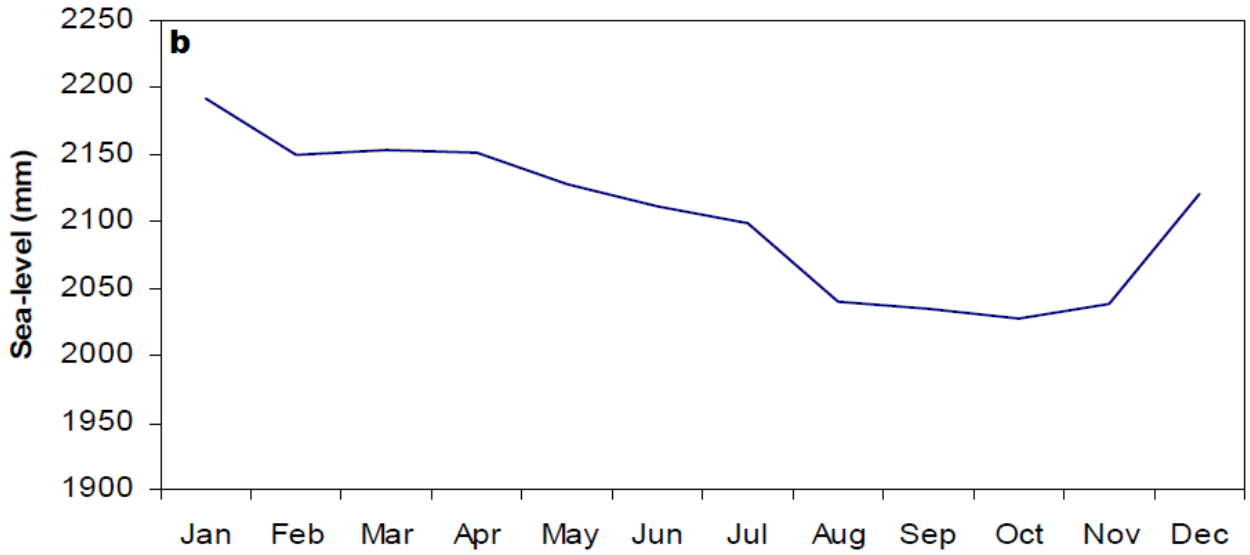


Figure 3-20: (a) Inter-annual variability and (b) seasonal variability of sea level at Hanimaadhoo (adapted from Shareef, 2006).

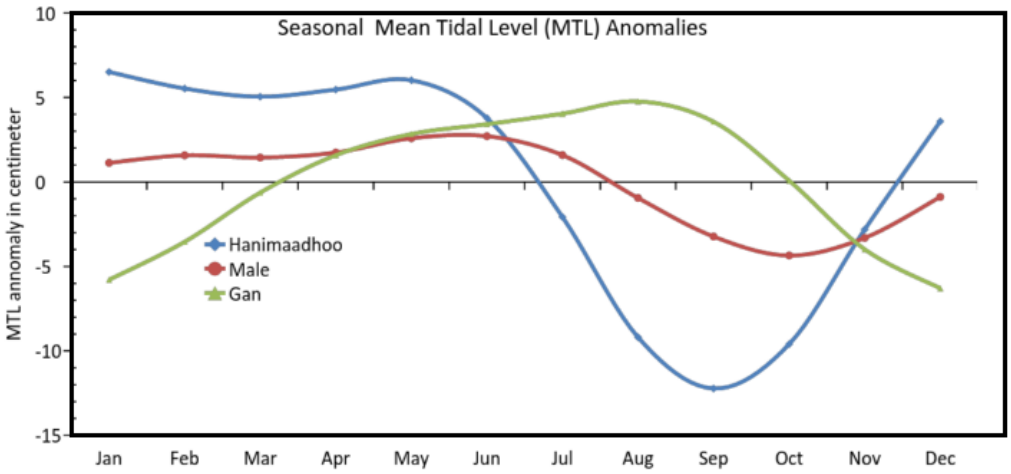


Figure 3-21: Seasonal mean tides levels (seasonal anomaly) for the three regions of Maldives.

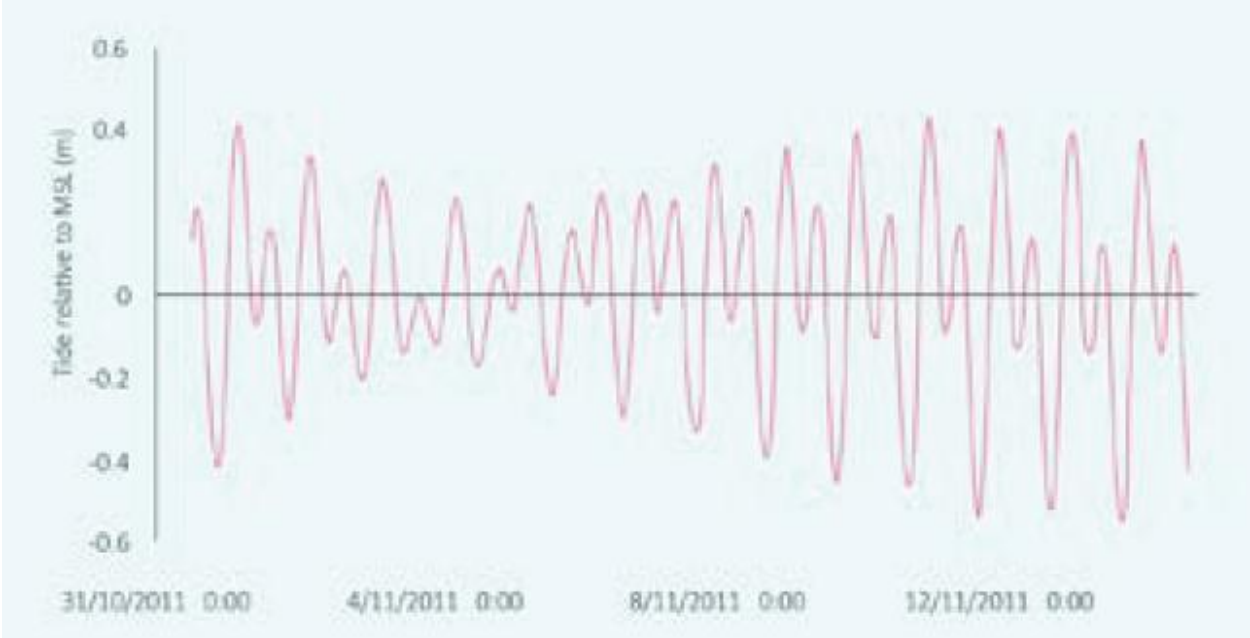


Figure 3-22: Diurnal tide observed in the Maldives (SNC, 2016).

3.4.2 Wave climate and Currents

In general, ocean currents in the Maldives are driven by monsoonal winds. Westerly current flow tends to dominate during the northeast monsoon season (January to March) (wind blows from the North-East, and the current comes from the east). Furthermore, easterly currents (wind driven current coming from the west) dominate during the southwest monsoon (May to November). During transition months (April and December), changes in current flow patterns occur (Kench et. al, 2006). However, it should be noted that the currents flowing near the coastal shoreline of the islands are slightly different from the oceanic currents due to the location, orientation and morphology of the reefs of the islands. In addition to the general ocean currents, the ocean currents flowing through channels between the atolls are driven by the monsoon winds (MEC 2004). Although the current flow in the Maldives is driven by monsoon winds, currents that may affect the proposed project area can be caused by combination of tidal currents, wind-induced currents and wave-induced currents. In general, during southwest monsoon season, west coast of Kulhudhuffushi would experience wind generated waves, while eastern side of the island would experience waves generated by northeast monsoon wind. In order to establish project area specific current patterns, long term (at least for one year) field measurements are required. Due to time constraints, current measurements were undertaken around the

project area during the field visit, to establish baseline conditions of current flow around the project area. The results of the current measurements (both speed and direction) are depicted in Figure 3-16. As it can be seen from the figure, currents are minimal close to the Current 3 and highest at Current 2. The current flow patterns at the time of the measurements appeared to be wind generated waves. The wind generated wave height is a function of wind speed, fetch length and duration of wind blowing from same direction. Since eastern side of the island is open to ocean, wind generated waves from this direction expected to be higher but limited in duration, while waves during the southwest monsoon generated inside the atoll would be fetch limited. Figure 3-23 shows wave pattern induced by wind around Kulhudhuffushi.

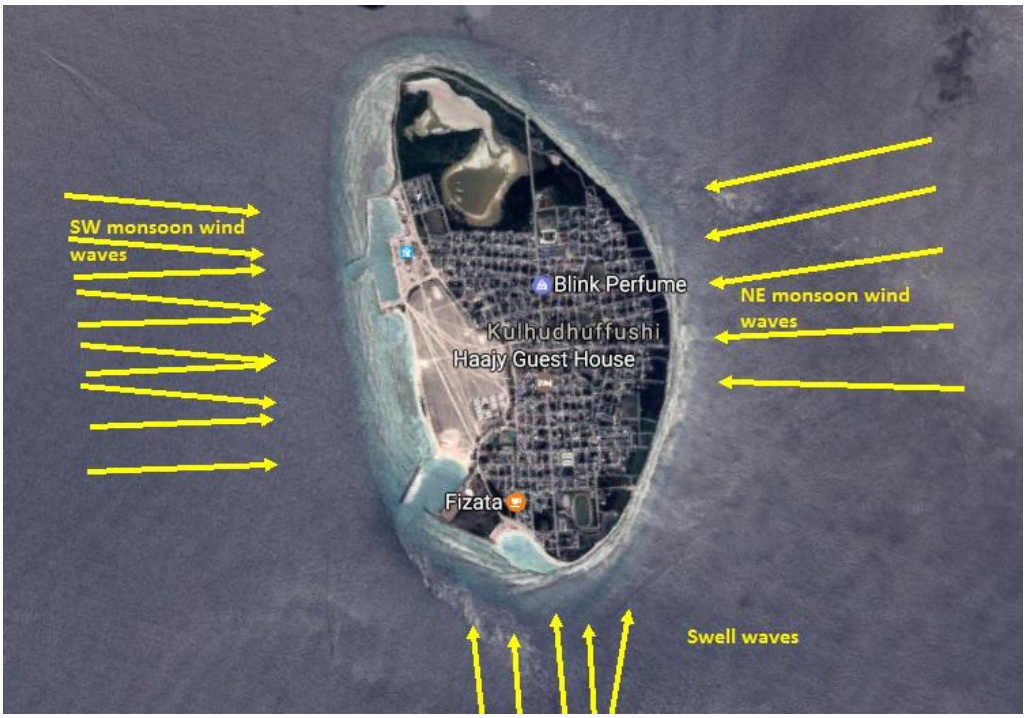


Figure 3-23: Wave patterns around Kulhudhuffushi.

3.4.3 Sea water quality

In order to establish baseline condition of the marine area for future monitoring, sea water samples were collected from three locations of project surrounding area. Figure 3-16 shows the locations where sea water samples and current measurements were taken. Sea water samples collected were sent to MWSC laboratory for chemical and physical testing specified in the TOR. Table 3-4 shows test results of sea water samples (see Appendix 4 for the test result report).

Table 3-4: Sea water sample test results for the 3 locations

Parameters	Test Results		
	SW1 (6°37'57.8"N, 73°03'42.0"E)	**SW2** (6°37'48.5"N, 73°04'23.0"E)	**SW3** (6°37'19.5"N, 73°04'37.0"E)
Physical Appearance	Clear with particles	Clear with particles	Clear with particles
pH	8.21	8.22	8.23
Salinity (‰)	33.13	32.95	32.87
SST (°C)	21.7	21.7	21.7
Turbidity (NTU)	0.147	0.213	0.332
Nitrate (mg/L)	3.7	4.4	6.0
Nitrogen Ammonia (mg/L)	0.05	0.04	0.07
Sulphate (ug/L)	2500	2650	2850
Phosphate (mg/L)	<0.05 (LoQ 0.05 mg/L)	<0.05 (LoQ 0.05 mg/L)	<0.05 (LoQ 0.05 mg/L)

3.5 Marine environment

Marine survey was carried out in three sites of the island to understand the composition of reef benthos and the fish community. During the construction phase of airport, coastal reclamation will take place hence this could have an adverse effect on the coral reefs. To understand the magnitude of this effect and the significance of the

reef areas within the vicinity of the reclamation areas, a detailed marine survey was carried out.

The marine survey was carried out in three sites of the island; site A which is near the harbour area (proposed reclamation area 1), site B (proposed reclamation area 2) and site C (eastern side of the island) as shown in 3-24. Sites A and B were selected based on the development activities which could result in a negative impact, while site C was selected as a reference.

Figure 3-24: A Google map showing the sites chosen for marine surveying (source: Google maps). Reef and fish community assessment was done around three sites where water samples were taken, as shown in Figure 3-16.

3.5.1 Equipment and Method used:

- 1m × 1m quadrat
- Go pro – hero 3 camera
- Garmin GPS

For benthic assessment (corals):

- A 1m × 1m quadrat was built by using PVC pipes with joints (Figure 3-25)
- Quadrat was laid at 3-5m at the top reef slope area
- Photo was taken for each quadrat; for data analysis
- 10 quadrats were laid randomly at each site.
- This procedure was repeated at the other two sites
- For each site GPS of the location was recorded
- All the photo quadrats were analyzed by using data analysis software called CPCE.
- The corals were identified on a morphological level instead of concentrating on the generic identification

For fish communities:

- All the fish which were visible along a 360° radius from the center of each quadrat were recorded on video transects
- These data was later analyzed on basic Excel statistics

3.5.1.1 Results and inferences

Table 3-5: Shows average composition of benthic and fish community abundance of the sites A, B, C

	Composition of benthos/%		
	Site A	Site B	Site C
Live coral cover	15	17	30
Dead corals	22	9	6

Sediment	31	11	7
Macro algae	20	23	12
Fish abundance	12	40	45

The average composition of reef is of live corals, dead corals, and sediment and macro algae. Site A which is near the harbor area is high in sediment compared to the other two sites. This is an expected scenario due to activities such as dredging during the harbor construction. This could also factor in to the low coral cover in the area, as high sedimentation rate could smother the corals resulting in to the mortality of coral recruits and settlement of larvae. Few fish species were observed within this side, mostly single species rather than big schools of fish.

Site B has relatively low coral cover compared to the Site C but a slight increase in comparison to the site A. Although coral cover is fish abundance is high in this site. Schools of fusiliers, banner fish and some butterfly fish were observed within this area. Some functional groups such as Acanthurus and Scaridae species were also observed in this site. The abundance of this species could also be the result of high macro algae cover in the reef, which these fishes feed up on as they are categorized under herbivorous fish. In site C a higher coral cover is observed in comparison to the other two sites. Overall the benthic composition is in a better state in site C as it has more coral cover and high fish abundance as well.

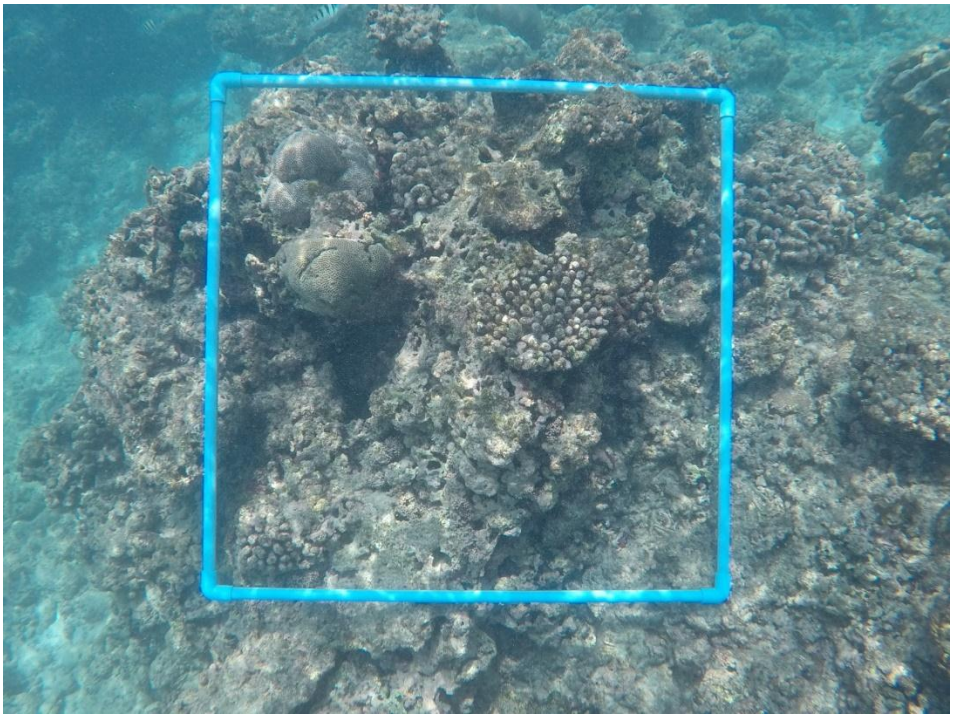


Figure 3-25: Shows are 1m×1m quadrat laid on the reef front at site C

From the visual observations (Figure 3-26), it is clear that the water is quite clear. Marine environment is much more attractive when the water is clean (free from pollutants) and clear (low turbidity) and able to see the coral, fish and sea bottom. However, in general there is not much of significance on the three sites that were surveyed (See Figure 3-27 for the benthic reef structure of site B). Mega fauna such as turtles, sharks, manta rays were not observed within this area. Also the corals observed in all three sites are mostly pocillopora sp, Pavona sp, Favia, Porites sp. few recruits of Pocillopora species were observed in site C. There are no bleached corals in the areas surveyed however there are quite a few corals which are dead and this could be assumed as a consequence of last year's bleaching episode. Most fish species observed belongs to the functional groups which are important in reef health maintenance. These fish species belongs to Acanthuridae, Cheatodontidae, Scaridae family which are a common species areas with high macro algae.

Figure 3-26: Visual observation of marine environment indicates that the sea water is quite clear. Some fish community is also visible from the surface of the water.

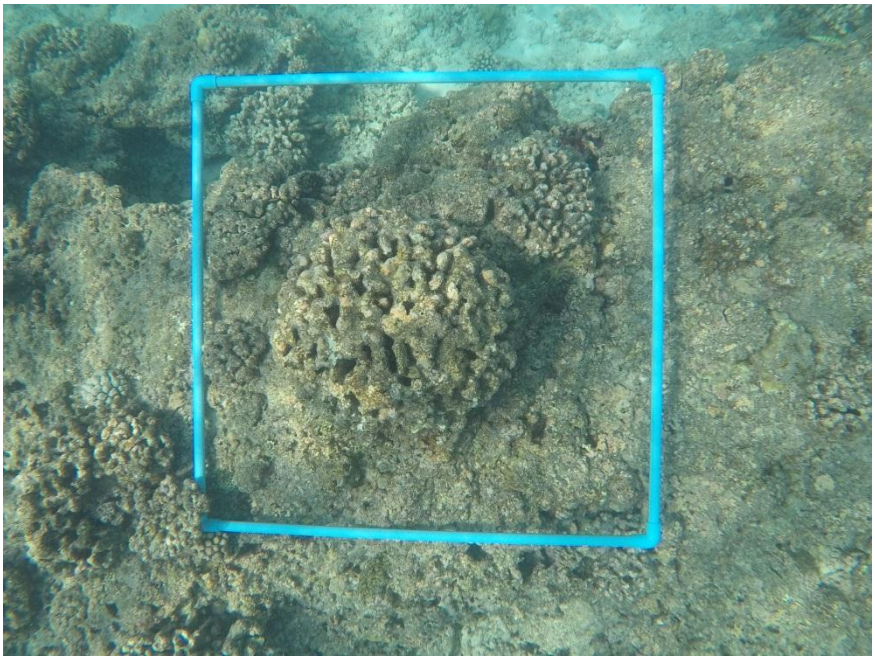


Figure 3-27: Show the benthic reef structure of site B

Although there is not much significant diversity in the area, due to the reclamation the health of the reef could be worsen. At present, although it has low coral cover, with more sedimentation the possibility of mortality of the recruits are high. With such consequences the possibility of the reef bouncing back to its normal conditions is far from being a reality.

To avoid further damages to the reef area, when reclaiming and dredging activities are performed, sediment traps could be used to avoid further sedimentation of the reef. Periodic monitoring is important during pre and post construction phase. When monitoring of the reef is conducted, the data collected for the EIA can be used as a base line data for the area and hence could check the overall trend of the health of this reef area. The project boundary is not in any of the Marine Protected Areas (MPAs) and sensitive sites, such as breeding or nursery grounds for protected or endangered species.

3.6 Hazard Vulnerability

Being a low-lying island state, the Maldives is one of the most vulnerable countries to the impacts of climate change and associated sea level rise. Low elevation makes Maldives particularly vulnerable to storms and changes in sea level. In addition to this, the Maldives is vulnerable to changes in temperatures and rainfall patterns. According to the Intergovernmental Panel on Climate Change (IPCC) in their Fifth Assessment Report (AR5), by the year 2100, sea level expected to rise by up to 70 cm. Since 80% of the islands of the Maldives are only 1m above mean sea level, project sea level rise will result in inundation of islands of the Maldives.

When sea level rise around Maldives area is considered, increasing trends of mean tidal level of about 3.9-4.1 mm/year for the period 1991-1999 have been found (UN-OHRLLS 2009). Using daily sea level data, Hay (2006) found a long term trend in sea level of 1.7 mm/year for the central Maldives for the period 1989-2005. Furthermore, Hay (2006) also found a 7 mm/year increase in maximum hourly sea level and pointed out that this is far in excess of the observed local and global trends in mean sea level. Currently, an hourly sea level of 70 cm above current mean sea level is a 100 year event, but by 2025 an hourly sea level of 70 cm is likely to be at least an annual event

for the central Maldives. Such exceptionally high sea levels will cause flooding, accelerated coastal erosion and salt water intrusion into groundwater (Hay 2006).

The disaster risk profile of the Maldives prepared by the UNDP after 2004 Tsunami presents tsunami vulnerable zones of the Maldives, which is displayed in Figure 3-28. Figure 3-29 shows cyclone tracks. According to the disaster risk profile of the Maldives, Kulhudhuffushi lies high risk zones for most of the hazards including severe storms, cyclone winds (hazard zone 5-highly vulnerable), storm surge (hazard zone 5-highly vulnerable) and tsunami (hazard zone 5-highly vulnerable). It should be noted that the 2004 tsunami caused damages to the Kulhudhuffushi Island.

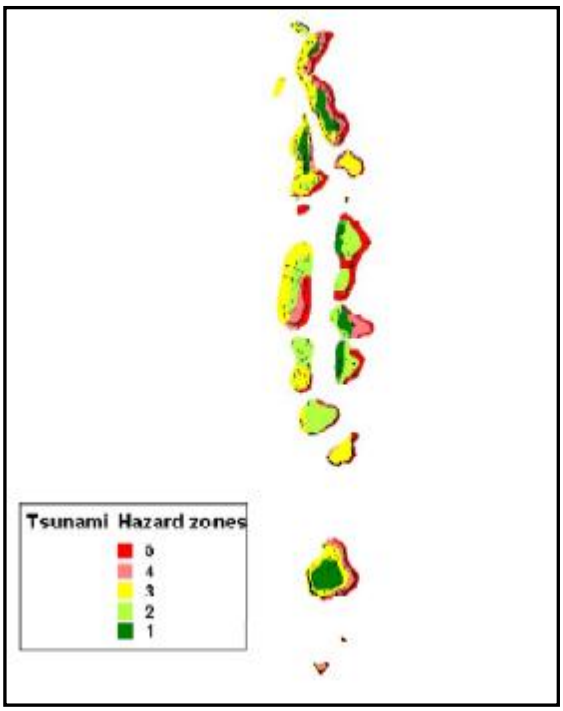


Figure 3-28: Tsunami Hazard Zones for the Maldives (obtained from UNDP, 2006).

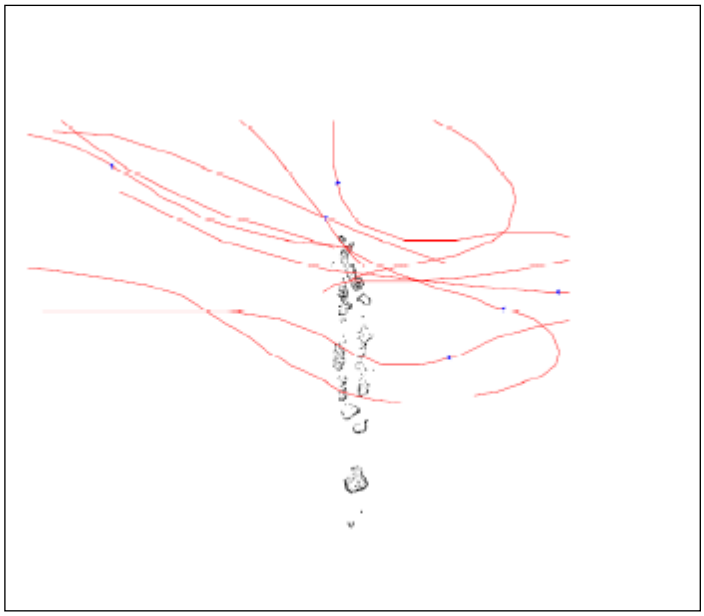


Figure 3-29: Track of cyclones which affected the Maldives during 1877-2004 (adopted from UNDP, 2006).

3.6.1 Rain induced flooding:

Frequency of occurrence of rainfall events for different threshold categories of daily rainfall for three regions of Maldives is presented in Table 3-6. On average the islands of the Maldives experienced about 6-8 daily events of rainfall between 50-99 mm each year, over the last 18 year period. The northern region (Hanimaadhoo) experienced rainfall events with a magnitude of 100-149 mm about once every two years, while the central and southern region experienced such events about once every year. When a daily rainfall threshold value greater than 50 mm is considered as the criterion for defining flood events, then the southern region is most vulnerable to flood events. The southern region had 166 rainfall events greater than 50 mm, while the northern region is least vulnerable to flood events, with only 123 rainfall events greater than 50 mm (Table 3-6) (Zahid, 2011). According to Shaig (2006), more than 90 islands of the Maldives (45% of all the inhabited islands) experienced flash flooding at least once during the last six years, and about 37 islands have experienced inundation regularly or at least once a year. Furthermore, about 71 inhabited islands were flooded in 2004 alone due to severe weather events (Shaig 2006).

Table 3-6: Frequency of occurrence of rainfall events for the three regions of the Maldives for different daily rainfall threshold categories for the period 1992-2009. The values in brackets indicate the percentage of occurrence during the monsoon season (May-November) (Zahid, 2011).

Rainfall threshold category (mm)	Northern		Central		Southern	
	Frequency	Average events per year	Frequency	Average events per year	Frequency	Average events per year
50-99	113 (88%)	6.3	109 (59%)	6.1	147 (65%)	8.2
100-149	10 (80%)	0.6	13 (92%)	0.7	16 (56%)	0.9
150-199	None	None	3 (100%)	0.2	3 (67%)	0.2
>200	None	None	None	None	None	None
Total no. of events > 50 mm	**123**		**125**	-	**166**	-

The frequency of occurrence of rainfall events or flash flood events are consistent with the return periods presented in Figure 3-30 and Table 3-7, illustrating modelled return periods for years 2025, 2050, 2075 and 2100, which is based on daily rainfall. As can be seen from Figure 3-30 and Table 3-7, at present a daily rainfall of 150 mm for the northern region is a 300 year event, but by year 2050 and 2100, it is likely that 150 mm rainfall events will become quite frequent with a return period of 66 and 23 years (Figure 3-30 and Table 3-7), respectively.

The flood impacts associated with a particular rainfall threshold may depend of geography (whether the island has low lying and flood prone areas), shape, soil type and the depth of the water lens of the particular island. Hence, as flash flood impacts associated with particular rainfall threshold values can have different impacts on different islands, threshold range can be used to identify flood related impacts. About 16% of the interviewed from Kulhudhuffushi indicated that they have experienced flood related damages to their household and flooding occurs annually due to rainfall events. To date no preventive measure have been taken against flooding due to

rainfall. However, MEE is in the process of formulating a flood drainage project for Kulhudhuffushi.

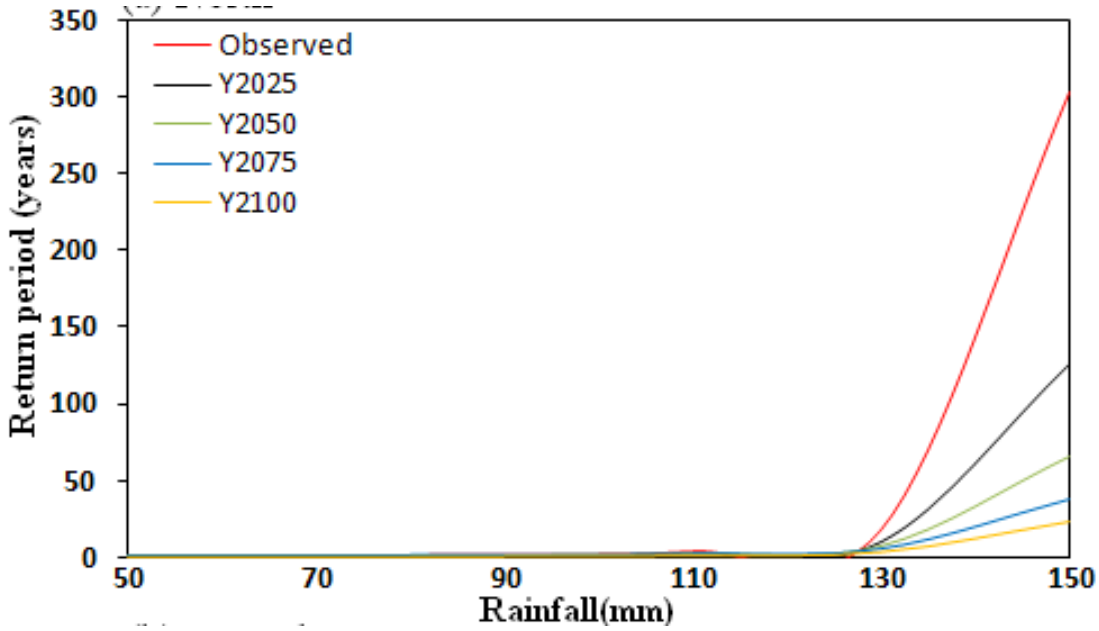


Figure 3-30: Observed and predicted (for years 2025, 2050, 2075 and 2100) return periods for Hanimaadhoo based on daily rainfall for the periods 1992-2009 (adopted from Zahid, 2011).

Table 3-7: Return period for Hanimaadhoo for different rainfall categories (adopted from Zahid, 2011).

Daily rainfall categories (mm)	Return period (Years)				
	Observed	Y2025	Y2050	Y2075	Y2100
50	1.0	1.0	1.0	1.0	1.0
70	1.2	1.1	1.1	1.1	1.0
90	1.6	1.4	1.3	1.2	1.2
110	3.7	2.7	2.3	1.9	1.7
130	17.9	10.4	7.2	5.2	4.0
150	303.5	125.8	66.2	37.6	23.0

From the observation it is clear that the island elevation have been modified and almost entire western side of the island is higher than the rest of the island natural land area due to the reclamation projects in the past. The elevation of the western side of reclaimed land area stands at 1.5m above MSL. The current topography of the island makes it very susceptible to for some areas to be flooded due to high rainfall events.

The extent of flooding is generally governed by the topography and the drainage capacity of the island. Low areas with no means of drainage are the most vulnerable to flooding. Figure 3-31 shows level of impact due to rainfall flooding. The whole boundary area lies within high category zone (impact level 3-5). The northern and southern areas of the island is very susceptible to flooding due to rain. If the northern part of the island (wet land area-Kulhi) is reclaimed as proposed, this will cause more flooding as the natural catchment area will be reduced and drainage capacity of the area will be reduced to ground compact for runway construction, leading to the area more susceptible to flooding due to rain.

