Ref: **CWWDA/AFD/PQ/W3/2022-2023/70**

Date: 23rd September,2024

To: All Bidders,

DESIGN, BUILD AND OPERATE OF MWACHE WATER TREATMENT PLANT AND ASSOCIATED WORKS - CONTRACT NUMBER: CWWDA/AFD/PQ/W3/2022-2023

RE: GEOTECHNICAL INVESTIGATION REPORT - WTP

Further to the Invitation for Bids issued on 19thAugust 2024 for the above referenced Contract, please find a Geotechnical Investigation Report for Mwache Treatment Plant (WTP) attached as additional information for your action.

Eng. Martin Tsuma
Ag. CHIEF EXECUTIVE OFFICER

Encl. Documents: *Geotechnical Investigation Report for Mwache Treatment Plant (WTP)*

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Republic of Kenya
Coast Water Works Development Agency

IMPROVEMENT OF DRINKING WATER AND SANITATION SYSTEMS IN MOMBASA : MWACHE CKE 1103

Preliminary Design, Tender Documents, Safeguards (ESIA and RAP) Reports and Construction Supervision of Mwache Water Treatment Plant

Contract No: CWSB/AFD/MWCE/C/4/2017

GEOTECHNICAL REPORT

SEPTEMBER 2021

Preliminary Design, Tender Documents, Safeguards (ESIA and RAP) and Construction Supervision of Mwache Water Treatment Plant

REPUBLIC OF KENYA - COAST WATER WORKS DEVELOPMENT AGENCY

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VERSION	DESCRIPTION	PREPARED BY	APPROVED BY	DATE
01	Geotechnical Report	Z. Kuria	GFY	

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1.0 INTRODUCTION

1.1 PREAMBLE

Regional Geophysical Survey Limited (RGS) was engaged by ARTELIA/MIBP JV to carry out a geotechnical investigation (GI) in support of the proposed Mwache Water Treatment Plant (WTP) in Kwale County.

The purpose of the investigation was to identify the subsurface conditions beneath the proposed structures and determine their structural properties necessary for the preparation of the designs. The fieldwork for the investigation, which mainly consisted of 6 No. borings and in-situ permeability tests, was executed by RGS personnel in the period between 20th June and 5th July, 2021.

This report encompasses the results of the geotechnical investigation to determine the prevailing subsurface soil/rock and ground water conditions, and based on this information, provides recommendations for the geotechnical design of foundations.

1.2 OBJECTIVES

The following were the primary objectives of the geotechnical survey:

a) Establish the subsurface stratigraphy at the borehole locations.
b) Provide descriptions of the lithologic units encountered in the boreholes.
c) Determine the in-situ permeability of the rock strata.
d) Establish the geotechnical parameters of the subsurface layers relevant to foundation design.
e) Document all findings and provide geotechnical recommendations.

1.3 SCOPE

To fulfil the abovementioned objectives, the scope of the investigation was as follows:

a) Drill, sample and log of a total of 6 No. vertical, geotechnical boreholes (BH1 through BH6) each to 20 m bgl (below ground level).
b) Perform Standard Penetration Tests (SPT) on soil layers encountered in the boreholes at 1 m intervals.
c) Carry out in-situ borehole Lugeon (Packer) permeability tests.
d) Perform laboratory tests on the representative soil and rock samples as per the GI specifications.
e) Prepare a comprehensive, interpretative, geotechnical report.

1.4 SITE LOCATION

The project site is located at Fulugani village, Kasemeni Ward, Kinango Sub-County of Kwale County, about 22 km northwest of Mombasa City. The proposed WTP site lies along a crest situated southeast of the dam reservoir. The elevation at the study area was measured using a handheld GPS device and found to range from 129 masl (metres above mean sea level) at BH1 to 119 masl at BH6.

Figure 1 shows the geographic location of the WTP site and the layout of the boreholes.

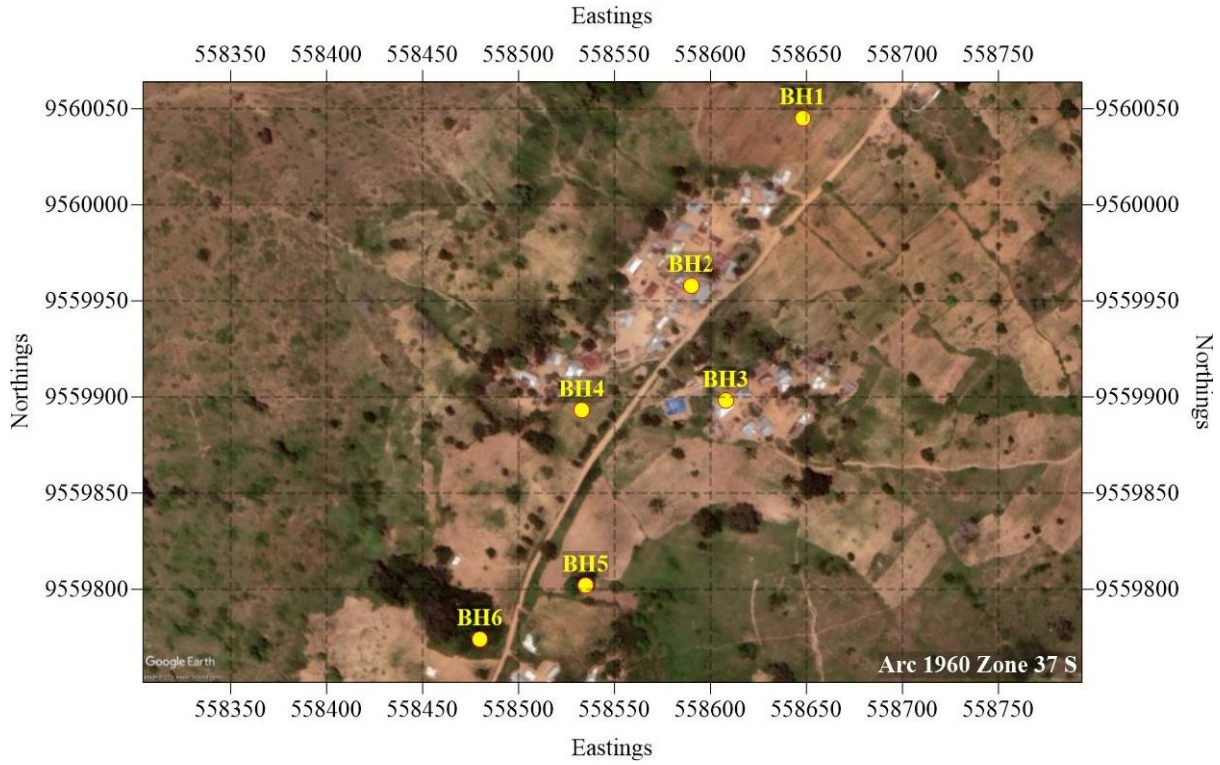

Figure 1 - Satellite Map of the WTP Site

2.0 FIELDWORK

2.1 GENERAL

The requirements given in British Standard, BS 5930:15, were used as a guide for carrying out the field investigations. A supervising geologist from RGS was stationed at the site in the entire duration of the fieldwork.

2.2 SETTING OUT

The table below presents the placed coordinates and elevations at all surveyed points in Arc 1960 (Zone 37 S) coordinate projection.

Table 1 - Coordinates and depths of investigation at the sampling points

Sampling Point	Depth (m)	Easting	Northing	Elevation (m)
BH1	20	558648	9560045	129.29
BH2	20	558590	9559958	122.09
BH3	20	558608	9559898	118.29
BH4	20	558533	9559893	119.15
BH5	20	558535	9559802	116.87
BH6	20	558480	9559774	118.71

2.3 METHODOLOGY

2.3.1 Rig and Accessories

Three (3) GY 150 rotary drilling rigs were procured to site to advance the boreholes to the required depths. Each of the hydraulic driven rigs was equipped with double tube barrels, hollow-stem and mud rotary auger, U100 samplers and standard SPT accessories.

The drilling equipment also included a mud pump which was used to impel drilling water into the borehole to cool the tungsten bit as it advanced through the bedrock as well as flush out cuttings from the bottom of the borehole.

2.3.2 Standard Penetration Test (SPT)

Standard Penetration Tests were performed in soil strata encountered at the bottom of the open boreholes at 1 m intervals. The dynamic test entailed the driving of a split spoon sampler into the soil layer by dropping a standard weight (63.5 kg) hammer through a standard distance (760 mm). This was followed by recording of the number of blows (N) required to achieve 300 mm penetration (in 150 mm increments) after an initial seating drive of 150 mm or 25 blows, whichever was achieved first.

2.3.3 Sampling

i. Soil Sampling

Soil samples were recovered from the boreholes through auguring. The disturbed soil samples were collected into standard moisture proof sample bags that were labelled to indicate the project name, borehole number, depth of recovery and date of sampling.

ii. Rock Sampling

Rock cores were carefully extracted from the double tube swivel type core barrels and placed into purpose made core boxes ensuring that the original depth orientation of each sample was maintained. The typical core box consisted of five grooves, each groove with adequate dimensions for containing one metre of the core section. Accordingly, at full recovery, every core box contained core samples from an approximately 5 m borehole section. The core boxes were labelled to indicate the project name, borehole number, core runs and date of sampling. Photographs of the core boxes are provided in Appendix A.

2.3.4 Logging of Soils and Rocks

The supervising geologist, stationed at the site, logged the soil and rock samples immediately after retrieval from the boreholes.

The recovered soils were visually and manually inspected according to the soil logging manual provided in BS 5930:99. It should be noted that subsequent laboratory testing was also used to further classify the sampled soils according to the Unified Soil Classification System (USCS). The latter classification (section 4.2.3) has been used in making geotechnical decisions as it is considered more definitive.

The rocks cores on the other hand were carefully examined for any exposed minerals, cementation, weathering condition, fracture/jointing condition and the quantity and quality of recovery.

2.3.5 Packer (Lugeon) Permeability Test

The packer test entails the measurement of the volume of water that can escape from an uncased section of borehole in a given time under a given pressure and assuming laminar flow.

Prior to performing the permeability test, the test borehole was flushed with drilling water until the returning water was as clean as the inflow water. After flushing was complete, a test section within the rock formation and to the bottom of the drill hole was isolated using a single, sealing, pneumatic packer. Water was then pumped in to this section at predetermined increasing and decreasing pressure levels. Each pressure stage was maintained for at least 10 minutes with injected quantity of water recorded every 5 minutes.

The maximum gauge pressure was kept below the estimated overburden stress at the test depth to minimize the risk of hydraulic fracture.

3.0 SUBSURFACE CONDITIONS

3.1 LIMITATIONS OF THE SAMPLING METHOD

Reference is to be made to the attached borehole logs (Appendix B) and geotechnical cross section (Appendix E) while reading this section. Stratigraphic boundaries indicated in the logs are inferred from non-continuous sampling methods and observation of drilling resistance which typically represent a transition from one stratum to another. These boundaries should not be interpreted to represent exact planes of geologic change but rather variation in subsurface conditions should be anticipated between and beyond the survey points.

The stratigraphy summary below has been simplified in terms of the major strata for the purposes of geotechnical design. This information may not be sufficient for estimating subsurface material quantities across the dam site or for the associated excavation costs. The factual data presented in the logs governs any interpretation of the site conditions.

Soil classifications reported in the logs are based on visual-manual inspection methods performed onsite. These classifications may differ from those deduced from subsequent laboratory classification tests.

3.2 STRATIGRAPHY

3.2.1 Silty Sand – Overburden Soil

A reddish-brown silty sand overburden soil layer was encountered at all six borehole locations. SPT tests in this surficial zone indicate dense in-situ soil packing. The depth of the overburden layer ranges from 2 m to 3 m.

3.2.2 Sandstone – Bedrock

Underlying the overburden soil is a brownish-grey sandstone bedrock. The rock head was found to be completely weathered at BH1 and BH6. Other minor rock types encountered within the bedrock are mudstone in BH1 and shale in BH3, BH5 and BH6.

4.0 ANALYSIS AND DISCUSSION OF TEST RESULTS

4.1 IN-SITU TESTS

4.1.1 Standard Penetration Tests (SPT)

The average SPT N-values within the overburden soil at the site was found to be about 33 blows/300 mm implying dense/hard in-situ conditions.

4.1.2 Lugeon Permeability Test

The lugeon value was computed from flow and pressure data using the formula below:

$$\boldsymbol{L = \frac{10 \times Q}{P}}$$

Where,
$\boldsymbol{L}$ = Lugeon value
$\boldsymbol{Q}$ = Water loss in litres/metre/min
$\boldsymbol{P}$ = Pressure in bars and,
$\mathbf{10}$ is the correction for standard test pressure of 10 bars

The interpreted lugeon values were acquired by introducing a best fit, straight line into the plot and a drawing second line parallel to the best fit but passing through the origin. The second line represents adjustments for water column pressure and was then extrapolated to 10 bars (1000kPa) to give the interpreted lugeon value. Permeability in ms^{-1} was computed by multiplying the lugeon values by 1.3×10^{-7}.

The Table below presents a summary of the permeability data from each of the in-situ tests.

Table 2 - Summary of in-situ permeability parameters

Hole ID	Depth		Interpreted Lugeon	Equivalent Permeability, k (ms^{-1})
	From	To		
BH1	4	9	13.65	1.77E-06
	9	14	1.19	1.55E-07
	14	19	0.47	6.11E-08
BH2	3	8	0.87	1.13E-07
	8	13	1.39	1.81E-07
	13	18	0.56	7.28E-08
BH3	4	9	1.22	1.59E-07
	9	14	1.84	2.39E-07
	14	19	1.2	1.56E-07
BH4	3	8	0.76	9.88E-08
	9	14	0.68	8.84E-08
	14	19	2.1	2.73E-07
BH5	4	9	0.5	6.50E-08
	9	14	0.41	5.33E-08
	14	19	0.4	5.20E-08
BH6	6	10	1.16	1.51E-07
	10	15	0.75	9.75E-08
	15	20	1.01	1.31E-07

4.2 LABORATORY TESTS

For the purposes of discussion, the following subsections highlight/summarize the key soil and rock parameters determined through laboratory testing. Comprehensive backup data sheets are provided in Appendix C and should be frequently referred to when reading this section.

The laboratory tests were conducted to conform to the respective standard codes indicated on Table 3 below. Any alterations/modifications of the prescribed standard methods of testing due to specimen-based limitations are clearly outlined.

Table 3 - Laboratory tests performed on soil and rock samples

Material	Test	Standard Code	No. of Tests
Soil	Atterberg Limits	BS 1377-2: 90	6
	Sieve Analysis	BS 1377-2: 90	6
	Hydrometer Analysis	BS 1377-2: 90	6
	Standard Proctor Density	BS 1377-4: 90	6
	Natural Moisture Content	BS 1377-2: 90	6
	Specific Gravity of Soils	BS 1377-2: 90	6
	Unconsolidated Undrained (UU) Triaxial Test	BS 1377-8: 90	6
	One-Dimensional Consolidation	BS 1377-5: 90	6
Rock	Porosity	ASTM C97-83	12
	Specific Gravity and Water Absorption	BS 1377-6: 90	12
	Unconfined Compressive Strength (UCS) of Rocks	ASTM D7012	24

4.2.1 Atterberg Limits

The Atterberg tests were performed to investigate whether the sampled soils exhibit the proper consistency to support structural loads even as their moisture levels change. The Atterberg limits comprise liquid limit (LL), plastic limit (PL) and shrinkage limit (SL). These define the boundaries between the four stages of soil consistency/behavior and are defined as follows;

The liquid limit is the moisture content at which a soil passes from the liquid to the plastic state and is directly proportional to the compressibility of a soil. The plastic limit is the moisture content at which a fine-grained soil can no longer be remolded without cracking. The shrinkage limit is the water content at which the soil changes from a semi-solid to a solid state. Finally, the soil plasticity index (PI) represents the range in water content through which the soil is in a plastic state and was acquired from the difference between LL and PL.

The measured plasticity indices range from 10.6% to 15.2% implying medium plastic soils according to the qualitative plasticity classification proposed by Burmister (1949).

The liquid limits average at 28.7% and suggest a low degree of compressibility (Mills *et al*, 1980). Dakshanamurthy and Raman (1974) recommend that soils with liquid limits between 20% and 35% should be classified as low swelling soils.

The linear shrinkage values from the tests peak at 7.2%. Soils with linear shrinkage below 12% are considered to have a non-critical expansive rating (Mills *et al*, 1980).

The Atterberg parameters are summarized in Table 4.

4.2.2 Particle Size Distribution

Particle size distribution analysis evaluates the relative portions of different sizes of soil particles. From this, it is possible to determine whether the soil consists of predominantly gravel, sand, silt or clay sizes and, to a limited extent, which of these size ranges is likely to control the engineering properties of the soil.

Representative soil samples were analyzed for particle size distribution through wet sieving and sedimentation analysis using the hydrometer to enable the plotting of a continuous grading curve from the size of the coarsest particles down to clay sizes.

Generally, the grading test results indicate a predominance of fine-grained soils within the overburden layer. Table 4 lists the percentage fines confirmed in each test sample.

4.2.3 Soil Classification

The key objective of performing both Atterberg and grading tests on the same soil samples is to facilitate classification of the soils according to the Unified Soil Classification System (USCS).

Firstly, soils with less than 50% fines are categorized as coarse-grained soils while those with fine content equal to or greater than 50% as fine-grained. Afterwards, their Atterberg parameters (PL and LL) are plotted on the USCS plasticity chart (provided in Appendix E) and inspected relative to the “A” line to determine their full identity.

As can be perceived from the table below, the soils at the site were mainly classified as lean clays (CL).

Table 4 - USCS soil classification

Hole ID	Depth (m)		Fines (%)	PI (%)	LL (%)	LS (%)	USCS Classification	
	From	To					Name	Sym.
BH1	0.00	0.20	36	12.3	28.2	5.8	Clayey Gravel with Sand	GC
BH2	0.00	1.85	72	14.4	31.6	6.8	Lean Clay with Sand	CL
BH3	0.00	0.20	50	15.2	32.8	7.2	Sandy Lean Clay	CL
BH4	0.00	0.20	58	11.8	25.1	5.6	Sandy Lean Clay	CL
BH5	0.00	1.50	43	10.6	27.6	5.0	Clayey Sand	SC
BH6	0.00	0.20	60	12.4	26.9	5.8	Sandy Lean Clay	CL

4.2.4 Standard Proctor Density

The dry density which can be achieved for a soil depends on the degree of compaction applied and the moisture content. The test involved compacting soil passing the 20 mm sieve at different moisture levels in a 1 litre mould using a 2.5 kg rammer with a 300 mm drop height.

The proctor test was performed on disturbed soil samples to acquire compacted specimens for the shear and consolidation tests. The acquired compaction parameters are tabulated below:

Table 5 - Summary of compaction parameters

Hole ID	Depth (m)		Standard Proctor Parameters	
	From	To	Maximum Dry Density, MDD (kg/m^3)	Optimum Moisture Content, OMC (%)
BH1	0.00	0.20	1905	12.5
BH2	0.00	1.85	1785	15.0
BH3	0.00	0.20	1823	13.8
BH4	0.00	0.20	1827	13.1
BH5	0.00	1.50	1851	12.6
BH6	0.00	0.20	1915	12.0

4.2.5 Natural Moisture Content

Select soil samples were evaluated for natural moisture content (w) through oven-drying at 110 °C. The lost mass due to drying was expressed as a percentage of the resulting dry soil mass and reported as the moisture content. The test results, summarized below, indicate that the natural soil moisture is generally dry of optimum.

Table 6 - Summary of soil moisture content

Hole ID	Depth (m)		Moisture Content (%)
	From	To	
BH1	0.00	0.20	1.3
BH2	0.00	1.85	3.8
BH3	0.00	0.20	3.5
BH4	0.00	0.20	1.1
BH5	0.00	1.50	3.0
BH6	0.00	0.20	1.1

4.2.6 Specific Gravity of Soils

The specific gravity (particle density) of representative soil samples was determined via the small pycnometer method. Riffled specimens were placed in a density bottle (pycnometer) followed by the addition of distilled water. The resulting slurry was thereafter de-aired in a vacuum desiccator until no further loss of air was apparent. The recorded weighings in the various stages of the test were used to compute the specific gravity of the soil sample. The results are tabulated below.

Table 7 - Summary of relative densities

Hole ID	Depth (m)		Specific Gravity
	From	To	
BH1	0.00	0.20	2.69
BH2	0.00	1.85	2.65
BH3	0.00	0.20	2.61
BH4	0.00	0.20	2.68
BH5	0.00	1.50	2.70
BH6	0.00	0.20	2.69

4.2.7 Unconsolidated Undrained (UU) Triaxial Test

In triaxial tests, a soil specimen with a height approximately equal to twice its diameter is placed in a triaxial cell and subjected to three stresses at right angles to each other. The test consists of two phases, the consolidation phase and the shear phase.

The UU (Q) triaxial tests were performed on remolded soil samples. Each of the test samples (assumed saturated) was first subjected to a confining pressure and then the principal stress difference applied immediately without permitting drainage (i.e. no consolidation) at any phase of the test. In this case, the applied confining pressure was not entirely carried by the soil skeleton but rather also resulted in an increase in pore water pressure. Since the pore and back pressures are not measured in the UU test, the results have been interpreted in terms of total stress over a confinement pressure.

The test was repeated for three different confining pressures and the results are summarized below:

Table 8 - Undrained shear parameters

Hole ID	Depth (m)		Undrained Shear Parameters	
	From	To	Angle of Shear Resistance, φ_u (°)	Cohesion, c_u (kN/m²)
BH1	0.00	0.20	28	28
BH2	0.00	1.85	19	34
BH3	0.00	0.20	21	38
BH4	0.00	0.20	17	44
BH5	0.00	1.50	18	39
BH6	0.00	0.20	16	38

4.2.8 One-Dimensional Consolidation

The objective of the consolidation test was to determine the compressibility characteristics of soils recovered from the boreholes. The test entailed determination of the magnitude and rate of the consolidation of a saturated or near-saturated specimen of soil in the form of a disc confined laterally, subjected to vertical axial pressure, and allowed to drain freely from the top and bottom surfaces.

The typical test sample was loaded axially in increments ranging from 50 – 800 kN/m^2 whereby each stress increment was held constant until the primary consolidation was complete. The consolidation test results along with the deduced parameters are provided below:

Table 9 - Summary of consolidation parameters

Hole ID	Depth (m)		H_o	H_1	σ'_o	σ'_1	M_v	C_v	C_{sec}	E_{oed}	Voids Ratio
	From	To									
BH01	0.00	2.00	20.00	19.47	0	62.5	0.424	9.210	Nil	2.4	0.401
			19.47	19.26	62.5	125	0.173	8.129	Nil	5.8	0.386
			19.26	18.90	125	250	0.150	8.605	Nil	6.7	0.360
			18.90	18.47	250	500	0.091	6.055	Nil	11.0	0.329
			18.47	17.96	500	1000	0.055	2.213	Nil	18.1	0.292
			17.96	17.49	1000	2000	0.026	4.302	Nil	38.2	0.258
BH02	0.00	1.85	20.00	19.54	0	62.5	0.368	8.468	Nil	2.7	0.504
			19.54	19.32	62.5	125	0.180	4.462	Nil	5.6	0.487
			19.32	18.88	125	250	0.182	3.513	Nil	5.5	0.453
			18.88	18.12	250	500	0.161	3.068	Nil	6.2	0.395
			18.12	17.45	500	1000	0.074	1.829	Nil	13.5	0.343
			17.45	16.79	1000	2000	0.038	2.309	Nil	26.4	0.293
BH03	0.00	2.00	20.00	19.67	0	62.5	0.264	11.371	Nil	3.8	0.477
			19.67	19.49	62.5	125	0.146	9.968	Nil	6.8	0.463
			19.49	18.64	125	250	0.349	5.972	Nil	2.9	0.399
			18.64	17.45	250	500	0.255	3.258	Nil	3.9	0.310
			17.45	16.62	500	1000	0.095	2.796	Nil	10.5	0.248
			16.62	15.88	1000	2000	0.045	2.861	Nil	22.5	0.192
BH04	0.00	2.00	20.00	19.78	0	62.5	0.176	9.351	Nil	5.7	0.486
			19.78	19.62	62.5	125	0.129	9.173	Nil	7.7	0.474
			19.62	19.40	125	250	0.090	8.247	Nil	11.1	0.458
			19.40	19.09	250	500	0.064	8.759	Nil	15.6	0.434
			19.09	18.71	500	1000	0.040	3.440	Nil	25.1	0.406
			18.71	18.24	1000	2000	0.025	6.830	Nil	39.8	0.370
BH05	0.00	1.50	20.00	19.53	0	62.5	0.376	10.162	Nil	2.7	0.454
			19.53	19.36	62.5	125	0.139	5.464	Nil	7.2	0.442
			19.36	19.03	125	250	0.136	8.713	Nil	7.3	0.417

Hole ID	Depth (m)		H_o	H_1	σ'_o	σ'_1	M_v	C_v	C_{sec}	E_{oed}	Voids Ratio
	From	To									
			19.03	18.65	250	500	0.080	2.884	Nil	12.5	0.389
			18.65	18.18	500	1000	0.050	4.001	Nil	19.8	0.354
			18.18	17.59	1000	2000	0.032	2.190	Nil	30.8	0.310
BH06	0.00	2.00	20.00	19.61	0	62.5	0.312	9.276	Nil	3.2	0.402
			19.61	19.49	62.5	125	0.098	3.206	Nil	10.2	0.393
			19.49	19.37	125	250	0.049	7.011	Nil	20.3	0.385
			19.37	19.04	250	500	0.068	4.569	Nil	14.7	0.361
			19.04	18.60	500	1000	0.046	3.070	Nil	21.6	0.330
			18.60	18.09	1000	2000	0.027	3.243	Nil	36.5	0.293

H_o	*Initial sample height (mm)*	M_v	*Coefficient of volume compressibility (m^2/MN)*
H_1	*Final sample height (mm)*	C_v	*Coefficient of consolidation (m^2/year)*
σ'_o	*Initial load (kN/m^2)*	***Deg.***	*Degree of compressibility after Carter (1991)*
σ'_1	*Final load (kN/m^2)*	E_{oed}	*Oedometric Modulus (MN/m^2)*

4.2.9 Rock Porosity

Rock porosity is the percentage of interstitial space within the rock relative to the total volume of the rock. Rock specimens from the site were evaluated for porosity using the procedures stipulated in ASTM C97-83. The test results are tabulated below:

Table 10 - Summary of porosity test results

Hole ID	Depth (m)		Rock ID	Porosity (%)
	From	To		
BH1	9.00	9.75	Sandstone	2.0
	18.00	18.70	Sandstone	1.1
BH2	8.00	8.40	Sandstone	1.4
	12.15	12.65	Sandstone	1.1
BH3	8.24	9.00	Sandstone	1.7
	18.30	18.60	Shale	1.0
BH4	6.00	6.60	Sandstone	1.4
	19.23	19.74	Sandstone	2.0
BH5	5.32	5.65	Sandstone	1.5
	17.16	17.36	Shale	0.7
BH6	6.47	6.77	Sandstone	1.7
	19.00	19.30	Sandstone	1.5

4.2.10 Specific Gravity and Water Absorption

The table below presents a summary of the specific gravity and water absorption tests performed on rock specimens:

Table 11 - Summary of specific gravity and water absorption

Hole ID	Depth (m)		Rock ID	Apparent Relative Density	Water Absorption (%)
	From	To			
BH1	9.00	9.75	Sandstone	2.63	0.4
	18.00	18.70	Sandstone	2.60	0.4
BH2	8.00	8.40	Sandstone	2.57	0.3
	12.15	12.65	Sandstone	2.61	0.6
BH3	8.24	9.00	Sandstone	2.61	0.2
	18.30	18.60	Shale	2.60	0.4
BH4	6.00	6.60	Sandstone	2.60	0.8
	19.23	19.74	Sandstone	2.63	0.7
BH5	5.32	5.65	Sandstone	2.60	0.8
	17.16	17.36	Shale	2.62	0.6
BH6	6.47	6.77	Sandstone	2.53	1.0
	19.00	19.30	Sandstone	2.62	0.2

4.2.11 Unconfined Compressive Strength of Rock Cores

The unconfined compressive strength (UCS) is the maximum axial compressive stress that a right-cylindrical sample of material can withstand under unconfined conditions i.e. at zero confining stress.

Intact rock core samples recovered from the various rock formations at the site were trimmed targeting a standard height-to-diameter (L/D) ratio of about 2.0 before being subjected to axial loading in a compression machine. A height to diameter ratio of up to 2.5 was allowed for the finished core followed by the standardization of the UCS value to an equivalent core whose L/D = 2.0 as recommended in the standard.

The ultimate rock bearing pressure (q_u) values were computed from UCS using the Goodman (1980) formula below:

$$\boldsymbol{q_u = q_{ur}(N_{\emptyset} + 1)}$$

Where,

$\boldsymbol{q_u}$ = Ultimate Bearing Capacity
$\boldsymbol{q_{ur}}$ = Factored unconfined compressive strength of the rock core. It has been observed that as the diameter of a UCS specimen increases, the unconfined compression strength decreases, which is referred to as the *scale effect*. For specimens larger than about 1 m in diameter, the UCS value remains approximately constant. There appears to be a fourfold to fivefold reduction in the magnitude (Braja, 2014). For this reason, to acquire q_{ur} for bearing capacity calculations, the laboratory standardized UCS values were factored down by 5.
$\boldsymbol{N_{\emptyset}}$ = A constant given by $\boldsymbol{tan^2(45 + {\emptyset}/{2})}$
$\emptyset$ = Angle of internal friction of the rock, estimated from $\boldsymbol{0.145 \times UCS + 25}$.

The design (safe) bearing pressures (q_d) were then calculated from the ultimate values by further applying a safety factor of 5 (Murthy, 2002). The compression test results and computed strength values are tabulated below;

Table 12 - Summary Rock UCS test results and interpreted bearing capacities

Hole ID	Depth (m)		Rock ID	Density (Kg/m³)	Standardized UCS (MPa)	q_u- Goodman (MPa)	q_d- Murthy (MPa)
	From	To					
BH01	9.00	9.75	Sandstone	2590	100.14	110.05	22.01
	12.48	13.00	Sandstone	2558	101.68	112.68	22.54
	18.00	18.70	Sandstone	2605	95.56	102.48	20.50
BH02	8.00	8.40	Sandstone	2538	106.16	120.54	24.11
	8.40	8.50	Sandstone	2604	106.93	121.92	24.38
	12.15	12.65	Sandstone	2619	80.87	80.40	16.08
	15.30	16.00	Sandstone	2568	103.78	116.31	23.26
BH03	8.23	9.00	Sandstone	2592	109.49	126.61	25.32
	12.30	12.86	Sandstone	2567	106.56	121.26	24.25
	18.30	18.60	Shale	2598	102.87	114.73	22.95
	19.37	19.63	Shale	2526	96.62	104.20	20.84
BH04	6.00	6.60	Sandstone	2478	76.69	74.67	14.93
	14.58	14.68	Sandstone	2562	122.26	151.96	30.39
	14.68	14.87	Sandstone	2562	136.07	183.54	36.71
	14.87	14.99	Sandstone	2605	61.32	55.40	11.08
	19.23	19.74	Sandstone	2636	85.31	86.74	17.35
BH05	5.32	6.65	Sandstone	2449	62.90	57.26	11.45
	5.69	5.90	Sandstone	2475	84.63	85.75	17.15
	14.08	14.47	Shale	2510	16.04	11.85	2.37
	16.36	16.50	Sandstone	2624	125.34	158.60	31.72
	17.10	17.30	Shale	2696	120.10	147.45	29.49
BH06	6.47	6.77	Sandstone	2371	32.94	26.16	5.23
	13.88	14.00	Sandstone	2399	36.11	29.08	5.82
	19.00	19.31	Sandstone	2540	119.35	145.90	29.18

5.0 RECOMMENDATIONS AND CONCLUSION

The recommendations and conclusions provided herein are based on the following:

- Our understanding of the proposed project;
- Site observations and data obtained during the field exploration;
- Experience with similar conditions at other sites; and,
- Generally accepted geotechnical engineering principles and practices.

5.1 EVALUATION OF IN-SITU SOILS, BEARING CAPACITY AND SETTLEMENT

The in-situ soils are concluded to be mainly medium plastic lean clays with sand content generally above 15%. The soils are expected to undergo some degree of volumetric changes with variation of soil moisture; however, we believe that any heave or shrinkage of the in-situ soils will not be significant to affect the integrity of conventional lightly loaded structures supported thereupon.

Typical size (1.2 m to 1.5 m) square pad and strip foundations, both founded on the lean clay soil at 1.2 m bgl were considered for bearing capacity analysis using the equations below based on the classical theories by Terzaghi (1943). The average shear and density parameters established from laboratory tests were used to characterize the typical subgrade soil for bearing analysis.

Strip footings: $$q_u = cN_c + \gamma D_f N_q + 0.5\gamma B N_\gamma$$

Rectangular foundations: $$q_u = cN_c(1 + 0.3\frac{B}{L}) + \gamma D_f N_q + 0.5\gamma B N_\gamma(1 - 0.2\ \frac{B}{L})$$

Where,
q_u = Ultimate bearing capacity
c = Soil cohesion
$\emptyset$ = Angle of internal friction
γ = Effective unit weight of soil
B = Width of the foundation
L = Length of the foundation
D_f = Foundation depth
N_c, N_q, N_γ = Terzaghi's bearing capacity factors for general shear failure (Figure 5)

A factor of safety of 5 was used to compute the allowable bearing capacity (q_a) from the ultimate capacity. The calculation results are tabulated below:

Table 13 - Bearing capacity calculation results

c (kN/m²)	∅ (°)	N_q	N_c	N_γ	D_f (m)	B (m)	q_a (kN/m²)	
							Strip	Spread
36	19.8	7.25	17.47	4.83	1.2	1.2	168	203
36	19.8	7.25	17.47	4.83	1.2	1.5	170	206

We recommend a limiting bearing capacity of **150 kN/m²** for shallow foundations constructed on the in-situ soils and embedded to a minimum depth of 1.2 m bgl.

Long term consolidation settlement of foundations constructed on compressible soil can be computed from the coefficient of volume compressibility (m_v), obtained from the one-dimensional consolidation test, using the equation below:

$$\rho = \int_0^H m_v \times \Delta\sigma \times H$$

Where,

$\boldsymbol{\rho} =$ Consolidation settlement (m).
$\boldsymbol{M_v}$= Coefficient of compressibility (average of 1.59 x 10^{-4} m^2/kN for net pressure increase of about 125 kN/m^2 see Table 9).
$\Delta\boldsymbol{\sigma} =$ Net increase in vertical stress (kN/m^2)
$\boldsymbol{H} =$ Height of homogenous layer under stress (m).

The table below presents the estimated consolidation settlements for the recommended limiting bearing pressures:

Table 14 - Estimated consolidation settlement of the subgrade soil

Depth (m)	Estimated Initial Overburden Pressure (kN/m²)	Recommended Limiting Design Bearing Values (kN/m²)	Net Increase in Pressure (kN/m²)	Estimated Consolidation Settlement (mm)
1.2	22	150	128	16.3

The consolidation settlement estimated above assumes homogenous subgrade material and that the maximum depth of the uniformly compressible layer is 0.8 m. Realistically, the soil at the site comprises both coarse and fine-grained soils. Therefore, it should be noted that the actual consolidation settlements of the heterogenous soil might be different from the theoretical estimate.

Finally, care should be taken to ensure the final bearing surface remains relatively undisturbed and free of water, debris and other deleterious matter.

5.2 EVALUATION OF THE BEDROCK AND BEARING CAPACITY

The bedrock at the site has been confirmed to be predominantly sandstone. The depth to bedrock is anticipated to range from 2 m to 3 m bgl. Structures sensitive to settlement should be directly supported on the bedrock subgrade. The table below presents our recommended design bearing capacities for the various subsurface zones at the borehole locations. The bearing recommendations are partly based on the results acquired through semi-empirical equations and partly on engineering judgment from experience with similar material.

Table 15 - Recommended limiting design pressures

Location	Depth (m)		Anticipated Bearing Material	Limiting Design Bearing Capacity (kN/m²)
	From	To		
BH1	0	2	Lean clay to silty sand	150
	2	4	Moderately to completely weathered Sandstone	300
	4	7	Highly weathered mudstone	450
	7	20	Slightly weathered sandstone	5000
BH2	0	2	Lean clay to silty sand	150
	2	20	Fresh to slightly weathered sandstone	5000
BH3	0	2.5	Lean clay to silty sand to weathered sandstone	150
	2.5	20	Fresh to slightly weathered sandstone/shale	5000
BH4	0	2	Lean clay to silty sand	150
	2	2.5	Highly weathered sandstone	500
	2.5	10	Slightly to highly weathered sandstone	2000
	10	15	Moderately weathered, highly fractured sandstone	2500
	15	20	Slightly weathered, fractured sandstone	4500
BH5	0	2	Lean clay to silty sand	150
	2	5	Slightly to highly weathered, fractured sandstone	1500
	5	10	Moderately weathered, fractured sandstone	2500

Location	Depth (m)		Anticipated Bearing Material	Limiting Design Bearing Capacity (kN/m²)
	From	To		
	10	20	Slightly weathered, fractured sandstone/shale	4500
BH6	0	3	Lean clay to silty sand	150
	3	5	Highly to completely weathered sandstone	450
	5	15	Moderately to highly weathered sandstone	2000
	15	20	Slightly weathered, fractured sandstone/shale	5000

5.3 EXCAVATIONS

We recommend providing sufficient slope (1.5H:1V) for temporary in clayey soils. Near vertical cuts in fresh to moderately weathered rock can be self-supporting provided there is no joint behind the cut face which would otherwise make the slope susceptible to release of vertical boulders.

5.4 BACKFILL

The in-situ soils are not recommended for backfilling purposes. All filling and backfilling should be with approved hardcore or similar, and brought up in horizontal layers not exceeding 150 mm compacted thickness. Each layer should be thoroughly mixed, watered or dried as necessary, and compacted to a minimum dry density of 95% MDD.

6.0 LIMITATIONS OF THE REPORT

6.1 GENERAL

The interpretation and recommendations submitted in this report are based in part upon data obtained from a limited number of boreholes. Advice provided herein is intended for use by MIBP in the design phase of the project. If there are changes to the project scope and development features, the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructability issues and quality control may not be relevant to the revised project.

There is no investigation which is thorough enough to determine all site conditions and anomalies, no matter how comprehensive the investigation program is as site data is derived from extrapolation of limited test locations (non-continuous sampling). The nature and extent of variations between test locations may not become evident until construction. The borings were carried out using investigation techniques consistent with those ordinarily exercised by other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project.

6.2 CHANGES IN SITE AND SCOPE

It must be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. In particular, caution should be exercised in the consideration of contractual responsibilities as they relate to disturbance of soils.

6.3 USE OF REPORT

This document is not intended to reduce the level of responsibility, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in to doing.

APPENDIX A

Core Box Photos

BH1: 0.0 – 6.0 m

BH1: 6.0 – 12.0 m

BH1: 12.0 – 17.0 m

BH1: 17.0 – 20.0 m

BH2: 0.0 – 5.0 m

BH2: 5.0 – 10.0 m

BH2: 10.0 – 15.0 m

BH2: 15.0 – 20.0 m

BH3: 0.0 – 5.0 m

BH3: 5.0 – 10.0 m

BH3: 10.0 – 15.0 m

BH3: 15.0 – 20.0 m

BH4: 0.0 – 5.0 m

BH4: 5.0 – 10.0 m

BH4: 10.0 – 15.0 m

BH4: 15.0 – 20.0 m

BH5: 0.0 – 5.0 m

BH5: 5.0 – 11.0 m


PROSECT : MWTP
DEPTH: 11.00M
CLIENT: MIBP
DATE: 26/06/2021
B/HOLE NO 05
CORE BOX NO 03 OF
11.00M
12.00M
13.00M
14.00M
15.00M
12.00M
13.00M
14.00M
15.00M
16.00M

BH5: 11.0 – 16.0 m

BH6: 0.0 – 6.0 m

BH6: 6.0 – 11.0 m

BH6: 11.0 – 16.0 m

BH6: 16.0 – 20.0 m

APPENDIX B

Borehole Logs

ABBREVIATIONS AND GENERAL INFORMATION

Weathering Grades

I: Fresh & Hard
II: Slightly Weathered
III: Moderately Weathered
IV: Highly Weathered
V: Completely Weathered
VI: Residual Soil

Recovery Properties

TCR	Total Core Recovery
RQD	Rock Quality Designation

Fracture Asperities

SR	Fresh & Hard
M	Mechanical
RI	Rough and Irregular

Fracture Index

WR	With residual material

DYNAMIC CONE PENETRATION TEST

Dynamic Cone Penetration Test (DCPT) involves driving a 60° steel cone into the ground using an 8 Kg sliding hammer over a 575 mm drop height and recording the penetration for every blow.

STANDARD PENETRATION TEST

Standard Penetration Test (SPT) is an in-situ dynamic penetration test that entails the driving of a split spoon sampler into soil strata at the bottom of the open boreholes by dropping a standard weight (63.5 kg) hammer through a standard distance (760 mm) and recording the number of blows (N) required to achieve 300 mm penetration after an initial seating drive of 150 mm or 25 blows, whichever is achieved first (BS EN ISO 22476-3). Blow counts in excess of 50 in the 300 mm test phase are recorded as 'refusal' to penetration and abbreviated 'R' in the logs. Below are typical consistency descriptions of soils based on N - values. Note that the test termination criteria can be modified to conform to the standard insisted upon by the client.

Cohesionless Soils

Relative Density	N - Value
Very Loose	< 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

Cohesive Soils

Consistency	Undrained Shear Strength, kPa	N - Value
Very Soft	< 12	< 2
Soft	12 - 25	2 - 4
Firm	25 - 50	4 - 8
Stiff	50 - 100	8 - 16
Very Stiff	100 - 200	16 - 32
Hard	> 200	> 32

FIELD MOISTURE DESCRIPTIONS

Dry - refers to a soil sample with a moisture content well below optimum ($w < w_{opt}$), absence of moisture, dusty, dry to the touch.
Moist - refers to a soil sample with a moisture content at or near optimum ($w \approx w_{opt}$), no visible pore water.
Wet - refers to a soil sample with a moisture content well above optimum ($w > w_{opt}$), has visible pore water.

ROCK DESCRIPTIONS

RQD (%)	Rock Mass Quality
0 - 25	Very Poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Compressive Strength (MPa)	Strength Classification
< 1	Extremely Weak
1 - 5	Very Weak
5 - 25	Weak
25 - 50	Medium Strong
50 - 100	Strong
100 - 250	Very Strong
> 250	Extremely Strong

SYMBOLS

▼ Last record of water level in the borehole. May not represent full equilibrium condition.

