

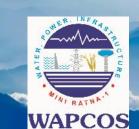
Ministry of Housing and Infrastructure, Maldives

- KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT

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GEO TECHNICAL INVESTIGATION REPORT







ELS International (Pvt) Ltd, H.Sisil Hiyaa Building, 9th Floor, Apartment B Male '20071, Republic of Maldiver

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NOVEMBER 2017



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POSSIBLE SOIL PROFILE

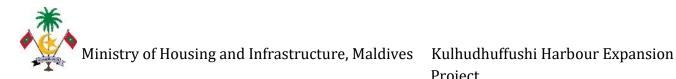
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Annexure – I: Borehole Logs

Annexure – II: Drawings of Sub soil Profile

Annexure – III : Site Photographs





GEOTECHNICAL INVESTIGATION FOR PROJECT MANAGEMENT **CONSULTANT FOR KULHUDHUFFUSHI HARBOR EXPANSION PROJECT, MALDIVES**

1.0 Background

The Government of Maldives has applied for a grant from the Asian Development Bank (ADB) for the Kulhudhuffushi Harbour Expansion Project and intends to apply a portion of proceeds to engage a consultant to support the Ministry of Housing and Infrastructure in the project implementation process for development of Kulhudhuffushi Harbour Expansion Project

2.0 **Project Area**

Kulhudhuffushi is one of the major population centers in the region with a total population of around 8,200 in 2014. Kulhudhuffushi is the capital of Haa Dhaalu Atoll and is one of the biggest and most populous Islands in the Northern part of the Maldives. Fishing (Tuna, Snapper, Marlin) is one of the biggest industries here, bringing in significant income for the islanders. Fishing is the lifeblood for Maldivians. The local men also work on the cargo vessels. Currently, Kulhudhuffushi is home to the regional hospital that provides general medical and specialist services, dental services, emergency services and intensive care units. The Island also hosts a range of education facilities such as primary schools, secondary schools, and a vocational training center, all designed to cater for the approximately 2,500 students from Kulhudhuffushi and other nearby Islands.

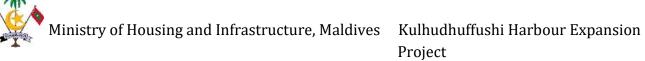
2.1 **Objectives**

The objectives of the Project are as follows:

- a) Dredging and reclamation works
- b) Breakwaters, revetments and quay-wall structures including harbor separation walls and finger piers
- c) Pavement
- d) Harbor navigational beacons and quay lighting
- e) Ice Plant
- f) Buildings Administration/Retail/Terminal



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g) Market – Fish/ Fruits and Vegetable

2.2 Scope of Work

The main requirement of the consultant is to assist the employer in

- i. The overall project management,
- ii. Detailed Engineering Design of the project,
- iii. Procurement of Civil work contract,
- iv. Construction Supervision and Contract Administration, and
- v. Project Compliance and Monitoring.

However, the consultant shall carry out detailed tasks outlined under each component as per the ToR / RFP, as detailed below for ready reference.

2.2.1 Component 1: Overall Project Management

Task 01	Provide project management services throughout detailed design,
	procurement, construction, and commissioning stages and post-defect
	liability period.
Task 02	Prepare project schedule and corresponding projected cash flow in
	conjunction with the Employer and provide ADB a realistic schedule for
	design, approvals, tendering, construction and commissioning, The
	consultant is to maintain and update the project schedule throughout the
	project.
Task 03	Formulate and maintain a project performance management system in the
	format acceptable by the Employer and ADB, which consists of (1) preparing
	in the initial stage a project performance management system, in accordance
	with the ADB's project design and monitoring framework (DMF) to monitor
	(i) the progress of the overall project implementation, and (ii) the
	development impact of the project; and (2) collecting/updating the project
	performance indicator benchmarks, this includes updating the baseline data in
	the DMF.
Task 04	Develop a project management plan in sufficient detail to enable the project
	to be monitored as per the Employer's requirements, and to support the
	Employer to prepare quarterly progress report to evaluate the scope,





implementation	arrangement,	progress,	and	achievement	of	the	project
objectives.							

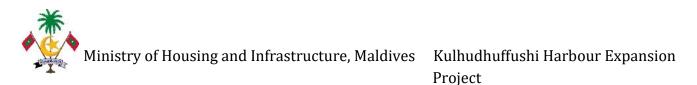
2.2.2 Component 2: Detail Design Engineering and Cost Estimates

Task 05	Review the preliminary design prepared during the project preparatory stage,
	validate/improve in accordance with best international standards and
	recommended practices. This includes carrying out value engineering -
	evaluating and proposing cost effective alternatives as deemed necessary. The
	detailed design should be prepared by considering the inputs from public
	consultation in Kulhudhuffushi.
Task 06	Review the existing surveys, identify and carryout additional detail surveys and
	undertake full detail design namely:
	✤ Carryout detail design for all improvement works – including preparation
	of detailed design drawings in sufficient details for accurate determination
	of quantities and cost and to facilitate construction.
	✤ Compile existing data and carry out limited hydrographic/oceanographic
	surveys as required to enable numerical modeling of the harbor and
	coastal structures to ensure sufficient safeguards against overtopping,
	harbor stilling and safe entry. Data collection may be required within the
	time available in the overall program.
	✤ Geotechnical site investigation to verify soil conditions for dredging and
	coastal structures
Task 07	Prepare estimated quantities and cost of all proposed works and equipment with
	best possible accuracy.

2.2.3 Component 3: Procurement Support

Task 08	Review the indicative contract packages, prepared during the project preparatory
	stage, and, if warranted, recommend better alternatives to in order to optimize
	contract administration, construction coordination, and competitive pricing.
Task 09	Based on the type of bidding procedures and contracts, as advised by the





	Employer, prepare bidding documents for all works and equipment packages.
	The bidding documents shall be prepared in accordance with ADB's latest
	applicable Standard Bidding Documents (SBD) available in the ADB website.
Task 10	Provide all necessary assistance for the procurement of contracts, including but
	not limited to, advertising the invitation to bid, bid clarifications, addenda, pre-
	bid meetings, bid openings, bid evaluation and reports, contract negotiations, and
	draft contract documents.

2.2.4 Component 4: Construction Supervision and Contract Administration

Approve contractor's work program, method statements, material sources, safety
plan and environmental management plan.
Review and check working drawings, the setting out of the works, and provide
instructions to the contractor.
Review the quality control programs of the contractors.
Inspect materials and works to ensure compliance with the contract specifications
and give notice to the contractor in the event that such materials and works fail to
comply with the specifications.
Accept or reject any part or parts of the completed works.
Make measurements and keeping measurement records.
Maintain records, correspondence, and diaries.
Certify work volume and interim certificates for progress payments.
Assist the Employer's representative with the maintenance of consolidated project
accounts, and with preparation of financial statements and withdrawal
applications for submission to ADB.
Certify completion of part or all of the works.
Periodically check the remaining quantities for completion, and undertake regular
monitoring of each contract through an earned value management framework





Task 22	Provide assessments to the Employer in relation to Contractor's variation claims,
	extensions of time claims, and other technical and contractual matters that may
	arise.
Task 23	Negotiate with each contractor and recommend the Employer the rates for any
	unscheduled items of work that may arise.
Task 24	Advise the Employer's representative on all matters relating to the execution of
	the works; and assist the representative with processing the contractor's possible
	claims.
Task 25	Prepare, at the completion of the contracts, a consolidated project completion
	report in a format provided by ADB.
Task 26	Check and certify as-built drawings for the works prepared by the contractors.
Task 27	Inspect the works at appropriate intervals during the defects liability period and
	certify the defects liability certificate for issuance by the Employer's
	representative.
Task 28	Provide the Employer with complete records, and inception, monthly, and
	completion reports.
Task 29	Assist the Employer to provide on-site training where required for the Employer's
	field staff on quality assurance and contract administration.

2.2.5 Component 5: Social Safeguard

Task 30	During the detailed design stage, conduct consultation with local communities in
	Kulhudhuffushi for input to the harbor design where appropriate.
Task 31	Support the Employer in matters relating to land acquisition and resettlement, if
	impact is identified during project implementation period. Tasks include preparing
	Resettlement Plan, monitoring the implementation of the resettlement plan and
	providing expert advice in all matters relating to acquisition and resettlement.
Task 32	Design, prepare and conduct HIV/AIDS, anti-trafficking and child labor awareness
	campaign at the project influence areas, monitor the status of contractor's
	compliance with HIV/AIDS, and Core Labor Standards.
Task 33	Implement gender-specific project features and ensure Contractor is in compliance
	with equal payment for equal work for men and women.



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Task 34	Ļ	Ensure compliance with social impact mitigation requirements of civil works
		contracts, and provide information to ADB on those processes in the semi-annual
		safeguard report.

2.2.6 Component 6: Environmental Assessment and Monitoring

Task 35	Review the Initial Environmental Examination (IEE) report and carry out additional
	studies and public consultations if recommended or required by the IEE. If there are
	changes in the project design or discovery of new environmental impacts update the
	IEE report and disclose it on the ADB website as necessary. Review the general
	engineering design and in discussion with the engineering team identify needs if any
	for design modification to enhance environment safeguard and/or mitigate climate
	risks. Update the Environmental Management Plan (EMP) and provide more
	specific details based on site visits, the revised design and new information acquired,
	if any. Review the bidding documents and ensure the inclusion of the EMP, related
	mitigation costs and all necessary provisions for compliance to environment
	safeguard requirements. The environment management plan will be updated as part
	of the updated IEE.
Task 36	Monitor the project's compliance to environment safeguards as given in the IEE
	report and implementation of the EMP by the contractor and ensure compliance with
	the environmental safeguard requirements of civil works contracts. Provide
	necessary training and technical advices including on-site advisory to the contractors
	as found necessary. Review and confirm that the EMP implementation records are
	maintained by the contractor. Prepare monthly and semi-annual environmental
	monitoring reports based on these records and on-site spot checks carried out and
	submit to the Employer. The semi-annual reports which will also cover social
	safeguard issues with inputs from the Social Development Specialist will be for
	submission for ADB for disclosure on the ADB website.

3.0 Geo technical Investigation

With reference to the task 6, WAPCOS has been undertaken the Geo technical investigation works at Kudhulffushi from 23rd September to 17th October, 2017 with the proposed Project





for Project Management Consultant for Kudhulffushi Harbour Expansion Project, Maldives.

A comprehensive Geotechnical assessment has been conducted by M/s. ELS International (Pvt) Limited, Male for M/s. WAPCOS Limited, Maldives to determine the geotechnical conditions present within the investigated land.

This Geotechnical investigation work includes borehole drilling, sampling of disturbed and un-disturbed materials, laboratory investigation of samples and in-situ testing.

This report embodies the findings of the site investigation including, nature and depth of soil strata, ground water levels at the site, physical and mechanical properties of soils and other relevant details of the geotechnical investigation.

3.1 **Site Description**

The investigated boreholes are at Kulhudhuffushi harbour premises for expansion of Kulhudhufffushi harbour. The location map shows the points were the Geo technical Investigations are carried out.

