

AMENDMENT-IV

Dated: 11.08.2025

SUBJECT: Tender for “Supply, installation and training of Desalination Plant for Republic of Marshall Islands (RMI) and Kerema, Papua New Guinea (PNG).”

Tender no.: HSCC/PUR/MEA-RMI & PNG /DESALINATION/2025/117 Dated 03.07.2025

A The Last date of submission & opening of bids has been extended as follows:

Last date to fill/upload the tender through e-Tendering : upto 12.00 hrs. on 18.08.2025

Date of Opening of bids 15 hrs. on 18.08.2025

The validity of Bid Security/ Earnest Money Deposit (EMD) to be submitted by the bidders with their bid in the form of Bank Guarantee (BG) shall be considered from the original due date of bid submission i.e., from 18.07.2025.

B Reply to Pre Bid Queries raised by bidders during pre -bid meeting on 10.07.2025 at HSCC, Head Office, Noida through VC are as below:

Sr. No.	Tender Clause/Para Ref.	Clause/Para Discription	Representation /query from bidder	Clarification/Amendment
1	33. General/Miscellaneous Clauses, 33.4 on page 31 of 100	Each member/constituent of the Supplier/its Indian Agent/CMC Provider, in case of consortium shall be jointly and severally liable to and responsible for all obligations towards the Purchaser/Consignee/Government for performance of contract/services including that of its Associates/Sub Contractors under the Contract.	Please confirm the joint venture (JV) conditions in details. Like no. of partners and condition for lead partner and condition for other partners.	Joint Venture (JV) is not allowed in this tender.
2		General Query	As this is a turnkey project and the civil works fall within the bidder's scope, we kindly request you to provide the soil bearing capacity report and relevant topographical survey data to enable a comprehensive evaluation of the project.	The soil bearing capacity report is enclosed herewith
3		General Query	Please specify the pipeline lengths to be considered for the intake, outfall, and brine discharge associated with the project.	Approx. 700m for intake and outfall etc.
4		General Query	Kindly also confirm the required capacity of the potable water tank to be provided with each RO system.	No Change, As per Tender Condition. Bidder shall do design engineering for smooth functionality of desalination plant based on specification and tender condition

Sr. No.	Tender Clause/Para Ref.	Clause/Para Discription	Representation /query from bidder	Clarification/Amendment
5	Section IX, Point 2.	Experience criteria: Bidder or OEM should have following Experience during the last Seven (7) years ending previous day of last date of submission of tenders : a) Three *similar works each costing not less than Rs. 12 Cr. OR b) Two *similar works each costing not less than 18 Cr. OR c) One *similar work costing not less than 24 Cr. *Similar works” shall mean “SWRO (Seawater Reverse Osmosis) technology desalination plant with a minimum capacity of 300 KLD or multiple plants totaling (at least three) greater than or equal to 600 KLD, commissioned within last 7 years with power backup through Solar Photo Voltaic (SPV) or Genset. Plants must have been operational for at least 12 months prior to technical bid opening date.”	We request you to also accept Tertiary RO powered through power connection meeting the required flow capacity and value as mentioned above	No Change, As per Tender Condition.
6	Section IX, Point 4.	The Bidder or OEM should have design, supplied, installed and commissioned (roof /Ground) Solar Photo Voltaic (SPV) system of cumulative capacity of 5 MW in last Seven years. These projects must be in Operation for at least one (1) year after commissioning prior to the technical bid opening date.	We kindly request that you permit us to collaborate with a qualified OEM partner to meet the eligibility criteria for this project, as it is unlikely that any water treatment company alone would possess prior experience with a solar plant of this scale.	No Change, As per Tender Condition.
7	Marshall Island(Specs) (Page no 39)	Required quality of Treated waterConductivity: 200 Micro mhos/cm	It should be below 300TDS instead of conductivity. The World Health Organization (WHO) recommends a TDS level of less than 300 mg/L for drinking water.	clause no. 19 page No. 50, shall be read as " Required quality of treated water conductivity: 700-1000 Micro mhos/cm".
8			Below 300 TDS instead of conductivity as per WHO recommendations.	

Sr. No.	Tender Clause/Para Ref.	Clause/Para Discription	Representation /query from bidder	Clarification/Amendment
9	Marshall Island (Specs)	Operating Data for Filter: Nos. of Streams offered- 15 Nos	Nos. of System offered-1 No 1. Only 1 system is required which has 15 streams or more for filtering raw water. 2. Considering the limited space available in the container, we propose the implementation of a singlestream configuration. 3. To achieve the same outcome, highly efficient membrane with superior salt rejection capabilities is already asked in the specifications.	No Change, As per Tender Condition.
10			Nos. of System offered-1 No It contains 15 streams	
11	Marshall Island (Specs)	Operating Data for 2 Pass RO Plant: 1. Nos. of Streams offered 1 No. 2. Feed flow rate per stream - 88.18m3/hr 3. Product flow rate per stream - 29.1m3/hr 6. Operating Hours - 22Hrs 7. Mode of Operation -Automatic	2 pass system is not required because desirable results will come in the single pass only. Moreover, it will also take a lot of space in the container which may not be feasible.	No Change, As per Tender Condition.
12			Kindly delete this clause The same outcome can be achieved from single pass system	
13	Marshall Island (Specs)	Water Treatment Plant: Pre–Treatment for Desalination Plant 2. Stilling chamber – NaOCl dosage from ECP to remove Algae. 3. Flash mixer – Fecl3 coagulant dosage to remove turbidity. 4. Flocculator–coagulant aid–poly electrolyte dosage to remove colloidal silica 5. Clarifier 7. Filter water storage.	We propose to Electro chlorination system instead of all above chemicals dosing system. Since, the above mentioned chemicals are not available at the site, and transporting HCl is particularly challenging. Hence, to ensure successful installation and operations we request this change.	No Change, As per Tender Condition.
14			Kindly delete this clause Electro chlorination system is required instead of water treatment plant as there will be no availability of required chemicals.	

Sr. No.	Tender Clause/Para Ref.	Clause/Para Discription	Representation /query from bidder	Clarification/Amendment
15	Marshall Island (Specs)	5. ENERGY REQUIREMENTS Local Electricity Supply Standards In Majuro, the capital of the Republic of the Marshall Islands, the standard grid supply voltage For commercial use is indeed 480 volts (phase-to-phase voltage) at a frequency of 60Hz. For highvoltage distribution within the grid, systems typically operate at 11 kilo volts (kV)or higher, enabling efficient transmission of electricity over longer distances before being stepped down to the standard voltage for consumer use.	n Majuro, the capital of the Republic of the Marshall Islands, the standard grid supply voltage For commercial use is indeed 480 volts (phase-to-phase voltage) at a frequency of 60Hz. For highvoltage distribution within the grid, systems typically operate at 4.16 kilo volts (kV)or higher, enabling efficient transmission of electricity over longer distances before being stepped down to the standard voltage for consumer use. 4.16 kilo volts (kV) is sufficient for the operations of the plant. This specification is for supply of step down transformer	No Change, As per Tender Condition.
16	Marshall Islands (RMI)	5. ENERGY REQUIREMENTS For high-voltage distribution within the grid, systems typically operate at 11 kilo volts (kV)or higher, enabling efficient transmission of electricity over longer distances before being stepped down to the standard voltage for consumer use.	4.10 volts in sufficient for the functioning of the plant	
17	Marshall Island (Specs)	6. EQUIPMENTS INVOLVED IN DESALINATION PLANT Disc filter- 2Nos(1W+1S)	Disc filter- 1 no.s I disc filter is sufficient to get the desired results.	No Change, As per Tender Condition.
			Disc filter- 1 no.s	

Sr. No.	Tender Clause/Para Ref.	Clause/Para Discription	Representation /query from bidder	Clarification/Amendment
18	Marshall Island (Specs)	Acid dosing pump2Nos(1W+1S)	Anti Scalant dosing pump2Nos(1W+1S) There is no acid component hence, anti scalant pump is required.	No Change, As per Tender Condition.
			Anti Scalant dosing pump-2Nos(1W+1S)	
19	Papua New Guinea (PNG) (Specs)	Request to add additional points:	17. Inflow Capacity 910 m3 Recovery:33 % Daily Capacity: 20m3 /20x15=300 KLD, Input parameter table is not provided in the Tender document. Kindly add the same.	No Change, As per Tender Condition
20	Papua New Guinea (PNG) (Specs)	Water Inflow and Requirements: Inflow Capacity: Each infiltration well has an inflow capacity of approximately 10 m³ per hour. Total Inflow: With three wells in operation, the total inflow is: Total Inflow = 10 m³/h x 3 = 30 m³/hour. Daily Water Requirement: For the operation of the desalination plant, a total of 30 m³ per hour is needed, which translates to 30m3/hour into 24 hours = 720m³/day However, if the stated requirement is 600 m³ per day, this indicates that the system is designed to manage within the available inflow and operational capacity.	Request to delete As the capacity has already been fixed, this is not required.	No Change, As per Tender Condition
			Kindly delete this clause as there is fixed capacity mentioned in the tender	
21	Papua New Guinea (PNG) (Specs)	Operational Considerations: Sufficiency of Water Supply: While the initial analysis indicates that the total inflow from the wells (720 m³/day) exceeds the daily requirement (600 m³/day), this provides a buffer to ensure consistent operation and accounts for any potential fluctuations in inflow.	Request to delete As the capacity has already been fixed, this is not required.	No Change, As per Tender Condition
			Kindly delete this clause as there is fixed capacity mentioned in the tender	
22	Papua New Guinea (PNG) (Specs)	20. SCOPE OF WORK Operating Data for Filter: Nos. of Streams offered- 4nos	Nos. of System offered- 1nos There are 4 streams inside one single system, hence the complete system is required which contains 4 streams. Or more to filtering volume of water	No Change, As per Tender Condition.
			Nos. of System offered- 1nos It contains 4 streams	