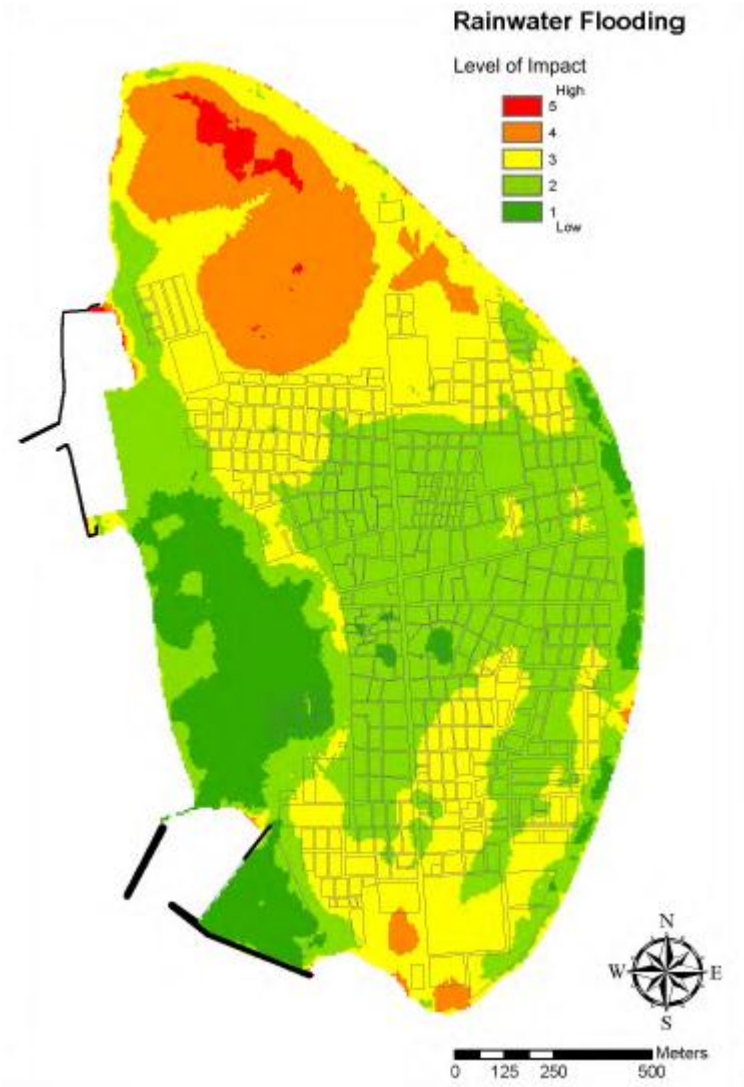


Figure 3-31: Areas showing different level of impact due to rainfall flooding. Taken from MEE, 2013.

3.6.2 Flooding due to Storm surge

The island of Kulhudhuffushi is exposed to storm surges generated due to low atmospheric pressure systems associated with cyclones and severe storms. As can be seen from Figure 3-32 and Figure 3-33, Kulhudhuffushi is located in a cyclone and storm surge zone (category 5: very high), respectively. Maximum storm surges of about 0.6 m is expected for this category. It is expected that storm surge combined with high tide and large wind generated waves can cause serious overtopping and damage to the Kulhudhuffushi. Inundation or overtopping due to storm surge and wave on the eastern side of the island is expected to be relatively low as the eastern side coastal ridge of Kulhudhuffushi acts as a natural barrier to flooding due to storm surge and wave induced flooding, compared to the southern and northern end of the island, which is lower in elevation. Figure 3-34 shows a hazard zone map of Kulhudhuffushi in relation to wave induced flooding. According to this, the project boundary area is in high impact zone area (impact level 4-5). From the field surveys and discussions held with locals, it is clear the island experience inundation/overtopping/over wash due to waves and the impact of such events are generally limited to the coastal areas. In the years 1812, 1819 and 1921, Kulhudhuffushi was affected by heavy rains and storms, causing substantial damage. The island was also affected during the Key Lakunu storm which lost half the population of the island (https://en.wikipedia.org/wiki/Kulhudhuffushi). According to MEE (2013), Kulhudhuffushi experienced major storm surge in 1955 and another event in 2007. The 2007 June event destroyied quay wall in the western side of the island and houses were flooded.

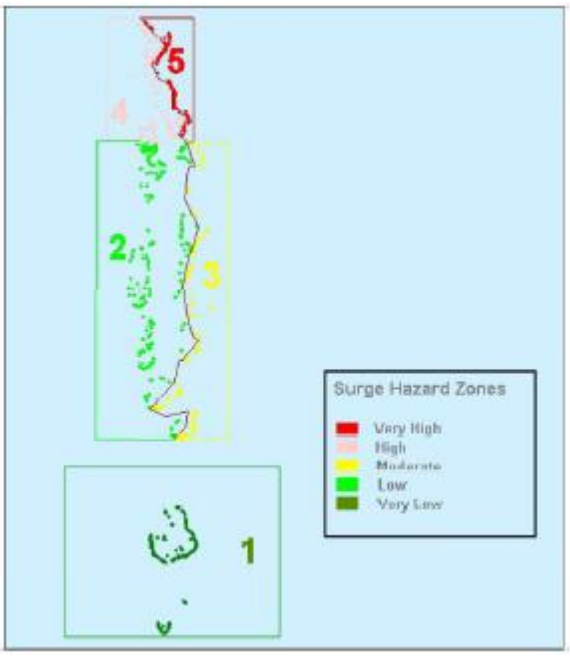


Figure 3-32: Surge Hazard Zones for the Maldives (obtained from UNDP, 2006).

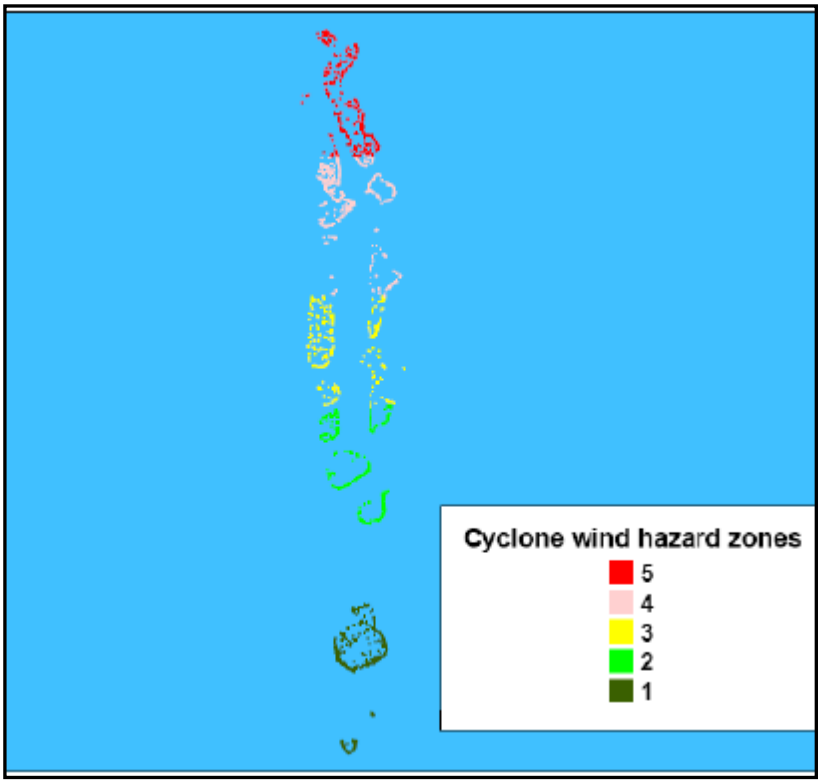


Figure 3-33: Cyclone Hazard Zones for the Maldives (obtained from UNDP, 2006).

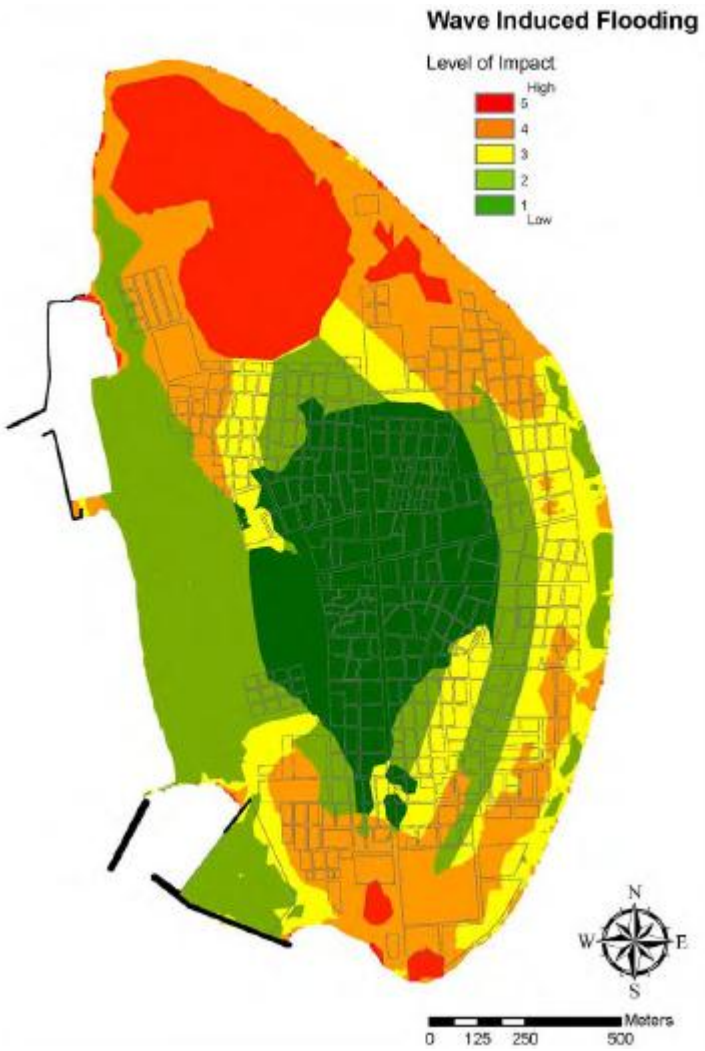


Figure 3-34: Wave induced flooding hazard map. Taken from "Detaild island Risk and Vulnerability Assessment-Hdh. Kulhudhuffushi, 2013"

3.7 Ecology

Ecology of project boundary area at Kulhudhuffushi was determined through discussions and field observations made during the field survey and also based on the literature.

3.7.1 Mangrove

The mangrove area of H.Dh. Kulhudhuffushi is located at the tip of North of the island 6°38'02.1"N 73°03'51.8"E (Figure 3-35). The mangrove lake of Kulhudhuffushi is listed as a "sensitive area" by the Environmental Protection Agency (EPA) of the Maldives due to the significant floral and faunal diversity observed in the area. This

area is known for its dense population of Black Mangrove, Burevi (Lumnitzera racemos) which is a true mangrove species.

Figure 3-35: A Google map showing the mangrove lake of H.Dh. Kulhudhuffushi (source: Google Maps)

The mangrove in Kulhudhuffushi is a closed mangrove system (Figure 3-36) where a brackish pond is encircled by mangrove species and its propagules. For classification, this type of mangrove is referred as a Lake-based Inland mangrove area. The vegetation is denser towards the landward, where mangrove species with prop roots are settled near the seaward. Young propagules of mangroves are seen near the seaward where sedimentation is high. The mangrove associated species such as Milo, Hirundhu (Thespesia populnea) and Pandanu, Kashikeyo (Pandanus sp.) are common in between the seaward and landward and also more towards the landward.

Figure 3-36: A snap shot of Mangrove Lake in H.Dh. Kulhudhuffushi

3.7.2 Vegetation analysis

A vegetation analysis of the mangrove area was done to understand the most abundant species in the mangrove area. A line transect was used to collect data with a random sampling. Even though random sampling was done, when laying the transect points, much was focused to the mangrove area where most of the construction activities are planned (see Figure 3-37). The rationale in doing so is to get an understanding of the type of species that will be threatened during the airport development process.

Same approach was adopted for determining vegetation for the projected boundary area. In order to determine the no of trees/coconut palms to be removed, line transects were laid in an area of 50m by 50m and no of trees were counted at 10m intervals and recorded. In order to get the total no of trees to be removed, no of trees within 50m*50m area was multiplied by the total project area, excluding Kulhi area.

Figure 3-37: Proposed development plan for the airport in the mangrove area of H.Dh. Kulhudhuffushi.

3.7.3 Methodology

3.7.3.1 Equipment and method used:

- 50m transect tape
- Garmin GPS
- ruler
- A 50m transect tape is laid across each selected sites. When laying the transect tape, the starting point of the tape was from the seaward and stretched out to land ward which is considered as the end point of the transect.
- Data was collected at 10m intervals. Any species which aligned to the 10m point of the transect was recorded. To avoid parallax error a ruler was used for accuracy in identifying the point of alignment at each 10m interval.
- At each transect, observation made were recorded. The observations which were recorded are avifauna, fauna and other floral which were within the radius of the transect.
- GPS locations were tagged for each site before the data collection
- A total of 9 line transects were laid in the vegetation area (Figure 3-38).

Figure 3-38: A Google map showing the study sites for the vegetation analysis. A total of 9 line transects were laid to determine the vegetation diversity and zonation of the area. (Source: Google map)

The seaward area of the mangrove lake has mostly prop root mangrove species, Rhizophora apiculata which is a true mangrove species. Saplings of black mangrove, Lumnitzera racemose is observed adjacent to the seaward vegetation which is then followed by leaf litter. Mangrove associated species such as Milo Thespesia Populnea is observed closer towards the landward of the lake. Around 2m towards the landward of the mangrove large thickets of black mangrove Lumnitzera racemose is observed (Figure 3-39) as well as iron wood Pemphis acudula and Pandanus species Pandanus sp are commonly observed across all the vegetation areas.

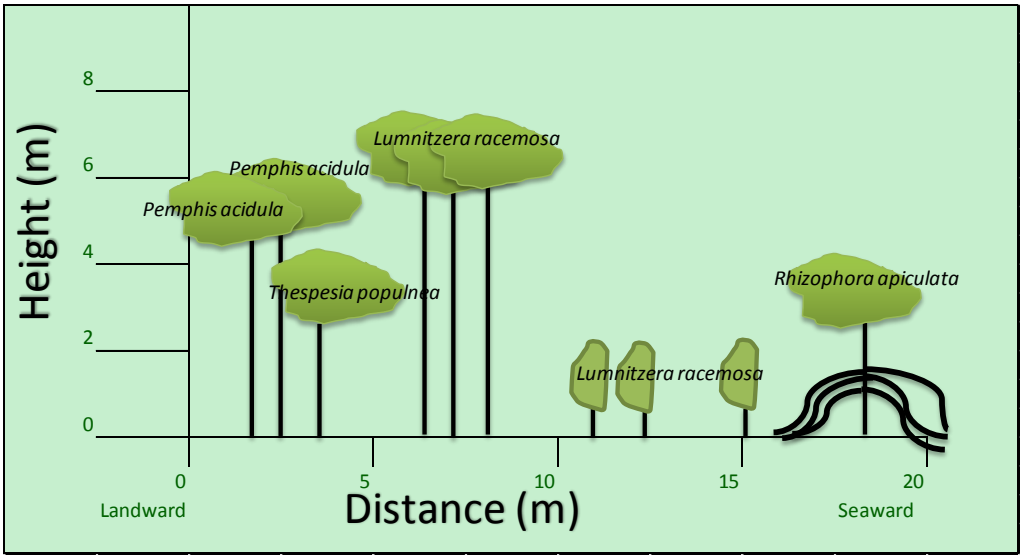


Figure 3-39: A vegetation profile diagram based on the average abundance and distribution observed within the mangrove lake of Kulhudhuffushi

3.7.4 Observed mangrove and associated species

Figure 3-40 shows average percentage of vegetation abundance observed in the mangrove area and some, while Figure 3-41 some of the vegetation's observed around Kulhi area. Observed mangroves and associated species are described below:

Black Mangrove, Burevi, Lumnitzera racemose: Black Mangrove, Burevi, Lumnitzera racemose is a true mangrove species which is mostly found in the mid to high intertidal zones. This species is a widespread species across the globe and is commonly found in the northern and southern islands. Unlike other true mangrove species, Black mangrove Lumnitzera racemose prefers dry conditions to survive and is highly sensitive to siltation and morphological changes to the land use and erosion. This non-viviparous species is a colonizing species and grows relatively quickly. The seeds of this mangrove species has similar physical characteristics as a terrestrial seedlings and the fruits are often used for germination of the seeds. High saline conditions are unfavorable for the germination of the seeds with a maximum threshold level beyond 25ppt (parts per thousand). Main trunk of the Black mangrove Lumnitzera racemose is a durable timber and is used for construction of wooden

houses and creating rafts. It is also considered as an excellent fire wood and is also a reliable source for the production of high quality charcoal.

Iron Wood, Kuredhi, Pemphis Acudula: Iron wood, Kuredhi, Pemphis acudula is a mangrove associated species which is regarded as a robust species and is widespread in some areas. Iron wood is a common species across all the coastal areas in most of the islands in the Maldives and is known for its wood as a source for timber. Iron wood is adaptive to variety of soil conditions such as coastal fine, coastal limestone, coral conglomerate, and limestone bedrock outcrops of atoll. This species also grows in saline conditions areas where the roots are in contact with the saltwater regularly. There are different methods for propagation of this species; wildlings, seedlings and root suckers. Nursery propagation of this species is more preferable compared to wildlings. It can also be propagated by planting straight stems at suitable places. Iron wood is known as a primary timber source for boat building as it is known for resistance to wood boring termites and molluscs. It is also an excellent source of firewood though with a hot flame.

Milo, Hirundhu, Thespesia populnea: Milo, Hirundhu, Thespesia populnea, is a mangrove associated species which grows in multiple soil conditions such as sand, limestone and basalt. It is also a common coastal plant across the islands of the Maldives. The wood of this plant is used as source of wood for making furniture and is a common shrub across the globe as well.

Mangrove, Thakafathi, Rhizophora apiculate: Mangrove, Rhizophora apiculate is a true mangrove species which consists of prop roots which are functioning as air-breathing roots. It grows favorably in mud, high sediment areas and is also capable of growing in sandy soil and coral ramparts. Propagules of this species can be collected and used for out planting. Survival rate does not differs from direct planting of propagules or planting of nursery-raised seedlings. The seedlings of 30cm and with four leaves should be kept in nursery for four to five months before plantation whereas the propagules can be planted by directly immersing up to one-third of the length of the propagule. Globally known as an excellent source of wood, though not as common due to its light weight nature and is less durable.

Small-leafed orange mangrove, Kan'doo, Brugeria cylindrical: Small-leafed orange mangrove, Kan'doo, Brugeria cylindrica is a true mangrove species which is known for its dominance among other species. This species has roots which are submerged and acts as an air reservoir. The roots are also covered with pores which does allow air, but not water. The propagules of this species are spindle shaped with purple-greenish color and with an average diameter of 0.5-1.0 cm. It grows on light, medium and heavy soil condition, though preference is for silty and clay soil and performs better intertidal zones. The propagules can be immersed one-third into the sediments for plantation. Direct planting of propagules are economically feasible and consumes less time than nursery of seedlings. The propagules were consumed during the famine is grown in most of the island during the famine period.

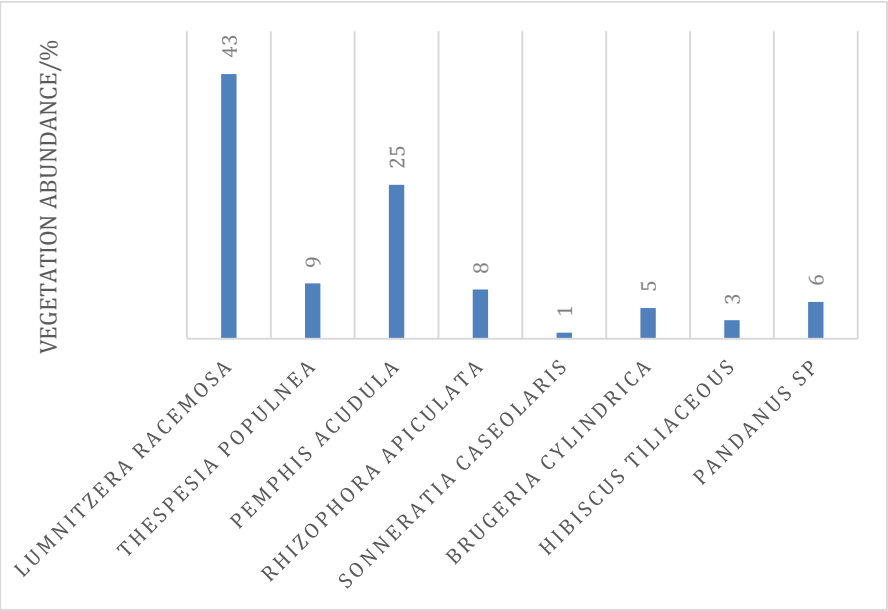


Figure 3-40: A bar graph showing the average vegetation abundance observed in the mangrove area. The most common species observed is Black Mangrove Lumnitzera racemose

Figure 3-41: Some of the vegetation's found in the wetland area of Kulhudhuffushi. None of the endangered species observed.

3.7.5 Observed fauna in the mangrove area

Maldivian Pond Heron, Kanbili, Ardeloa graii phillipsi: The Maldivian Pond Heron, Kanbili, Ardeloa graii phillipsi, is a subspecies of Indian Pond Heron is endemic to the Maldives. The Maldivian Pond Heron is different than to its continental counterpart, as the female has longer deeper bills which are also used for feeding and digging up the holes in wet areas which they use as a habitat.

Eastern Grey Heron, Maakana, Ardea cineria rectrostris: Eastern Grey Heron, Maakana, Ardea cineria rectrostris are partially migratory and sedentary bird which can be found in habitats such as mangroves, marshes, rivers, ponds or coastal mudflat areas. The heron is significant for its long neck prefers areas with dense vegetation mainly for breeding. The successive individuals often return or use the same area for breeding.

Cattle Eagret, Iruvaahudhu, Bubulcus ibis: Cattle Eagret, Iruvaahudhu, Bubulcus ibis is a protected bird under the Environmental Protection Act, is a common bird found in Asia, Africa and Europe. Tropic regions are favorable for its breeding throughout the year and migration is dependent upon the food resources and rainfall. It is an adapted well to both terrestrial and aquatic ecosystem and can be found in marshes, mangroves, livestock pastures, savanna and meadows.

3.7.6 Significance of the Mangrove ecosystem and the potential impacts to the area from the project activities.

A mangrove ecosystem has various socio-economic and ecological benefits to the area within and around the ecosystem. Mangrove area serves as a drainage system for the island of Kulhudhuffushi, during flooding events hence averts the impacts of flooding to the island. It also acts as a buffer zone for high wave action by smothering the energy of the waves, hence acts as a natural coastal defense systems. Mangroves are also considered as a breeding ground for many life forms including aquatic, terrestrial and marine faunas. The thick vegetation is a nesting area for birds such as Heron and Egret hence is worth conserving the area for its significance in biodiversity.

The mangrove area is also used in various ways. One of the most common uses is creating catchments in the muddy sediment areas to keep the dried coconut husks. This is a common scene in Kulhudhuffushi mangrove area and many islanders mostly women are seen in this area regularly checking their catchments near the mangrove area. The mangrove vegetation is also an excellent and reliable source of wood for the locals and over the years it has been used as fire woods, timber for constructing house and boat hulls.

As the airport is being built inside the mangrove by filling the lake area and reclaiming one third of the area, there could be potential negative consequences to the distribution and abundance of floral and faunal community which resides in the area. The vegetation around the seaward of the mangrove area grows best on the muddy and clay sediment area, hence the filling of the lake could potentially have a negative impact on the sedimentation of the area which will result in a decrease in growth of these vegetation.

Burrowing areas are also within the mangrove area, hence this could very much disrupt the morphological structure of the mangrove area, which in terms will have lasting effects to the vegetation of the area. If the vegetation thickets and the saplings are in decline in terms of abundance and zonation, the number of birds, crabs, and other faunas seen in this area will decline as this area is functionally diverse to these organisms by providing nesting, roosting and breeding grounds.

Due to the filling of the lake area and reclamation of some of the vegetation to pave way for airport infrastructure, it could also effects the natural drainage system built within the island. At present, during any event of flooding, the mangrove area regulates and manages the flood avoiding significant damages to the island. Once change is being brought to the physical conditions of the mangrove area, it would affect the functional diversity of the area, and flood management is one area which is in concern.

None of the mangrove species observed in the project boundary area and "environmentally sensitive area" is listed as endangered species. Although endangered species relocation and monitoring plan for monitoring the wellbeing of the species relocated to a new area is not needed (due to none existence of endangered species), all necessary arrangements needs to be arranged to declare and manage a new "protect area" with similar environmental features, as per the ToR. When declaring a new protected area, it is recommended to the follow the following "Mangrove Restoration Plan".

3.7.7 Mangrove Restoration Plan

1. Aim:

Conserving the environmental sensitive areas

2. Objective:

Restoration of the mangrove species found in Kulhudhuffushi

3. Rationale:

H.Dh. Kulhudhuffushi mangrove area is an inland closed lake area surrounded by thick vegetation which are mostly dominated by two species; Black mangrove, Burevi, Lumintzera racemosa and Iron wood,Kuredhi, Pemphis acudula. This mangrove area is among the few and one of the largest areas in the Maldives and is also the only mangrove where such dense forest of Black mangrove is seen. Species of Brugeria and Gymnorhhiza are also seen along with varieties of other mangrove associated species. The area is significant for its diversity in terms of vegetation and also the supportive functions to other species such as birds and crabs. The leaf litters, sediments, muddy

flat areas, vegetation thickets are roosting, nesting and breeding ground for many faunas.

Apart from its significance in its biodiversity, it also performs as a natural coastal defense system by smothering wave energy and moreover protects the island from flooding by acting as a drainage area. This area is also used by locals where they made catchments near the sediment muddy areas to put the dry coconut husks and also the vegetation acts as a good source of wood.

As this area is a significant area in terms of biodiversity and is beneficial in terms of socio-economic perspectives, the conservation efforts for the area should be of a prioritizing task. The vegetation species found might be IUCN least concerned species, but locally there is a decline in the population of these vegetation as such ecosystems are rare in the Maldives. Hence it is recommended to relocate mangrove species found the Kulhudhuffushi "sensitive area" to the new declared protected area as outlined in Table 3-8.

4. Site:

When declaring a new protected area consideration of following parameters could assist in the adaptability of the flora and fauna found in the existing area.

The parameters area:

1. Geomorphology of the area
2. Type of soil and sediment texture of the area
3. Surrounding features of the area
4. Potential barriers that could be hindering the development of the area
5. Physical characteristics such as temperature, salinity and water quality of the area.
6. The depth of the sedimentation
7. Existing zonation of the area

These parameters are important in considering when declaring a site as these factors are beneficial for the development of the area.

Table 3-8: Action plan matrix developed on for the restoration of mangrove species found in Kulhudhuffushi sensitive area.

Activities	Responsible authority	Duration	Monitoring indicators	Monitoring duration
Consultation with EPA and carrying out a study on possible location to declare a new protect area	Regional Airports (RA)	3 months	Survey report	N/A
Declaration of a new protected area for restoration of mangroves	Ministry of Environment and Energy, EPA	1 months	Survey report on the existing environment	N/A
Creating a nursery area for the development of the vegetation	EPA, RA	6 months	reports, area declared for nursery of the vegetation seeds	every week
Plantation of the vegetation's in the Kulhudhuffushi mangrove area in the new location	RA	4 months	Survey report	Growth of the trees monitored every month

3.7.8 Vegetation removal

Inside the 50m×50m quadrat, most of the trees counted were coconut palms and coastal lettuce. A total of 69 plants were presented where coconut palms were the most dominant species in the area. 25 coconut palms were observed (Figure 3-42) within the areas which are used by the locals for coconut husks. As the site is closed to the coastal area, Coastal lettuce species were also dominant in the area. Removal of the coastal lettuce could have a lasting effect as it is shoreline shrub which stabilizes the soil protecting it from the erosion, and coconut palm removal could be a negative impact for the local community as they use it for the coconuts and its husk.

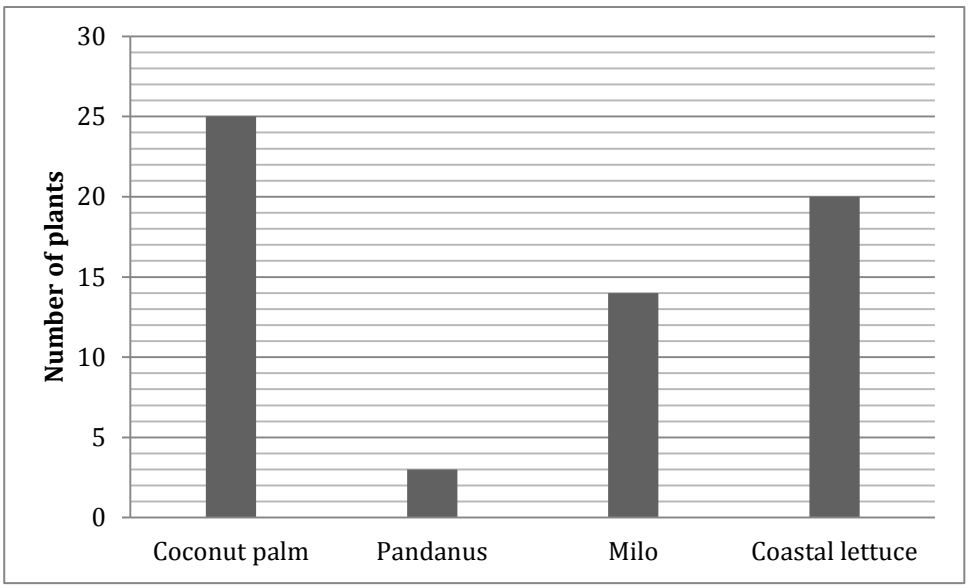


Figure 3-42: The total number of trees found within the 50m×50m quadrat to estimate the vegetation removal.

3.8 Socio-Economic Environment

According to the Year Book 2016, Kulhudhuffushi has a population of 6998 in 2006, with 3299 and 3699 Male and Female, respectively. On the other hand, in 2014, the registered population of the island stands at 9366, with 4801 Male and 4565 Female. According to the island council, the current registered population of Kulhudhuffushi now stands at 9781, with 5006 males and 4775 females (Table 3-9). This shows that the island experiences steady population growth. This puts pressure on the available for infrastructure development projects and for residential plots. In total 2028 plots have been allocated for residential developments.

Locations of the important infrastructure of the island are depicted in Figure 3-43. Some of the important infrastructures include 6 mosques, 4 schools (1755 students), water network (water service), Power plant, Sewerage system, Hospital, Police and MNDF, Post, Harbour, Bank, Stadium, 4 football grounds and sports arena. The economic activities on the island (see Table 3-10) include fishing, agriculture, construction and retail business. Business establishments and their numbers are depicted in Table 3-11. In addition to these establishments, people from other island of Haa Dhaal and the neighboring atolls of Haa Alif, Shaviyani and Noonu visits Kulhudhuffushi for services like education, health and businesses. Every Saturday Kulhudhuffushi hosts Saturday market (see Figure 3-44) and lot of people from islands visit the island. This shows that the island is very much connected to the other islands. The mode of transport between islands include cargo boats, ferry, normal dhoani and speed boat.