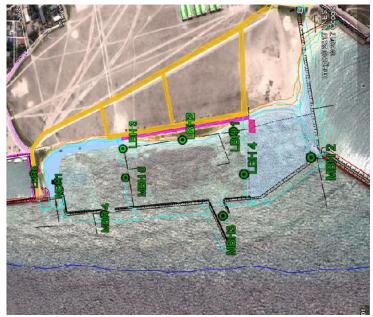


Fig 1 Geotechnical Investigation locations

Borehole No.	Latitude	UTM	Longitude	UTM	Remarks
MBH 1	6°37'22.33"N	285902.00 m E	73° 3'48.52"E	732476.00 m N	Quay wall area
MBH 2	6°37'0.15"N	286033.00 m E	73° 3'52.87"E	731794.00 m N	Break water

Table.1 Borehole Locations



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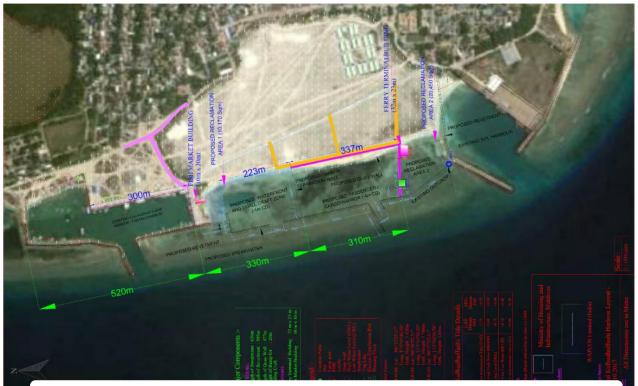
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Kulhudhuffushi Harbour Expansion Project

MBH 3	6°37'6.50"N	285892.00 m E	73° 3'48.25"E	731990.00 m N	area
MBH 4	6°37'17.23"N	285846.00 m E	73° 3'46.71"E	732320.00 m N	
MBH 5	6°37'15.07"N	285940.00 m E	73° 3'49.78"E	732253.00 m N	Separation Wall
LBH 1	6°37'5.64"N	286068.00 m E	73° 3'53.99"E	731963.00 m N	
LBH 2	6°37'9.81"N	286040.00 m E	73° 3'53.06"E	732091.00 m N	Quay wall area
LBH 3	6°37'15.28"N	286005.00 m E	73° 3'51.90"E	732259.00 m N	
LBH 4	6°37'4.85"N	285984.00 m E	73° 3'51.26"E	731939.00 m N	Ferry terminal Building area
LBH 5	6°37'25.11"N	285912.00 m E	73° 3'48.83"E	732562.00 m N	Fish Market Building area



Layout of for expansion of Kulhudhufffushi harbour

3.2 General Geological and Sub Grade Characteristic of Site Area

The underneath geological formation of the site is considered, the coral reef formation is predominated at all the Maldivian islands, it may be stated that a classic atoll chain and the reef limestone, of which they are built, have accumulated on a volcanic ridge foundation





associated with a transform fault on the floor of the Indian ocean which is now inactive. As mentioned above the Male Island also had been formed under volcanic ridge foundational phenomena.

Describing the soil conditions in the Maldives, it has been observed from previous investigations that the structure of the reef flats generally consists of either coral sand, soft or hard coral rock and is usually overlaid with a relatively thick layer of coral sand. On the lagoon side of the reef edge the reef is mostly covered with dead corals and a few colonies of live corals. The cavities between the coral heads are constantly being filled up with coral sand and pieces of broken and dead corals and will ultimately become a substantially hard cemented material.

When considering the climatic characteristics, Maldives experience a monsoonal climate, as the northeast monsoon is from January to March; hot days, cooler nights and relatively dry periods are common feature during this season. The wet, southwest monsoon prevails from mid-May to November. Gales and heavy rainfall occur during this season.

3.3 Formation of Coral in the Region

With respect to coral formation in general corals are preserved as calcareous skeletons, originally secreted by a simple animal known as polyps. Reef building polyps avoid deep water more than 25m deep and grow optimally at depths within 10m. The sea water temperature should be between 25^oC-29^oC. Emersion or exposure above water could be tolerated only for short periods during tidal cycles. Salinity levels should generally be between 2.7% and 4.0%. The water turbulence is desirable in order to disperse carbon-dioxide to bring in plank tonic food and oxygen.

A moderate fall out of fine sediments from the water can be tolerated because corals have self cleansing mechanisms but burial beneath sediment for lengths of time could result in an asphyxiation and death. The polyp sack like body had an internal cavity which acted as its stomach. There was only a single opening to the out side, surrounded by tentacles. The polyp sat in a cup like depression on to pot its calcareous skeleton, or corallites, which is built





upwards to form a support as it grew. Coral are classified according to this internal structure, which cannot often be observed directly.

3.4 Field Investigation

Field investigation consisted of advancing ten boreholes at the locations marked in Figure 1. The Field investigation was commenced on 23rd September to 17th October.

3.5 Borehole Investigation

The boreholes were advanced by means of rotary drilling machine and the drilling was carried out with overburden cutting tools and the wash boring process was adopted to remove the cuttings from the bottom of the borehole. During the drilling operation the walls of the boreholes were supported by 82 mm dia. NX type flush coupling casings. In order to achieve better alignment of borehole NWY flush coupling drill rods were used. Details of the depths of drilling are indicated in the Table 2.

Borehole No.	Water Level (m)	Overburden / Soil	Rock / Boulder	Total Depth (m)
		Drilling (m)	Drilling (m)	
M BH – 01	+2.00	18.45	-	18.45
M BH – 02	+2.00	18.45	-	18.45
M BH – 03	+2.00	18.45	-	18.45
M BH – 04	+2.00	18.45	-	18.45
M BH – 05	+2.00	18.45	-	18.45
L BH – 01	+2.00	18.45	-	18.45
L BH – 02	-0.80	13.50	3.00	16.50
L BH – 03	+2.00	18.45	-	18.45
L BH – 04	+2.00	18.45	-	18.45
L BH – 05	-1.20	15.50	3.00	18.50

Table 2 Summary of the Borehole Investigation





3.6 Standard Penetration Test (SPT)

The SPT was carried out in regular intervals in the overburden, at each of the borehole. The performance of this test is based on the test method specified in BS 1377. Disturbed samples of soil were collected from SPT tube.

3.7 Test Procedure

- SPT sampler (Split spoon sampler) inserted in to the boring and it has been connected via steel rods to 63.5kg hammer.
- Using automatic safety hammer mechanism, hammer was raised a distance of 760mm and allowed it to fall freely and the energy drives the sampler in to the bottom of the boring. The process was repeated until the sampler has penetrated a distance of 450mm. The numbers of blows were recorded for first 150mm (Seating drive) and then two consecutive 150mm intervals (Test drives).
- The N value was computed by summing the blow counts for the two 150mm intervals of penetration. The blow count for the first 150mm is retained for reference purposes but not used to compute N value because the bottom of the boring is likely to be disturbed by drilling process and may be filled with loose soil that fell from the side of the boring.
- The SPT samples were extracted from the sampler and saved the obtained soil samples in appropriate manners.
- > Boring to the depth of the next test been done with the above procedure.

3.8 Ground water conditions

Ground water measurements were obtained from the open boreholes where the water levels were obtained after a considerable response time. The ground water levels obtained can fluctuate with the seasons, periods of precipitation and temperature.

4.0 Sub-Surface Conditions

The sub surface conditions encountered at the site are graphically presented in the borehole logs attached in Annex I. The soil horizons identified at the borehole locations are inferred from the samples taken from the borehole locations. Soil horizons/layers generally represent

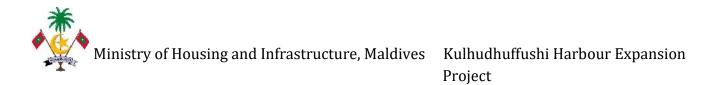


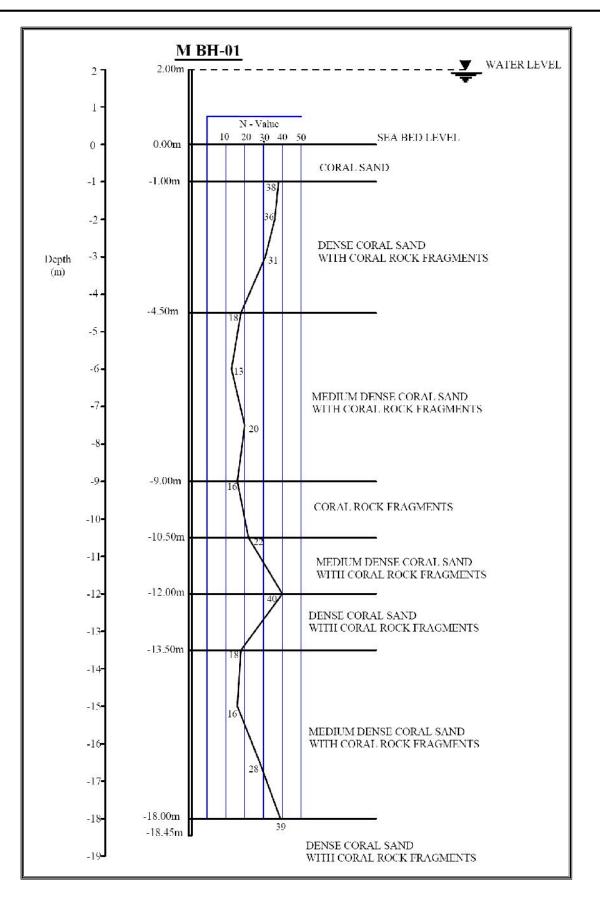


a transition from one soil type to another and that should not be assumed to be representing an exact plane of geological change.

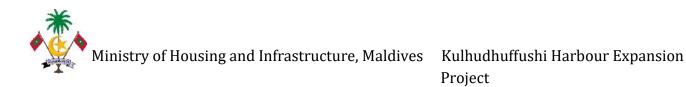
Further, the conditions may vary between and beyond the borehole locations. A comprehensive detail about the sub soil conditions at /across the boreholes is graphically shown in the Figure 2(a) to 2(j) as **Annexure I**. The sub soil profile drawings are shown in the Figure 2(k) to 2(m) as **Annexure II**. Few photographs were shown in **Annexure III** taken during the Geo technical investigations works.