REGIONAL GEOPHYSICAL SURVEY

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	129.29		
		UTM Coordinates (ARC 1960)	E 0558648	Zone 37 S	
			N 9560045		
		Drilling Date	Start 22/06/2021		
			End 24/06/2021		

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH1
Drill Rig Type: GY 150	Drilled By: Richard	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 1 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
0	129	1	100	-		Recovered as slightly moist, reddish brown, tinge green dense silty sand. Colluvium soil.(friable zone)	VI	-	
1	128	1	100	-		Recovered as slightly moist, reddish brown, tinge green dense silty sand with cobbly fragments of sandston. Colluvium soil.(friable zone)	VI	-	
2	127	1	100	-		Recovered as redish brown, tinge green completely weathered cobbly fragments of sandstone characterized by irregular non intact fractures	V	>20	
3	126	1	100	-		Brownish grey, moderately weathered, hard, medium to fine grained sandstone. Characterised by closely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	III	>20	
4	125	2	50	-		light grey, tinge green moderatly to highly weathered, crumbly, fine grained mudstone. Characterised by closely spaced, horizontal to subvertical fractures	IV	>20	
5	124								
6	123	2	50	14		Brownish grey, moderately to highly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal to subvertical, rough and irregular fracture surfaces.	III	>20	
7	122								
8	121	1	100	100		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by non intact, sub vertical , rough and regular fracture surfaces.	II	0	
9	120	1	100	95		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by widely spaced, sub vertical , rough and irregular fracture surfaces.	II	1	
10									

KEY: Silty Sand; Sandstone; Mudstone

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	129.29		
		UTM Coordinates (ARC 1960)	E	0558648	Zone
			N	9560045	37 S
		Drilling Date	Start	22/06/2021	
			End	24/06/2021	

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH1
Drill Rig Type: GY 150	Drilled By: Richard	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 2 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
10	119	1	100	83		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal , rough and regular fracture surfaces.	II	2	
11	118	1	100	54		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal , rough and regular fracture surfaces.	II	2	
12	117	1	100	75		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal , rough and regular fracture surfaces.	II	3	
13	116	1	100	92		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal , rough and regular fracture surfaces.	II	1	
14	115	1	100	69		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal to sub vertical , rough and irregular fracture surfaces.	II	5	
15	114	1	100	75		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal to sub vertical , rough and irregular fracture surfaces.	II	4	
16	113	1	100	100		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by non intact, horizontal , rough and irregular fracture surfaces.	II	4	
17	112	1	100	-		Brownish grey, tinge green, slightly weathered, hard, medium to fine grained sandstone. Characterised by non intact, horizontal , rough and regular fracture surfaces.	II	3	
18	111	1	100	60		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal to sub vertical , rough and irrregular fracture surfaces.	II	4	
19	110	1	100	37		Brownish grey, slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal to sub vertical , rough and irrregular fracture surfaces.	II	5	
20									

KEY Silty Sand Sandstone Mudstone

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	122.09		
		UTM Coordinates (ARC 1960)	E	0558590	Zone 37 S
			N	9559958	
		Drilling Date	Start	21/06/2021	
			End	22/06/2021	

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH2
Drill Rig Type: GY 150	Drilled By: Hillary	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm; Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 1 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
0	122	1	100	0		Slightly moist, reddish brown, dense silty sand soil. Colluvium soil.	VI	-	
1	121	1	100	0		Slightly moist, reddish brown, dense silty sand soil. Colluvium soil.	VI	-	32
2	120	1	100	91		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	2	
3	119	1	100	93		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	4	
4	118	1	100	87		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	8	
5	117	1	100	91		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	4	
6	116	1	100	19		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	12	
7	115	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	0	
8	114	1	100	79		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	3	
9	113	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	4	
10									

KEY: Silty Sand; Sandstone

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	122.09		
		UTM Coordinates (ARC 1960)	E	0558590	Zone
			N	9559958	37 S
		Drilling Date	Start	21/06/2021	
			End	22/06/2021	

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH2
Drill Rig Type: GY 150	Drilled By: Hillary	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm | Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 2 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
10	112	1	100	82		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	3	
11	111	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	2	
12	110	1	100	65		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	3	
13	109	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	3	
14	108	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	2	
15	107	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	1	
16	106	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	3	
17	105	1	100	82		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	4	
18	104	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	2	
19	103	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	2	
20									

KEY  Silty Sand  Sandstone

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	118.29		
		UTM Coordinates (ARC 1960)	E	0558608	Zone 37 S
			N	9559898	
		Drilling Date	Start	20/06/2021	
			End	23/06/2021	

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH3
Drill Rig Type: GY 150	Drilled By: Mulinge	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm; Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 1 of 2

Depth (m)	Elevation (m)	Recovery: Run (m)	Recovery: TCR (%)	Recovery: RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
0	118	1	100	0		Slightly moist, reddish brown, dense silty sand soil. Colluvium soil.	VI	-	
1	117	1	100	0		Slightly moist, reddish brown, dense silty sand soil. Colluvium soil.	VI	-	33
2	116	1	100	14		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	6	
3	115	1	100	71		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	7	
4	114	1	100	100		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	3	
5	113	1	100	57		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	5	
6	112	1	100	56		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	II	7	
7	111	1	100	72		Brownish grey, slightly weathered, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces that are weathered to brownish black.	I	6	
8	110	1	100	92		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	2	
9	109	1	100	97		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	1	
10									

KEY: Silty Sand; Sandstone; Shale

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	118.29		
		UTM Coordinates (ARC 1960)	E	0558608	Zone
			N	9559898	37 S
		Drilling Date	Start	20/06/2021	
			End	23/06/2021	

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH3
Drill Rig Type: GY 150	Drilled By: Mulinge	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 2 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
10	108	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	4	
11	107	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	3	
12	106	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	3	
13	105	1	100	100		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	2	
14	104	1	100	71		Grey, fresh, hard, medium grained sandstone. Characterised by closed, horizontal, rough and irregular fracture surfaces.	I	8	
15	103	1	100	22		Grey, Slightly weathered, hard, medium grained shale. Characterised by closed, closely spaced, horizontal, rough and irregular fracture surfaces.	I	11	
16	102	1	100	60		Grey, Slightly weathered, hard, medium grained shale. Characterised by closed, closely spaced, horizontal, rough and irregular fracture surfaces.	I	8	
17	101	1	100	49		Grey, Slightly weathered, hard, medium grained shale. Characterised by closed, closely spaced, horizontal, rough and irregular fracture surfaces.	I	11	
18	100	1	100	44		Grey, Slightly weathered, hard, medium grained shale. Characterised by closed, closely spaced, horizontal, rough and irregular fracture surfaces.	I	15	
19	99	1	100	83		Grey, Slightly weathered, hard, medium grained shale. Characterised by closed, closely spaced, horizontal, rough and irregular fracture surfaces.	I	7	
20									

KEY  Silty Sand  Sandstone  Shale

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	119.15		
		UTM Coordinates (ARC 1960)	E 0558533	Zone 37 S	
			N 9559893		
		Drilling Date	Start 01/07/2021		
			End 04/07/2021		

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH4
Drill Rig Type: GY 150	Drilled By: Richard	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm; Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 1 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
0	119	1	100	-		Recovered as slightly moist, reddish brown, tinge green dense clayey silty sand. Colluvium soil.(friable zone)	VI	-	
1	118	1	100	-		Recovered as slightly moist, reddish brown, tinge green dense clayey silty sand. Colluvium soil.(friable zone)	VI	-	
2	117	0.5	98	-		Brownish grey, moderately weathered, hard, medium to fine grained sandstone. Characterised by closely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	III	9	
		0.5	99	-		Brownish grey, moderately weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	III	3	
3	116	1	100	96		Brownish grey tinge green, moderately weathered, hard, medium to fine grained sandstone. Characterised by widely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	III	2	
4	115	1	100	85		Brownish grey tinge green, moderately weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	III	4	
5	114	1	100	94		Brownish grey tinge green, moderately weathered, hard, medium to fine grained sandstone. Characterised widely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	III	2	
6	113	1	100	92		Brownish grey tinge green, slightly weathered, hard, medium to fine grained sandstone. Characterised widely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	II	2	
7	112	1	100	72		Brownish grey tinge green, slightly weathered, hard, medium to fine grained sandstone. Characterised closely to widely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	II	6	
8	111	1	100	50		Brownish grey tinge green, slightly weathered, hard, medium to fine grained sandstone. Characterised closely to widely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	II	7	
9	110	1	100	89		Brownish grey tinge green, slightly weathered, hard, medium to fine grained sandstone. Characterised closely to widely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	II	2	
10									

KEY: Clayey Silty Sand; Sandstone

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	119.15		
		UTM Coordinates (ARC 1960)	E	0558533	Zone 37 S
			N	9559893	
		Drilling Date	Start	01/07/2021	
			End	04/07/2021	

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH4
Drill Rig Type: GY 150	Drilled By: Richard	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm; Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 2 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
10	109	1	100	-		Recovered as brownish grey, tinge green highly weathered cobbly fragments of sandstone characterized by irregular non intact fractures	IV	>20	
11	108	1	100	25		Brownish grey tinge green, moderately weathered, hard, medium to fine grained sandstone. Characterised by closely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	III	>20	
12	107	1	100	22		Brownish grey tinge green, moderately weathered, hard, medium to fine grained sandstone. Characterised by closely spaced, horizontal to subvertical, rough and irregular fracture surfaces that are weathered to redish brown	III	12	
13	106	1	100	40		Brownish grey, tinge green moderately to slightly weathered hard, medium to fine grained shaly sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	III	11	
14	105	1	100	20		Brownish grey, tinge green moderately to slightly weathered hard, medium to fine grained shaly sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	III	18	
15	104	1	100	45		Brownish grey, tinge green slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	II	8	
16	103	1	100	73		Brownish grey, tinge green slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	II	6	
17	102	1	100	52		Brownish grey, tinge green slightly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	II	7	
18	101	1	100	49		Brownish grey, tinge green slightly weathered, hard, medium to fine grained sandstone. Characterised by closely spaced, horizontal and irregular fracture surfaces	II	13	
19	100	1	100	73		Brownish grey, tinge green slightly weathered hard, medium to fine grained shaly sandstone. Characterised by widely spaced, horizontal and irregular fracture surface	II	6	
20									

KEY  Clayey Silty Sand  Sandstone

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	116.87		
		UTM Coordinates (ARC 1960)	E	0558535	Zone 37 S
			N	9559802	
		Drilling Date	Start	26/06/2021	
			End	27/06/2021	

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH5
Drill Rig Type: GY 150	Drilled By: Richard	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm; Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 1 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
0	116	1	100	-		Recovered as slightly moist, reddish brown, tinge green dense clayey silty sand. Colluvium soil.(friable zone)	VI	-	
1	115	1	100	-		Recovered as slightly moist, reddish brown, tinge green dense silty sand crumbly cobbly fragments of sandstone. Colluvium soil.(friable zone)	VI	-	
2	114	1	100	47		Brownish grey, moderately to highly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	IV	>20	
3	113	1	96	41		Brownish grey, moderately to highly weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	IV	14	
4	112	2	50	10		Brownish grey, moderately to highly weathered, hard, medium to fine grained sandstone. Characterised by closely spaced, horizontal and irregular fracture surfaces	IV	6	
5	111	1	100	47		Brownish grey, moderately weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	III	8	
6	110	2	50	13		Brownish grey, moderately weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	III	15	
7	109								
8	108								
9	107	1	98	26		Brownish grey, moderately weathered, hard, medium to fine grained sandstone. Characterised by closely to widely spaced, horizontal and irregular fracture surfaces	III	11	
10									

KEY: Silty Sand; Clayey Silty Sand; Sandstone; Shale

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	116.87		
		UTM Coordinates (ARC 1960)	E 0558535	Zone 37 S	
			N 9559802		
		Drilling Date	Start 26/06/2021		
			End 27/06/2021		

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH5
Drill Rig Type: GY 150	Drilled By: Richard	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm; Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 2 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	TCR (%)	RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
10									
	106	1	96	30		Dark grey, tinge green, moderately weathered, fine grained shale. Characterised by closely spaced, horizontal, smooth and regular fracture surface.	II	14	
11									
	105	1	95	44		Dark grey, tinge green, moderatey weathered, fine grained shale. Characterised by closely spaced, horizontal, smooth and regular fracture surface.	III	12	
12									
	104	1	5	62		Dark grey, tinge green, slightly weathered, fine grained shale. Characterised by closely spaced, horizontal, smooth and regular fracture surface.	II	9	
13									
	103	1	98	72		Dark grey, tinge green, slightly weathered, fine grained shale. Characterised by closely spaced, horizontal, smooth and regular fracture surface.	II	13	
14									
	102	1	100	79		Dark grey, tinge green, slightly weathered, fine grained shale. Characterised by closely spaced, horizontal, smooth and regular fracture surface.	II	17	
15									
	101	1	99	73		Brownish grey, dark grey, tinge green, slightly weathered, medium to fine grained shaly sandstone. Characterised by closely to widely spaced, horizontal to sub vertical irregular fractures (stong)	II	8	
16									
	100	1	97	67		Brownish grey, dark grey, tinge green, slightly weathered, medium to fine grained shaly sandstone. Characterised by closely to widely spaced, horizontal to sub vertical irregular fractures (stong)	II	11	
17									
	99	1	98	58		Dark grey, tinge green, slightly weathered, fine grained shale. Characterised by closely spaced, horizontal, smooth and regular fracture surface.	II	>20	
18									
	98	1	96	28		Dark grey, tinge green, slightly weathered, fine grained shale. Characterised by closely to widely spaced, horizontal, smooth and regular fracture surface.	II	>20	
19									
	97	1	96	69		Brownish grey, dark grey, tinge green, slightly weathered, medium to fine grained shaly sandstone. Characterised by closely to widely spaced, horizontal to sub vertical irregular fractures (stong)	II	18	
20									

KEY: Silty Sand; Clayey Silty Sand; Sandstone; Shale

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	118.71		
		UTM Coordinates (ARC 1960)	E	0558480	Zone 37 S
			N	9559774	
		Drilling Date	Start	01/07/2021	
			End	05/07/2021	

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH6
Drill Rig Type: GY 150	Drilled By: Hillary	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm; Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 1 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
0	118	1	100	-	Clayey Silty Sand	Recovered as slightly moist, reddish brown, tinge green dense clayey silty sand. Colluvium soil.(friable zone)	VI	-	
1	117	1	100	-	Clayey Silty Sand	Recovered as slightly moist, reddish brown, tinge green dense clayey silty sand. Colluvium soil.(friable zone)	VI	-	
2	116	1	100	-	Clayey Silty Sand	Recovered as slightly moist, reddish brown, tinge green dense clayey silty sand with friable cobbly fragments of sandstone. Colluvium soil.(friable zone)	VI	-	
3	115	2	50	-	Sandstone	Recovered as slightly moist, rownish grey, tinge green friable cobbly fragments of highly to completely weathered sandstone. Characterised by non intact irregular fractures(friable zone)	V	>20	
4	114								
5	113	1	100	25	Sandstone	Brownish grey, moderately to highly weathered, medium to fine grained sandstone. Characterised by closely to widely spaced ,horizontal to sub vertical irregular fractures.	IV	>20	
6	112	1	100	39	Sandstone	Brownish grey, moderately to highly weathered, medium to fine grained sandstone. Characterised by closely to widely spaced ,horizontal to sub vertical irregular fractures.	IV	>20	
7	111	1	100	22	Sandstone	Brownish grey, moderately to highly weathered, medium to fine grained sandstone. Characterised by closely spaced ,horizontal to sub vertical irregular fractures.	IV	19	
8	110	1	100	37	Sandstone	Brownish grey, moderately to highly weathered, medium to fine grained sandstone. Characterised by closely to widely spaced ,horizontal to sub vertical irregular fractures.	IV	12	
9	109	1	100	78	Sandstone	Brownish grey, moderately to highly weathered, medium to fine grained sandstone. Characterised by closely to widely spaced ,horizontal to sub vertical irregular fractures.	IV	9	
10									

KEY: Clayey Silty Sand; Sandstone; Shale

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

Project: Mwache WTP Location: Kwale County Client: MIBP	REGIONAL GEOPHYSICAL SURVEY	Elevation (m)	118.71		
		UTM Coordinates (ARC 1960)	E	0558480	Zone 37 S
			N	9559774	
		Drilling Date	Start	01/07/2021	
			End	05/07/2021	

BOREHOLE LOG

Drilling Method: Rotary	Logged By: Solomon	Borehole ID.: BH6
Drill Rig Type: GY 150	Drilled By: Hillary	Total Depth Drilled: 20 m
Barrel Ø: 86/101 mm; Augur Ø: 150 mm	Water rest Level: -	Inclination From Vertical: 0°

Sheet 2 of 2

Depth (m)	Elevation (m)	Recovery Run (m)	Recovery TCR (%)	Recovery RQD (%)	Lithology	Lithology Description	Weathering Grade	Fracture Frequency	SPT N - Value
10	108	1	100	27		Brownish grey, highly weathered, medium to fine grained sandstone. Characterised by closely to widely spaced ,horizontal to sub vertical irregular fractures.	IV	18	
11	107	1	100	-		Brownish grey, highly weathered, medium to fine grained sandstone. Characterised by closely spaced ,horizontal to sub vertical irregular fractures.	IV	>20	
12	106	1	100	12		Brownish grey, highly weathered, medium to fine grained sandstone. Characterised by closely spaced ,horizontal to sub vertical irregular fractures.	IV	>20	
13	105	1	98	13		Brownish grey, highly weathered, medium to fine grained sandstone. Characterised by closely spaced ,horizontal to sub vertical irregular fractures.	IV	11	
14	104	1	98	10		Brownish grey, dark grey, tinge green, moderately to slightly weathered, medium to fine grained shaly sandstone. Characterised by closely spaced horizontal to sub vertical irregular fractures	III	11	
15	103	1	98	32		Dark grey, tinge green, moderately to slightly weathered, fine grained shale. Characterised by closely to widely spaced, horizontal, smooth and regular fracture surface.	III	12	
16	102	1	97	67		Dark grey, tinge green, slightly weathered, fine grained shale. Characterised by closely spaced, horizontal, smooth and regular fracture surface.	II	9	
17	101	1	96	55		Brownish grey, tinge green, slightly weathered, medium to fine grained sandstone. Characterised by closely Tto widely spaced ,horizontal to sub vertical irregular fractures.	II	11	
18	100	1	96	-		Brownish grey, tinge green, slightly weathered, medium to fine grained sandstone. Characterised by closely Tto widely spaced ,horizontal to sub vertical irregular fractures. (stong)	II	9	
19	99	1	90	52		Brownish grey, dark grey, tinge green, slightly weathered, medium to fine grained shaly sandstone. Characterised by closely to widely spaced, horizontal to sub vertical irregular fractures (stong)	II	6	
20									

KEY: Clayey Silty Sand; Sandstone; Shale

Note: See appended explanatory notes for details of abbreviations and basis of descriptions.

APPENDIX C

Atterberg Limits

DANELLI ENGINEERING LABORATORIES LIMITED
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Kenya

REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
ATTERBERG LIMITS: CONE PENETROMETER
BS 1377: Part 2
BH 01(0.0-2.0M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

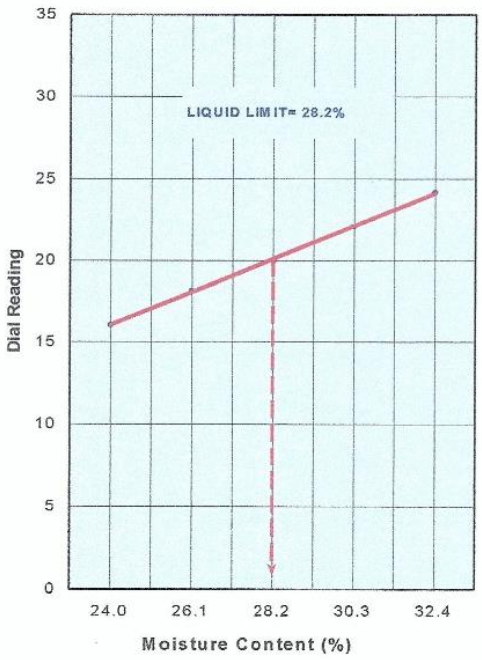
Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3884 **Sample No.** 3884

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 - 2.0M **Date Tested:** 01-08-21

	LIQUID LIMIT					PLASTIC LIMIT	
Container No.	CO	NE	PE	NO	TR	OM	TA
Initial Dial Reading (mm)	0	0	0	0	0	-	-
Final Dial Reading (mm)	16.1	18.2	20.0	22.1	24.2	-	-
Mass of Container+Wet Soil, M2 (g)	117.2	116.0	116.4	107.5	114.5	30.4	32.9
Mass of Container+Dry Soil, M3 (g)	94.5	92.0	90.8	80.7	86.5	26.2	28.4
Mass of Container M1 (g)	-	-	-	-	-	-	-
Mass of Moisture (M2-M3) (g)	22.7	24.0	25.6	26.8	28.0	4.2	4.5
Mass of Dry Soil (M3-M1) (g)	94.5	92.0	90.8	88.4	86.5	26.2	28.4
Moisture Content (%)	**24.0**	**26.1**	**28.2**	**30.3**	**32.4**	**16.0**	**15.8**

PLASTIC LIMIT = 15.9%

LIQUID LIMIT



LINEAR SHRINKAGE

LS = 1 - Length of dried sample x 100
Initial Length of sample

= 5.8%

PLASTICITY INDEX/PLASTICITY MODULUS

Liquid limit, LL= 28.2%

Plasticity Index, PI = LL - PL
= 12.3%

Plasticity Modulus = PI x 0.425mm % pass
= 673

SOIL CLASSIFICATION	
USCS	AASHTO
GC	A-6
Clayey Gravel of Low Plasticity	

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

DANELLI ENGINEERING LABORATORIES LIMITED

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Independent Materials testing & Inspection Centre
Email: danellilab3@gmail.com
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Kenya

REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

ATTERBERG LIMITS: CONE PENETROMETER

BS 1377: Part 2

BH 02(0.0-1.85M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

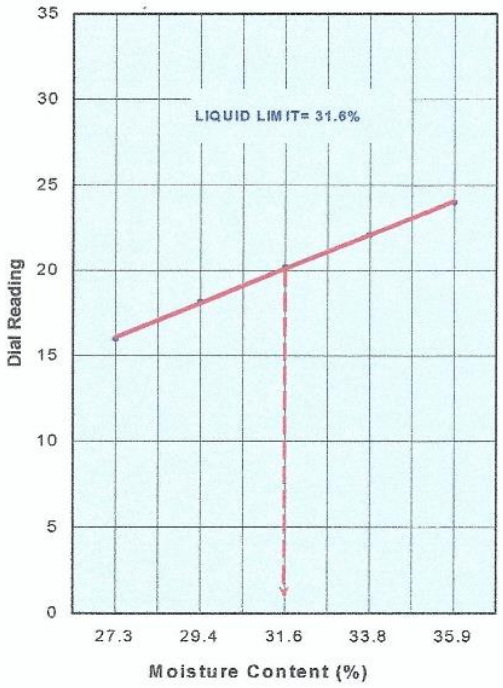
Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3888 **Sample No.** 3888

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 - 1.85M **Date Tested:** 01-08-21

	LIQUID LIMIT					PLASTIC LIMIT	
Container No.	MU	TU	GA	WA	KI	OK	TE
Initial Dial Reading (mm)	0	0	0	0	0	-	-
Final Dial Reading (mm)	16.0	18.2	20.2	22.1	24.0	-	-
Mass of Container+Wet Soil, M2 (g)	112.7	111.8	109.0	111.2	121.4	31.1	33.6
Mass of Container+Dry Soil, M3 (g)	88.5	86.4	82.8	80.7	89.3	26.5	28.7
Mass of Container M1 (g)	-	-	-	-	-	-	-
Mass of Moisture (M2-M3) (g)	24.2	25.4	26.2	30.5	32.1	4.6	4.9
Mass of Dry Soil (M3-M1) (g)	88.5	86.4	82.8	90.2	89.3	26.5	28.7
Moisture Content (%)	**27.3**	**29.4**	**31.6**	**33.8**	**35.9**	**17.3**	**17.1**

PLASTIC LIMIT = 17.2%

LIQUID LIMIT



LINEAR SHRINKAGE

LS = 1 - Length of dried sample x 100
Initial Length of sample

= 6.8%

PLASTICITY INDEX/PLASTICITY MODULUS

Liquid limit, LL= 31.6%

Plasticity Index, PI = LL - PL
= 14.4%

Plasticity Modulus = PI x 0.425mm % pass
= 1411

SOIL CLASSIFICATION	
USCS	AASHTO
CL	A-6
Sandy Clay of Low Plasticity	

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

DANELLI ENGINEERING LABORATORIES LIMITED

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Kenya

REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

ATTERBERG LIMITS: CONE PENETROMETER

BS 1377: Part 2

BH 03(0.0-2.0M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

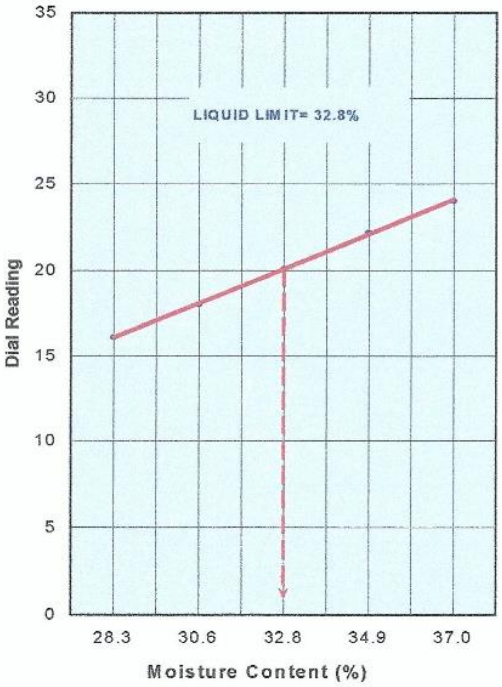
Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3893 **Sample No.** 3893

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 - 2.0M **Date Tested:** 01-08-21

	LIQUID LIMIT					PLASTIC LIMIT	
Container No.	LT	QU	ID	LI	MI	TA	TN
Initial Dial Reading (mm)	0	0	0	0	0	-	-
Final Dial Reading (mm)	16.1	18.0	20.1	22.2	24.0	-	-
Mass of Container+Wet Soil, M2 (g)	105.6	110.5	113.9	111.4	122.2	32.0	34.2
Mass of Container+Dry Soil, M3 (g)	82.3	84.6	85.8	80.7	89.2	27.2	29.1
Mass of Container M1 (g)	-	-	-	-	-	-	-
Mass of Moisture (M2-M3) (g)	23.3	25.9	28.1	30.7	33.0	4.8	5.1
Mass of Dry Soil (M3-M1) (g)	82.3	84.6	85.8	87.9	89.2	27.2	29.1
Moisture Content (%)	**28.3**	**30.6**	**32.8**	**34.9**	**37.0**	**17.7**	**17.5**

PLASTIC LIMIT = 17.6%

LIQUID LIMIT



LINEAR SHRINKAGE

LS = 1 - Length of dried sample x 100
Initial Length of sample

= 7.2%

PLASTICITY INDEX/PLASTICITY MODULUS

Liquid limit, LL= 32.8%

Plasticity Index, PI = LL - PL
= 15.2%

Plasticity Modulus = PI x 0.425mm % pass
= 1111

SOIL CLASSIFICATION	
USCS	AASHTO
GC	A-6
Clayey Gravel of Low Plasticity	

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

ATTERBERG LIMITS: CONE PENETROMETER

BS 1377: Part 2

BH 04(0.0-2.0M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

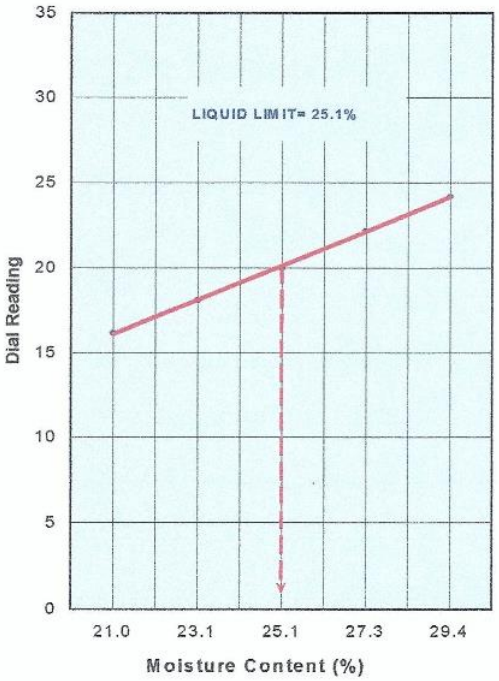
Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3898 **Sample No.** 3898

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 - 2.0M **Date Tested:** 01-08-21

	LIQUID LIMIT					PLASTIC LIMIT	
Container No.	VI	DA	OU	GO	OM	AN	NE
Initial Dial Reading (mm)	0	0	0	0	0	-	-
Final Dial Reading (mm)	16.2	18.1	20.0	22.2	24.2	-	-
Mass of Container+Wet Soil, M2 (g)	111.9	115.0	113.2	105.2	111.0	27.3	29.7
Mass of Container+Dry Soil, M3 (g)	92.5	93.4	90.5	80.7	85.8	24.1	26.2
Mass of Container M1 (g)	-	-	-	-	-	-	-
Mass of Moisture (M2-M3) (g)	19.4	21.6	22.7	24.5	25.2	3.2	3.5
Mass of Dry Soil (M3-M1) (g)	92.5	93.4	90.5	89.6	85.8	24.1	26.2
Moisture Content (%)	**21.0**	**23.1**	**25.1**	**27.3**	**29.4**	**13.4**	**13.2**

PLASTIC LIMIT = 13.3%

LIQUID LIMIT



LINEAR SHRINKAGE

LS = 1 - Length of dried sample x 100
Initial Length of sample

= 5.6%

PLASTICITY INDEX/PLASTICITY MODULUS

Liquid limit, LL= 25.1%

Plasticity Index, PI = LL - PL
= 11.8%

Plasticity Modulus = PI x 0.425mm % pass
= 1165

SOIL CLASSIFICATION	
USCS	AASHTO
CL	A-6
Sandy Clay of Low Plasticity	

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

ATTERBERG LIMITS: CONE PENETROMETER

BS 1377: Part 2

BH 05(0.0-1.5M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

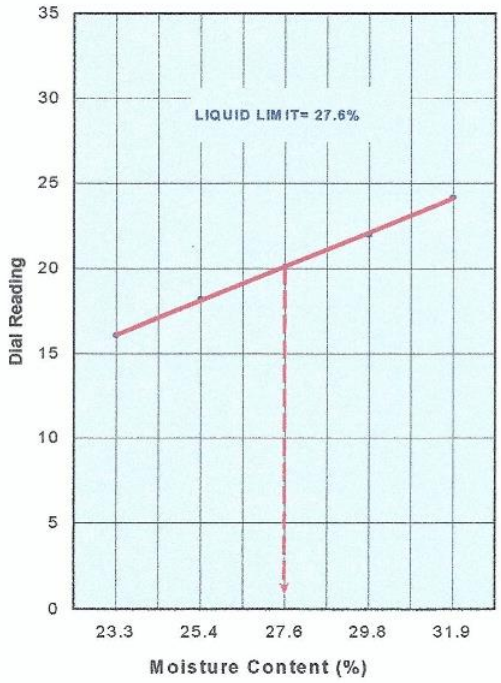
Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3904 **Sample No.** 3904

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 - 1.5M **Date Tested:** 01-08-21

	LIQUID LIMIT					PLASTIC LIMIT	
Container No.	MU	SE	MB	IN	NY	NG	KV
Initial Dial Reading (mm)	0	0	0	0	0	-	-
Final Dial Reading (mm)	16.1	18.2	20.1	22.0	24.2	-	-
Mass of Container+Wet Soil, M2 (g)	101.2	106.1	109.5	106.7	120.4	31.4	33.8
Mass of Container+Dry Soil, M3 (g)	82.1	84.6	85.8	80.7	91.3	26.8	28.9
Mass of Container M1 (g)	-	-	-	-	-	-	-
Mass of Moisture (M2-M3) (g)	19.1	21.5	23.7	26.0	29.1	4.6	4.9
Mass of Dry Soil (M3-M1) (g)	82.1	84.6	85.8	87.2	91.3	26.8	28.9
Moisture Content (%)	**23.3**	**25.4**	**27.6**	**29.8**	**31.9**	**17.1**	**16.9**

PLASTIC LIMIT = 17.0%

LIQUID LIMIT



LINEAR SHRINKAGE

LS = 1 - Length of dried sample x 100
Initial Length of sample

= 5.0%

PLASTICITY INDEX/PLASTICITY MODULUS

Liquid limit, LL= 27.6%

Plasticity Index, PI = LL - PL
= 10.6%

Plasticity Modulus = PI x 0.425mm % pass
= 913

SOIL CLASSIFICATION	
USCS	AASHTO
SC	A-6
Clayey Sand of Low Plasticity	

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
ATTERBERG LIMITS: CONE PENETROMETER
BS 1377: Part 2
BH 06(0.0-2.0M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

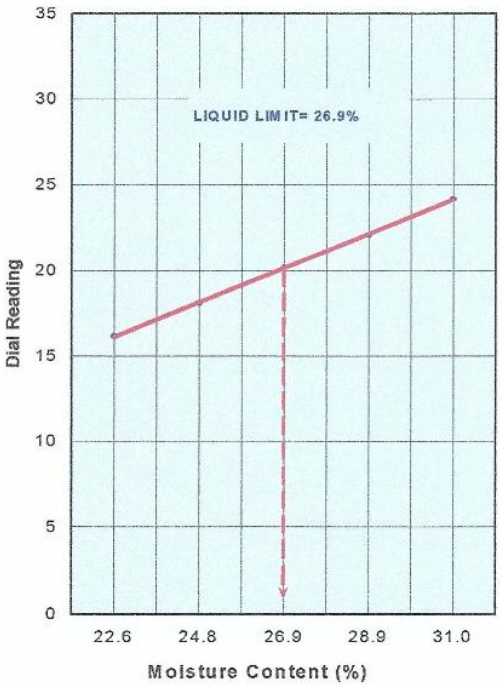
Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3910 **Sample No.** 3910

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 - 2.0M **Date Tested:** 01-08-21

	LIQUID LIMIT					PLASTIC LIMIT	
Container No.	LO	CA	TI	ON	OC	MA	LI
Initial Dial Reading (mm)	0	0	0	0	0	-	-
Final Dial Reading (mm)	16.2	18.1	20.2	22.1	24.2	-	-
Mass of Container+Wet Soil, M2 (g)	104.3	109.3	114.0	107.2	122.9	29.3	31.8
Mass of Container+Dry Soil, M3 (g)	85.1	87.6	89.8	80.7	93.8	25.6	27.8
Mass of Container M1 (g)	-	-	-	-	-	-	-
Mass of Moisture (M2-M3) (g)	19.2	21.7	24.2	26.5	29.1	3.7	4.0
Mass of Dry Soil (M3-M1) (g)	85.1	87.6	89.8	91.6	93.8	25.6	27.8
Moisture Content (%)	**22.6**	**24.8**	**26.9**	**28.9**	**31.0**	**14.6**	**14.4**

PLASTIC LIMIT = 14.5%

LIQUID LIMIT



LINEAR SHRINKAGE

LS = 1 - Length of dried sample x 100
Initial Length of sample

= 5.8%

PLASTICITY INDEX/PLASTICITY MODULUS

Liquid limit, LL= 26.9%

Plasticity Index, PI = LL - PL
= 12.4%

Plasticity Modulus = PI x 0.425mm % pass
= 1143

SOIL CLASSIFICATION	
USCS	AASHTO
SC	A-6
Clayey Sand of Low Plasticity	

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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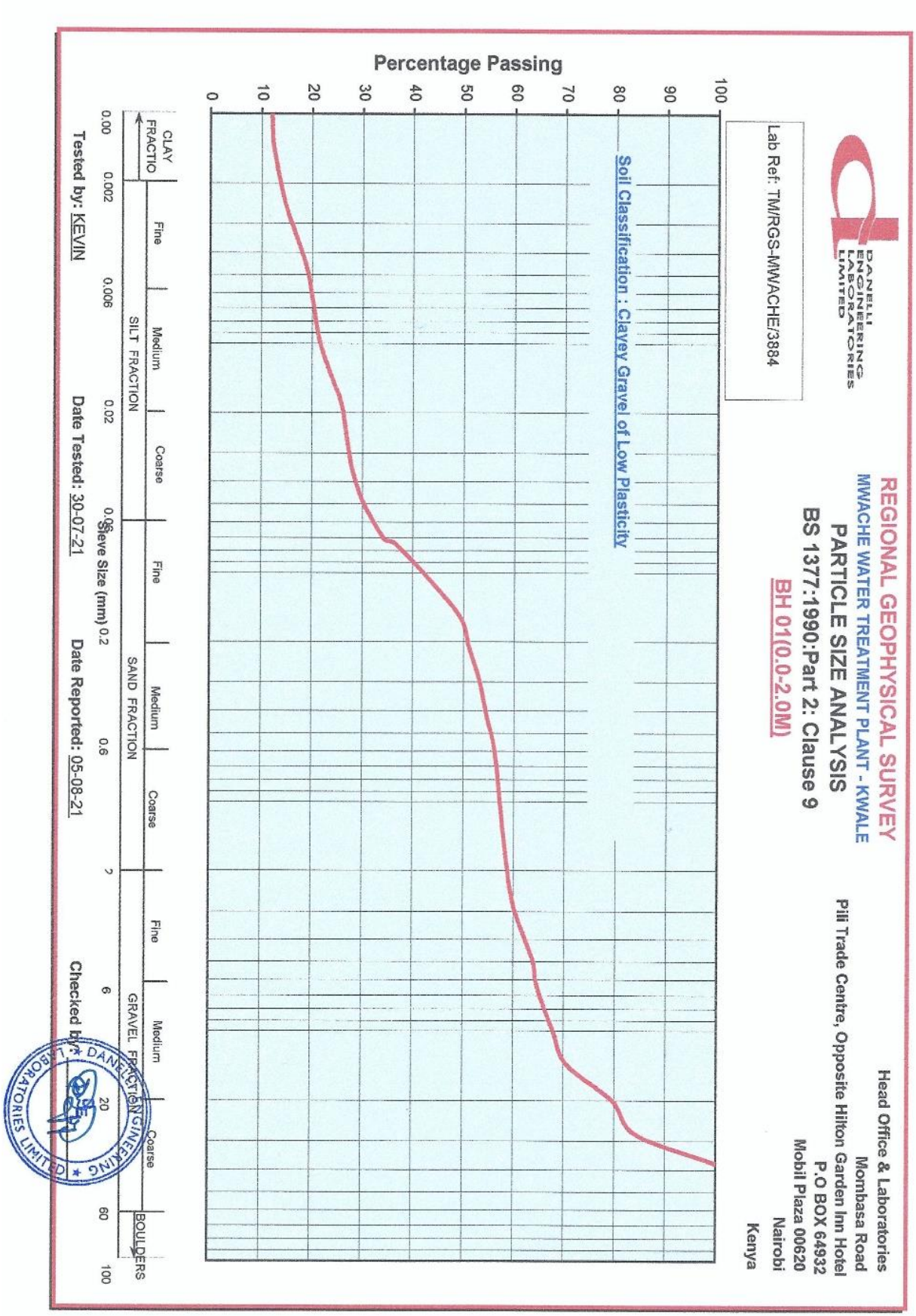
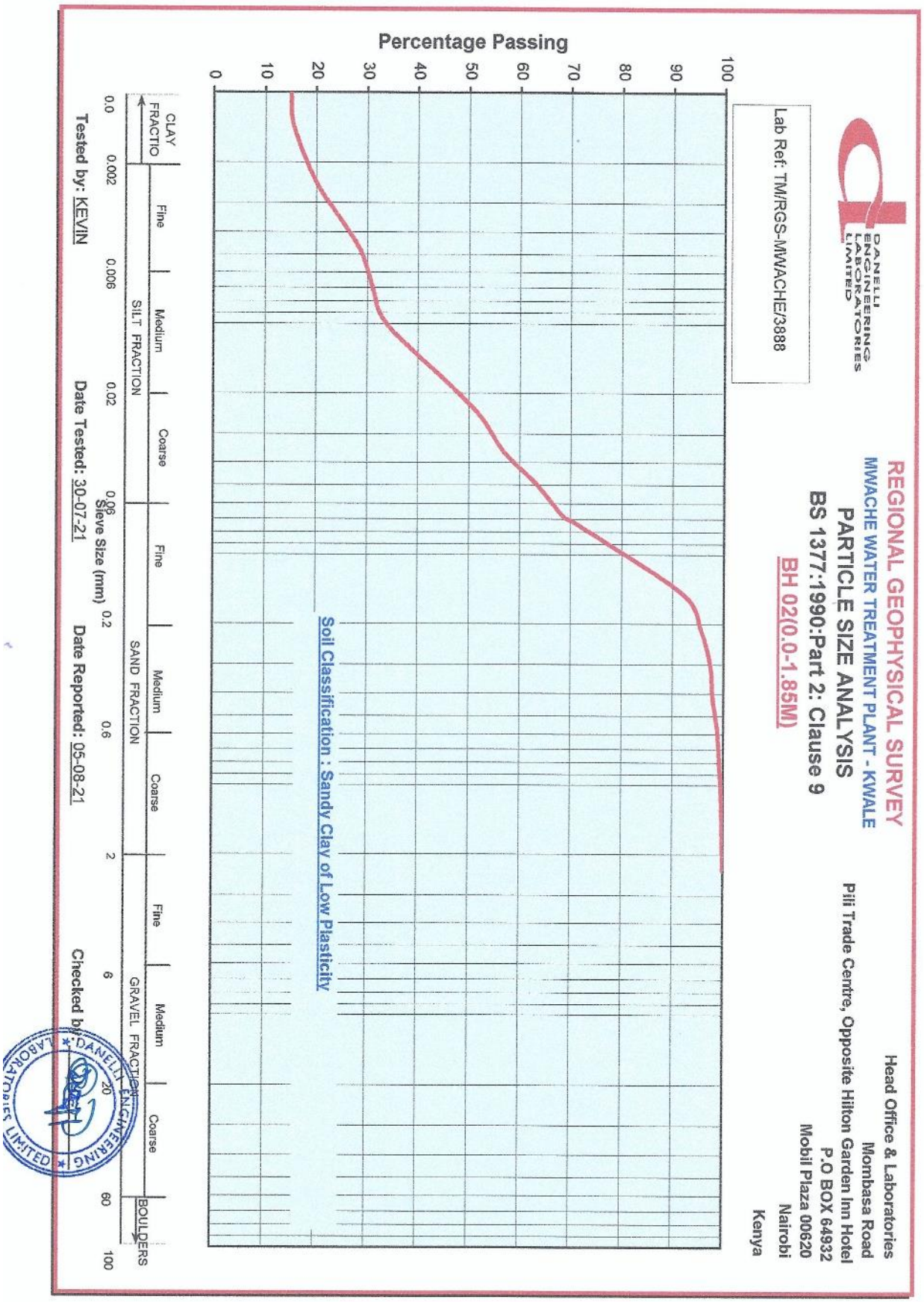
Particle Size Distribution – Grading Curves