Sr. No.	Tender Clause/Para Ref.	Clause/Para Discription	Representation /query from bidder	Clarification/Amendment
23	Papua New Guinea (PNG) (Specs)	Operating Data Ultra Filtration: Nos. of Streams offered- 8 nos	Nos. of System offered- 1nos There are 8 streams inside one single system, hence the complete system is required which contains 8 streams. Or more for filtering water raw input flow.	No Change, As per Tender Condition.
24			Nos. of System offered- 1nos It contains 8 streams Nos. of System offered- 1nos It contains 8 streams	
25		Request for additional specifications:	1. 640 KLD to be accommodated in two 40 ft containers. 2. 300 KLD to be accommodated in two containers one 20 ft and one 40 ft. 3. Seawater bore is to be under the scope of the supplier. 4. Consumables for one year to be supplied by the supplier. Input Parameter table: Inflow Capacity 910 m3 Recovery 33% Daily Capacity 20m3 /20x15=300 KLD • 2 no.(s) 40 ft containers for 640 KLD • 1 no. 20 ft and 1 no. 40 ft. containers for 300 KLD • Seawater bore has to be done by the vendor. • One year consumables supply has to be made by the vendor.	No Change, As per Tender Condition
26	General Clauses:	Delivery and Supply: The supply (with its design, and fabrication as per specifications), installation at the consignee site should be completed within 150 days from NOA/LOA (Dispatch should be within 60days from PO, and final delivery at consignee site, Installation, commissioning etc within 150 days from date of PO). The bidder will also provide onsite training to the locally authorized persons for	Delivery and Supply: The supply (with its design, and fabrication as per specifications), installation at the consignee site should be completed within 280 days from NOA/LOA (Dispatch should be within 180 days from PO, and final delivery at consignee site, Installation, commissioning etc within 280 days from date of PO).	No Change, As per Tender Condition

Sr. No.	Tender Clause/Para Ref.	Clause/Para Discription	Representation /query from bidder	Clarification/Amendment
27		operation and routine maintenance of desalination plant. Bidders shall be responsible to provide End to End solution for Supply, Inspection, Insurance, Freight, Local Transportation & Air/Sea Transportation, Handling, Custom Clearance, Handing-over etc to the Consignee	Delivery and Supply: The supply (with its design, and fabrication as per specifications), installation at the consignee site should be completed within 270 days from NOA/LOA (Dispatch should be within 150 days rom PO, and final delivery at consignee site, Installation, commissioning etc within 270 days from date of PO). The bidder will also provide onsite training to the locally authorized persons for operation and routine maintenance of desalination plant. Bidders shall be responsible to provide End to End solution for Supply, Inspection, Insurance, Freight, Local Transportation & Air/Sea Transportation, Handling, Custom Clearance, Handing-over etc to the Consignee 1. Major components like the pump and energy recovery system require a minimum lead time of 15 to 18 weeks 2. All materials arriving at the site by sea may require a lead time and clearance period of up to 60 to 75 days. 3. Site preparation, installation, and commissioning may take approximately 60 days	No Change, As per Tender Condition
28	General Clauses:	Pg. 10, Clause 17.2, Sub-Clause a) In case the tenderer offers to supply goods, which are manufactured by some other firm, the tenderer has been duly authorised by the goods manufacturer to quote for and supply the goods to the purchaser. The tenderer shall submit the manufacturer's authorization letter to this effect as per the standard form provided under Section XIV in this document. However, in case of an equipment without such authorization at the time of submission of bid, the undertaking from the bidder to be submitted to comply with the condition and submit the manufacturer's authorization letter at the time of supply. The bidder must provide details of make and model for the quoted products.	In case the tenderer offers to supply goods, which are manufactured by some other firm, the tenderer has been duly authorised by the goods manufacturer to quote for and supply the goods to the purchaser. The tenderer shall mandatory submit the manufacturer's authorization letter to this effect as per the standard form provided under Section XIV in this document during the submission of the technical bid.	No Change, As per Tender Condition

Sr. No.	Tender Clause/Para Ref.	Clause/Para Discription	Representation /query from bidder	Clarification/Amendment
29		Pg-64, Section – IX Qualification Criteria, Clause 6 Other documents: Bidder should submit the manufacturer's authorization letters, technical compliance statements and quality certifications as per the technical specifications for the following critical components: a) Reverse Osmosis (RO) based Seawater Desalination Plant b) RO membranes c) High-pressure pumps d) Energy Recovery Devices e) Disc Filter f) Solar Panel g) Gensets	Other documents: Bidder should mandatory submit the manufacturer's authorization letters , technical compliance statements and quality certifications as per the technical specifications for the following critical components: a) Reverse Osmosis (RO) based Seawater Desalination Plant b) RO membranes c) High-pressure pumps d) Energy Recovery Devices e) Disc Filter f) Solar Panel g) Gensets	No Change, As per Tender Condition
30		Pg. 75 SECTION – XIV MANUFACTURER'S AUTHORISATION FORM (In case of an equipment without such authorization at the time of submission of bid, the undertaking from the bidder to be submitted to comply with the condition and submit the manufacturer's authorization letter at the time of supply)	Kindly remove: (In case of an equipment without such authorization at the time of submission of bid, the undertaking from the bidder to be submitted to comply with the condition and submit the manufacturer's authorization letter at the time of supply)	No Change, As per Tender Condition

All other terms & conditions remain unchanged.

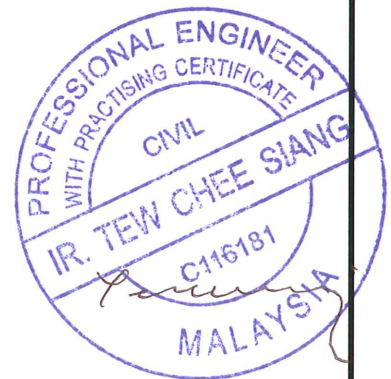
Prospective bidders are advised to regularly visit through HSCC e-tender portal <https://hsccltd.co.in>, HSCC website <http://www.hsccltd.co.in> & CPP Portal <https://eprocure.gov.in/epublish/app> as corrigendum/amendments etc., if any, will be notified on this portal only and not be published anywhere else.

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GM (Proc.)
HSCC (INDIA) LTD.

THE PROJECT FOR THE INSTALLATION OF
SOLAR ELECTRICITY GENERATION SYSTEM IN
EBEYE ISLAND

SOIL BEARING CAPACITY CHECKING REPORT

January 2020, Revision 1



Prepared by:

KnT Consult SDN. BHD.
B-16-01, Tower B, Atria Sofo Suites,
Jalan SS22/23, Damansara Jaya,
47400 Petaling Jaya
Selangor, Malaysia

Tel/Fax : +603 – 7495 6640
Email: info.kntconsult@gmail.com

DISCLAIMER

This report has been prepared based on the available soil data obtained from soil investigation report made available. Care and diligence has been placed in interpretation of the subsoil data. However, in view of heterogeneous nature of subsoil profile, composition and strength, the actual subsoil may behave differently. The contractor is to report immediately to the Engineer if the subsoil is found to be significantly different from that shown in soil investigation report during physical construction works.

The results of Mackintosh Probes can be converted to SPT-N, as proposed by Chan & Chan, 1972. (refer to [Appendix 1](#))

The conversions are as below,

- (a) For Cohesive Soil, $N = 0.091M + 1.8$
- (b) For Cohesionless Soil, $N = 0.1M$

The subsoil at project site is consisted mainly of calcacereous deposits and these deposits normally exhibit cohesionless characteristic with little to low plasticity. Hence, the conversion of cohesionless soil can be adopted here. Further, the conversion formulae of cohesionless soil shall yield lower SPT-N value and thus more conservative.

The results of Mackintosh Probes (21 nos) with corresponding SPT-N value after conversion are as enclosed in [Appendix 2](#). Most of the Mackintosh Probes could not advance further upon hitting rock layer at depths of around 0.6m to 1.2m below existing ground level, except MP Point 1 which managed to penetrate up to depths of 3.6m.

From the results, the following subsoil strengths are generated, (lower bound value are used here)

Depths	Corresponding SPT-N value
0m – 1.2m	20
1.2m – 4.0m	10
>4.0m	50

As shallow foundation is proposed for the intended structure, a check and calculation on the soil allowable bearing capacity is carried out. The detailed calculation is enclosed in [Appendix 3](#).

The calculation indicates the allowable bearing capacity for various shallow foundation options. From '3.1 – Allowable bearing pressure for square pad foundation', for square footing of 1m x 1m, if the settlement is to be limited to 10mm, the allowable bearing capacity of the subsoil is at 150kN/m².