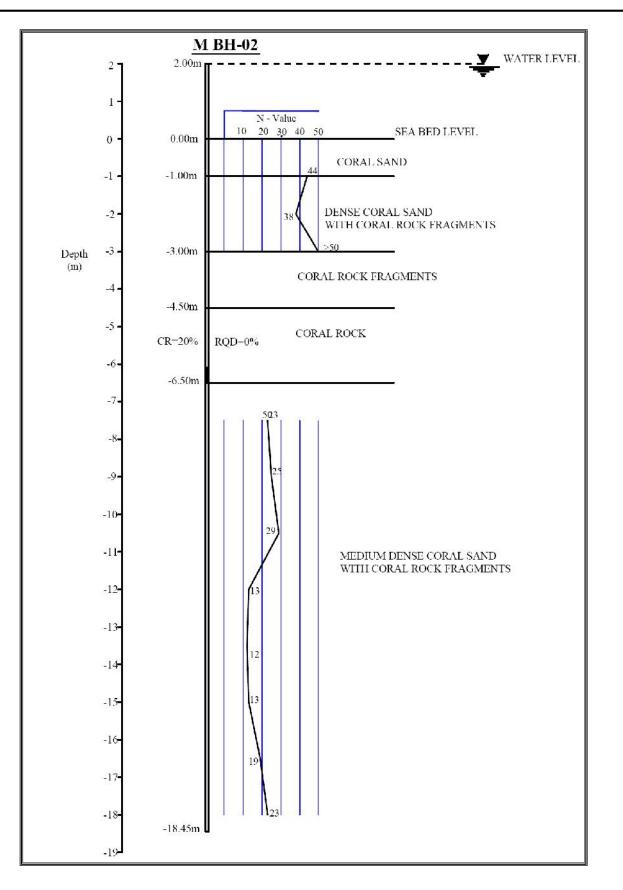






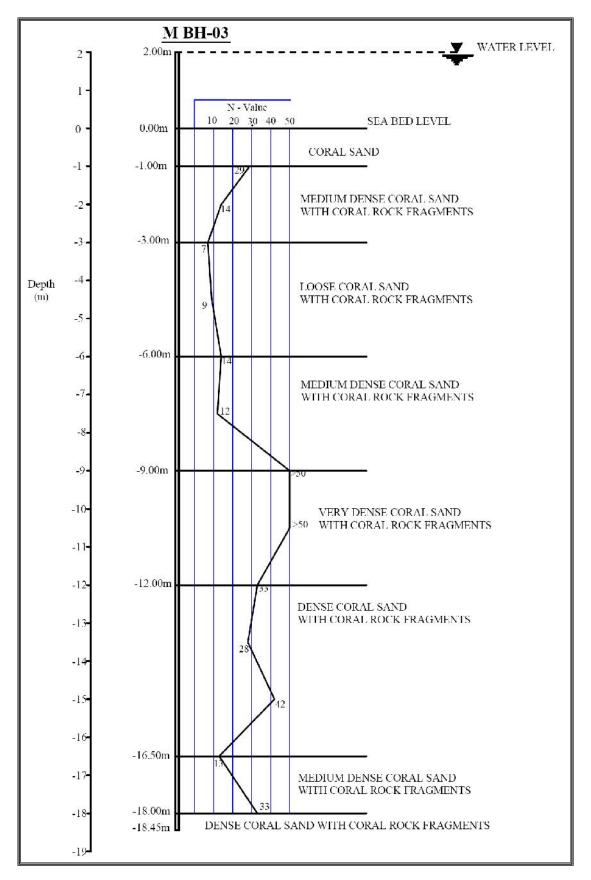




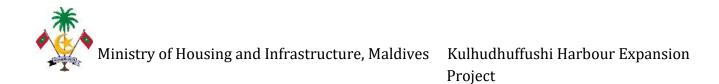


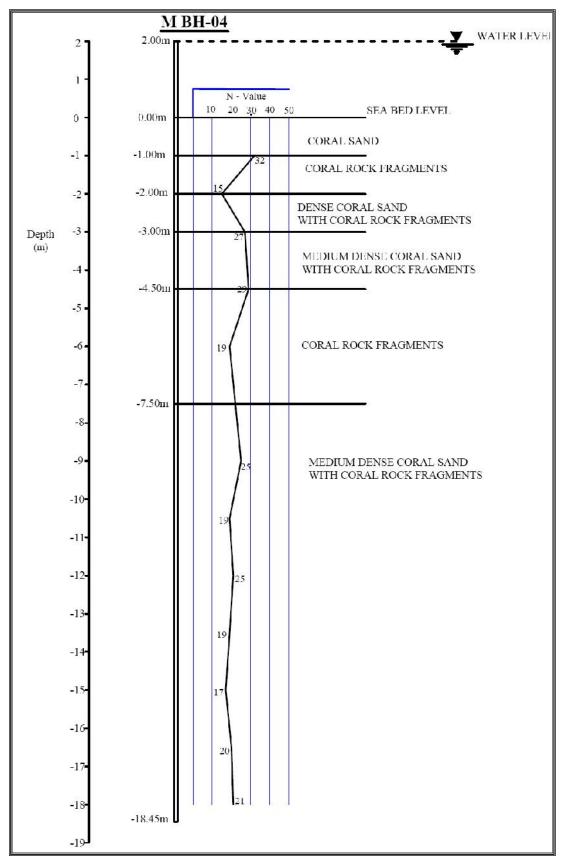




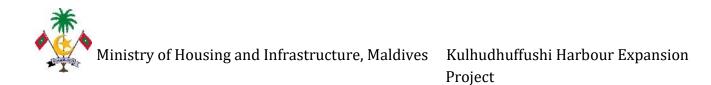


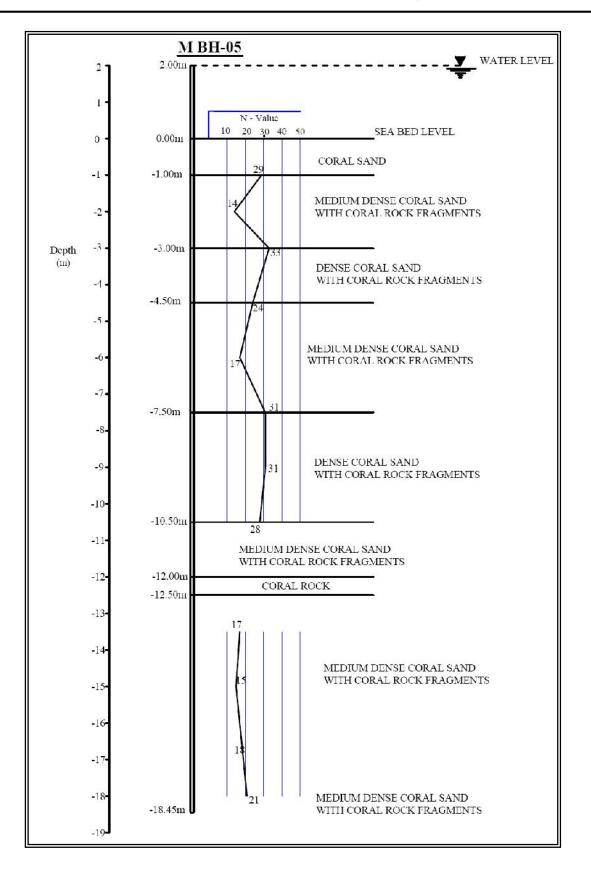




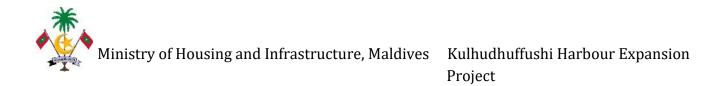


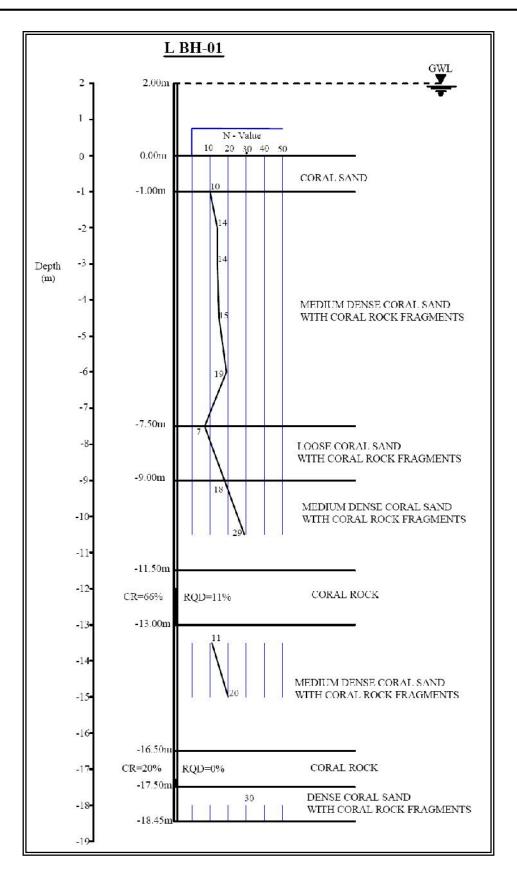






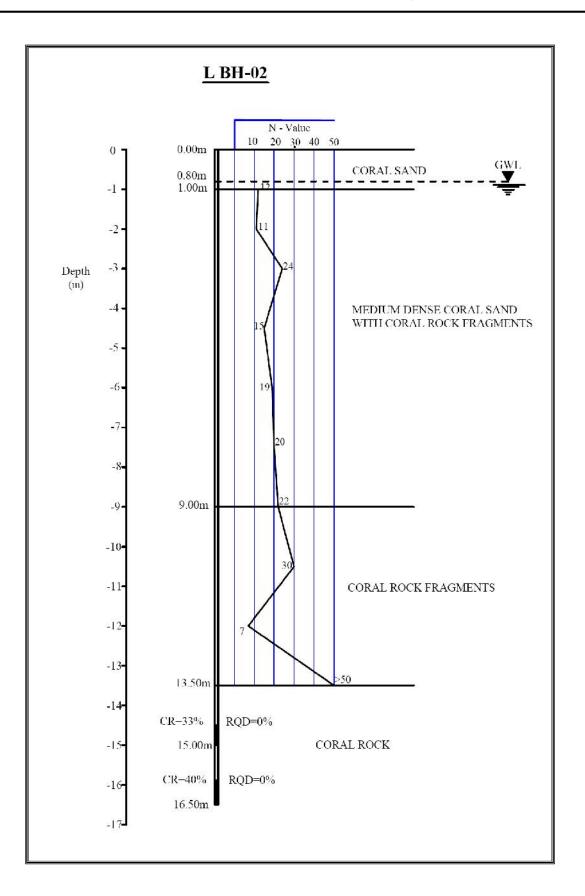




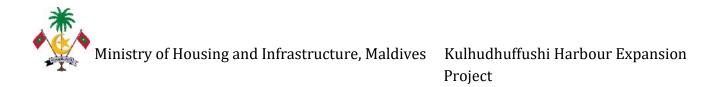


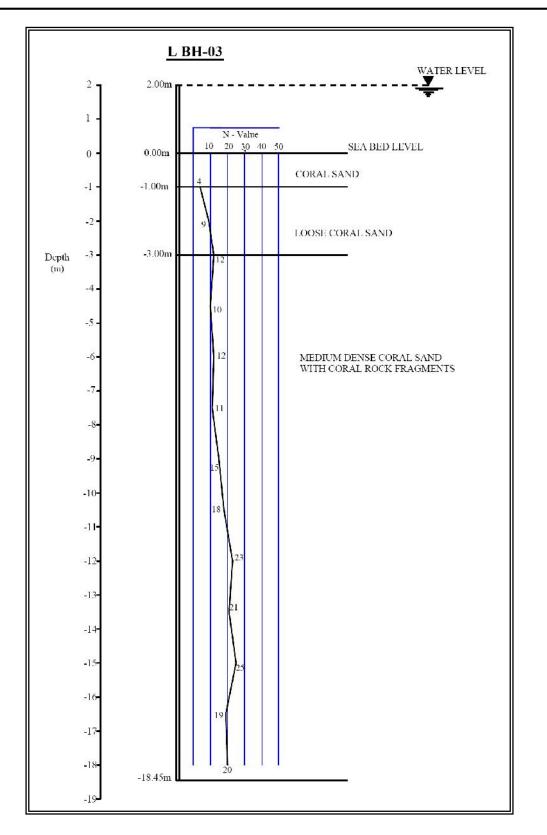






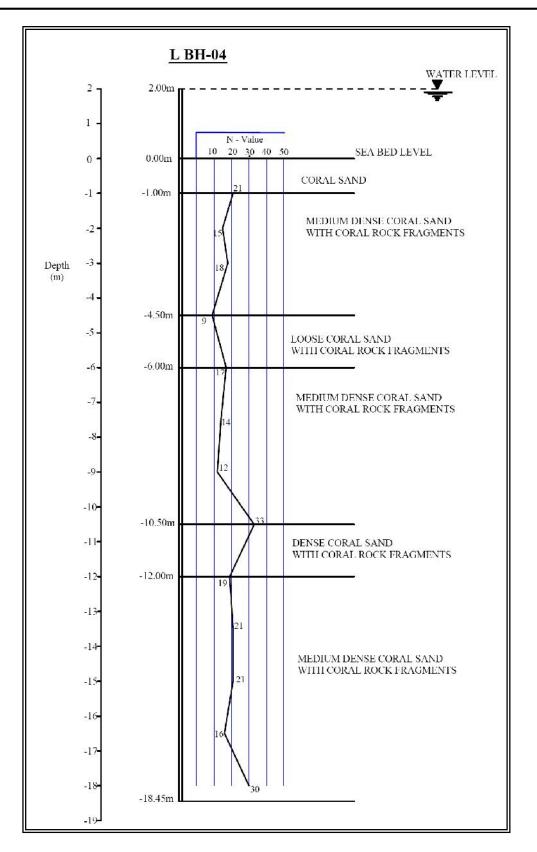




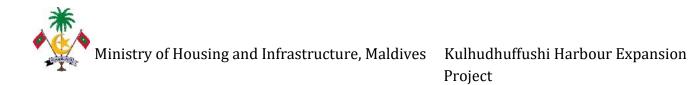


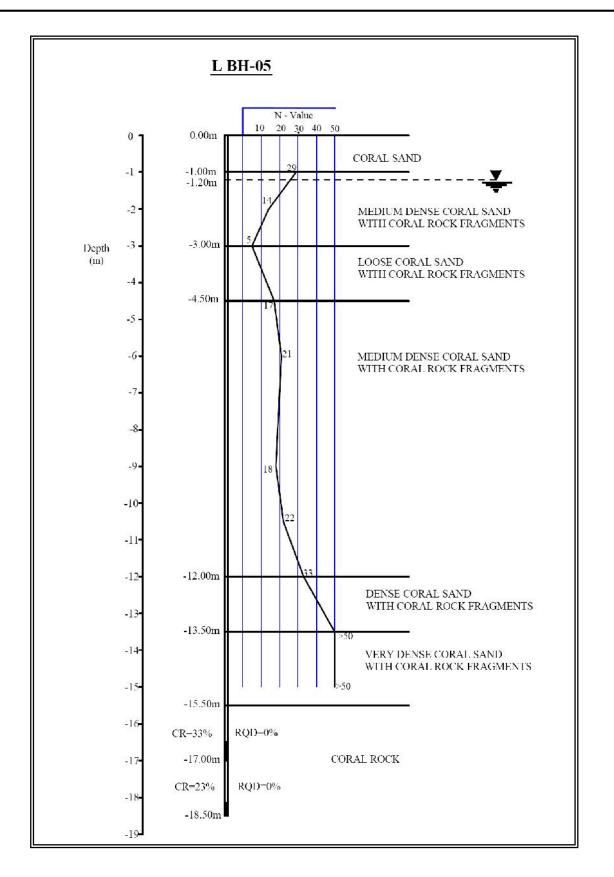
















ANNEXURE-I

BOREHOLE LOGS





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ELS INTERNATIONAL (PVT) LTD. SITE INVESTIGATIONS DIVISION

Figure 2 (a)

Format No: ELS-SI-02

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Depth (m)	Pu			the second s	_														
pth	Sa. Cond	Sa.NO.	Typ	Kulhudhurfushi 12.10.2017 Rig Dense, light gray, sub anguar to angular coal SAND with coral rock fragments Cord Issue (SPT) Water Column Height 2 (Coordinates 285902.0) (Coordinates 285902.0) (Coordina		90													
	Sa.	Sa.	Sa.	Rec	De	Le					cm	E	cm	-	SP	T Resistance		/ft	<u> </u>
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M/s. WAPCOS Limited, India

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																	Γ			F	igur	e 2 (b)
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Pro	jec	t						stigatio	n for Proj Expansion	ject Ma	nage	ment	Cons			r	Вс	orehol	e No	Τ	M BI	1-02	-
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9.00 - 10.00	X	D6	ss ws	s 0.0									7	10	15	25				25			
		_	001,51						umple Key / Tes	t Kev			_				_		Ren	arks	Logged F	i <u>v:</u>	_
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torted	10	Kulh				Joy	Core D			54mr	n	Water	Column			2.00n
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inish		30.09	9.201	7	Casing Diameter	76mm	Elevati	on (m)	ŝ		00000000000000000000000000000000000000	en a mental de s		28603	
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ype	cedl	h (n	pu		Soil Descrip	otion				PT)		10 20 30	ined Shea 40 5		gth - t/m 70 80	
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_	_				-			Sample Key / Tes						_		<u>.</u>	Re	marks	Logge	d By :	-
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			, after th stered	ne satur	ration			UD- Undisturbed Sample CS- Core Sample		Bulk Density Vane Shear T	est		pH - Cl O - Ory	temical tanic cont	ent		100000000	he zero		Prasa I By:	d
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\propto	Ma	de G	iround	1	*****	7		Gravel	-	Laterit		lules			omplete			Rock	6	1	
-1	Cla	y			1.1.1	San	d	Organic Mat	ter	* Silty S	and		1	High	hly Wea	thered	Rock		F	resh R	lock



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E	5						ELS INTER SITE INV	RNATIO ESTIGAT									Format N ELS-SI-0
Proj		t			Kulh	udhu	ical Investigation for Pro Iffushi Harbor Expansio				sulta	nt fo	r	Borehol	e No		BH-03
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ocat			ted		03.10				Casing			18.00			1	0	2.001 1990N
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Ê.	_			evel	6					Fi	eld I	Recor	ds		loisture Co		
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Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Redu	Dep	Leg				E	E	E		7.4 T 744 TS	Resistance		
.00							Continue from	Page 1		IScm	15cm	15cm	z	5 10 15	20 25	30 35	40 4:
.00 Z	X	D9 SS 0					Same as previous	descriptior	1	НВ	13	20	>50				>50
00									8	12	16	28				3	
10 Z			ws			0 0 0 0	Dense to medium dense coarse, angular to sub ar with coral rock	ngular coral								28	
10	X	D12	ss ws			00 00 00				6	18	24	42			/	42
00	X	D13	ss ws		16.50	00 00 00 00	Medium dense, light gr angular to sub angular coral rock fra	coral SANI		8	6	7	13	<	13		
	\langle	D13	SS		18.00	0.0	Dense, light gray, fine to co angular coral SAND with o			18	20	13	33			3	3
00	18.45 The borehole was terminated at the dial 18.45 18.45m Sample Key / Test Key							depth of									
		_	_			_				_		_			Remark	s Logge	d By :
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-			round	11	*****	Silt	ີ Gravel	A A	Laterite	Nod	ulee	1	1 Ca	npletely Wea	thered Peal		/