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT - KWALE
PARTICLE SIZE ANALYSIS
BS 1377:1990:Part 2: Clause 9
BH 02(0.0-1.85M)
Lab Ref: TM/RGS-MWACHE/3888
Percentage Passing
Soil Classification : Sandy Clay of Low Plasticity
CLAY FRACTIO
SILT FRACTION
SAND FRACTION
GRAVEL FRACTION
BOULDERS
Fine
Medium
Coarse
Sieve Size (mm)
Tested by: KEVIN
Date Tested: 30-07-21
Date Reported: 05-08-21
Checked by:
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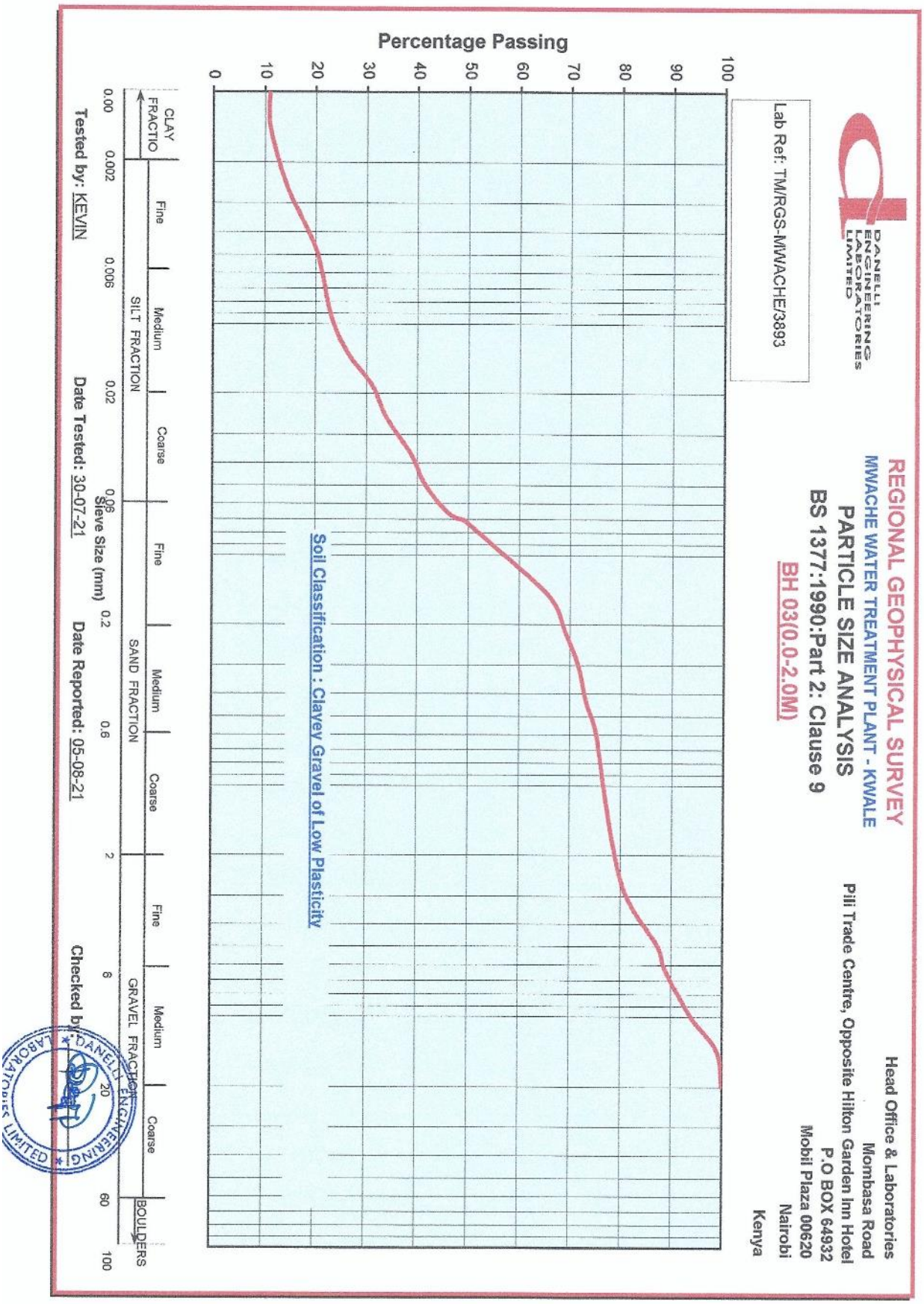
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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT - KWALE
PARTICLE SIZE ANALYSIS
BS 1377:1990:Part 2: Clause 9
BH 03(0.0-2.0M)
Lab Ref: TM/RGS-MWACHE/3893
Percentage Passing
Soil Classification : Clavey Gravel of Low Plasticity
CLAY FRACTIO
SILT FRACTION
SAND FRACTION
GRAVEL FRACTION
Fine
Medium
Coarse
BOULDERS
Sieve Size (mm)
Tested by: KEVIN
Date Tested: 30-07-21
Date Reported: 05-08-21
Checked by:
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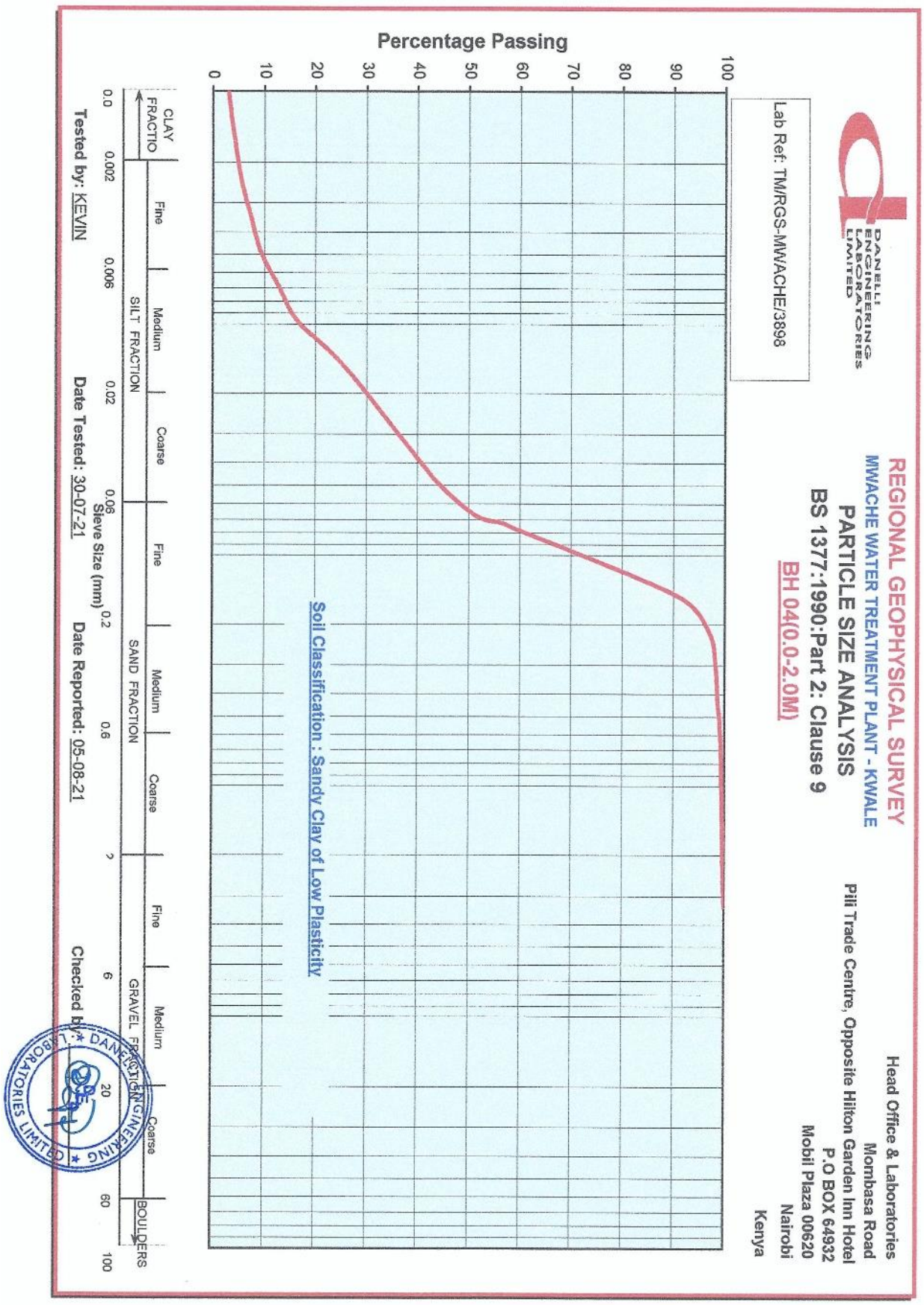
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MWACHE WATER TREATMENT PLANT - KWALE
PARTICLE SIZE ANALYSIS
BS 1377:1990:Part 2: Clause 9
BH 04(0.0-2.0M)
Lab Ref: TM/RGS-MWACHE/3898
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Mobil Plaza 00620
Nairobi
Kenya
Percentage Passing
Soil Classification : Sandy Clay of Low Plasticity
CLAY FRACTIO
SILT FRACTION
SAND FRACTION
GRAVEL FRACTION
BOULDERS
Fine
Medium
Coarse
Sieve Size (mm)
Tested by: KEVIN
Date Tested: 30-07-21
Date Reported: 05-08-21
Checked by:
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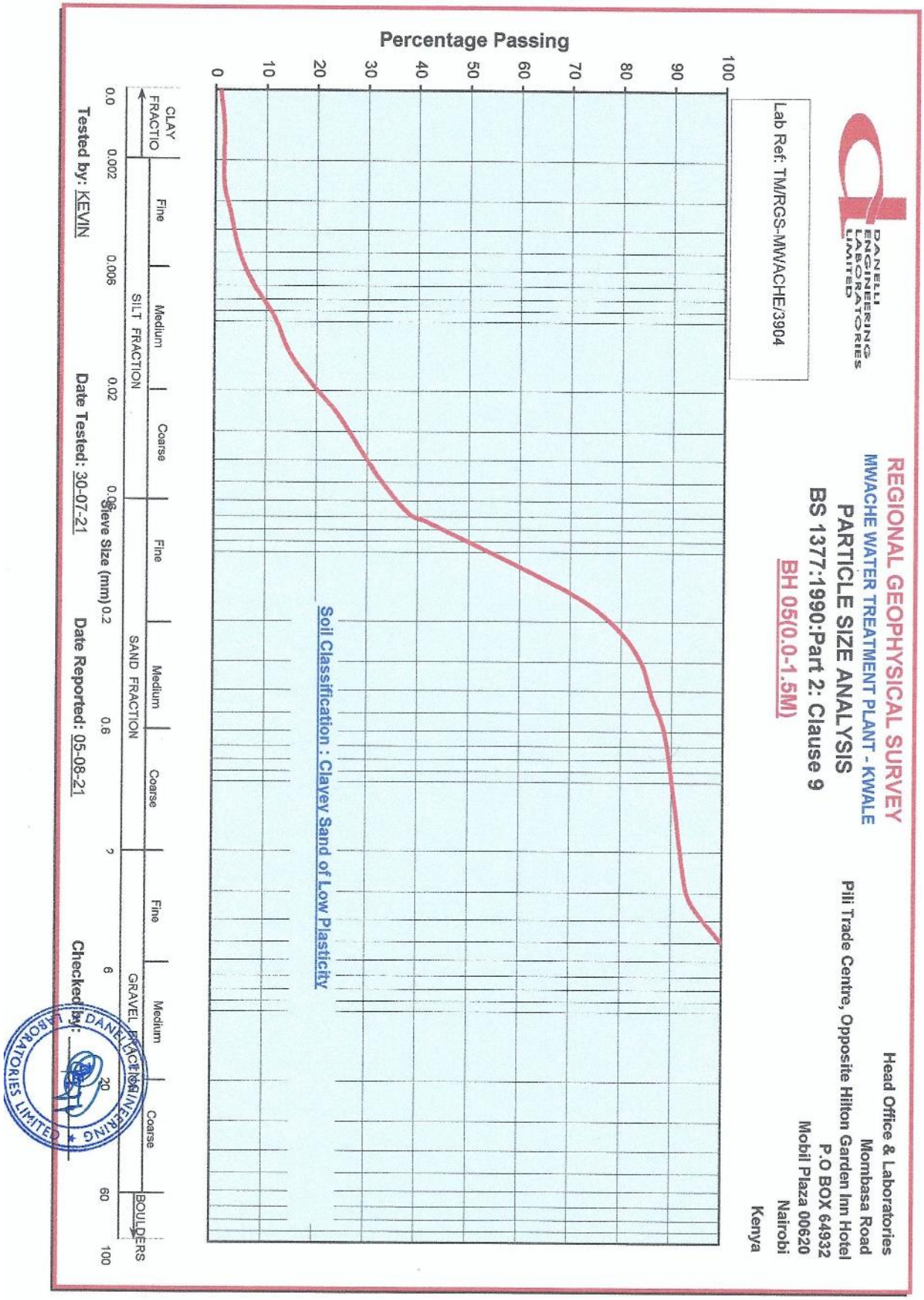
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MWACHE WATER TREATMENT PLANT - KWALE
PARTICLE SIZE ANALYSIS
BS 1377:1990:Part 2: Clause 9
BH 05(0.0-1.5M)
Lab Ref: TM/RGS-MWACHE/3904
Percentage Passing
Soil Classification : Clavey Sand of Low Plasticity
CLAY FRACTIO
Fine
Medium
Coarse
SILT FRACTION
Fine
Medium
Coarse
SAND FRACTION
Fine
Medium
Coarse
GRAVEL FRACTION
BOULDERS
Sieve Size (mm)
Tested by: KEVIN
Date Tested: 30-07-21
Date Reported: 05-08-21
Checked by:
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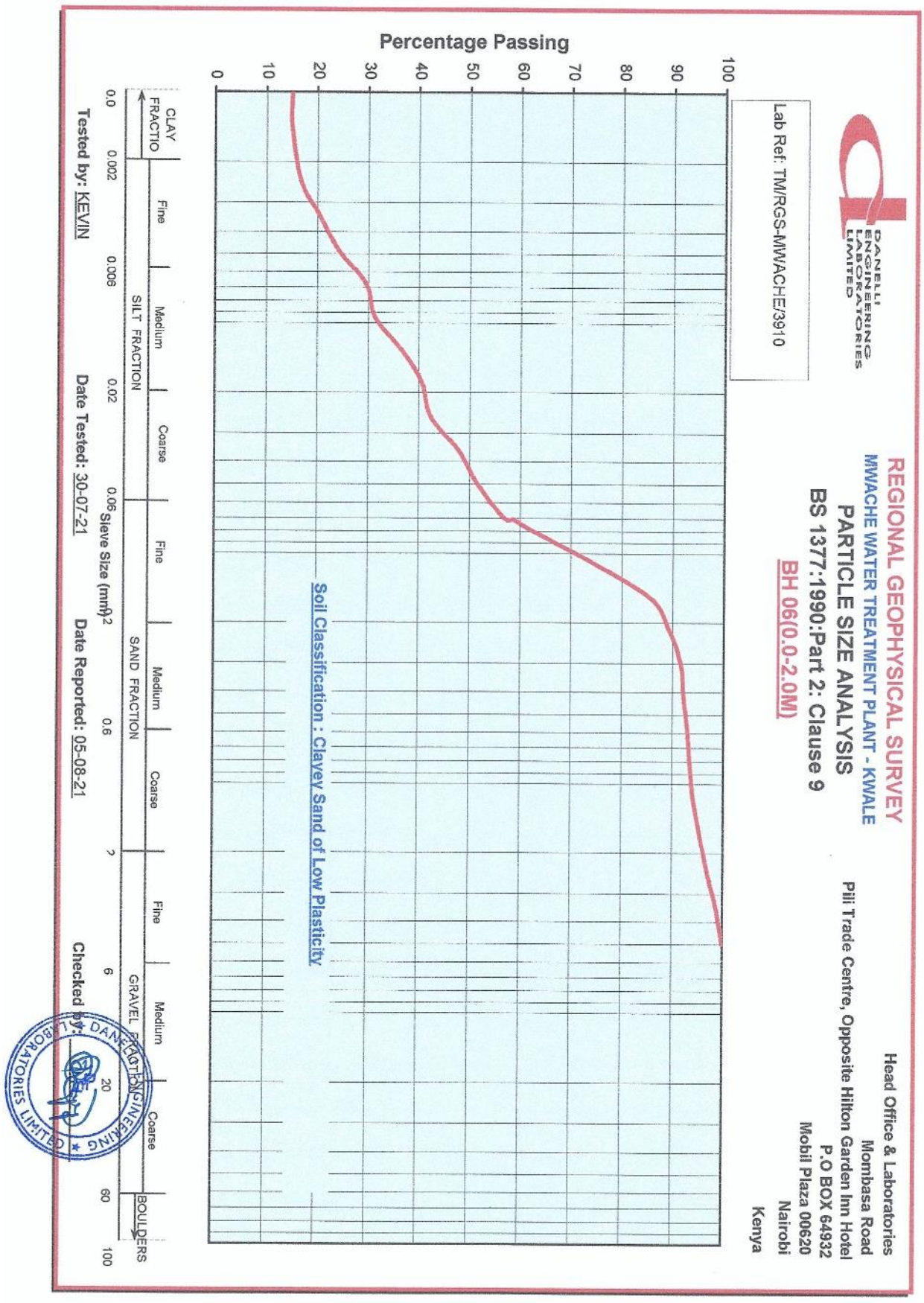
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MWACHE WATER TREATMENT PLANT - KWALE
PARTICLE SIZE ANALYSIS
BS 1377:1990:Part 2: Clause 9
BH 06(0.0-2.0M)
Lab Ref: TM/RGS-MWACHE/3910
Percentage Passing
Soil Classification : Clayey Sand of Low Plasticity
CLAY FRACTIO
SILT FRACTION
SAND FRACTION
GRAVEL FRACTION
BOULDERS
Fine
Medium
Coarse
Sieve Size (mm)
Tested by: KEVIN
Date Tested: 30-07-21
Date Reported: 05-08-21
Checked by:
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Particle Size Distribution – Hydrometer Data

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT

Particle Size Distribution: Hydrometer Method
BS 1377: Part 2:1990
BH 01 (Depth: 0.0-2.0m)

Site: MWACHE W. T. P | Location: KWALE | Date Received: 23-07-21
Sample Classification: - | Lab Ref: TM/RGS-MWACHE/3884 | Sample No. 3884
Sampled by: REGIONAL GEOPHYSICAL SURVEY | Depth: - | Date Tested: 30-07-21

General Information

Dry Weight, g	40	Hydrometer Type	152H
Specific Gravity (Assumed)	2.60	Zero Correction	2
Temperature (^{0} C)	21	S.G Correction Factor	1.01
K Factor	0.01369	Temperature Correction Factor	0.40

Test Data

Time (Min)	Actual Hydrometer Reading	Adjusted Hydrometer Reading (R_h)	Composite Correction	Corrected Hydrometer Reading	Effective Hydrometer Depth (cm)	Diameter of Particles (mm)	% Finer in Suspension	% Finer Based on Whole Sample
0.25	18.0	19.0	-3.4	15.60	13.3	0.0987	94.4	34.7
0.5	17.0	18.0	-3.4	14.60	13.5	0.0703	88.3	32.5
1	16.0	17.0	-3.4	13.60	13.7	0.0499	82.3	30.3
2	15.0	16.0	-3.4	12.60	13.8	0.0358	76.2	28.1
4	14.5	15.5	-3.4	12.10	13.9	0.0256	73.2	26.9
8	14.0	15.0	-3.4	11.60	14.0	0.0182	70.2	25.8
15	13.0	14.0	-3.4	10.60	14.2	0.0134	64.1	23.6
30	12.0	13.0	-3.4	9.60	14.3	0.0095	58.1	21.4
60	11.5	12.5	-3.4	9.10	14.4	0.0068	55.1	20.3
120	11.0	12.0	-3.4	8.60	14.5	0.0048	52.0	19.1
240	10.0	11.0	-3.4	7.60	14.7	0.0034	46.0	16.9
480	9.0	10.0	-3.4	6.60	14.8	0.0024	39.9	14.7
1440	8.0	9.0	-3.4	5.60	15.0	0.0014	33.9	12.5

Tested by: KEVIN | Date Reported: 05-08-21 | Checked by:

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Particle Size Distribution: Hydrometer Method
BS 1377: Part 2:1990
BH 02 (Depth: 0.0-1.85m)

Site: MWACHE W. T. P | **Location:** KWALE | **Date Received:** 23-07-21

Sample Classification: - | **Lab Ref:** TM/RGS-MWACHE/3888 | **Sample No.** 3888

Sampled by: REGIONAL GEOPHYSICAL SURVEY | **Depth:** - | **Date Tested:** 30-07-21

General Information

Dry Weight, g	40	Hydrometer Type	152H
Specific Gravity (Assumed)	2.60	Zero Correction	4
Temperature (^{0} C)	21	S.G Correction Factor	1.01
K Factor	0.01369	Temperature Correction Factor	0.40

Test Data

Time (Min)	Actual Hydrometer Reading	Adjusted Hydrometer Reading (R_h)	Composite Correction	Corrected Hydrometer Reading	Effective Hydrometer Depth (cm)	Diameter of Particles (mm)	% Finer in Suspension	% Finer Based on Whole Sample
0.25	20.5	21.5	-5.4	16.10	12.9	0.0987	97.4	69.9
0.5	20.0	21.0	-5.4	15.60	13.0	0.0703	94.4	67.8
1	19.0	20.0	-5.4	14.60	13.2	0.0499	88.3	63.4
2	17.5	18.5	-5.4	13.10	13.4	0.0358	79.3	56.9
4	16.5	17.5	-5.4	12.10	13.6	0.0256	73.2	52.6
8	15.0	16.0	-5.4	10.60	13.8	0.0182	64.1	46.0
15	13.5	14.5	-5.4	9.10	14.1	0.0134	55.1	39.5
30	12.0	13.0	-5.4	7.60	14.3	0.0095	46.0	33.0
60	11.5	12.5	-5.4	7.10	14.4	0.0068	43.0	30.8
120	11.0	12.0	-5.4	6.60	14.5	0.0048	39.9	28.7
240	10.0	11.0	-5.4	5.60	14.7	0.0034	33.9	24.3
480	9.0	10.0	-5.4	4.60	14.8	0.0024	27.8	20.0
1440	8.0	9.0	-5.4	3.60	15.0	0.0014	21.8	15.6

Tested by: KEVIN | **Date Reported:** 05-08-21 | **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Particle Size Distribution: Hydrometer Method
BS 1377: Part 2:1990
BH 03 (Depth: 0.0-2.0m)

Site: MWACHE W. T. P | **Location:** KWALE | **Date Received:** 23-07-21

Sample Classification: - | **Lab Ref:** TM/RGS-MWACHE/3893 | **Sample No.** 3893

Sampled by: REGIONAL GEOPHYSICAL SURVEY | **Depth:** - | **Date Tested:** 30-07-21

General Information

Dry Weight, g	40	Hydrometer Type	152H
Specific Gravity (Assumed)	2.60	Zero Correction	6
Temperature (^{0} C)	21	S.G Correction Factor	1.01
K Factor	0.01369	Temperature Correction Factor	0.40

Test Data

Time (Min)	Actual Hydrometer Reading	Adjusted Hydrometer Reading (R_h)	Composite Correction	Corrected Hydrometer Reading	Effective Hydrometer Depth (cm)	Diameter of Particles (mm)	% Finer in Suspension	% Finer Based on Whole Sample
0.25	22.5	23.5	-7.4	16.10	12.6	0.0987	97.4	49.3
0.5	21.5	22.5	-7.4	15.10	12.8	0.0703	91.4	46.2
1	20.0	21.0	-7.4	13.60	13.0	0.0499	82.3	41.6
2	19.0	20.0	-7.4	12.60	13.2	0.0358	76.2	38.6
4	17.5	18.5	-7.4	11.10	13.4	0.0256	67.2	34.0
8	16.5	17.5	-7.4	10.10	13.6	0.0182	61.1	30.9
15	15.0	16.0	-7.4	8.60	13.8	0.0134	52.0	26.3
30	14.0	15.0	-7.4	7.60	14.0	0.0095	46.0	23.3
60	13.5	14.5	-7.4	7.10	14.1	0.0068	43.0	21.7
120	13.0	14.0	-7.4	6.60	14.2	0.0048	39.9	20.2
240	12.0	13.0	-7.4	5.60	14.3	0.0034	33.9	17.1
480	11.0	12.0	-7.4	4.60	14.5	0.0024	27.8	14.1
1440	10.0	11.0	-7.4	3.60	14.7	0.0014	21.8	11.0

Tested by: KEVIN | **Date Reported:** 05-08-21 | **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Particle Size Distribution: Hydrometer Method
BS 1377: Part 2:1990
BH 04 (Depth: 0.0-2.0m)

Site: MWACHE W. T. P | **Location:** KWALE | **Date Received:** 23-07-21

Sample Classification: - | **Lab Ref:** TM/RGS-MWACHE/3898 | **Sample No.** 3898

Sampled by: REGIONAL GEOPHYSICAL SURVEY | **Depth:** - | **Date Tested:** 30-07-21

General Information

Dry Weight, g	40	Hydrometer Type	152H
Specific Gravity (Assumed)	2.60	Zero Correction	5
Temperature (^{0} C)	21	S.G Correction Factor	1.01
K Factor	0.01369	Temperature Correction Factor	0.40

Test Data

Time (Min)	Actual Hydrometer Reading	Adjusted Hydrometer Reading (R_h)	Composite Correction	Corrected Hydrometer Reading	Effective Hydrometer Depth (cm)	Diameter of Particles (mm)	% Finer in Suspension	% Finer Based on Whole Sample
0.25	21.5	22.5	-6.4	16.10	12.8	0.0987	97.4	56.7
0.5	20.0	21.0	-6.4	14.60	13.0	0.0703	88.3	51.4
1	18.0	19.0	-6.4	12.60	13.3	0.0499	76.2	44.4
2	16.5	17.5	-6.4	11.10	13.6	0.0358	67.2	39.1
4	15.0	16.0	-6.4	9.60	13.8	0.0256	58.1	33.8
8	13.5	14.5	-6.4	8.10	14.1	0.0182	49.0	28.5
15	12.0	13.0	-6.4	6.60	14.3	0.0134	39.9	23.2
30	10.0	11.0	-6.4	4.60	14.7	0.0095	27.8	16.2
60	9.0	10.0	-6.4	3.60	14.8	0.0068	21.8	12.7
120	8.0	9.0	-6.4	2.60	15.0	0.0048	15.7	9.2
240	7.5	8.5	-6.4	2.10	15.1	0.0034	12.7	7.4
480	7.0	8.0	-6.4	1.60	15.2	0.0024	9.7	5.6
1440	6.5	7.5	-6.4	1.10	15.2	0.0014	6.7	3.9

Tested by: KEVIN | **Date Reported:** 05-08-21 | **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Particle Size Distribution: Hydrometer Method
BS 1377: Part 2:1990
BH 05 (Depth: 0.0-1.5 m)

Site: MWACHE W. T. P **Location:** KWALE **Date Received:** 23-07-21

Sample Classification: - **Lab Ref:** TM/RGS-MWACHE/3904 **Sample No.** 3904

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** - **Date Tested:** 30-07-21

General Information

Dry Weight, g	40	Hydrometer Type	152H
Specific Gravity (Assumed)	2.60	Zero Correction	3
Temperature (^{0} C)	21	S.G Correction Factor	1.01
K Factor	0.01369	Temperature Correction Factor	0.40

Test Data

Time (Min)	Actual Hydrometer Reading	Adjusted Hydrometer Reading (R_h)	Composite Correction	Corrected Hydrometer Reading	Effective Hydrometer Depth (cm)	Diameter of Particles (mm)	% Finer in Suspension	% Finer Based on Whole Sample
0.25	18.0	19.0	-4.4	14.60	13.3	0.0987	88.3	41.5
0.5	16.5	17.5	-4.4	13.10	13.6	0.0703	79.3	37.2
1	15.0	16.0	-4.4	11.60	13.8	0.0499	70.2	33.0
2	13.5	14.5	-4.4	10.10	14.1	0.0358	61.1	28.7
4	12.0	13.0	-4.4	8.60	14.3	0.0256	52.0	24.5
8	10.0	11.0	-4.4	6.60	14.7	0.0182	39.9	18.8
15	8.5	9.5	-4.4	5.10	14.9	0.0134	30.9	14.5
30	7.5	8.5	-4.4	4.10	15.1	0.0095	24.8	11.7
60	6.0	7.0	-4.4	2.60	15.3	0.0068	15.7	7.4
120	5.0	6.0	-4.4	1.60	15.5	0.0048	9.7	4.5
240	4.5	5.5	-4.4	1.10	15.5	0.0034	6.7	3.1
480	4.0	5.0	-4.4	0.60	15.6	0.0024	3.6	1.7
1440	4.0	5.0	-4.4	0.60	15.6	0.0014	3.6	1.7

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Particle Size Distribution: Hydrometer Method
BS 1377: Part 2:1990
BH 06 (Depth: 0.0-2.0m)

Site: MWACHE W. T. P **Location:** KWALE **Date Received:** 23-07-21

Sample Classification: - **Lab Ref:** TM/RGS-MWACHE/3910 **Sample No.** 3910

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** - **Date Tested:** 30-07-21

General Information

Dry Weight, g	40	Hydrometer Type	152H
Specific Gravity (Assumed)	2.60	Zero Correction	3
Temperature (^{0} C)	21	S.G Correction Factor	1.01
K Factor	0.01369	Temperature Correction Factor	0.40

Test Data

Time (Min)	Actual Hydrometer Reading	Adjusted Hydrometer Reading (R_h)	Composite Correction	Corrected Hydrometer Reading	Effective Hydrometer Depth (cm)	Diameter of Particles (mm)	% Finer in Suspension	% Finer Based on Whole Sample
0.25	19.5	20.5	-4.4	16.10	13.1	0.0987	97.4	58.8
0.5	19.0	20.0	-4.4	15.60	13.2	0.0703	94.4	57.0
1	17.5	18.5	-4.4	14.10	13.4	0.0499	85.3	51.5
2	16.5	17.5	-4.4	13.10	13.6	0.0358	79.3	47.9
4	15.0	16.0	-4.4	11.60	13.8	0.0256	70.2	42.4
8	14.5	15.5	-4.4	11.10	13.9	0.0182	67.2	40.6
15	13.5	14.5	-4.4	10.10	14.1	0.0134	61.1	36.9
30	12.0	13.0	-4.4	8.60	14.3	0.0095	52.0	31.4
60	11.5	12.5	-4.4	8.10	14.4	0.0068	49.0	29.6
120	10.0	11.0	-4.4	6.60	14.7	0.0048	39.9	24.1
240	9.0	10.0	-4.4	5.60	14.8	0.0034	33.9	20.5
480	8.0	9.0	-4.4	4.60	15.0	0.0024	27.8	16.8
1440	7.5	8.5	-4.4	4.10	15.1	0.0014	24.8	15.0

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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Standard Proctor Density

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Dry Density/Moisture Content Relationship

BS 1377: Part 4: 1990

BH 01(0.0-2.0M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3884 **Sample No.** 3884

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 -2.0M **Date Tested:** 29-07-21

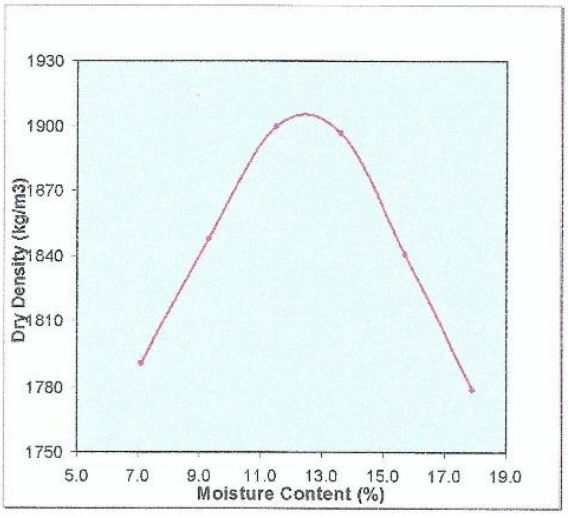
Method of Compaction: standard

Moisture Addition	200cc	250cc	300cc	350cc	400cc	450cc
Mass of Mould+Base+Soil	5353	5449	5541	5576	5552	5522
Mass of Mould + Base	3550	3550	3550	3550	3550	3550
Mass of Compacted Soil	1803	1899	1991	2026	2002	1972
Bulk Density (kgs/m^3)	1918	2020	2119	2155	2130	2097

Tin No.	MW	AC	HE	DA	MU	KE
Wgt of Wet Soil + Tin	113.1	118.3	123.3	126.3	121.4	129.2
Wgt of Dry Soil + Tin	105.6	108.2	110.6	111.2	104.9	109.6
Wgt of Water	7.5	10.1	12.7	15.1	16.5	19.6
Wgt of Tin	_	_	_	_	_	_
Wgt of Dry Soil	105.6	108.2	110.6	111.2	104.9	109.6
Moisture Content %	**7.1**	**9.3**	**11.5**	**13.6**	**15.7**	**17.9**

Dry Density (Kgs/m^3)	**1791**	**1848**	**1900**	**1897**	**1841**	**1779**

Maximum Dry Density = 1905Kg/m^3 **Optimum Moisture Content = 12.5%**



Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Dry Density/Moisture Content Relationship

BS 1377: Part 4: 1990

BH 02(0.0-1.85M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3888 **Sample No.** 3888

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 -1.85M **Date Tested:** 29-07-21

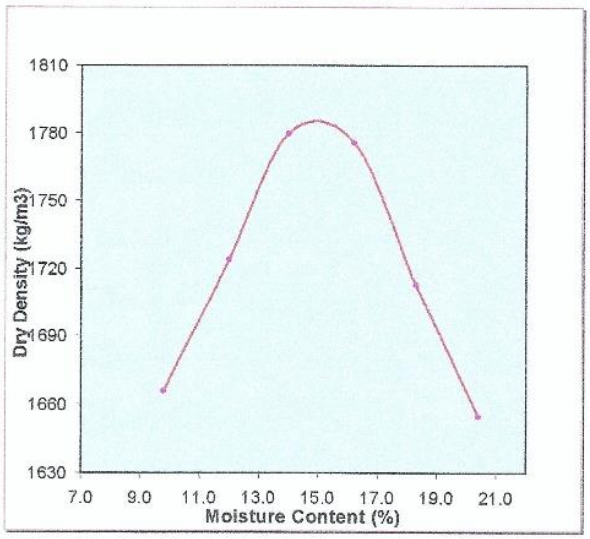
Method of Compaction: standard

Moisture Addition	200cc	250cc	300cc	350cc	400cc	450cc
Mass of Mould+Base+Soil	5270	5365	5457	5490	5455	5423
Mass of Mould + Base	3550	3550	3550	3550	3550	3550
Mass of Compacted Soil	1720	1815	1907	1940	1905	1873
Bulk Density (kgs/m^3)	1829	1931	2029	2064	2026	1993

Tin No.	MU	SY	OK	AW	KA	LE
Wgt of Wet Soil + Tin	131.9	137.2	135.0	139.0	136.5	141.1
Wgt of Dry Soil + Tin	120.1	122.5	118.4	119.6	115.4	117.2
Wgt of Water	11.8	14.7	16.6	19.4	21.1	23.9
Wgt of Tin	_	_	_	_	_	_
Wgt of Dry Soil	120.1	122.5	118.4	119.6	115.4	117.2
Moisture Content %	**9.8**	**12.0**	**14.0**	**16.2**	**18.3**	**20.4**

Dry Density (Kgs/m^3)	**1666**	**1724**	**1780**	**1776**	**1713**	**1655**

Maximum Dry Density = 1785Kg/m^3 **Optimum Moisture Content = 15.0%**



Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Dry Density/Moisture Content Relationship

BS 1377: Part 4: 1990

BH 03(0.0-2.0M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3893 **Sample No.** 3893

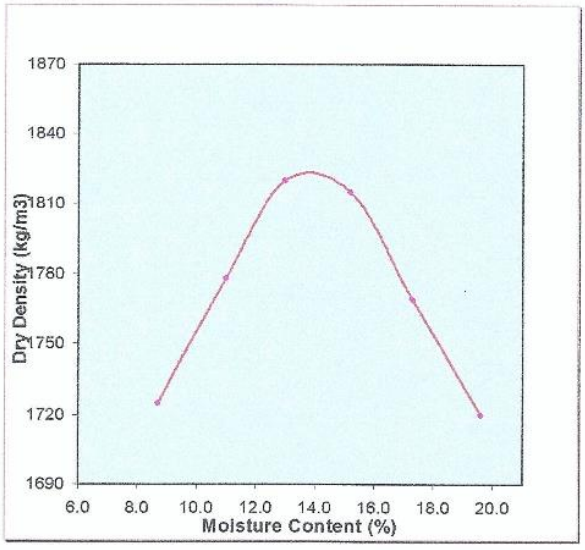
Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 - 2.0M **Date Tested:** 29-07-21

Method of Compaction: standard

Moisture Addition	200cc	250cc	300cc	350cc	400cc	450cc
Mass of Mould+Base+Soil	5313	5405	5483	5515	5501	5482
Mass of Mould + Base	3550	3550	3550	3550	3550	3550
Mass of Compacted Soil	1763	1855	1933	1965	1951	1932
Bulk Density (kgs/m^3)	1875	1974	2057	2091	2075	2055

Tin No.	KA	LE	KY	EN	IN	YN
Wgt of Wet Soil + Tin	117.3	125.9	131.6	125.8	123.5	133.8
Wgt of Dry Soil + Tin	107.9	113.4	116.5	109.2	105.3	112.0
Wgt of Water	9.4	12.5	15.1	16.6	18.2	21.8
Wgt of Tin						
Wgt of Dry Soil	107.9	113.4	116.5	109.2	105.3	112.0
Moisture Content %	**8.7**	**11.0**	**13.0**	**15.2**	**17.3**	**19.5**
Dry Density (Kgs/m^3)	**1725**	**1778**	**1820**	**1815**	**1769**	**1720**

Maximum Dry Density = 1823Kg/m^3 **Optimum Moisture Content = 13.8%**



Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Dry Density/Moisture Content Relationship

BS 1377: Part 4: 1990

BH 04(0.0-2.0M)

Site: MWACHE W.T.P | Location: KWALE | Date Received: 23-07-21

Sample Classification: SOIL SAMPLE | Lab Ref: TM/RGS-MWACHE/3898 | Sample No. 3896

Sampled by: REGIONAL GEOPHYSICAL SURVEY | Depth: 0.0 - 2.0M | Date Tested: 29-07-21

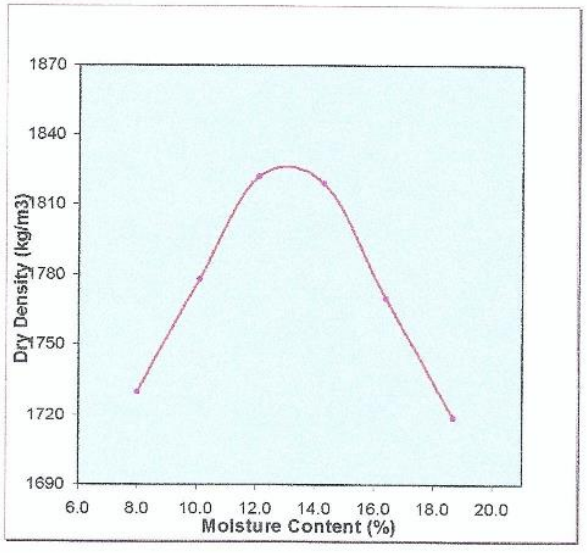
Method of Compaction: standard

Moisture Addition	200cc	250cc	300cc	350cc	400cc	450cc
Mass of Mould+Base+Soil	5306	5390	5470	5504	5487	5468
Mass of Mould + Base	3550	3550	3550	3550	3550	3550
Mass of Compacted Soil	1756	1840	1920	1954	1937	1918
Bulk Density (kgs/m^3)	1868	1958	2042	2079	2060	2040

Tin No.	JO	MW	AK	KE	NE	DY
Wgt of Wet Soil + Tin	129.2	134.1	138.6	142.9	144.6	143.5
Wgt of Dry Soil + Tin	119.6	121.8	123.6	125.0	124.2	120.9
Wgt of Water	9.6	12.3	15.0	17.9	20.4	22.6
Wgt of Tin						
Wgt of Dry Soil	119.6	121.8	123.6	125.0	124.2	120.9
Moisture Content %	**8.0**	**10.1**	**12.1**	**14.3**	**16.4**	**18.7**

Dry Density (Kgs/m^3)	**1730**	**1778**	**1822**	**1819**	**1770**	**1719**

Maximum Dry Density = 1827Kg/m^3 | Optimum Moisture Content = 13.1%



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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Dry Density/Moisture Content Relationship

BS 1377: Part 4: 1990

BH 05(0.0-1.5M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3904 **Sample No.** 3904

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 - 1.5M **Date Tested:** 29-07-21

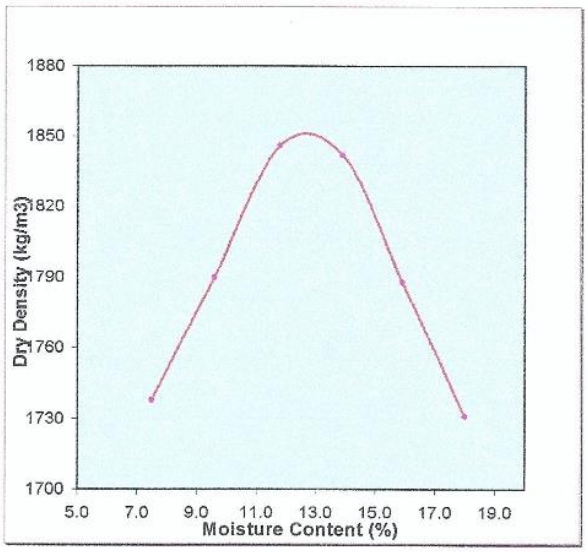
Method of Compaction: standard

Moisture Addition	100cc	150cc	200cc	250cc	300cc	350cc
Mass of Mould+Base+Soil	5306	5394	5490	5522	5498	5470
Mass of Mould + Base	3550	3550	3550	3550	3550	3550
Mass of Compacted Soil	1756	1844	1940	1972	1948	1920
Bulk Density (kgs/m^3)	1868	1962	2064	2098	2072	2043

Tin No.	MA	KA	MI	NI	EK	OE
Wgt of Wet Soil + Tin	134.2	138.5	142.1	140.3	145.8	152.1
Wgt of Dry Soil + Tin	124.8	126.4	127.1	123.2	125.8	128.9
Wgt of Water	9.4	12.1	15.0	17.1	20.0	23.2
Wgt of Tin	_	_	_	_	_	_
Wgt of Dry Soil	124.8	126.4	127.1	123.2	125.8	128.9
Moisture Content %	**7.5**	**9.6**	**11.8**	**13.9**	**15.9**	**18.0**