Appendix 1

The shear strength of cohesive soils has been deduced from the values of Mackintosh probe (M) using the correlation between Mackintosh probe and Standard Penetration Resistance (N) as proposed by Chan and Chin (1972).

$$N = 0.091M + 1.8$$

where N = SPT, No. of blows per 1 ft. penetration
M = Mackintosh probe value

However, from our experience, the above relationship needs to be corrected for N values less than 4. Chan and Chin (1972) implied that this relationship is conservative, if applied to cohesionless soils. We found that the relationship

$$N = 0.1M$$

is generally applicable for cohesionless soils.

The correlation between M, N and the shear strength Cu based on the above is shown in Table 1.

Table 1a : Cohesive Soils

Consistency	N	M	Cu (KN/m ²)
very soft	0 - 2	0 - 12	< 12
soft	2 - 4	12 - 25	12 - 25
medium stiff	4 - 8	25 - 70	25 - 50
stiff	8 - 15	70 - 150	50 - 100
very stiff	15 - 30	150 - 300	100 - 200
hard	> 30	> 300	> 200

Appendix 2

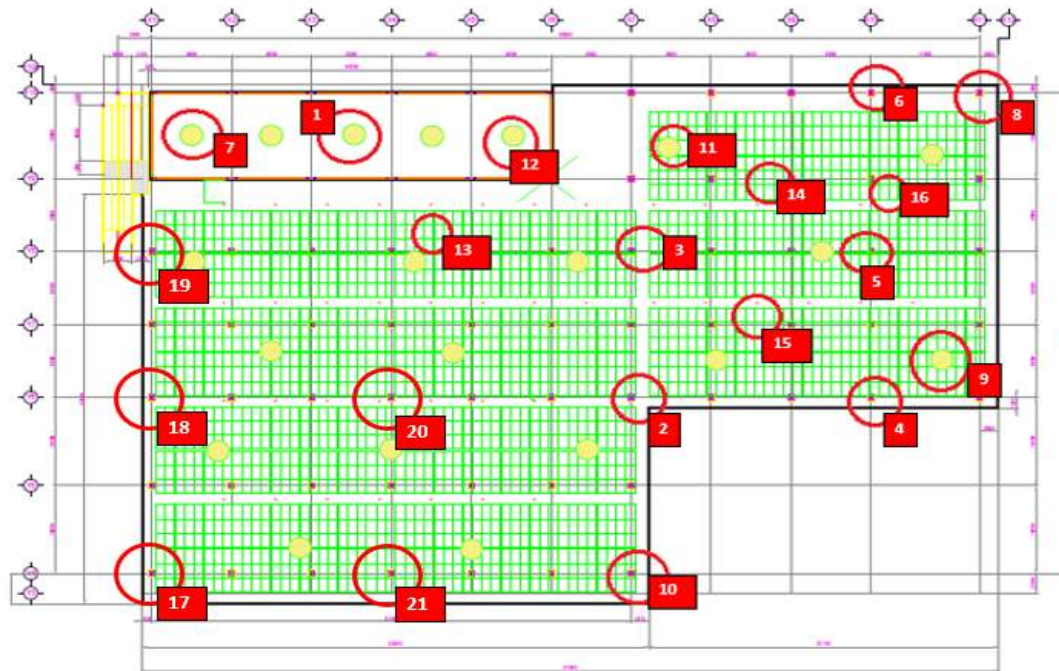
Mackintosh Probe Test Report

Discussion :

The Mackintosh Probe Test was conducted at the site at Ebeye Island on the 26th, 27th, 28th of November 2019 and 13th January 2020. The test was done and recorded by representatives from Mitsubishi Electric, Stella Corp and OCG. There were a total of 21 points from different locations taken to get the result. All the points were highlighted in the Top View Map attached below.

For each point, the "Number of Blows" was recorded for every 0.3 meters of the probe was hit into the ground. Certain points have fewer data because the probe was unable to go further into the ground. It is concluded that the probe has reached the rocks.

The following table are the results from the test.



Depth (m)	No. of Blows																				
	Point1	Point2	Point3	Point4	Point5	Point6	Point7	Point8	Point9	Point10	Point11	Point12	Point13	Point14	Point15	Point16	Point17	Point18	Point19	Point20	Point21
0.0-0.3	290	305	643	764	683	690	594	831	670	343	523	322	406	550	475	564	341	262	473	456	340
0.3-0.6	490	450	276	330	301	531	-	467	447	285	438	294	322	335	313	347	425	222	201	252	340
0.6-0.9	185	-	96	170	300	104	-	218	377	241	430	284	130	-	560	390		438	465	462	402
0.9-1.2	336	-	200	260	-	-	-	305	230	255	203	202	-	-	465	-		305			
1.2-1.5	640	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		267			
1.5-1.8	152	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		226			
1.8-2.1	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		202			
2.1-2.4	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		122			
2.4-2.7	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		160			
2.7-3.0	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		154			
3.0-3.3	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		241			
3.3-3.6	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		123			
Remarks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks	Reached to rocks
	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-starting point at ground level	-Starting point 24cm below ground level	-Starting point 17cm below ground level	-Starting point 20cm below ground level	-Starting point 27cm below ground level

Appendix 3

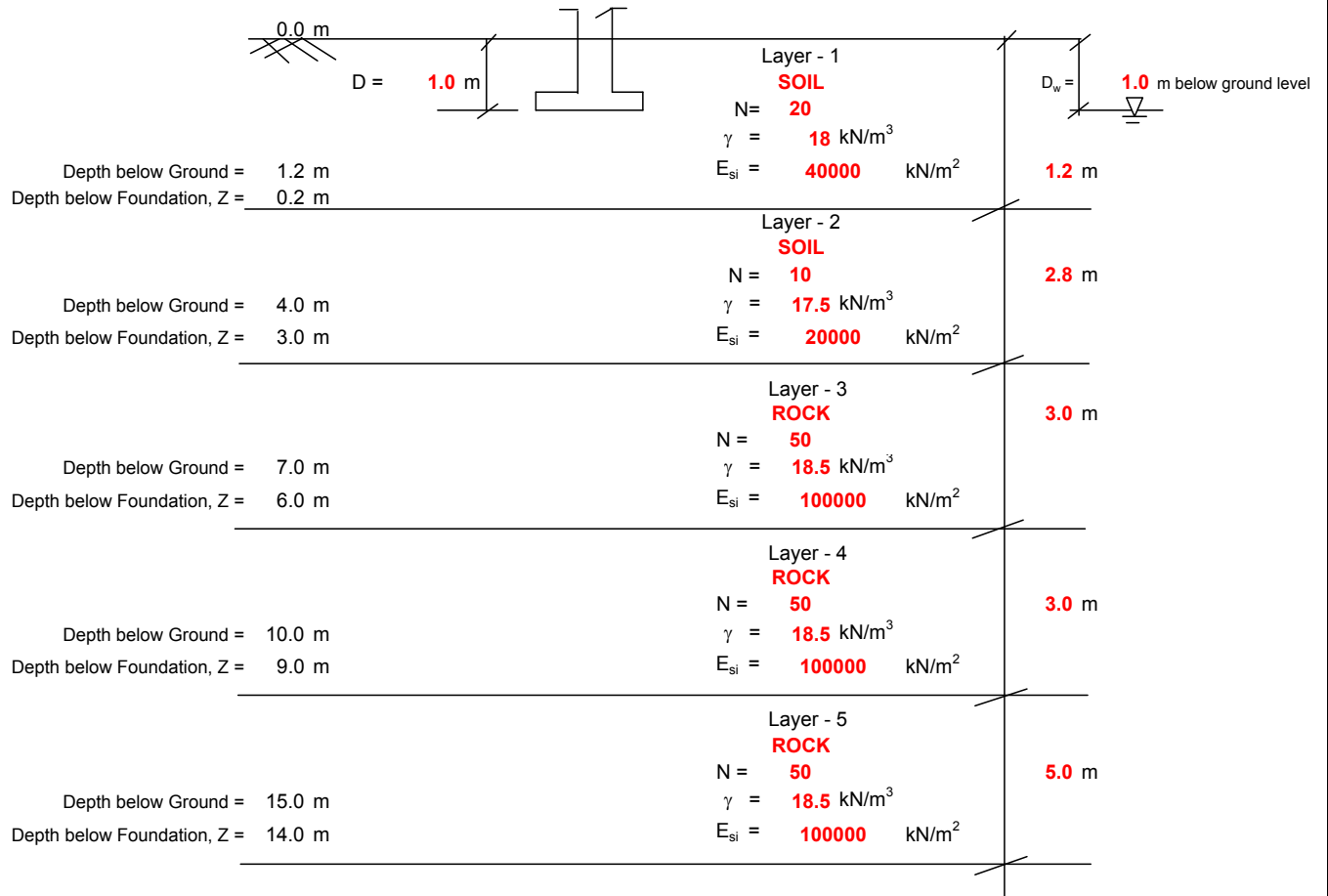
Marshall Island

BEARING CAPACITY CALCULATIONS

MP 1 to 21

1.0 BEARING CAPACITY FOR PAD FOUNDATION

1.1 Soil Model :



Marshall Island
0
0
BEARING CAPACITY CALCULATIONS

1.2 Allowable Bearing Capacity based on "c" and "φ"

Adopted Design Parameter:

$$c = 5.0 \text{ kN/m}^2 \quad \text{and} \quad \phi = 26^\circ$$

From Meyerhof modified bearing capacity formula, the ultimate bearing capacity q_{ult} is

$$\begin{aligned} q_{ult} &= c N_c S_c + \gamma D N_q S_q + 1/2 \gamma B N_\gamma S_\gamma \quad \text{if ground water level lower than } B \text{ m below the foundation} \\ q_{ult} &= c N_c S_c + \gamma D N_q S_q + 1/2 \gamma' B N_\gamma S_\gamma \quad \text{if ground water level within } B \text{ m below the foundation} \\ q_{ult} &= c N_c S_c + \gamma' D N_q S_q + 1/2 \gamma' B N_\gamma S_\gamma + \gamma_w (D - D_w), \quad \text{if ground water level higher than the foundation level} \end{aligned}$$

where B = least lateral dimension of footing

L = lateral dimension of footing

γ = effective unit weight of soil = **17.5 kN/m³**

γ' = effective unit weight of soil from below ground water table = **7.7 kN/m³**

γ_w = effective unit weight of water = **9.81 kN/m³**

N_c, N_q and N_γ = bearing capacity factors

$$N_c = (N_q - 1) / \tan \phi = 22.254$$

$$N_\gamma = 1.5(N_q - 1) \tan \phi = 7.94$$

$$N_q = \exp(\pi \tan \phi) \tan^2(45 + \phi/2) = 11.85$$

S_c, S_q, S_γ = shape factors and given by

$$S_c = 1 + 0.2 K_p B/L \quad S_q = S_\gamma = 1 + 0.1 K_p B/L$$

$$\text{where } K_p = \tan^2(45 + \phi/2) = 2.56$$

$$\begin{aligned} \text{The ultimate net bearing capacity } q_{net} &= q_{ult} - \gamma D \\ \text{The allowable bearing capacity } q_a &= q_{net} / F.O.S. \end{aligned}$$

$$\text{Considering F.O.S.} = 3.0$$

	B (m)	L (m)	B/L	S _c	S _q , S _γ	cN _c S _c	γDN _q S _q	1/2γB'N _γ S _γ	γ _w (D-D _w)	q _{ult}	q _{net}	q _a (kN/m ²)
Square (L/B = 1)	1.0	x 1.0	1	1.51	1.26	168.1	260.5	38.3	0.0	467	449	150
	2.0	x 2.0	1	1.51	1.26	168.1	260.5	76.7	0.0	505	488	163
	3.0	x 3.0	1	1.51	1.26	168.1	260.5	115.0	0.0	544	526	176
	4.0	x 4.0	1	1.51	1.26	168.1	260.5	153.3	0.0	582	564	189
	5.0	x 5.0	1	1.51	1.26	168.1	260.5	191.7	0.0	620	603	201
	6.0	x 6.0	1	1.51	1.26	168.1	260.5	230.0	0.0	659	641	214
	8.0	x 8.0	1	1.51	1.26	168.1	260.5	306.7	0.0	735	718	240
	10.0	x 10.0	1	1.51	1.26	168.1	260.5	383.3	0.0	812	794	265
Strip	1.0		Strip	1.00	1.00	111.3	207.4	30.5	0.0	349	332	111
	2.0		Strip	1.00	1.00	111.3	207.4	61.1	0.0	380	362	121
	3.0		Strip	1.00	1.00	111.3	207.4	91.6	0.0	410	393	131
	4.0		Strip	1.00	1.00	111.3	207.4	122.1	0.0	441	423	142
L/B = 3	1.0	x 3.0	0.33	1.17	1.09	130.2	225.1	33.1	0.0	388	371	124
	2.0	x 6.0	0.33	1.17	1.09	130.2	225.1	66.3	0.0	422	404	135
	3.0	x 9.0	0.33	1.17	1.09	130.2	225.1	99.4	0.0	455	437	146
	4.0	x 12.0	0.33	1.17	1.09	130.2	225.1	132.5	0.0	488	470	157
	5.0	x 15.0	0.33	1.17	1.09	130.2	225.1	165.7	0.0	521	504	168
L/B = 5	1.0	x 5.0	0.2	1.10	1.05	122.6	218.1	32.1	0.0	373	355	119
	2.0	x 10.0	0.2	1.10	1.05	122.6	218.1	64.2	0.0	405	387	130
	3.0	x 15.0	0.2	1.10	1.05	122.6	218.1	96.3	0.0	437	419	140
	4.0	x 20.0	0.2	1.10	1.05	122.6	218.1	128.4	0.0	469	452	151
L/B = 10	1.0	x 10.0	0.1	1.05	1.03	117	212.7	31.3	0.0	361	344	115
	2.0	x 20.0	0.1	1.05	1.03	117	212.7	62.6	0.0	392	375	125
	3.0	x 30.0	0.1	1.05	1.03	117	212.7	93.9	0.0	424	406	136

Marshall Island
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BEARING CAPACITY CALCULATIONS

2.0 SETTLEMENT OF PAD FOUNDATION

Total settlement of foundation :

$$\Delta H = \Delta H_i \quad \text{where} \quad \Delta H_i = \text{Elastic settlement of foundation}$$

2.1 Elastic settlement of Pad Foundation

The elastic settlement based on linear stress-strain relationship is calculated as follows :

$$\Delta H = q \cdot B \cdot (1 - \mu^2) \cdot \Delta \omega / E_{si} \quad \text{where } q = \text{base pressure in kN/m}^2$$

B = width of footing
 μ = poissons ratio of soil
 $\Delta \omega$ = influence coefficient difference between top and bottom of the layer (Vasiljev)
 E_{si} = elastic modulus of soil in kN/m²

Typical Calculation :

$$B = 3.0 \text{ m} \quad L = 30.0 \text{ m} \quad \mu = 0.3 \quad L/B = 10.0$$

$$q = 100 \text{ kPa} \quad \nu_f = 1.0 \text{ m}$$

Layer No.	Layer Thickness H_i (m)	Depth of the layer Z (m)	Depth ratio Z/B	Influence coefficient ω	$\Delta \omega$	Soil modulus E_{si} (kPa)	Layer settlement ΔH_i (mm)
1	0.2	0.2	0.07	0.035	0.035	40000	0.24
2	2.8	3.0	1.00	0.500	0.465	20000	6.35
3	3.0	6.0	2.00	0.860	0.360	100000	0.98
4	3.0	9.0	3.00	1.110	0.250	100000	0.68
5	5.0	14.0	4.67	1.327	0.217	100000	0.59
$\Sigma \Delta H_i =$							8.85

Table 1, Influence Coefficient, ω

	Circle	Square				Strip
L/B	0	1	2	5	10	∞
Z/b	1	2	3	4	5	6
0.00	0	0	0	0	0	0
0.25	0.120	0.130	0.130	0.130	0.130	0.130
0.50	0.230	0.250	0.250	0.260	0.260	0.260
0.75	0.330	0.370	0.380	0.380	0.390	0.390
1.00	0.410	0.450	0.470	0.480	0.500	0.510
1.50	0.520	0.560	0.660	0.670	0.700	0.730
2.00	0.580	0.630	0.770	0.830	0.860	0.890
2.50	0.620	0.680	0.860	0.960	1.000	1.030
3.00	0.650	0.710	0.910	1.060	1.110	1.140
5.00	0.700	0.780	1.050	1.310	1.370	1.450
10.00	0.750	0.840	1.160	1.560	1.800	1.960
20.00	0.790	0.880	1.220	1.720	2.120	2.500

Marshall Island
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BEARING CAPACITY CALCULATIONS

Total settlement of footings vs base pressure:

Footing q (kPa)	1 m x 1 m	2 m x 2 m	3 m x 3 m	4 m x 4 m	5 m x 5 m	6 m x 6 m
	Settlement of Foundation (mm)					
0	0.0	0.0	0.0	0.0	0.0	0.0
50	1.6	2.7	3.4	3.9	4.2	4.4
100	3.1	5.3	6.8	7.8	8.4	8.8
150	4.7	8.0	10.2	11.7	12.5	13.3
200	6.3	10.6	13.5	15.6	16.7	17.7
300	9.4	15.9	20.3	23.4	25.1	26.5

Footing q (kPa)	8 m x 8 m	10 m x 10 m	1 m	2 m	3 m	4 m
	Settlement of Foundation (mm)					
0	0.0	0.0	0.0	0.0	0.0	0.0
50	4.8	5.1	2.9	4.0	4.6	4.9
100	9.6	10.3	5.9	8.1	9.2	9.9
150	14.4	15.4	8.8	12.1	13.7	14.8
200	19.3	20.5	11.8	16.2	18.3	19.7
300	28.9	30.8	17.7	24.3	27.5	29.6