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Figure 2 (d)

V	15			ELS INTERNATIO SITE INVESTIGA Geotechnical Investigation for Project Man Kulhudhuffushi Harbor Expansion Project.																	Forma ELS-	
	-				Cent	ochni	col Invo												. 1			0.3988
ro	jec	t												suita	nt io		Bore	hole N	No	M	BH-0)4
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	tion					udhuf		Rig		J	оу	Core D	Diamo	eter	54m	m	W	ater C	olumn	Heigh	nt 2.	.00r
		Star				0.2017				thod V		Casing			18.0	0m	Co	ordina	otes		32320	
ate	of	Fini	shee	-	15.10	0.2017		Casir	ng Diar	meter 7	6mm	Elevati	on (1	n)			Co				85846	
(iii)	p			leve	Ē								Fi	eld F	Recor	ds –	11	201001005	sture Co d Shear			-
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Del	Sa.	Sa.1	Sa.	Red	De	Leg							15cm	15cm	15cm	z			esistance			
00	-					I			Grou	and level			15	15	15	~	5 10	15	20 25	30	35 40	45
00	Х	DI	DS		0.00	0 ° 0 0 ° 0	-		coral SA		sub ang ith sea s											
0				J	1.00	$\hat{\mathbf{O}}^{0}$	Li	ght gr	ay, cor	al rock	fragmer	nts										
1	∇	D2	SS	-	2.00	:0.0	P			•	••••••••••••••••••••••••••••••••••••••		16	12	20	32						+
0	\bigtriangleup		ws	G.W.L at 2.00m	~	00	Dense coral SA		with co		ilar to ar fragme	-									32	
0	\vee	D3	SS		3.00	0.0							6	7	8	15		/	\sim			+
)	\bigtriangleup		ws			0 0 0 0 0 0		dium dense, light gray,sub angular to ngular, coral SAND with coral rock fragments with some silt										\$				
,	Х	D4	ss ws		4.50	00							10	16	11	27				27		
	X	D5	SS			Ø					RAL RC coral sar		8	17	12	29				29		
,	X	D6	ws ss		7.50	00							6	10	9	19			19			
	X	D7	ws ss		b i j						8	10	15	25			$\left\langle \right\rangle$	25				
00			ws			0 0			Sample K	ev / Test Ke	- x								Remark		ged By :	
r nl	the is g : Gro Bon Not I -Ha	here full 0.3m penetration has not been achieved D - Disturbed Sample N - Natural M the number of blows for the quoted penetration SS - SPT Sample L - Atterberg is given (not N-value) W - Water Sample G - Grain Size Ground Water Level observed inside the WS-Wgrey Sample SG - Specific O Borehole, after the saturation UD- Undisturbed Sample B - Bulk Dens ot Encountered CS - Core Sample V - Vane Sheit Hammer Bounce Cr - Core Recovery (%) Free Down Made Ground X * * * X Silt So of Gravel						Atterberg Lin Grain Size An -Specific Grav Bulk Density	nit Test alysis ity Test		UCT-U CU - C UU-Un pH - Cl O - Org SO ₄ ²⁻ -	onsolidated consolidate	ontent	d g	Existin ground le consider as the ze level	g vel <u>Sup</u> ed	Dimut ervised By Prase led By: Nima	ad				
-								1.0			1.2	_										



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€							ERNATIO NVESTIGAT										rmat N LS-SI-0
roje	ct			Kulh	udhuffus	Investigation for I hi Harbor Expans	Project Man	agement	Cons			r	2,551,55 ac 564,947 c	nole No		M BH	on the Berlins
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ocatio					udhuffushi		Joy	Core D					Wa	ter Colun	in He		2.00
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a p			leve	(E)	_				Fi		Recor	ds —	Un	drained She	C-11-12-12-12-12-12-12-12-12-12-12-12-12-	2.2.2.2.2.2.2.	m ²
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r Whe	ere full	0.3m ps	netratio	n has not b	een achieved	D - Disturbed Sample		 Natural Mois 	ture Cor	itent	C - Cons	olidation		Rem	arks	Logged B	<u>v:</u>
th	ne numb	er of bl	ows for	the quoted		SS -SPT Sample	L	Atterberg Lir	mit Test		UCT-Un	confined C	ompression	Exis	ting		imuthu
	given (d.	W - Water Sample	1.00	- Grain Size Ar			Construction of the	nsolidated		ground	~	Supervised	<u>d By:</u>
	round V orehole.			erved inside ation	e the	WS-Wgrey Sample UD- Undisturbed Sam		 Specific Grav Bulk Density 			UU-Unco pH - Che		Undrained	consi	dered	F	Prasad
Not	Encour	ntered				CS- Core Sample	v	 Vane Shear T 			O - Orga	nic content		as the		Drilled By	
-н	lammer Free Dov					Cr - Core Recovery (A STATISTICS AND					ulphate Co		le	/el		Nimal
- F		11.0				RQD-Rock Quality D	resignation (%)			-	CI - Clor	ide Conten	1				* di tidi l
X T	ade G		1	*****	Silt	ം മോഗ് Gravel	44	Laterite	e Nod	ulee	1	1 6-	nnletaly V	Weathered R	ock	N A	