Dry Density (Kgs/m^3)	**1738**	**1790**	**1846**	**1842**	**1788**	**1731**

Maximum Dry Density = 1851Kg/m^3 **Optimum Moisture Content = 12.6%**



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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Dry Density/Moisture Content Relationship

BS 1377: Part 4: 1990

BH 06(0.0-2.0M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Sample Classification: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3910 **Sample No.** 3910

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Depth:** 0.0 - 2.0M **Date Tested:** 29-07-21

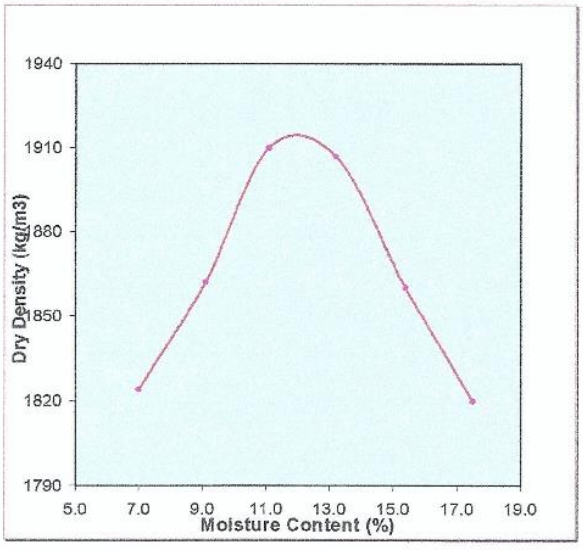
Method of Compaction: standard

Moisture Addition	**150cc**	**200cc**	**250cc**	**300cc**	**350cc**	**400cc**
Mass of Mould+Base+Soil	5385	5460	5545	5579	5568	5560
Mass of Mould + Base	3550	3550	3550	3550	3550	3550
Mass of Compacted Soil	1835	1910	1995	2029	2018	2010
Bulk Density (kgs/m^3)	1952	2031	2122	2159	2146	2139

Tin No.	**MO**	**IS**	**TU**	**RE**	**CO**	**NT**
Wgt of Wet Soil + Tin	130.0	131.6	131.5	131.0	136.1	145.5
Wgt of Dry Soil + Tin	121.5	120.6	118.4	115.7	117.9	123.8
Wgt of Water	8.5	11.0	13.1	15.3	18.2	21.7
Wgt of Tin						
Wgt of Dry Soil	121.5	120.6	118.4	115.7	117.9	123.8
Moisture Content %	**7.0**	**9.1**	**11.1**	**13.2**	**15.4**	**17.5**

Dry Density (Kgs/m^3)	**1824**	**1862**	**1910**	**1907**	**1860**	**1820**

Maximum Dry Density = 1915Kg/m^3 **Optimum Moisture Content = 12.0%**



Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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Natural Moisture Content

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NATURAL MOISTURE CONTENT
BS 1377: 1990 Part 2: Clause 3

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE	**Date of Test:**	30-07-21
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE	**Site:**	MWACHE W.T.P
Material Description	SOIL SAMPLES				

Sample Reference.	**BH05**		**BH06**					
Depth (m):	**0.0-1.5M**		**0.0-2.0M**					
Sample No.	**3904**		**3910**					
Test No.	**1**	**2**	1	**2**				
Initial Weight of Sample (g)	72.8	90.3	92.1	104.2				
Weight of Dry Sample (g)	70.6	87.8	91.2	103.0				
Weight of Water (g)	2.2	2.5	0.9	1.2				
% Moisture Content	3.1	2.8	1.0	1.2				
Average Moisture Content (%)	**3.0**		**1.1**					

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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NATURAL MOISTURE CONTENT

BS 1377: 1990 Part 2: Clause 3

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE	**Date of Test:**	30-07-21
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE	**Site:**	MWACHE W.T.P
Material Description	SOIL SAMPLES				

Sample Reference.	**BH01**		**BH02**		**BH03**		**BH04**	
Depth (m):	**0.0-2.0M**		**0.0-1.85M**		**0.0-2.0M**		**0.0-2.0M**	
Sample No.	**3884**		**3888**		**3893**		**3898**	
Test No.	1	2	1	2	1	2	1	2
Initial Weight of Sample (g)	77.0	151.1	88.1	82.2	120.2	93.3	122.0	85.2
Weight of Dry Sample (g)	76.1	149.0	85.1	79.0	116.1	90.2	121.0	84.1
Weight of Water (g)	0.9	2.1	3.0	3.2	4.1	3.1	1.0	1.1
% Moisture Content	1.2	1.4	3.5	4.1	3.5	3.4	0.8	1.3
Average Moisture Content (%)	**1.3**		**3.8**		**3.5**		**1.1**	

Tested by: KEVIN

Date Reported: 05-08-21

Checked by:

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Specific Gravity of Soils

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity Test
BS 1377: Part 2: 1990: Clause 8
BH 01(Depth: 0.0-2.0m)

Site: MWACHE W.T.P | Location: KWALE | Date Received: 23-07-21

Material Description: SOIL SAMPLE | Lab Ref: TM/RGS-MWACHE/3884 | Sample No: 3884

Sampled by: REGIONAL GEOPHYSICAL SURVEY | Source: SITE | Date Tested: 02-08-21

TEST NO.		1	2	Average Values
A	The mass of saturated surface dry in (g)	-	-	
B	The mass of Density bottle or wide mouthed glass vessel containing sample & filled with water (g)	96.8	96.2	
C	The mass of Density bottle or wide mouthed glass vessel filled with water only (g)	81.6	81.6	
D	The mass of oven-dried sample in (g)	24.2	23.3	
Relative Density on an oven-dried basis =D/A-(B-C)		-	-	
Relative Density on a saturated & surface-dried basis = A/A-(B-C)		-	-	
Apparent Relative Density = D/D-(B-C)		2.69	2.68	2.69
Water Absorption (% of dry mass) =100(A-D)/D		-	-	

Tested by: KEVIN | Date Reported: 05-08-21 | Checked by:

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity Test
BS 1377: Part 2: 1990: Clause 8
BH 02(Depth: 0.0-1.85m)

Site: MWACHE W.T.P | Location: KWALE | Date Received: 23-07-21

Material Description: SOIL SAMPLE | Lab Ref: TM/RGS-MWACHE/3888 | Sample No: 3888

Sampled by: REGIONAL GEOPHYSICAL SURVEY | Source: SITE | Date Tested: 02-08-21

TEST NO.		1	2	Average Values
A	The mass of saturated surface dry in (g)	-	-	
B	The mass of Density bottle or wide mouthed glass vessel containing sample & filled with water (g)	99.5	105.8	
C	The mass of Density bottle or wide mouthed glass vessel filled with water only (g)	81.6	81.6	
D	The mass of oven-dried sample in (g)	28.8	38.8	
Relative Density on an oven-dried basis =D/A-(B-C)		-	-	
Relative Density on a saturated & surface-dried basis = A/A-(B-C)		-	-	
Apparent Relative Density = D/D-(B-C)		2.64	2.66	2.65
Water Absorption (% of dry mass) =100(A-D)/D		-	-	

Tested by: KEVIN | Date Reported: 05-08-21 | Checked by:

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity Test
BS 1377: Part 2: 1990: Clause 8
BH 03(Depth: 0.0-2.0m)

Site: MWACHE W.T.P | Location: KWALE | Date Received: 23-07-21

Material Description: SOIL SAMPLE | Lab Ref: TM/RGS-MWACHE/3893 | Sample No: 3893

Sampled by: REGIONAL GEOPHYSICAL SURVEY | Source: SITE | Date Tested: 02-08-21

TEST NO.		1	2	Average Values
A	The mass of saturated surface dry in (g)	-	-	
B	The mass of Density bottle or wide mouthed glass vessel containing sample & filled with water (g)	103.2	102.2	
C	The mass of Density bottle or wide mouthed glass vessel filled with water only (g)	81.6	81.6	
D	The mass of oven-dried sample in (g)	34.9	33.5	
Relative Density on an oven-dried basis =D/A-(B-C)		-	-	
Relative Density on a saturated & surface-dried basis = A/A-(B-C)		-	-	
Apparent Relative Density = D/D-(B-C)		2.62	2.60	2.61
Water Absorption (% of dry mass) =100(A-D)/D		-	-	

Tested by: KEVIN | Date Reported: 05-08-21 | Checked by:

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity Test
BS 1377: Part 2: 1990: Clause 8
BH 04(Depth: 0.0-2.0m)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3898 **Sample No:** 3898

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 02-08-21

TEST NO.		1	2	Average Values
A	The mass of saturated surface dry in (g)	-	-	
B	The mass of Density bottle or wide mouthed glass vessel containing sample & filled with water (g)	103.5	103.6	
C	The mass of Density bottle or wide mouthed glass vessel filled with water only (g)	81.6	81.6	
D	The mass of oven-dried sample in (g)	34.9	35.2	
Relative Density on an oven-dried basis =D/A-(B-C)		-	-	
Relative Density on a saturated & surface-dried basis = A/A-(B-C)		-	-	
Apparent Relative Density = D/D-(B-C)		2.68	2.67	2.68
Water Absorption (% of dry mass) =100(A-D)/D		-	-	

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity Test
BS 1377: Part 2: 1990: Clause 8
BH 05(Depth: 0.0-1.5m)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3904 **Sample No:** 3904

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 02-08-21

TEST NO.		1	2	Average Values
A	The mass of saturated surface dry in (g)	-	-	
B	The mass of Density bottle or wide mouthed glass vessel containing sample & filled with water (g)	102.2	100.6	
C	The mass of Density bottle or wide mouthed glass vessel filled with water only (g)	81.6	81.6	
D	The mass of oven-dried sample in (g)	32.8	30.2	
Relative Density on an oven-dried basis =D/A-(B-C)		-	-	
Relative Density on a saturated & surface-dried basis = A/A-(B-C)		-	-	
Apparent Relative Density = D/D-(B-C)		2.69	2.70	2.70
Water Absorption (% of dry mass) =100(A-D)/D		-	-	

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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MWACHE WATER TREATMENT PLANT

Specific Gravity Test
BS 1377: Part 2: 1990: Clause 8
BH 06(Depth: 0.0-2.0m)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: SOIL SAMPLE **Lab Ref:** TM/RGS-MWACHE/3910 **Sample No:** 3910

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 02-08-21

TEST NO.		1	2	Average Values
A	The mass of saturated surface dry in (g)	-	-	
B	The mass of Density bottle or wide mouthed glass vessel containing sample & filled with water (g)	99.5	101.0	
C	The mass of Density bottle or wide mouthed glass vessel filled with water only (g)	81.6	81.6	
D	The mass of oven-dried sample in (g)	28.6	30.8	
Relative Density on an oven-dried basis =D/A-(B-C)		-	-	
Relative Density on a saturated & surface-dried basis = A/A-(B-C)		-	-	
Apparent Relative Density = D/D-(B-C)		2.67	2.70	2.69
Water Absorption (% of dry mass) =100(A-D)/D		-	-	

Tested by: KEVIN **Date Reported:** 05-08-21 **Checked by:**

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Unconsolidated Undrained Triaxial Test

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Quick Undrained Triaxial Test
BS 1377: Part 8: 1990
BH 01 (Depth: 0.0-2.0m)

Site: MWACHE W.T.P | **Location:** KWALE | **Date Received:** 23-07-21

Soil Type: DISTURBED | **Lab Ref:** TM/RGS-MWACHE/3884 | **Sample No. :** 3884

Mean Diameter of Sample: 62 mm | **Height of Sample:** 125 mm | **Mean Area:** 3019.1 mm^2

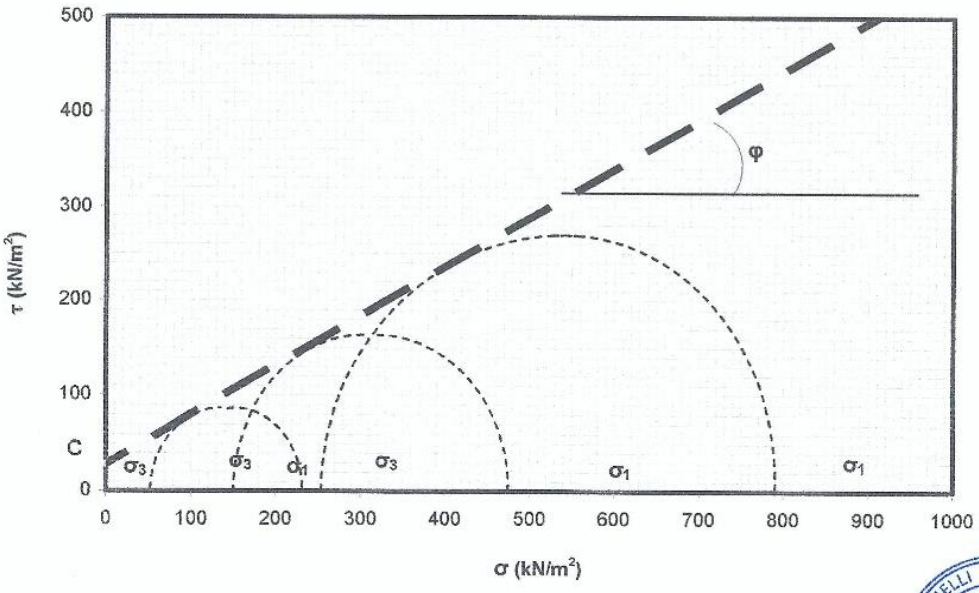
Weight of Specimen: 768.3 grams | **Volume of Specimen:** 377.38 cm^3 | **Date of Test:** 02-08-21

TEST	1	2	3
Cell Pressure (kN/m^2)	50	150	250
Principal Stress difference at failure (kN/m^2)	178	325	538

a) TOTAL STRESS ANALYSIS

TEST	1	2	3
σ_1	228	475	788
σ_3	50	150	250

c = 28 kN/m^2 φ =28°



Tested By: KEVIN | **Date Reported:** 05-08-21 | **Checked By:**

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Quick Undrained Triaxial Test
BS 1377: Part 8: 1990
BH 02 (Depth: 0.0-1.85m)

Site: MWACHE W.T.P | **Location:** KWALE | **Date Received:** 23-07-21

Soil Type: DISTURBED | **Lab Ref:** TM/RGS-MWACHE/3888 | **Sample No. :** 3888

Mean Diameter of Sample: 62 mm | **Height of Sample:** 125 mm | **Mean Area:** 3019.1 mm^2

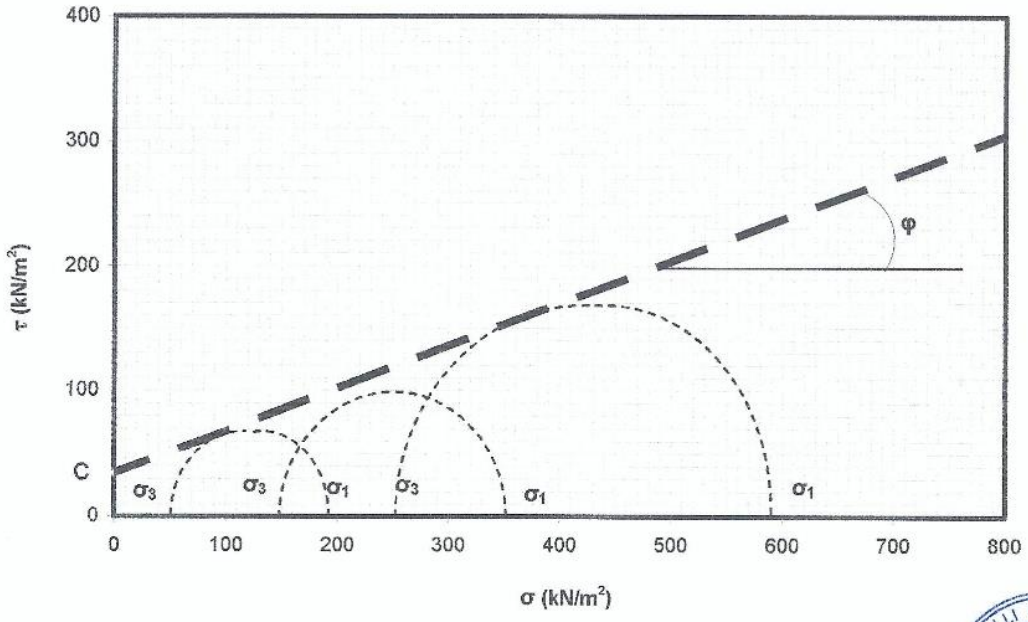
Weight of Specimen: 735.9 grams | **Volume of Specimen:** 377.38 cm^3 | **Date of Test:** 02-08-21

TEST	1	2	3
Cell Pressure (kN/m^2)	50	150	250
Principal Stress difference at failure (kN/m^2)	140	200	340

a) TOTAL STRESS ANALYSIS

TEST	1	2	3
σ_1	190	350	590
σ_3	50	150	250

c = 34 kN/m^2 φ = 19°



Tested By: KEVIN | **Date Reported:** 05-08-21 | **Checked By:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Quick Undrained Triaxial Test

BS 1377: Part 8: 1990

BH 03 (Depth: 0.0-2.0m)

Site: MWACHE W.T.P | **Location:** KWALE | **Date Received:** 23-07-21

Soil Type: DISTURBED | **Lab Ref:** TM/RGS-MWACHE/3893 | **Sample No. :** 3893

Mean Diameter of Sample: 62 mm | **Height of Sample:** 125 mm | **Mean Area:** 3019.1 mm^2

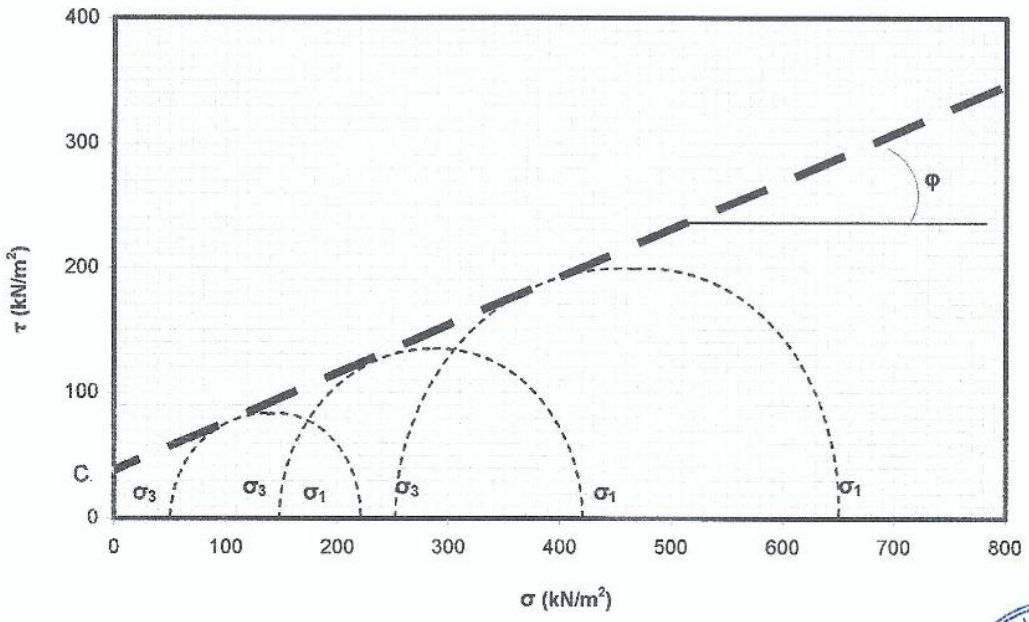
Weight of Specimen: 743.8 grams | **Volume of Specimen:** 377.38 cm^3 | **Date of Test:** 02-08-21

TEST	1	2	3
Cell Pressure (kN/m^2)	50	150	250
Principal Stress difference at failure (kN/m^2)	168	270	400

a) TOTAL STRESS ANALYSIS

TEST	1	2	3
σ_1	218	420	650
σ_3	50	150	250

c = 38 kN/m^2 φ =21°



Tested By: KEVIN | **Date Reported:** 05-08-21 | **Checked By:**

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Quick Undrained Triaxial Test
BS 1377: Part 8: 1990
BH 04 (Depth: 0.0-2.0m)

Site: MWACHE W.T.P | **Location:** KWALE | **Date Received:** 23-07-21

Soil Type: DISTURBED | **Lab Ref:** TM/RGS-MWACHE/3898 | **Sample No. :** 3898

Mean Diameter of Sample: 62 mm | **Height of Sample:** 125 mm | **Mean Area:** 3019.1 mm^2

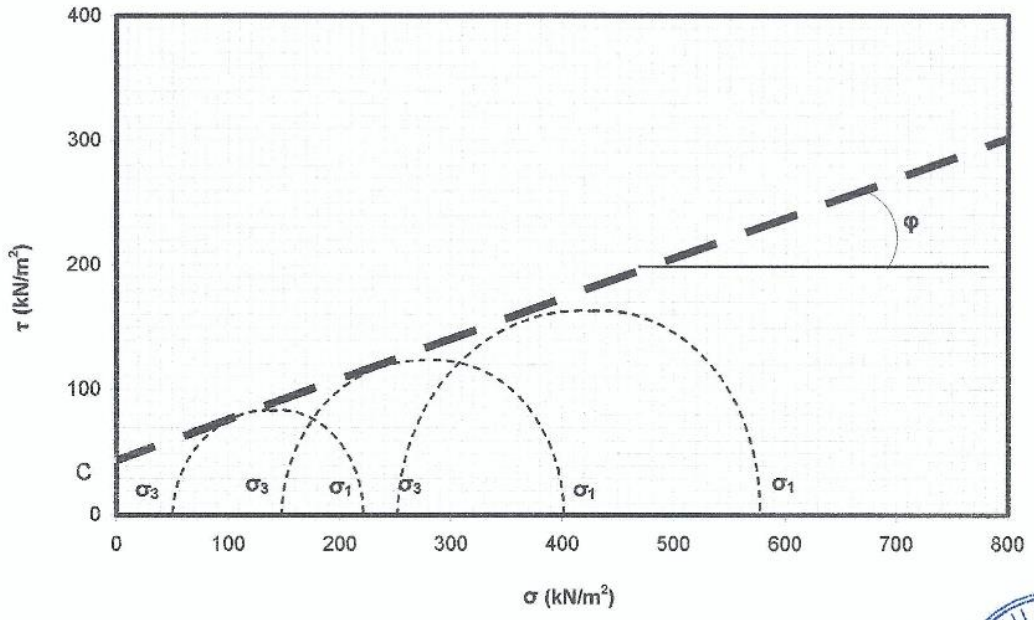
Weight of Specimen: 740.8 grams | **Volume of Specimen:** 377.38 cm^3 | **Date of Test:** 02-08-21

TEST	1	2	3
Cell Pressure (kN/m^2)	50	150	250
Principal Stress difference at failure (kN/m^2)	160	250	328

a) TOTAL STRESS ANALYSIS

TEST	1	2	3
σ_1	210	400	578
σ_3	50	150	250

c = 44 kN/m^2 φ =17°



Tested By: KEVIN | Date Reported: 05-08-21 | Checked By:

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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Quick Undrained Triaxial Test
BS 1377: Part 8: 1990
BH 05 (Depth: 0.0-1.5m)

Site: MWACHE W.T.P | **Location:** KWALE | **Date Received:** 23-07-21

Soil Type: DISTURBED | **Lab Ref:** TM/RGS-MWACHE/3904 | **Sample No. :** 3904

Mean Diameter of Sample: 62 mm | **Height of Sample:** 125 mm | **Mean Area:** 3019.1 mm^2

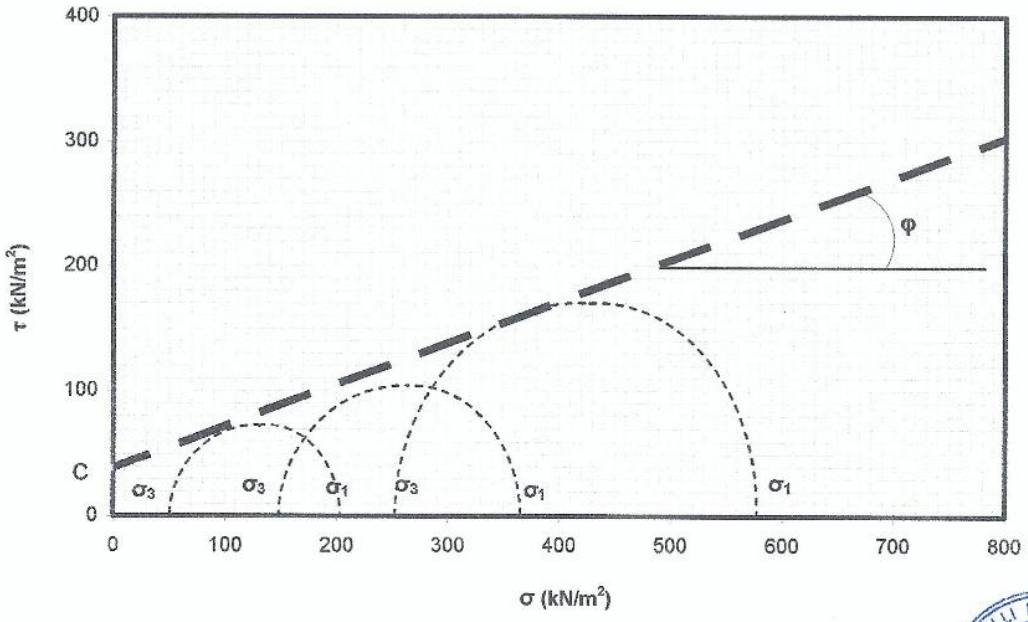
Weight of Specimen: 747.2 grams | **Volume of Specimen:** 377.38 cm^3 | **Date of Test:** 02-08-21

TEST	1	2	3
Cell Pressure (kN/m^2)	50	150	250
Principal Stress difference at failure (kN/m^2)	150	212	339

a) TOTAL STRESS ANALYSIS

TEST	1	2	3
σ_1	200	362	589
σ_3	50	150	250

c = 39 kN/m^2 φ = 18°



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REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
Quick Undrained Triaxial Test
BS 1377: Part 8: 1990
BH 06 (Depth: 0.0-2.0m)

Site: MWACHE W.T.P | **Location:** KWALE | **Date Received:** 23-07-21

Soil Type: DISTURBED | **Lab Ref:** TM/RGS-MWACHE/3910 | **Sample No. :** 3910

Mean Diameter of Sample: 62 mm | **Height of Sample:** 125 mm | **Mean Area:** 3019.1 mm^2

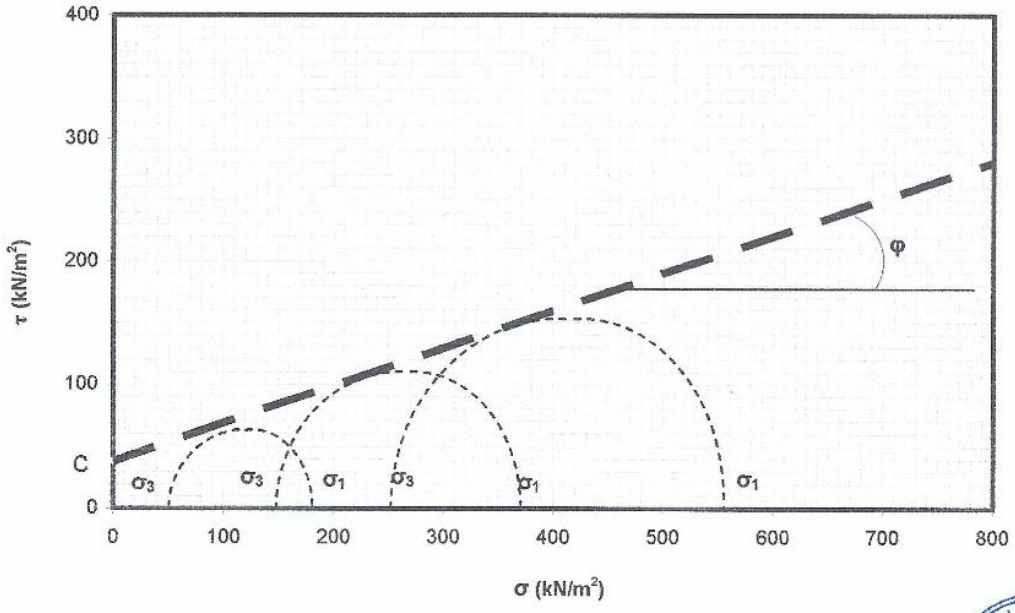
Weight of Specimen: 769.1 grams | **Volume of Specimen:** 377.38 cm^3 | **Date of Test:** 02-08-21

TEST	1	2	3
Cell Pressure (kN/m^2)	50	150	250
Principal Stress difference at failure (kN/m^2)	130	220	305

a) TOTAL STRESS ANALYSIS

TEST	1	2	3
σ_1	180	370	555
σ_3	50	150	250

c = 38 kN/m^2 φ =16°



Tested By: KEVIN | Date Reported: 05-08-21 | Checked By:

One-Dimensional Consolidation

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES.

Tested in Accordance with BS 1377: 1990: Part 5: Clause 3.

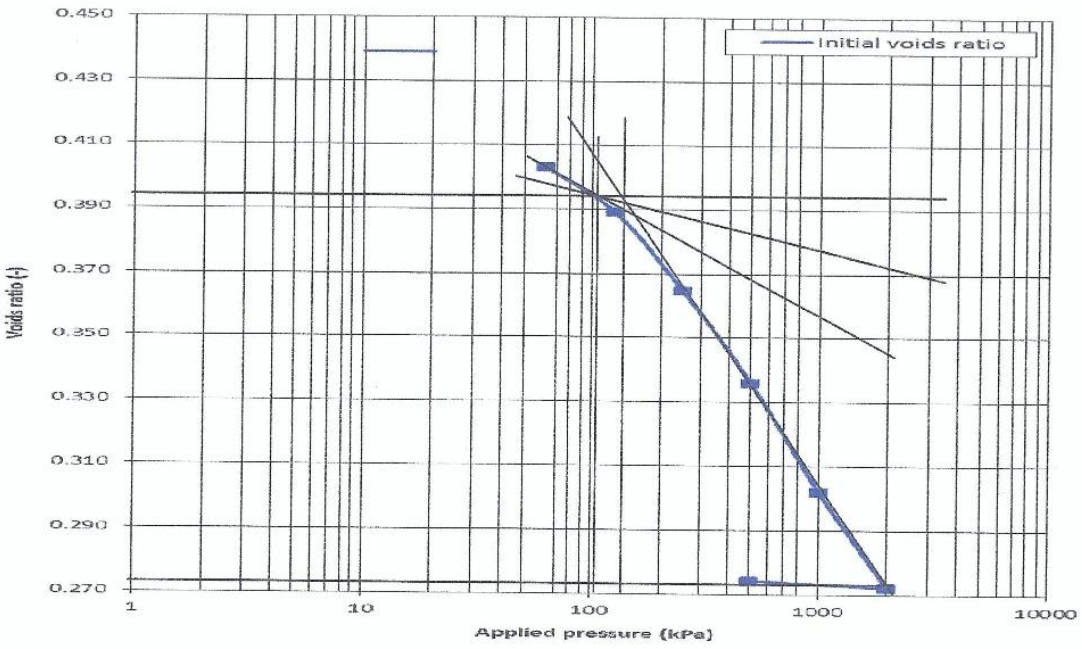
BH 01 (Depth: 0.0-2.0m)

Site: MWACHE W.T.P
Classification Group Name: -
Ring Diameter: 50.0 mm
Area (A): 1963.5mm^2
Initial voids ratio: 0.436
Pre-consolidation stress: 150 Kn/m^2
Coefficient of Re-Compression Index: 0.0266

Location: KWALE
Lab Ref: TM/CCL-KORUDAM/3860
Height of soil particles: 13.90mm
Moisture Content after Test: 12.5%
Assumed Soil Density: 2600 kg/m^3

Depth: 0.0-2.0m
Sample No. 3860
Height of Ring: 20 mm
Bulk Density: 2036kg/m^3
Dry Density: 1810kg/m^3
Coefficient of Compression Index: 0.095

Voids Ratio against Applied Pressure



Tested By: MICHAEL

Date Reported: 06-08-21

Checked By:

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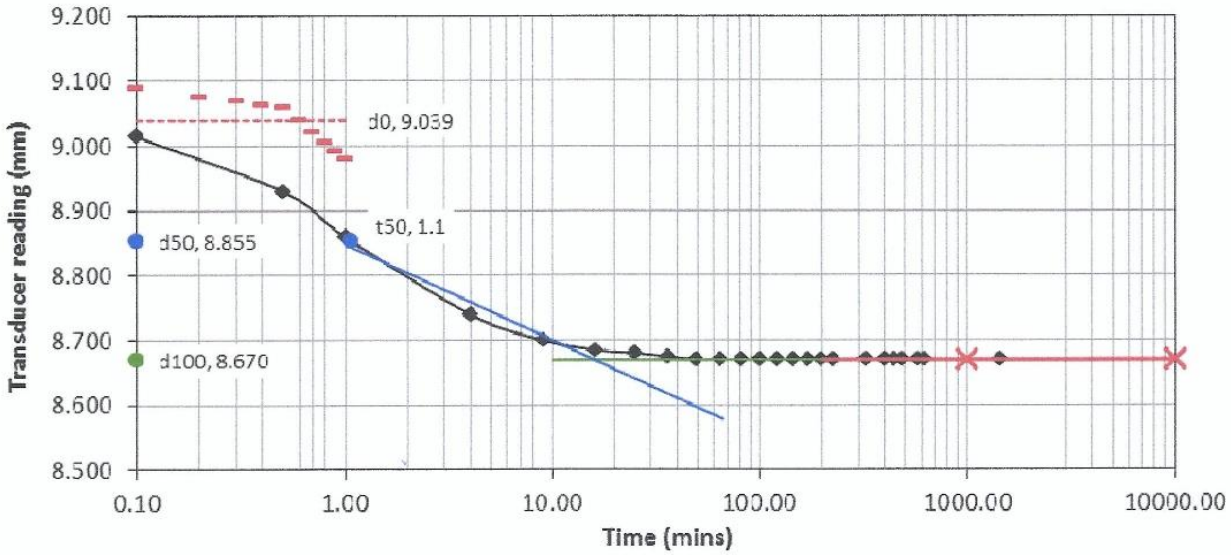
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 01 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	30-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 01 (0.0-2.0m)
LOADING STAGE: No. 1		**PRESSURE** (kpa)	62.5	**MASS** (kg)	1.25



CALCULATIONS

Change in Height = 0.530 mm
From the plot, t_{50} = =1.1 mins
H_1 = 20.00 mm
H_2 = 19.47 mm
H = (20.00+19.47)/2
= 19.74 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **9.210 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.424 m^2/MN**

Specimen information (cumulative)
Compression (mm) = 0.530
Net compression (mm) = 0.503
Height mm (H_2) = 19.47
Equivalent height of solids Hs = 13.90
Voids Ratio = (H_2 – Hs)/Hs = **0.401**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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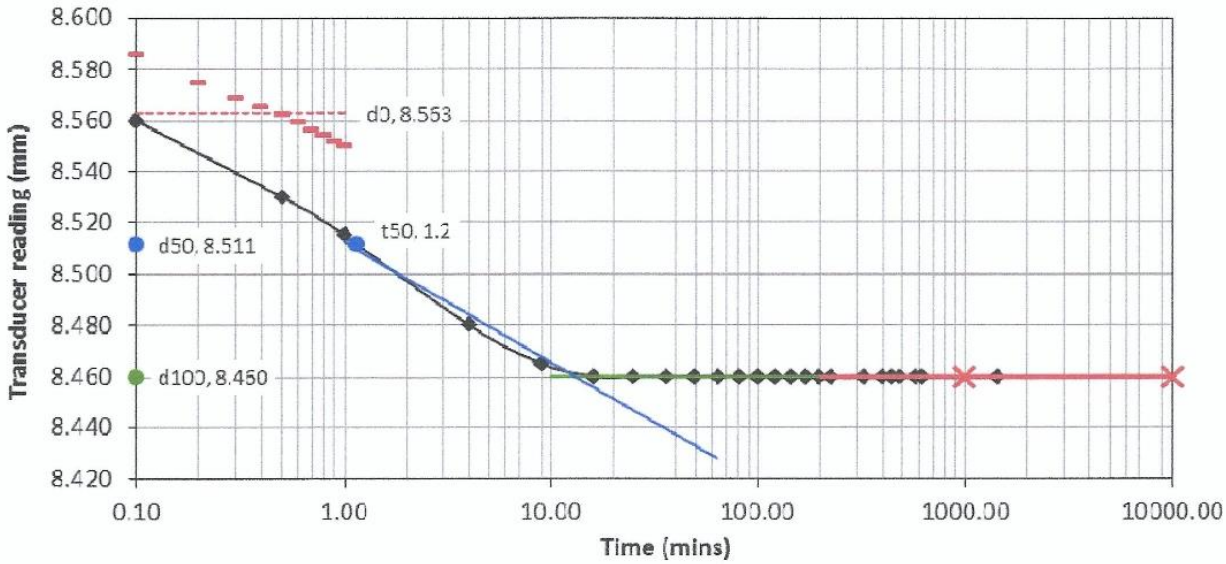
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 01 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	31-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 01 (0.0-2.0m)
LOADING STAGE: No. 2		**PRESSURE** (kpa)	125	**MASS** (kg)	2.50



CALCULATIONS

Change in Height = 0.210 mm
From the plot, t_{50} = =1.2 mins
H_1 = 19.47 mm
H_2 = 19.26 mm
H = (19.26+19.47)/2
= 19.37 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 8.129 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.173 m^2/MN

Specimen information (cumulative)
Compression (mm) = 0.740
Net compression (mm) = 0.695
Height mm (H_2) = 19.26
Equivalent height of solids Hs = 13.90
Voids Ratio = (H_2 – Hs)/Hs = 0.386

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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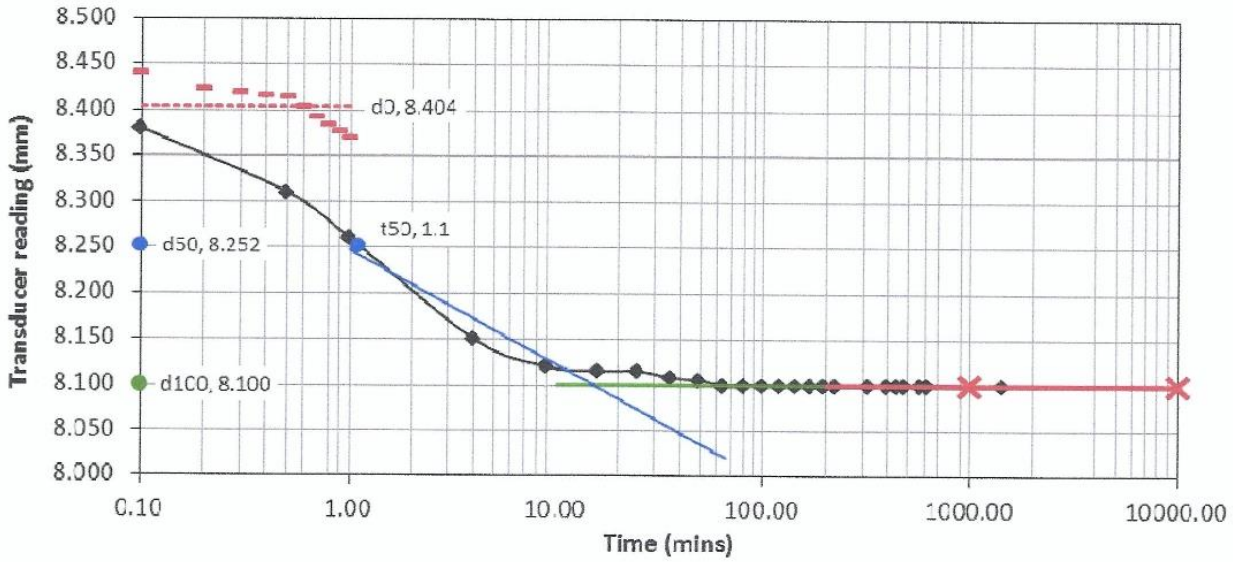
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 01 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	01-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 01 (0.0-2.0m)
LOADING STAGE: No. 3		**PRESSURE** (kpa)	250	**MASS** (kg)	5.00



CALCULATIONS

Change in Height = 0.360 mm
From the plot, t_{50} = =1.1 mins
H_1 = 19.26 mm
H_2 = 18.90 mm
H = (19.26+18.90)/2
= 19.08 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **8.605 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.150 m²/MN**

Specimen information (cumulative)
Compression (mm) = 1.100
Net compression (mm) = 1.035
Height mm (H_2) = 18.90
Equivalent height of solids Hs = 13.90
Voids Ratio = (H_2 – Hs)/Hs = **0.360**

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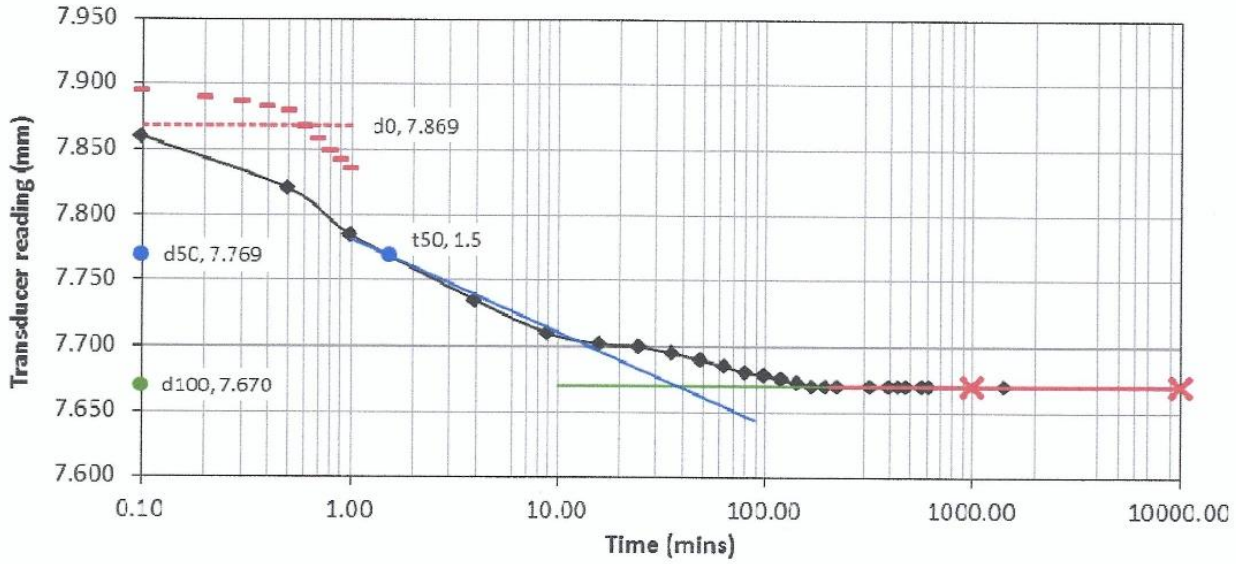
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 01 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	02-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 01 (0.0-2.0m)
LOADING STAGE: No. 4		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = 0.430 mm
From the plot, t_{50} = =1.5 mins
H_1 = 18.90 mm
H_2 = 18.47 mm
H = (18.47+18.90)/2
= 18.69 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **6.055 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, M_v = $\frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.085 m^2/MN**