Table 3-9: Population and household statistics

Gender	Age Under 18	Age 18-35	Age 35-65	Above 65	Total
Male	907	2001	1819	279	5006
Female	878	1992	1701	204	4775
Total	1785	3993	3520	483	9781

Source: Island council

Table 3-10: Economic Activities in the Island and no of female and male working in the respective sector (Source: Island Council)

1. Fishing		Agriculture		Tourism		Construction		Government jobs		Others	
Male	Female	Male	Female	Male	Female	Male	Female	. Male	Female	Male	Female
150	20	8	9	20	10	80	-	200-300	400-500	800+	400+

Table 3-11: Business establishments and their no (Source: Island Council)

Economic establishments	Number
Retail and Wholesale	205
Café', Restaurants, Hotaa	13
Guesthouses	7
Tailors	5
Saloon	3
Carpentry	5
Pharmacy	3
Medical Clinics	2
Workshops	12
Fuel supply	1
Warehouse	15
Other(s)	-

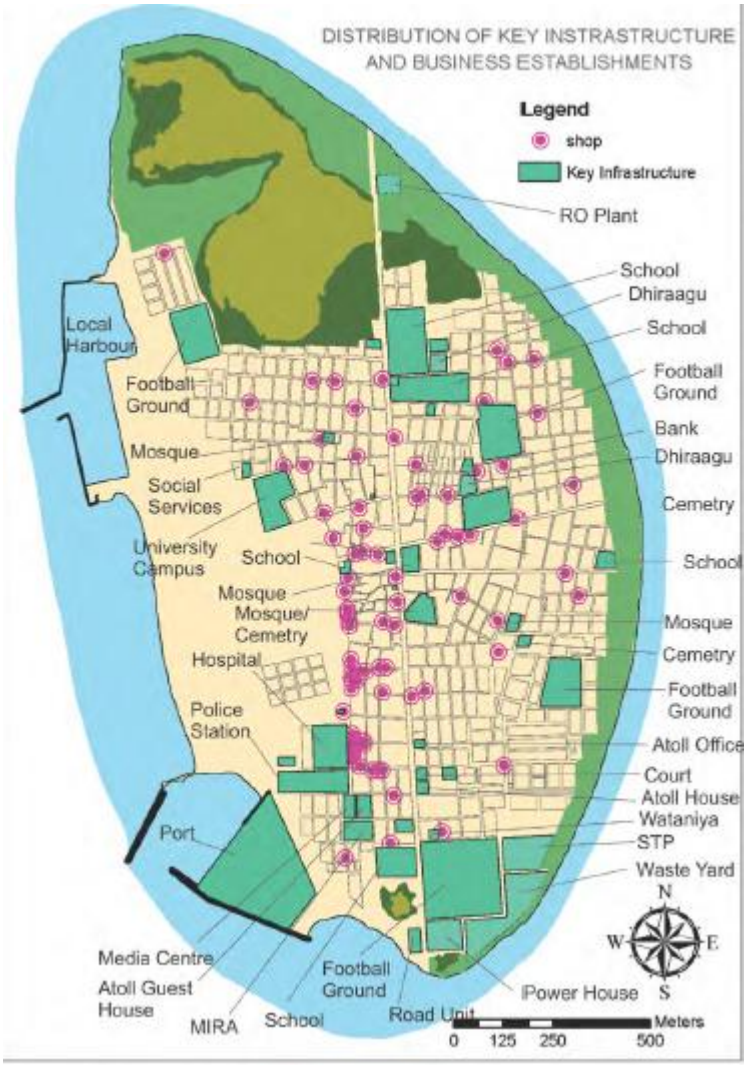


Figure 3-43: Locations of important infrastructures in the island. Taken from "Detaild island Risk and Vulnerability Assessment-Hdh. Kulhudhuffushi, 2013"

Figure 3-44: Lot of people from nearby islands visit Kulhudhuffushi for Saturday market.

The natural resources of the island includes sea (including reef), beach, vegetation and Kulhi (wetland areas) and ground water. Some of the available natural resources are limited, including land, clean ground water, vegetation, mangroves and coconut palms and are under thread due to various activities. The island community heavily depends on the project area (Kulhi) area for coir rope making (Figure 3-45). According to the locals, almost every household use Kulhi for burying the coconut husk and considered as a substantial income for the family. Local people use the Kulhi as a relaxing area and kids consider the area as a recreational ground for playing, catching fish (Figure 3-46), watching bird movements.

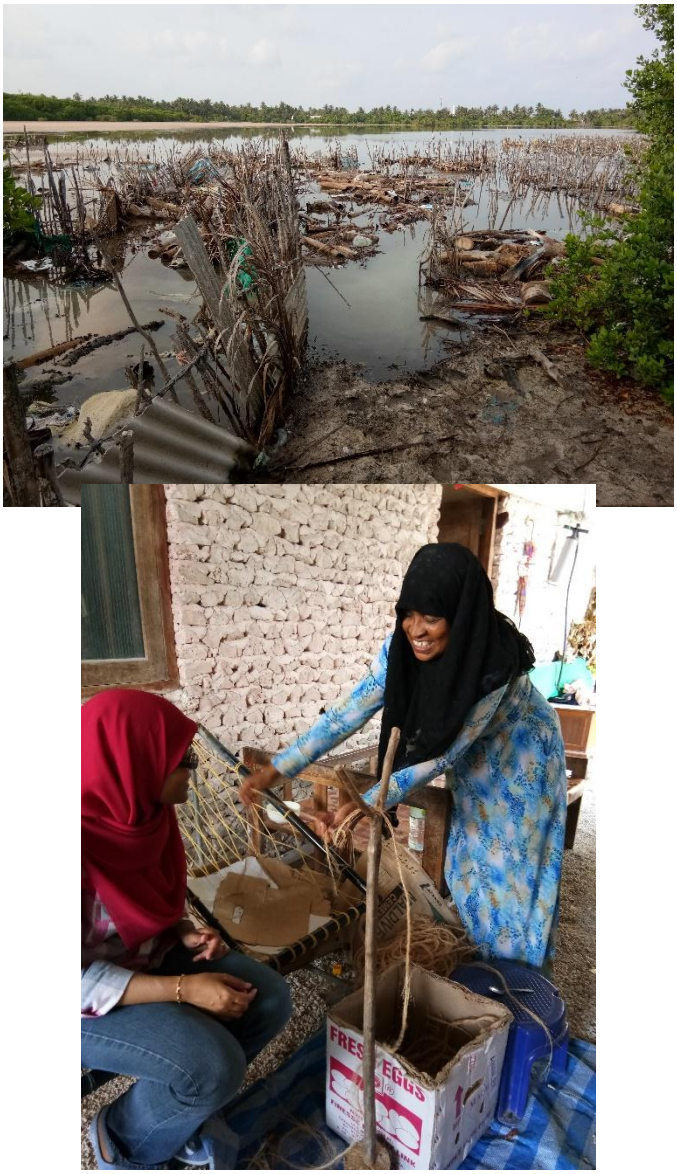


Figure 3-45: Kulhudhuffushi is used for burying coconut husk for making coir rope.

Figure 3-46: Kulhudhuffushi is used as a recreational activities, such as catching fish and people visit the area to relax just by viewing the natural beauty.

3.8.1 Volume of Surface water:

Due to the geographic (low-lying) nature of the islands of the Maldives, very few surface water resources exist. Only limited numbers of island have surface water in the form of swampy areas or freshwater ponds/rivers (locally known as Kulhi). Kulhudhuffushi island is one of the island where there are two Kulhi (the larger one is located at the northern end of island: Figure 3-47 and the other smaller one in the south). The majority of freshwater resources in the islands of the Maldives exist as groundwater. This groundwater is the result of rainfall and the amount that infiltrates into the islands‟ sandy coral soils and accumulates as fresh groundwater. This fresh groundwater is found in the form of freshwater lenses underlying the islands and floating on top of the saline water due to the density difference (Ibrahim 2008; Millar 2002; Woodroffe 1989) and the maximum freshwater lens occurs towards the middle of the island (Figure 3-48).

Figure 3-47: Surface water resources exist in the form of ponds (locally known as Kulhi) at Kulhudhuffushi.

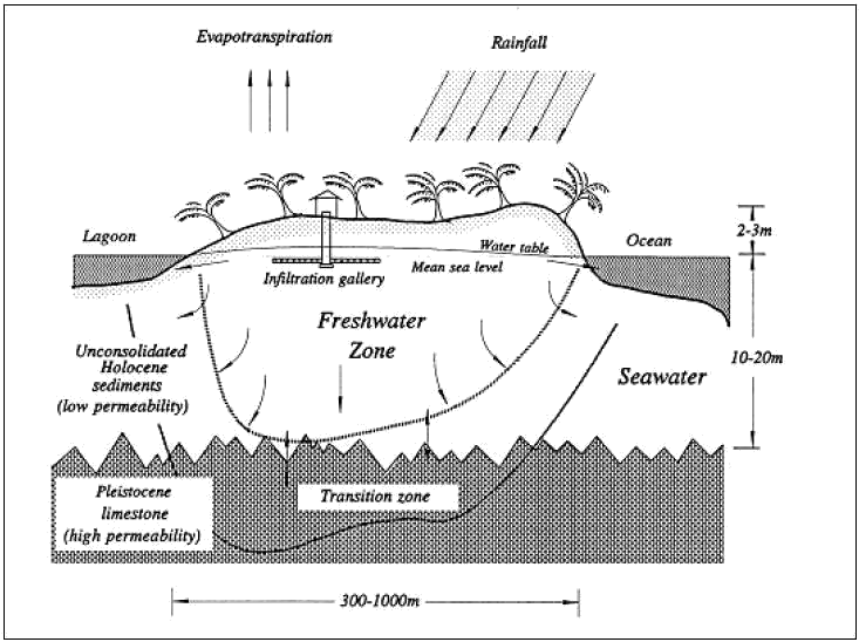


Figure 3-48: Freshwater lens zone in relation to rainfall, island width and depth of water lens (Taken from Falkland 2001)

The thickness of a freshwater lens (hence available groundwater for extraction) is influenced by a number of factors such as island width, island geology/geometry (aquifer permeability and porosity), rainfall recharge rate, abstraction rate (groundwater withdrawal), evapotranspiration (depends on soil type and vegetation cover of the island) and tidal movement (Bailey et al. 2008; Falkland 1993; Falkland 2001; Ibrahim 2008; Woodroffe 1989). According to Woodroffe (1989), the freshwater lens exists or develops only when the width of the island is large enough (with a

threshold width of 200, but 300-400 m is a more realistic minimum width for a lens to develop). The relationship derived between freshwater lens thickness, annual rainfall and island width for small coral islands suggests that a permanent freshwater lenses can only occur where the island width is more than 120 m. For the Maldivian islands, typically for every 250 m of island width, the freshwater lens is expected to be about 1 m thick and hence where an island width is 500 m it can be expected that the freshwater lens will be about 2 m thick, but there are islands where the freshwater lens thickness is greater or less than this (Ibrahim 2008). Based on field studies carried out in some of the islands of the Maldives, Ibrahim (2008) suggested that the freshwater lens thickens further away from the coastline and in general maximum freshwater lens thickness occurs in the middle of the islands, and hence freshwater lens thickness is controlled by the width of the island, but not the island length. One of the most important factors determining the thickness of a freshwater lens is the amount and variability of recharge to the groundwater.

Groundwater recharge is the balance between rain falling onto the island (input) and evapotranspiration (output of water from the surface of the island) (Bailey et al. 2008; Falkland 2001; Woodroffe 1989). Based on a number of small island groundwater recharge studies, Falkland (2001) provided a relationship between annual rainfall and annual recharge rate as illustrated in Figure 3-49, which takes account of average vegetation cover of the islands, since vegetation cover has a major effect on recharge. In the absence of field estimates of recharge, Falkland (2001) used this simple method to estimate recharge rates for some of the islands of the Maldives.

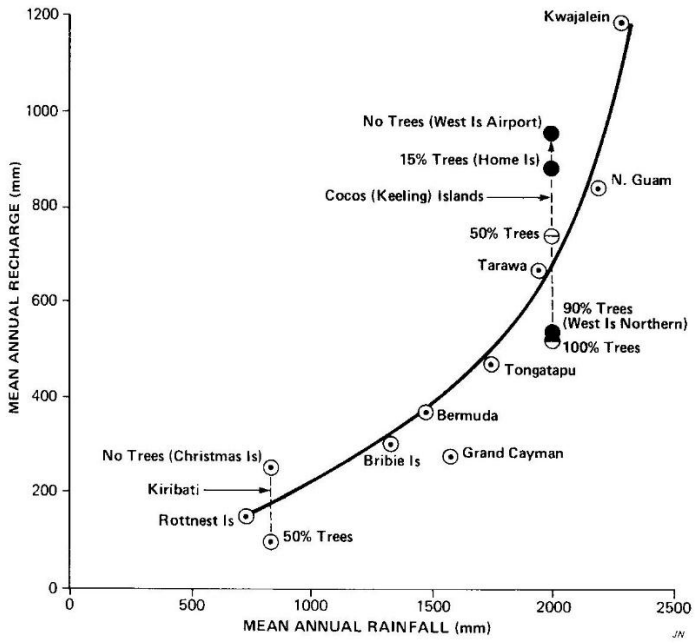


Figure 3-49: Relationship between mean annual rainfall and mean annul recharge on coral islands. In the absence of field estimates of recharge, this simple method could be applied to estimate recharge at Kulhudhuffushi. Taken from Falkland (2001).

In order to estimate recharge (and hence groundwater resources) for the Kulhudhuffushi island, a similar approach used by Falkland (2001) was adopted here. Based on regional rainfall (Hanimaadhoo rainfall for the period 2006-2016), the graph in Figure 3-49, and observations made during the field survey regarding vegetation cover, recharge was estimated for Kulhudhuffushi as well as estimates of other parameters (as depicted in Table 3-12). Moderate to low vegetation cover was assumed for the island. Based on this observation, it was assumed that the recharge rate is 45% of the rainfall for Kulhudhuffushi where the vegetation cover is moderate to low. Recharge rate was calculated by multiplying regional rainfall with recharge (0.45). Assuming that permanent freshwater lenses only exist where the island width is greater than 200 m and freshwater lenses do not exist within 50 m of the shoreline, freshwater lens area for the Kulhudhuffushi was estimated from Google earth maps and depicted in Table 3-12. Falkland (2001) also used the minimum island width approach for estimating freshwater lens areas for some of the islands of Maldives.

Table 3-12: Estimated groundwater parameters based on Hanimaadhoo rainfall and field survey observations.

Parameters	Parameter Value
Island area (ha)	200.0
Regional rainfall (mm)	1726.0
Population	9781.0
Estimated freshwater lens area (ha)	147.0
Recharge rainfall (%)	45.0
Recharge rate(mm/year)	776.7
Recharge volume (m3/year)	1,141,749.0
Recharge volume (m3/day)	3,128.1
Sustainable yield (m3/day)	938.4
Sustainable yield (lpcpd)	95.9
Freshwater lens thickness zone (m)	7.3
Freshwater lens volume (m3)	3,528,000.0
Residence time (years)	2.8

Not all the recharge volume calculated above is available for extraction. The volume of fresh groundwater that is available for extraction from the island aquifer is referred as sustainable yield, and depends on both groundwater storage and recharge, and represents the amount of freshwater that can be extracted without causing long-term depletion of the freshwater lens (Falkland 2001). Since much of the recharge volume is

required to maintain the groundwater, sustainable yield could only represent a small proportion of recharge volume. Since no field data is available 30% of the average recharge volume is assumed as sustainable yield as suggested by Falkland (2001). The estimated sustainable groundwater yield for Kulhudhuffushi is given in Table 3-12, together with other estimated parameters. Zahid (2011) estimated Sustainable yield (litre per capita per day: lpcpd) for 12 islands and pointed out that it varies considerably from island to island, with the highest and lowest lpcpd being 1036.3 and 208.9 for Hdh. Finey and S. Hithadhoo, respectively. The estimated sustainable yield for Kulhudhuffushi is much lower than these estimates. Another parameter that is important for groundwater resource management is freshwater lens volume (groundwater storage). Using freshwater lens thickness information available from the literature (for Ha. Kelaa, Ha. Baarah and S.Hithahdoo), a rough freshwater lens volume was estimated for Kulhudhuffushi using freshwater lens thickness of 7.3m and is given in Table 3-12. However, it should be noted that the freshwater lens thickness can vary from island to island. For example, freshwater lens thickness as small as 0.5 m (Hoarafushi) and as large as 15 m (S. Gan) have been estimated from field observations by Falkland (2000; 2001), respectively.

The estimated freshwater lens volume for Kulhudhuffushi islands should only be used as a rough estimate. Another important parameter shown in Table 3-12 is residence time, which represents the number of years of rainfall recharge the freshwater lens volume holds. The larger the residence time, the longer the freshwater will exists for extraction and it will take more time for groundwater to become saline. The residence time shown in Table 3-12 suggests that the groundwater resources in the island is not vulnerable to a single drought year or in immediate threat from salinity. However, due to the reclamation of the Kulhi area for the proposed project, the groundwater at Kulhudhuffushi will be reduced and will make groundwater more saline, as the wetland area will be highly modified and more water will be evaporated from the remaining Kulhi area, as the water will be warmed more easily and more evaporation will take place due the reduction of the water body. Hence, minimal area should be reclaimed from the Kulhi area and remaining part of the Kulhi water should not be directly connected to the drainage system. Not less than 15cm high distance should be

left between mean water level of the Kulhi and the drainage system, so that during rain water can be collected in the area.

The Kulhi and the surrounding wetland area at Kulhudhuffushi acts as a natural catchment area and helps to mitigate flooding in the surrounding area. For the project, part of Kulhi will be reclaimed and the area will be compacted and will reduce water infiltration to the soil. This will make the surrounding area more susceptible to flooding. In the past the northern area (Hanimaadhoo) experienced rainfall of 146.9 mm on 26th May 2008, within 24hrs. This amount of rainfall is expected to cause flooding. In future, extreme rainfall events expected to increase. In order to reduce the flood impacts, minimal area should be reclaimed and minimal vegetation should be removed. In order to remove excess water easily and flood water spreading to the nearby residential areas, proper drainage system should be established. The drainage system should be built in such a way that the water level at the Kulhi rises to 15cm (from mean water level of the Kulhi), then the excess water should go to the drainage system and directed to sea. 15cm is allowed to retain some of the accumulated catchment water so that the water will evaporate naturally and the Kulhi area will not become dry entirely.

In recent years, extreme rainfall events within few hours have caused extensive flooding. Hence, the drainage system should be designed considering rainfall rate of at least 75mm/hour. The system also should be able to cater runoff water coming from the runway towards the island (inward side of the island). It is recommended to establish two pumps to remove excess water collected in the area during extreme rainfall events and flood waters due to inundation from waves. One pump can be located around Kulhi area, while the other one can be located as southeast end of runway.

4. Legislative and Regulatory Considerations

4.1 Legislative and Regulatory Considerations

This chapter will describe the relevant national relevant laws, regulations and international agreements that are applicable to this project. The main legal instruments that will be covered are:

- The Environmental Protection and Preservation Act (Law No. 4/93) 1993
- The Environmental Impact Assessment Regulations 2007
- The Civil Aviation Act of the Maldives 2001
- The Civil Aviation Regulations
- The Maldives Tourism Act 1999
- The Regulation on the Protection and Conservation of Environment

4.1.1 The Environmental Protection and Preservation Act (Law No. 4/93) 1993

The Environmental Protection and Preservation Act (Law No. 4/93) 1993

The Environmental Protection and Preservation Act (EPP Act) of the Maldives (Law No. 4/93) is an umbrella law that manages all regulations related to environment and is enforced by Ministry of Environment and Energy. The Environmental Protection and Preservation Act 1993 states that the natural environment and its resources are a national heritage that should be protected and preserved for the benefit of future generations. It also states specifies the importance of protecting and preserving the country's land and water resources, flora and fauna, the beaches, reefs, lagoons and all natural habitats for the sustainable development of the country. In addition, Clause 5a of this Act states that an impact assessment study shall be submitted to the Ministry of Environment and Energy prior to implementing any development project that may have a potential impact on the environment. As per this clause an EIA is required for this project.

Furthermore, it includes the obligations of Ministry of Environment and Energy such as formulating policies, rules, regulations and guidelines for protection and conservation of the environment in areas that do not have a designated government authority, identifying and registering protected areas and natural reserves, drawing up of rules and regulations for their protection and preservation.

4.1.2 Solid Waste Management Regulation (2013/R-58)

The EPP Act 1993 also states that it is prohibited to dispose any kind of waste, oil, poisonous substances, and harmful toxic / hazardous substances within the territory of the Maldives. According to the Waste Management Regulation (2013/R-58) waste shall be disposed only in the areas designated for the purpose and permitted by Environmental Protection Agency. If such waste is to be incinerated, permit from EPA should be attained prior to incineration and appropriate precaution should be undertaken to avoid any harm to the health of the population.

4.1.3 Dredging and Reclamation Regulation (2013/R-58)

The dredging and reclamation regulation of Maldives came into force in 2014. The objective of this regulation which falls under the EPP Act 1993 is to mitigate the damages that may be caused during dredging and reclamation of developmental projects.

Clause 7 and 8 of this regulation specifies the situations in which dredging and reclamation can be done.

Clause 11 of the regulation states that if any standard have been formulated by a government authority regarding dredging and reclamation, it will have to be followed. The regulation also specifies the locations that can be utilized as borrow areas and those areas where dredging or reclamation is prohibited.

In addition, the amendment of Clause 13 of regulation of dredging and reclamation regulation in 2014 states that even though environmentally sensitive areas can be utilized in developing projects, they can only be dredged or reclaimed after assigning another area with the same natural attributes, as a sensitive area.

Clause 14 outlines the uses and disposal methods for dredged soil while

Clause 15 outlines the maximum area for dredging and

Clause 16 states the maximum area that can be reclaimed.

4.1.4 Regulation on Uprooting, Cutting and Transportation of Palms and Trees

This Regulation was implemented on 1 February 2006 by the then Ministry of Environment, Energy and Water. The primary purpose of the Regulation is to control and regulate large scale uprooting, removal, cutting and transportation of palms and trees from one island to another. According to the regulation, certain types of trees and plants that have unique attributes are prohibited to be removed from its natural environment. Also, uprooting and removal of 50 or more trees and palms are subject to environmental impact assessment (EIA), which is required to be submitted to the Environmental Protection Agency and written approval is required prior to implementation of the project.

4.1.5 Environmental Damage Liability Regulation (2011/R-9)

Under the Environmental Protection and Preservation Act (No. 4/93), then the Ministry of Housing and Environment formulated the Environmental Damage Liabilities Regulation in February 2011. This regulation encompasses the basis to avoid environmental deterioration, extinction of biological resources, environmental degradation and avoid wastage of natural resources.If for any reason, The EPP Act 1993 or any regulation made under this Act has been breached, a fine ranging between Rf. 5.00 (Five Rufiyaa) and Rf. 500.00 (Five Hundred Rufiyaa) shall be paid for minor offenses and a fine not exceeding Rf. 100,000,000.00 (One Hundred Million Rufiyaa) shall be paid for all major offenses. The fine shall be levied by the Environmental Protection Agency or any other government authority designated by Ministry of Environment and Energy. In addition the government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment. Penalties and compensation values for the damages caused to the

environment are calculated according to Regulation on Environmental Damage Liability Regulation (2011/R-9).

Article 22 of national constitution that states that protection, preservation and maintenance of the Maldivian natural environment, the richness of the living species, the natural resources and the beauty of the Maldives for the present generations as well as for the future generations is a basic obligation of the Maldivian government.

One of the key objectives of the environmental liability regulation is also to practice polluter pay-principles in the Maldives. All project developer and contractors shall be made aware of this provision and contractors shall take all practical measures to ensure that all relevant laws and regulations, and the monitoring and mitigation plans proposed in this EIA are followed.

4.1.6 The Environmental Impact Assessment Regulation

Under the Environmental Protection and Preservation Act the most significance component is preparation of Environmental Impact Assessment (EIA) for all development projects that could have a significant impact on natural environment. In this regard an EIA Regulation was legislated in May 2007 and revised EIA regulation came into force in 2012 to guide the process of undertaking the EIAs in the Maldives. It provides a comprehensive outline of the EIA process, including the application to undertake an EIA, details on the contents, format of the IEE/EIA report, the roles and responsibilities of the consultants and the proponents as well as minimum requirements for consultants developing the EIA.

Environmental monitoring programmes need to be incorporated into project plan that shall be undertaken upon completion of the project. The monitoring programme shall outline the objectives of monitoring, the specific information to be collected, the data collection program and managing the monitoring programme. These programmes will specify the institutions responsible for tasks detailed, requirements for reporting and ensure that adequate resources required for monitoring are provided to the respective institution. A monitoring program is included in this EIA for this project in accordance to EIA regulation 2012.

4.2 The Civil Aviation Act of the Maldives 2001

The Civil Aviation Act of the Maldives includes requisites on registration and operation of civil aircraft, construction, registration, operation and use of civil aerodromes and all matters that are related to civil aviation and its safety. According to the Act, construction, registration and usage of civil aerodromes in the Maldives shall be in accordance with the Act and regulations made under the Act. Also, any aerodrome in the Maldives shall be constructed only after land or space required for such purpose has been obtained lawfully after submission and approval of the drawings, specification of the aerodrome to be constructed and other details required under regulations made under this Act.

The Civil Aviation Act of the Maldives provides wide statutory powers to the Ministry under which the Civil Aviation falls. These include establishing guidelines and formulating regulations regarding safety of civil aerodromes, to be followed within the zone in respect of the following matters:

- Construction of buildings and other structures
- Planting and cultivating trees and other crops
- Driving and parking of various types of vehicles
- Illuminating, rearing of birds and having airborne objects and engage in other operations that will endanger the safety of civil aviation.

The Civil Aviation Act of the Maldives also outlines the penalties for breaching the Act and any Regulations under the Act.

4.3 The Civil Aviation Regulations

The Maldivian Civil Aviation Regulations (MCAR) was introduced in July 2007, aimed at complying with the requirements of the International Civil Aviation Organisation (ICAO) and harmonisation with international standards, such as European Aviation Safety Agency (EASA). The MCAR comprise of important regulatory measures such as Aerodrome Rules, Air Traffic Control, Conditions of Flight, Carriage of Dangerous Goods

by Air, Aeronautical Information Services, Aeronautical Charts, Instrument Flight procedure Design, Rescue and Fire Fighting Services, Airport and Aircraft Security, Accident Investigation, Protection of the Environment and Fees for Licenses and Charges for Airport Navigation Services. The amendments brought to MCAR also consist of an Aerodrome Standards Manual which came into effect on 15th December 2008. The manual is a comprehensive guideline of the MCAR as per the requirements of the ICAO. Accordingly, this project, will comply with the MCAR and its Aerodrome Standards Manual.

The following outlines the primary components of the Civil Aviation Regulations that are relevant to this project:

Chapter MCAR-139 of the Maldivian Civil Aviation Regulations states that, aircrafts shall not land at any place in the Maldives unless the place has been certified as an aerodrome under MCAR and its use is authorized by the Director of Civil Aviation according to the terms prescribed in MCAR. These include the applicant's competency and sound safety measures, having regarded in particular to the physical characteristics of and the surrounding of the aerodrome. MCAR also states that any licensed aerodrome open to public use shall be open to any aircraft used in the service of the Maldives and also to any aircraft which possesses the nationality of a Contracting State on the same terms and conditions as for Maldivian aircraft. All aircraft which possesses the nationality of a Contracting State shall also be entitled to use such aerodromes and such visual and non-visual aids to air navigation as open to public use.

Among the many obligations of the aerodrome operator, includes to complying with standards and practices specified in MCAR and with any conditions endorsed in the certificate pursuant to MCAR

In addition, it also states that the aerodrome operator shall establish a Safety Management System for the aerodrome describing the structure of the organization and the duties, powers and responsibilities of the officials in the organization structure, with a view to ensuring that operations are carried out in a demonstrably controlled way and are improved where necessary. Furthermore, Rescue and Fire Fighting Services are mandatory for all aerodromes approved for schedule and/or non-schedule traffic with aeroplanes carrying passengers.

The MCAR also highlights on obstruction clearance and marking, suppression of aircraft noise and vibration, protection of the environment, air navigational aids, aeronautical lights and dangerous lights, delivery of aviation fuel and checking its' quality, and zoning of Land and waters in the vicinity of aerodromes.

4.4 The Maldives Tourism Act 1999

The Maldives Tourism Act 1999 comprises the issues related to the development of tourism in the Maldives. This Act provides for the determination of zones and islands for the development of tourism in the Maldives including the leasing of islands for development as tourist resorts, the leasing of land for development as tourist hotels and tourist guesthouses, the leasing of places for development as marinas, the management of all such facilities and the regulation of persons providing such services. The Act states that zones for the development of tourism in the Maldives, islands for development as tourist resorts and places for development as marinas shall be determined by the President.

4.4.1 Regulation on the Protection and the Conservation of Environment in the Tourism Industry

The Regulation on the Protection and the Conservation of Environment in the Tourism Industry is made pursuant to the Maldives Tourism Act 1999. The purpose of this Regulation is to protect the environment in the tourism industry and to encourage and facilitate sustainable tourism development in the Maldives. This Regulation has provisions for Protection of Environment during Construction; Protected Species; Planting of Trees, Use of Fertilizers and Keeping Living Species; Waste Management; Storage of Water and Sewage and

Treatment. In addition, the penalties for breaching any provision under this Regulation are specified. The Regulation states that depending on the seriousness of the non-compliance, a fine of between MRF 1000.00 and MRF 10,000.00 would be charged in the first instance. Parties repeatedly in non-compliance should be liable to a fine between MRF 50,000.00 and MRF 100,000.00. Further, if non-compliance of a provision occurs more than once, the Tourism Ministry reserves the right to revoke the licence.

5. Impact Assessment

5.1 Introduction

5.1.1 Methods and Limitations

The methods used to predict and evaluate the environmental impacts that may be associated with the proposed airport development on Kulhudhuffushi have been through analysis of the proposed project, discussions with the project proponent, field surveys, observations and assessment as well as based on field experience of similar works in the country. Data collected from field work were analyzed to predict the extent and significance of the impacts that may arise from the proposed project activities. However these predictions may not be the most comprehensive as the degree of accuracy in predicting the impacts depend on the natural variability and uncertainties comprised with it. Nonetheless, the methods used are concise and provide a general overview as well as the range of impacts that can affect the environment.

5.1.2 Impact Identification

The project has impacts on the terrestrial, wetland area, marine, coastal and socio-cultural environment. These impacts are either short term reversible or long term irreversible damage or alteration to the environment.

The impacts identified here will be based on location and magnitude. The intensity or severity of the impacts is further grouped into negligible, minor, moderate and major. This will help in identifying and carrying out remedial and mitigation measures. A description of the impact categories are presented below.

- Negligible: no significant impact on environment

- Minor: the impact is short term and cause little impact on the environment which may be reversible in the long run.
- Moderate: Impacts significant, may cause long term environmental concerns but are likely short term, acceptable and justifiable
- Major: long term impact, large scale environmental alterations

5.1.3 Uncertainties in Impacts Identification

Environmental impact prediction involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geomorphological or social conditions in a particular place. Although in the past surveys and studies have been done on the wetland area of Kulhudhuffushi, these data are not accessible hence impact prediction is based on the limited field data and information collected within a limited time frame.

However, the level of uncertainty, is expected to be low compared to other islands as availability of previous EIAs that have been done for a other development projects (such as the Kulhudhuffushi harbor project phase 1 and harbor expansion project to be begun in 2017) on the island and also other similar projects that have been undertaken in other parts of Maldives. As the marine environment is prone to extreme weather conditions the impacts predicted for the marine environment may include high level of uncertainties. In addition, the socio-economic environment has higher level of uncertainties as the proposed project would occupy part of the wetland which is currently used as burial site for coconut husk. Furthermore, relocating of housing units present in the area adds to the uncertainties of socio-economic environment as the compensations have not been finalized yet. Although this project is expected to bring more economic values to the island, it may not outweigh the negative impacts.