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E	3							ELS INTER									•		nat No -SI-02
	jec							SITE INV stigation for Pro arbor Expansio	ject Mana	agement	Cons			r	Boreho	le No	N	M BH-	5757 (S
	nt				M/s.	WAI	PCOS Li	mited							Sheet		1	of	
	tion	n Star	tad		Kulh 14.10		ffushi	Rig Drilling Method	Joy Wash	Core D Casing			54m		Wate	r column		t 2 53.00N	.00r
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e o	Sa.	Sa.NO.	Sa.	Red	Der	Leg					15cm	l5cm	l5cm	z	7/300	T Resistan			*
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	X	D2			1.00	0.0					23	11	18	29			▲ 29	9	
	V	D3	ws ss			0.0		m dense, light gr gular to angular, coral rock fra	coral SAN		13	6	8	14		/			
	Δ		ws			0.0		colui lock ila	ginents							14			_
	X	D4	SS		3.00	0.0		ight gray, fine to	coarse, sul	o angular	9	10	23	33				33	-
E			ws	to angu				ular, coral SANI fragmer	O with cora	-							/		
	X	D5	ss		4.50	. o . O					19	6	18	24		4	24		
	X	D6	ws ss			0 0 0 0 0 0		m dense, light gr gular to angular, coral rock fra	coral SAN	1000	18	10	7	17		17			
			ws			0 0 0 0						1075	120						
	Х	D7	SS		7.50	0 0 0 0					19	11	20	31				31	_
	X	WS 0.0 D8 SS WS 0.0 U 0.0 U							-	17	20	11	31			†	31		
00			ws																
L	the is g : Gro Bor Not I	e numb given (1 ound V rehole, Encour	er of blo not N+v Vater Lo , after th itered	ows for alue) evel obs se satur	on has not b the quoted served insid ation	penetrat		Sample Kev / Te D - Disturbed Sample SS -SPT Sample W - Water Sample WS-Wgrey Sample UD- Undisturbed Sample CS- Core Sample	N L - G SC B	 Natural Moist Atterberg Lin Grain Size An Specific Grave Bulk Density Vane Shear To 	nit Test nalysis ity Test		UCT-U CU - C UU-Un pH - Cl O - Org	onsolidated consolidate emical anic conte		Exist ground consid as the leve	ing level St ered zero D	Dim Dim upervised B Pras rilled By:	<u> šy:</u>
~	- Fr	Hammer Bounce Cr - Core Recovery (%) Free Down RQD-Rock Quality Designation (%)											Sulphate C oride Conte				Nin	nal	
×	Ma	ide G	round	1	*****	Silt		Gravel		Laterit	e Nod	lules	1	: Co	mpletely We	athered Ro	ck	\leq	





E	5							ELS INTE SITE INV				100									rmat l _S-SI-	
roj	jec	t			Geotechnical Investigation for Project Management Consultant for Kulhudhuffushi Harbor Expansion Project, Maldives											Borehole No			M BH-05			
lie							COS Lin		n Project.	Maidiv	es				-	Sheet			2	of		
oca					Kulh			Rig	Joy	Core	Diam	eter	54m	n	-			olumn			2.00	
ate			ted		14.10			Drilling Method		Casin			18.0m						732253.00N			
			shee	ł	15.10			Casing Diamete		Eleva	<u> </u>	_				Co	ordina	ates		940.0		
0	2. N			evel	-	2 3 3					F	ield	Recor	de			Moi	sture Co	mieni	- %	-	
u (u	ond		be	ed le	n (n	Pu		Soil Description					PT)					d Shear		gth - t/	m² 🕳	
Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	F				_		en e		10	10 20 30 40 50 SPT Resistance						
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Ī	2				1	00			10 10 10			-					1	TT	T			
						. 0.	S	ame as previous	s descriptio	on					_				\uparrow			
		D9	SS		10,50	°0					15	12	16	28			-		▲ 28			
.00	\wedge	1000			100000000000000000000000000000000000000	0.0	Medium dense, light gray, fine to coarse,															
	6 - 14 1					0												+				
			ws			0	sub ang	gular to angular,		D with					-		-		+			
						0.	coral rock fragments											+-				
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00						0.0		n dense, light gi														
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k								coral rock fra	agments									21				
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	Wher	e full).3m p	enetratio	n has not be	en achie	ved	Sample Key / T D - Disturbed Sample		- Natural Mo	isture Co	ntent	C - Con	solidation	1		-+	Remar	<u>1</u>	_ogged B	<u>y :</u>	
	the	the number of blows for the quoted penetration SS -SPT Sample L - Atterberg I								imit Test					Compression Existi				Dimuthu			
L		s given (not N-value) W - Water Sample G - Grain Size Ground Water Level observed inside the WS-Wgrey Sample SG - Specific G Borehole, after the saturation UD- Undisturbed Sample B - Bulk Dens												d Undrained ground				Supervise		d By:		
6 2 3												DU-Une pH - Ch		ed U	Conside				I	rasad		
	Not I	Encou	itered		CS- Core Sample V - Vane She								O - Orga	nic cont		as the z				TO Drilled By:		
	-Hammer Bounce Cr - Core Recovery - Free Down ROD-Rock Quality								motion (9/1			SO42- S			content level				Nimal			
- Free Down Made Ground					×××××	RQD-Rock Quality Designation (%)								loride Content Completely Weathered Ro								
>1								a o de tiravei		TAA I ator	te Nod	ulee								Fresh Rock		



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F	3						E	LS INTER										gure	•
	ject	t						SITE INV	ject Mana	gement	Con		<u> </u>	r	Boreho	le No	L	BH-0	
	ent						COS Limit	oor Expansion	i Project,	Maldiv	es				Sheet		1	of	-
	tion	i.				udhufi			Joy	Core I	Diamo	eter	54m	m		Column I			.00r
-	of S	_			05.10			illing Method		Casing	· ·	_	18.0	0m	Coor	dinates		31963	
ite	ofI	Fini	shed	_	06.10	0.2017	Ca	ising Diameter	76mm	Elevat	ion (1	m)			138390202			36068	
	р		0	leve	(E)		Field Records						ds –		Moisture Con ained Shear			-	
	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description					(SPT		Ŀ	10 20 30	60 7	-		
	Sa	Sa.	Sa	Rec	De	Le		Contraction	1		15cm	15cm	l5cm	z		T Resistance			*
)		DI	DS		0.00	·		Ground lev	vel		31	11	11		5 10 1	5 20 25	30 3	35 40	4
)	Х	DI	DS		0.00	0 ° 0 0		y, fine to coars r, coral SAND fragmen	with sea s										
	Х	D2	SS		1.00	0.0	-				3	5	5	10	10				
						00													+
	Д		ss ws			. 0. 0 . 0. 0		lense, light gra			6	4	10	14		14			
						0		, coral SAND		rock				_					
	Х	D4 3	ss			00	Ir	agments with	some silt		8	5	9	14		14			
			ws			0 0 0													
	X	D5	SS		4.50	0.0					8	8	7	15		15			
	X		ws ss			0 0 0 0 0 0		dense, light gra			10	12	7	19		19			
			ws			0 0 0 0 0 0	~								/				
	Х	D7	SS		7.50	0 0 0 0	Washed e	ample: light gr	av sub and	ular to	3	3 NO SA	4 MPLI	7	{				
			ws			0.0		, coral SAND											
	X	D8	SS		9.00	00	angular, c	dense, light gra coral SAND w	ith some s		13	10	8	18	X	12			
00			ws			0.0		coral rock fra											
5 5	Whar	full o	300 0-	etratio	n has not b	een achier	ed ID	Sample Kev / Tes Disturbed Sample		Natural Mois	ture Cer	ntent	C . Cer	solidation		Remark	Log	ged By :	
L	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value) : Ground Water Level observed inside the Borehole, after the saturation Not Encountered -Hammer Bounce					penetratio							UCT-U CU - Co UU-Un pH - Ch O - Org SO4 ²⁻ -1	nconfined (onsolidated consolidate emical anic conter Sulphate C	ontent	Existin ground le consider as the ze level	ed	Dimu <u>ervised B</u> Pras led <u>By:</u> Nime	<u>y:</u> ad
- Free Down					*****	Silt		Lateri	te Nod	lules	CI-Ck	Conte		athered Roc			nd I		
	Iviac	ue U	ound		1x****	Sint] Sand		Gravel	tter	and the second		ules	1	- Co	npietely We	athered Roci			



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e	3							ELS INTI	ERNATI										Forma ELS-S	
Pro	jec	t						igation for F rbor Expans	Project Ma	nageme	nt Con	1		r	Boreh	ole No		LB	H-01	
Clie	ent				M/s.	WAI	PCOS Lim	ited							Sheet		2	2	of	2
Loca					Kulhu	idhuf	fushi I	Rig	Joy	Cor	e Diame	eter	54m	n	Wate	r Colu	mn He	eight	2.0)0m
Date	of	Star	ted		05.10			Drilling Meth	od Wash	Cas	ing dep	th	18.00)m	Cas	rdinate		731	963N	1
Date	of	Fini	shee	d	06.10	.201	7 (Casing Diame	eter 76mm	Ele	vation (1	m)				rdinate	s –	286	6068E	5
(1	_			evel	(1						Fi	ield	Recor	ds		Moistur				
n (n	ond		be	ed l	n (n	P		Soil Des	cription				PT)	-		rained S	C. C. Marcallana	-	t/m ²	
Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend					-	1800	<u> </u>			30 40 PT Resis		60 70	80	90
10.00	s	ŝ	S	2				Continue fr	om Page 1		15cm	I5cm	15cm	z		15 20		30 35	40	45
-0.00		- 1		-	-			Continue n	om ruge r			-	_			15 20		50 55		1
11.00	X	D9	SS			0 0 0 0 0 0	Sa	ume as previo	ous descript	tion	1.023	9 NO S.	20 AMPLI	29				-29		
<u>1</u> 2.00 <u>1</u> 3.00					11.50			gray, porous discolored, c			CR-	66%	RQD-	-11%						
<u>1</u> 4.00 <u>1</u> 5.00 <u>1</u> 6.00	X	D10	ws		13.00	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Medium d	lense, fine to ar, coral SAN fragm	D with co		4 sub 10	11	9	20			20			
17.00					16.50	P		gray, porous discolored, c			CR=	-20%	RQD	=0%						
18.00	X	D12	SS		17.50	00		lense, fine to ar, coral SAN fragm	D with con		sub 15	18	12	30				30		
<u>1</u> 9.00					18.45		The bore	nole was term 18.4		he depth	of									
20.00																				
SPT GWL NE HB FD	the is g : Gro Bor Not I -Ha - Fn	numb iven () sund V rehole Encou mmer ee Do	er of b not N Vater I , after i ntered Bounc	lows for t value) Level obse the satura	has not be he quoted p erved inside tion $x \times x \times x$	the	on S ע ע נ נ ג ג ג ג ג ג ג ג ג ג ג ג ג ג ג ג	Sample Key D - Disturbed Sample S -SPT Sample VS-Wgrey Sample VD- Undisturbed Sample T- Core Recovery (QD-Rock Quality Do Core Gravel	ple %)	L - Atterbe G - Grain S	Gravity Test nsity near Test	3	UCT-Un CU - Co UU-Une pH - Chi O - Orga SO4 ²⁻ - S	nsolidatec onsolidate emical unic contei ulphate C ride Conte	ontent	E: grou cor as t	xisting und leve nsidered the zero level		Dimuth ised By: Prasad	1