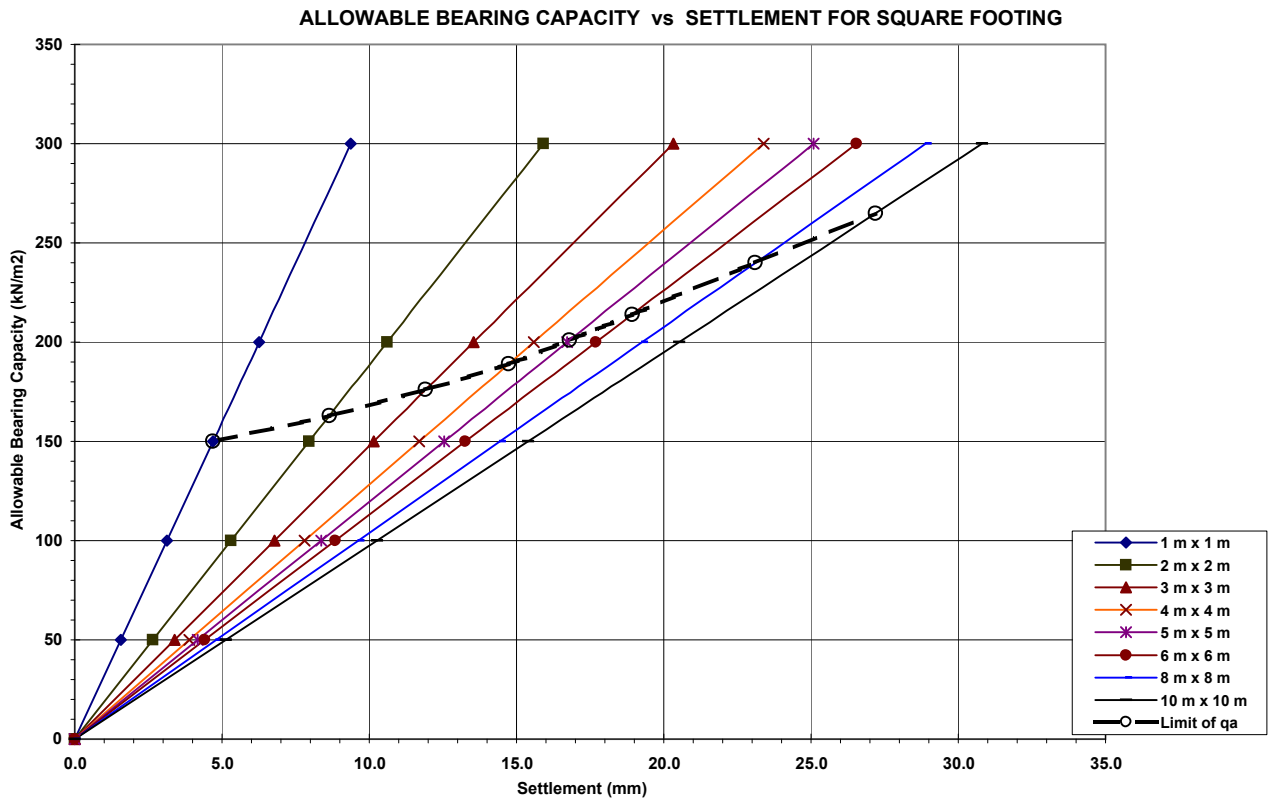
Footing q (kPa)	1 m x 3 m	2 m x 6 m	3 m x 9 m	4 m x 12 m	5 m x 15 m	1 m x 5 m
	Settlement of Foundation (mm)					
0	0.0	0.0	0.0	0.0	0.0	0.0
50	2.2	3.4	4.0	4.5	4.8	2.5
100	4.5	6.8	8.0	9.0	9.5	5.1
150	6.7	10.2	11.9	13.4	14.3	7.6
200	8.9	13.6	15.9	17.9	19.1	10.2
300	13.4	20.3	23.9	26.9	28.6	15.3

Footing q (kPa)	2 m x 10 m	3 m x 15 m	4 m x 20 m	1 m x 10 m	2 m x 20 m	3 m x 30 m
	Settlement of Foundation (mm)					
0	0.0	0.0	0.0	0.0	0.0	0.0
50	3.6	4.2	4.7	2.8	3.8	4.4
100	7.2	8.5	9.4	5.6	7.7	8.8
150	10.8	12.7	14.1	8.3	11.5	13.3
200	14.4	16.9	18.8	11.1	15.3	17.7
300	21.6	25.4	28.1	16.7	23.0	26.5

Marshall Island
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BEARING CAPACITY CALCULATIONS

3.0 ALLOWABLE BEARING PRESSURE

3.1 Allowable Bearing Pressure For Square Pad Foundation

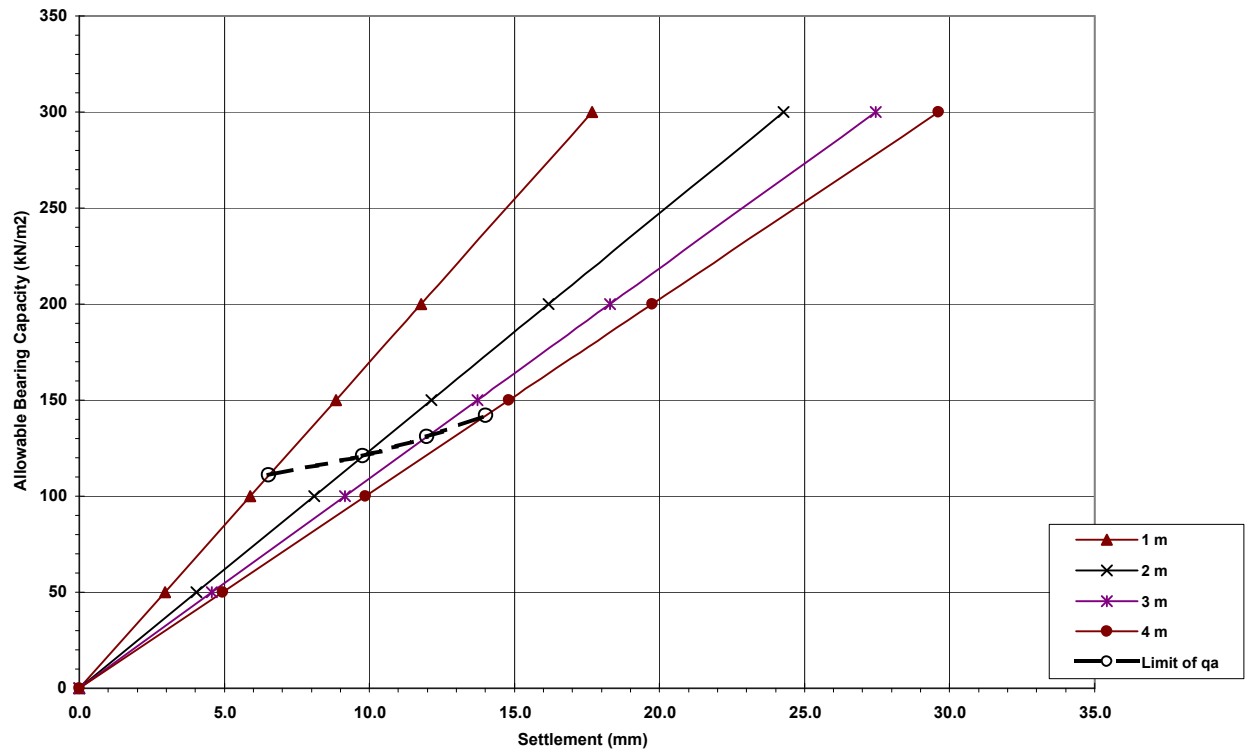


Footing Dimension	Calculated Bearing Capacity					Recommended Allowable Bearing Pressure (kN/m²)		
	By Meyerhof Formula	Settlement Criteria (mm)						
		10	15	25		10	15	25
1 m x 1 m	150	320	480	800		150	150	150
2 m x 2 m	163	189	283	471		160	160	160
3 m x 3 m	176	148	221	369		145	175	175
4 m x 4 m	189	128	192	321		125	185	185
5 m x 5 m	201	120	179	299		115	175	200
6 m x 6 m	214	113	170	283		110	165	210
8 m x 8 m	240	104	156	260		100	155	240
10 m x 10 m	265	97	146	244		95	145	240

Marshall Island
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BEARING CAPACITY CALCULATIONS