5.2 Overall Positive and Negative Impacts

The overall impact of the proposed project is negative. However social impact is positive due to the strong socioeconomic potential of the proposed project. The major positive socio-economic impacts of the project include:

- The creation of employment opportunities (direct and indirect)
- Improvement of transport and related services,

- Elevation of tourism industry such as resorts, hotels and guesthouse operation
- Increased economic ventures/opportunities (direct and indirect)
- Growing of government revenue
- Boosting of value of land and other properties

However, due the location of the proposed project and the borrow areas proposed by the proponent, major to moderate negative impacts of the proposed project have been identified. These include: the

- changes in hydrodynamics around the island (major)
    - Intrusion of salt water due to deep land dredging
    - Island flooding due to occupancy of current catchment area as airport location
- sedimentation and sediment re-suspension in the water column as a result of dredging and reclamation (moderate),
- impacts on coastal and marine biodiversity and habitats in in the reclaimed area
- impact on livelihood of island community members that depends on rope making (moderate)
- impact on population that need to be relocated
- be disruption to natural system due to the large vegetation removal

Project Impact area is shown in the following image

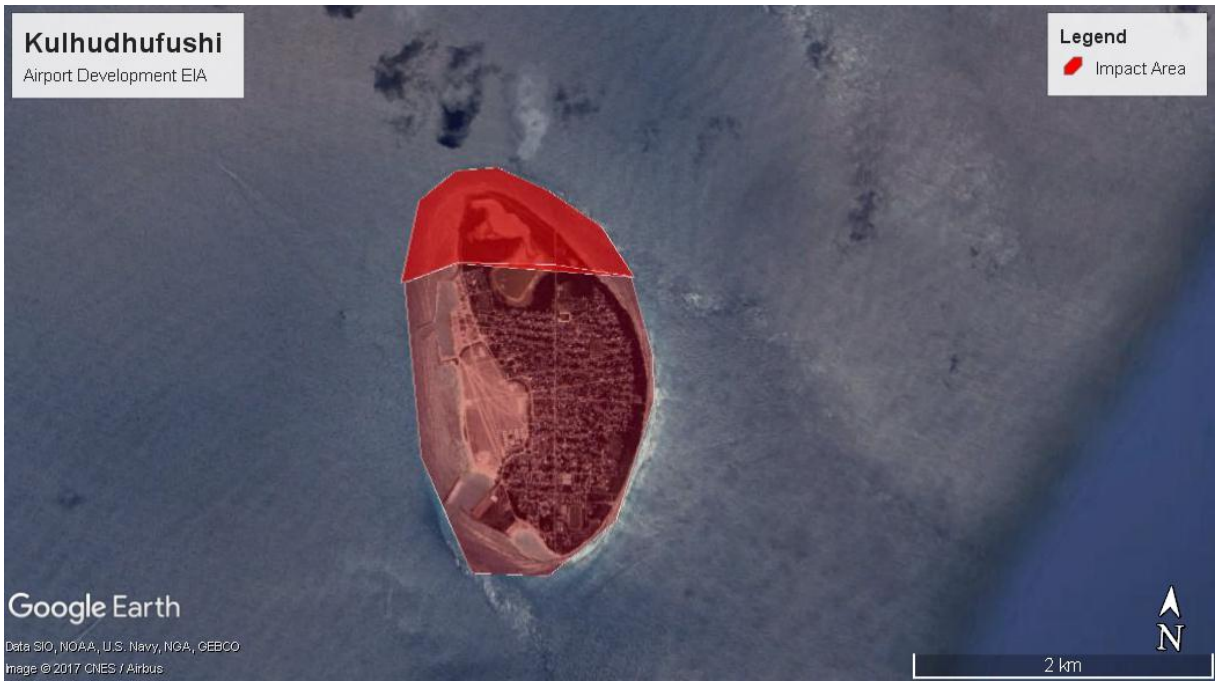


Figure 50 Project Impact Area (dark red - direct imapct, light red - indirect impact)

5.3 Impacts – Construction Phase

The construction work involves the main activities to be carried out including dredging, reclamation, levelling of the land, development of road, construction of boundary fencing and construction of paved roads, terminal building, apron, runway/taxiway, fuel storage and other infrastructure facilities, provision of utilities, laying of pipelines for water supply, sewerage and storm water management, development of transmission towers and other project components along with open areas, allotted for greenery. The associated impacts due to all these construction activities have been discussed in the following sections.

5.3.1 Construction Materials Transportation and Mobilization

The construction materials such as sand, aggregate will be essentially sourced from outside. The proposed development work could lead to erosion of base soil by continuous excavation, levelling and stock piling over the surface area. The airport development will further increase impervious surface areas, which will be associated with the development of roads, runways/taxiways, and eventually will increase the amount of storm water flow.

5.3.2 Waste Disposal

The waste that would be generated during the construction phase of the airport will cause adverse environmental impacts during its storage, transportation and disposal. Construction waste includes the following:

- Construction material;
- Excavated materials;
- Chemical waste material from washing of equipment and vehicle carrying construction material
- Municipal wastes from labour force

The principal adverse effects related to waste generation include contamination of water quality in the surrounding area or it may cause pollute top soil layers which may be then be transferred to ground water via infiltration in case of waste discharge on land.

5.3.3 Labour-related Impacts

During construction phase, some degree of wastewater will be generated from onsite labour camps, which would be characterized by high levels of BOD, Suspended Solids, Nitrogen and bacteria Escherichia coli (E. coli). Significant impact on the water quality of the area may occur if the sewage is disposed without any prior treatment. Therefore, proper treatment and sanitation facilities shall be provided such as having a septic tank followed by soak pit to treat the effluent generated from the temporary labour force during construction phase. The impact on the quality of water resources is predicted to be insignificant as proper storage facilities will be maintained for construction materials, construction waste and oil and grease.

5.3.4 Air Pollution

During the construction phase, Suspended Particulate Matter (SPM) is expected to be the most critical pollutant associated with the construction activity and hauling of material. Mild impacts due to air pollutants may be experienced by local population in the living in the airport area.

Therefore, mobilization of machinery and personnel to site shall be located farthest from the population just outside airport border. In addition air mild pollution impacts may be experienced by the locals if roads of the island are used for the purpose of the project.

5.3.5 Noise Pollution

As Kulhudhuffushi has a large population spreading throughout the island and airport development is located just next to the residential area, there will be noise pollution to some extent during construction. The noise emission sources during construction phase will include construction machineries/equipment to be used at site. As mitigation measures will be taken to minimize the effects it is predicted that the extent of noise pollution occurring will be felt to an insignificant level.

5.3.6 Ecology

The primary and secondary impacts due to the on the biological environment of the island was analysed using the methods indicated in the impact identification section. The most significant impact to the ecology is the removal of vegetation and reclamation of the wetland, which is further detailed below

5.3.7 Vegetation Clearance

Vegetation clearing is one of the most significant impacts of the proposed project. It is predicted that about roughly 250 trees, mainly coconut trees, funa and Hirundhu, boakeyo trees will be removed completely for airport construction. A total of over 1200 trees (including bushes) may have to be removed for this project. This loss will be irreversible as the area has to be left cleared for the rest of the airport operational period. Clearing the vegetation on the coastal region will expose the island to severe erosion and periodic flooding. In addition it will be risky during natural hazards such as damages due to occurrence of a tsunami will be increased five-fold due to the absence of any protective barrier. Furthermore, the mangroves found encircling the wetland area when removed on the airport area, may dry and deteriorate the mangroves on the wetland area left on the residential side of the island. Loss of vegetation will lead to loss of fauna that depend on the removed vegetation. Birds, rats, fruit bats and invertebrates are some of the species that depend on vegetation for survival.

The area for the proposed project also contains mangrove habitats that will be completely destroyed by the construction of runway and airport development. Clearing of vegetation will also impact the top soil layer as direct sunlight onto soil layer will degrade it lead to loss of soil minerals. Furthermore, elevated level of greenhouse gas emissions will take place, since trees are a known carbon sink. In addition, changes to the vegetation within the island will imminent.

The Environmental buffer zone between the airport and the residential area of the island may start growing grass, weed and alien species. Another Impact that may occur due to removal of vegetation, especially those trees that have large trunks rooted deeper into soil may leave large holes on the ground which is predicted to enhance soil degradation if coupled with periods of heavy rainfall. However, since the backfilling and levelling will be undertaken shortly afterwards the impacts would be short-lived.

5.3.8 Impact on wetland environment

Reclamation of the wetland will deeply affect the flora and fauna depending on this environment. Even though the project is utilizing only half of the wetland, it is predicted that the wetland on the whole will loose its natural effects upon starting construction works. Even though mitigation measures have been suggested in the corresponding section to prevent the effects of reclamation. Reclamation of wetland may escalate the flooding issue that Kulhudhuffushi already experience as wetland is used as the catchment area for the flood drainage system of the island. In addition, this would limit the local people earning from the rope making (using coconut husks) business which would have little effect on the tourism industry. The species present on the wetland area such as various species of birds, fishes and other invertebrates will be impacted majorly as some of these animals may die during the construction phase while others capable of leaving the area would do so. This will be a major negative impact on the whole Kulhudhuffushi as some of the species may distinct from the island during the process.

5.3.9 Dredging

The project proposed for the fill material to be acquired from deep sea dredging. The most significant direct cause of dredging is sedimentation and consequential increase in turbidity of the coastal waters, benthic destruction and changes in reef communities,

dredge spoil as well as its impacts on the marine environment such as water quality deterioration, changes in light intensity, habitat destruction, reef damage as well as negative impacts on reef fishes. However since dredging is going to be carried out by a trailer suction hopper dredger, the level of sedimentation in the Kulhudhufushi lagoon area would be lower. The impacts due to dredging from the borrow area location will be studied further in an addendum once the locations are finalised in a geotechnical study.

5.3.10 Reclamation

The largest source of sedimentation would arise from the process of reclamation. As the sand is being pumped onto the proposed site, there would be high levels of sedimentation, siltation and turbidity. Furthermore, as two channels will be created for flow of water from Kulhi area to sea (water within the Kulhi and water that comes together with the sand from the dredger), will cause turbidity. The related impacts of sedimentation are as follows. Large volumes of sediment released into the ambient environment, as a result of reclamation activities are harmful to the establishment, development and survival of many corals. Due to effects of sedimentation and siltation, seawater becomes more turbid by suspended fine sediments in the water column, which drastically decreases light intensity of the area where its effects are felt on corals that depend on sunlight for growth, reproduction and development. In addition, turbid water alters seawater quality, which may be potentially harmful to survival of marine organisms such as fish and invertebrates as it significantly decreases the amount of dissolved oxygen in the water.

The ecological effects of sedimentation on coral reefs range from a temporary slow-down in coral growth to gradual dying and permanent changes in community structure and species. As sedimentation causes serious implications on the overall reef and community structure, significant changes could be felt on the environment including sand loading, sedimentation and silt deposition on coral colonies, other organisms, crevices and cavities. Within the coral reef ecosystem, corals and coralline algae are first to suffer from sedimentation. Some corals and algae will immediately die because they cannot resist mass sedimentation episodes while mollusks and crustaceans as well as fish may leave the damaged reef or die, resulting total decrease in species richness and diversity as well as loses its renewable high productivity. However, in terms of

withstanding and removing fine sediments falling on corals depends on the type of coral since different types of corals have different abilities to either withstand or reject sedimentation. Branching species are more advantageous than other flat and massive growthforms in remaining viable in situations of prolonged sediment deposition. Coral species with habitats close to the coastline, on fringing reefs, are generally more efficient cleaners than species that live on the outer reef slope.

If appropriate mitigation measures are not taken and pumping sand from deep sea, is undertaken, the sedimentation can have serious impacts on the marine water quality as well as the terrestrial ecosystems and infrastructure on land.

5.3.11 Changes in Coastal Waters

During reclamation operations, excessive rate of suspended particles in water could change turbidity level which in turn will affect the quality, quantity and intensity of light reaching reef organisms hence; it will affect coral metabolism, productivity and growth of reef building corals. The effects of turbidity due to dredging on corals may be lethal, sub-lethal or acute or chronic depending on the intensity and duration of disturbance.

5.3.12 Impacts on Coral Reef Communities

Coastline development activities such as reclamation causes adverse impacts on the general reef ecosystems, it is apprehensible that all levels of physical and biological content of a reef system including the lagoon will undergo drastic changes. In the vicinity of the reclamation site, the main damage is expected to be caused by sand loading, sedimentation, silt deposition on coral colonies, other benthic organisms, crevices and cavities, and such drastic modifications lead to very significant changes in the biotic composition and sometimes lead to the death of the reef.

In a coral reef ecosystem, corals and coralline algae are known to suffer from sedimentation first. Some corals and algae will immediately die because they cannot reject mass sedimentation episodes while mollusks and crustaceans as well as fish leave the damaged reef or die.

5.3.13 Impacts on the oceanography of the area

As the dredging option proposed by the consultant is from deep sea far from Kulhudhuffushi, it is predicted that there will be minimal impacts on the oceanography. Mostly impacts on oceanography of the area occurs if shallow areas are dredged as it would then create deeper areas than the surrounding area, thus the increasing energy of the incoming waves. The effect of such dredging areas will be localized and will occur only in the dredged area. Nevertheless, if dredging areas are set close to the island, dredged areas the increased water depth will result in larger waves containing greater energy crossing the reef and approaching the area. The deeper water depth may direct some of the tidal currents into the inner lagoon through the dredged area. If there is a high current in the surrounding environment, this current will enter through the entrance that may cause a change in the current pattern of the lagoon system.

5.3.14 Impacts on Reef Fish and Other marine Organisms

As a result of dredging and reclamation and its consequential impacts on the physical and biological environments, a large number of baitfish, reef fish and other marine organisms such as sea cucumbers, giant clams, shells, etc will be associated with this impact and will be affected in terms of declining in its numbers and diversity as well as eventual death in certain species. Also as a direct consequence, sedimentation may reach long distances within the same reef as well as to other reefs in close proximity causing similar threats. As the island is closer to several other islands of the atoll, mild impacts on reef fish and baitfish may be noticed, the magnitude of these impacts depends on the current flow patterns and magnitude in the region.

5.3.15 Health and Safety

Construction of large development projects such as airports will involve a large number of construction workforce and a number of risks related construction activities. Key impacts predicted for the construction workforce is related to health and safety issues. Often in such construction environments, diseases are prone and have the potential to affect workers. Also,

if precautionary measures on health and safety are not taken into serious consideration, the entire operation may be affected as a result of diseases and injuries.

5.4 Impacts - Operational Phase

5.4.1 Air

The major air emissions expected during the operation phase of the proposed project will be emission of particulate matter and other pollutant gases due to the movement of aircraft. These include the release of aircraft emissions during taxing or idling on the aprons, which may increase greenhouse gas emissions and ground level pollutant concentrations. However these impacts are small due to the airport being domestic hence limits the use of the airport. In addition, the airport operation will also involve operation of vehicles passenger and staff movement and this is expected to generate some amounts of air pollution, however it will be very minimal as this is not going to be a large operation.

5.4.2 Noise

Airport operation will cause noise pollution due to aircrafts or its components, during various phases of a flight: on the ground while parked such as auxiliary power units; while taxiing; on run-up from propeller and jet exhaust during takeoff; underneath and lateral to departure and arrival paths; over-flying while en-route or during landing time. The population living near the proposed airport site and its surrounding will get adversely affected.

5.4.3 Waste related impacts

The operation of airport is expected to generate moderate amounts of waste from various uses, such as municipal solid waste generated from airport office and travelling passengers (food waste, paper, plastic, rags, metal and glass) domestic wastewater from lavatories/restrooms and wastewater from cleaning and servicing works. The most noticeable impact originating from solid waste would be pollution and degradation of soil due to abandoned waste on the ground for lengthy durations. Impacts due to wastewater include pollution of marine environment as wastewater is discharged without treating it. Waste may also have minor impact on the groundwater due to infiltration of liquid waste that may build-up within the solid waste. Therefore, appropriate measures will need to be placed accordingly to address issues of solid and

liquid waste. The generation of hazardous waste is expected to be minimal and will be carefully handled and stored.

5.4.4 Ecology

The impacts from the airport operation on island ecology has been predicted, which indicate that some of the impacts will be felt on a permanent basis. Arial lighting during the operation phase of the airport will have major impact in behavioural response of the animals, birds and insects residing in the airport area. In addition, the sound produced during the operation phase while landing and take-off of aircrafts will disrupt the normal behavioural response of the above mentioned fauna. It is predicted that no major vegetation will be available within the vicinity of airstrip boundary; therefore no impact is predicted on the vegetation.

5.4.5 Coastal Hydrodynamics

Proposed shore protection works in the reclaimed areas may have some impacts on the coastal environment. Direct interference in current patterns, velocity and sediment layout along the coast are predicted to change. Especially due to the sharp projections in the shore protection structures, a drift pattern may occur; hence leading to severe erosion on other parts of the island. Therefore, it is also proposed to create a round shape at revetment area rather than that proposed, in order to minimize any potential impacts due to strong currents. Monitoring programs need to be carried out to observe any linked erosion. The unprotected area on the north of the airstrip also needs to be monitored for potential erosion. Adequate protection measures such as revetment or submerged breakwater would have to be provided in case of erosion. Furthermore, if the erosion is not severe, in order to reduce the cost of protection, a groyne field may be considered.

In order to assess the significance of the impacts identified through the above methods, 2 separate methodology has been adapted and amalgamated.

The impacts of the project activities have been evaluated according to the framework proposed by Posford Haskoning (2004). The decision framework is illustrated in following Figure. This lets decision makers view each project activity that may cause impacts individually and determine what type of impact they have on the environment, and whether they are of significant concern.

The main factors used to evaluate impacts under the framework are as follows:

- Sensitivity of Receptor
- Recoverability of Receptor
- Importance of Receptor
- Spatial Distribution of impact

Table 13 Impact Evaluation Criteria

Criteria	**Scale**	**Attribute**
Sensitivity *How sensitive the receptor is to the impact*	-1	Positive Effect
	0	Not sensitive
	1	Low
	2	Medium
	3	High
Recoverability *How long it would take for the receptor to recover from the impact*	1	Short
	2	Medium
	3	Non-recoverable
Importance *The importance of the receptor to the environment*	1	Low
	2	Medium
	3	High
Spatial Distribution *Distribution of impact*	1	local scale
	2	regional scale
	3	global scale

If the impact receives a -1, it deems the impact to have a positive effect on the receptor and the other criteria is then not applied. The impact is referred to as a beneficial impact.

The significance of the negative impacts will be given based on the following range:

- 1 – 5 : Minor Impact
- 6 – 9 : Moderate Impact
- 10 – 12: Major Impact

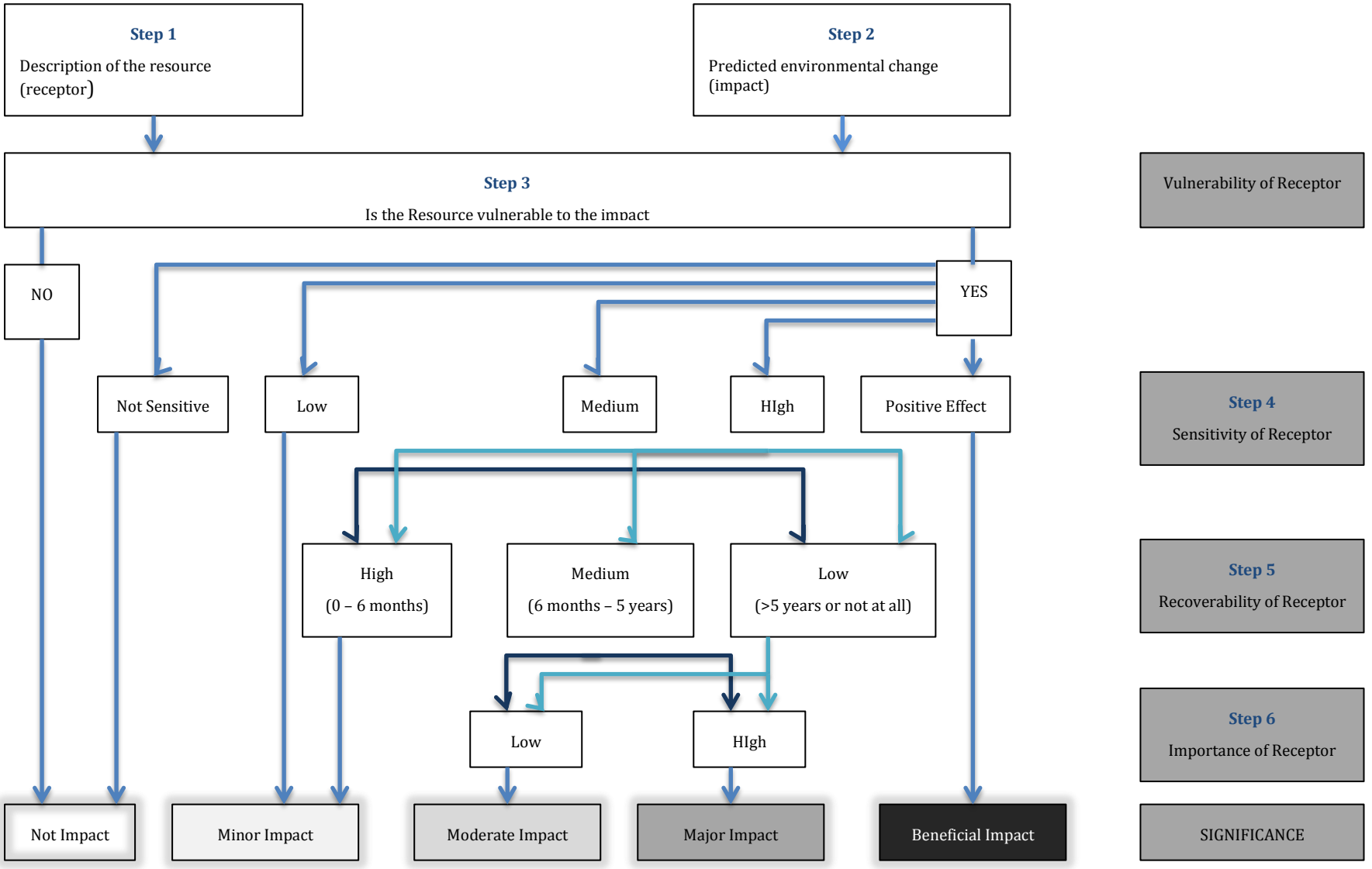


Figure 57 Impact Assesment Diagram (Haskoning 2004)

5.5 Assessment of significance of impact

Table 14 Analysis of potential impacts during the construction phase of the project

Activity	Potential Impact	Impact Area	Impact Nature	Significance Evaluation				Significance
				Sensitivity	Recoverability	Importance	Distribution	
CONSTRUCTION PHASE								
Mobilisation, operation and transport of machinery	Generation of noise Reduction of sea water quality Deterioration of visual amenity Direct impact on reef Air pollution	Marine/water quality, Construction staff Flora and Fauna	Indirect/Direct Cumulative Local	2	2	2	1	7 Moderate
	Oil spill and leakages into the marine environment can decrease the water quality, effect the light penetration properties, and also come into direct contact with marine species such as	Marine / Flora and Fauna, Water Quality	Direct Local	2	2	2	1	7 Moderate

	turtles and dolphin. Also birds can come into contact with the disperse oil plumes.							
	Movements of the machinery can result in turbidity of waters and effect the bottom substrates. It can also cause abrasions to the reef structure of the island	Marine/Water Quality, Bottom Substrates, Reef structure	Direct Local	2	2	2	1	7 Moderate
	Noise Pollution. Noise at the construction area would be in excess of 75 dBA.	Terrestrial/ Human environment	Direct Local	2	1	1	1	5 Minor
Temporary site setup. Material handling and storage, waste management	Generation of waste Health and safety impacts Generation of noise Loss of visual amenity	Terrestrial ground water quality Marine/water quality Construction staff Flora and Fauna	Direct, Indirect Immediate, Cumulative Local	2	1	1	1	5 Minor
	Improper handling and storage of	Terrestrial /Flora and	Direct Cumulativ	2	2	2	1	7 Moderat

	materials can cause damage terrestrial ecosystem of the island	Fauna	e Local					e
	Packaging covers of the materials if not properly collected and disposed can result in litter. Packaging covers, If blown away to the waters, can block the light of corals and have direct detrimental effects such as entanglement and ingestion in case of other species	Terrestrial /Flora and Fauna Marine/ Flora & Fauna	Direct Local	1	1	2	1	5 Minor
Dredging borrow area	Impact on marine life and coral on N reef Sedimentation Direct removal of benthic habitats	Marine environmen t Sea water quality quality	Direct Immediate /Cumulati ve Local	2	2	3	1	8 Moderat e
Bund wall construction	Impact on marine life and coral on S reef Sedimentation	Marine environmen t Sea water	Direct Cumulativ e	3	3	3	1	10 Major

		quality	Local					
Reclamation of Project Coastal Area	Impact on marine life and corals on S reef	Marine environment Sea water quality Coastal Hydrodynamics	Direct Cummulative Local	3	3	2	1	9 Moderate
Reclamation of the wetland area	Impact on local wetland ecology Complete destruction and irreversible damages to local habitats	Wetland environment Terrestrial habitats Local flora and fauna	Direct Immediate and Cumulative Local Irreversible	3	3	3	1	10 Major
Building construction and dewatering	Generation of noise Air pollution Water pollution	Terrestrial ground water quality	Direct Immediate Local	1	1	1	1	4 Minor
Brine Discharge & Sewage outfall	Impact on corals and marine life Sea water pollution	Marine/sea water quality	Direct Immediate Local	1	1	1	1	4 - Minor
Construction of borehole	Ground water quality degradation	Terrestrial groundwater quality	Direct Immediate	1	1	1	1	4 - Minor

	Air pollution Noise generation		Local					
Flora clearance	Destruction of habitat Loss of visual amenity Generation of green waste	Terrestrial ground water quality	Direct Immediate /Cumulative Local	2	2	2	1	7 Moderate
	Loss of bottom substrates. Not much life was observed in the direct vicinity of the reef flat	Marine & Intertidal / Flora and Fauna	Direct Local	1	2	2	1	6 Moderate
OPERATIONAL PHASE								
Waste generation and management	Contamination of soil and groundwater Generation of excess solid waste Generation of hazardous wastes Generation of liquid wastes	Terrestrial Groundwater Sea water quality Human environment	Direct/Indirect Cumulative Local	2	1	2	1	6 Moderate
Coastal hydrodynamics	Erosion of unprotected area Erosion of revetment area	Marine environment Sea water	Direct Cumulative	3	3	3	1	10 Major

	with current design	quality Shoreline	Local					
Drainage	Flooding Damages to structures/vegetation Natural habitats Groundwater degradation	Terrestrial Groundwater Vegetation Structures	Direct Cumulative Local	3	3	3	1	10 Major
General operation of utilities	Air Pollution Noise pollution Light pollution Groundwater degradation	Terrestrial Groundwater Natural habitats	Indirect/Direct	2	1	2	2	7 Moderate
Feed water intake	Groundwater degradation	Groundwater	Direct Cumulative Local	1	1	1	1	4 - Minor
Brine discharge	Sea water quality degradation	Marine/ Seawater	Indirect Cumulative Local	1	1	1	1	4 - Minor
RO Product water	Degradation of water quality	Human environmen	Direct Cumulativ	2	2	3	2	9 Moderat

	Unrest and illness among staff	t	e Local					e
General operation of the airport	Air Pollution Noise pollution Ecological impacts Health and safety issues	Terrestrial Groundwater Vegetation Natural habitats Human environment	Direct/Indirect Cumulative/Immediate Local	2	2	3	2	9 Moderate
Socio economic impacts	Human environment (neighboring communities)	Agriculture Construction industry Tourism Local businesses Job opportunities at airport	Direct/Indirect Cumulative/Immediate	-1				Beneficial

6. Mitigation and Management of Negative Impacts

6.1 Introduction

It is evident the development of the proposed airport at the proposed location will have grave implications on the environment and is highly likely to susceptible changes. As described earlier, some impacts will be felt largely while others may be localized. However, most of the environmental impacts associated with the development of the airport cannot be either reduced or minimized unless effective environmental management and mitigation as well remediation process are well placed accordingly.

The following section will describe the key environmental mitigation measures that will be undertaken during the construction and operation of the proposed airport project.

6.2 Mitigation measures

6.2.1 Waste management

A well-defined waste management plan will need to be developed aiming to reduce the amount of waste generated through material re-use and recycling and be disposed through a licensed waste transporter to regional waste disposal site at R. Vandhoo. Extreme care will be taken to alleviate the impacts caused by the excavated materials and residual wastes during their handling, temporary storage on site, transportation and final disposal. This may be achieved by consideration and application of the following in the waste management plan for the construction phase.

1. Reducing waste generation wherever practical.
2. Reusing and any material that can be considered within the technical specification of project for example; maximizing reuse of timber framework wherever possible, utilization of excavated material for filling or landscaping
3. Maximizing the opportunity for recovering materials. It will be ensured that construction debris will be reused on site to the maximum extent possible.
4. Segregating waste according to type such as separation of recyclable materials like metal, timber, inert construction materials, etc to facilitate re-use and for the ease of disposal.
5. Co-coordinating material deliveries to minimize storage times on site to avoid the likelihood of material damage.
6. Ensuring that all treatment and disposal options comply with all relevant guidelines and standards.
7. It must be ensured that silt mud dug up from the wetland area is kept separately and managed properly before disposal, for example having temporary retention basins for mud.
8. Comprehensive and accurate records of waste will be kept.
9. On-site burning will be prohibited.

10. Staffs will be provided with training on best practices in waste minimizing techniques, handling, storing and transporting of waste.

The following measures will be implemented to mitigate the likely adverse impacts to the environment;

1. Excavated material and sites will be covered to prevent washout and erosion during heavy rainfall;
2. Dust suppression techniques will be adopted;
3. Designated areas for stockpiling will be fenced
4. Waste will be transported to disposal facilities as soon as possible.

A temporary refuse collection facility will be set-up within the boundary of the project by the contractor and wastes will be stored in appropriate closed containers prior to collection and disposal.

6.2.2 Health and Safety

Considering the nature of work, proper equipment and safety gears will be provided to the workers. Regular check ups for the workforce would be done to ascertain that no negative health impact arises due to construction activities. To minimize the risks associated with health and safety, the project proponent will be responsible to ensure that adequate health care arrangements are available at the site throughout the construction period.

6.2.3 Air and Noise

Air quality of the surrounding areas may be impacted during the construction phase as the overall construction process itself is a dusty operation. The vehicles used to transport materials to and from the site may also induce air pollution to a small degree. The following mitigation measures are proposed to minimize such impacts of the project.

- Avoid usage of old vehicles for transporting materials to and from the project site. Vehicles considered for the project should be well tuned, serviced and have valid road worthiness certificates.

- Avoid keeping construction material in open air. If any material is stockpiled ensure that they are properly covered.
- The construction site should be watered regularly to minimize the impact of dust nuisance to nearby residents
- Increase height of fencing surrounding the project site as much as possible (by using nets) to minimize spreading out of dust.

The operation of heavy machinery and vehicles during construction and demolition works may lead to increased noise levels. The following mitigation measure must be followed to minimize the impact of noise.

- Except for foundation and concrete works, other loud noise generating activities should be undertaken during day time as the project site is within the residential area.
- Instruct construction workers to wear ear muffs when using machinery that produce significant noise.

6.2.4 Ecology

As the proposed airport development project, is to be located on partly on wetland a large area and also a small part of the runway lies on a reclaimed area hence a large area will be dredged and reclaimed. Hence, significant ecological impacts will occur to the island environment.

In order to reduce the impacts on the ecology of the island, the following mitigation measures will be undertaken;

- Labour force will be made aware of the fragile nature of the environment; as part of the proposed site for the project includes a sensitive area, and is resorted by varieties of vegetation, birds and other flora and fauna.
- Sheet piling of wetland or construction of a concrete retaining wall, separating the area that will be used in the development of airport and that will be left as it is, before commencement of construction works so as to protect the ecological flora and fauna present in the wetland that is not considered in the project area.
- An environmental buffer area will be created around the project area.

- To reduce the impact of aerial lighting and sound, construction activity will be minimized during the night time. If in case, the work needs to be continued during the night time, lighting will be concentrated only in that particular area.
- Undertake conservation of another wetland area in the region as stipulated under the regulation.

6.2.5 Reducing Sedimentation

The greatest impacts that will generate from dredging and reclamation operations will be sedimentation and its consequential effects. The most common impacts generated from sedimentation would be habitat destruction, decreased abundance and diversity of organisms, loss of corals and fish, turbidity and water quality deterioration. However, since the recommended dredging area is from deep sea it is expected that it would have minimal effect on the above factors. Although special consideration will be given to the fishing areas, resort locations and dive sites in guiding the sediment plume. Moreover, by use of appropriate equipment and best practice methods, effective measures to minimize and mitigate adverse impacts of sedimentation will be carried out. One of the most effective means of reducing sediment overflow into the surrounding marine environment is by using physical barriers in which sediments will be only confined to a certain location in the operation area. In this regard, the reclamation area should be cordoned first either by sheet piles or some revetment structure as discussed under Alternatives, so that suspended sediments during reclamation process will be only confined to project boundary area.

Before the reclamation or removal of silt and clay layer begins in the kulhi area, the area shall be cordoned first as described above. The silt and clay and muddy soil that will be removed from the boundary area should be disposed properly. This material perhaps can be used to create similar environment in another location or making compost or can be disposed off at R. Vandhoo.

The reclamation area from the seaside is about 0.5m below MSL on average and most of the reef flat areas are nearly dry during low tide, direct placement at the peripheral areas during low tide has been considered appropriate to minimize sedimentation

arising as a result of reclamation. However, in the unlikely event that additional sediment control becomes necessary, earthen bund and settlement basins within the bund using excavators may be constructed or further sediment control measures using silt screens may be considered.

For channelling excess water from Kulhi area (water within the Kulhi and water that comes together with the sand from the dredger), channels needs to be created. This should be limited to two areas and should be created from shortest distance.

6.2.6 Dredging Methods

If sand has to be borrowed from deep sea the dredging process will be carried out by the use of a trailer suction hopper dredger. Mitigation measures during the dredging process will depend on the precise location in which dredging is undertaken. Therefore mitigation of dredging process impacts will be further discussed and analysed under an addendum to this study, which focuses on dredging and the borrow area.

6.2.7 Timing and Scheduling of Reclamation

Reclamation of the wetland is advised to be undertaken upon installation of sheet piling, to mitigate the impacts on the intact section of the wetland. Dredging operations of sea would be undertaken during low tides and on calm weather to enhance reduction of sediment transport to greater distances.