6	5							ELS INTER	NATIO	NAL (I	PVT	') L'	ГD.			Figur	e 2 (g)
	jec	_			Geot	echni	ical Inves	SITE INVE	ESTIGAT	IONS D	IVIS	201			Borehole No	LB	H-02
lie	ent				M/s.	WAI	PCOS Lir	nited							Sheet	1	of 2
oca	tion	n			Kulh	udhu	ffushi	Rig	Joy	Core D			54m		Ground W		0.80m
		Star			20.10			Drilling Method		Casing			13.5	0m	Coordinate	c	091N
ate	of	Fin	shee		23.10	0.201	/	Casing Diameter	/6mm	Elevati			I	_	Moistur	re Content - %	5040E
(m)	pu		e	d lev	(II)	ъ		Call Danala			Fi		Recor	ds –		hear Strength -	
(m) mqsu	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend		Soil Descrip	tion	8			PT)		10 20 30 40	50 60 70	80 90
й 10	Sa	Sa	S	Re	Ď	Ľ		Ground leve	el		15cm	l5cm	15cm	z	5 10 15 20	stance - Blows/1	ft A
	\checkmark	DI	DS		0.00	0.0			20.4		-		-				40 45
0	\triangle			•		° 0 0 °		gray, fine to coarse ular coral SAND fragment	with sea sh								
50 20	Х	D2	SS	G.W.L. at 0.80m	1.00	0 0 0 0	Mediu	m dense, light gra	y, fine to c	oarse,	3	7	5	12	12		
)	Х	D3	SS WS			0 0 0 0		ilar to angular con shell fragme	al SAND v		6	7	4	11	11		
,	Χ	D4	ss		3.00	0 0 0 0					5	10	14	24		24	
0			ws			0 o 0 0											
	Χ	D5	SS			0 o 0 o 0 o					12	10	5	15	15		
Section and	X	D6	ws ss			0 0 0 0 0 0	 Construction de la construction de la	m dense, light grag gular to angular co coral rock frag	oral SANE	1	25	12	7	19		19	
100			ws			0 0 0 0											
	Х	D7	ss ws			0 0 0 0 0 0					13	9	11	20	1	20	
	Х	D8	SS		9.00	0 ° 0 0 ° 0	Light gra	ay, brown, coral fr	ragments v	vith fine	18	12	10	22		22	
)0			ws			00		to coarse, coral	Key							emarks Logged	By:
	the is g : Gro Boi Not I -Ha	numb iven () ound V rehole Encou	er of b not N Vater I , after i ntered Bounc	lows for t value) Level obso the satura	n has not b he quoted erved inside tion	penetrati		D - Disturbed Sample SS -SPT Sample W - Water Sample WS-Wgrey Sample UD- Undisturbed Sample CS- Core Sample Cr - Core Recovery (%) RQD-Rock Quality Designal	L - G - SG - B - V -	Natural Moist Atterberg Lin Grain Size Ar Specific Grav Bulk Density Vane Shear T	nit Test nalysis rity Test		UCT-U CU - C UU-Un pH - C O - Org SO ₄ ²⁻ -	onsolidated	Compression E: d Undrained grou ed Undrained cor nt as i content	xisting ind level Superv insidered the zero level Drilled	Dimuthu <u>ised By:</u> Prasad <u>By:</u> Nimal
X	Ma	de G	roun	d	*****	Silt		ംറ്റ്റ്റ് Gravel	Å^A	Laterit	e Noc	ules	200	_	mpletely Weathered	Rock	1
-	Cla	1000] San		Organic Mat					1	-	ly Weathered Rock	1	esh Rock



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E	b									RNATI VESTIG				-										mat No S-SI-02
Pro	jec	et			Geo	echn	ical Inve	stigati	on at Ku	lhudhuff	ushi	Island					в	oreho	ole I	No		L	BH-	-02
Cli Loca	atio	n	rted		Kulh		PCOS Li ffushi 7	Rig	ng Metho	Joy d Wash		Core D Casing			54mr		S	heet Gro	unc	l Wa	2 iter L	leve	of 1 (3209	2 0.80m
		Fin	sa.Type	Reduced level		0.201 0.201		Casir		er 76mm		Elevati	ion (1	m) ield l	Record	_	10		Mois	sture (d She	Conte	28 nt - % ength	3604 %	•0E ■ n ² ●
00.0	Sa.	Sa.NO.	Sa.7	Redt	Dep	Leg		C	Continue fro	m Page 1			15cm	15cm	15cm	z	5	SP	ΤR	esista	nce - I	Blow	111111	*
1.00	X	D9	SS WS			0 0 0 0 0 0 0 0					• 1000		26	18	12	30			/	/		. 30		
2.00	X	D10	ss ws			0 0 0 0 0 0		Same a	is previou	s descript	tion		10	3	4	7	4	<						
						0.0			ROCK L	EVEL				NO S.	AMPLI	E >50								
4.00 5.00	X	DII	SS CS		13.50					, light gra g coral RC			CR-	33%	RQD	-0%								>50
5.00			cs		15.00					, light gra g coral RC			CR-	40%	RQD	-0%								
7.00					16.50		The bor	ehole ·	was termi 16.50	nated at tl 9m	he do	epth of												
8.00																								
9.00																								
0.00 PT	When	FO 6-1"	0.1	onot		L .	mad		Sample Key /	Test Key	N. N	atureal h 4-2-	tures C.	tour.	6.6-	alid-ti		1		Rem	arks	Log	ged By	1
PT WL E B O	the is g : Gr Bo Not I -Ha	given (ound ' orehole Encou	er of b not N- Water 1 , after ntered Bound	lows for value) Level ob the satu	on has not l the quoted served insic ration	penetrat		SS -SPT W - Wat WS-Wgr UD- Und CS- Core Cr - Core	er Sample ey Sample listurbed Sample)	L - A G - G SG -S B - B	latural Moist Atterberg Lin irain Size Ar pecific Grav ulk Density 'ane Shear T	nit Test talysis ity Test		CU - Co	confined nsolidate onsolida mical nic cont ulphate	l Compres ed Undrai ted Undra ent Content	ned		ground consi as the	sting d leve dered e zero vel		ervised Pr led By:	nuthu By: asad imal
8	Ma Cla		Groun	d	× × × ×	Silt			Gravel	5	****			ules		: (Complet	tely We eathere			lock		Fresh	Rock



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6	5							ELS	INTER	NATIO	NAL (I	PVT	') L'	TD.					r'i	igur	2 ت	(11)
2	0								ITE INVE		and a share of the second	and the second second										
Pro	S								n for Proj Expansion				sulta	nt foi	r	в	orehol	e No		LBI	H-03	I.
Clie	ent	223					COS Li				IC T			164	0.000		heet Water	a 1	1		of	2
.oca Date			rted		Kulht 09.10			Rig Drillin	g Method	Joy Wash	Core I Casing			54m		+			1 Heig		2.0 259N	
			ishee	_	10.10				Diameter		Elevat	ion (1	m)				Coord				005E	-
Ē	pu		2	Reduced level	(III)	-						Fi		Recor	ds –		2114	loisture (2 V. W. W.		-
Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	educed	Depth (m)	Legend		Se	oil Descrip	tion				PT)		10	20 30	40	50 60	70	80	90
00	Š	Se	Ň	R	9	7			Ground leve	el		15cm	15cm	15cm	z	5	10 15	Resista	25 30		40	45
	X	D1	DS		0.00	00	Light	rrav fir	e to coarse	e sub and	ular to											
	\square					· 0.			ral SAND												_	_
						0.0	Ŭ		fragment							-	-			-	-	+
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	Δ					.00										1 4						
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00						0.0			th coral ro									_	-	_		-
	Х	D3	SS			.0.0			some silt	t		8	4	3	9		9	_	-		+	+
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00						0.0 0.0										_						
	Х	D4	SS		3.00	0.0						10	6	6	12	_	1	2		_	-	-
ľ						:0:0											T	-		-	+	+
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						.0 0																
00						.0.										_		_		_	_	_
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ſ						.0.0	angu	lar, cora	al SAND v		rock					-					+-	+
00			ws			0.			fragment	s										-	+	t
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						.0.														-	+	t
.00			ws			0.0																
Т	When	e full	0.3m p	enetratio	n has not be	een achie	ved	D - Disturb	mple Key / Test bed Sample		Natural Mois	ture Cor	ntent	C - Cor	solidation	0	50	Rem	arks	Logged	<u>By :</u>	
			er of bl not N-v		the quoted j	penetratio	on	SS -SPT Sa W - Water			Atterberg Lin Grain Size Ar			1.121	nconfined				ting	Supervis	Dimuthu sed By:	u
VL.	: Gro	ound V	Water L	evel obs	erved inside	e the		WS-Wgrey	Sample	SG	-Specific Grav	ity Test		UU-Un	consolida			ground	d level			8
	Not I	Encou	ntered	he satura	nion			CS- Core S			Bulk Density Vane Shear T				anic cont			as the	zero	Drilled E	Prasad <u>By:</u>	45
3		mmer ee Do	Bounc wn	e					ecovery (%) Quality Designat	tion (%)					Sulphate (oride Cont			lev	vel		Nimal	
XI	-		iroun	4	××××××	Silt		°2°2			Laterit			1			tely Wea	di ana di D		\sim	1	





	5							ELS INTER SITE INV											ormat N LS-SI-0
Proj					Geot	echni	cal Invest	tigation for Pro						r	Boreho	la No		L BH	1.02
		•						rbor Expansion	n Project,	Maldive	es				51.54.5201.0041.5354			C. Martine C.	
Clie		2					COS Lin			10 0					Sheet	~ 1	2	of	
ocat						udhuf		Rig	Joy	Core D					Water	Column	Heig		2.001
		Start Finis		1		0.2017		Drilling Method Casing Diameter		Casing Elevati			18.00	m	Coor	dinates	<u> </u>	7322: 2860	
_		r mus	snec	_		1.2017		Casing Diameter	701111	Lievau			S		-	Moisture C	ontent		055
Ê.	р		2	d lev	Ē			C.: 1 D			Fi		Recor	ds –		ained Shea			/m ²
Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend		Soil Descrip	ption			(S	PT)		10 20 3				80 90
0.00	Sa	Sa	Sa	Re	Ď	Ľ	20	Continue from	Daga 1		15cm	15cm	15cm	N		T Resistan			10 1
.00	+	+	+		-	· () •)		Continue from	rage i		-	-1	1		5 10	15 20 2	3 30	35	40 45
	X	D10 D11 D12	ws ss ws ss ss ws				Sa	ame as previous	description		15 18 8 6	10 8 9 8	8 15 12 17	18 23 21 25			25		
.00		D13	ws			0 0 0 0 0 0 0 0					6	9	11	20		19			
ŕ	Δ				18.45	u	The bore	hole was termina	ated at the c	lepth of				-		▲ 20			
.00								18.45m											
	_	_	_	_	<u> </u>			Sample Key / Tes			_					Reman	ks	Logged B	y:
	the is gi	numbei iven (n	r of bloot N-v	ows for alue)	n has not b the quoted	penetratio	on S	D - Disturbed Sample SS -SPT Sample W - Water Sample	L -	Natural Moist Atterberg Lir Grain Size Ar	nit Test	ntent	N		ompression Jndrained	Existi ground		D <u>Supervise</u>	Dimuthu ad By:
L :					erved insid	e the		WS-Wgrey Sample		Specific Grav	ity Test				Undrained	conside			Dencord
,		ehole,		he satur	ation			UD- Undisturbed Sample CS- Core Sample		Bulk Density Vane Shear T	est		pH - Che O - Orga	mical nic content		as the		E Drilled By	Prasad <u>v:</u>
1				8				Cr - Core Recovery (%)		June Street I			SO42 S	ulphate Co	ntent	leve	1		ten.
	-Hammer Bounce - Free Down Made Ground						3	RQD-Rock Quality Design	ation (%)					ide Conten				1 1	Nimal
				18 9	Silt		Gravel		Laterite			01 0101	-	npletely We		<u> </u>	~ ~		