3.2 Allowable Bearing Pressure For Strip Foundation

ALLOWABLE BEARING CAPACITY vs SETTLEMENT FOR STRIP FOOTING

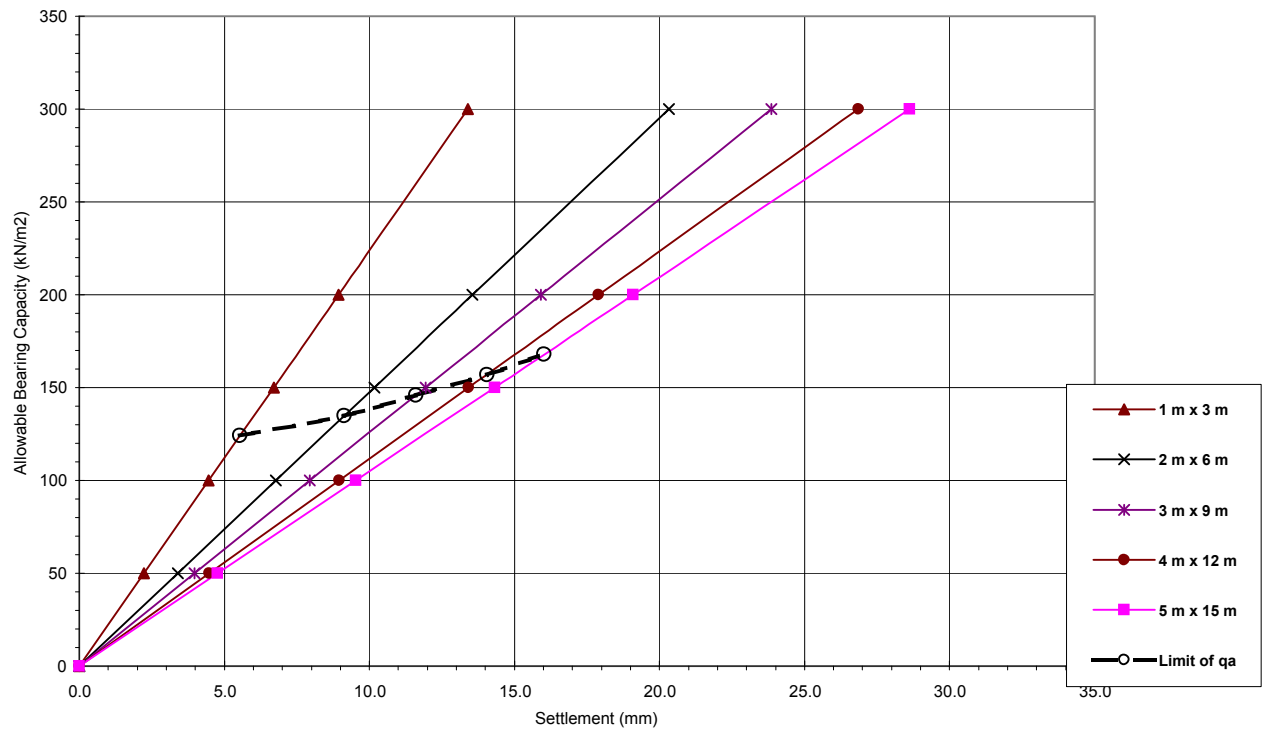


Footing Dimension	Calculated Bearing Capacity					Recommended Allowable Bearing Pressure (kN/m ²)		
	By Meyerhof Formula	Settlement Criteria (mm)						
		10	15	25		10	15	25
1 m	111	170	255	424		110	110	110
2 m	121	124	185	309		120	120	120
3 m	131	109	164	273		105	130	130
4 m	142	101	152	253		100	140	140

Marshall Island
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BEARING CAPACITY CALCULATIONS

3.3 Allowable Bearing Pressure For Rectangular Foundation (L/B = 3)

**ALLOWABLE BEARING CAPACITY vs SETTLEMENT FOR
RECTANGULAR FOOTING (L/B = 3)**

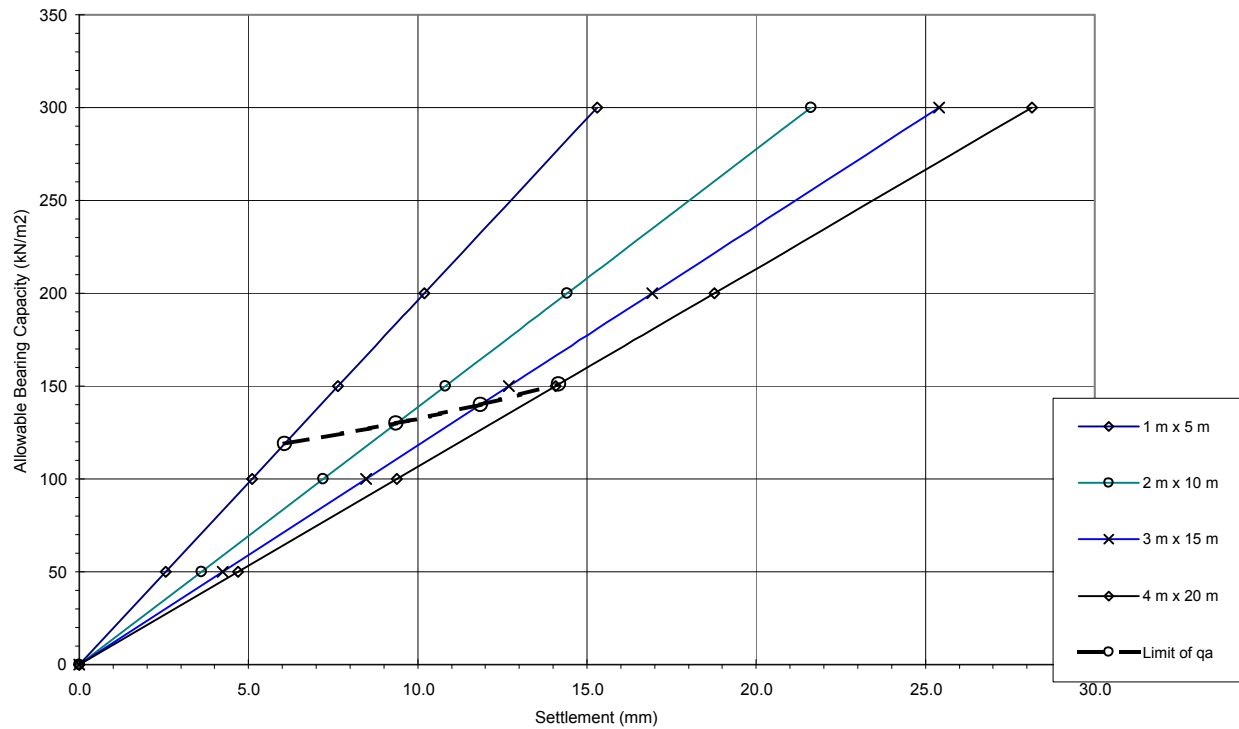


Footing Dimension	Calculated Bearing Capacity					Recommended Allowable Bearing Pressure (kN/m ²)		
	By Meyerhof Formula	Settlement Criteria (mm)						
		10	15	25		10	15	25
1 m x 3 m	124	224	336	559		120	120	120
2 m x 6 m	135	148	221	369		135	135	135
3 m x 9 m	146	126	189	314		125	145	145
4 m x 12 m	157	112	168	279		110	155	155
5 m x 15 m	168	105	157	262		100	155	165

Marshall Island
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BEARING CAPACITY CALCULATIONS

3.3 Allowable Bearing Pressure For Rectangular Foundation (L/B = 5)

**ALLOWABLE BEARING CAPACITY vs SETTLEMENT FOR
RECTANGULAR FOOTING (L/B = 5)**

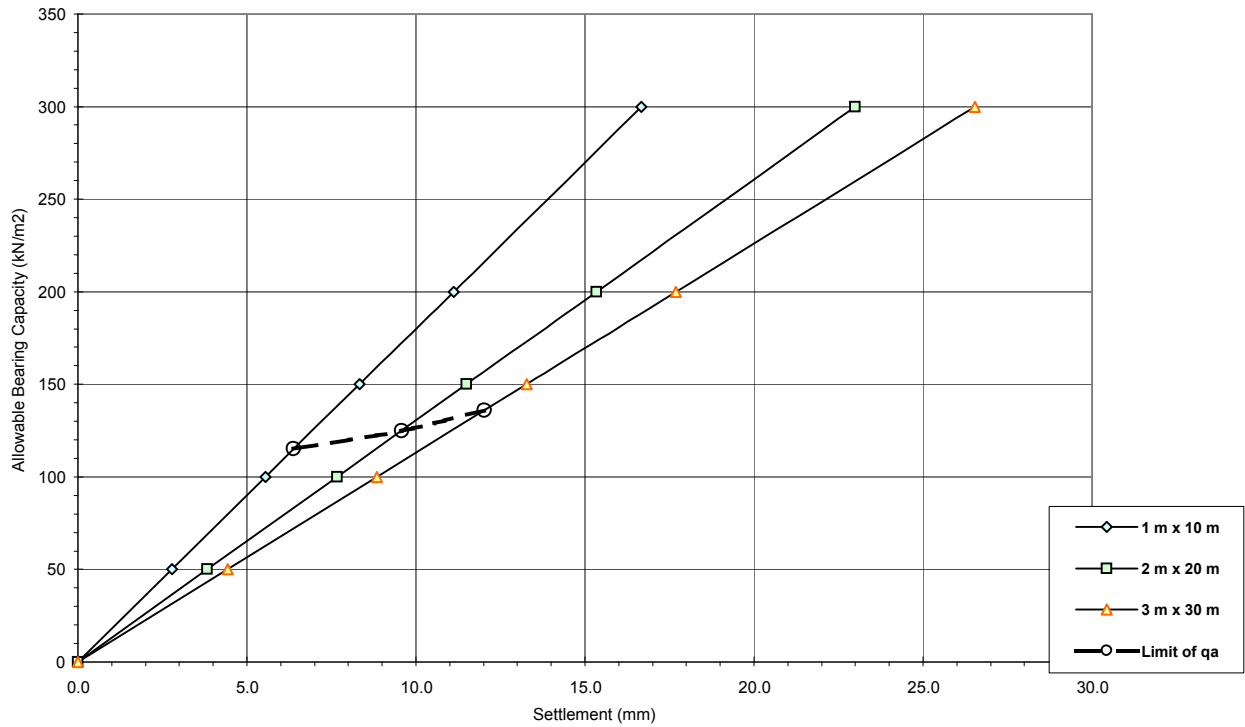


Footing Dimension	Calculated Bearing Capacity					Recommended Allowable Bearing Pressure (kN/m ²)		
	By Meyerhof Formula	Settlement Criteria (mm)						
			<u>10</u>	<u>15</u>	<u>25</u>	<u>10</u>	<u>15</u>	<u>25</u>
1 m x 5 m	119		196	294	490	115	115	115
2 m x 10 m	130		139	208	347	130	130	130
3 m x 15 m	140		118	177	295	115	140	140
4 m x 20 m	151		107	160	266	105	150	150