During dredging and reclamation from both ends (sea side) of the proposed location, movement of personnel and equipment over the reef will be restricted and if need to be used then a very narrow passage would be considered to minimize any possible physical damage to the corals.

6.2.8 Mitigation Measure: Operational Phase

The project aims to provide a dedicated airport that would ease the risk of travelling via sea and expedite the process. To fulfil this intention the airport will require to establish a modern management structure that would aim to operate safely with good quality service and handles the fast growing passenger and cargo volumes in

accordance with all the regulatory obligations, international standards and procedures.

6.2.9 Erosion

Erosion of the beach profile in between the reclaimed areas from the lagoon area is highly expected considering the motion of waves in the northeast monsoon (refer Figure 3-23). The impacts on the shoreline will be monitored during the course of the project construction phase and if necessary for the first two years during the operational phase. In case of potential threats of erosion, which could be linked to the proposed project, mitigation measures such as a groyne field would be considered.

Erosion of the reclaimed area can be mitigation by adopting different revetment designs as discussed under project alternatives.

6.2.10 Air Pollution

It is predicted there will be no elevated air pollution issues due to the operation of the airport, as the power supplied to the airport will be via local service provider. If a need to incorporate a powerhouse to the airport is planned later on, then air pollution due to the use of diesel generators is expected. Carbon monoxide, sulphur dioxide, oxides of nitrogen and particulate matter could then be expected as potential pollutants. In such case, appropriate devices like soot filers will be used in the exhausts of powerhouse and regular monitoring will be carried out to identify the concentration of gases in the immediate atmosphere and action can be taken to control the negative impacts.

6.2.11 Reducing Emissions from Aircraft

Other major pollutants expected to be generated in an airport is from the exhausts of aircrafts.

To mitigate pollution, following methods of abatement can be adopted at the source level.

- Shutting down of engines to the maximum possible extent during taxiing and idling period.

- Permitting aircrafts with International Civil Aviation Organization's (ICAO) certified engines to land and take-off and prohibiting any aircraft that does not satisfy the principal codes of ICAO.

6.2.12 Noise

It is evident that the operation phase of the airport will cause noise pollution due to due to aircraft or its components concurrently with the phases of a flight. Noise mitigation is best achieved by undertaking the following measure

- Reducing noise level at source;
- Altering operational procedures for abatement of noise;
- Operating restrictions on aircraft

Other policy instruments that could be used to reduce noise from aircraft, include:

- Controlling Air Traffic by reducing the times that planes wait to take off
- Acoustic shield for noisy plants and machinery and generator sets.
- Careful operation and maintenance of machineries to minimize high noise generation.
- Providing guidance to airport operators on potential mitigation measures such as preparation of a list of take-off noise limits realistically achievable by different aircraft types

6.2.13 Mitigating Impacts from solid waste

As Kulhudhuffushi airport development project does not include any other food facility or hotels, it is anticipated that waste generated from the airport would be minimal. Waste generated is mostly expected to include recyclable materials such as paper. In addition, small amounts of hazardous waste from chemicals and oils will be generated.

Waste will be initially sorted and contained at the waste collection area of airport. All general waste will be taken to the waste collection area of Kulhudhuffushi daily, while hazardous material will be stored and later transported to regional waste management center.

6.2.14 Ecological Environment

An environmental buffer zone of about approximately 30% will be maintained consisting adequate tree plantation with appropriate species. A thick green belt fence will be developed to prevent light dispersion and scattering in adjacent areas. This will minimize the impact on animals and birds that reside in these habitats.

Since the airport is in a wetland area and even upon completion of the project, part of the wetland area will be left as it was various types of birds and other animals are expected to use this area as their niche. In addition as per proponent, predicting from past experience, airports themselves attract birds to reside in the area. Therefore to prevent collision of birds during the operation phase, it is recommended to emit ultra sonic sound waves before flight landing and takeoff.

6.2.15 Health and safety

Appropriate health and safety measures for all workers at the airport during airport operation will be provided. In this regard, safety shoes, overalls, helmets, ear plugs will be provided at all time. Health and safety procedural manual will be prepared and made available for all operations in the airport.

6.2.16 Operational Safety Measure

A vast range of safety measures need to be considered in accordance with local laws and regulations as well as the ICAO standards. In this respect appropriate framework conditions will have to be provided for;

- Emergencies;
- Rescue and fire fighting services; and
- Bird strike

To comply with operational safety requirements in accordance with local standards steps and measures will have to be taken in terms of organization, equipment, staffing, training and operation.

6.2.17 Airport Emergency Plan

An airport emergency plan as per the requirements of Maldives Civil Aviation Authority and ICAO will be developed to coordinate activities and actions to be taken in an emergency occurring at the airport or its vicinity.

6.2.18 Rescue and Fire fighting

The rescue and fire fighting plan will be inclusive of the following measures, which is a requirement of the local authority as well as the ICAO standard operational procedures. The fire fighting plan will have the following sectors incorporated into it.

- Level of protection to be provided
- Fire fighting
- Rescue equipment
- Response time
- Emergency access roads
- Fire Stations
- Communication and alerting systems
- Number of rescue and fire fighting vehicles
- Personnel and training requirements

6.3 Mitigation for Major impacts

Major impacts identified by the impact matrix include; sedimentation impacts during Bund construction, continuous erosion due to revetment design, flooding issues, and destruction of wetland area as an irreversible major impact on the terrestrial habitat.

Alternatives have been proposed in the following section to prevent these major impacts especially with respect to sand bund methodology and revetment design.

Regarding flooding, it is proposed to design a new flood mitigation system for the island, taking into account the natural flood mitigation by the kulhi area will no longer work as before.

The irreversible major impact on the wetland is unavoidable under the current proposed project and there is no practical way it can be mitigated. Therefore, as stipulated under the regulation for projects such as these, it is upon the developer to

commit to financing a project to conserving another wetland area in the region with assistance from the Ministry of Environment and Energy or EPA.

7. Alternatives

7.1 Introduction

Considering the project alternatives, the project would either be executed or not. If the project were to continue then measures should be taken to resolve the problems. It would be necessary to take economic, ecological and social aspects of the project into consideration and ensure that these concerns exist within a delicate balance. Neither the economic benefits nor the social and ecological concerns can be avoided. Therefore, it is important to consider all options and ensure that the best available option(s) is/are chosen to solve the issues/problems. Not all the impacts of a project can be completely prevented, however, with the use of appropriate technology and management measures; the magnitude of some of the impacts discussed previously can be either reduced or minimized. Nevertheless, the effectiveness of these technology and mitigation measures highly depends on the environmental condition and procedures in which they are applied in the field. On the other hand, there are complex and sophisticated procedures of minimizing environmental impacts by means of alternative methods to some of the activities. Often, alternative means are not economically competent with the extent of the project itself. However, to some of the activities where predicted impacts and its magnitudes on the environment are very adverse, alternate means must be applied considering long-term benefits from use of alternatives, as short-term environmental restorations can become very costly. The following section describes and evaluates some alternatives in terms of locations and various project activities and methods of construction for the development of the domestic airport HDh. Kulhudhuffushi. As project alternatives 3 major options have been discussed. These are choosing an alternate location for the proposed project, altering the proposed design and no-project option.

7.2 Alteration of the proposed design

7.2.1 Providing coastal modification to the whole airport area

The proposed airport design for Kulhudhuffushi does not provide coastal protection to the whole airport area located on the north beach of the island. Coastal modification structures have been proposed for the reclaimed areas only hence there is high possibility, considering the current status of eroded beach on the northern side of Kulhudhuffushi. Therefore, it is recommended that coastal modification be provided to the whole beach area that covers airport.

Additionally, a typical revetment structure on sand is proposed as a shore protection measure currently. Due to the nature of the wave climate in the proposed area, it is recommended for breakwater or semi breakwater structures to be implemented instead of the typical revetment structure. This structure will not depend on the sand for structural stability and will therefore be more rigid to incoming waves during construction. This will greatly reduce sedimentation impacts.

Furthermore, the proposed 250 – 500 kg unit weight materials to be used in the revetment structure will not be suitable for the wave conditions at the site. It is recommended to utilise at least 1000kg unit weight materials. Ideally 1500 to 2000kg would be better suited to this environment.

7.2.2 Construction of the bund

It is currently proposed to construct a sand bund prior to reclamation commencement to contain the sand in the area. Based on the findings in this study, it can be concluded that constructing a sand bund will not be effective in this area to contain sand and will only lead to more sedimentation as the bunds will get easily washed out. In addition to the environmental consequences this will result in, it will also cause a significant financial burden on the developer when the contracted volume of sand gets washed out without being retained in the designated area.

It is instead recommended to construct the bund using alternative materials such as sheet piles, rock boulders, geo bags, or jumbo bags.

Sheet pile structure will be the most rigid and will act as a retaining wall for the final structure as well. However, this will be very expensive and may not be feasible for the developer/contractor. Use of rock boulders with geo textile is recommended as well. This will be a very rigid structure and will effectively break incoming waves while containing the sand. A more feasible option will be to construct the same structure using sand filled geo bags. This may take more time as the bags would need to be sewed and filled with sand before being placed. A further alternative is use of jumbo bags. The main difference between geo bags and jumbo bags in this context is the materials. While geobags will be more long lasting and can be used in the final structure, jumbo bag material will get easily damaged and would need to be replaced soon.

Based on all these factors, it is recommended to use sheet piles if feasible, or the most feasible option among those given instead of simply using sand bunds.

7.2.3 Establishing a drainage system that will mitigate the island flooding issues

The location proposed for the airport consists of a vast wetland considered as a sensitive area by the Environmental Protection Agency of Maldives. This wetland has been used as the catchment area to prevent flooding of Kulhudhuffushi. As this catchment area will be lessened if this project goes ahead then the natural drainage system and hydrogeology of the island will be altered and the flooding may prolong before infiltration.

7.2.4 Changing borrow area method/locations

Borrow area locations proposed previously for the project are soil strips within the boundary of airport. This was an alternative that was previously discussed. As the soil strips to be excavated are of 6-8m of depth, it is not recommended as this would bring major negative environmental impacts. Major Impacts are predicted to follow due to land dredging proposed for the reclamation of wetland area. Out of the four strips to be dredged three of them are adjacent to the shoreline; it is predicated that dredging to a depth of 6-8m would cause

degradation of soil and cause severe erosion on north side of island. In addition, leaving these areas unattended or without filling may heighten the risk to construction worker on the site. Another impact due to the dredging of land strips would be the easy accessibility of salt intrusion into the water table of the island.

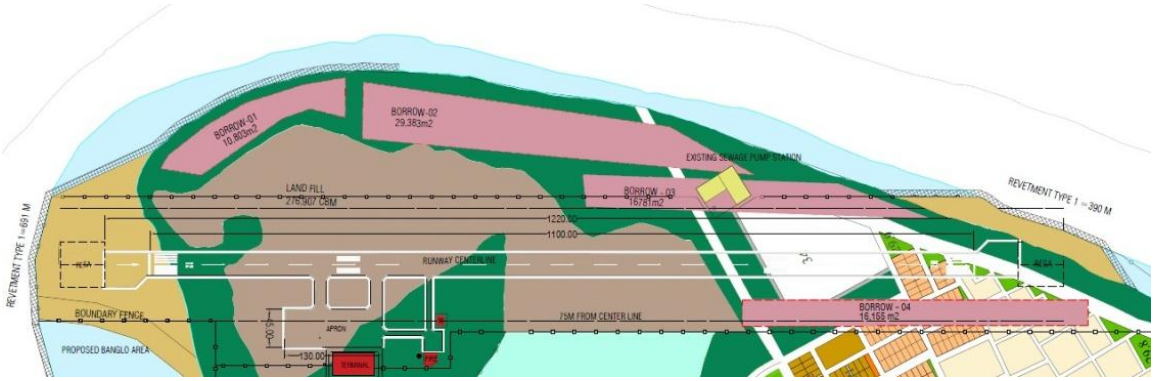


Figure 7-1: Previously Proposed Dredging Strips (in pink)

Previously it has been proposed to use silt/clay removed from the Kulhi area to be used as fill material for these dredged strips. As these pits that would be dug are not naturally occurring wetlands, it is predicted that filling the pits with silt and clayey layers will further degrade the soil present in the area and also elevate the risk to the workers as they may accidentally fall into these pits and may drown in it as pits are to be dug to a depth between 6-8m. Land dredging will also enhance the impacts discussed clearing vegetation.

Therefore, it is recommended to follow the currently proposed deep sea dredging for the project.

7.3 Alternate Project Location

The participants of stakeholder and public consultation held, requested for an alternate location but the after considering other options the Government has categorically chosen the proposed location. As per proponent the local recommended location on the eastern side of Kulhudhuffushi is not feasible as a larger residential area will have to be demolished and deeper lagoon area will need to be reclaimed hence boosting the cost of the project. However, as

feasibility study has not been done in there is no concrete evidence that the eastern side of Kulhudhuffushi cannot be selected for the proposed project.

Having the airport in the current proposed location would be beneficial to communities surrounding Kulhudhuffushi to get easily connected with the rest of the atolls in terms of passenger movements and transport of cargo as well as to the airport in Malé as proposed location is closer to the existing harbor of the island, and has a shorter route and easy access to airport rather than walking or driving to the eastern end of the island. Another advantage would be the current location with the environmentally sensitive wetland have been neglected and mismanaged for a very long time.

Other major location alternatives include constructing the airport in another island in the same region. However, the developer has informed that there is absolutely no option for the location to change at this stage. Therefore, it is recommended for future such projects, that more studies are undertaken during planning stage before finalising location for airport development.

7.4 No Project option

It is believed that a number of environmental impacts will be generated from the proposed development of domestic airport in Kulhudhuffushi Island. Although no environmental impacts is predicted to occur if the proposed development of the airport does not go ahead, this may eliminate an important development that will have direct linkages to the benefits discussed in the project description of this EIA. However on the bright side, the no-project option will not have any environmental impacts and environmentally sensitive wetland of Kulhudhuffushi can be safeguarded. Furthermore, on the contrary the following projects can be undertaken to improve the socio-economic status and other living standards of Kulhudhuffushi.

7.4.1 Operating seaplanes to and from Kulhudhuffushi

The major source of Maldives' income is generated from the tourism industry. Therefore the tourism industry ensures that easy accessibility is provided the

tourists arriving to the dispersed islands of the Maldives. As majority of the tourist resorts are not closer to airports, tourists travel via seaplane which lands on floating docks. If such a system can be established, then there may not be an urgent need or economic justification of the airport until a further demand is realized.

7.4.2 Establishing reliable ferry services

Even though an existing airport is located (at HDh. Hanimaadhoo) approximately half an hour away from Kulhudhuffushi, a reliable ferry service hasn't been established to cater the passengers arriving. During the public consultations held for this project, several locals expressed that if a comfortable and reliable ferry services could be set up, then an airport may not be as significant as currently perceived.

7.4.3 Renovating and upgrading the current regional Airport

Renovating and upgrading the regional airport at Hanimaadhoo Island would enhance the socio-economic status of the region. This would increase the number of flights flying and ferries travelling to and from Hanimaadhoo; hence introducing job opportunities to the atoll. In addition, if the airport is upgraded to a more established international airport, then there is high expectancy that the bussing tourism industry in the region would boost. More frequent trips of air ambulance can be operated to accommodate passengers needing medical assistance.

8. Stakeholder Consultations

8.1 Stakeholder Consultation

8.1.1 Scoping meeting

Scoping meeting was held on 11 April 2017 to discuss about the Kulhudhuffushi Airport Development Project scope. Meeting was attended by various stakeholders related to the project, including EPA, MEE, MHI, Civil Aviation, Regional Airport, Kulhudhuffushi Island Council and Haa Dhaal Atoll council. Various issues were discussed about the project, including social, environmental, economical, construction and operational phase issues. Some of the specific issues discussed includes sensitive area (wetland area) reclamation, creation of similar environment in another location and relocating endangered species (if any), reclamation of coastal areas and coastal protection, proposed barrow areas (reclamation material), existing water network pipes and submarine cable, flooding that may cause due to the reclamation of the wetland area (natural catchment area), houses that fall to the boundary of the Airport land area and height restrictions. Based on the discussions on the above issues, EPA issued the ToR (Appendix 5) for the EIA on 20 April 2017. Approved ToR specified consulting with various stakeholders and public as part of EIA. The issues/concerns/views pointed out during the consultation with various stakeholders and public were described below:

8.1.2 Meeting with Kulhudhuffushi Island stakeholders

EIA consultant and the survey team visited the island on 19th April and met with the Kulhudhuffushi island council on 19th morning. The meeting was attended by the council members (Appendix 6). The EIA consultant provided background information about the project. The council members are aware of the project, as some of the council members attended the scoping meeting held at EPA. The council members did not express much concerns about the project but

highlighted that the project is much linked to the sentiments of Kulhudhuffushi people and is a long awaited project. Members pointed out that they will provide all the support and assigned a focal point for arranging needed assistance. The EIA consultant requested to organize two separate meetings: one meeting all the other stakeholders in the island and second meeting with the public.

Kulhudhuffushi Island stakeholders: A meeting was held at the island council on 20th April with the stakeholders on the island (see attached Appendix 6). Most of the stakeholders highlighted the need for an airport at Kulhudhuffushi and they are looking forward to see the project being implemented. They pointed out that during the rough seas, it is very difficult to transfer sick/ill people to Hanimaadhoo during emergencies. The stakeholders also said that an airport at Kulhudhuffushi will not only make life easier for the Kulhudhuffushi island people but also people from Haa Dhaal, Shaviyani and Noonu atoll. According to the most of the stakeholders, the airport will reduce their expenditure on travelling. Some of the stakeholders indicated that the current proposed location is not ideal for the project as the wetland area needs to be reclaimed and it will destroy the ecosystem, natural view, might increase flooding and the project cost will be too high to construct an airport at the proposed location. As an alternative location, some of the stakeholders indicated that eastern side of the island is a better location for constructing the airport. Stakeholders suggested to reclaim the eastern side to create land for constructing the airport, as this will not require relocating houses and the houses needs to be relocated for the proposed location. Some of the stakeholders also pointed out there are two schools nearby around the proposed project area and during day time the schools are occupied by the students most of the time.

Some of the stakeholders pointed out that there is no need to build an Airport at Kulhudhuffushi Island, as there is another Airport (Hanimaadhoo), which can be reached within about 20-30 minutes time. Some of the stakeholders who attended the meeting suggested that it will be much beneficial to invest in a tertiary hospital at Kulhudhuffushi, instead of investing for the airport.

None of the stakeholders identified any concern with regards to their area of work. In general sentiments were mixed, and it could be seen that there was support for the project.

Haa Dhaal Atoll council: A separate meeting was held with Haa Dhaal Atoll council on 22nd April, as per the ToR. Meeting was attended by the council members (see Appendix 6). Some of the members indicated the need for the airport, while others indicated that there is no need to build an airport at Kulhudhuffushi, as there is an airport within reach and the available land is very limited at Kulhudhuffushi. Members also suggested that it will be better to construct the airport on the eastern side of the island by reclaiming the land. However, this reclamation may not be feasible considering the lack of lagoon in the area.

8.1.3 Meeting with MHI

A meeting was held with Officials (see Appendix 6) from Planning and Engineering department of Ministry of Housing and Infrastructure (MHI) to discuss about the project. MHI highlighted the need for incorporating Kulhudhuffushi Airport Development in the land use plan of the island and requested to send the concept for MHI approval. The officials also highlighted the need for deciding on the houses that fall into the project area. They also pointed out that the government should decide on whether the compensation will be given from the project or by the government and relocation of houses needs to be decided before the project implementation.

With regards to the coastal protection, they also suggested to do coastal protection measures around the project boundary area.

The officials also believes by reclaiming the wetland area will increase the chance of frequent flooding in the island. To overcome this, they suggested to implement proper drainage system.

8.1.4 Meeting with MEE

A meeting was held with waste, coastal protection and environment department, of Ministry of Environment and Energy to discuss about the project. Water department of the ministry was also invited but did not attend the meeting. A separate meeting was held with different sections of Environmental Protection Agency.

Environment Ministry officials expressed their concerns on:

1. Reclamation of wetland area (sensitive area)
2. Flooding associated with the project
3. Proposed barrow areas
4. Water network infrastructure within project boundary area
5. Waste generated during construction phase
6. Coastal protection measures proposed
7. Cost of the project will be too high due to the complexity of the project (reclamation of the wetland area, lagoon reclamation, coastal protection and relocation of houses)

The experts highlighted that the wetland area is sensitive area declared by the Environment ministry due to the ecological/biological/economic and natural features of the area and uttermost importance should be given not to harm the existing environment. They highlighted that the cost of the project will be too high for to build an airport at proposed location compared to the similar projects elsewhere in the Maldives due to the complexity of the project location (reclamation of the wetland area, lagoon reclamation, coastal protection and relocation of houses) and recommended to consider another location for the project. Experts also pointed out that the wetland area is a natural catchment area for flood mitigation and reclamation of the area will have far reaching negative consequences in terms of flood mitigation. Careful considerations should be given in designing the airport on how to mitigate flooding that may experience in the future and pointed out it will impact the groundwater lens also.

The officials also raised concerns about the existing water network facility within project boundary area and pointed out that the MEE regulates the water provision in the country and pointed that the water distribution should not be disrupted at any time (during construction and operational phase).

Officials highlighted currently there is no proper waste management facility in the island and pointed out that during the construction phase of the project, large volume of waste will be generated. They pointed out that the waste generated from the project should not put extra pressure on the waste management of the island.

Environment ministry officials also highlighted the need for constructing coastal protection around the whole coastal area to prevent coastal erosion.

8.1.5 Meeting with Utilities Companies (FENAKA, MWSC, Dhiraagu)

A meeting was held with utilities companies (see Appendix 6)to clarify in relation to the proposed project and the services provided by the utilities companies. FENAKA informed that they plan to procure a new Genset (2MW) this year. They suggested that they can provide power needed for the construction and operation with minimal cabling and pointed out there is no need to establish a separate power house for the airport. It will put extra pressure on the government budget and maintenance cost will be high for the airport if they establish their own power house. FENAKA also highlighted that the system in the island is an energy efficient system and emissions are low from energy efficient systems. Regionals airports informed that a suitable location can be allocated from airport area for housing sub-station.

During the scoping it was highlighted that there might be a need to relocate Dhiraagu submarine cable since the cable run beneath the runway and maintenance might be an issue. The experts from Dhiraagu who attend the meeting pointed it is not an issue for them that the cable run beneath the runway. They said during construction stage the cable should be protected and should be careful in doing the ground work. Dhiraagu also pointed out that they can put extra cable beneath the runway through proper pipe so future maintenance can be carried out easily.

None attended the meeting from MWSC. However, regional Airports informed that they had a meeting with MWSC after the scoping to discuss the issue of relocating the water network pipes. Regional Airports informed to the consultant that the WMSC has no issues in running the piple beneath the runway and MWSC agreed to provide a letter confirming this. Consultant informed to regional airports to get MWSC commitment letter that the tariff will not be increased in association due to the changes in the water network system due to the airport project, as this was advised by the EPA. So far the consultant have not received the confirmation and commitment letter from MWSC.

8.1.6 Regional Airports and Hanimaadhoo Airport

The consultant held meetings with regional airports at different times (see Appendix 6). The consultant informed the regional airports about the concerns raised and suggestions proposed by the various stakeholders and Kulhudhuffushi community.

From the discussions, it is clear that there is no approved concept for the project and no detailed work exists for the proposed project. Regional airports informed that the compensation for the Houses will be taken care by the Government although no agreement was documented between government and residents to be relocated. It was also stated by the Regional Airports that the no changes to the land use plan of Kulhudhuffushi has been brought or approved from the Ministry of Housing and infrastructure.

Further from the discussions held Regional Airports informed that Maldives Water and Sewerage Company (MWSC) had not issues regarding the runway been laid on the water network pipes. MWSC did not attend the stakeholder consultation hence the consultant did not get to discuss the issue and clarify this from MWSC's side.

In addition, the proponent has not decided which alternative sensitive area location will be developed as the EPA has advised in the scoping meeting. This will be finalised after the EIA process is completed.

Meeting with Hanimaadhoo Airport management: The management of Hanimaadhoo airport informed that they welcome Kulhudhuffushi airport project and they are happy that a new airport is coming to the region. They

informed that it will reduce the pressure on Hanimaadhoo airport (sometimes seats are unavailable for emergency patients). Also they highlighted that they might lose some of their trained staff once Kulhudhuffushi opens but more jobs will be created in the region.

Meeting with other stakeholders: The consultant has sent requests to meet other stakeholders stated in the ToR. However, they have not responded to the requests. Therefore, the consultant informed this to the project proponent (regional airports) and requested to facilitate the consultation meeting with those stakeholders, with no success.

8.2 Public Consultation

A meeting was held at the Atoll Education Centre on 20th April 2017 to get/hear community (public) view/concerns/issues on the proposed project, Kulhudhuffushi Airport Development Project. The meeting was organized by the island council.

The meeting was attended by varying ages and includes both gender (See Figure 8-1 and Appendix 6). It should be noted that not all the people who attended the meeting signed the attendance sheet (some refused to sign). Island Council members also attended the meeting.

One of the council member opened the meeting and handed over to the consultant to conduct the meeting.

The EIA consultant briefed the community members who attended the meeting, how the EIA process works in relation to a project in particular to the Kulhudhuffushi Airport Development Project and informed to the people that for this project the EIA consultant was hired by the contractor. The consultant informed to the attendants of the meeting that stakeholder and public consultation should be carried out as part of EIA process and it is a requirement of an EIA. The EIA consultant informed that the aim of the meeting is to get community views, concerns, issues and requirements and these will be incorporated in the EIA report.

The EIA consultant provided background information about the project, including project location, reclamation areas, coastal protection measures and barrow areas. After providing the information, the floor was opened for questions and clarifications.

Some of the questions asked by the general public includes:

1. Whether the project will be implemented or not?

2. Whether an EIA was done for the project before?
3. How the location is decided?
4. Is there any possibility to change the location after the EIA?
5. Whether a feasibility study was done for the project?

The consultant responded the questions based on available information and knowledge about the project.

Then the consultant asked the following questions from the audience:

1. Is an airport needed for the island?
2. What is your view on the project?
3. Is there an alternative solution for the project?
4. Is there an alternative location for the project?
5. Is there an alternative barrow area?

Majority of the community members who attended the meeting expressed that there is need for an airport at Kulhudhuffushi and suggested that they are eagerly waiting to see the project being implemented. Most of the people believes it is a good project but according to the majority of the people which attended the meeting, location should be changed to the eastern side of the island.

As an alternative solution for the project, some people suggested to have a proper frequent regular ferry between Kulhudhuffushi and Hanimaadhoo. Some also suggested to upgrade the Kulhudhuffushi hospital so that the services available from Male' can be provided by the Kulhudhuffushi hospital.

In responding to the alternative location for the project, majority of the people said the airport should be developed on the eastern side of the island and said that they reject the proposed location and will oppose and stop the project. Some people also suggested already existing reclaimed land area on the western side of the island (near harbour area) as an alternative location while others suggested one of the island nearby as an alternative location for the project.

According to the people who attended the meeting, most of the people are against borrowing sand from the island (either from Airport boundary or any other area). As an alternative location for barrow area, people suggested to use dredging material from harbour expansion project. While others suggested to get materials outside the island (from deep sea), as it was done for western side reclamation.

Some people who attended the meeting also pointed out the project should be done after doing cost-benefit analysis and raised the concerns about reclaiming the wet land area and indicated it can have so much consequences in the future.

Importance of maintaining the wetland area for flood mitigation, the value that the wetland provides to the community, aesthetic value, habitat to the migratory birds and economic benefits of the area was also highlighted by the members of the community. Community also raised the concerns over the coastal protection measures suggested. People said if part of the area is not protected, the area will be eroded easily and they would like to see coastal protection measures implemented along the whole coastal area around the project area.

Community also expressed their concern about the relocation of houses. According to some of the people, they are not sure about what will happen to their houses and where they will be relocated. Another issue the community raised was height restriction and existing water network facility around project location. According to the people, there should not be disruption to the water. Furthermore, people suggested that if the wetland area is reclaimed, the ground water also will be impacted.

Figure 8-1: Public consultation

Apart from the meeting held at AEC with general public, members of the community were interviewed individually by visiting houses, community places and on the street. The summary of the responses are given in table below:

Public Consultation Guiding Questions:

Issues	**Summary of Participants' opinion, comments and suggestions**
Perception/Opinion about the project and the awareness about the proposed project?	Most of the people indicated that they are in favour of the project, while some others suggested that an Airport is not needed for the island, as there is an airport nearby and existing land area is very limited in the island. Majority of the people are aware of the project but they are not aware of the exact location and design on the project. Consultant provided background information about the location and project design.
Do you support or local people will support the proposed project?	Most of the people who were interviewed said that they support the project and there will be support for the project from the local community as well.
Any critical issues or concerns, problems regarding the project?	Number of concern/issues and sugguestion were raised: 1. Loss of revenue from Roanu Veshun (traditional rope making in Maldives), as wetland area is used to bury the coconut husk. According the locals, almost every household makes earnings out of rope making (it has been there for a long time) and average income per House hold is estimated to be about MVR3500-5000/month. 2. Natural beauty will be lost (aesthetic value) 3. Flooding will be experienced more frequently if the wetland area is reclaimed. 4. The proposed location is not suitable and it should be built on eastern side 5. The area should not be reclaimed by borrowing sand from already existing land area 6. If coastal protection is done in some parts, erosion will occur 7. Noise pollution will increase 8. Land area will be limited for other uses 9. Height restriction for the houses nearby and this

	is disadvantage for them. 10. Relocation of households 11. Cost of the project will be too high due to the complexity of the project (reclamation of the wetland area, lagoon reclamation, coastal protection and relocation of houses) **12.** Ground water impacts
Are there any criteria you would like to see considered during the project design, construction and operation stage?	Criteria proposed by the community: 1. The Airport should be developed on the eastern side of the island 2. Sand should not be borrowed from the land area 3. The whole coast line should be protected 4. Barrow area should be from deep sea (outside the island) 5. Minimum area should be reclaimed from the wetland area 6. Proper fencing should be there 7. People from the island should be selected for the Jobs
In your opinion, are there any negative impacts associated with the project?	1. Loss of revenue for the household from rope making 2. Environmental destruction (loss of biological diversity and habitat for the migratory birds) 3. Flooring due to the reclamation of the wetland area 4. Noise pollution 5. Reduce available land for other purpose 6. Relocation of households 7. Natural beauty will be lost
In your opinion, are there any positive impacts or benefits associated with the project?	1. Increased in job opportunity 2. Will make travel easier 3. Will increase business opportunities
Is there an alternatives for the project (project design, location operation)?	As an alternative location majority of the people suggested eastern side of the island. People suggested to reclaim minimum area from the wetland area for the airport development project and to implement coastal protection along whole coastal area. People also suggested deep sea as an alternative

	to the proposed barrow areas. As an alternative for the project, many people suggested to establish a proper frequent regular and reliable ferry system between the island and Hanimaadhoo as an alternative solution for the project. Some people also suggested to establish sea plan service between the island and Hanimaadhoo as an alternative solution for the project, while others suggested to establish a tertiary hospital an alternative solution for the project and to reduce dependency on Male'.
Will there be likely involvement of local people in the implementation of the project?	Yes. Yes-if only the airport is developed in the eastern side No-airport is not needed for this island.
Loss of residential/commercial structures, if any due to the project?	18-22 Households needs to relocated
Loss of community life like any market places or community activities to be affected?	• Rope making business • Recreational activities (going to beach and wetland area)
Is the site prone to disasters?	Yes-Flooding and inundation due to waves
Is this consultation useful? Comments? Anything you would like to add?	Consultation useful: Yes-provided information, informative, provided opportunity to express views Comments: It will be a costly project. Will not support the projected for the proposed location. The location should be changed to eastern side. An airport not needed for this island. Looking forwarded to see this project implemented.