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6	ß							ELS INT	ERN	NATIO	NAL (PVT) L'	ГD.			•	Figur	C 4 (I
	jeo				100000000000000000000000000000000000000			SITE I stigation for I arbor Expan	Proje		gement	Cons	A. 4		r	Borehole No	>	LBH-	N-04
	ent				M/s.	WAP	COS Li	nited						_		Sheet	1	0	<u> </u>
	atio					udhuf		Rig		Joy	Core 1			54m		Water Colu	umn He	-	2.001
		Star	ted	1		0.2017		Drilling Meth Casing Diam			Casing			10.9	0m	Coordinat	es 🛏	7319	
			snee			1	/	Casing Diam	eter	/onin	Lieva	1		1		Moistu	ire Conter		-04L
(II)	puc		be	ed lev	E I	р		Soil Des	erint	ion		FI		Recor PT)	ds	Undrained			-
Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend		bon be	,en pr							10 20 30 40 SDT Pas	50 60 istance - I		80 90
00	S	S.	S	R		L		Groun	d leve	1		15cm	15cm	15cm	z –	5 10 15 20		30 35	40 43
00	X	D1	DS		0.00	0° 0°		gray, sub angu ND with cora											
0	X	D2	SS WS		1.00	00						17	14	7	21	1	21		
	X	D3	ss ws			0 0 0 0	1 101101101101101101101101	m dense, light	~ ~	(1) (3) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1		12	9	6	15	15			
D	X	D4				0 ° 0 0 ° 0		ılar coral SAN fragments wit				9	7	11	18		18		
)	X	D5	ws ss ws		4.50	00000000		light gray, su oral SAND wi				7	5	4	9	9			
	X	D6	SS WS		6.00	0 0 0 0 0 0 0 0 0 0						8	11	6	17		7		
	X	D7	SS WS			0 0 0 0 0 0 0 0	angu	m dense, ligh ular coral SAN fragments wit	JD w	ith coral	rock	11	4	10	14	14			
00	X	D8	SS WS			0 0 0 0 0 0						10	7	5	12	12			
50	_					1	l	Sample Key	/ Test I	<u>Key</u>				1			Remarks	Logged I	<u>3y:</u>
L	the is g : Gr Bo Not -Ha	e numb given (round V orchole Encour	er of blo not N-v Vater L , after t ntered Bounco	ows for alue) evel ob he satur	on has not b the quoted served insid ation	penetrati		D - Disturbed Sample SS -SPT Sample W - Water Sample WS-Wgrey Sample UD- Undisturbed Sam CS- Core Sample Cr - Care Recovery (RQD-Rock Quality D	ıple (%)	L - G - SG B - V -	Natural Moi Atterberg L Grain Size A -Specific Gra Bulk Density Vane Shear	imit Test analysis wity Test		UCT-U CU - C UU-Un pH - Cl O - Org SO4 ²⁻ -	onsolidatec consolidate	I Undrained gro ed Undrained cc nt as ontent	Existing ound level onsidered the zero level	Supervis	Prasad
8	Ma	ade G	iroun	b	*****	Silt),	Gravel			Lateri	ite Nod	ules	1	-	mpletely Weathere	d Rock	\approx	
X	_	ade G		d	××××;	Silt San	d						ules	CT-CI	i Co			Fre	Nima sh R



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E	3	1						ELS INTER SITE INVE				5.						rmat N _S-SI-0
ro		-						stigation for Proj arbor Expansion	ect Mana	gement	Cons			r	Borehole No		LBH-1	N-04
Clie					M/s.	WAF	PCOS Li			13.					Sheet	2	of	
oca					Kulhu				Joy	Core D					Water Colum	nn Heig		2.00r
			rted	1	15.10			Drilling Method		Casing			10.90)m	Coordinates		73193	
	01	Fin	ishe		16.10	.201	/	Casing Diameter	/omm	Elevati	<u> </u>				Moisture	Content		84E
Deptn (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend		Soil Descrip	tion			(S	Recor PT)	ds –	Undrained Sh 10 20 30 40 SPT Resist	ear Strer	ngth - t/1 70 8	m ² •
ם 00.	S	Sa	š	Re	<u> </u>	Ę	-	Continue from I	Page 1		15cm	15cm	15cm	z	5 10 15 20	25 30		40 45
						0.0	5	Same as previous o		1						N		
	X	D9	ss		10.50	00					20	18	15	33			▶ 33	
.00						0.0		, light gray, sub an								+		
			ws			.0.0	corar SP	traces of s		its with						\square		
00		DIG	SS		12.00	0.0	-				8	13	6	19				
	А	Die	35		12.00	:0:0					°	13	0		19	+		
00			ws			0 0 0												
	X	DII	ss			0 0 0 0					13	11	10	21		21		
00			ws			°0.								-				
00			104101			0 0.	Mediu	ım dense, light gra	v. sub ang	uar to								
00	X	D12	ss ws			00	angu	lar coral SAND w fragments with tra	vith coral r		16	13	8	21		21		
00	Х	D13	ss			0 ° 0 °					9	10	6	16	16			
			ws			0 0 0												
00	Х	D13	ss			0 0. 0 0					15	13	17	30		X	30	
00					18.45		The bor	ehole was termina 18.45m	ted at the c	lepth of								
00									•									
6	the	e numi	ber of b	lows for	n has not be the quoted p			Sample Kev / Test D - Disturbed Sample SS -SPT Sample	N - L -	Natural Moist Atterberg Lir	nit Test	itent	UCT-Ur		Compression Ex	isting		imuthu
L	: G	round		evel obs	erved inside	the		W - Water Sample WS-Wgrey Sample UD- Undisturbed Sample	SG -	Grain Size Ar Specific Grav		ŝ		onsolidate	1 Undrained	nd level idered	Supervised	<u>d By:</u> rasad
			e, after i intered	he satura	non			CS- Core Sample		Bulk Density Vane Shear T	est		O - Orga	nic conten	t as th	ie zero	P Drilled By	100000
			Bound	e				Cr - Core Recovery (%)	1					ulphate Co	men	evel	~	Slige-1
∇		ree Do	Groun	d	××××	Silt		RQD-Rock Quality Designat	tion (%)	A Laterite	Nad	ulas	Cl - Clo	ride Conter	mpletely Weathered	Pool	<u></u>	Nimal
		and (Juoun	n#.	LA X X	1 out		Organic Mat	AV7	a Laterite	- INOG	uics		- CO	inpictory weathered	LOCK L	~~	



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Figure 2 (j)

																		F	igur	e 2 (
e	3							ELS INTER SITE INVI												rmat No .S-SI-02
Pro	jec	et						stigation for Proj arbor Expansion				sulta	nt fo	r	Boreh	ole N	ю	1	L BH	-05
	ent				M/s.	WAP	COS Li	mited							Sheet			1	of	
	ation		- 1			udhuf		Rig	Joy	Core I			54m		Gro	ound	water			1.20n
			rted	d		0.2017		Drilling Method Casing Diameter		Casing Elevat			18.0	0m	Coo	rdina	tes		73250 2859	
1992			ished	_		1		Cusing Diameter	/ Onin	Lieva	T	ield F		1	_	Moist	ure Co			
II (III	ond		/be	ed le	u (m	p		Soil Descrip	otion		F		PT)				Shear		-	-
Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend					-			+			o 50 sistance	60 - Blo	70 8 ws/ft	10 90
00	0	S	0)	H	-	-		Ground lev	/el		15cm	15cm	15cm	z			20 25	30		40 45
00	X	D1	DS	75	0.00	0 ° 0 ° 0 °		gray, fine to coars ular, coral SAND fragment	with sea s											
00	X	D2	SS		1.00	0 0 0 0					13	24	5	29			/	▲ 2	9	
00	X	D3	ss ws			0 0 0 0					7	6	8	14	/	14				
00	X	D4	ss ws			0 0 0 0					6	3	2	5	5					
0	X	D5	SS			0 0 0 0 0					7	7	10	17			17			
00	X	D6	ws ss			0 0 0 0 0 0	200000000000000000000000000000000000000	im dense, light gra ilar, coral SAND fragments with	with coral		10	9	12	21			21			
0	X	D7	DD			0 0 0 0 0 0					1	NO SA	MPLI							
00	X	D8	SS			0 0 0 0 0 0					7	10	8	18		1	18			
0.00			WS			· . · .		Samela March 19	t Kay								Bernal		outred P	
T WL E B D	the is g : Gro Bo Not I -Ha - Fr	numb given (ound V rehole Encou ummer ee Do	er of bl not N-v Water I , after t ntered Bounc wn	lows for value) Level ob the satur	on has not b the quoted served insid- ation	penetratic		Sample Kev / Tes D - Disturbed Sample SS -SPT Sample W - Water Sample WS-Wgrey Sample UD- Undisturbed Sample CS- Core Sample Cr - Core Recovery (%) RQD-Rock Quality Design	N - L - G - SG B - V - ation (%)	Natural Moi Atterberg Li Grain Size A -Specific Gra Bulk Density Vane Shear	imit Test analysis wity Test v Test	i i	UCT-U CU - C UU-Un pH - Cl O - Org SO4 ²⁻ -	onsolidate consolidat nemical ganic conte Sulphate C pride Cont	Compression d Undrained ed Undrained nt Content ent	gı c a	Existin round le onsider is the ze level	g vel <u>s</u> ed ro <u>p</u>	upervised P Prilled By	imuthu <u>4 By:</u> 'rasad
\propto	Ma Cla		iroun	d	<u>x×××x</u> 	Silt	d	Gravel Organic Mat	-	Lateri	ite Nod Sand	lules	议		mpletely W ly Weathere			k [2	Fres	h Rock





e	b						ELS INTE SITE INV	RNATIO /estigat			· · · · ·							ormat No LS-SI-02
	jec				Kulh	udhu	cal Investigation for Pro ffushi Harbor Expansio				sulta	nt fo	r		ole No		L BI	
	ent ation					WAP udhuf	YCOS Limited	Joy	Core D	liam	eter	54m	12	Sheet	ound y	2 vater le		f 1.20n
		Star	ted			0.2017			Casing			18.00		1 1000	0.18	:		62N
_			ishee	d		0.2017			Elevati	-				- Coo	rdinat	es 🗖		912E
Depth (m)	Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	end	Soil Descr	ription		Fi		Recor PT)	ds _			ure Conte Shear Str	255 J. C. C.	/m ² • 90
00.0	Sa. (Sa.N	Sa.T	Redu	Dep	Legend	Continue from	n Page 1		15cm	15cm	15cm	z	S		istance -		
00 2.00 5.00		D9 D10	ws ss ws		12.00		Same as previous Medium dense, light g angular, coral SAND fragments with Very dense, light gra angular, coral SAND fragments with	s description ray,sub ang) with coral 1 some silt ny,sub angul) with coral	ular to rock ar to	5	10 17 30	12 16 HB	22 33 >50				33	>50
.00	X	D12	cs		15.50		ROCK LE Highly fractured, porou ROCI	ıs, light gray	y, coral	HB CR=	33%	RQD	=0%					>50
.00			CS		17.00	Ď	Highly fractured, porou ROCI	ĸ		CR=	23%	RQD	=0%					
.00					18.50		The borehole was termin 18.50		depth of									
_		_					Sample Key / T									Remarks	Logged	By:
1	the is g : Gro Boi Not I -Ha	numb given (i ound V rehole, Encour immer	er of bl not N-1 Water I , after 1 ntered Bounc	lows for value) evel of the satu	on has not b the quoted served insid ration	penetrati	on SS -SPT Sample W - Water Sample WS-Wgrey Sample UD- Undisturbed Sample CS- Core Sample Cr - Core Recovery (%)	L - G - SG B - V -	Natural Moist Atterberg Lin Grain Size Ar -Specific Grav Bulk Density Vane Shear T	nit Test aalysis ity Test		UCT-Ur CU - Co UU-Unc pH - Chi O - Orga SO4 ²⁻ - S	nsolidated onsolidated emical nic content ulphate Co	l Undrained	gro co	Existing ound leve onsidered s the zero level	l Supervis	Prasad <u>By:</u>
<u>×</u>	-		RQD-Rock Quality Designation (%) Ground X*X*XX Silt Silt Gravel AAAA Lat							ules	CT - Clo		n mpletely W ly Weather			Fre	Nimal	



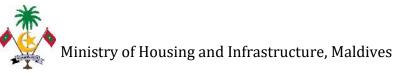
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ANNEXURE-II