Marshall Island
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BEARING CAPACITY CALCULATIONS

3.3 Allowable Bearing Pressure For Rectangular Foundation (L/B=10)

**ALLOWABLE BEARING CAPACITY vs SETTLEMENT FOR
RECTANGULAR FOOTING (L/B = 10)**



Footing Dimension	Calculated Bearing Capacity					Recommended Allowable Bearing Pressure (kN/m ²)		
	By Meyerhof Formula	Settlement Criteria (mm)						
		10	15	25		10	15	25
1 m x 10 m	115	180	270	450		115	115	115
2 m x 20 m	125	130	196	326		125	125	125
3 m x 30 m	136	113	170	283		110	135	135

SOIL BEARING REPORT OF PNG

Establishing a Desalination Plant Capacity OF 300KLD

- **Findings:** Preliminary DCP tests at the proposed site indicate that the soil profile may vary in consistency, with a combination of loose and compacted layers. This data will help guide the design of the foundation systems for the desalination plant.

2. Groundwater Table Observations

- **Purpose:** Monitoring the groundwater table is essential for determining the potential for water table fluctuations and ensuring the desalination plant's design accommodates proper drainage and foundation requirements.
- **Scope:** Recent observations by the DoWH's Materials Science and Technology Branch involved measuring the static water levels in test boreholes around the Kerema Town area. These measurements provide an initial understanding of the proximity of the groundwater table to the surface.
- **Findings:** Groundwater levels appear to be relatively stable, though fluctuations may occur seasonally. The data will inform the design of foundation piles and drainage systems to prevent any structural issues related to water table changes.

3. Soil Classification and General Conditions

- **Purpose:** A general classification of soil types in the area (e.g., clay, sand, silt, gravel) is essential for understanding soil behavior under load, permeability, and drainage properties.
- **Scope:** Although no comprehensive laboratory soil testing has yet been completed for the site, we have made use of existing soil classification data based on field observations. It is anticipated that the soils at the site consist primarily of fine-grained sediments with occasional sandy and gravel layers, typical of coastal regions.
- **Findings:** Preliminary classification indicates a mix of cohesive and non-cohesive soils, which will need to be addressed through site-specific foundation design strategies. Further laboratory tests are recommended to refine these preliminary findings.

4. Site Stability and Seismic Considerations

- **Purpose:** To ensure that the desalination plant will remain structurally sound and safe over time, it is essential to understand the soil's response to seismic activity and other environmental factors.
- **Scope:** Seismic data relevant to the region, along with soil compaction and stability assessments, are considered as part of the overall site evaluation.
- **Findings:** Based on existing seismic data, Kerema Town is located in a region with moderate seismic activity. The soil's response to seismic forces will require additional structural engineering analysis.

However, we are currently in the planning and development phase of the project, we would like to inform you that, at this stage, we do not have access to specific soil test data or a comprehensive geological report for the site. However, we are closely following the existing data available from recent studies conducted by the Department of Works and Highways, including the Dynamic Cone Penetrometer (DCP) test and groundwater table observations carried out by the Department's Materials Science and Technology Branch in Port Moresby.

Establishing a Desalination Plant Capacity OF 300KLD

We trust that the data obtained from these tests will provide a solid basis for further assessing the soil and geological conditions of the proposed site. Our team is committed to ensuring that any subsequent steps, such as detailed geotechnical investigations, will be conducted in accordance with the highest industry standards to guarantee the safety, efficiency, and sustainability of the desalination plant.

These points of interests are basically prone to failure and are marked on the map with GPS coordinates for referencing.

The number of blows required to drive the DCP down to its termination depths were recorded. The total number of blows required to drive the DCP Rods due to the free fall of the 9kg drop hammer through a distance of 575 mm for the total DCP tests were carefully recorded on the DCP sheet. All DCP Analysis are attached in the Appendices and Interpreted below in the recommendations.

Table 2.DCP Details- at ground level (GL)

Location	Easting (m)	Southing (m)	Position	Chainage (m)	Termination/Refusal Depth (m)
Airstrip Runway – 200m interval					
DCP 1	145°46'25"E	7°58'02"S	LHS	CH 00	2.3m
DCP 2	145°46'21"E	7°57'57"S	CL	CH 200	2.5m
DCP 3	145°46'18"E	7°57'51"S	RHS	CH 400	2.6m
DCP 4	145°46'15"E	7°57'46"S	CL	CH 600	2.6m
DCP 5	145°46'10"E	7°57'41"S	LHS	CH 800	2.6m
DCP 6	145°46'07"E	7°57'35"S	CL	CH 1000	2.5m
End to End of Runway					
DCP 7	145°46'08"E	7°57'36"S			0.9m
DCP 8	145°46'25"E	7°58'02"S			2.4m
Airstrip Extension – Land reclamation area					
DCP 9	145°46'04"E	7°57'31"S			0.6m



Figure 2. Geotechnical Engineer DOWH-MST Branch conducting DCP Tests at Chainage 00 – LHS of airstrip 10m from the edge of existing pavement (runway)

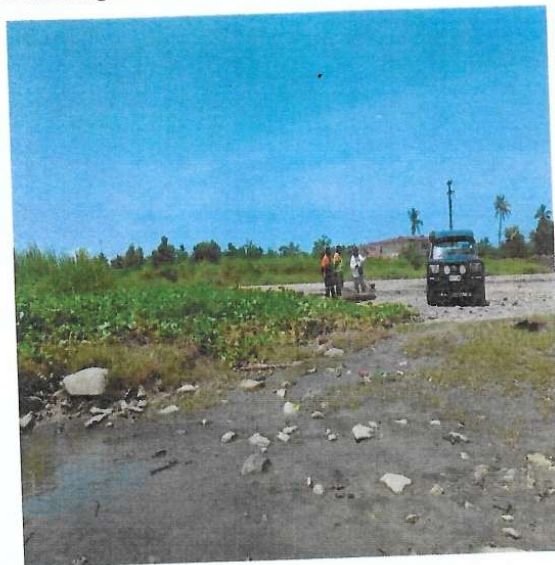
Establishing a Desalination Plant Capacity OF 300KLD



DOWH-MST BRANCH Geotechnical Engineer and team conducting DCP test at CH 00 – Start Point



DCP tests conducted at CH400 by MST Geotechnical Team and NAC representative.

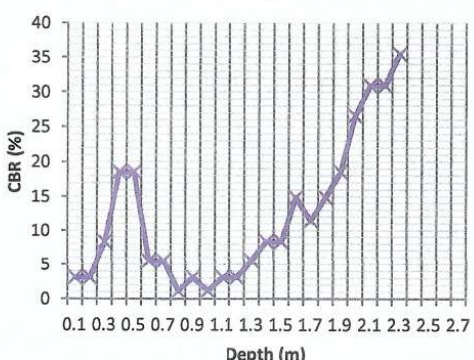
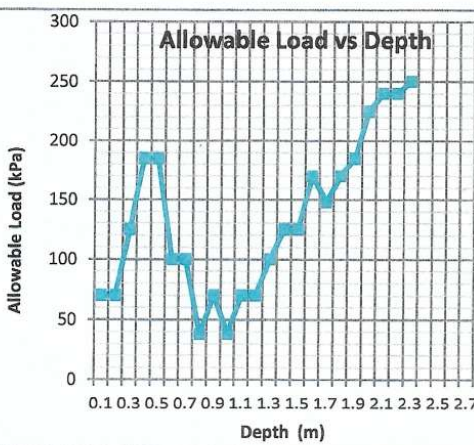


Land reclamation area where DCP 9 was conducted, proposed for airstrip extension



Low sea level & high presence of bedrock formation from coronous rocks and limestone formation – Preferable for stable foundation to cater for airstrip extension