9. Environmental Monitoring

9.1 Introduction

The environmental monitoring program outlined here provides a an opportunity to address some of the adverse environmental impacts relating to the proposed project during its execution and operation, to enhance project benefits, and to introduce standards of good practice to be adopted for all project works, as the impacts identified in this EIA is based upon a range of assumptions about the timing and methodology of the construction works. This monitoring program is important as it provides useful information and helps to:

- Define the responsibilities of the project proponents, contractors and environmental monitors and provides means of effectively communicating environmental issues different parties and thus taking appropriate mitigation measures.
- Define monitoring mechanism and identify monitoring parameters so that future monitoring can be carried out
- Evaluate the performance and effectiveness of mitigation measures proposed in the report and suggest improvements if required,
- Detect any development of unwanted environmental situation resulting from inaccurate predictions, and thus, provides opportunities for adopting appropriate control measures wherever possible,
- Determine project compliance with regulatory requirements, standards and government policies

9.2 Environmental Monitoring program

The proposed monitoring program shall be adhered to reduce negative impacts due to the project and should be carried out for longer term, as some of the impacts can be cumulative impacts and takes time to see noticeable changes in the environment. Hence, the proposed monitoring programme is recommended for at least five years from the project starting date. Based on five year

monitoring results, monitoring should be extended for further years. The monitoring plan outlined in the table provides environmental parameters that needs to be monitored.

Table 9-1: Recommended Environmental Monitoring Protocol-Construction phase

Monitoring aspect	**Location**	**Monitoring mechanism**	**Monitoring Reporting frequency**	**Monitoring cost**
Groundwater quality	From baseline sampling locations	By collecting water samples and tested by an accredited laboratory for the following parameters: Electronic Conductivity , pH, Salinity, temperature, Nitrate, Sulphides, Phosphate and Hydrocarbons	Every month	USD800/per test (for all parameters)
Surface Water Quality	Water body (Kulhi) within project boundary area	pH, conductivity, TSS, TDS, heavy metals, BOD, COD etc	Every fortnight.	USD600 (for all parameters/month)
Seawater quality	From baseline sampling	By collecting water samples and	Every 2 months	USD800 (for all parameters/mont

	locations	tested by an accredited laboratory for the following parameters: pH, Salinity, temperature, Turbidity, Nitrate, Nitrogen Ammonia, Sulphate and Phosphate		h)
Reef benthos (Coral and other benthic cover)	Baseline survey locations	Random photo quadrate (1m*1m) method	Every 3 months	USD400 (per survey)
Fish (diversity and abundance)	Baseline survey locations	Census of fish diversity and abundance through video transects (visible along a 360° radius)	Every 3 months	USD400 (per survey)
Sedimentation	Baseline survey locations	Samples collected through sediment traps.	Every week for the entire duration of reclamation works and once every 4 weeks	600 USD (per survey)

			thereafter	
Clearance of trees	At Project Location	Inventory of trees likely to be cut and number of trees to be planted as part of Tree Plantation program	During site preparation	USD 250/month
Noise Levels	At project site and nearby schools and residential areas	using Noise meters	Major working days	USD350/survey
Solid waste Generation	At Project boundary area	Inventory of waste	Every week	USD250/month
Habitat Disturbance	Within the Project site boundary	Visual Observation	Once every month	USD350/month
Compensatory tree plantation	Tree plantation locations	Survival rate of tree saplings	Once every 2 months	USD250/month
Flood drainage system	Pump stations and drainage system	Visual observation of water flow rate and checking drainage system and pumps established for removing excess water	During and after every storm event and every month	USD250/month

Socio-economic	Kulhudhuffushi island	Inventory of jobs created locally and migration of people, economic and social development of the island	Once every 3 months	USD900

Table 9-2: Recommended Environmental Monitoring Protocol-Operational phase

Monitoring aspect	**Location**	**Monitoring mechanism**	**Monitoring Reporting frequency**	**Monitoring cost**
Groundwater quality	From baseline sampling locations	By collecting water samples and tested by an accredited laboratory for the following parameters: Electronic Conductivity, pH, Salinity, temperature, Nitrate, Sulphides,	Every 6 months	USD800/per test (for all parameters)

		Phosphate and Hydrocarbons		
Surface Water Quality	Water body (Kulhi) within project boundary area	pH, conductivity, TSS, TDS, heavy metals, BOD, COD etc	Every 6 months for 5 years	USD600 (for all parameters/month)
Seawater quality	From baseline sampling locations	By collecting water samples and tested by an accredited laboratory for the following parameters: pH, Salinity, temperature, Turbidity, Nitrate, Nitrogen Ammonia, Sulphate and Phosphate	Every 6 months for 3 years	USD800 (for all parameters/month)
Reef benthos (Coral and other benthic cover)	Baseline survey locations	Random photo quadrate (1m*1m) method	Every 6 months for 3 years	USD400 (per survey)
Fish (diversity	Baseline survey	Census of fish diversity	Every 6 months for	USD400 (per

and abundance)	locations	and abundance through video transects (visible along a 360° radius)	3 years	survey)
Sedimentation	Baseline survey locations	Samples collected through sediment traps.	Every 3 months for one year and once every year thereafter for 5 years	600 USD (per survey)
Noise Levels	Nearby schools and residential areas	Using noise meters	Every 6 months for one year and once every year thereafter for 5 years	USD350/survey
Solid waste Generation	At airport boundary area	Inventory of waste	Every month for the first year and every 6 months thereafter for 5 years	USD250/month
Habitat Disturbance	Surrounding area of Kulhi and project boundary area	Visual Observation	Once every 3 months during first two years and every 6 months for 3 years	USD350/month

Compensatory tree plantation	Tree plantation locations	Survival rate of tree saplings	Once every 2 months for the first year and once every 6 months thereafter for 5 years	USD250/month
Flood drainage system	Pump stations and drainage system	Visual observation of water flow rate and checking drainage system and pumps established for removing excess water	During and after every storm event and every 6 month for 5 years	USD250/month
Socio-economic	Kulhudhuffushi island	Inventory of jobs created locally and migration of people, economic and social development of the island	Once every 6 months for 5 years.	USD900

9.3 Monitoring responsibility and report

Environmental monitoring reports shall be submitted every six months to EPA for the duration of construction phase and a detailed monitoring report shall be compiled after the completion of the construction period based on the data collected during the construction phase (weekly, monthly, quarterly, six-monthly and yearly) for the parameters included in the monitoring programme. Furthermore, on yearly basis environmental monitoring report during operation

phase shall be submitted to EPA based on parameters monitored (specified in the proposed monitoring program) during operation. For the monitoring report preparation, monitoring report structure outlined in the EIA Regulations 2012 (201 2/R-27) shall be followed.

10. Conclusion

For the proposed Airport Development Project at Kulhudhuffushi, this Environmental Impact Assessment was done based on the data collected from the field, secondary data from the literature and information gathered through discussions and knowledge gained through experience from similar projects. In this regard, previous Chapters of the report provided information on Rational of the project, method of data collection, project description, description of the existing environment, legislative and regulatory requirement relevant to the project, impacts associated with the project, mitigation measures for minimizing impacts, alternative considerations, stakeholder consultation and environmental monitoring.

The most significant environmental impact associated with the project is the reclamation of part of Kulhi area. Kulhi area is a designated “environmental sensitive area” due to the environmental features of the area. Due to the project activities, Kulhi water will be reduced to half and surrounding vegetation will be lost permanently. This is an irreversible environmental damage. To compensate for this environmental damage to the “environmental sensitive area” of Kulhudhuffushi, it has been proposed to create a similar environment in another location as per the current EIA regulation or undertake efforts to conserve a wetland area in the same region as the project site. The location is to be chosen together with the Ministry of Environment and Energy. Reclamation of the Kulhi area will increase the chance of flooding in the island, especially in the surrounding area. In order to minimize this impact, a proper drainage system should be implemented.

The second most significant impact associated with the project is reclamation of the sea area for constructing runway of the airport. From two ends of the runway is proposed to be reclaimed from sea area. This will cause permanent loss of marine environment around the proposed reclaimed area. During reclamation (construction phase), it is anticipated that the seawater quality will be impacted moderately and impacts on marine habitat are anticipated to be minor to moderate due to the low live coral coverage in both proposed sites.

To mitigate against other impacts on the environmental associated with the project, appropriate mitigation measures has been proposed and environmental monitoring program for both the construction and operational stages of the project has been formulated. The project proponent commits to undertake environmental mitigation measures and monitoring plans recommended in this EIA report and confirms to allocate adequate funds for their effective implementation.

With regards to the proposed location for the project, there are some among the Kulhudhuffushi island community that opposes the current proposed location for the airport development. They had proposed to develop the airport on the eastern side of the island by creating part of land required for the airport through reclamation of land from sea area and using existing land area on the eastern side. However, the developer had informed that any location change is not feasible at this stage.

By considering both construction and operational phase of the project, the positive impacts might not outweigh the negative impacts associated with the project, especially considering the irreversible damages to the wetland area. Development of an airport at Kulhudhuffushi may not be environmentally, socially and economically viable due to the nature of the project (location, reclamation, coastal protections, flood mitigation system and anticipated high cost for the project) and existence of an airport within reach by 20 minutes. However, this project fits overall government's policy of transport connectivity and tourism expansion policy of Maldives. Therefore, in the likely event the project proceeds, it is strongly recommended to undertake the following:

- Make arrangements to declare and manage a new protected area with similar environmental features under the guidance of the Ministry of Environment and Energy or EPA
- Design a drainage system for the island to control flood water and for the implementation of the drainage system Construction of a revetment or retaining wall structure on the sides facing the wetlands to ensure continuous sediment dispersal to the wetland does not occur
- Determine the houses to be relocated and compensate the home owners before commencing the project civil works.
- Construction of a sheet pile or semi breakwater or revetment structure as the bund before commencing reclamation works
- Change of the revetment structure to sheet piles or semi breakwater structure to ensure continuous erosion does not occur
- Undertake strict environmental monitoring to determine the magnitude of impacts
- Undertake EIA addendum to determine the environment and assess impacts once borrow area is finalized for deep sea dredging

Acknowledgement

As the lead environmental consultant this EIA, I would like to acknowledge and thank all who provided inputs for formulating this report. In this regard, I would like to thank survey team and extend my appreciation to the Kulhudhuffushi island council for providing socio-economic information and arranging consultation meetings.

EIA project team members CV is attached in Appendix 7.

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Appendices

Appendix 1: Project work schedule

KULHUDHUUFUSHI AIRPORT PROJECT

WORK SCHEDULE

Bill No:	Description	Unit	Qty	Month-1	Month-2	Month-3	Month-4	Month-5	Month-6	Month-7	Month-8	Month-9	Month-10	Month-11	Month-12	Month-13	Month-14	Month-15	Month-16	Month-17	9.00
1	***DESIGN & CONSULTANCY***																				
1.1	Preparattion, Submission & Approval																				
2	PRELIMINARIES	Sum																			
3	***DREDGING & RECLAMATION***																				
3.2	DREDGING & RECLAMATION (refer to specification)	Cbm	136,620																		
3.3	LAKE FILL AND COMPACTION	Cbm	240,790																		
3.4	FILL, SPREAD, GRADE AND COMPACTION	Cbm	19,600																		
3.5	SHORE PROTECTION - REVETMENT SYSTEM (refer to specification)	Lm	1,215																		
3.6	SHORE PROTECTION - BREAKWATER SYSTEM (refer to specification)	Lm	204																		
4	***AIRPORT CONSTRUCTION***																				
4.1	JUNGLE CLEARING	Sqm	139,000																		
4.2	SUB-BASE PREPARATION	Sqm	50,749																		
4.3	BASE COURSE	Sqm	50,749																		
4.4	HOT MIX ASPHALT LAYER																				
4.5	AIRFIELD LIGHTING AND LANDING AIDS	Sum																			
5	***FENCING, SHORE PROTECTION AND SERVICES***																				
5.1	SECURITY AND BOUNDARY FENCE	Lm	3,193																		
5.2	LIGHTNING PROTECTION SYSTEM	Sum																			
5.3	SUPPLY AD INSTALLATION OF OPERATIONAL EQUIPMENT	Sum																			
5.5	EXTERNAL WORKS SEWERAGE SYSTEM	Sum																			
5.6	EXTERNAL WORKS WATER SUPPLY	Sum																			
5.7	SUPPLY AND INSTALLATION OF POWER GENERATION & ELECTRICAL DISTRIBUTION SYSTEM	Sum																			
6	***SUPPORTING BUILDING FACILITIES***																				
7	***FINAL INSPECTION & HANDOVER***																				

Appendix 2: Concept and Borrow areas previously proposed for the reclamation (top) and new concept for the project is shown at the bottom.


THIS CONCEPT IS DEVELOPED FOR DISCUSSION USE
CONCEPT WILL BE FINALIZED BASED ON EIA DECISION STATEMENT
MWSC
Key Ashi
Kulhudhuffushi
Bank Of Maldives ATM
Coffee Hour
Kulhudhuffushi
RUNWAY LENGTH - 1220 M
RUNWAY WIDTH - 30 M
TAXIWAY LENGTH - 45 M
TAXIWAY WIDTH - 15 M
APRON LENGTH - 130 M
APRON WIDTH -45 M
RECLAMATION AREA (6.21 HEC)
AIRPORT BOUNDARY REQUIRED FROM VILLAGE
SWAMP AREA (8.95 HEC)
LAND AREA (15.09 HEC)
AIRPORT CONCEPT LAYOUT - CPT/01/17
KULHUDHUFFUSHI H.DH. ATOLL
0 50 100 200m

RUNWAY LENGTH - 1220 M	RECLAMATION AREA (6.21 HEC)
RUNWAY WIDTH - 30 M	AIRPORT BOUNDARY REQUIRED FROM VILLAGE
TAXIWAY LENGTH - 45 M	SWAMP AREA (8.95 HEC)
TAXIWAY WIDTH - 15 M	LAND AREA (15.09 HEC)
APRON LENGTH - 130 M	
APRON WIDTH -45 M	

AIRPORT CONCEPT LAYOUT - CPT/01/17
KULHUDHUFFUSHI H.DH. ATOLL

0 50 100 200m

PROJECT: KULHUDHUFFUSHI AIRPORT

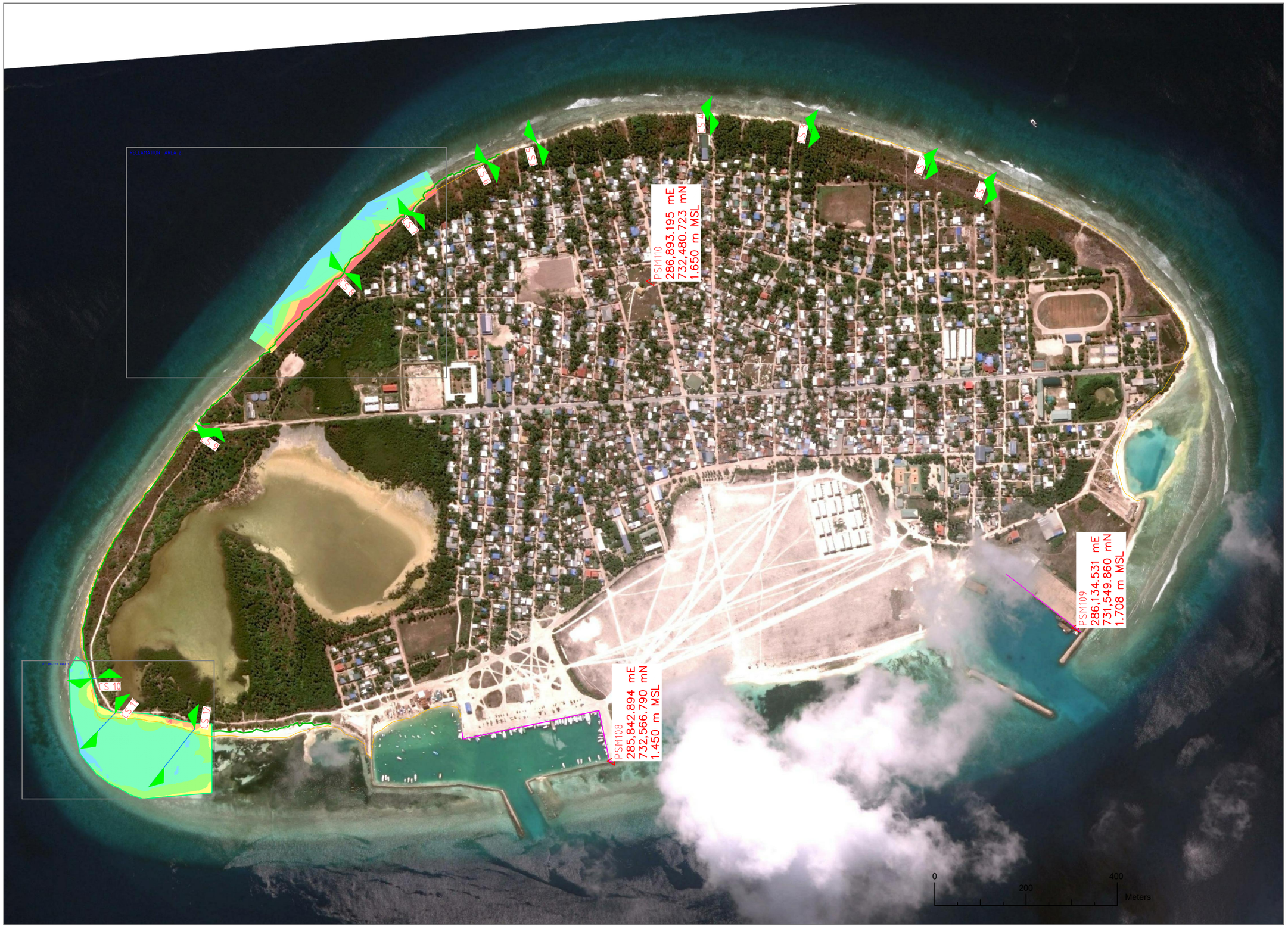
TITLE: AIRPORT CONCEPT LAYOUT

DRAWN BY:	MAHREEN
DESIGN BY:	MAHREEN
DRAWING NO:	CPT/01/2017
SCALE:	SCALE: -
DATE:	JUNE- 2017
CHECKED BY:	MAHREEN

REGIONAL AIRPORTS
MIN. OF TOURISM
MALE'
REP. OF MALDIVES
TEL: 323806, FAX: 320911
Email: regional@airports.gov.mv

Appendix 3: Bathymetry survey

HDH. KULDHUFUSHI PROPOSED AIRPORT EIA SURVEY



AHMED NASHID
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HIGUN, MALE'20306, MALDIVES.
CELL: +960779099
EMAIL: MR.NASHID@GMAIL.COM

LEGEND

- PSM
- BEACH LINE
- VEGTATION LINE
- QUAY WALL LINE
- GRID LINE
- PROFILE VIEW LINES

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- THIS MAP IS INTENDED FOR EIA PURPOSES ONLY AND DATA SHOULD NOT BE USED FOR NAVIGATIONAL OR ENGINEERING PURPOSES.

REVISIONS

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PROJECT TITLE
HDH. KULDHUFUSHI AIRPORT DEVALOPMENT

CLIENT
GRYPHON ENERGY

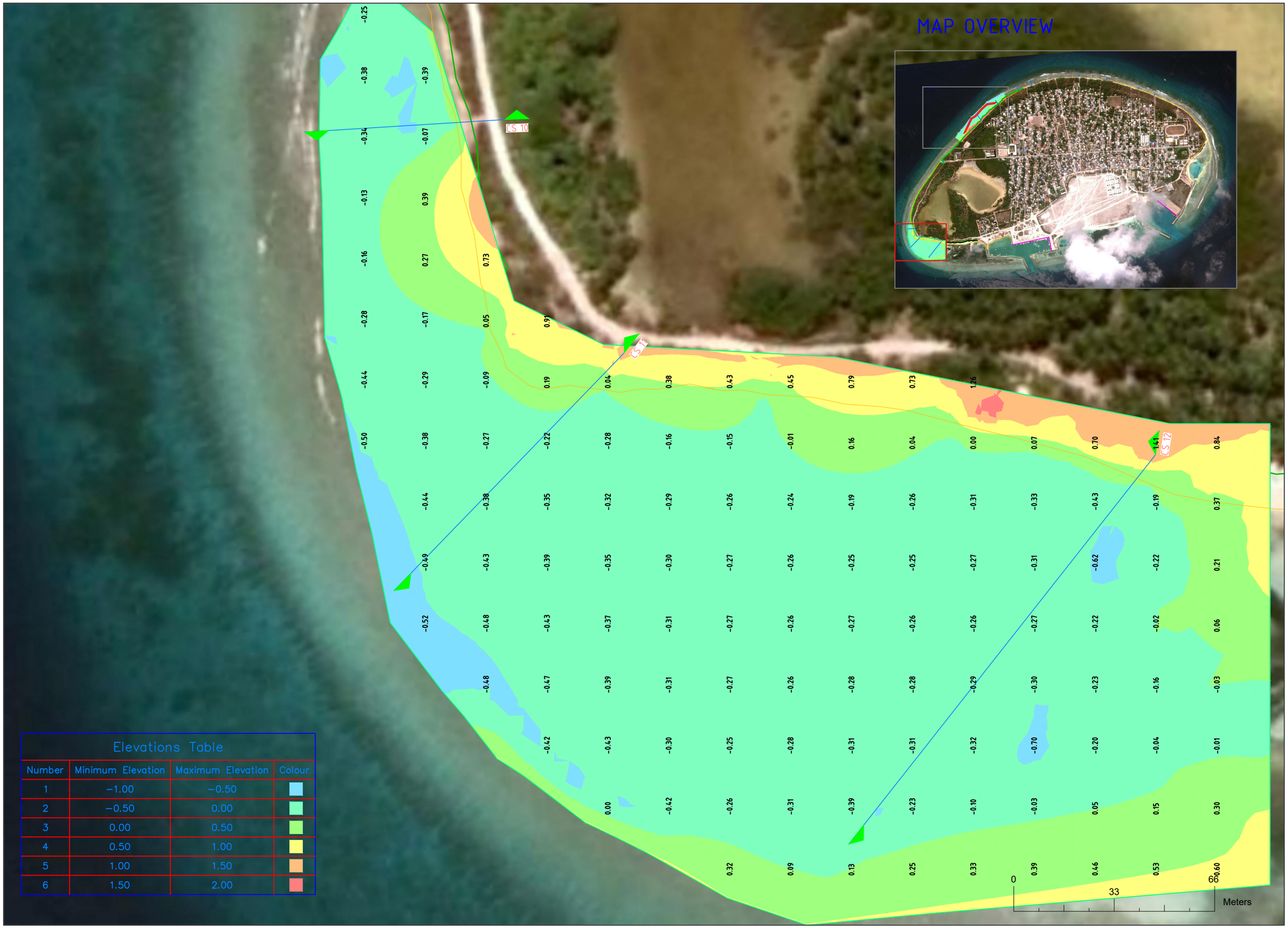
DRAWING TITLE
HADH KULHUDHUFUSHI PROPOSED AIRPORT EIA SURVEY

SHEET TITLE
INDEX MAP

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	19-21/04/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	24/04/2017
SCALE	1 : 8000
PAPER	A3

DRAWING NUMBER
AN/2017/114/01.1

HDH. KULDHUFUSHI PROPOSED AIRPORT EIA SURVEY



Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Colour
1	−1.00	−0.50	
2	−0.50	0.00	
3	0.00	0.50	
4	0.50	1.00	
5	1.00	1.50	
6	1.50	2.00	

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
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LEGEND

- PSM
- BEACH LINE
- VEGTATION LINE
- QUAY WALL LINE
- GRID LINE
- PROFILE VIEW LINES

NOTE

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REVISIONS

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PROJECT TITLE
HDH. KULDHUFUSHI AIRPORT DEVALOPMENT

CLIENT
GRYPHON ENERGY

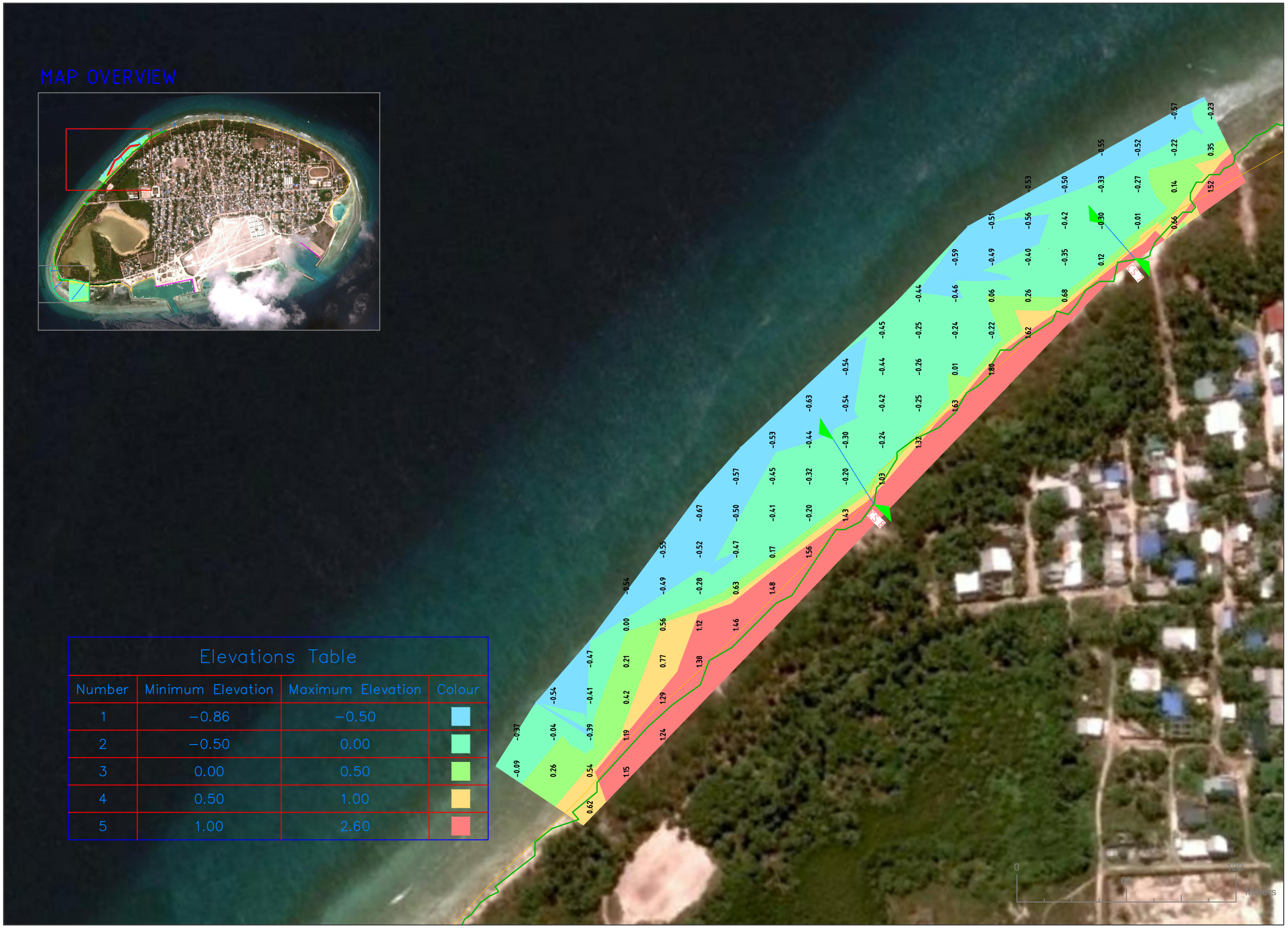
DRAWING TITLE
HADH KULHUDHUFUSHI PROPOSED AIRPORT EIA SURVEY

SHEET TITLE
RECLAMATION AREA 1

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	19-21/04/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	24/04/2017
SCALE	1 : 1200
PAPER	A3

DRAWING NUMBER
AN/2017/114/01.2

HDH. KULDHUFUSHI PROPOSED AIRPORT EIA SURVEY



Elevations Table

Number	Minimum Elevation	Maximum Elevation	Colour
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2	−0.50	0.00	
3	0.00	0.50	
4	0.50	1.00	
5	1.00	2.60	

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LEGEND

- PSM
- BEACH LINE
- VEGTATION LINE
- QUAY WALL LINE
- GRID LINE
- PROFILE VIEW LINES

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- THIS MAP IS INTENDED FOR EIA PURPOSES ONLY AND DATA SHOULD NOT BE USED FOR NAVIGATIONAL OR ENGINEERING PURPOSES.

REVISIONS

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PROJECT TITLE
HADH KULHUDHUFUSHI AIRPORT DEVALOPMENT

CLIENT
GRYPHON ENERGY

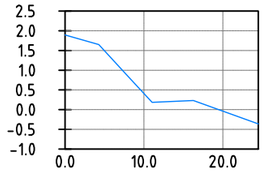
DRAWING TITLE
HADH KULHUDHUFUSHI PROPOSED AIRPORT EIA SURVEY

SHEET TITLE
RECLAMATION AREA 2

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	19-21/04/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	24/04/2017
SCALE	1 : 2000
PAPER	A3

DRAWING NUMBER
AN/2017/114/01.3

HDH. KULDHUFUSHI PROPOSED AIRPORT EIA SURVEY



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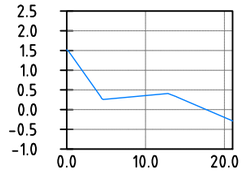

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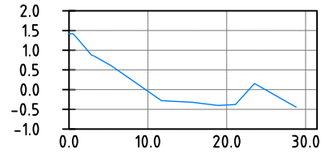

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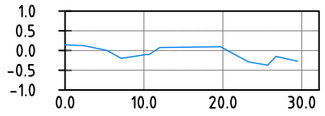

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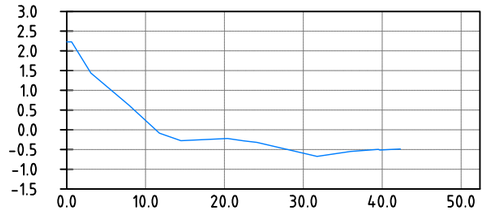

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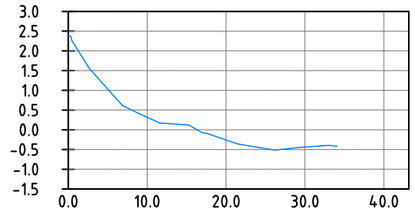

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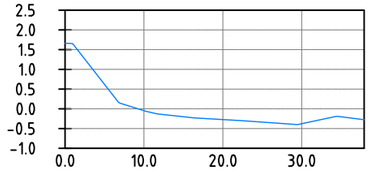

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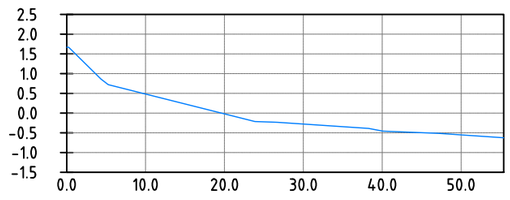

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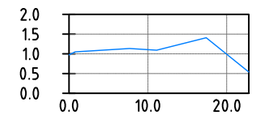

CS 9

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LEGEND

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- THIS MAP SHOULD NOT BE USED FOR ENGINEERING AND NAVIGATION PURPOSES AS IT CONTAINS DATA FOR EIA PURPOSES ONLY.

REVISIONS

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PROJECT TITLE
HDH. KULDHUFUSHI AIRPORT DEVALOPMENT

CLIENT
GRYPHON ENERGY

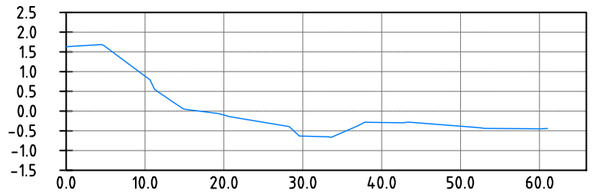
DRAWING TITLE
HADH KULHUDHUFUSHI PROPOSED AIRPORT EIA SURVEY

SHEET TITLE
PROFILES CS1 - CS9

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	19-21/04/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	24/04/2017
SCALE	
PAPER	A3

DRAWING NUMBER
AN/2017/114/01.4

HDH. KULDHUFUSHI PROPOSED AIRPORT EIA SURVEY



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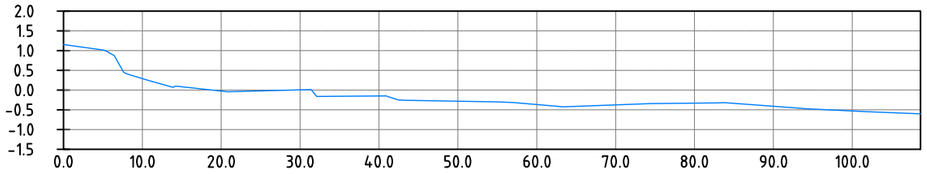

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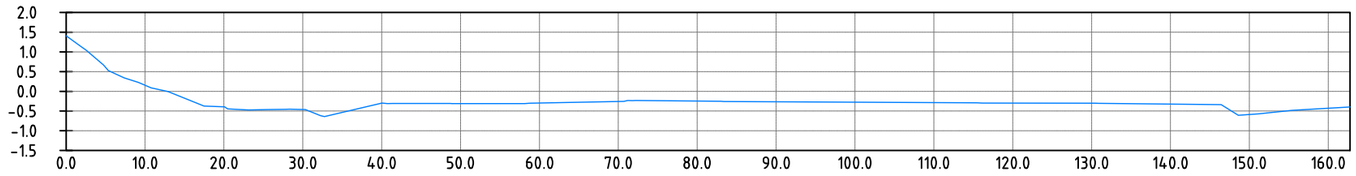

CS 12

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LEGEND

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
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REVISIONS

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PROJECT TITLE
HADH KULHUDHUFUSHI AIRPORT DEVALOPMENT

CLIENT
GRYPHON ENERGY

DRAWING TITLE
HADH KULHUDHUFUSHI PROPOSED AIRPORT EIA SURVEY

SHEET TITLE
PROFILES CS10 - CS12

SURVEYOR AHMED NASHID HUSSAIN NEESHAM	S/L # BP02006
SURVEYED DATE	19-21/04/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	24/04/2017
SCALE	
PAPER	A3

DRAWING NUMBER
AN/2017/114/01.5

HDH. KULDHUFUSHI PROPOSED AIRPORT EIA SURVEY

AHMED NASHID
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LEGEND

- PSM
- BEACH LINE
- VEGTATION LINE
- QUAY WALL LINE
- GRID LINE
- PROFILE VIEW LINES
- SPOT HEIGHTS

NOTE

- UNITS IN METERS
- WGS84 UTM ZONE 43 COORDINATE SYSTEM
- THIS MAP IS INTENDED FOR EIA PURPOSES ONLY AND DATA SHOULD NOT BE USED FOR NAVIGATIONAL OR ENGINEERING PURPOSES.