Specimen information (cumulative)
Compression (mm) = 1.830
Net compression (mm) = 1.436
Height mm (H_2) = 18.47
Equivalent height of solids Hs = 13.90
Voids Ratio = (H_2 – Hs)/Hs = **0.329**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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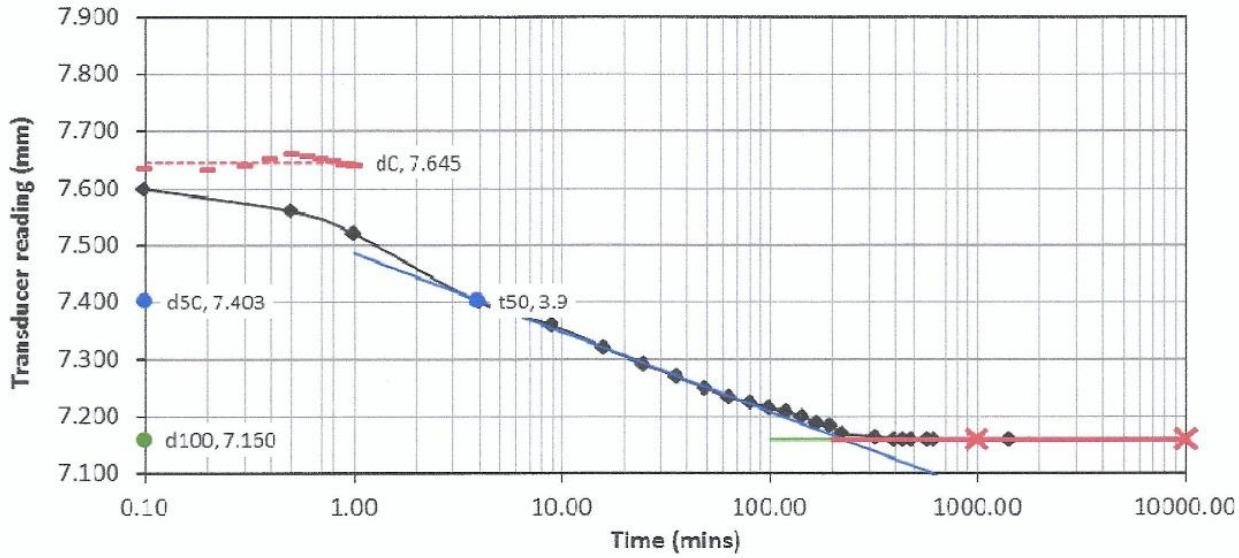
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 01 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	03-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 01 (0.0-2.0m)
LOADING STAGE:	**No. 5**	**PRESSURE** (kpa)	1000	**MASS** (kg)	20.02



CALCULATIONS

Change in Height = 0.510 mm
From the plot, t_{50} = =3.9 mins
H_1 = 18.47 mm
H_2 = 17.96 mm
H = (18.47+17.96)/2
= 18.22 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **2.213 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.055 m²/MN**

Specimen information (cumulative)
Compression (mm) = 2.040
Net compression (mm) = 1.904
Height mm (H_2) = 17.96
Equivalent height of solids Hs = 13.90
Voids Ratio = (H_2 – Hs)/Hs = **0.292**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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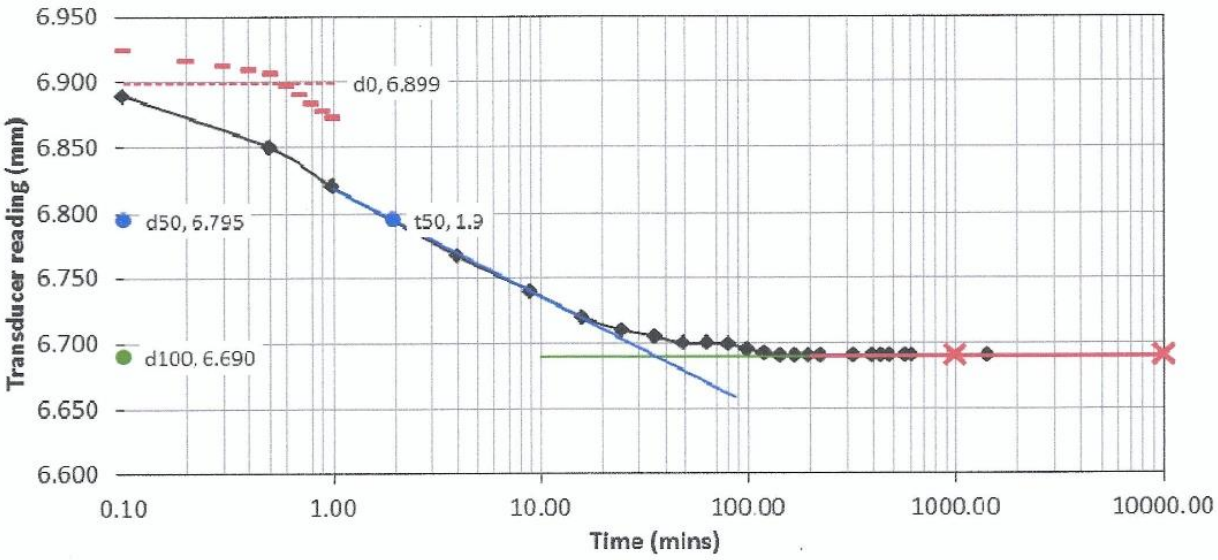
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 01 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	04-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 01 (0.0-2.0m)
LOADING STAGE: No. 6		**PRESSURE** (kpa)	2000	**MASS** (kg)	40.04



CALCULATIONS

Change in Height = 0.470 mm
From the plot, t_{50} = =1.9 mins
H_1 = 17.96 mm
H_2 = 17.49 mm
H = (17.49+17.96)/2
= 17.73 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 4.302 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.026 m^2/MN

Specimen information (cumulative)

Compression (mm)	= 2.510
Net compression (mm)	= 2.320
Height mm (H_2)	= 17.49
Equivalent height of solids Hs	= 13.90
Voids Ratio = $(H_2 - Hs)/Hs$	= 0.258

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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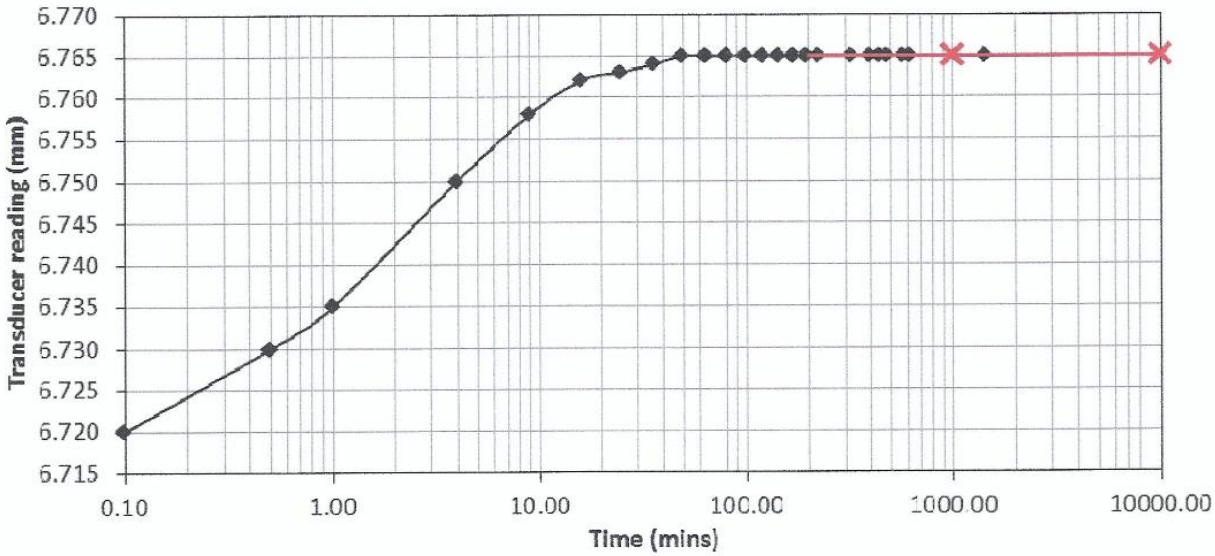
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 01 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	05-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 01 (0.0-2.0m)
UNLOADING STAGE:		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = -0.075 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}} =$ - m^2/year

Co-efficient of Secondary Compression, $C_{sec} =$ Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= - m^2/MN

Specimen information (cumulative)

Compression (mm)	= 2.435
Net compression (mm)	= 2.293
Height mm (H_2)	= 17.71
Equivalent height of solids Hs	= 13.90
Voids Ratio = (H_2 – Hs)/Hs	= 0.274

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

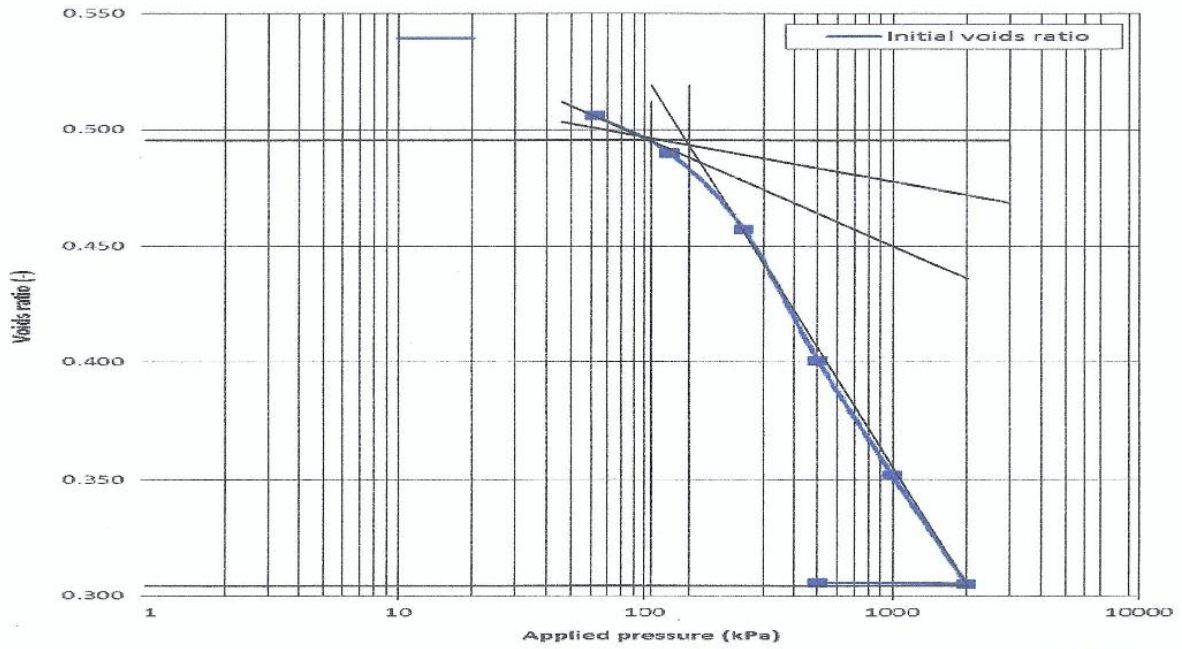
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES.

Tested in Accordance with BS 1377: 1990: Part 5: Clause 3.

BH 02 (Depth: 0.0-1.85m)

Site: MWACHE W.T.P
Location: KWALE
Depth: 0.0-1.85m
Classification Group Name: -
Lab Ref: TM/CCL-KORUDAM/3888
Sample No. 3888
Ring Diameter: 50.0 mm
Height of soil particles: 12.99mm
Height of Ring: 20 mm
Area (A): 1963.5mm^2
Moisture Content after Test: 15.0%
Bulk Density: 1950kg/m^3
Initial voids ratio: 0.533
Assumed Soil Density: 2600 kg/m^3
Dry Density: 1696kg/m^3
Pre-consolidation stress: 160 Kn/m^2
Coefficient of Compression Index: 0.142
Coefficient of Re-Compression Index: 0.0216

Voids Ratio against Applied Pressure



Tested By: MICHAEL
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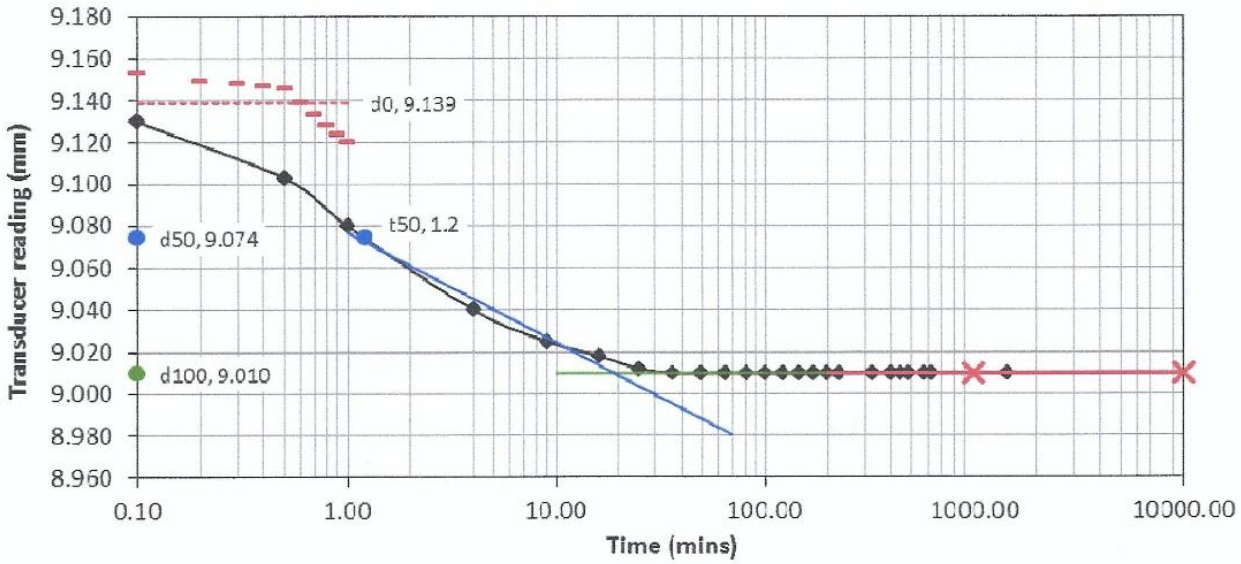
BH 02 (0.0-1.85m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	30-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 02 (0.0-1.85m)
LOADING STAGE: No. 1		**PRESSURE** (kpa)	62.5	**MASS** (kg)	1.25



CALCULATIONS

Change in Height = 0.460 mm
From the plot, t_{50} = =1.2 mins
H_1 = 20.00 mm
H_2 = 19.54 mm
H = (20.00+19.54)/2
= 19.77 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 8.468 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.368 m^2/MN

Specimen information (cumulative)

Compression (mm)	= 0.460
Net compression (mm)	= 0.433
Height mm (H_2)	= 19.54
Equivalent height of solids Hs	= 12.99
Voids Ratio = (H_2 – Hs)/Hs	= 0.504

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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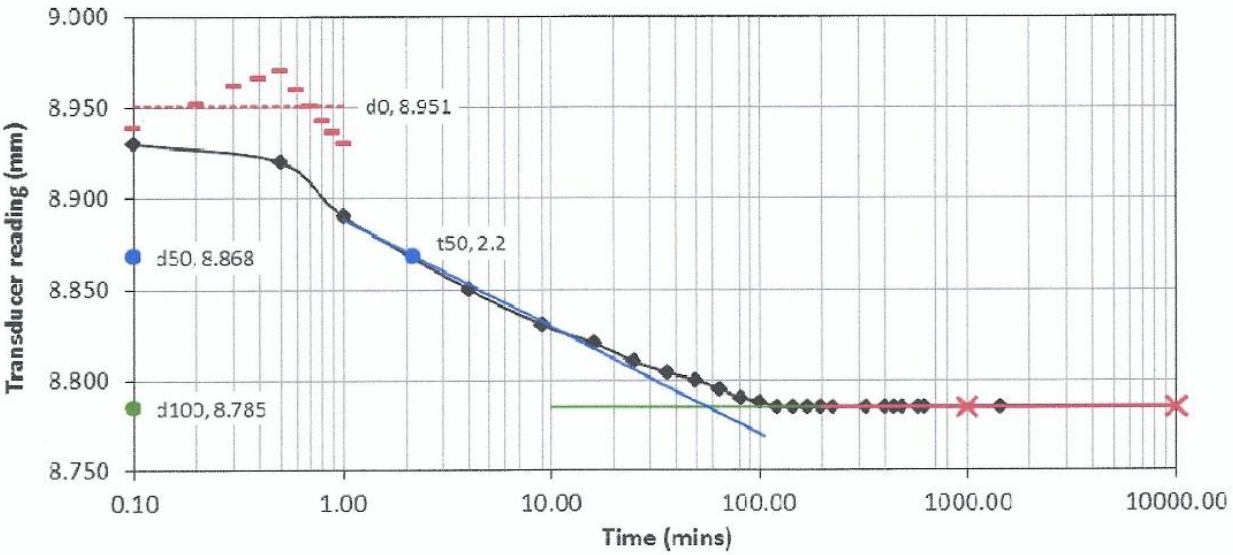
BH 02 (0.0-1.85m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	31-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 02 (0.0-1.85m)
LOADING STAGE: No. 2		**PRESSURE** (kpa)	125	**MASS** (kg)	2.50



CALCULATIONS

Change in Height = 0.225 mm
From the plot, t_{50} = =2.2 mins
H_1 = 19.54 mm
H_2 = 19.32 mm
H = (19.32+19.54)/2
= 19.43 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **4.462 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.184 m²/MN**

Specimen information (cumulative)

Compression (mm)	= 0.685
Net compression (mm)	= 0.640
Height mm (H_2)	= 19.32
Equivalent height of solids Hs	= 12.99
Voids Ratio = (H_2 – Hs)/Hs	= **0.487**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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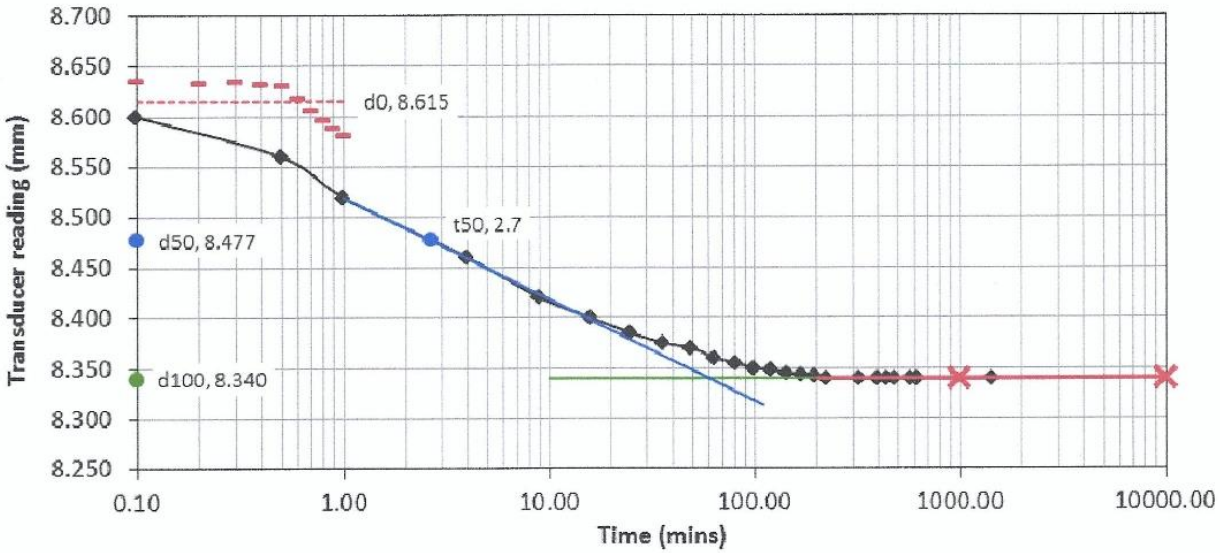
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 02 (0.0-1.85m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	01-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 02 (0.0-1.85m)
LOADING STAGE: No. 3		**PRESSURE** (kpa)	250	**MASS** (kg)	5.00



CALCULATIONS

Change in Height = 0.445 mm
From the plot, t_{50} = =2.7 mins
H_1 = 19.32 mm
H_2 = 18.88 mm
H = (19.32+18.88)/2
= 19.10 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **3.513 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.184 m²/MN**

Specimen information (cumulative)

Compression (mm)	= 1.130
Net compression (mm)	= 1.065
Height mm (H_2)	= 18.88
Equivalent height of solids Hs	= 12.99
Voids Ratio = (H_2 – Hs)/Hs	= **0.453**

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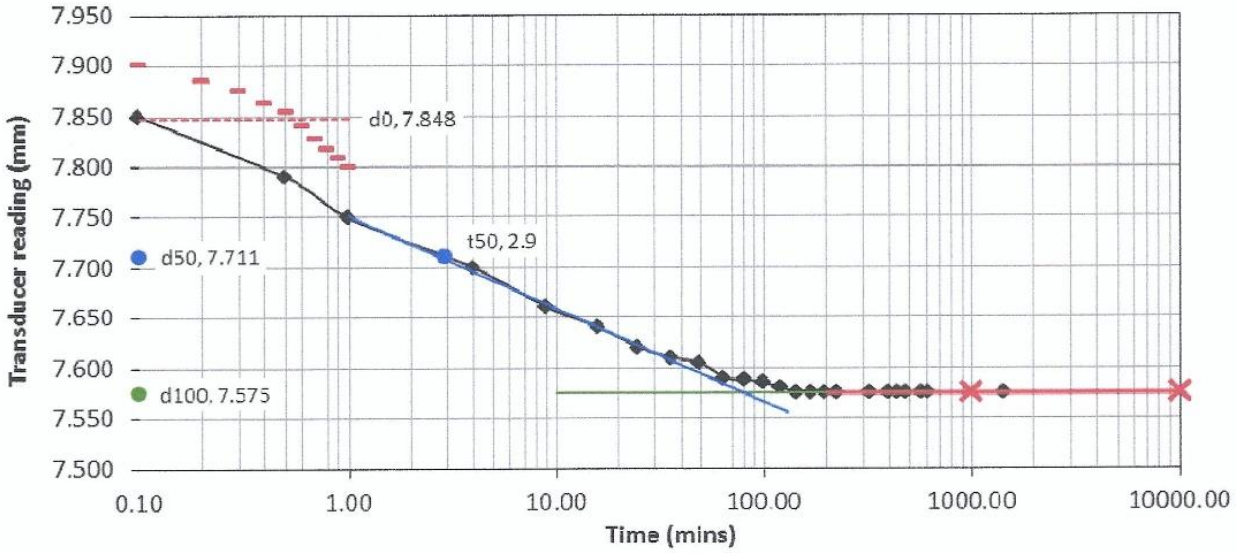
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 02 (0.0-1.85m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	02-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 02 (0.0-1.85m)
LOADING STAGE: No. 4		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = 0.765 mm
From the plot, t_{50} = =2.9 mins
H_1 = 18.88 mm
H_2 = 18.12 mm
H = (18.12+18.88)/2
= 18.50 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **3.068 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.162 m²/MN**

Specimen information (cumulative)

Compression (mm)	= 1.895
Net compression (mm)	= 1.801
Height mm (H_2)	= 18.12
Equivalent height of solids Hs	= 12.99
Voids Ratio = (H_2 – Hs)/Hs	= **0.395**

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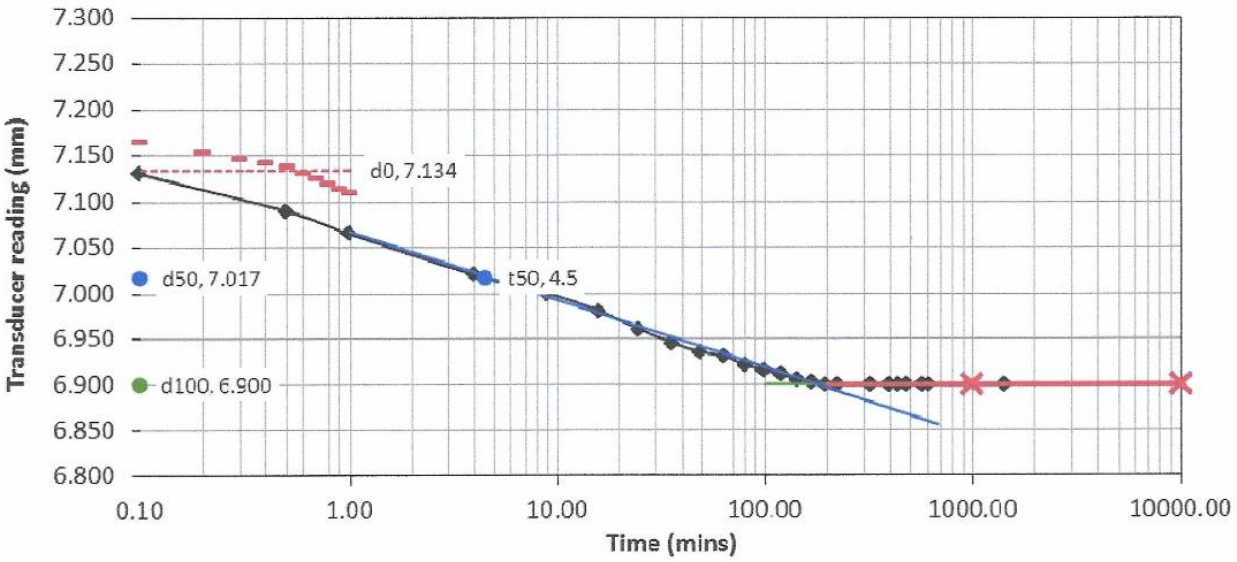
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 02 (0.0-1.85m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	03-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 02 (0.0-1.85m)
LOADING STAGE: No. 5		**PRESSURE** (kpa)	1000	**MASS** (kg)	20.02



CALCULATIONS

Change in Height = 0.675 mm
From the plot, t_{50} = =4.5 mins
H_1 = 18.12 mm
H_2 = 17.45 mm
H = (18.12+17.45)/2
= 17.79 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 1.829 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.075 m^2/MN

Specimen information (cumulative)

Compression (mm)	= 2.570
Net compression (mm)	= 2.434
Height mm (H_2)	= 17.45
Equivalent height of solids Hs	= 12.99
Voids Ratio = (H_2 – Hs)/Hs	= 0.343

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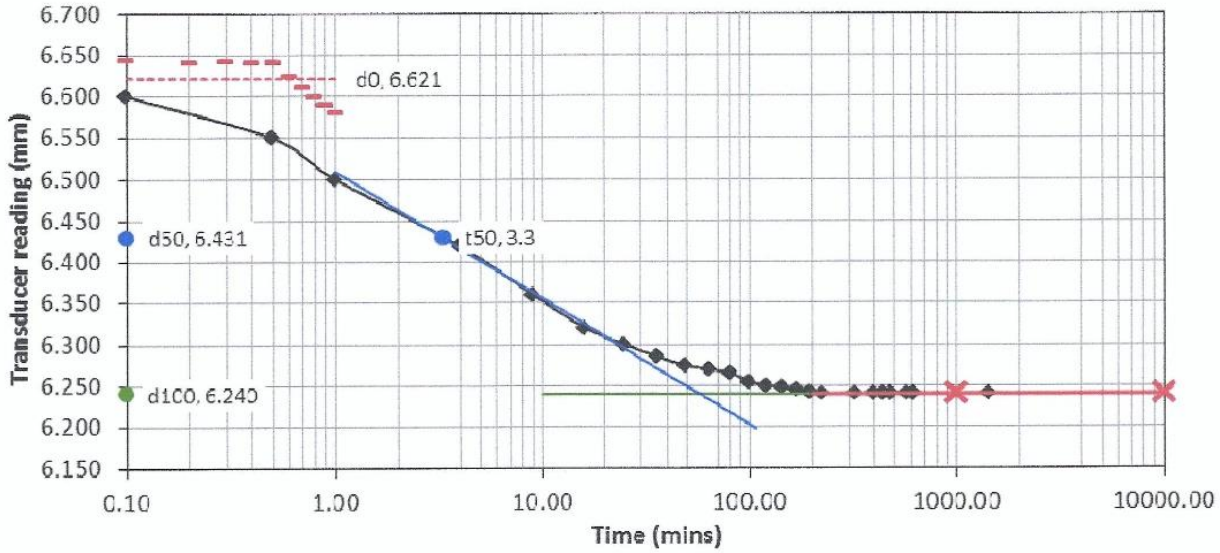
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 02 (0.0-1.85m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	04-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 02 (0.0-1.85m)
LOADING STAGE: No. 6		**PRESSURE** (kpa)	2000	**MASS** (kg)	40.04



CALCULATIONS

Change in Height = 0.660 mm
From the plot, t_{50} = = 3.3 mins
H_1 = 17.45 mm
H_2 = 16.79 mm
H = (16.79+17.45)/2
= 17.12 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 2.309 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.038 m^2/MN

Specimen information (cumulative)

Compression (mm)	= 3.230
Net compression (mm)	= 3.040
Height mm (H_2)	= 16.79
Equivalent height of solids Hs	= 12.99
Voids Ratio = (H_2 – Hs)/Hs	= 0.293

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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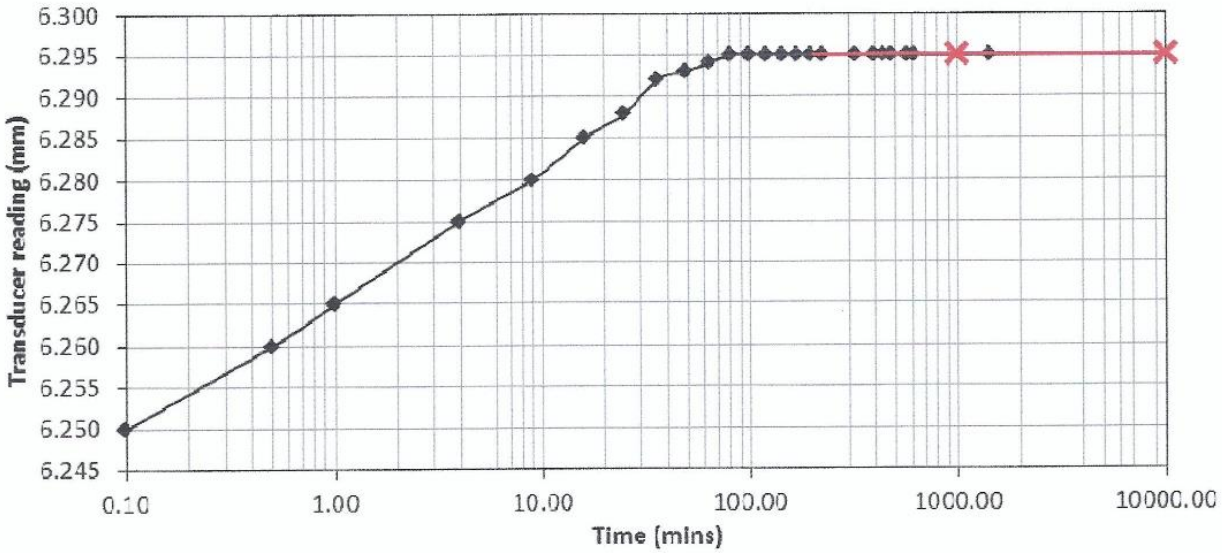
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 02 (0.0-1.85m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	05-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 02 (0.0-1.85m)
UNLOADING STAGE:		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = -0.055 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = - m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, M_v = $\frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= - m^2/MN

Specimen information (cumulative)

Compression (mm)	= 3.175
Net compression (mm)	= 3.033
Height mm (H_2)	= 16.97
Equivalent height of solids Hs	= 12.99
Voids Ratio = (H_2 – Hs)/Hs	= 0.306

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

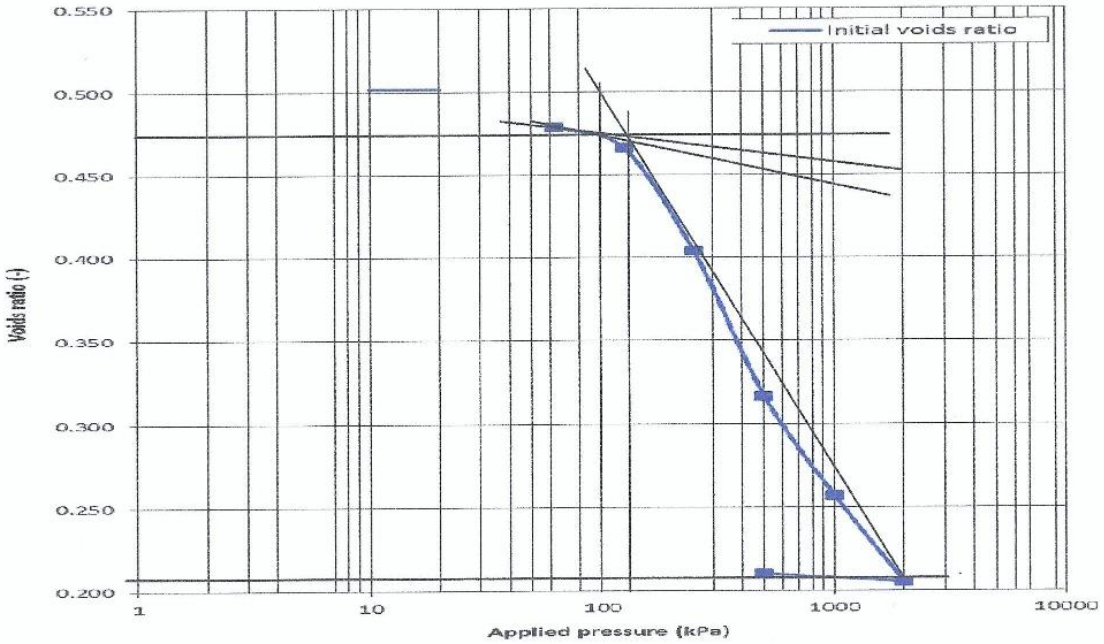
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES.

Tested in Accordance with BS 1377: 1990: Part 5: Clause 3.

BH 03 (Depth: 0.0-2.0m)

Site: MWACHE W.T.P
Location: KWALE
Depth: 0.0-2.00m
Classification Group Name: -
Lab Ref: TM/CCL-KORUDAM/3893
Sample No. 3893
Ring Diameter: 50.0 mm
Height of soil particles: 13.32mm
Height of Ring: 20 mm
Area (A): 1963.5mm^2
Moisture Content after Test: 13.8%
Bulk Density: 1971kg/m^3
Initial voids ratio: 0.501
Assumed Soil Density: 2600 kg/m^3
Dry Density: 1732kg/m^3
Pre-consolidation stress: 150 Kn/m^2
Coefficient of Compression Index: 0.210
Coefficient of Re-Compression Index: 0.0299

Voids Ratio against Applied Pressure



Tested By: MICHAEL
Date Reported: 06-08-21
Checked By:

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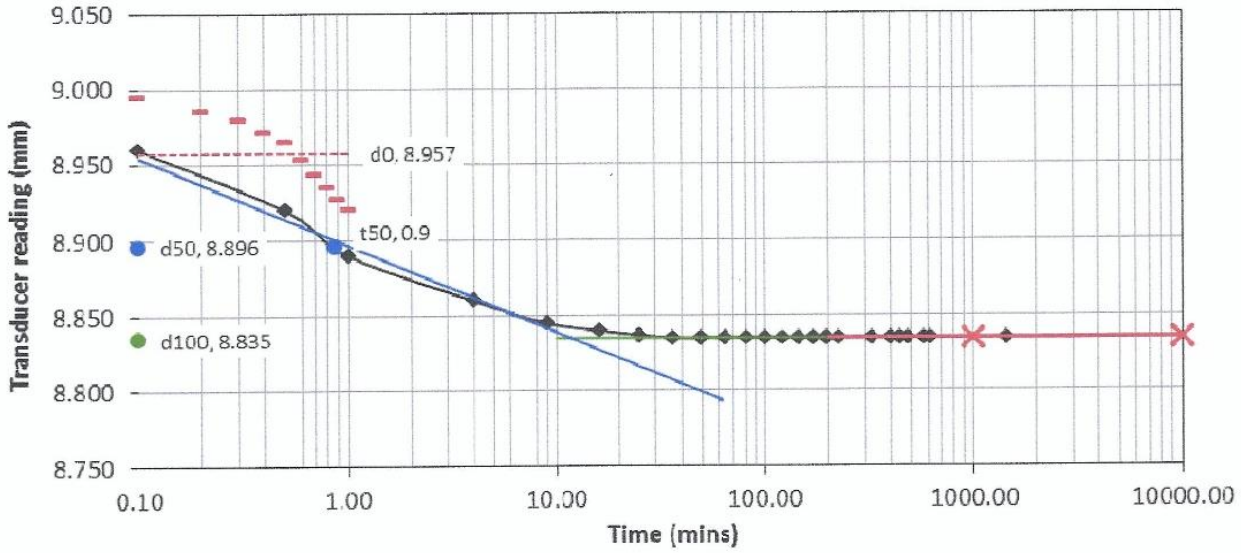
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 03 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	30-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 03 (0.0-2.0m)
LOADING STAGE: No. 1		**PRESSURE** (kpa)	62.5	**MASS** (kg)	1.25



CALCULATIONS

Change in Height = 0.335 mm
From the plot, t_{50} = =0.9 mins
H_1 = 20.00 mm
H_2 = 19.67 mm
H = (20.00+19.67)/2
= 19.84 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **11.371 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.268 m^2/MN**

Specimen information (cumulative)

Compression (mm)	= 0.335
Net compression (mm)	= 0.308
Height mm (H_2)	= 19.67
Equivalent height of solids Hs	= 13.32
Voids Ratio = (H_2 – Hs)/Hs	= **0.477**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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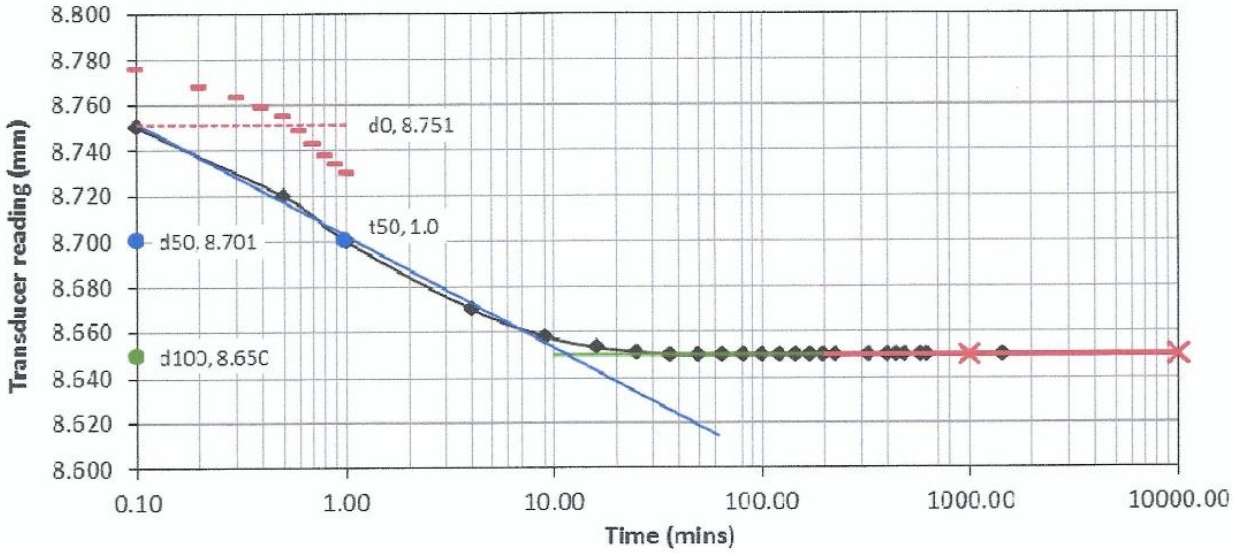
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 03 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	31-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 03 (0.0-2.0m)
LOADING STAGE:	**No. 2**	**PRESSURE** (kpa)	125	**MASS** (kg)	2.50



CALCULATIONS

Change in Height = 0.185 mm
From the plot, t_{50} = =1.0 mins
H_1 = 19.67 mm
H_2 = 19.49 mm
H = (19.49+19.67)/2
= 19.58 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **9.968 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.150 m^2/MN**

Specimen information (cumulative)

Compression (mm)	= 0.520
Net compression (mm)	= 0.475
Height mm (H_2)	= 19.49
Equivalent height of solids Hs	= 13.32
Voids Ratio = (H_2 – Hs)/Hs	= **0.463**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

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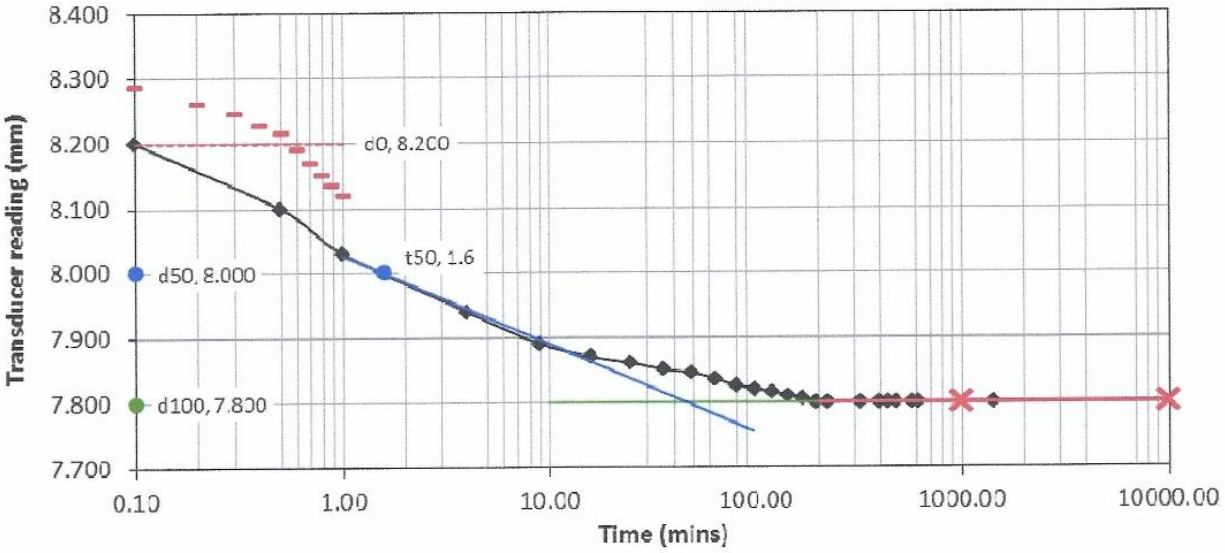
BH 03 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	01-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 03 (0.0-2.0m)
LOADING STAGE:	**No. 3**	**PRESSURE** (kpa)	250	**MASS** (kg)	5.00