SUB SOIL PROFILE DRAWINGS

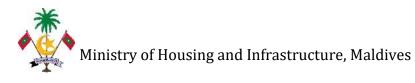




R LEVEL	LBH NO1 (Along the Shore	VALUE Linel / RQD	LBH ND-2 (Along the Shore Line	VALUE VALUE VALUE	LBH ND -3 [Along the Shore Line]	"N" VALUE / RQD	WATER LEVEL	2.00		
-	1.00						-	- 1.00	LEGEND	
EA BED)	0.00		224574	12	plant a			0.00 (SEA BED)	DUARAL SAND	82
	(-) 1.00		8888 B			04		(-) 1.00	HEDRIM DENSE CORAL SAND WITH CORAL ROOK FRAGMENTS	1414
		10		11			-	-	LODSE CORAL SAMD WITH CORAL ROOK PRAGMENTS	1000
	(-) 2.00	14	00000	24		09		(-) 2.00	HEDILH DENSE CORAL SAND WITH CORAL ROCK FRAGMENTS	623
-	(-) 3.00	14	0.000	15	0000000	10000		- (-) 3.00	DENSE CORAL SAND WITH CORAL ROCK FRAGMENTS	
-	(-) 4.00	14		CI		12		(-) 4.00	VERY DENSE CORAL SAND WITH CORAL ROOK FRAGMENTS DORAL ROCK FRAGMENTS	
	(~) 5.00	15		19		10		- (-) 5.00	LODSE CORAL SAND	
	(-) 6 00	201		12				(-) 6.00	CORAL ROCK	628
		19		20		12		1 1 7 00		1000
	(-) 7.00	07	000000		0.000	11		March and Sold		
-	(-) 8.00	07		22	0.000.000			- (-) 8.00		
-	(-) 9.00	18		0.0	100000	15		(-) 9.00		
	(-) 10.00	10		30		2		(-) 10.00		
	(-) 11 00	29		07		18		- (-) 11.00		
	a construction of the second							2016 Steaming	Index Ma	ар
	(-) 12.00		0.00	>50		23		- (-) 12.00		Day and
-	(-) 13.00	30	80	33%		21		- (-) 13.00		28
-	(-) 14.00	-	200	23/0	0.000000		_	- (-) 14.00	- I,T +	-
	(-) 15.00	20	66	40%		25		(-) 15.00		
	(-) 16.00		K AL	4070		25		(-) 16.00		
	(-) 17.00					19		(-) 17.00	ाज्यत्र वाज्यतेश WAPCOS	LINERD
	(-) 18.00	20				20		(-) 18.00	WAPCOS L 76-C, Sector-18, Inst	imite
	(-) 19.00	30				20		(-) 19.00	Gurgaon, Haryar Tel: +91-0124 2	na 12201:
									Drawing No. 2	Y

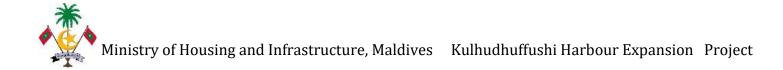
SUB - SOIL PROFILE (LBH 1 to LBH 3) - Along the Shoreline





WATER LEVEL		BH NO:-4 the Shore Line	VALUE VALUE VRQD	LBH NO5 (Along the Shore Li	"N" VALUE nel / RQD WATER I	LEVEL 2.00		
(SEA BED)	1.00					1.00	LEGEND	
LICK DEDI	0.00					0.00 (SEA BEDI	COMPAL SAND	522
	- Setting and			000000	29	- Printerio de	MEDIUM DENSE CORAL SAND WITH CORAL ROCK FRAGMENTS	1.1.1
	(-) 1.00	626355	21	1000000		(-) 1.00	LODSE CORAL SAND WITH CORAL ROCK FRAGMENTS	1000
	(-) 2.00		15		14	- (-) 2.00	MEDIUM DENSE CORAL SAND WITH CORAL ROCK FRAGMENTS	22
	(-) 3.00				05	(-) 3.00	DENSE DORAL SAND WITH CORAL ROCK FRAGMENTS	
	(-) 4.00		18		19	(-) 4.00	VERY DENSE CORAL SAND WITH CORAL ROCK FRAGMENTS	
			09		10		CORAL ROCK FRAGMENTS	222
6	(-) 5.00	******			21	- (-) 5.00	LODSE CORAL SAND	
	(-) 6.00	610000	17			(-) 6.00	CORAL ROCK	182
	(-) 7.00		911P			(-) 7.00		
	(-) 8.00		14			(-) 8.00		
	(-) 9.00				18	- (-) 9.00		
	- *		12					
	(-) 10.00				22	- (-) 10.00		
	(-) 11.00	0000	33		22	- (-) 11.00	Index Ma	ap
	(-) 12.00	0000	10		33	(-) 12.00		
	(-) 13.00		19		->50	(-) 13.00		-
			21		200		1	TT L
	(-) 14.00		21		>50	(-) 14.00	The t	
	(-) 15.00		21	020		_ (-) 15.00		
	(-) 16.00	10000	Patrol 10	200	33%	(-) 16.00		
	(-) 17.00		16	200	2122626	(-) 17.00	🚭 वापको स ७४२००७	Service UNITED
				Roy	23%	de Conservation	WAPCOS L	imited
	(-) 18.00	(c) (c) (c)	30			(-) 18.00	76-C, Sector-18, Inst	
	L(-) 19.00					_ (_) 19.00	Gurgaon, Haryar Tel: +91-0124 2	





2.00	MBH ND:-1	N	Lines Line -	"N"						WATER LEVE	2.00	
1.00	Hon Nul-1	VALUE / RDD	MBH NO:-2	VALUE / RDD	MBH NO:-3	VALUE / RQD	MBH NO:4	"N" VALUE / RQD	MBH ND:-4	VALUE / RQD	1.00	LEGEND
0.00		10.0239.0		0.0000000		1 Hab		7 100	200000000	7 RUD	0_00 ISEA BEDI	TDARAL SAND
() 1.00							認識強				(-) 1.00	LODSE CORAL BOCK PRACHENTS
a an area and	0000	38		44		29				29	_	MEDIAM DENSE CORAL SAND WITH CORAL NOCK MAXAMENTS
(-) 2.00	0000	36		38		14		32		14	(-) 2.00	DENSE CORAL SAND WITH CORAL ROCK FRACMENTS
(-) 3.00	0000	31	600	>50		09	0000000	15	0000	33		VERV GENEE CORAL SAND WITH CORAL ROCK PRACHENTS
(-) 4:00	0000	18	020			09	10000000 10000000	27	0000	24	(-) 4.00	LODGE CORAL SAND
(-) 5.00	000000	10				09		0.000			_ (-) 5.00	
(-) 6.00		13				14		29	0000000	17	_ (-) 6.00	
(-) 7.00		1999				2.57		19	0000000	31	_ (-) 7.00	
(-) 8.00		20		23		12	0000000	2.3	0000		_ (-) 8.00	
(-) 9.00		16		25		>50		25	0000	31	_ (-) 9.00	
(-) 10.00		10		20		200		19	0000	28	(_) 10.00	
(-) 11.00		22		29		>50		15		20	(-) 11.00	
(-) 12.00								21			(-) 12.00	WART - LANGE
(-) 13.00	0000	40		13	10001	33			Seconds		_ (-) 13.00	
(-) 14.00		18		12	10001	28		19		17	(-) 14.00	-1-+-+-*
(-) 15.00	14140-041414			0.00	10001	20		17		15	(-) 15.00	
(-) 16.00		16	1.1.1.1	13		42	000000	14	000000	- C1	(-) 16.00	
(-) 17 00	1000000	28		19	10001	13		20		18	(-) 17.00	
	10000000	20		13	5755555	15	0.000	21		04	The second second	WAPCOS Limite 76-C, Sector-18, Institutional
(_) 18.00	0000	39			5000	33	0.000000	21	1011111111 1011111111	21	_ (_) 18.00	Gurgaon, Haryana 12201



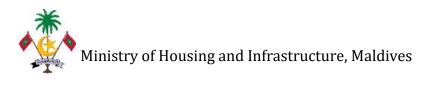
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ANNEXURE-III

PHOTOGRAPHS







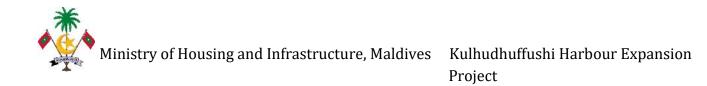
Drilling of Bore hole at LBH-02 location



Core Box for LBH-05 location



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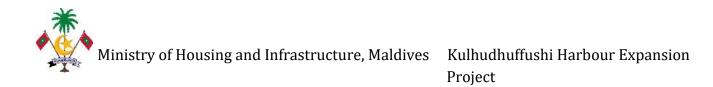
Shifting of Barge to MBH – 02 location



Drilling of Borehole at MBH – 02 location



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Jack up Barge at MBH – 03 location

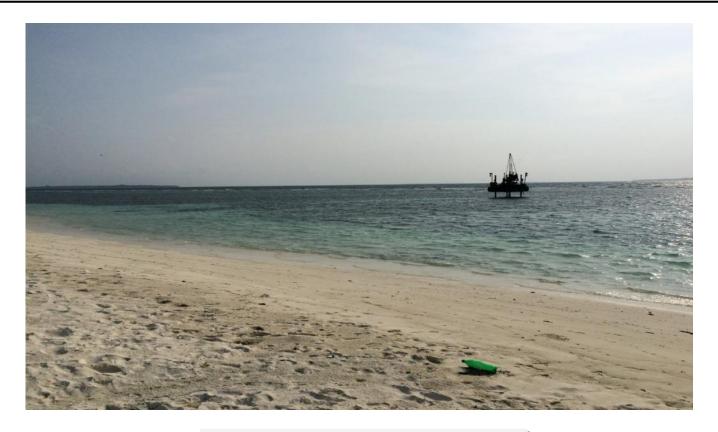


Drilling of Borehole at MBH – 03 location



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Drilling of Borehole at MBH – 05 location



Drilling of Borehole at MBH – 05 location



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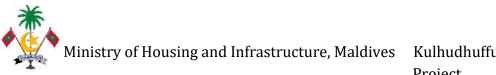
Drilling of Borehole at LBH – 01 location

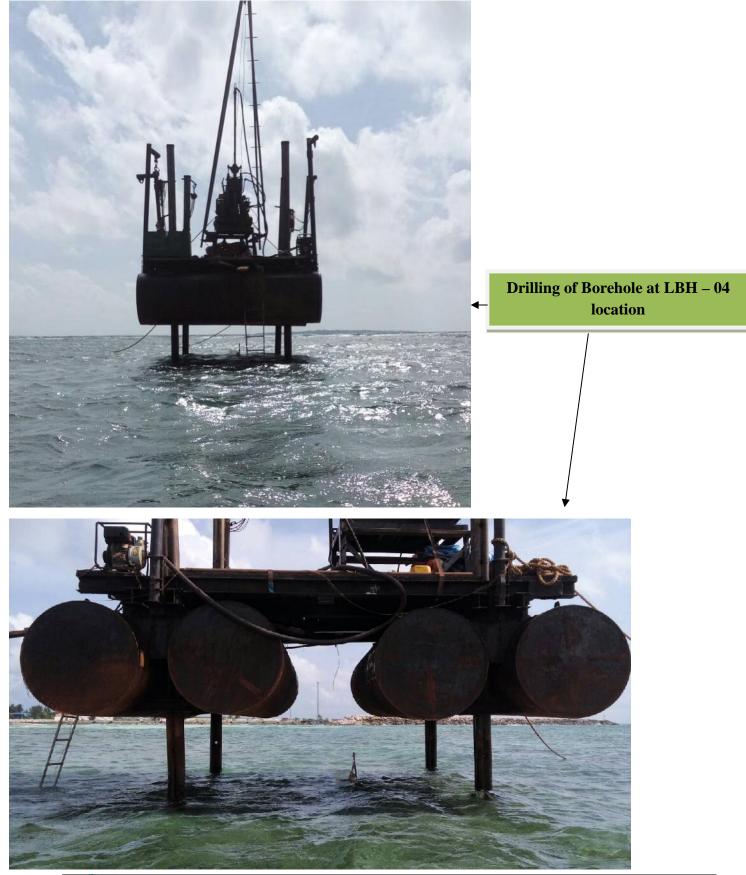
Drilling of Borehole at LBH – 03 location



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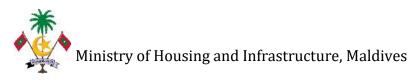
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Drilling of Borehole at MBH – 04 location



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