Establishing a Desalination Plant Capacity OF 300KLD

 DEPARTMENT OF WORKS & HIGHWAYS MATERIAL SCIENCE & TECHNOLOGY BRANCH Materials Testing Laboratory		REPORT No. 24P-228																																																																																																																																																																					
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CLIENT: NAC PROJECT: KEREMA AIRSTRIP RUNWAY LOCATION: KEREMA, TOWN MATERIAL DESCRIPTION: IN-SITU MATERIAL TEST METHODS: AS1289 6.3.2		TEST PIT / BH No. LH DEPTH: Max-3m TESTED BY JM DATE TESTED: 21/09/2024 DATE REPORTED: 04/ 10/ 2024																																																																																																																																																																					
DCP#01- CH00 <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th>Depth (m)</th> <th>Field Data (Blw/100mm)</th> <th>e' Value mm/blow</th> <th>CBR Value %</th> <th>Soil Bearing Capacity kPa</th> </tr> </thead> <tbody> <tr><td>0.1</td><td>2</td><td>50.00</td><td>3</td><td>70</td></tr> <tr><td>0.2</td><td>2</td><td>50.00</td><td>3</td><td>70</td></tr> <tr><td>0.3</td><td>4</td><td>25.00</td><td>8</td><td>125</td></tr> <tr><td>0.4</td><td>7</td><td>14.29</td><td>18</td><td>185</td></tr> <tr><td>0.5</td><td>7</td><td>14.29</td><td>18</td><td>185</td></tr> <tr><td>0.6</td><td>3</td><td>33.33</td><td>5</td><td>100</td></tr> <tr><td>0.7</td><td>3</td><td>33.33</td><td>5</td><td>100</td></tr> <tr><td>0.8</td><td>1</td><td>100.00</td><td>1</td><td>38</td></tr> <tr><td>0.9</td><td>2</td><td>50.00</td><td>3</td><td>70</td></tr> <tr><td>1.0</td><td>1</td><td>100.00</td><td>1</td><td>38</td></tr> <tr><td>1.1</td><td>2</td><td>50.00</td><td>3</td><td>70</td></tr> <tr><td>1.2</td><td>2</td><td>50.00</td><td>3</td><td>70</td></tr> <tr><td>1.3</td><td>3</td><td>33.33</td><td>5</td><td>100</td></tr> <tr><td>1.4</td><td>4</td><td>25.00</td><td>8</td><td>125</td></tr> <tr><td>1.5</td><td>4</td><td>25.00</td><td>8</td><td>125</td></tr> <tr><td>1.6</td><td>6</td><td>16.67</td><td>15</td><td>170</td></tr> <tr><td>1.7</td><td>5</td><td>20.00</td><td>11</td><td>148</td></tr> <tr><td>1.8</td><td>6</td><td>16.67</td><td>15</td><td>170</td></tr> <tr><td>1.9</td><td>7</td><td>14.29</td><td>18</td><td>185</td></tr> <tr><td>2.0</td><td>9</td><td>11.11</td><td>27</td><td>225</td></tr> <tr><td>2.1</td><td>10</td><td>10.00</td><td>31</td><td>240</td></tr> <tr><td>2.2</td><td>10</td><td>10.00</td><td>31</td><td>240</td></tr> <tr><td>2.3</td><td>11</td><td>9.09</td><td>35</td><td>250</td></tr> <tr><td>2.4</td><td colspan="4">Terminate</td></tr> <tr><td>2.5</td><td></td><td></td><td></td><td></td></tr> <tr><td>2.6</td><td></td><td></td><td></td><td></td></tr> <tr><td>2.7</td><td></td><td></td><td></td><td></td></tr> <tr><td>2.8</td><td></td><td></td><td></td><td></td></tr> <tr><td>2.9</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.0</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.1</td><td></td><td></td><td></td><td></td></tr> <tr><td>3.2</td><td></td><td></td><td></td><td></td></tr> </tbody> </table>		Depth (m)	Field Data (Blw/100mm)	e' Value mm/blow	CBR Value %	Soil Bearing Capacity kPa	0.1	2	50.00	3	70	0.2	2	50.00	3	70	0.3	4	25.00	8	125	0.4	7	14.29	18	185	0.5	7	14.29	18	185	0.6	3	33.33	5	100	0.7	3	33.33	5	100	0.8	1	100.00	1	38	0.9	2	50.00	3	70	1.0	1	100.00	1	38	1.1	2	50.00	3	70	1.2	2	50.00	3	70	1.3	3	33.33	5	100	1.4	4	25.00	8	125	1.5	4	25.00	8	125	1.6	6	16.67	15	170	1.7	5	20.00	11	148	1.8	6	16.67	15	170	1.9	7	14.29	18	185	2.0	9	11.11	27	225	2.1	10	10.00	31	240	2.2	10	10.00	31	240	2.3	11	9.09	35	250	2.4	Terminate				2.5					2.6					2.7					2.8					2.9					3.0					3.1					3.2					CBR vs Depth  Allowable Load vs Depth 
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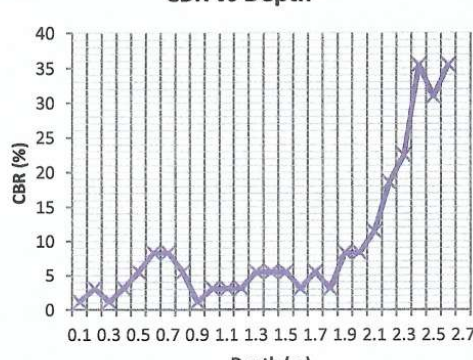
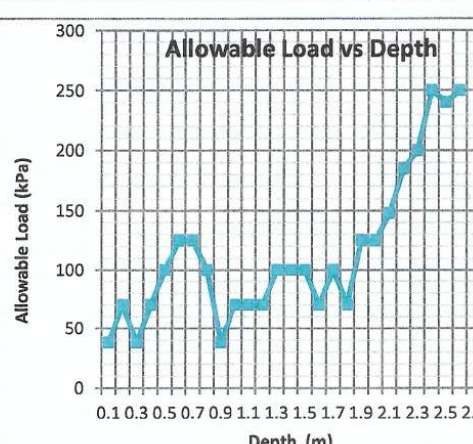
Establishing a Desalination Plant Capacity OF 300KLD

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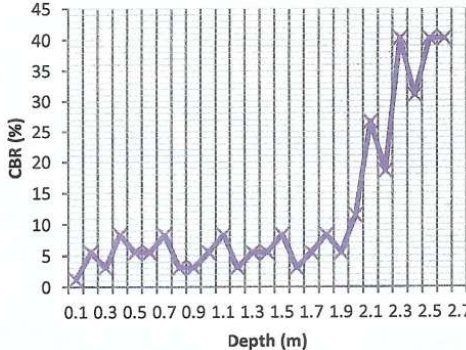
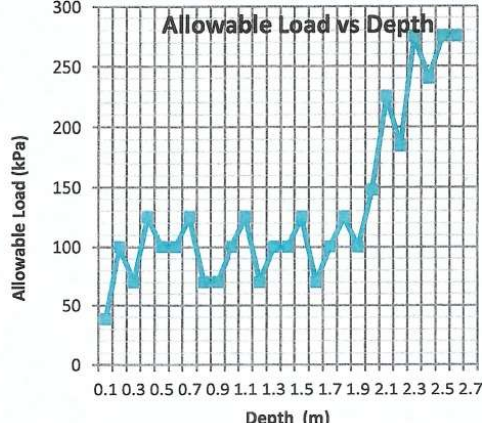
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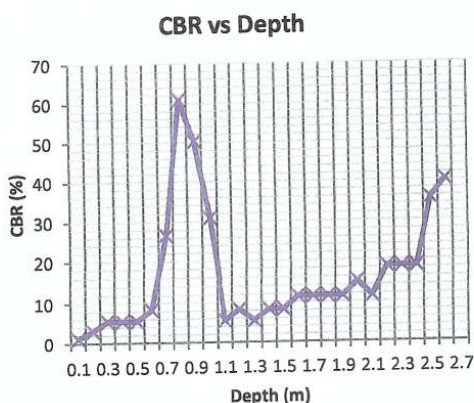
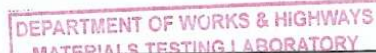
Establishing a Desalination Plant Capacity OF 300KLD

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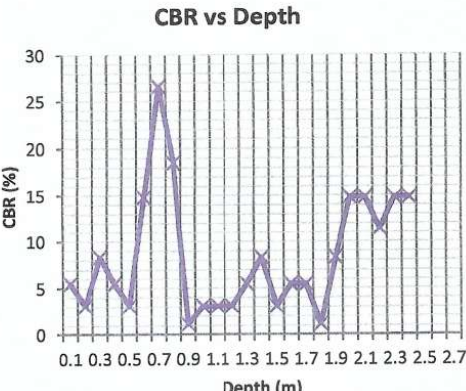
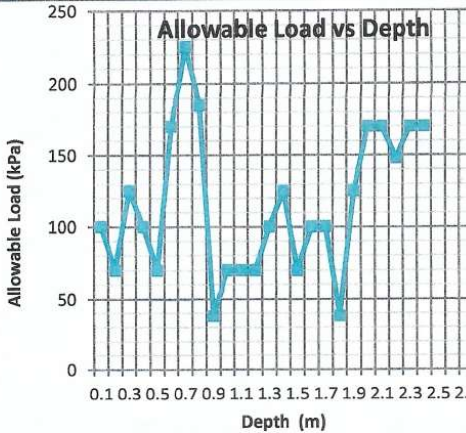
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Establishing a Desalination Plant Capacity OF 300KLD

 DEPARTMENT OF WORKS & HIGHWAYS MATERIAL SCIENCE & TECHNOLOGY BRANCH Materials Testing Laboratory	☒ Port Moresby, ☐ Lae, ☐ Mt. Hagen, ☐ Annex Lab.:		REPORT No. 24P-228																																																																																																																																																																			
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