CALCULATIONS

Change in Height = 0.850 mm
From the plot, t_{50} = =1.6 mins
H_1 = 19.49 mm
H_2 = 18.64 mm
H = (19.49+18.64)/2
= 19.07 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **5.972 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.349 m²/MN**

Specimen information (cumulative)
Compression (mm) = 1.370
Net compression (mm) = 1.305
Height mm (H_2) = 18.64
Equivalent height of solids Hs = 13.32
Voids Ratio = (H_2 – Hs)/Hs = **0.399**

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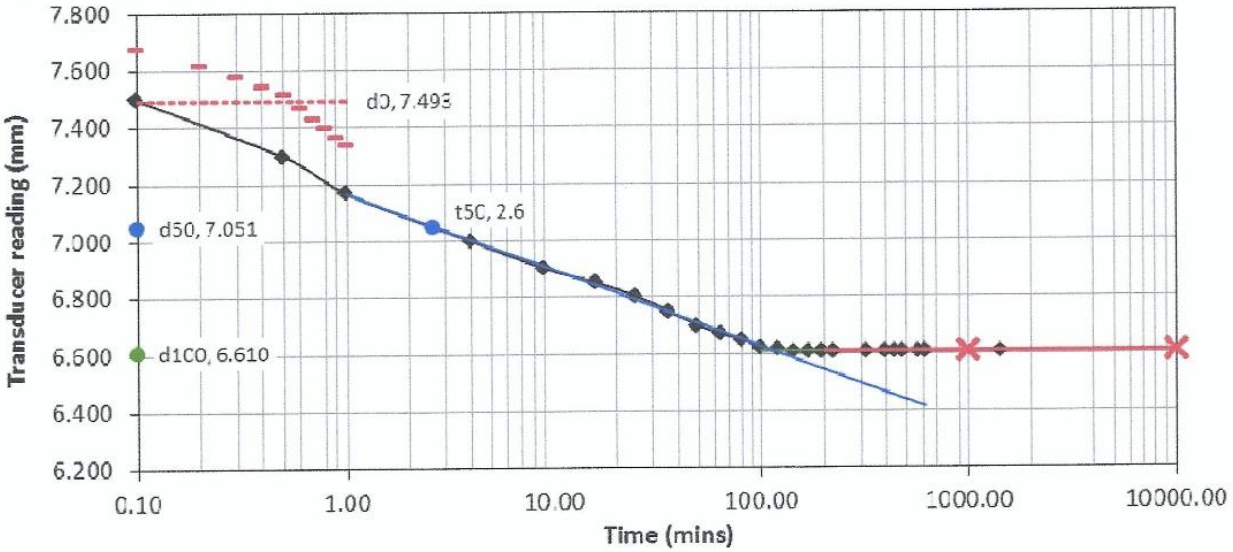
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 03 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	02-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 03 (0.0-2.0m)
LOADING STAGE: No. 4		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = 1.190 mm
From the plot, t_{50} = =2.6 mins
H_1 = 18.64 mm
H_2 = 17.45 mm
H = (17.45+18.64)/2
= 18.05 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **3.258 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, M_v = $\frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.255 m²/MN**

Specimen information (cumulative)

Compression (mm)	= 2.560
Net compression (mm)	= 2.466
Height mm (H_2)	= 17.45
Equivalent height of solids Hs	= 13.32
Voids Ratio = (H_2 – Hs)/Hs	= **0.310**

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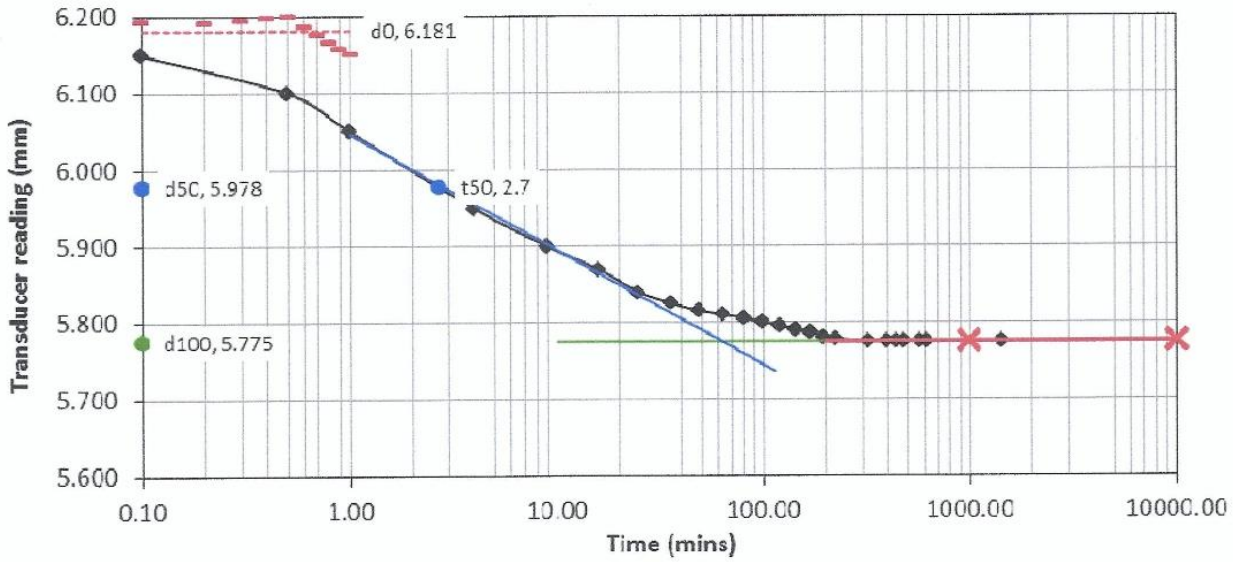
BH 03 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	03-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 03 (0.0-2.0m)
LOADING STAGE:	**No. 5**	**PRESSURE** (kpa)	1000	**MASS** (kg)	20.02



CALCULATIONS

Change in Height = 0.835 mm
From the plot, t_{50} = ≈2.7 mins
H_1 = 17.45 mm
H_2 = 16.62 mm
H = (17.45+16.62)/2
= 17.04 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **2.796 m²/year**

Co-efficient of Secondary Compression, C_{sec} = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.096 m²/MN**

Specimen information (cumulative)
Compression (mm) = 3.395
Net compression (mm) = 3.259
Height mm (H_2) = 16.62
Equivalent height of solids Hs = 13.32
Voids Ratio = (H_2 – Hs)/Hs = **0.248**

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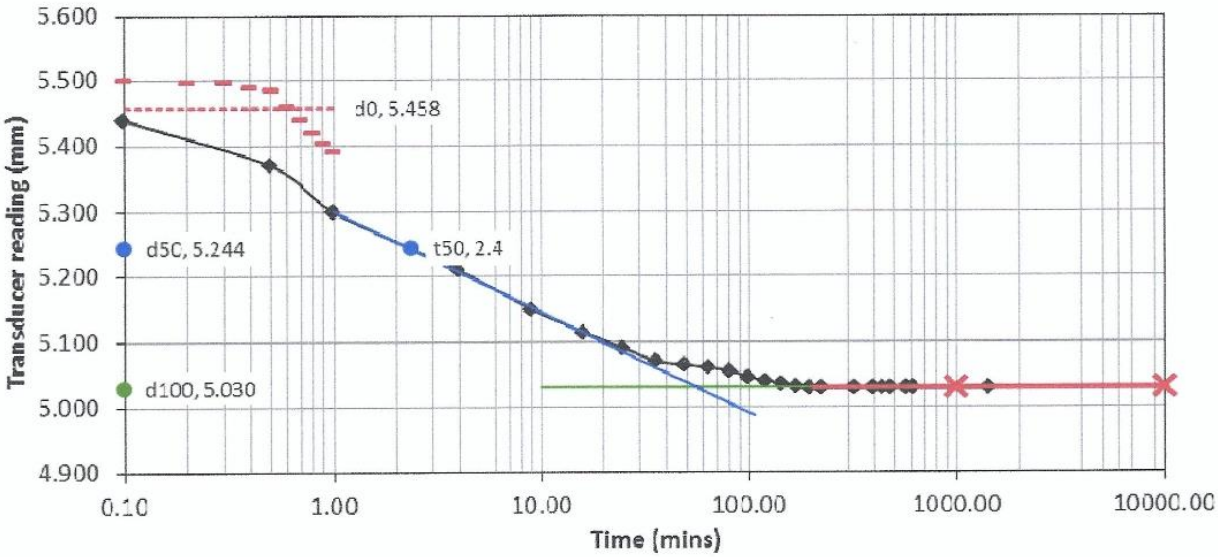
BH 03 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	04-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 03 (0.0-2.0m)
LOADING STAGE:	**No. 6**	**PRESSURE** (kpa)	2000	**MASS** (kg)	40.04



CALCULATIONS

Change in Height = 0.745 mm
From the plot, t_{50} = =2.4 mins
H_1 = 16.62 mm
H_2 = 15.88 mm
H = (15.88+16.62)/2
= 16.25 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **2.861 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.045 m^2/MN**

Specimen information (cumulative)

Compression (mm)	= 4.140
Net compression (mm)	= 3.950
Height mm (H_2)	= 15.88
Equivalent height of solids Hs	= 13.32
Voids Ratio = $(H_2 - Hs)/Hs$	= **0.192**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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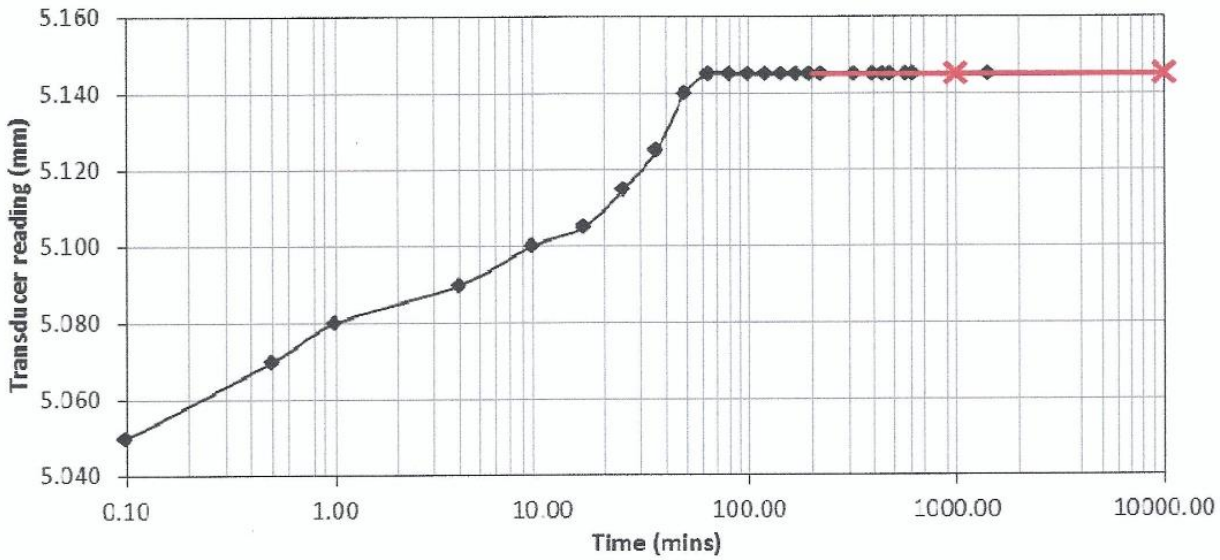
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 03 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3884	**Date:**	05-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 03 (0.0-2.0m)
UNLOADING STAGE:		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = -0.115 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = - m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, M_v $= \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= -m^2/MN

Specimen information (cumulative)

Compression (mm)	= 4.025
Net compression (mm)	= 3.883
Height mm (H_2)	= 16.12
Equivalent height of solids Hs	= 13.32
Voids Ratio = (H_2 – Hs)/Hs	= 0.210

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES.

Tested in Accordance with BS 1377: 1990: Part 5: Clause 3.

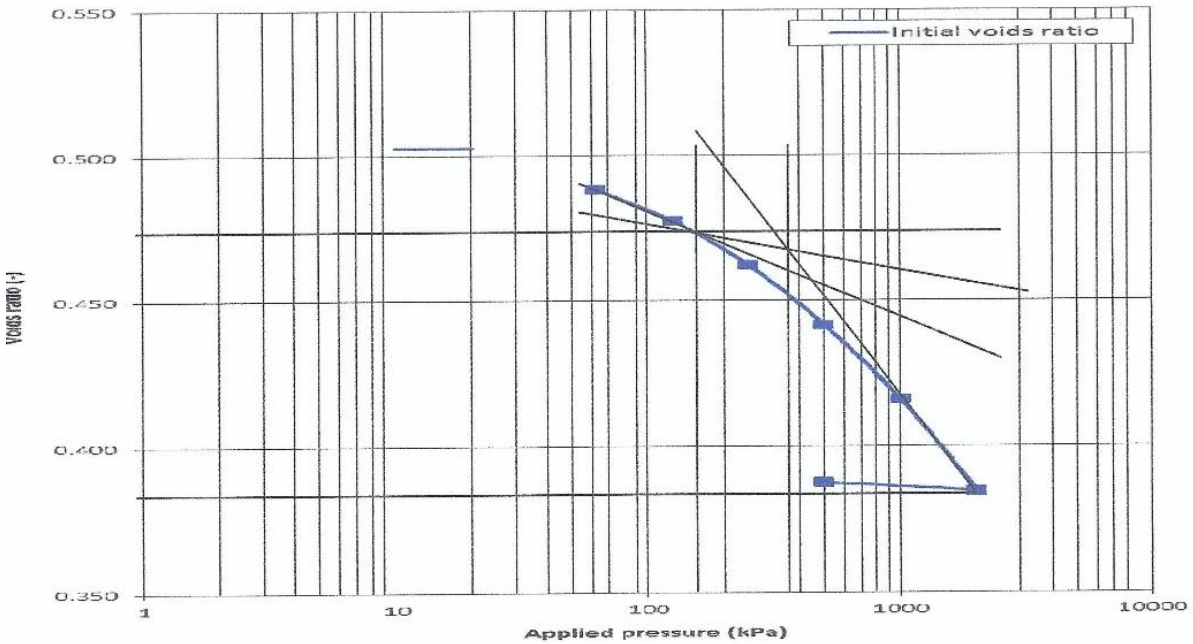
BH 04 (Depth: 0.0-2.0m)

Site: MWACHE W.T.P
Classification Group Name: -
Ring Diameter: 50.0 mm
Area (A): 1963.5mm^2
Initial voids ratio: 0.498
Pre-consolidation stress: 370 Kn/m^2
Coefficient of Re-Compression Index: 0.0299

Location: KWALE
Lab Ref: TM/CCL-KORUDAM/3898
Height of soil particles: 13.31mm
Moisture Content after Test: 13.8%
Assumed Soil Density: 2600 kg/m^3

Depth: 0.0-2.00m
Sample No. 3898
Height of Ring: 20 mm
Bulk Density: 1963kg/m^3
Dry Density: 1736kg/m^3
Coefficient of Compression Index: 0.128

Voids Ratio against Applied Pressure



Tested By: MICHAEL

Date Reported: 06-08-21

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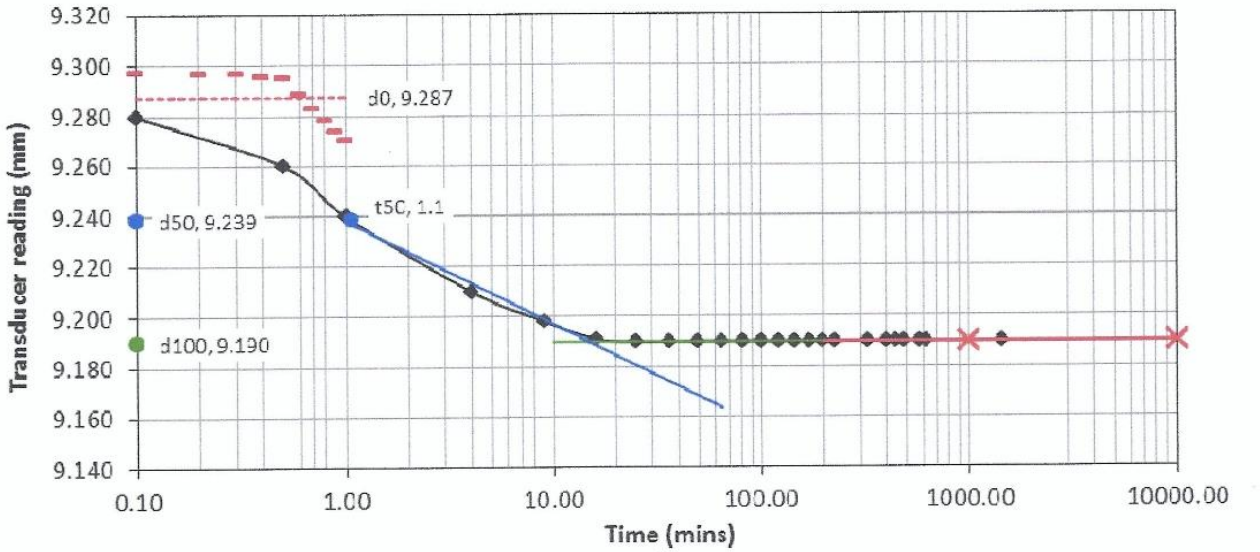
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 04 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3898	**Date:**	30-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 04 (0.0-2.0m)
LOADING STAGE: No. 1		**PRESSURE** (kpa)	62.5	**MASS** (kg)	1.25



CALCULATIONS

Change in Height = 0.220 mm
From the plot, t_{50} = =1.1 mins
H_1 = 20.00 mm
H_2 = 19.78 mm
H = (20.00+19.78)/2
= 19.89 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **9.351 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.176 m²/MN**

Specimen information (cumulative)
Compression (mm) = 0.220
Net compression (mm) = 0.193
Height mm (H_2) = 19.78
Equivalent height of solids Hs = 13.31
Voids Ratio = (H_2 – Hs)/Hs = **0.486**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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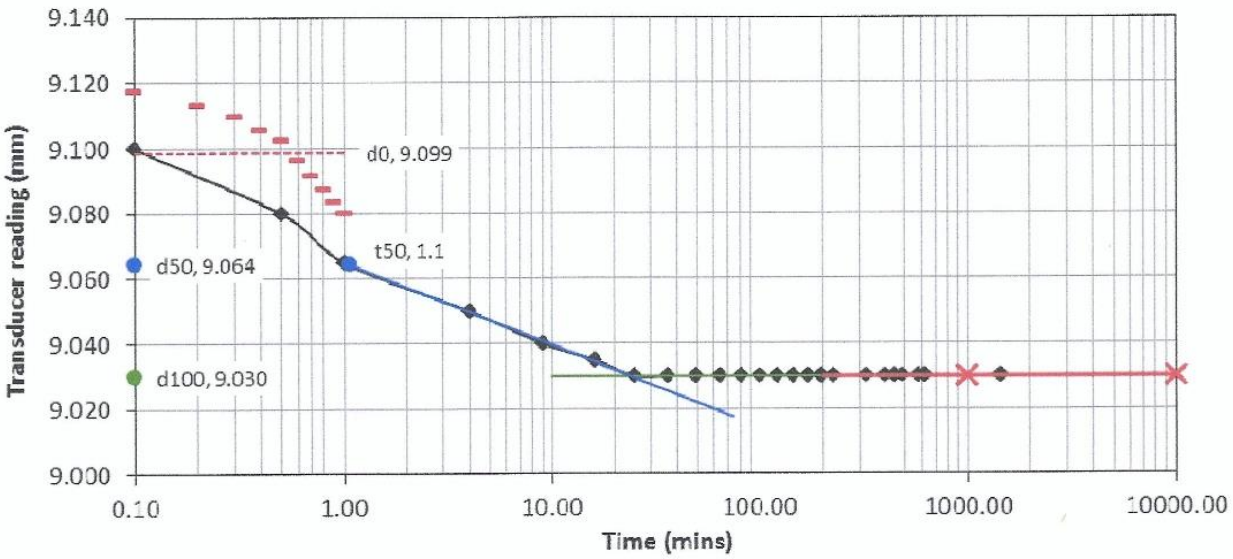
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 04 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3898	**Date:**	31-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 04 (0.0-2.0m)
LOADING STAGE: No. 2		**PRESSURE** (kpa)	125	**MASS** (kg)	2.50



CALCULATIONS

Change in Height = 0.160 mm
From the plot, t_{50} = =1.1 mins
H_1 = 19.78 mm
H_2 = 19.62 mm
H = (19.62+19.78)/2
= 19.70 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **9.173 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.129 m^2/MN**

Specimen information (cumulative)

Compression (mm)	= 0.380
Net compression (mm)	= 0.335
Height mm (H_2)	= 19.62
Equivalent height of solids Hs	= 13.31
Voids Ratio = (H_2 – Hs)/Hs	= **0.474**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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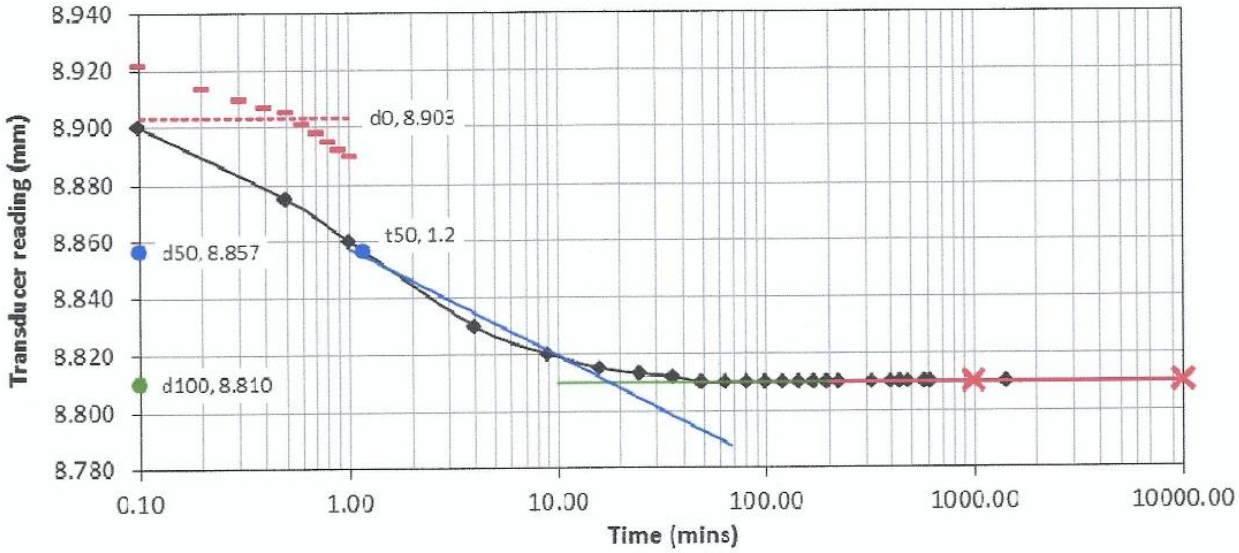
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 04 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3898	**Date:**	01-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 04 (0.0-2.0m)
LOADING STAGE: No. 3		**PRESSURE** (kpa)	250	**MASS** (kg)	5.00



CALCULATIONS

Change in Height = 0.220 mm
From the plot, t_{50} = =1.2 mins
H_1 = 19.62 mm
H_2 = 19.40 mm
H = (19.62+19.40)/2
= 19.51 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 8.247 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.090 m^2/MN

Specimen information (cumulative)
Compression (mm) = 0.600
Net compression (mm) = 0.535
Height mm (H_2) = 19.40
Equivalent height of solids Hs = 13.31
Voids Ratio = (H_2 – Hs)/Hs = 0.458

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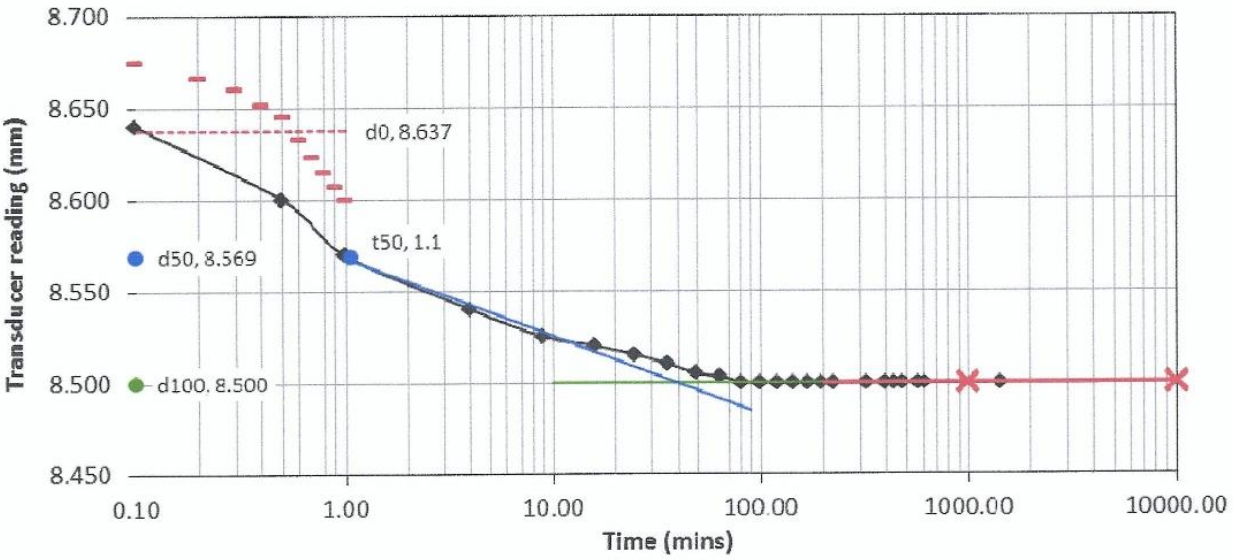
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 04 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3898	**Date:**	02-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 04 (0.0-2.0m)
LOADING STAGE: No. 4		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = 0.310 mm
From the plot, t_{50} = =1.1 mins
H_1 = 19.40 mm
H_2 = 19.09 mm
H = (19.40+19.09)/2
= 19.25 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **8.759 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.064 m^2/MN**

Specimen information (cumulative)

Compression (mm)	= 0.910
Net compression (mm)	= 0.816
Height mm (H_2)	= 19.09
Equivalent height of solids Hs	= 13.31
Voids Ratio = (H_2 – Hs)/Hs	= **0.434**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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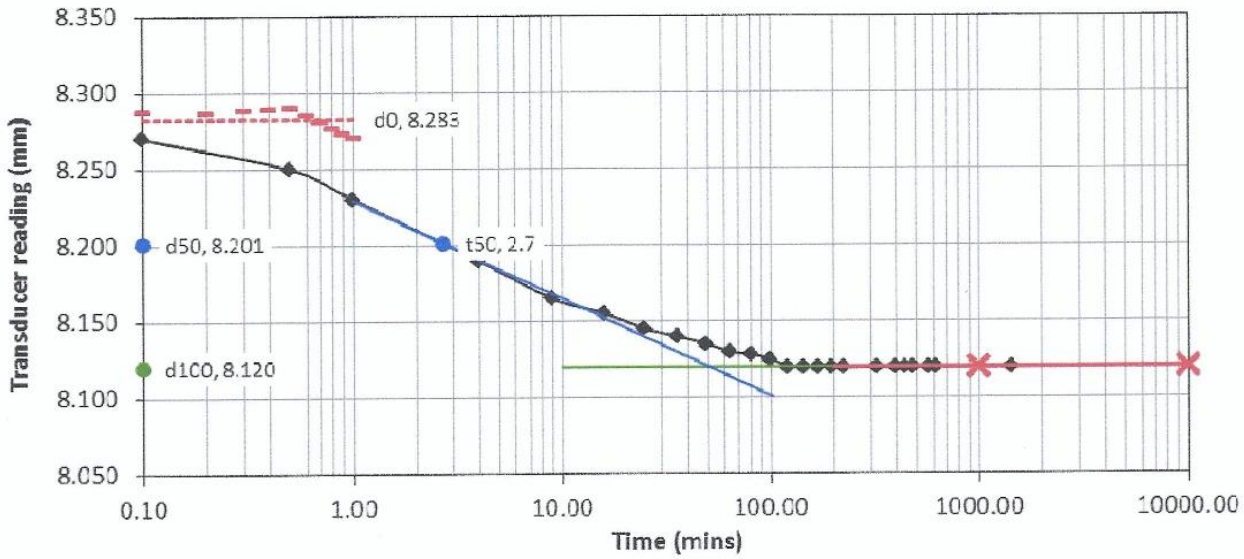
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 04 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3898	**Date:**	03-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 04 (0.0-2.0m)
LOADING STAGE: No. 5		**PRESSURE** (kpa)	1000	**MASS** (kg)	20.02



CALCULATIONS

Change in Height = 0.380 mm
From the plot, t_{50} = =2.7 mins
H_1 = 19.09 mm
H_2 = 18.71 mm
H = (18.71+19.09)/2
= 18.90 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 3.440 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.040 m^2/MN

Specimen information (cumulative)
Compression (mm) = 1.290
Net compression (mm) = 1.154
Height mm (H_2) = 18.71
Equivalent height of solids Hs = 13.31
Voids Ratio = (H_2 – Hs)/Hs = 0.406

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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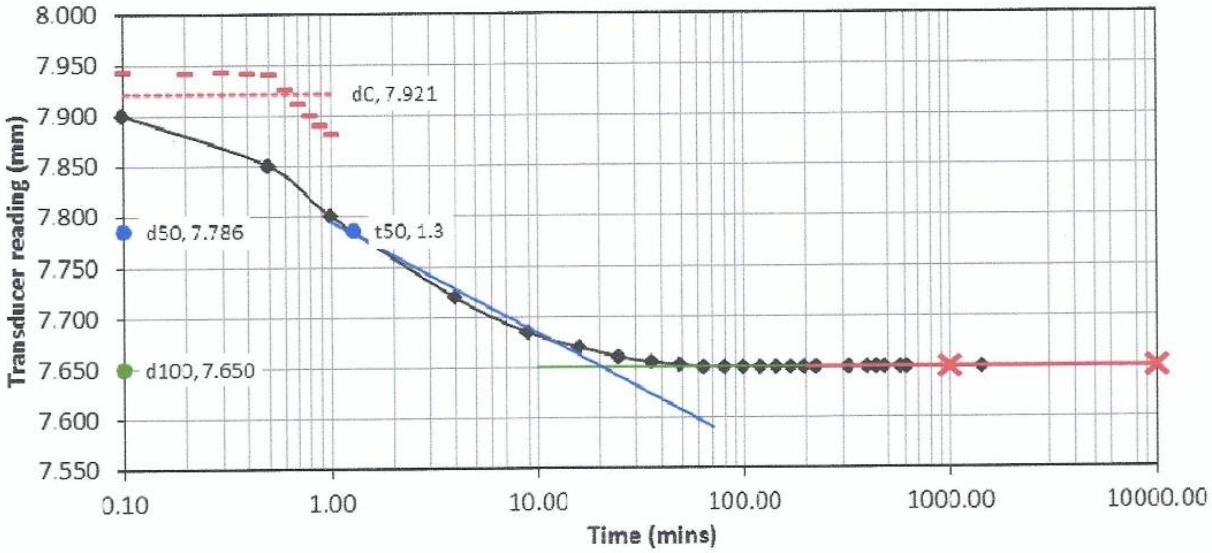
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 04 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3898	**Date:**	04-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 04 (0.0-2.0m)
LOADING STAGE: No. 6		**PRESSURE** (kpa)	2000	**MASS** (kg)	40.04



CALCULATIONS

Change in Height = 0.470 mm
From the plot, t_{50} = =1.3 mins
H_1 = 18.71 mm
H_2 = 18.24 mm
H = (18.71+18.24)/2
= 18.48 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **6.830 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.025 m²/MN**

Specimen information (cumulative)

Compression (mm)	= 1.760
Net compression (mm)	= 1.570
Height mm (H_2)	= 18.24
Equivalent height of solids Hs	= 13.31
Voids Ratio = (H_2 – Hs)/Hs	= **0.370**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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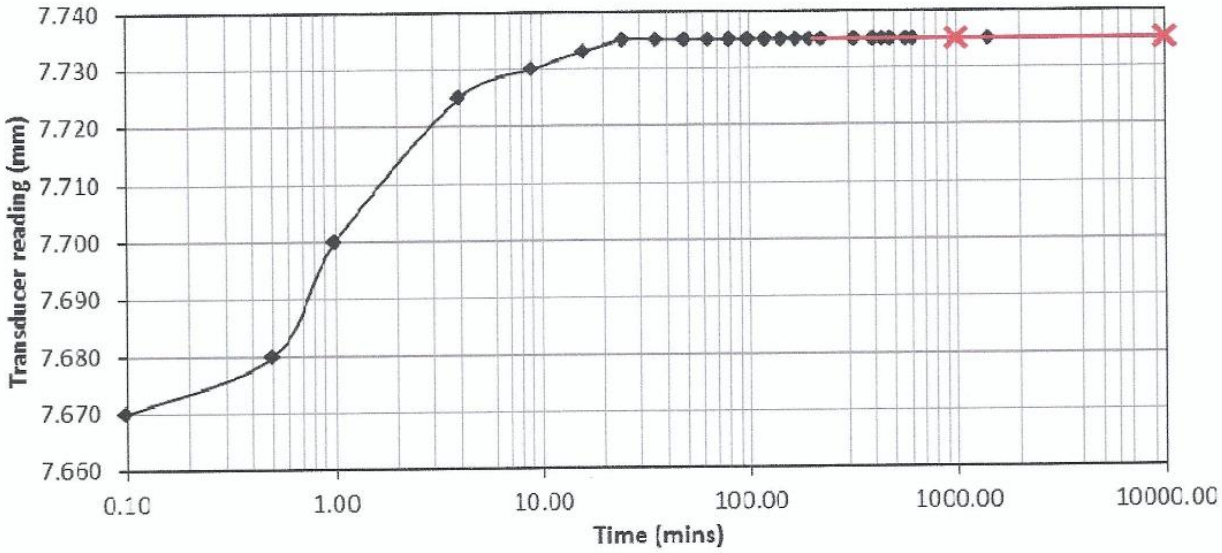
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 04 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3898	**Date:**	04-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 04 (0.0-2.0m)
UNLOADING STAGE:		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = -0.085 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = - m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, M_v = $\frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= - m^2/MN

Specimen information (cumulative)

Compression (mm)	= 1.675
Net compression (mm)	= 1.533
Height mm (H_2)	= 18.47
Equivalent height of solids Hs	= 13.31
Voids Ratio = (H_2 – Hs)/Hs	= 0.388

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

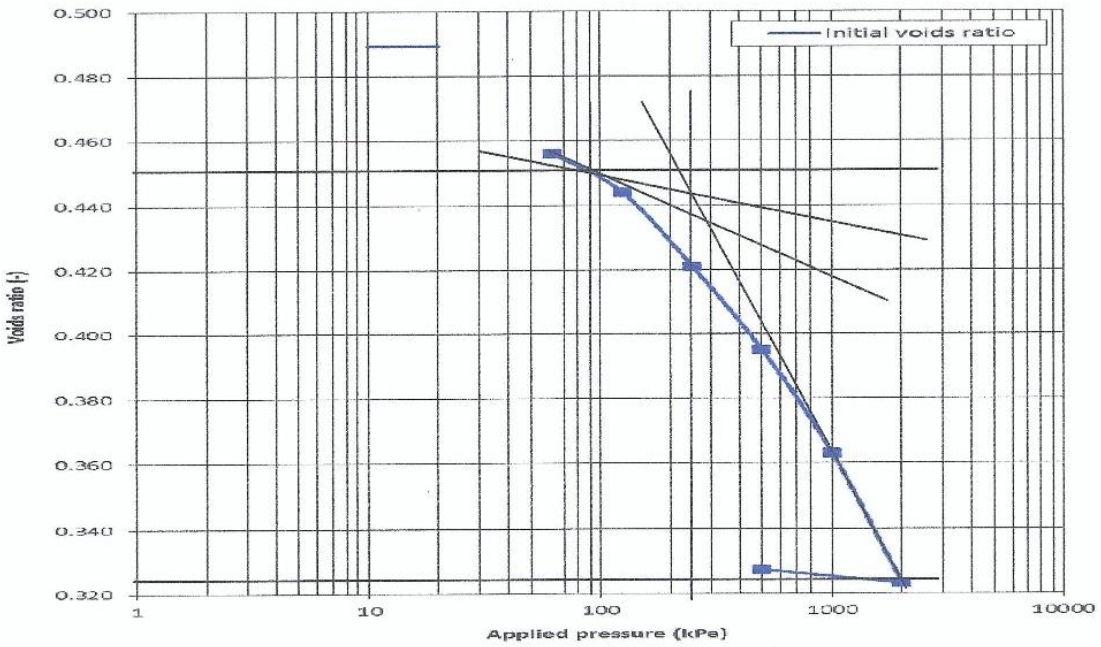
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES.

Tested in Accordance with BS 1377: 1990: Part 5: Clause 3.