REVISIONS

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-	-

PROJECT TITLE
HADH KULHUDHUFUSHI AIRPORT DEVALOPMENT

CLIENT
GRYPHON ENERGY

DRAWING TITLE
HADH KULHUDHUFUSHI PROPOSED AIRPORT EIA SURVEY

SHEET TITLE
KULHI AREA SPOT HEIGHTS

SURVEYOR	S/L #
AHMED NASHID	BP02006
HUSSAIN NEESHAM	
SURVEYED DATE	19-21/04/2017
DRAWN BY	NASHID,SAEED
DRAWN DATE	18/10/2017
SCALE	1 : 2000
PAPER	A3

DRAWING NUMBER
AN/2017/114/02

Appendix 4: Water samples test results

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
FEN Building,5th Floor, Machangoalhi, Ameenee Magu, Male', Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

WATER QUALITY TEST REPORT
Report No: 500173694

Customer Information:
DR. Zahid
Elhagedharu

S.Hulhudhoo -

Report date: **10/05/2017**
Test Requisition Form No: **900175539**
Sample(s) Recieved Date: **04/05/2017**
Date of Analysis: **04/05/2017 - 05/05/2017**

Sample Description	Ground 1	Ground 2	Ground 3	TEST METHOD	UNIT
Sample Type	Ground Water	Ground Water	Ground Water		
Sample No	83186402	83186403	83186404		
Sampled Date	03/05/2017	03/05/2017	03/05/2017		
PARAMETER	ANALYSIS RESULT				
Physical Appearance	Pale yellow with particles	Pale yellow with particles	Pale yellow with particles		
Conductivity	40700	2500	2090	Method 2510 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	µS/cm
pH	8.33	7.21	7.38	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Salinity	25.91	1.29	1.07	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	‰
Temperature	21.1	21.2	21.3	Electrometry	°C
Nitrite	0.005	<0.002 (LoQ 0.002 mg/L)	5.18	Method 8507 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Sulphide	<5 (LoQ 5 µg/L)	<5 (LoQ 5 µg/L)	5	Method 8131 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	µg/L
Phosphate	0.10	0.16	0.60	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L

Keys: µS/cm : Micro Seimen per Centimeter, **‰** : Parts Per Thousand, **°C** : Degree Celcius, **mg/L** : Milligram Per Liter, **µg/L** : Microgram Per Liter

Checked by
Afnan Farooq
Laboratory Executive Gr.1

Approved by
Mohamed Eyman
Assistant Manager, Quality

Notes: Sampling Authority: Sampling was not done by MWSC Laboratory
This report shall not be reproduced except in full, without written approval of MWSC
This test report is ONLY FOR THE SAMPLES TESTED.
~ Information provided by the customer

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
FEN Building,5th Floor, Machangoalhi, Ameenee Magu, Male', Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

WATER QUALITY TEST REPORT
Report No: 500173694

Customer Information:
DR. Zahid
Elhagedharu

S.Hulhudhoo -

Report date: **10/05/2017**
Test Requisition Form No: **900175539**
Sample(s) Recieved Date: **04/05/2017**
Date of Analysis: **04/05/2017 - 05/05/2017**

Sample Description	Ground 4	Ground 5	TEST METHOD	UNIT
Sample Type	Ground Water	Ground Water		
Sample No	83186405	83186406		
Sampled Date	03/05/2017	03/05/2017		
PARAMETER	ANALYSIS RESULT			
Physical Appearance	Yellow with particles	Pale yellow with particles		
Conductivity	1343	1368	Method 2510 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	µS/cm
pH	7.20	7.35	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Salinity	0.67	0.68	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	‰
Temperature	21.4	21.4	Electrometry	°C
Nitrite	0.006	6.11	Method 8507 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Sulphide	12	<5 (LoQ 5 µg/L)	Method 8131 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	µg/L
Phosphate	0.36	0.34	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L

Keys: µS/cm : Micro Seimen per Centimeter, **‰** : Parts Per Thousand, **°C** : Degree Celcius, **mg/L** : Milligram Per Liter, **µg/L** : Microgram Per Liter

Checked by
Afnan Farooq
Laboratory Executive Gr.1

Approved by
Mohamed Eyman
Assistant Manager, Quality

Notes: Sampling Authority: Sampling was not done by MWSC Laboratory
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This test report is ONLY FOR THE SAMPLES TESTED.
~ Information provided by the customer

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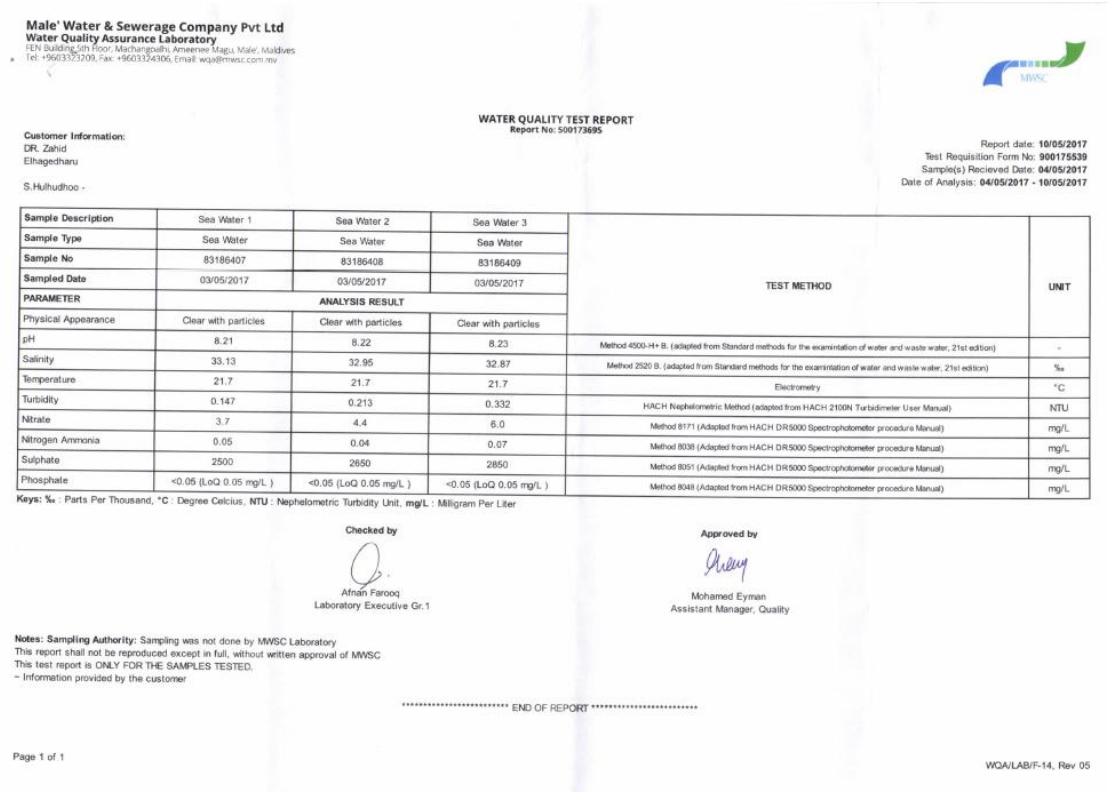

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
FEN Building,5th Floor, Machangolhi, Ameenee Magu, Male', Maldives
Tel: +9603373200, Fax: +9603324306, Email: wqa@mwsc.com.mv

MWSC

WATER QUALITY TEST REPORT
Report No: 500173695

Customer Information:
DR. Zahid
Elhagedharu

S.Hulhudhoo -

Report date: **10/05/2017**
Test Requisition Form No: **900175539**
Sample(s) Recieved Date: **04/05/2017**
Date of Analysis: **04/05/2017 - 10/05/2017**

Sample Description	Sea Water 1	Sea Water 2	Sea Water 3	TEST METHOD	UNIT
Sample Type	Sea Water	Sea Water	Sea Water		
Sample No	83186407	83186408	83186409		
Sampled Date	03/05/2017	03/05/2017	03/05/2017		
PARAMETER	**ANALYSIS RESULT**				
Physical Appearance	Clear with particles	Clear with particles	Clear with particles		
pH	8.21	8.22	8.23	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Salinity	33.13	32.95	32.87	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	‰
Temperature	21.7	21.7	21.7	Electrometry	°C
Turbidity	0.147	0.213	0.332	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU
Nitrate	3.7	4.4	6.0	Method 8171 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Nitrogen Ammonia	0.05	0.04	0.07	Method 8038 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Sulphate	2500	2650	2850	Method 8051 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Phosphate	<0.05 (LoQ 0.05 mg/L)	<0.05 (LoQ 0.05 mg/L)	<0.05 (LoQ 0.05 mg/L)	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L

Keys: ‰ : Parts Per Thousand, **°C** : Degree Celcius, **NTU** : Nephelometric Turbidity Unit, **mg/L** : Milligram Per Liter

Checked by
Afnan Farooq
Laboratory Executive Gr.1

Approved by
Mohamed Eyman
Assistant Manager, Quality

Notes: Sampling Authority: Sampling was not done by MWSC Laboratory
This report shall not be reproduced except in full, without written approval of MWSC
This test report is ONLY FOR THE SAMPLES TESTED.
~ Information provided by the customer

********** END OF REPORT **********

Page 1 of 1

WQA/LAB/F-14, Rev 05

Appendix 5: Approved ToR for the project

No: 203-EIARES/448/2017/14

Extended Terms of Reference for Environmental Impact Assessment for the Proposed Airport Development Project at Hdh. Kulhudhuhffushi

The following is the Extended Terms of Reference (ToR) following the scoping meeting held on *11th April 2017* for undertaking the EIA of the proposed Airport development at *Kulhudhuhffushi, Hdh Atoll. The proponent of the project is Regional Airports.*

While every attempt has been made to ensure that this TOR addresses all of the major issues associated with development proposal, they are not necessarily exhaustive. They should not be interpreted as excluding from consideration matters deemed to be significant but not incorporated in them, or matters currently unforeseen, that emerge as important or significant from environmental studies, or otherwise, during the course of preparation of the EIA report.

1. **Introduction and rationale** – Describe the purpose of the project and, if applicable, the background information of the project/activity and the tasks already completed. Objectives of the development activities should be specific and if possible quantified. Define the arrangements required for the environmental assessment including how work carried out under this contract is link other activities that are carried out or that is being carried out within the project boundary. Identify the donors and the institutions arrangements relevant to this project. List down the methodologies to be used for this study.

2. **Study area** – Submit a minimum A3 size scaled plan with indications of all the proposed infrastructures. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size. The study area should include adjacent or remote areas, such as relevant developments and nearby environmentally sensitive sites (e.g. coral reef, sea grass, mangroves, marine protected areas, special birds site, sensitive species nursery and feeding grounds). Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites.

3. **Scope of work** – Identify and number tasks of the project including preparation, construction and decommissioning phases.
   Task 1. Description of the proposed project – Provide a full description and justification of the relevant part of the works, using maps at appropriate scales where necessary. Information on the following activities should be provided where appropriate:

   - Details on mobilisation and temporary site setup
   - Scope of island expansion
   - Dredging and reclamation procedures including information on possible borrow areas
   - Scope of land clearance works
   - Details of required Access roads
   - Vegetation removal and management

9-1-1-1.

- Measures to protect environmental values during construction and once the new area has been established;
- Labour requirement and availability
- Land profiling and coastal protection
- Waste management during and after construction and during operational phase
- Safety measures at construction site
- Fire safety and prevention during operations
- Construction of utilities facilities
- Sewage and waste water disposal management during construction and operational phase
- Water production and distribution during construction and operational phase (including details of RO plants, intake location and methodology, brine outfall location)
- Energy production and distribution during construction and operational phase
- Road development
- Building construction
- Airport operations and management

Fuel Management

- Volume required
- Rate of waste lube oil generation its collection, storage and disposal;
- Fuel storage tank details (size, location);
- Fuel transport and Pipeline drawings and specifications especially leakage proofing;
- Measures of fuel containment
- Method of fuel transport from harbour to storage
- Fuel handling and management plan during operations
- Mitigations in case of fuel spillage

Project management (include scheduling and duration of the project (component wise scheduling) and life span of facilities; communication of construction details, progress, target dates, labour requirement, local labour availability, housing of temporary labour, construction/operation/closure of labour camps. Emergency plan in case of spills (diesel, grease, oil) access to site, safety, equipment and material storage, fuel management and emergency plan in case of spills)

Task 2. Descriptions of the environment – Assemble, evaluate and present the environmental baseline study/data regarding the study area and timing of the study (e.g. monsoon season). Identify baseline data gaps and identify studies and the level of detail to be carried out by consultant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a way that they will be usefully applied to future monitoring. The report should outline detailed methodology of data collection utilized.

The baseline data will be collected before construction and from at least two benchmarks. All sampling/survey locations shall be geo referenced including but not limited to water sampling points, reef transects/photo quadrats, vegetation transects, soil profiles, and manta tows sites for monitoring data comparison. Information may be divided into the categories shown below:

Part a)

Climate

- Temperature, rainfall, wind, waves,
- Natural Hazard Risks including storm surges;

Geology and geomorphology

- Island geomorphology including presence of beach rocks and any special characteristics (use maps);
- Bathymetry of the required sites (use maps) including harbour area and coastal modification areas (borrow area/reclamation area);
- (Seasonal) patterns of coastal erosion and accretion (see appendix for monitoring details), and
- Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts during construction;
- Ground water quality from 5 locations of the island measuring temperature, pH, salinity, electronic conductivity, nitrite, sulphides, phosphates, hydrocarbons.

Hydrography/hydrodynamics (use maps)

- Tidal ranges and tidal currents;
- Wave climate and wave induced currents;
- Wind induced (seasonal) currents;
- Sea water quality measuring these parameters: temperature, pH, salinity, turbidity, phosphate, nitrate, ammonia, sulphate.

Ecology

- Identify marine protected areas (MPAs) and sensitive sites such as breeding or nursery grounds for protected or endangered species (e.g. coral reefs, spawning fish sites, nurseries for crustaceans or specific sites for marine mammals, sharks and turtles). Include description of commercial species, species with potential to become nuisances or vector.
- Detailed study of the environmentally sensitive area on the island including flora and fauna in this area, endangered species, their habitats and breeding grounds.
- Benthic and fish community monitoring around harbor, reclamation and borrow areas.
- Vegetation survey of potential impact areas including existing condition of the area and details of vegetation to be removed.
- Fate of vegetation removed and method of ground leveling and source of sand for ground leveling.
- Landscape integrity, and
- Include ground water monitoring

Socio-economic environment:

- Demography: total population, sex ratio, density, growth and pressure on land and marine resources;
- Income situation and distribution
- Economic activities of both men and women (e.g. fisheries, home gardening, fish processing, employment in industry, government);
- Seasonal changes in activities;
- Land use planning, natural resource use and zoning of activities at sea;
- Accessibility and (public) transport to other island;
- Services quality and accessibility (water supply, waste/water disposal, energy supply, social services like health and education);
- Community needs;
- Sites with historical or cultural interest or sacred places (mosques, graveyard).
- Details of local community use of the project area and families depending on the project area for their livelihood
- Details of houses, families and any other infrastructures (including, but not limited to buildings, pipes, cables etc.) that may have to be relocated due to the project and arrangements for providing compensation for such infrastructures shall be clearly demonstrated.

Hazard vulnerability:

- Vulnerability of area to flooding and storm surge.
- Identify the existing flooding areas of the island

Part b) The following is an essential requirement for this EIA report and without the required information in this section, the EIA report will be deemed incomplete.

1. Provide a detail ecological study of the organisms and endangered species within the project impact footprint.
2. Estimate the volume of surface water and carry out and appropriate survey to determine its chemical and physical signature.
3. Survey and research of impacts on ground water lens due to project, and take all the necessary steps to avoid any adverse impact.
4. Forecast flooding which may arise due to the project and provide appropriate mitigation measures to reduce potential flooding impacts due to the proposed activities.
5. Commitment needs to be included in the EIA report and proponent shall provide a schedule to carry out the following activities:
   5.1 Endangered species must be relocated to another area (approved by relevant authorities) with similar environmental conditions. A Monitoring plan needs to be provided and approved by EPA to monitor the wellbeing of the species once they are relocated to the new area
   5.2 Make all the necessary arrangements to declare and manage a new protect area with similar environmental features, under the guidance of EPA.
   5.3 Propose an appropriate drainage system to control flood water and for the implementation of the drainage system

Absence of facilities in the country to carry out the water quality tests will not exempt the proponent from the obligation to provide necessary data. The report should outline the detailed methodology of data collection utilized to describe the existing environment.

Task 3. Legislative and regulatory considerations – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project.

Task 4. Potential impacts (environmental and socio-cultural) of proposed project, incl. all stages – The EIA report should identify all the impacts, direct and indirect, during and after construction, and evaluate the magnitude and significance of each. Particular attention shall be given to impacts associated with the following:

Impacts on the natural environment

- Impacts due to mobilization
- Changes in flow velocities/directions, resulting in changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology;
- Loss of marine bottom habitat, both in the borrow area as well as due to enlargement of the islands, resulting in loss of bottom life, which may impact fish stocks and species diversity and density of crabs, shellfish etc.;
- Sediment dispersal in water column (turbidity at the dredging site (overflow), the reclamation areas and related to shore protection activities), possibly resulting in changes in visibility, smothering of coral reefs and benthic communities and affecting fish and shellfish etc.;
- Impacts of noise, vibration and disturbance;
- Impacts on ground water table and quality (leaching of salts in the deposited sediments and change in ground water quantity);
- Impacts on unique or threatened habitats or species (coral reefs, sea turtles etc.), and
- Impacts on landscape integrity/scenery.
- Impacts due to generation of waste
- Loss of coastal vegetation if any
- Impact on island shore line due to hydrodynamic changers (coastal protection and reclamation)
- Flooding issues that may arise due to the proposed activities

Impacts on the socio-economic environment

- Benefits and impacts of the works in fishing and other industrial activities;
- Impacts of the airport development on resource users (adjacent businesses, nearby resorts and dive sites);
- Impacts on employment and income, potential for local people to have (temporary) job opportunities (and what kind) in the execution of the works;

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Male', Rep. of Maldives, 20392
Tel: [+960] 333 5949 [+960] 333 5951
Fax: [+960] 333 5953
Email: secretariat@epa.gov.mv
Website: www.epa.gov.mv

- Impacts of the reclamation works (diminished) access to groundwater and risks of covering up hazardous materials, and
- Level of protection against hazards like sea level rise, storm surges, etc.
- Employment and economic opportunities and diversification;
- Increased demands on natural resources and services (domestic water supply, waste water disposal, treatment systems, solid waste disposal systems, energy supply, etc.);
- Social destabilization of the island community, and
- Monitoring of socioeconomic and demographic development.

Construction related hazards and risks

- Pollution of the natural environment (e.g. oil spills, discharge of untreated waste water and solid waste, including construction waste);
- Risk of accidents and pollution on workers and local population, and
- Impacts on social values, norms and belief due to presence of workers of dredging company on local population.

The methods used to identify the significance of the impacts shall be outlined. One or more of the following methods must be utilized in determining impacts; checklists, matrices, overlays, networks, expert systems and professional judgment. Justification must be provided to the selected methodologies. The report should outline the uncertainties in impact prediction and also outline all positive and negative/short and long-term impacts. Identify impacts that are cumulative and unavoidable.

Task 5. Alternatives to proposed project – Describe alternatives including the *"no action option"* should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the "no action alternative". This should include alternative location of STP and outfall pipe, water intake, sand borrow areas, technologies, materials, designs, timing, etc. environmental, social and economic factors should be taken into consideration.

The report should highlight how the location was determined. Alternatives need to consider design and locations to minimize impacts on the bay area.

Alternative options for obtaining sand need to be investigated and feasible alternatives need to be provided

All alternatives must be compared according to international standards and commonly accepted standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

Task 6. Mitigation and management of negative impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These will include both environmental and socio-economic mitigation measures. Mitigation measures to avoid or compensate habitat destruction, e.g. temporal sediment control structures, coastal protection structures to reduce erosion, coral reconstruction, temporary docking jetty and MPA replacement areas. Measures for both construction and operation phase shall be identified. Cost the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. An Environmental management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

Task 7. Development of monitoring plan (see appendix)– Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for coastal modification, beach morphology, sediment movement around the island, waste management, etc. Ecological monitoring will be submitted to the EPA to evaluate the damages during construction, after project completion and every three months thereafter, up to one year and then on a yearly basis for five years after. The baseline study described in task 2 of section 2 of this document is required for data comparison. Detail of the monitoring program including the physical and biological parameters for monitoring, cost commitment from responsible person to conduct monitoring in the form of a commitment letter, detailed reporting scheduling, costs and methods of undertaking the monitoring program must be provided. Monitoring is required in:

- Coastal erosion around the island;
- Water quality assessments (ground water and surrounding seawater quality);
- Waste management
- Noise assessment
- Flooding
- Marine ecosystems monitoring (coral reef, seagrass and fish and invertebrates communities), and
- Socio-economic monitoring for project success or improvement requirements.

Task 8. Stakeholder consultation, Inter-Agency coordination and public/NGO participation) – The EIA report should include a list of people/groups consulted and summary of the major outcomes and concerns raised. The following parties should be consulted.

- Civil Aviation Authority,
- Atoll council
- Island council
- Water Department of Ministry of Environment and Energy,
- Waste Department of Ministry of Environment and Energy
- Environment Department of Ministry of Environment and Energy
- Energy Department of Ministry of Environment and Energy
- National Disaster Management Centre

- Health Protection Agency
- Ministry of Fisheries and Agriculture
- EPA (relevant sections)
- General Public
- Hanimaadhoo Airport
- Planning Department of Ministry of Housing and Infrastructure
- Engineering Department of Ministry of Housing and Infrastructure
- All utility providers of the island
- Municipal waste service provider
- Proponents of all on-going projects on the island
- Kulhudhuffushi Hospital

Stakeholder consultations must highlight the issues related to compensation for infrastructure that needs to be relocated and development constraints that arise due to the proposed airport.

Presentation- The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations f or any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2012

Timeframe for submitting the EIA report – The developer must submit the completed EIA report before 20th April 2018.

20th April 2017

Appendix 6: Attendance list

بسم الله الرحمن الرحيم

Secretariat of the Atoll Council,
South Thiladhunmathi
Hdh. Kulhudhuffushi, Rep. of Maldives

ހިތަދުމަތީ ދެކުނުމަތީ ހާދަގު ކައުންސިލްގެ ލިޔަމަށް
ހ.ތުލްހުދުހުއްޝީ، ދިވެހިރާއްޖެ

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(ބުދަ ދުވަސް) 22 ނޮވެމްބަރ 2017

13:00

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2	[illegible]	7788847	
3	[illegible]	7521915	
4	[illegible]	9908558	
5	[illegible]	7797147	
6	[illegible]	7910870	
7	[illegible]	7904887	
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Preparatory Survey for Kulhudhufushi Airport Development Project

Stakeholder Consultation (Attendance List):

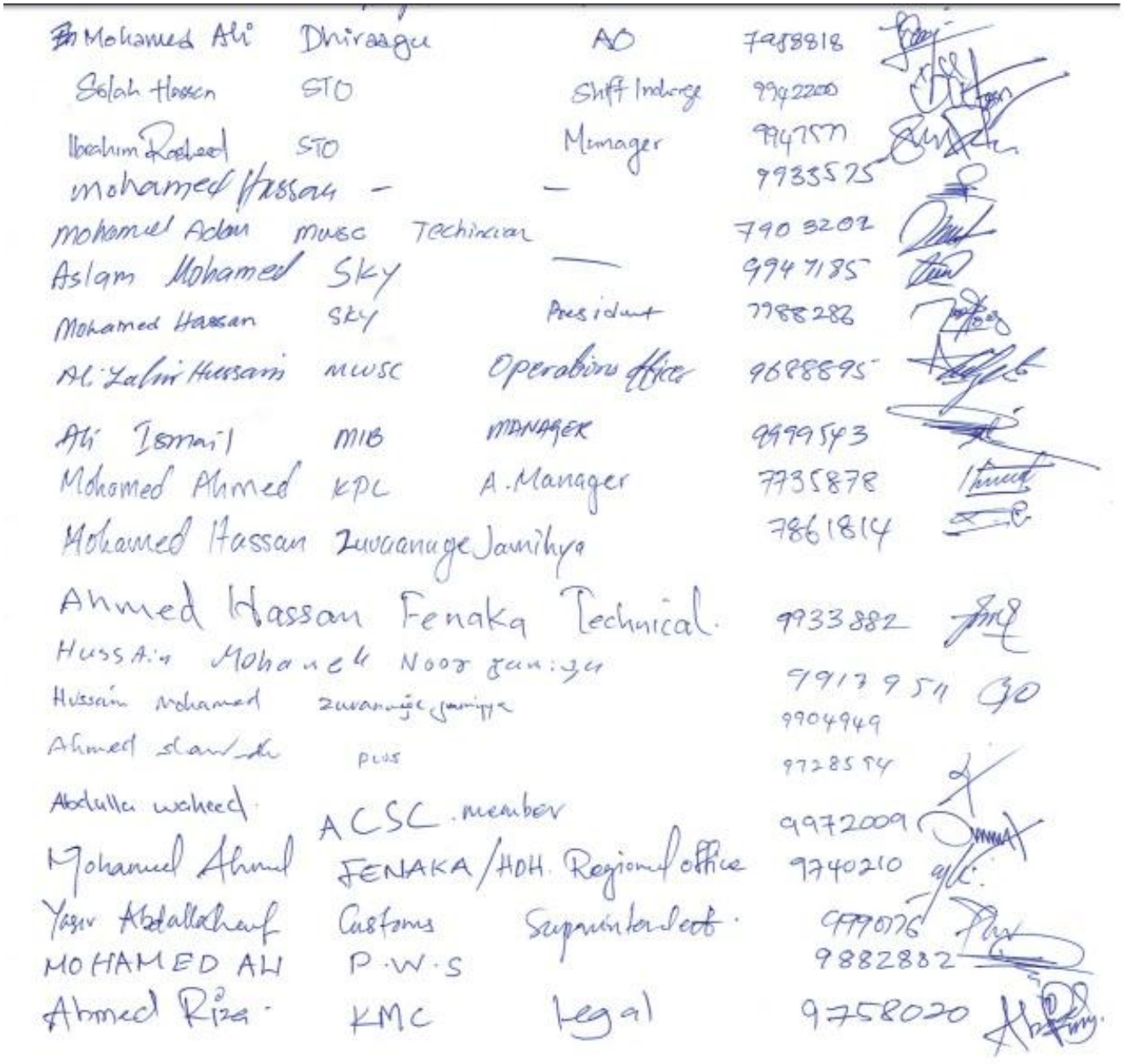
Island Name: **Date:** **Time:**

Name	Organization	Designation	Contact no	Signature or E-mail
Aminath Shazaa Rasheedh	A.C.S.C	member	9690957	
Abdulla Adam	Jalaluddin School	LT	7973505	
Aminath Mohamed	Jalaluddin School	Deputy principal	9877664	
Shaziyya Mohamed	MNU. Kulhudhuffushi campus.	Senior Academic Officer	7606167	
Ibrahim Mohamed	MNU. Kulhudhuffushi Campus	Campus manager	9933996	
M. Hassan	MRDC KF site		9982241	
Mohamed Qasim	Kulhudhuffushi Council		7740225	
Shamseera Zakariyya	Afeefuddin School	School Administrator	7863880	
Nasiha Idrees	Afeefuddin School	Principal	7791960	
Aishath A. Raheem	Bank of Maldives	Manager	9992482	A. Raheem
Nizar Moosa	Dhivehi Masakai Theringe Jamiyya	Founder	7997330	
Mohamed Afrah	PGO	Prosecutor	9998697	
A. Rameez	PGO	AD	7932449	
Asima Ahmed	Hdh. FCSC	SSO	9958966	
Aminath Adam	H.dh. FCSC	A.SSO	9820819	
Aishath Sahuna	Rehendhi. NGO		7977759	
Mohamed Hassan	KRH	ZV	7951916	
Ibrahim Nafiu	KRH		795	
Ibrahim Nafiu	KRH	MNGR	7795038	
[illegible]	[illegible]	[illegible]	[illegible]	
AHMED ABDULLA	MRC HDH	EXECUTIVE	7938817	
SAEED A. BAKURU	OOREDOO		9624929	
ABDUL MUHAIMIN	OOREDOO	regional Sales manager	9708999	
Adam Mohamed		R. manager	9964681	

Stakeholder Consultation (Attendance List):

Island Name: **Date:** **Time:**

Name	Organization	Designation	Contact no	Signature or E-mail
FATHIMATH REEMA	EPA	DIRECTOR	3335949	
Yoosuf Ahmed	EPA	Director	7905373	
HAWWA NAMSA	EPA	Asst project officer	9162638	
ALI NISHAN	EPA	Asst. Environment officer	9192936	
ALI MISHAL	EPA	ENGINEER	7766699	
Ismail Ziaan	Dhiraagu	Manager	7787274	
Ibrahim Anwar	Dhiraagu	Engineer	7783978	
Abdulla Nashith	Fenaka.	Director	9993667	
Zuhurullah Siyad	MHI – Planning	DG	7781725	
Hussain Rasheed	MHI - Planning	Director	9962899	planning@housing.gov.mv
Nafha Aijaz	MHI – Infrastructure	Environment Analyst	7721554	mu@housing.gov.mv
Ibrahim Shihan	MHI - Infrastructure	A. Engineer	7850909	infrastructure@housing.gov.mv
Mohamed Azim	MHI-Housing	DG	7914997	
Shafarath Ibrahim	Waste Management and Pollution control, MEE	Civil Engg.	7548715	
Abdul Rasheed	MEE, ED	A. Engineer	9845460	
Aishath Rashfa	MEE, Waste MPC dept	Asst. Director	7787783	
Ahmed Raoof Mohamed	MEE, ED	A. Statistical Officer	9718393	
Abdulla Ziyad	MEE, SM		7781502	
Liusha Mohamed	MEE	Environment Analyst	9902408	



Mohamed Ali	Dhiraagu	AO	7988818	
Solah Hassen	STO	Shift Incharge	9942200	
Ibrahim Rasheed	STO	Manager	9947577	
Mohamed Hassan	—	—	9933525	
Mohamed Adam	MWSC	Technician	7903202	
Aslam Mohamed	Sky	—	9947185	
Mohamed Hassan	Sky	President	7788282	
Ali Zahir Hussain	MWSC	Operations Officer	9688895	
Ali Ismail	MIB	MANAGER	9999543	
Mohamed Ahmed	KPL	A. Manager	7735878	
Mohamed Hassan	Zuvaanuge Jamihya		7861814	
Ahmed Hassan Fenaka	Technical.		9933882	
Hussain Mohamed	Noor Jamiyya		9917951	
Hussain Mohamed	Zuvaanuge Jamiyya		9904949	
Ahmed Shareef	PWS		9728554	
Abdulla waheed.	ACSC. member		9972009	
Mohamed Ahmed	FENAKA/HDH. Regional office		9740210	
Yasir Abdulla Hanif	Customs	Superintendent.	9779076	
MOHAMED ALI	P.W.S		9882882	
Ahmed Riza.	KMC	Legal	9758020	