BH 05 (Depth: 0.0-1.5m)

Site: MWACHE W.T.P
Location: KWALE
Depth: 0.0-1.5m
Classification Group Name: -
Lab Ref: TM/CCL-KORUDAM/3904
Sample No. 3898
Ring Diameter: 50.0 mm
Height of soil particles: 13.43mm
Height of Ring: 20 mm
Area (A): 1963.5mm^2
Moisture Content after Test: 12.6%
Bulk Density: 1980kg/m^3
Initial voids ratio: 0.479
Assumed Soil Density: 2600 kg/m^3
Dry Density: 1758kg/m^3
Pre-consolidation stress: 260 Kn/m^2
Coefficient of Compression Index: 0.095
Coefficient of Re-Compression Index: 0.0282

Voids Ratio against Applied Pressure



Tested By: MICHAEL
Date Reported: 06-08-21
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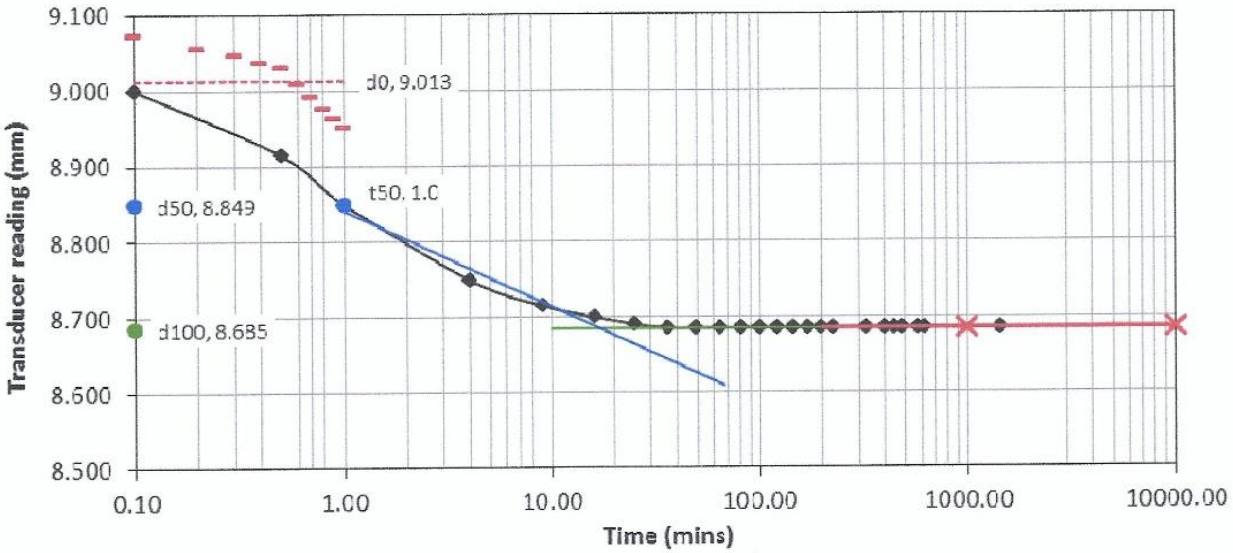
BH 05 (0.0-1.5m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3904	**Date:**	30-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 05 (0.0-1.5m)
LOADING STAGE: No. 1		**PRESSURE** (kpa)	62.5	**MASS** (kg)	1.25



CALCULATIONS

Change in Height = 0.475 mm
From the plot, t_{50} = =1.0 mins
H_1 = 20.00 mm
H_2 = 19.53 mm
H = (20.00+19.53)/2
= 19.77 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **10.162 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.380 m^2/MN**

Specimen information (cumulative)

Compression (mm)	= 0.475
Net compression (mm)	= 0.448
Height mm (H_2)	= 19.53
Equivalent height of solids Hs	= 13.43
Voids Ratio = (H_2 – Hs)/Hs	= **0.454**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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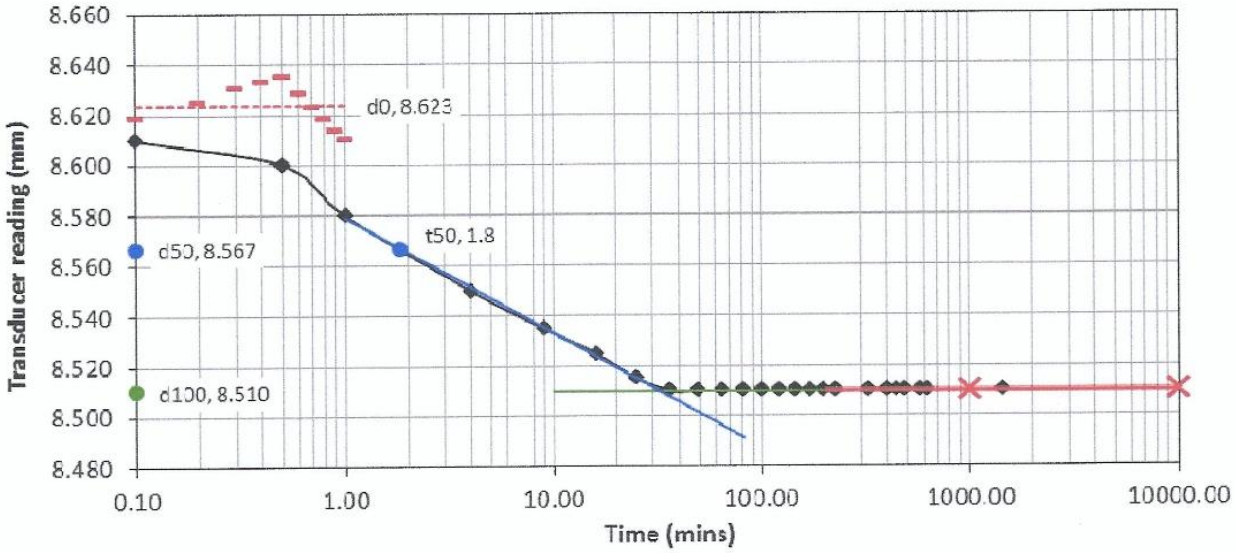
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 05 (0.0-1.5m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3904	**Date:**	31-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 05 (0.0-1.5m)
LOADING STAGE: No. 2		**PRESSURE** (kpa)	125	**MASS** (kg)	2.50



CALCULATIONS

Change in Height = 0.175 mm
From the plot, t_{50} = =1.8 mins
H_1 = 19.53 mm
H_2 = 19.36 mm
H = (19.36+19.53)/2
= 19.45 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **5.464 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.143 m^2/MN**

Specimen information (cumulative)

Compression (mm)	= 0.650
Net compression (mm)	= 0.605
Height mm (H_2)	= 19.36
Equivalent height of solids Hs	= 13.43
Voids Ratio = (H_2 – Hs)/Hs	= **0.442**

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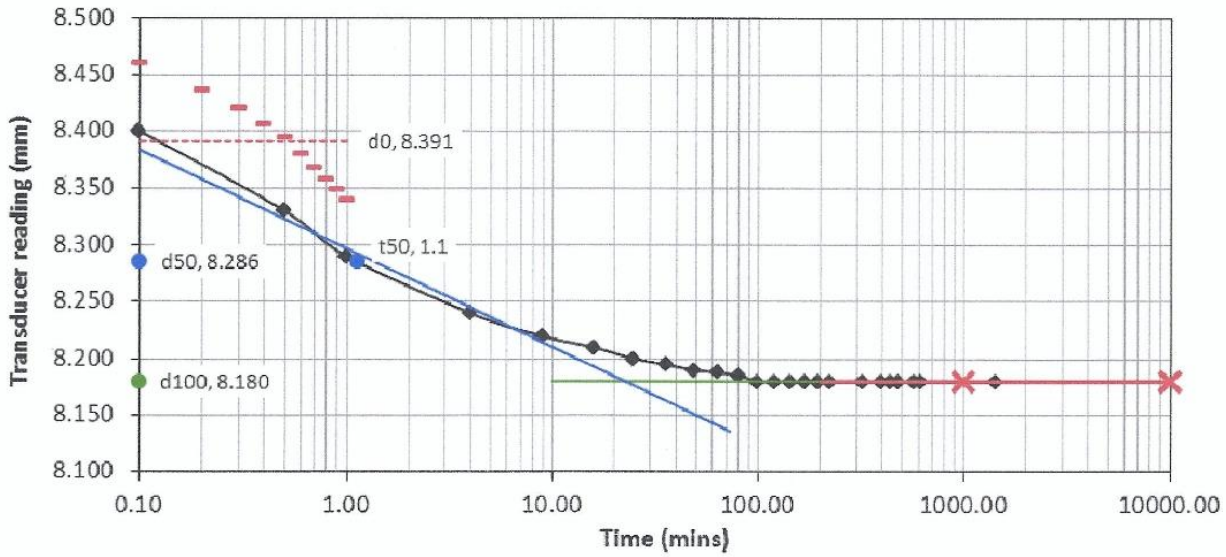
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 05 (0.0-1.5m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3904	**Date:**	01-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 05 (0.0-1.5m)
LOADING STAGE: No. 3		**PRESSURE** (kpa)	250	**MASS** (kg)	5.00



CALCULATIONS

Change in Height = 0.330 mm
From the plot, t_{50} = =1.1 mins
H_1 = 19.36 mm
H_2 = 19.03 mm
H = (19.36+19.03)/2
= 19.20 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **8.713 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, M_v $= \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.136 m^2/MN**

Specimen information (cumulative)
Compression (mm) = 0.980
Net compression (mm) = 0.915
Height mm (H_2) = 19.03
Equivalent height of solids Hs = 13.43
Voids Ratio = (H_2 – Hs)/Hs = **0.417**

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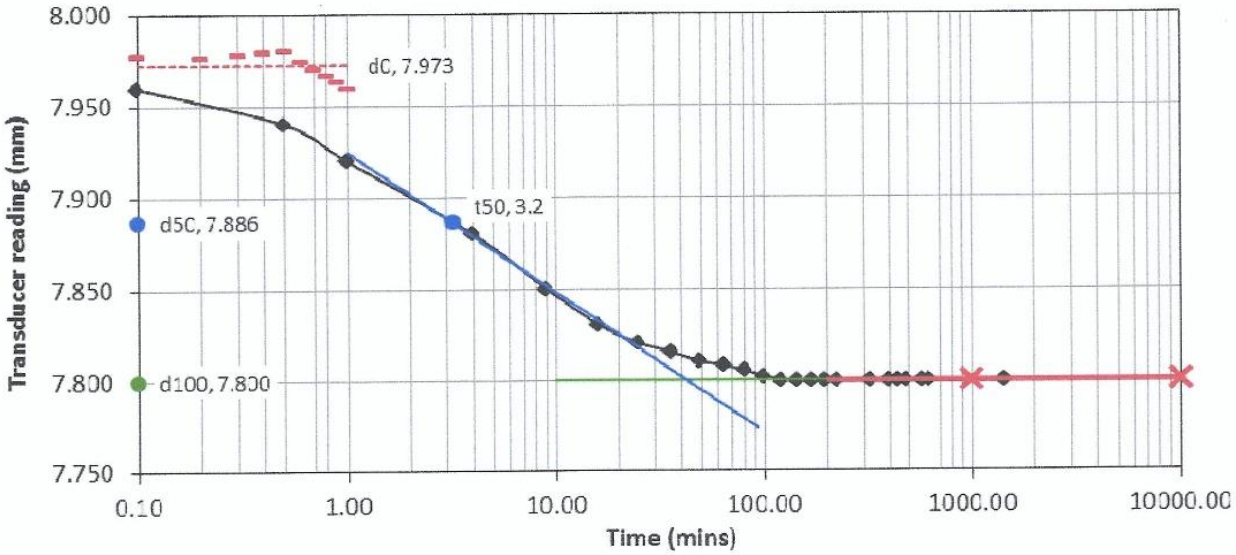
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 05 (0.0-1.5m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3904	**Date:**	02-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 05 (0.0-1.5m)
LOADING STAGE: No. 4		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = 0.380 mm
From the plot, t_{50} = =3.2 mins
H_1 = 19.03 mm
H_2 = 18.65 mm
H = (18.65+19.03)/2
= 18.84 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **2.884 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, M_v = $\frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.080 m²/MN**

Specimen information (cumulative)

Compression (mm)	= 1.360
Net compression (mm)	= 1.266
Height mm (H_2)	= 18.65
Equivalent height of solids Hs	= 13.43
Voids Ratio = (H_2 – Hs)/Hs	= **0.389**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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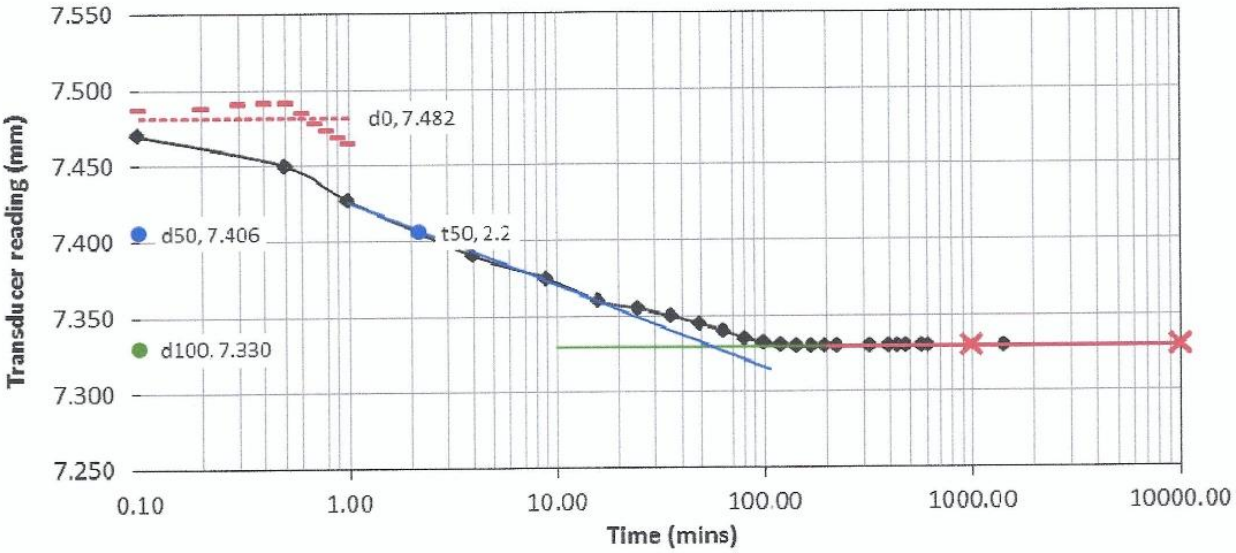
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 05 (0.0-1.5m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3904	**Date:**	03-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 05 (0.0-1.5m)
LOADING STAGE: No. 5		**PRESSURE** (kpa)	1000	**MASS** (kg)	20.02



CALCULATIONS

Change in Height = 0.470 mm
From the plot, t_{50} = 2.2 mins
H_1 = 18.65 mm
H_2 = 18.18 mm
H = (18.65+18.18)/2
= 18.42 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 4.001 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.050 m^2/MN

Specimen information (cumulative)

Compression (mm)	= 1.830
Net compression (mm)	= 1.694
Height mm (H_2)	= 18.18
Equivalent height of solids Hs	= 13.43
Voids Ratio = (H_2 – Hs)/Hs	= 0.354

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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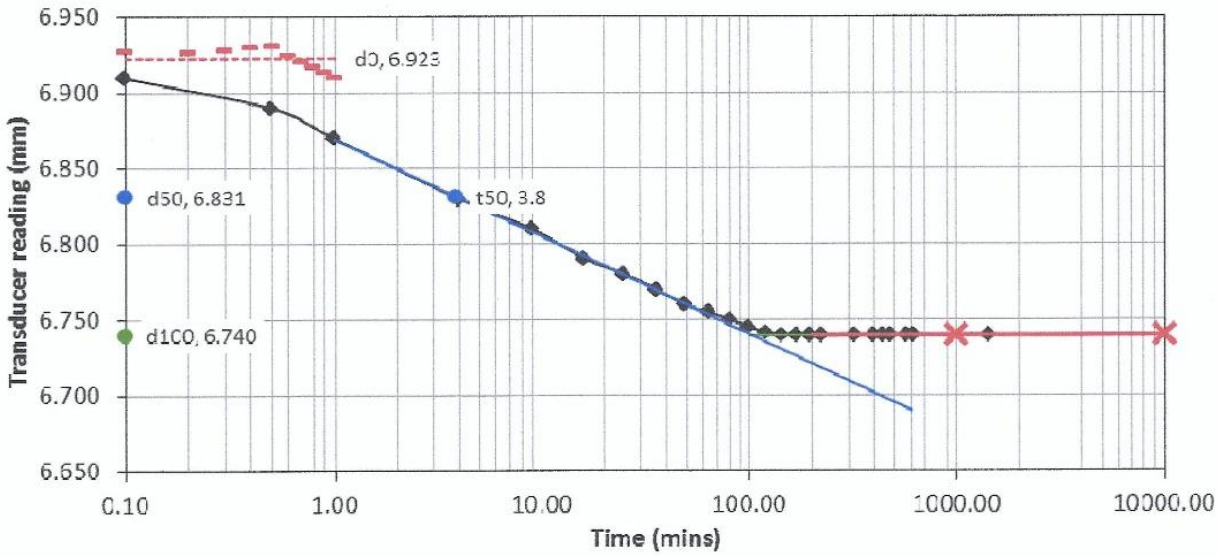
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 05 (0.0-1.5m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3904	**Date:**	04-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 05 (0.0-1.5m)
LOADING STAGE:	**No. 6**	**PRESSURE** (kpa)	2000	**MASS** (kg)	40.04



CALCULATIONS

Change in Height = 0.590 mm
From the plot, t_{50} = 3.8 mins
H_1 = 18.18 mm
H_2 = 17.59 mm
H = (17.59+18.18)/2
= 17.89 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **2.190 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.032 m^2/MN**

Specimen information (cumulative)
Compression (mm) = 2.420
Net compression (mm) = 2.230
Height mm (H_2) = 17.59
Equivalent height of solids Hs = 13.43
Voids Ratio = (H_2 – Hs)/Hs = **0.310**

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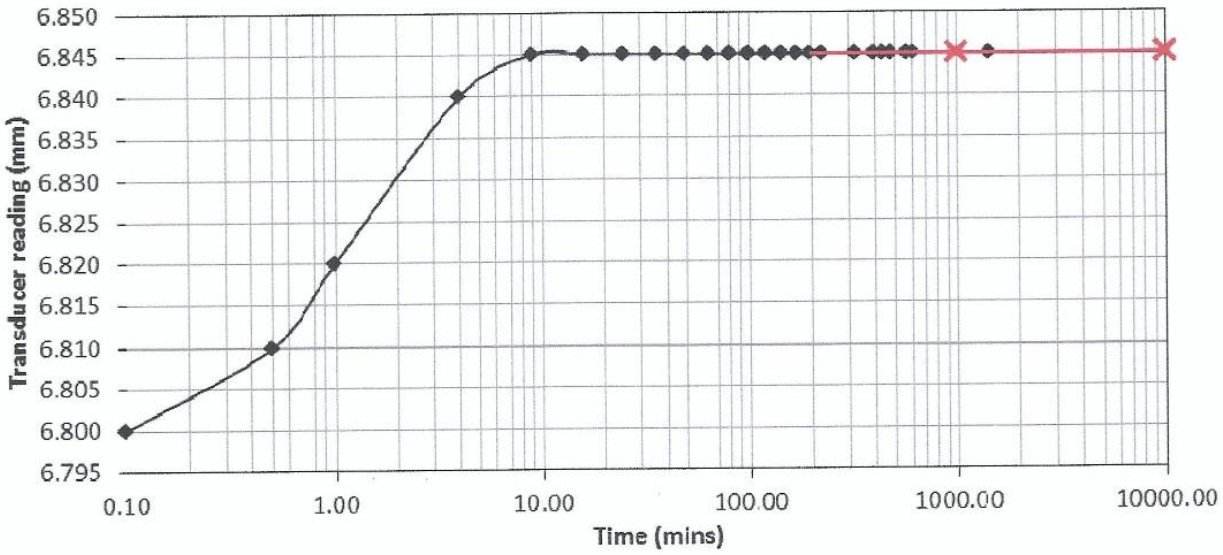
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 05 (0.0-1.5m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3904	**Date:**	05-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 05 (0.0-1.5m)
UNLOADING STAGE:		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = -0.105 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = - m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, M_v = $\frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= - m^2/MN

Specimen information (cumulative)

Compression (mm)	= 2.315
Net compression (mm)	= 2.173
Height mm (H_2)	= 17.83
Equivalent height of solids Hs	= 13.43
Voids Ratio = (H_2 – Hs)/Hs	= 0.327

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

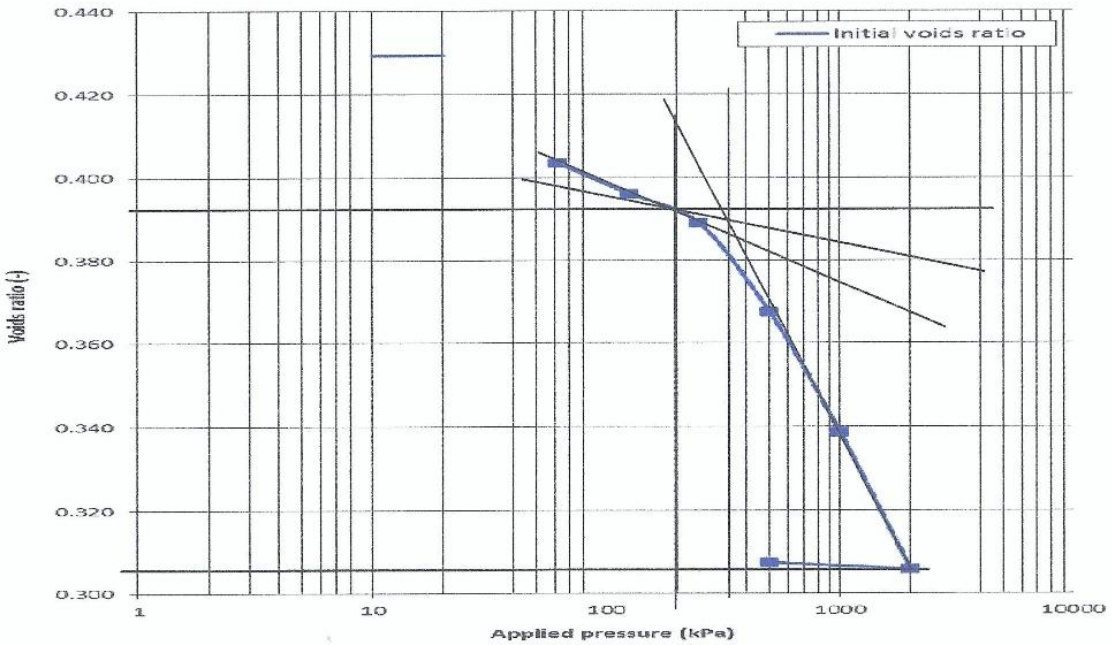
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES.

Tested in Accordance with BS 1377: 1990: Part 5: Clause 3.

BH 06 (Depth: 0.0-2.0m)

Site: MWACHE W.T.P
Location: KWALE
Depth: 0.0-1.5m
Classification Group Name: -
Lab Ref: TM/CCL-KORUDAM/3910
Sample No. 3810
Ring Diameter: 50.0 mm
Height of soil particles: 13.99mm
Height of Ring: 20 mm
Area (A): 1963.5mm^2
Moisture Content after Test: 12.0%
Bulk Density: 2038kg/m^3
Initial voids ratio: 0.429
Assumed Soil Density: 2600 kg/m^3
Dry Density: 1819kg/m^3
Pre-consolidation stress: 345 Kn/m^2
Coefficient of Compression Index: 0.057
Coefficient of Re-Compression Index: 0.0233

Voids Ratio against Applied Pressure



Tested By: MICHAEL
Date Reported: 06-08-21
Checked By:

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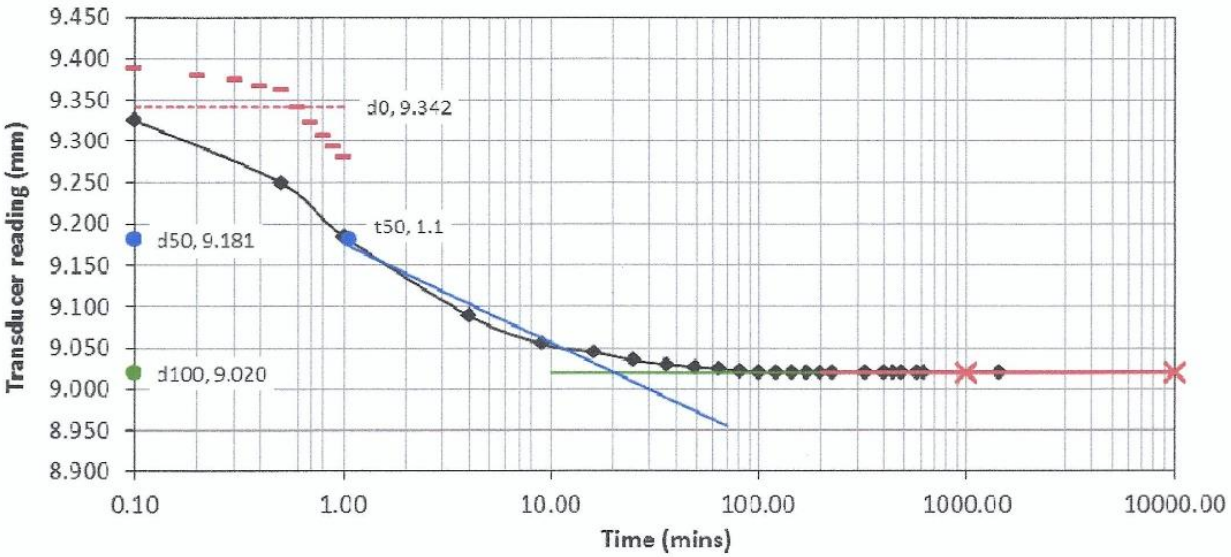
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 06 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3910	**Date:**	30-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 06 (0.0-2.0m)
LOADING STAGE:	**No. 1**	**PRESSURE** (kpa)	62.5	**MASS** (kg)	1.25



CALCULATIONS

Change in Height = 0.390 mm
From the plot, t_{50} = =1.1 mins
H_1 = 20.00 mm
H_2 = 19.61 mm
H = (20.00+19.61)/2
= 19.81 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **9.276 m²/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.312 m²/MN**

Specimen information (cumulative)

Compression (mm)	= 0.390
Net compression (mm)	= 0.363
Height mm (H_2)	= 19.61
Equivalent height of solids Hs	= 13.99
Voids Ratio = (H_2 – Hs)/Hs	= **0.402**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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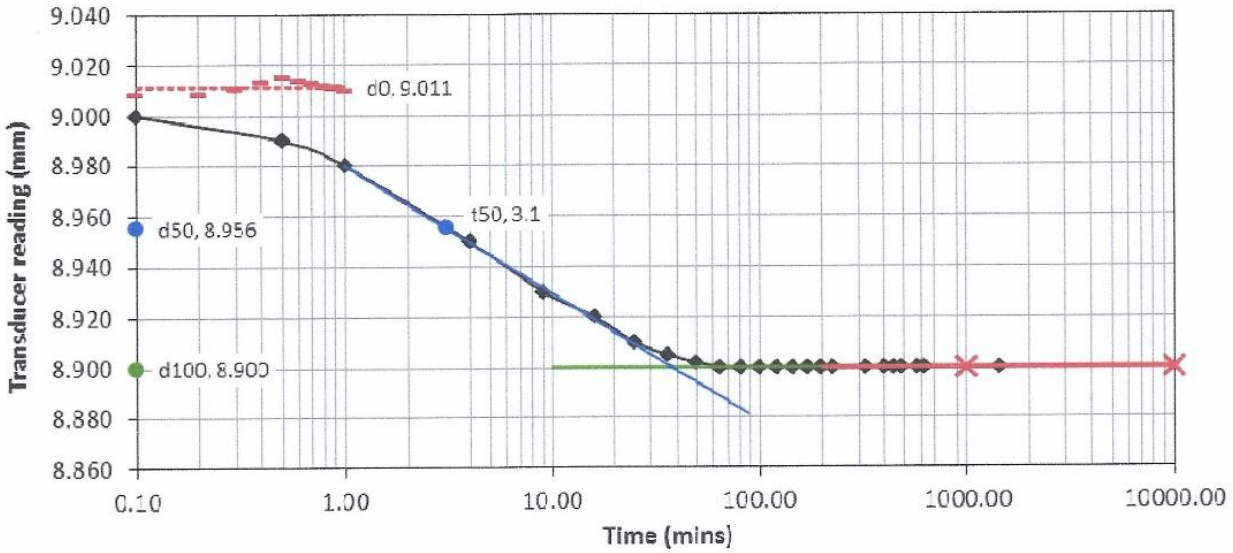
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 06 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3910	**Date:**	31-07-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 06 (0.0-2.0m)
LOADING STAGE: No. 2		**PRESSURE** (kpa)	125	**MASS** (kg)	2.50



CALCULATIONS

Change in Height = 0.120 mm
From the plot, t_{50} = =3.1 mins
H_1 = 19.61 mm
H_2 = 19.49 mm
H = (19.49+19.61)/2
= 19.55 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **3.206 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, M_v = $\frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.098 m^2/MN**

Specimen information (cumulative)
Compression (mm) = 0.510
Net compression (mm) = 0.465
Height mm (H_2) = 19.49
Equivalent height of solids Hs = 13.99
Voids Ratio = (H_2 – Hs)/Hs = **0.393**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

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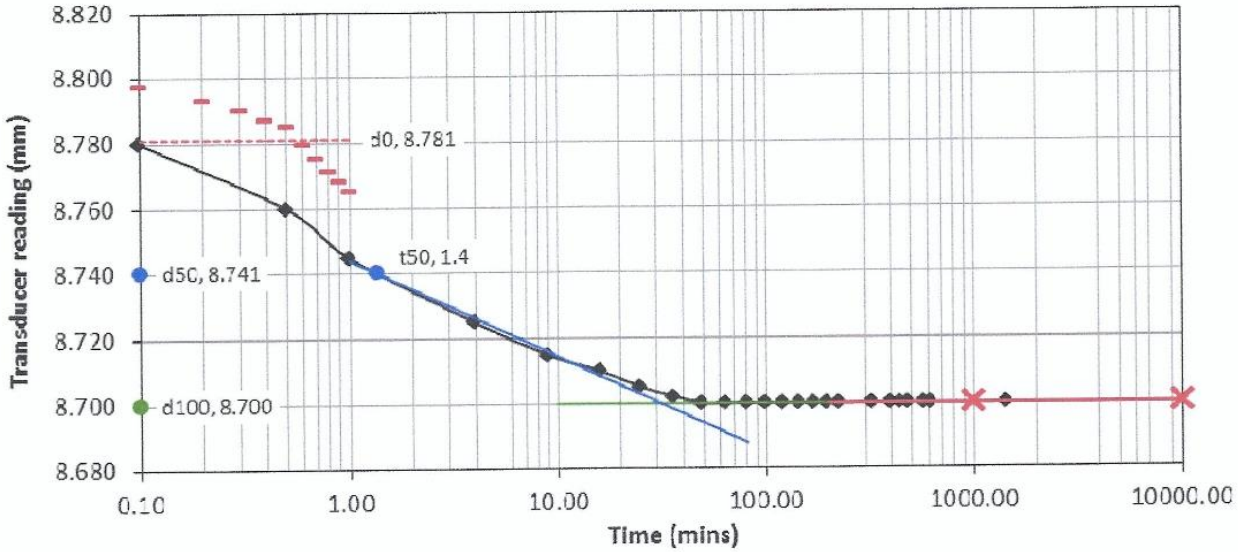
BH 06 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3910	**Date:**	01-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 06 (0.0-2.0m)
LOADING STAGE: No. 3		**PRESSURE** (kpa)	250	**MASS** (kg)	5.00



CALCULATIONS

Change in Height = 0.120 mm
From the plot, t_{50} = =1.4 mins
H_1 = 19.49 mm
H_2 = 19.37 mm
H = (19.49+19.37)/2
= 19.43 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 7.011 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, M_v $= \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.049 m^2/MN

Specimen information (cumulative)

Compression (mm)	= 0.630
Net compression (mm)	= 0.565
Height mm (H_2)	= 19.37
Equivalent height of solids Hs	= 13.99
Voids Ratio = (H_2 – Hs)/Hs	= 0.385

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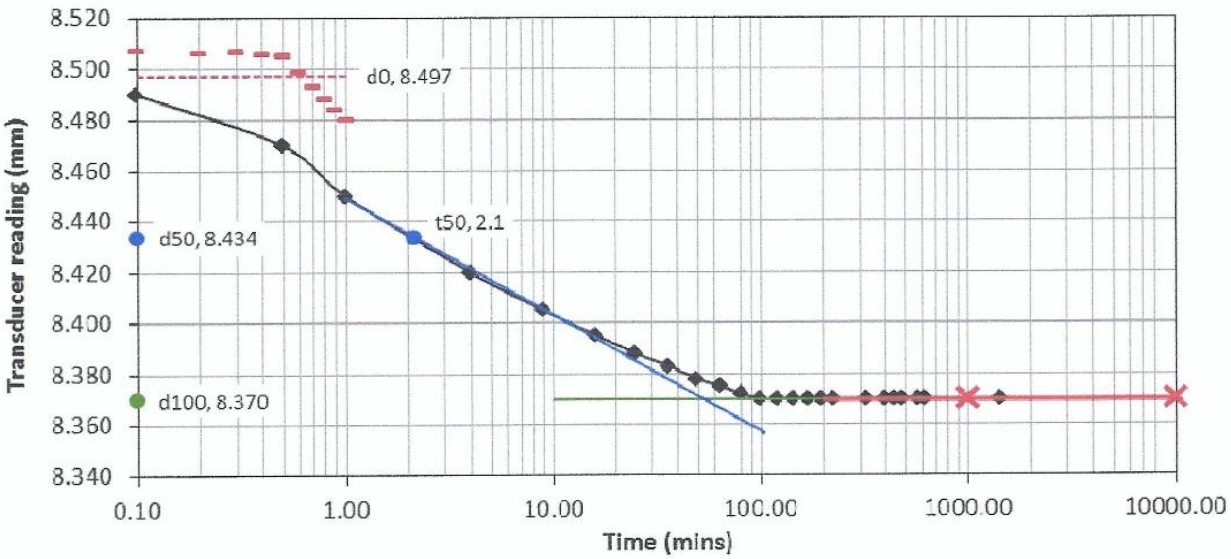
BH 06 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3910	**Date:**	02-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 06 (0.0-2.0m)
LOADING STAGE: No. 4		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = 0.330 mm
From the plot, t_{50} = 2.1 mins
H_1 = 19.37 mm
H_2 = 19.04 mm
H = (19.04+19.37)/2
= 19.21 mm

Co-efficient of Consolidation, $C_V = \frac{0.026\ H^2}{t_{50}}$ = **4.569 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.068 m^2/MN**

Specimen information (cumulative)

Compression (mm)	= 0.960
Net compression (mm)	= 0.866
Height mm (H_2)	= 19.04
Equivalent height of solids Hs	= 13.99
Voids Ratio = (H_2 – Hs)/Hs	= **0.361**

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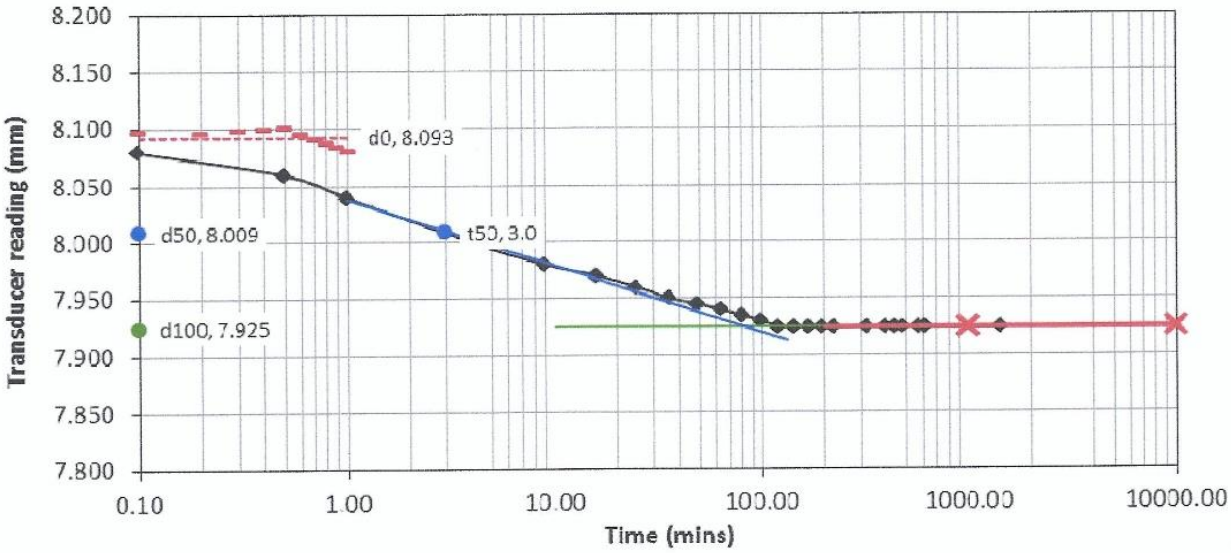
Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 06 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3910	**Date:**	03-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 06 (0.0-2.0m)
LOADING STAGE: No. 5		**PRESSURE** (kpa)	1000	**MASS** (kg)	20.02



CALCULATIONS

Change in Height = 0.445 mm
From the plot, t_{50} = 3.0 mins
H_1 = 19.04 mm
H_2 = 18.60 mm
H = (19.04+18.60)/2
= 18.82 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = 3.070 m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= 0.047 m^2/MN

Specimen information (cumulative)

Compression (mm)	= 1.405
Net compression (mm)	= 1.269
Height mm (H_2)	= 18.60
Equivalent height of solids Hs	= 13.99
Voids Ratio = (H_2 – Hs)/Hs	= 0.330

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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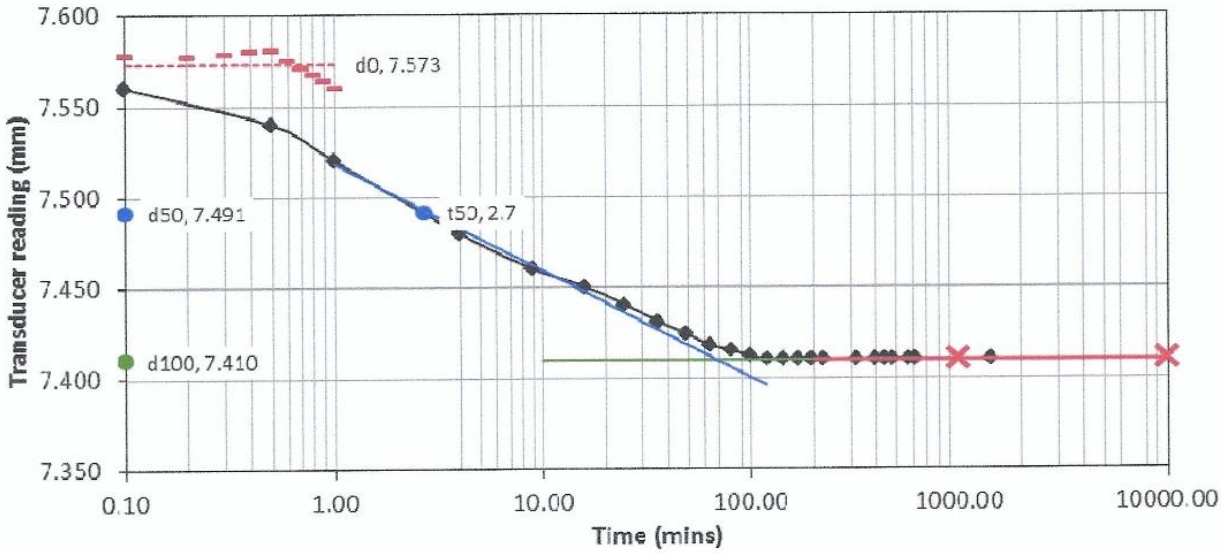
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 06 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3910	**Date:**	04-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 06 (0.0-2.0m)
LOADING STAGE:	**No. 6**	**PRESSURE** (kpa)	2000	**MASS** (kg)	40.04



CALCULATIONS

Change in Height = 0.515 mm
From the plot, t_{50} = 2.7 mins
H_1 = 18.60 mm
H_2 = 18.09 mm
H = (18.09+18.60)/2
= 18.35 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = **3.243 m^2/year**

Co-efficient of Secondary Compression, C_{sec} = = **Nil**

Co-efficient of volume compressibility, $M_v = \frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= **0.028 m^2/MN**

Specimen information (cumulative)
Compression (mm) = 1.920
Net compression (mm) = 1.730
Height mm (H_2) = 18.09
Equivalent height of solids Hs = 13.99
Voids Ratio = (H_2 – Hs)/Hs = **0.293**

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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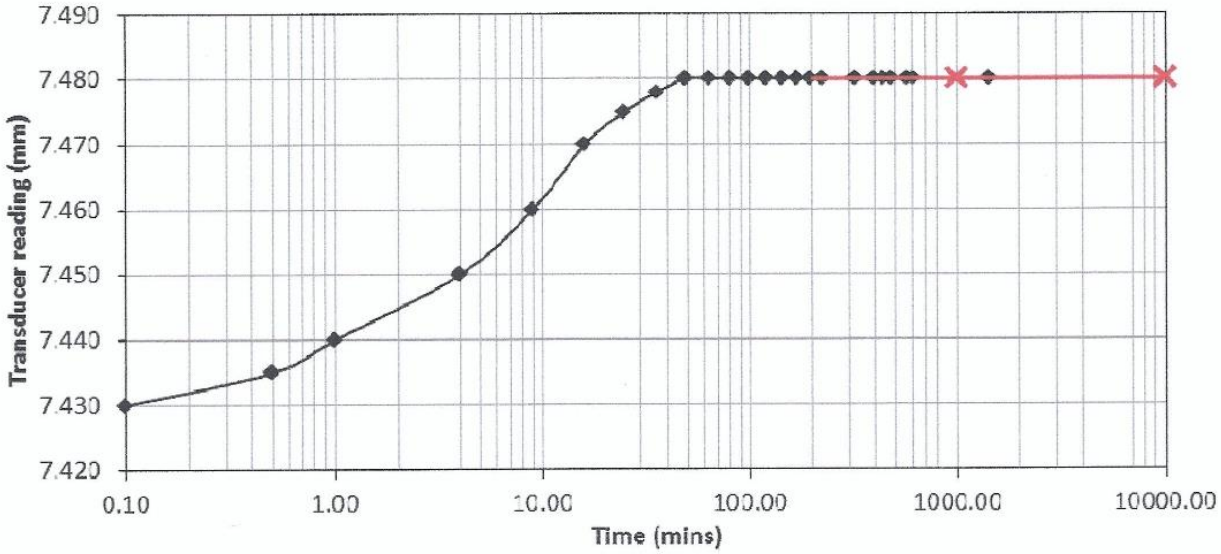
DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Tested in Accordance with BS 1377:1990:Part 5: Clause 3

BH 06 (0.0-2.0m)

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS-MWACHE/3910	**Date:**	05-08-21
Project	MWACHE WATER TRATMENT PLANT	**Location:**	KWALE	**Sample**	BH 06 (0.0-2.0m)
UNLOADING STAGE:		**PRESSURE** (kpa)	500	**MASS** (kg)	10.01



CALCULATIONS

Change in Height = -0.070 mm

Co-efficient of Consolidation, $C_v = \frac{0.026\ H^2}{t_{50}}$ = - m^2/year

Co-efficient of Secondary Compression, C_{sec} = = Nil

Co-efficient of volume compressibility, M_v = $\frac{H_1 - H_2}{H_1} \times \frac{1000}{P_2 - P_1}$

= - m^2/MN

Specimen information (cumulative)

Compression (mm)	= 1.850
Net compression (mm)	= 1.708
Height mm (H_2)	= 18.29
Equivalent height of solids Hs	= 13.99
Voids Ratio = (H_2 – Hs)/Hs	= 0.307

Tested By: MICHAEL **Date Reported:** 06-08-21 **Checked By:**

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DETERMINATION OF POROSITY OF ROCK MATERIALS

Tested in accordance with ISRM /ASTM C97-83

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS–MWACHE/3913	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	115	**Diameter: (mm)**	71

Rock Sample Reference No.	**BH 06 (Depth: 19.0-19.30m)**	
Saturated surface Dry Mass M_{sat} (g)	1154.0	
Dry Specimen Mass M_s, (g)	1147.0	
Specimen Bulk Volume V (cm^3)	455.3	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	7.0	
Porosity n = V_v/ V x100 (%)	1.5	

Tested by: KEVIN

Date Reported: 07-08-21

Checked by:

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Rock Porosity

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DETERMINATION OF POROSITY OF ROCK MATERIALS

Tested in accordance with ISRM /ASTM C97-83

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS--MWACHE/3911	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	90	**Diameter: (mm)**	71

Rock Sample Reference No.	**BH 06 (Depth: 6.47-6.77m)**	
Saturated surface Dry Mass M_{sat} (g)	884.0	
Dry Specimen Mass M_s (g)	878.0	
Specimen Bulk Volume V (cm^3)	356.3	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	6.0	
Porosity n = V_v/ V x100 (%)	1.7	

Tested by: KEVIN

Date Reported: 07-08-21

Checked by: _____

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DETERMINATION OF POROSITY OF ROCK MATERIALS

Tested in accordance with ISRM /ASTM C97-83

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS–MWACHE/3909	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	171	**Diameter: (mm)**	71

Rock Sample Reference No.	**BH 05 (Depth: 17.16-17.36m)**	
Saturated surface Dry Mass M_{sat} (g)	1894.0	
Dry Specimen Mass M_s, (g)	1889.0	
Specimen Bulk Volume V (cm^3)	677.0	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	5.0	
Porosity n = V_v/ V x100 (%)	0.7	

Tested by: KEVIN

Date Reported: 07-08-21

Checked by:

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DETERMINATION OF POROSITY OF ROCK MATERIALS

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Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS–MWACHE/3905	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	174	**Diameter: (mm)**	71

Rock Sample Reference No.	BH 05 (Depth: 5.32-5.65m)	
Saturated surface Dry Mass M_{sat} (g)	1722.0	
Dry Specimen Mass M_s, (g)	1712.0	
Specimen Bulk Volume V (cm^3)	688.9	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	10.0	
Porosity n = V_v/ V x100 (%)	1.5	

Tested by: KEVIN

Date Reported: 07-08-21

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DETERMINATION OF POROSITY OF ROCK MATERIALS

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Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS--MWACHE/3903	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	177	**Diameter: (mm)**	71

Rock Sample Reference No.	**BH 04 (Depth: 19.23-19.74m)**	
Saturated surface Dry Mass M_{sat} (g)	1436.0	
Dry Specimen Mass M_s, (g)	1425.0	
Specimen Bulk Volume V (cm^3)	554.3	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	11.0	
Porosity n = V_v/ V x100 (%)	2.0	

Tested by: KEVIN

Date Reported: 07-08-21

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DETERMINATION OF POROSITY OF ROCK MATERIALS

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Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS–MWACHE/3899	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	149	**Diameter: (mm)**	71

Rock Sample Reference No.	**BH 04 (Depth: 6.0-6.60m)**	
Saturated surface Dry Mass M_{sat} (g)	1470.0	
Dry Specimen Mass M_s (g)	1462.0	
Specimen Bulk Volume V (cm^3)	589.9	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	8.0	
Porosity n = V_v/ V x100 (%)	1.4	

Tested by: KEVIN

Date Reported: 07-08-21

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DETERMINATION OF POROSITY OF ROCK MATERIALS

Tested in accordance with ISRM /ASTM C97-83

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS–MWACHE/3896	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	174	**Diameter: (mm)**	71

Rock Sample Reference No.	**BH 03 (Depth: 18.30-18.60m)**	
Saturated surface Dry Mass M_{sat} (g)	1007.0	
Dry Specimen Mass M_s (g)	1003.0	
Specimen Bulk Volume V (cm^3)	392.0	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	4.0	
Porosity n = V_v/ V x100 (%)	1.0	

Tested by: KEVIN

Date Reported: 07-08-21

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DETERMINATION OF POROSITY OF ROCK MATERIALS

Tested in accordance with ISRM /ASTM C97-83

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS–MWACHE/3894	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	177	**Diameter: (mm)**	71

Rock Sample Reference No.	**BH 03 (Depth: 8.24-9.00m)**	
Saturated surface Dry Mass M_{sat} (g)	1836.0	
Dry Specimen Mass M_s, (g)	1824.0	
Specimen Bulk Volume V (cm^3)	700.8	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	12.0	
Porosity n = V_v/ V x100 (%)	1.7	