~~Preparatory Survey on the Digital Terrestrial Television Broadcasting Network Development Project in the Republic of Maldives~~ Stakeholder

~~Public~~ Consultation (Attendance List):

Island Name: Date: Time:

Name	Address	Contact no	Signature
Hassan Shahid	Hanimaadhoo Int Airport	9919949	
Ali Waheed	〃	9995520	
Ibrahim Shakir	〃	9978712	

Stakeholder Consultation (Attendance List):

Island Name: **Date:** **Time:**

Name	Organization	Designation	Contact no	Signature or E-mail
Aminath Shazra Rasheedh	ACSC		9690957	
Abdulla Adam	Jalaluddin School	LT	7973505	
Aminath Mohamed	Jalaluddin School	Deputy Principal	9877664	
Shazigya Mohamed	MNU. Kulhudhuffushi campus	Senior Admin officer	7606167	
Ibrahim Mohamed	MNU Kulhudhuffushi Campus	Campus manager	9933996	
Mohamed Hassan			9982211	
MOHAMED GASH	KULHUDHUFFUSHI COUNCIL		7640725	
Shamseera Zakariyya	Afeefuddin School	School Administrator	7863880	
Nasiha Idrees	Afeefuddin School	Principal	7791960	
Aishath Abdul Raheem	Bank of Maldives	Manager	9992482	
Nizar Moosa	Dhivehi Masakai Theringe Jamiyya	Founder	7997330	
Mohamed Afrah	PGO	Director	9998697	
Ali Rameez	PGO	AD	9932449	
Asima Ahmed	H.dh. FCSC	Social Service officer	9958966	
Aminath Adam	H.dh. FCSC	E.S.S. worker	9820819	
Aishath Suhuma	Rehendhi NGO		7977757	
Mohamed Hassan	KRH (ZV)	ZV	7951916	
Ibrahim Nuhad	KRH	MNGR	7795038	
MOHAMED HASSAN	DHIRAAGU	MKTG	7878007	
AHMED ABDULLA	MRC IHDH	EXECUTIVE	7938817	
SAEED A-BAKURU	OOREDOO	S. Supervisor	962492	
Abdul Muhaimin	OOREDOO	Regional Sales manager	9708994	
ADAM MOHAMED FENAKA		R. Manager	9967481	
Ibrahim Zakariyya	Kulhudhuffushi Magistrate Court	IT Technician	7944014	
Mohamed Ali	DHIRAAGU	AO	7958818	

Solal Hassan	STO	Shift Incharge	9942200
Ibrahim Rasheed	STO	Manager	9947577
Mohamed Hassan.	—	—	9933575
Mohamed Adam	MWSC	Technician	7903202
Aslam Mohamed	SKY	—	9947185
MOHAMED HASSAN	SKY	President	7788286
Ali Zahir Hussain	MWSC	Operations officer	9688895
Ali Ismail	Maldives Islamic Bank.	Manager	9999543
Mohamed Ahmed	KPL	A. Manager	7735878
Mohamed Hassan	Zuvaanunge Jamihiya		7861814
Ahmed Hassan	Fenaka Technical		9933882
HUSSAINMOHAMED	Noor Kumiya		9913954
Hussain mohamed	Zuvaanunge Jamiyya		9904949
Ahmed shamsuddin	PWS		9728594
Abdulla waheed.	ACSC member		9972009
Mohamed Ahmed	Fenaka/HDH.	Regional office	9740210
Yasir Abdulladheef	Customs	Superintendent	9990776
MOHAMED ALI	P.W.S.		9882882
Ahmed Riza.	KMC	Legal	9758020

Preparatory Survey for Kulhudhufushi Airport Development Project

Public Consultation (Attendance List):

Island Name: **Date:** **Time:**

Name	Address	Contact no	Signature
Fathmath Rizmeena	Neelofarumaage	7688561	
Ali Ibrahim	Venus	7542599	
Ismail Ibrahim	Manaage	7698087	
Mariyam Shathira	Dhon faith bageechaage	9920801	
Najda Adam	Riyaz	9151541	
Inayath Hussain	Gulabbasge	9686185	
Aneetha Ibrahim	Dhuveli	9107383	
Nasira Mohamed	Jambugasdhoshuge	7996442	
Mohamed Ali	Dheeframge	7610766	
Abdulla Hassan	Jaavaththage	7912117	
Hassan Ali	Koffyge	9863255	
Abdul Latheef	Dheydharuge	7912389	
Hussein Naveen	Husnuheenaage	7824144	
Abdulla Nushad	Kanboo ranihiyaa Aooz	7649002	
Sofiyya Adam	Sun reef	9173101	
Aminath Ali	Sun reef	7682582	
Ibrahim Ahmed	Fulhefi	7896445	
Fathmath Adam	HA. Muraidhoo mirusmaage	7856518	
Aminath Moosa	HA. Utheem Dheyliyaage	7550875	
Fathmath Azmira	HA. Utheem Pansana	7565866	

Preparatory Survey for Kulhudhufushi Airport Development Project

Name	Address	Contact no	Signature
[illegible]	[illegible]	7666937	
Hassam Ali	Babogge	7947133	
[illegible]	[illegible]	7788697	
ADAM SHAREEF	REDPEARL	9955266	
AHMED ATHIF	MAANINA	9908[illegible]	
Ummu Isoom	Landhoogge	7797141	
IBRAHIM MOHAMED	LeeRA	7959940	
IBRAHIM MOHA	MSRAAB	7838167	
Ayyoob Abdulla	Kandithoalhige	7788767	
HASSAN AHMED	ALAFARU.	7711688	
[illegible]		7739577	
Abdulla [illegible]	[illegible]	9637676	
[illegible]	[illegible]	7757552	
HASSAN ALI	HAAUFAA	7918646	
Ali Adam	Thavalai	9915222	
Ali Shareef	Seheriyaage	7979360	
MOHAMED WAHEED	RIO	9753034	
Aboobakuru Adam	Vashafaruge	9991145	
[illegible]	[illegible]	7709718	

Preparatory Survey for Kulhudhufushi Airport Development Project

Name	Address	Contact no	Signature
Inasa umar	Aaaru	9725040 7615861	
Rifdha Mohamed	Dharuma	7615861	
Sana Ibrahim	Phiththundi	9639773	
Shandhiyaa Jaufaru	Vakifaru	9159339	
Ahmed Mohamed	Zamaameege	9151864	
Hassan Hussain	Thithilee	9115527	
Ismail Asif	Gahaadhoshuge	9116090	
Ali Hassan	Maabulhaage	9905525	

Preparatory Survey for Kulhudhufushi Airport Development Project

Name	Address	Contact no	Signature
		7647777	
Ibrahim	Thibroazge		
Mohamed	—		
Ahmed	—		
Mohamed			
Mohamed	Madheena	9919820	
Abdulsatta		9648996	
Adam		7741726	
Ali		777192	
Aishath Hassan	Kofyge	7685085	
Mariyam Adam	Rasfushi	9563719	
Habeeba Ali	Venice.	9722966	
Mariyam Ali	Dhullisaage	9133332	
Hawwa Adam	Lainoofaru maage	7132652	
Fathmath Ahmed	Noomaage	-	
Latheefa Hussein	Thuni Veli	6527371	
Aishath Mohamed	Semi	6528128	

Preparatory Survey for Kulhudhufushi Airport Development Project

Public Consultation (Attendance List):

Island Name: **Date:** **Time:**

Name	Address	Contact no	Signature
~~Abdul Hakeem~~	HA.Utheem, Ashigas	-	
Abdul Hakeem	HA. Utheem, Ashigas	-	

Appendix 7: Commitment letter.

بسم الله الرحمن الرحيم

ދިވެހިރާއްޖެ ގުޅުއްވާލައްވާ ދިވެހި ދަތުރުފަތުރު ދާއިރާ

ދިވެހިރާއްޖޭގެ ދަތުރުފަތުރު ދާއިރާ

Regional Airports

ޓުއަރިޒަމް ދާއިރާ

Ministry of Tourism

Ref: 448/203/2017/13

Date: 18th October 2017

Mr. Ibrahim Naeem,
Director General
Environmental Protection Agency
Ministry of Environment and Energy,
Green Building,
Ameenee Magu, Maafanny,
Male' 203092, Maldives

Proponent's Declaration and Commitment: EIA for the Proposed Airport Development Project at Kulhudhuffushi

This is to confirm as the proponent of the proposed Airport Development Project at Kulhudhuffushi, that the following activities will be carried out as scheduled below:

Activities to be carried out:	Schedule of activities
1. Relocation of endangered species to another area (approved by relevant authorities) with similar environmental conditions if endangered species exists in the project area. If it is required, monitoring plan will be provided (approved by EPA) to monitor the wellbeing of the species once they are relocated to the new area	3-4 months from EIA approval
2. Make arrangements to declare and manage a new protect area with similar environmental features, under the guidance of EPA	2-3 months from EIA approval
3. Propose an appropriate drainage system to control flood water and for the implementation of the drainage system	1-2 months from EIA approval

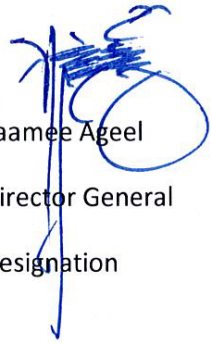
	(Tel)	(Fax)	E-mail address/ ލ.ޕ.ދ	(ފެކްސް)	(ފޯން)	
Regional Airports Office	332 3776	332 0911	regional@airports.gov.mv	332 0911	332 3776	ދިވެހިރާއްޖޭގެ ދަތުރުފަތުރު ދާއިރާ
Hanimaadhoo Airport Office	652 0023	791 9842	hanimaadhoo@airports.gov.mv	791 9842	652 0023	ހަނިމާދޫ ދަތުރުފަތުރު ދާއިރާ
Fuvahmulah Airport Office	686 8688	686 8688	fuvahmulah@airports.gov.mv	686 8688	686 8688	ފުވައްމުލަ ދަތުރުފަތުރު ދާއިރާ

We also confirm that we have read the report and to the best of our knowledge that the information provided in the report in relation to the proposed project (project description activities, operation of the facility) are accurate and complete.

We hereby confirm our commitment to finance all mitigation measures and monitoring recommended and specified in the report.

Thanking you,

Sincerely yours,



Saamee Ageel

Director General

Designation

	(Tel)	(Fax)	E-mail address/	(ٹ)	(ف)	
Regional Airports Office	332 3776	332 0911	regional@airports.gov.mv	332 0911	332 3776	ރީޖަނަލް ތަކެއްޗާ ދިވެހި
Hanimaadhoo Airport Office	652 0023	791 9842	hanimaadhoo@airports.gov.mv	791 9842	652 0023	ހަނިމާދޫ ތަކެއްޗާ ދިވެ
Fuvahmulah Airport Office	686 8688	686 8688	fuvahmulah@airports.gov.mv	686 8688	686 8688	ފުވައްމުލަ ތަކެއްޗާ

Appendix 8: Document sent receipt to the Atoll council

Gmail **amir musthafa <amir.musthafa@gmail.com>**

Fwd: EIA report for the Kulhudhufushi Airport Development Project

Zahid Hameed <zahidhameed@gmail.com> Sun, Oct 22, 2017 at 8:04 AM
To: amir musthafa <amir.musthafa@gmail.com>

---------- Forwarded message ----------
From: **Zahid Hameed** <zahidhameed@gmail.com>
Date: Sun, Oct 22, 2017 at 8:04 AM
Subject: EIA report for the Kulhudhufushi Airport Development Project
To: info@haadhaal.gov.mv
Cc: Kulhudhuffushi Council <kulhudhuffushicouncil@gmail.com>

Dear H.Dh Atoll Council President,
Attached please find the EIA report for the H.Dh. Kulhudhufushi Airport Development Project.

In order to submit the EIA report to the EPA, I would need a letter from atoll council stating that the council has received the EIA. Hence, I would appreciate if you could provide a letter stating that you have received the EIA report.

Kind regards
Dr. Zahid
EIA consultant for the project.

--
_____

Zahid
Elhagedar
S.Hulhudhoo
Maldives

Kulhudhuffushi Airport EIA -final draft.pdf
17710K

Appendix 9: EIA team members CV.

Dr. Zahid CV

Ms. Aminath Nizar CV

Mr. Abdulla Fisam CV

CURRICULUM VITA-ZAHID, PHD

1. Personal information

Name: **Zahid**

Date of Birth: **September 22, 1974**

Permanent Address: Seenu Hulhudhoo/ Elhagedhar/Maldives

Contact Address: Endheri 3, Hulhumale', Maldives

E-mail: **zahidhameed@gmail.com**

Cell phone: **+960 7786847**

2. Key Qualifications

2011 PhD in Environmental Science, University of Canterbury, New Zealand

2004 M.Sc. Environmental Science, University of Wollongong, Australia

2002 B.Sc. Atmospheric Science (Climatology), Macquarie University, Australia

1997 General Certification of Education (Advanced level), University of London (Studied at Science Education Centre, Maldives).

1995 General Certificate of Education (Ordinary Level), University of London (Studies at Malé English School, Maldives)

3. Fellowships

- PhD scholarship-Awarded by the Government of New Zealand (NZAid-Open category), 2006.
- Postgraduate Scholarship (Master of Environmental Science)-Awarded by the Government of Maldives (under 3rd Education Project), Malé. Maldives, 2003
- Undergraduate Scholarship (Climatology-Atmospheric Science)-Awarded by United Nations Development Programme and World Meteorological Organization (under Human Resource Development Project of Department of Meteorology), Malé, Maldives, 1999.

4. Experience and Competence

Currently working at Maldives Meteorological Service as Deputy Director General Climatology (head of Climate Division). I have handled all the projects relating to the Environmental Impact Assessments, including bid document preparation, project management, co-ordination and management of internal specialists and sub-consultants and field surveying and EIA report writing. Registered EIA Consultant (EIA Registration no: EIA P20/2012).

5. Professional Experience

From 2014 November to Present: ***Deputy Director General Climatology***, Maldives Meteorological Service.

From 2012 January to 2014: ***Director Climatology***, Maldives Meteorological Service.

From 2008 to 2008: ***Teaching Assistant***, University of Canterbury, New Zealand

From 2005 to 2007: ***Senior Meteorological Forecaster***, Department of Meteorology, Malé, Maldives

From 2002 to 2004: ***Meteorological Forecaster Grade 2***, Department of Meteorology, Malé, Maldives

From 1998 to 1999: ***Air Traffic Control Officer (Trainee)***, Maldives Airports Authority, Malé, Maldives

6. Major Service/Administrative Activities

- Member of task force group formed for dealing with the extreme weather event experienced by the Maldives in Oct/Nov 2012 and acted as team leader for assessment and relief operation.
- Organized first Monsoon forum held in Gn. Fuvahmulah, Maldives, July 2012
- Organized pre-monsoon Monsoon workshop held in Gn. Fuvahmulah, Maldives, March 2012

7. Committees and Memberships

- National Geographic Information System (NGIS) steering committee member, since 2012
- Technical committee member for the "Increasing climate change resilience of Maldives through adaptation in the tourism sector project", since May 2012

- Focal point for the "Formulation of Inter-Governmental Monsoon Initiative Programme , initiated by SAARC Meteorological Research Center (SMRC), since January 2012
- Focal point for Regional Integrated Multi-Hazard Early Warning System (RIMES), since January 2012
- Member of Second national communication to the Republic of Maldives to the United Nations Framework on Climate Change committee, Ministry of Housing and Environment, Male' Maldives, since February 2012.
- Member of Golden Key International Honour Society (academic honour society which recognizes and encourages scholastic achievement and excellence among college and university students from all academic disciplines), Macquarie University(Sydney), Australia, since 2001
- Member of Seventh National Development Plan committee, Ministry of Planning and National Development, Male' Maldives, since 2005.
- Disaster Risk Management Program Institutional Framework Sub Committee focal point from Department of Meteorology for United Nations Development Program, Male', Maldives, since 2005
- Education and Training Focal Point from Department of Meteorology for the World Meteorological Organization, Geneva, Switzerland, since 2005.

8. Major Trainings/Workshops and Meetings attended

- Climate Change and Disaster Prevention (SAARC Special Program), March 28-April 17, 2013, Seongnam & Cheonan, Korea
- International Workshop on Climate Data Requirements and Application from 4-8 March 2013, Nanjing, China
- Regional Workshop on Climate Services at the National Level for the least developed countries (LDCs) in Asia, from 8 to 10 Oct 2012, Bangkok, Thailand
- The 5th Meeting of the SAARC STORM International Programme Committee (IPC) and Seminar on "Results and Review of SAARC STORM Field Experiments" Islamabad, Pakistan: 03-06 September 2012
- Completed Targeted Training Activity (TTA) on "ENSO Monsoon in the Current and Future Climate" and attended high level meeting on "The Looming Environmental Crisis and Global Sustainability" from 30 July to 10 August 2012, ICTP, Trieste/Italy.
- Meeting on "Formulation of Inter-Governmental Monsoon Initiative Programme" SMRC, Dhaka, 30-31 May 2012.
- Completed Training workshop on "Geo-Climate Information System-a visualization tool for displaying climate change scenarios for Maldives" organized by Regional Integrated Multi-Hazard Early Warning System (RIMES), in Maldives, 22-26 January 2012.

9. Presentations and Lectures

Prepared and conducted the following:

- Gave a presentation on Climate Change, Impacts and Adaptation Measures at the climate change advocacy workshop targeted for school students, held in N. Kendhikulhudhoo from 22-23 February, 2013.
- Prepared and delivered a lecture (as a guest speaker) on climate change and adaptation for the students of Faculty of Hospitality and Tourism Studies, Maldives National University, 7 February 2013.

- Delivered a lecture on Climate Change: Impacts and Adaptation at climate change awareness campaign for school students, held in G. Fuvahmulah from 19-20 October 2012.
- Gave presentation on Climate Change: Impacts and Adaptation Measures to Higher Secondary School students, Addu Atoll, 21-22 September, 2012.
- National Training workshop on "Basic Concepts of Disaster Risk Management" organized by UNDP, Maldives, 10-14 July 2005

10. **Reports**

- Climate Change and Sea Level Rise-University of Wollongong, Wollongong, Australia, 2004.
- Monsoon and Rainfall Report-Maldives 2003-Department of Meteorology, Male', Maldives, 2004
- Monsoon and Rainfall Report-Maldives 2002-Department of Meteorology, Male', Maldives, 2003.
- The Model for the Assessment of Greenhouse-gas Induced Climate Change/SCENario GENerator (MAGICC/SCENGEN)-Macquarie University, Sydney, Australia, 1999-2002.
- Undertaken Environmental Impact Assessment for Proposed New Fish Market in Male', Maldives, 2006.
- Undertaken Environmental Impact Assessment for Tsunami monument, Maldives, 2006.
- Undertaken Environmental Impact Assessment for Maldives Ports Authority, Male', Maldives, 2006.
- Undertaken Environmental Impact Assessment for Male International Airport, Male', Maldives, 2007.
- Carried out Environmental Impact Assessment for Haa Alif Baarah island Jetty Development project, Maldives, 2012
- Undertaken Huvafenfushi island resort powerhouse Environmental Impact Assessment, Maldives, 2012.
- Undertaken Huvafenfushi island resort Water treatment facility (RO plant) Environmental Impact Assessment, Maldives, 2012.
- **EIA for proposed development of Breakwater at Kanduhulhudhoo, Maldives, 2013**
- **EIA for proposed Harbor Project at Ga. Kon'dey, Maldives, 2013**
- **EIA for proposed football field at Dhaandhoo, Maldives, 2013**
- **EIA for Anantara Kihavah Island Beach Nourishment, 2013**
- **EIA for Makundhoo Mariculture Project, 2013.**
- **Velidhu Island Resort RO plant EIA, 2013**
- **EIA for H.Dh Hanimaadhoo Sewerage System Project, 2013**
- **EIA for R. Kinolhas Sewerage System Project, 2013**
- **Have undertaken field survey for 5 islands for preparing outer islands for sustainable energy (POISE) development project (ADB local environmental consultant), 2013.**
- **EIA for the Development of Waste Collection Centre at Sh. Foakaidhoo, 2013 (Value: MVR 0.00 -For the Ministry of Environment and Energy)**
- **EIA for the Development of Waste Collection Centre at R. Ungoofaaru, 2014 (Value: MVR 0.00 -For the Ministry of Environment and Energy)**
- **EIA for the Development of Waste Collection Centre at R. Maakurath, 2014 (Value: MVR 0.00 -For the Ministry of Environment and Energy)**
- **EIA for the Development of Waste Collection Centre at AA. Thoddoo, 2014 (Value: MVR 0.00 -For the Ministry of Environment and Energy)**

- **EIA for the Development of Waste Collection Centre at Th. Veymandhoo, 2014 (Value: MVR 0.00 -For the Ministry of Environment and Energy)**
- **EIA for Ha. Filladhoo Sewerage System Project, 2015**
- **Holiday Island RO plant registration, 2015**
- **EIA for the construction of mooring piles at Kaafu Dhiyaneru project, MPL, 2015**
- **Environmental Impact Assessment (EIA) Report for proposed Tourist Resort**
- **Development project at Lundhufushi, 2015.**
- **Kandooma Resort Island RO plant registration, 2016**
- **Social and Environmental Survey of 21 islands for the proposed JAICA funded Digital Terrestrial Television Broadcasting Network Development Project in the Republic of Maldives, 2016**
- **EIA for Sun Island resort service jetty entrance channel deepening project, 2016**

11. Publications and Conference papers

- Zahid, 2003. 'Nakaiy thakaai Moosun'. An Interactive CD-Room, Department of Meteorology, Male', Maldives.
- Zahid, 2004. "Met Data-Maldives". An Interactive CD-Room, Department of Meteorology, Male', Maldives.
- Zahid, 2006. Early Warning System in the Maldives, Journal of Rain O Shine, Vol 1. Department of Meteorology, Male', Maldives.
- Presented a paper on "onset and withdrawal dates of Maldives monsoon season", Auckland, New Zealand, 2009
- Presented a paper on "Prediction of Maldives monsoon rainfall using modelling techniques", Canberra, Australia, 2010.
- K. Budhavant , A. Andersson , C. Bosch , M. Kruså , A. Murthaza , Zahid , Ö. Gustafsson (2015) Apportioned contributions of PM 2.5 fine aerosol particles over the Maldives (northern Indian Ocean) from local sources vs long-range transport. Sci. Tot. Environ., 536, 72–78. K. Budhavant, B. Srinivas, A. Andersson, E. Asmi, J. Backman, J. Kesti, Zahid, S. K. Satheesh, Ö. Gustafsson (2017) Anthropogenic aerosols in the dry season South Asian outflow are fine and regionally mixed, (Under review).

12. Referees

Professor Andy Sturman
Department of Geography (HoD)
University of Canterbury
Private Bag 4800
Christchurch
New Zealand
Phone: +64 3 364 2502
Fax: +64 3 364 2907
E-mail: andrew.sturman@canterbury.ac.nz

Mr. Ajwad Musthafa
Permanent Secretary
Ministry of Environment and Energy
Maldives, Male'
Mobile: +960 7958100
E-mail: ajwad.musthafa@environment.gov.mv

13. Certification

Certification

I, the undersigned, certify that to the best of my knowledge and belief, the information given above correctly describes my qualifications and experience:

Dr. Zahid

October 2017

Aminath Nizar, MSc, B.Eng

M. Light Signal, Koarukendi Magu, Male', Republic of Maldives
Tel: 009607701531, Email: aimie.nixar@gmail.com
Date of Birth: 25 Feb 1979, **Gender**: Female, **Nationality:** Maldivian, **National ID No:** A038465

Profile

Completed MSc in Environmental Engineering from University of Strathclyde and B. Eng (hons) in Civil Engineering from University of Leeds. Over 8 years of work experience in the construction industry as an established draftsperson and 8 years of experience as an engineer. Involved in designing and managing infrastructure projects. In addition, 2 years as an experienced Environmental Engineer, at the Environmental Protection agency of Maldives as the Section head of Waste Management and Pollution Prevention.

Technical Skills

- Excellent analytical and engineering skills
- Excellent drafting knowledge using AutoCAD
- Excellent knowledge on contract document preparation
- Excellent knowledge in FIDIC contracts, Bid documents and Evaluation process and construction phase of projects.
- Excellent knowledge of Microsoft Office software package
- Ability to inspect and coordinate progress meetings
- Ability to identify problems and undertake research
- Expertise in certification of interim bills

Personal Skills

- Ability to work effectively as part of a team
- Excellent interpersonal skills
- The ability to act calmly and deliver when under pressure
- Excellent organisation and planning skills
- Effective communicator in verbal and written English

Educational Qualifications

2011-2013	**MSc Environmental Engineering , (Results 1:2)** University of Strathclyde, www.strath.ac.uk, United Kingdom.
2007-2008 (3rd Year)	**B.Eng (Hons) in Civil and Structural Engineering , (Results 1:1)** University of Leeds, www.leeds.ac.uk, United Kingdom.
2005-2007 (1st & 2nd Year)	**B.Eng (Hons) in Civil Engineering and Structural Engineering** INTI International University College, www.intimal.edu.my, Malaysia
1997-1999	**General Certificate of Secondary Education (GCSE) Advance Level (4 Subjects)** University of London, UK/ Science Education Centre, Maldives.
1992-1996	**General Certificate of Secondary Education (GCSE) Ordinary Level (9 Subjects)** University of London, UK/ Aminiya School, Maldives.

Professional Experience

Sep 99 - Apr 05	**Draftsperson** (Fulltime) **Ministry of Construction and Public Infrastructure**, www.constuction.gov.mv, Maldives.
Dec 03 – Apr 05	**Draftsperson** (Part-time)

Gedor Architecture Pvt Ltd, www.gedor.com.mv, Maldives
Responsibilities included drafting buildings, site surveying, site inspection, project handling, consulting contractors, etc.

Some major projects involved includes:

1. National Computer Centre (NCIT)
2. Northern Regional School
3. Villingilli Ferry Terminal
4. Zone one Health posts and Health Centers
5. Th. Funaddoo Laundry and Linen Services
6. Lhohifushi, New Staff Building
7. Velanaage office building
8. Faculty of Higher Education.
9. Presidential Jetty
10. Fuvahmulahku Jetties
11. Youth Ministry (eight storey building)
12. Resort Proposals for Hondaafushi Kalhufahalafushi, dholhiadhoo & maavelaavaru island.
13. Lhohifushi Extension Water Bungalows
14. Private residential buildings

Oct 08 - Sept 11 **Assistant Engineer** (Fulltime)
Ministry of Housing and Environment, www.housing.gov.mv Maldives
Responsibilities included, managing infrastructure projects, preparation of contract documents, evaluation of bid documents, site inspection, consulting communities and contractors, preparation and approving of interim bills, etc.

Some major projects involved includes:

1. Seven Harbour Project (Th. Veymandoo, L. Maamendhoo, N. Kendhikulhudhoo, R. Maakurathu, K. Maafushi, Aa. Rasdhoo, Sh. Milandhoo)
2. H.Dh Kulhudhuffushi Harbour project
3. Gn. Fuah mulaku shore protection project
4. F. Bilehdhoo harbour
5. N.Magoodhoo Harbour
6. R. Inguraidhoo Harbour
7. GA. Nilandhoo Harbour
8. Tsunami Re- Construction Project / R. Ungoofaaru, N. Manadhoo, HDh. Makunudhoo (AFD Loan project)
9. Sh.Komandoo Land Reclamation
10. Dh.Meedhoo harbour
11. M. Mulah Harbour
12. Felidhoo sewerage
13. Miladhoo Sewerage

Nov 14 - Apr 17 **Engineer, Waste Management and Pollution Prevention** (Fulltime)
Environmental Protection Agency, www.epa.gov.mv,
Maldives.
Formulating regulations in relation to waste management, issuing licence in accordance to waste management regulation, Formulation of work plan and annual budget for all the solid waste and pollution related regulatory works, and approving infrastructures related to waste management

Apr 17 – To-date **Project Director** (Kulhudhuffushi Harbour Expansion Project), **Infrastructure Department** (Fulltime)
Ministry of Housing and Infrastructure, www.housing.gov.mv,
Managing Kulhudhuffushi harbour expansion project funded by Asian Development Bank

Referees

Prof Robert Kalin
Professor of Environmental Engineering for Sustainability
David Livingstone Center for Sustainability Level 6,
Graham Hills Building, 50 Richmond Street,
Glasgow, G1 1XN, Scotland
Direct line: +44 141 548 4649
Email: Robert.Kalin@Strath.ac.uk

Fathimath Shaana Farooq
Director General, Infrastructure
Ministry of Housing and Infrastructure
Ameenee Magu, Male'
Republic of Maldives
Tel: + 960 3004300
Email: shaana.farooq@housing.gov.mv

Personnel Information

Full Name: Abdulla Fisam

Date of Birth: 12-January-1989

Place of Birth: Hithadhoo, Addu City

Nationality: Maldives

Contact Number: 9711183

E-mail address: Fisam.abdulla@gmail.com

Educational background

- IGCSE Ordinary Level (O/Level)& Secondary School Certificate, 2006
- Edexcel Advance Level (A/Level) & Higher Secondary Certificate, 2009
- Bachelors of Environmental Management, Maldives National University, 2015

Training/Workshops attended

- World Water Day workshop, Maldives Water and Sewerage Company (MWSC), 2006
- Basic First Aid course, Faculty of Health and Science, Maldives National University, 2011
- Data Collection Survey of Enabling Activities to Facilitate Early Action on the Implementation of the Stockholm Convention on Persistent Organic Pollutants in the Maldives, Ministry of Environment and Energy, 2013
- Climate Financing Workshop, Transparency Maldives, 2012
- Sharkwatch protocol training workshop, project REGENERATE (IUCN Maldives), 2014
- Volunteer at Moodhu Maakan'du Fesitval, project REGENERATE (IUCN Maldives), 2014
- Catlin sea view survey expedition Maldives (as an observer), University of Queensland, 2015
- Turtle watch protocol training workshop, project REGENERATE (IUCN Maldives), 2015
- Maldives Scientific Expedition North Ari atoll, project REGENERATE (IUCN Maldives), 2016
- International Coral reef Leadership and Management programme, Reef Ecologic, Australia, 2016
- Global Youth Leadership Peace Camp, Management and Science University, Sri Lanka, 2017
- Coral Data base training workshop, Marine Research Center, Maldives, 2017
- Ecological Monitoring methods workshop, project REGENERATE (IUCN Maldives), 2017

- Adaptive Climate Governance Workshop, Transparency Maldives, 2017
- Excellence in Field Management of Natural Resources – Technical Training for Rangers, project REGENERATE (IUCN Maldives), 2017

Professional Experiences

- Sales assistant, Novelty Bookshop (October 2007- January 2008)
- Supervisor/ Enumerator at Household Income and Expenditure Survey (HIES), Department of National Planning, 2009
- Data Collection at the Mangroves For the Future grant programme at K.Hura, Maldives National University, 2014- 2015
- Intern at project REGENERATE, IUCN Maldives, 2014
- Junior Community Liaison Officer, project REGENERATE, IUCN Maldives, 2015
- Marine Conservation Officer, project REGENERATE, IUCN Maldives, 2015 – present
- Lecturer (Marine Biology) at Foundation of Marine Studies, Villa College , 2015
- Part-time Lecturer (Marine Biology) at Bachelor of Environmental Management, Maldives National University, 2016
- Consultancy work for EIA undertaken to develop an Airport at H.dh. Kulhudhuffushi, Maldives, 2017

Skills and Responsibilities

- Communicating with community stakeholders
- Developing Terms of References, Budgets, Contracts
- Recruiting staffs, reviewing the overall performances
- Project Planning, developing proposals
- Networking with International and local professionals
- Research Designing, Data analysis
- Fisheries Data collection (size and species)
- Ecological Data Collection (Reef Health Impact Survey's)
- Communicating and Liaising with multi institutions
- Terrestrial Data collection (mangrove distributions, species abundance)
- Logistics and finance management
- Team work and leadership

Publications

- Ecosystem services assessments of North Ari Atoll (co-author, report, IUCN Publication)
- Resource Dependence and Social Resilience in North Ari Atoll (co-author, report, IUCN Publication)

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