Tested by: KEVIN

Date Reported: 07-08-21

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DETERMINATION OF POROSITY OF ROCK MATERIALS

Tested in accordance with ISRM /ASTM C97-83

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS–MWACHE/3891	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	137	**Diameter: (mm)**	82

Rock Sample Reference No.	**BH 02 (Depth: 12.15-12.65m)**	
Saturated surface Dry Mass M_{sat} (g)	1890.0	
Dry Specimen Mass M_s (g)	1882.0	
Specimen Bulk Volume V (cm^3)	723.5	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	8.0	
Porosity n = V_v/ V x100 (%)	1.1	

Tested by: KEVIN

Date Reported: 07-08-21

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DETERMINATION OF POROSITY OF ROCK MATERIALS

Tested in accordance with ISRM /ASTM C97-83

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS--MWACHE/3889	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	166	**Diameter: (mm)**	82

Rock Sample Reference No.	**BH 02 (Depth: 8.0-8.40m)**	
Saturated surface Dry Mass M_{sat}, (g)	2233.0	
Dry Specimen Mass M_s, (g)	2221.0	
Specimen Bulk Volume V (cm^3)	876.6	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	12.0	
Porosity n = V_v/ V x100 (%)	1.4	

Tested by: KEVIN

Date Reported: 07-08-21

Checked by:

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DETERMINATION OF POROSITY OF ROCK MATERIALS

Tested in accordance with ISRM /ASTM C97-83

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS--MWACHE/3887	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	171	**Diameter: (mm)**	71

Rock Sample Reference No.	**BH 01 (Depth: 18.0-18.70m)**	
Saturated surface Dry Mass M_{sat} (g)	1212.0	
Dry Specimen Mass M_s, (g)	1205.0	
Specimen Bulk Volume V (cm^3)	463.2	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	5.0	
Porosity n = V_v/ V x100 (%)	1.1	

Tested by: KEVIN

Date Reported: 07-08-21

Checked by:

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DETERMINATION OF POROSITY OF ROCK MATERIALS

Tested in accordance with ISRM /ASTM C97-83

Client:	REGIONAL GEOPHYSICAL SURVEY	**Job Reference:**	TM/RGS–MWACHE/3885	**Date of Test:**	03-08-21		
Project:	MWACHE WATER TREATMENT PLANT	**Location:**	KWALE COUNTY	**Site:**	MWACHE W.T.P		
Material Description	ROCK CORE	**Sampled By:**	REGIONAL GEOPHYSICAL SURVEY	**Height: (mm)**	173	**Diameter: (mm)**	71

Rock Sample Reference No.	**BH 01 (Depth: 9.0-9.75m)**	
Saturated surface Dry Mass M_{sat}, (g)	1718.0	
Dry Specimen Mass M_s, (g)	1707.0	
Specimen Bulk Volume V (cm^3)	554.3	
Pore Volume V_v =(M_{sat} - M_s /Density of Water)	11.0	
Porosity n = V_v/ V x100 (%)	2.0	

Tested by: KEVIN

Date Reported: 07-08-21

Checked by:

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Specific Gravity and Water Absorption

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000

BH 01(9.0-9.75M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3885 **Sample No:** 3885

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	804.0	907.3	
M2	The mass in water containing of saturated sample (g)	497.6	557.8	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	800.9	902.8	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.61	2.58	2.60
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.62	2.60	2.61
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.64	2.62	2.63
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.4	0.5	0.4

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 01(18.0-18.70M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3887 **Sample No:** 3887

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	564.6	518.1	
M2	The mass in water containing of saturated sample (g)	346.9	316.6	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	562.4	515.8	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.58	2.56	2.58
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.59	2.57	2.58
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.61	2.59	2.60
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.4	0.4	0.4

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 02(8.00-8.40M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3889 **Sample No:** 3889

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	548.8	525.8	
M2	The mass in water containing of saturated sample (g)	334.3	320.0	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	547.3	524.8	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.55	2.55	2.55
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.56	2.55	2.56
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.57	2.56	2.57
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.3	0.2	0.3

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 02(12.15-12.65M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3891 **Sample No:** 3891

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	517.5	511.2	
M2	The mass in water containing of saturated sample (g)	317.2	313.7	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	514.5	508.5	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.57	2.57	2.57
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.58	2.59	2.59
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.61	2.61	2.61
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.6	0.5	0.6

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 03(8.24-9.00M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3894 **Sample No:** 3894

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	566.5	537.1	
M2	The mass in water containing of saturated sample (g)	348.5	329.7	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	565.6	536.0	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.59	2.58	2.59
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.60	2.59	2.60
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.61	2.60	2.61
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.2	0.2	0.2

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 03(18.30-18.60M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3896 **Sample No:** 3896

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	587.9	574.5	
M2	The mass in water containing of saturated sample (g)	361.0	351.6	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	585.5	572.9	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.58	2.57	2.58
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.59	2.58	2.59
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.61	2.59	2.60
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.4	0.3	0.4

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 04(6.0-6.60M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3899 **Sample No:** 3899

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	535.6	534.3	
M2	The mass in water containing of saturated sample (g)	327.2	325.5	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	531.0	530.6	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.55	2.54	2.55
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.57	2.56	2.57
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.61	2.59	2.60
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.9	0.7	0.8

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 04(19.23-19.74M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3903 **Sample No:** 3903

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	615.1	559.2	
M2	The mass in water containing of saturated sample (g)	379.4	344.3	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	611.6	555.1	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.59	2.58	2.59
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.61	2.60	2.61
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.63	2.63	2.63
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.6	0.7	0.7

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 05(5.32-5.65M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3905 **Sample No:** 3905

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	539.4	512.0	
M2	The mass in water containing of saturated sample (g)	330.2	311.7	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	535.6	507.8	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.56	2.54	2.55
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.58	2.56	2.57
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.61	2.59	2.60
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.7	0.8	0.8

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 05(17.16-17.36M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3909 **Sample No:** 3909

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	654.2	459.1	
M2	The mass in water containing of saturated sample (g)	402.6	281.5	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	651.1	456.5	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.59	2.57	2.58
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.60	2.59	2.60
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.62	2.61	2.62
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.5	0.6	0.6

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 06(6.47-6.77M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3911 **Sample No:** 3911

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	562.0	626.6	
M2	The mass in water containing of saturated sample (g)	336.2	375.4	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	556.5	620.0	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.46	2.47	2.47
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.49	2.49	2.49
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.53	2.53	2.53
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		1.0	1.1	1.0

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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REGIONAL GEOPHYSICAL SURVEY

MWACHE WATER TREATMENT PLANT

Specific Gravity & Water Absorption Test
BS EN 1097: Part 6:2000
BH 06(19.0-19.31M)

Site: MWACHE W.T.P **Location:** KWALE **Date Received:** 23-07-21

Material Description: CRUSHED ROCK CORES **Lab Ref:** AGG/RGS-MWACHE/3913 **Sample No:** 3913

Sampled by: REGIONAL GEOPHYSICAL SURVEY **Source:** SITE **Date Tested:** 04-08-21

TEST NO.		1	2	
M1	The mass of saturated surface dry in (g)	607.0	729.0	
M2	The mass in water containing of saturated sample (g)	375.2	448.5	
M3	The mass in water of the empty basket (g)	-	-	
M4	The mass of oven-dried sample in (g)	605.8	727.8	
Relative Density on an oven-dried basis $= M_4/(M_1-[M_2- M_3])$		2.61	2.58	2.60
Relative Density on a saturated & surface-dried basis $= M_1/(M_1-[M_2- M_3])$		2.62	2.59	2.61
Apparent Relative Density $= M_4/(M_4-[M_2- M_3])$		2.63	2.61	2.62
Water Absorption (% of dry mass) $=100(M_1- M_4)/ M_4$		0.2	0.2	0.2

Tested by: KEVIN **Date Reported:** 07-08-21 **Checked by:**

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Unconfined Compressive Strength of Rocks

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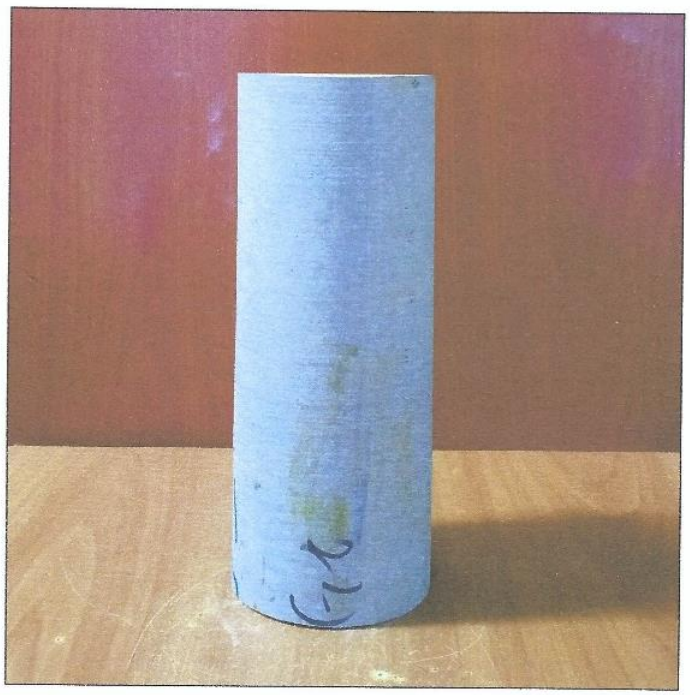
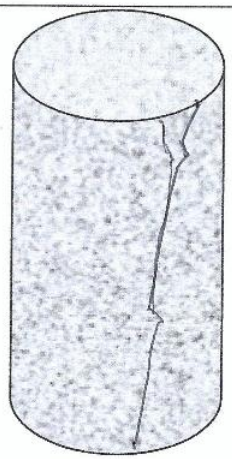
REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3885
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

Sample Ref. No.	BH01	**Weight in Air (g):**	1784	**Density (kg/m^3):**	2590
Load at Failure (KN) :	384.8	**Compressive Strength N/mm^2:**	97.2	**Remarks:**	-
Depth(M):	9.00-9.75m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	174



CORE DESCRIPTION:
S/Ref. No. BH01 (Depth: 9.00-9.75)m
FAILURE MODE



Tested by: KEVIN

Date Reported: 05-08-21

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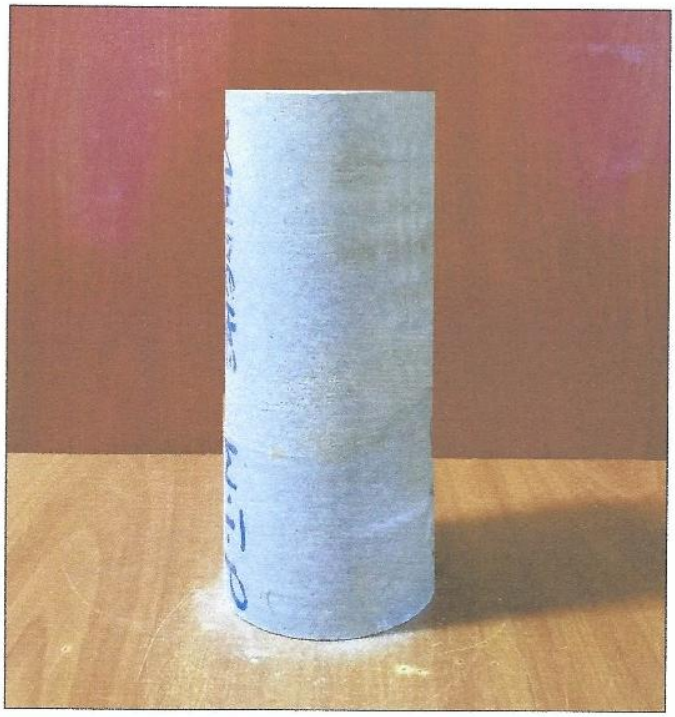
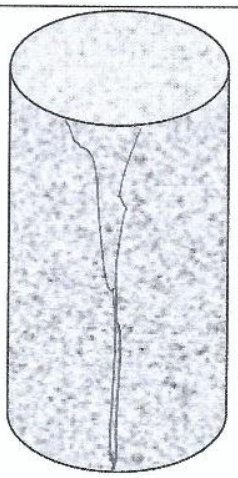
REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3886
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

Sample Ref. No.	BH01	**Weight in Air (g):**	1722	**Density (kg/m^3):**	2558
Load at Failure (KN) :	391.6	**Compressive Strength N/mm^2:**	98.9	**Remarks:**	-
Depth(M):	12.48-13.00m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	170



CORE DESCRIPTION:
S/Ref. No. BH01 (Depth: 12.48-13.00)m
FAILURE MODE



Tested by: KEVIN

Date Reported: 05-08-21

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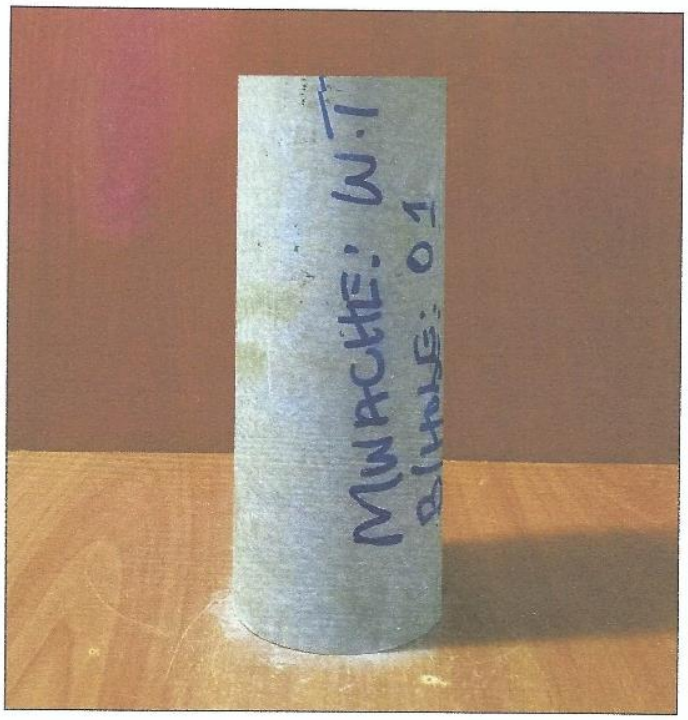
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3887
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

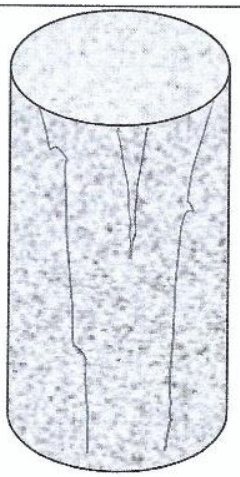
Sample Ref. No.	BH01	**Weight in Air (g):**	1784	**Density (kg/m^3):**	2605
Load at Failure (KN) :	367.4	**Compressive Strength N/mm^2:**	92.8	**Remarks:**	-
Depth(M):	18.00-18.70m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	173



CORE DESCRIPTION:

S/Ref. No. BH01 (Depth: 18.00-18.70)m

FAILURE MODE



Tested by: KEVIN

Date Reported: 05-08-21

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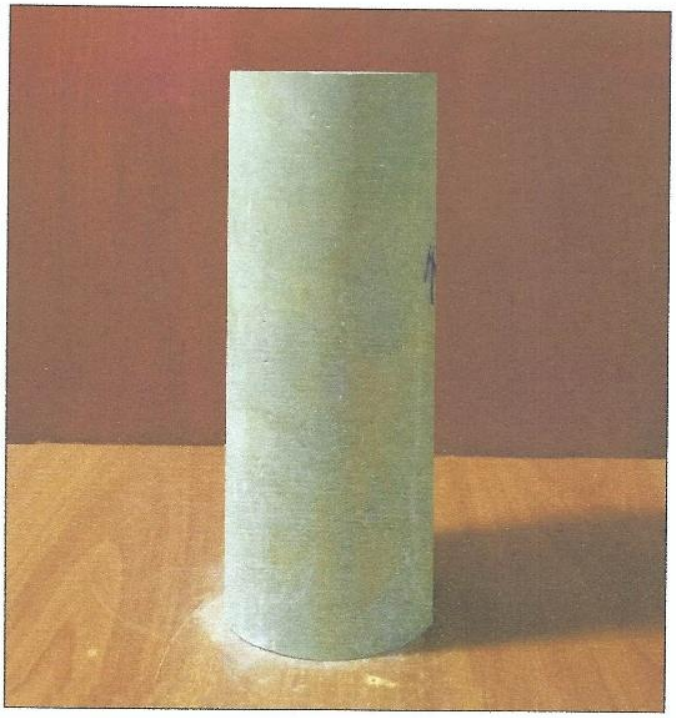
REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3889
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

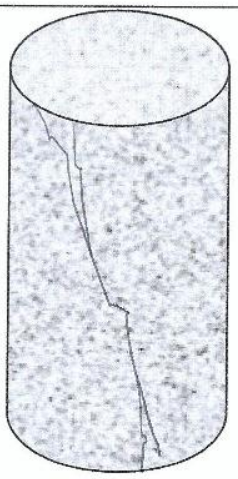
Sample Ref. No.	BH02	**Weight in Air (g):**	2681	**Density (kg/m^3):**	2538
Load at Failure (KN) :	544.4	**Compressive Strength N/mm^2:**	103.1	**Remarks:**	-
Depth(M):	8.00 -8.40m	**Core Diameter (mm) :**	82	**Core Height (mm) :**	200



CORE DESCRIPTION:

S/Ref. No. BH02 (Depth: 8.00-8.40)m

FAILURE MODE



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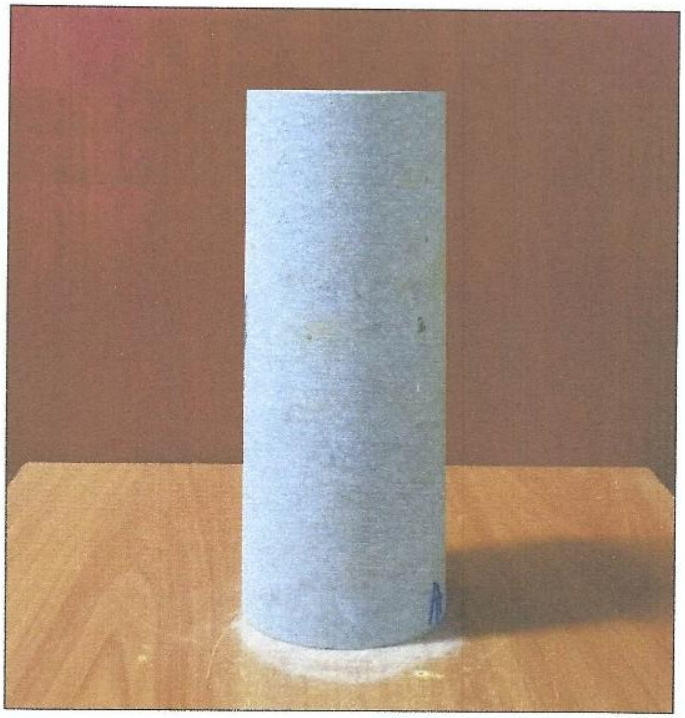
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3890
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

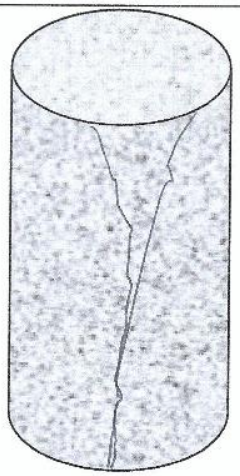
Sample Ref. No.	BH02	**Weight in Air (g):**	2365	**Density (kg/m^3):**	2604
Load at Failure (KN) :	556.7	**Compressive Strength N/mm^2:**	105.4	**Remarks:**	-
Depth(M):	8.40-8.50m	**Core Diameter (mm) :**	82	**Core Height (mm) :**	172



CORE DESCRIPTION:

S/Ref. No. BH02 (Depth: 8.40-8.50)m

FAILURE MODE



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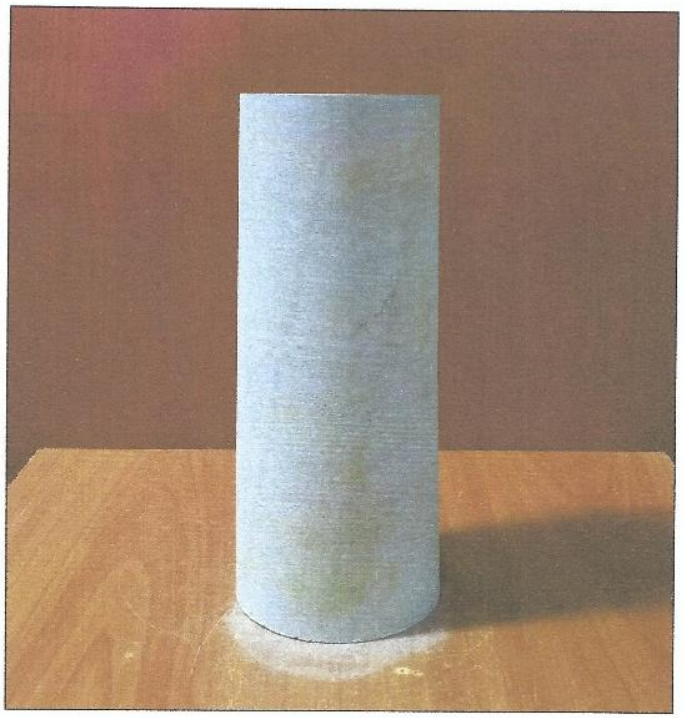
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3891
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

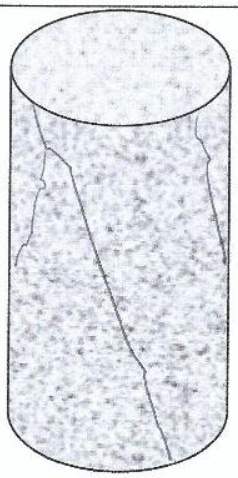
Sample Ref. No.	BH02	**Weight in Air (g):**	2739	**Density (kg/m^3):**	2619
Load at Failure (KN) :	415.1	**Compressive Strength N/mm^2:**	78.6	**Remarks:**	-
Depth(M):	12.15 -12.65m	**Core Diameter (mm) :**	82	**Core Height (mm) :**	198



CORE DESCRIPTION:

S/Ref. No. BH02 (Depth: 12.15-12.65)m

FAILURE MODE



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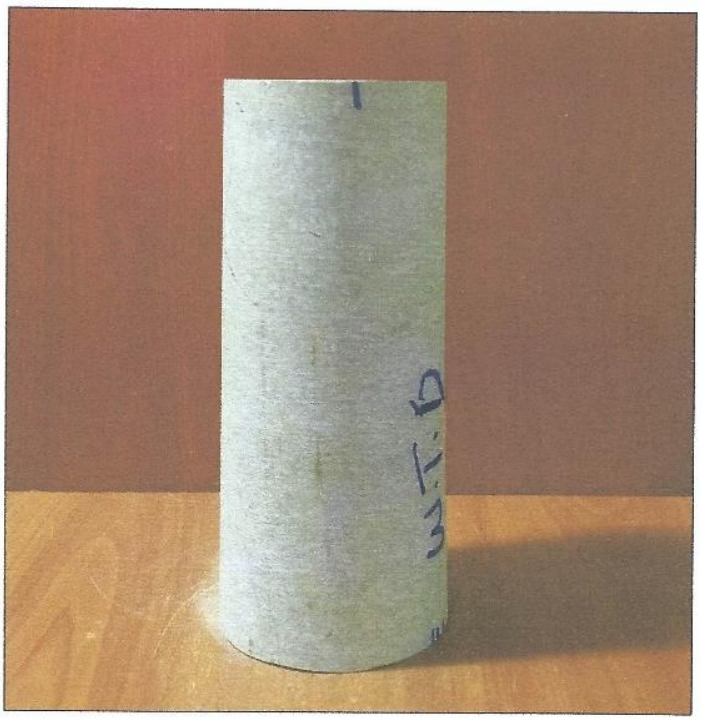
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3892
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

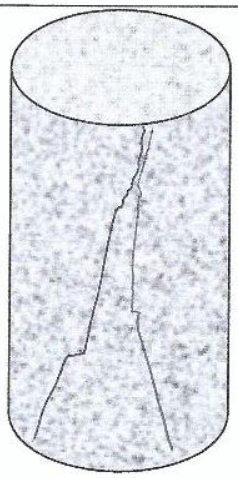
Sample Ref. No.	BH02	**Weight in Air (g):**	2658	**Density (kg/m^3):**	2568
Load at Failure (KN) :	533.2	**Compressive Strength N/mm^2:**	101.0	**Remarks:**	-
Depth(M):	15.30 -16.00m	**Core Diameter (mm) :**	82	**Core Height (mm) :**	196



CORE DESCRIPTION:

S/Ref. No. BH02 (Depth: 15.30-16.00)m

FAILURE MODE



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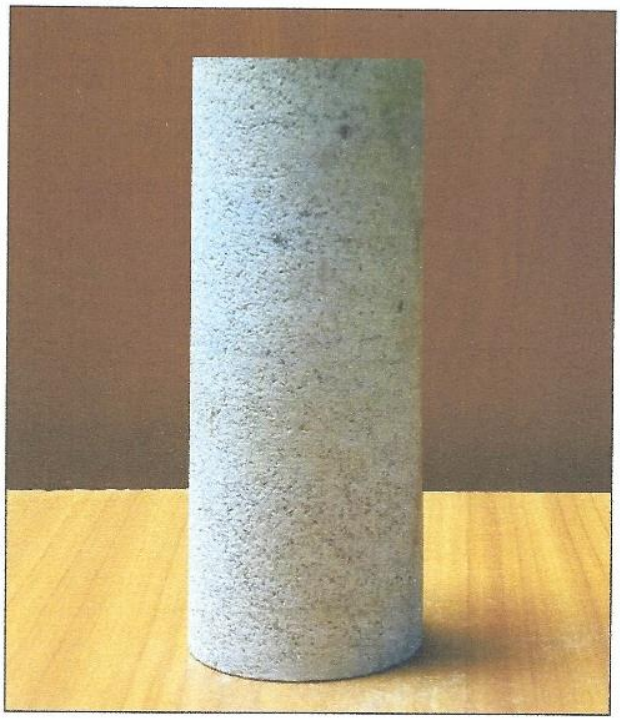
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3894
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

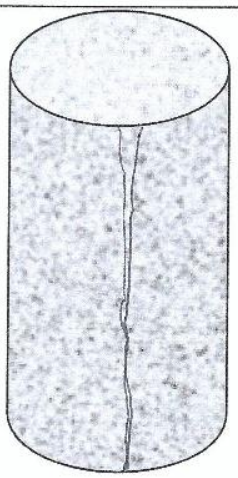
Sample Ref. No.	BH03	**Weight in Air (g):**	1796	**Density (kg/m^3):**	2592
Load at Failure (KN) :	420.5	**Compressive Strength N/mm^2:**	106.2	**Remarks:**	-
Depth(M):	8.24 -9.00m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	175



CORE DESCRIPTION:

S/Ref. No. BH03 (Depth: 8.24-9.00)m

FAILURE MODE



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REGIONAL GEOPHYSICAL SURVEY
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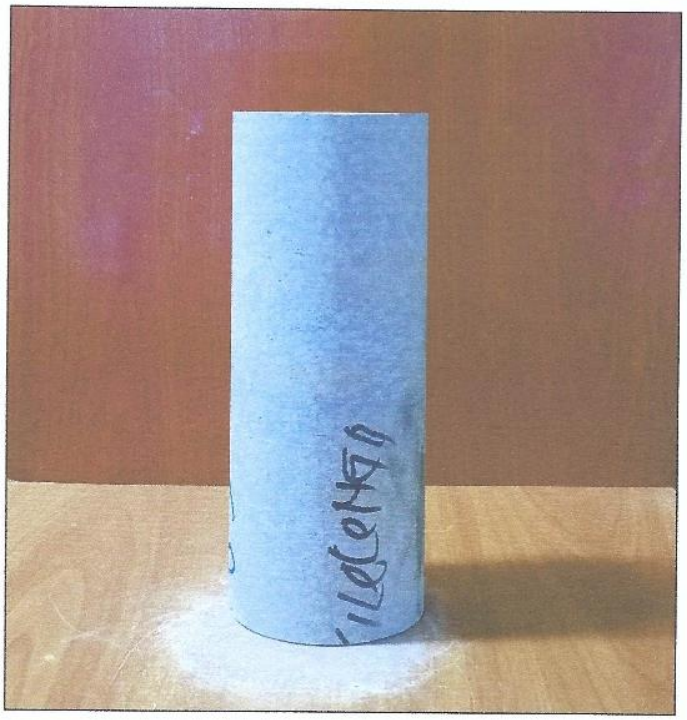
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3895
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

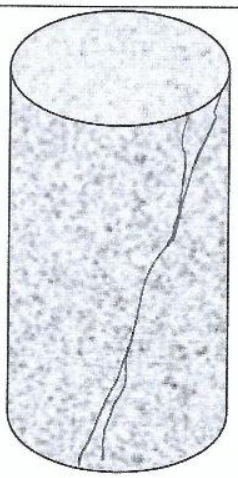
Sample Ref. No.	BH03	**Weight in Air (g):**	1728	**Density (kg/m^3):**	2567
Load at Failure (KN) :	410.4	**Compressive Strength N/mm^2:**	103.7	**Remarks:**	-
Depth(M):	12.30 -12.86m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	170



CORE DESCRIPTION:

S/Ref. No. BH03 (Depth: 12.30-12.86)m

FAILURE MODE



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REGIONAL GEOPHYSICAL SURVEY
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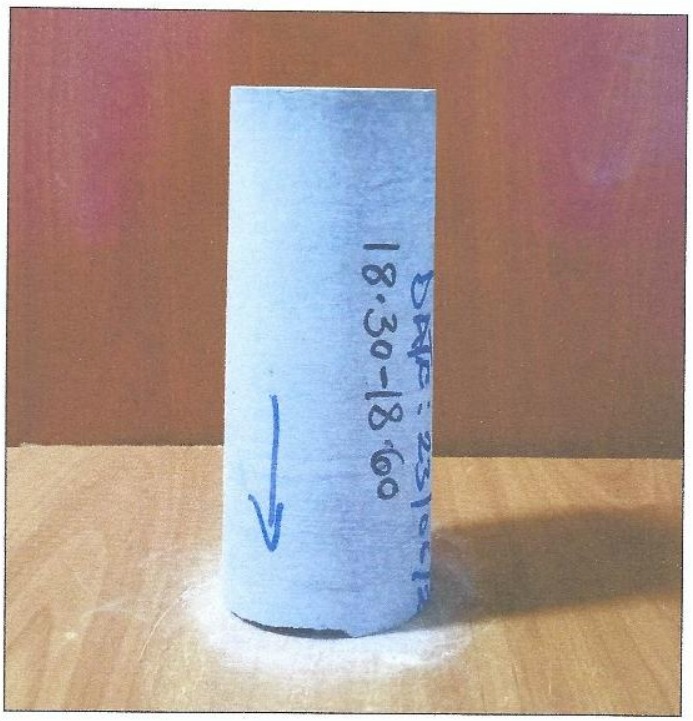
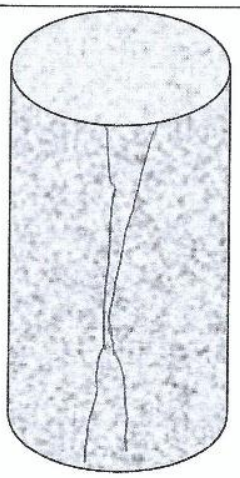
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3896
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

Sample Ref. No.	BH03	**Weight in Air (g):**	1790	**Density (kg/m^3):**	2598
Load at Failure (KN) :	395.3	**Compressive Strength N/mm^2:**	99.8	**Remarks:**	-
Depth(M):	18.30 -18.60m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	174



CORE DESCRIPTION:
S/Ref. No. BH03 (Depth: 18.30-18.60)m
FAILURE MODE



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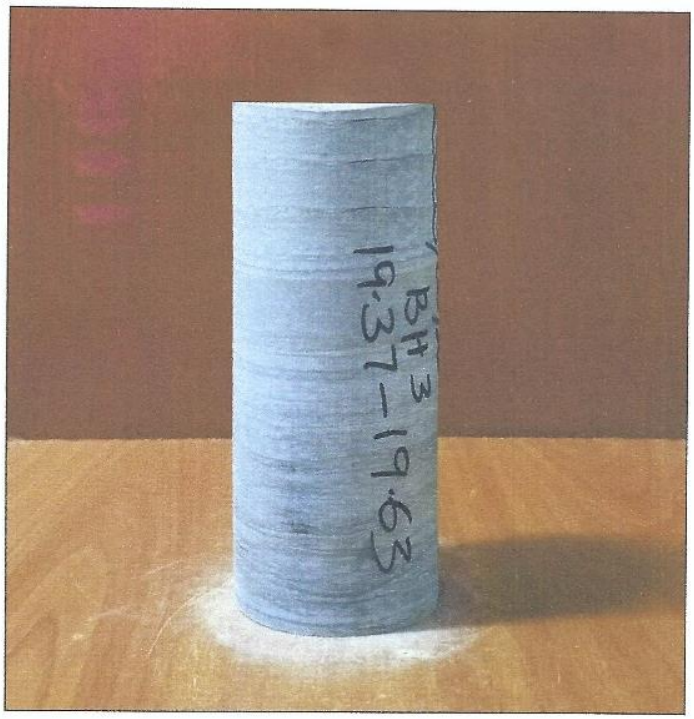
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3897
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

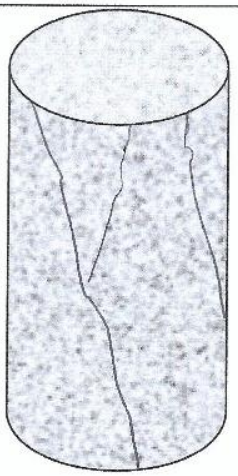
Sample Ref. No.	BH03	**Weight in Air (g):**	1450	**Density (kg/m^3):**	2526
Load at Failure (KN) :	378.2	**Compressive Strength N/mm^2:**	95.5	**Remarks:**	-
Depth(M):	19.37 -19.63m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	145



CORE DESCRIPTION:

S/Ref. No. BH03 (Depth: 19.37-19.63)m

FAILURE MODE



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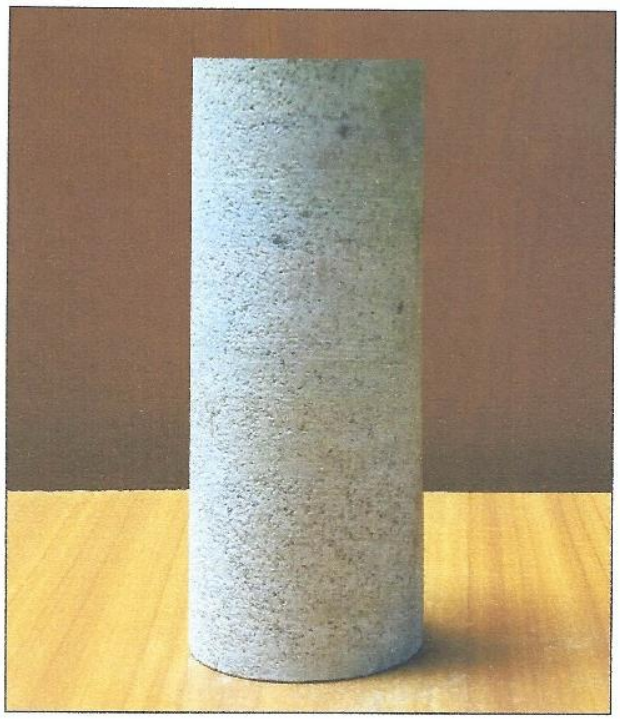
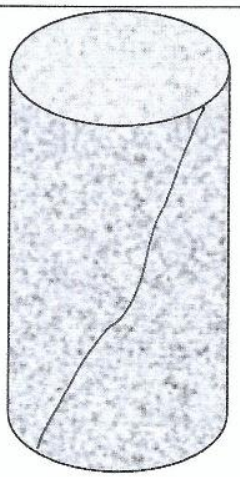
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3899
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

Sample Ref. No.	BH04	**Weight in Air (g):**	1727	**Density (kg/m^3):**	2478
Load at Failure (KN) :	294.4	**Compressive Strength N/mm^2:**	74.4	**Remarks:**	-
Depth(M):	6.00 -6.60m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	176



CORE DESCRIPTION:
S/Ref. No. BH04 (Depth: 6.00-6.60)m
FAILURE MODE



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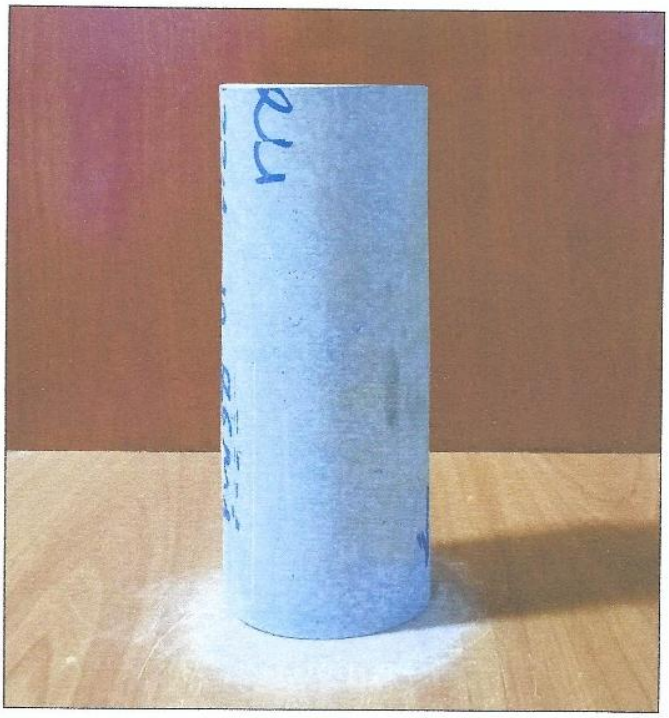
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3900
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

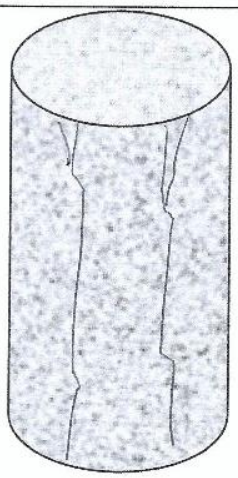
Sample Ref. No.	BH04	**Weight in Air (g):**	1765	**Density (kg/m^3):**	2562
Load at Failure (KN) :	469.8	**Compressive Strength N/mm^2:**	118.7	**Remarks:**	-
Depth(M):	14.58 -14.68m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	174



CORE DESCRIPTION:

S/Ref. No. BH04 (Depth: 14.58-14.68)m

FAILURE MODE



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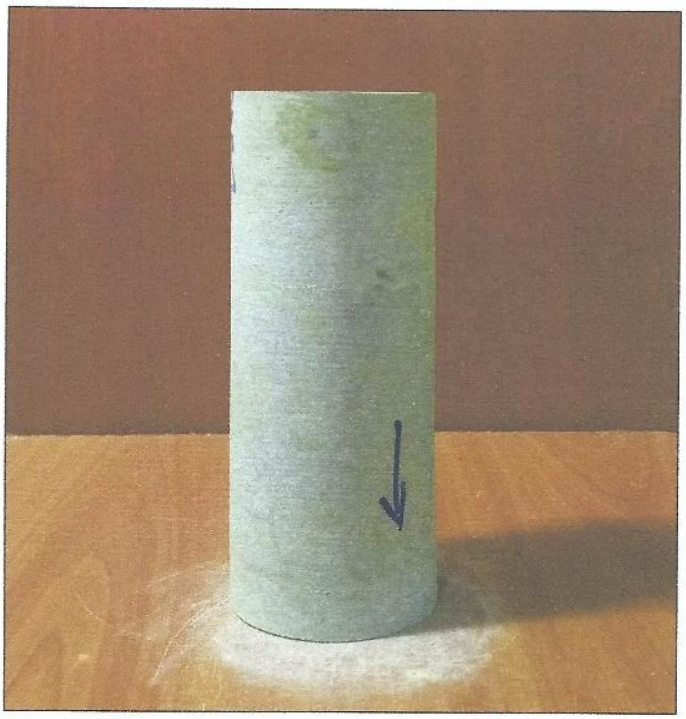
Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3901
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

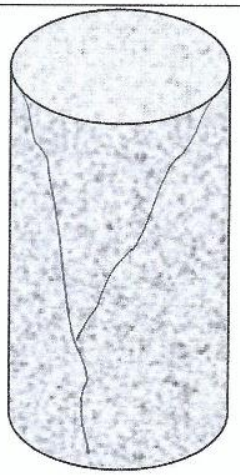
Sample Ref. No.	BH04	**Weight in Air (g):**	1775	**Density (kg/m^3):**	2562
Load at Failure (KN) :	522.6	**Compressive Strength N/mm^2:**	132.0	**Remarks:**	-
Depth(M):	14.68 -14.87m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	175



CORE DESCRIPTION:

S/Ref. No. BH04 (Depth: 14.68-14.87)m

FAILURE MODE



Tested by: KEVIN

Date Reported: 05-08-21

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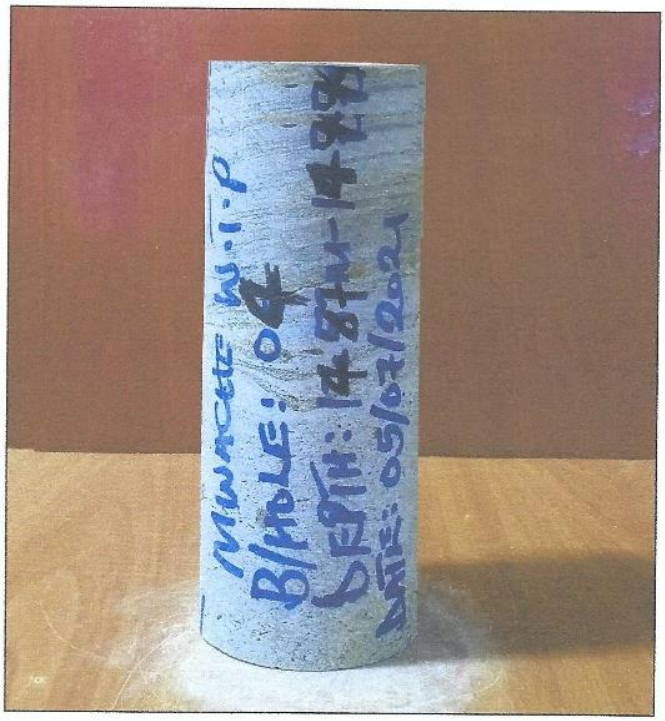
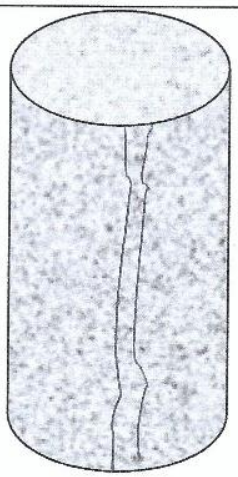
REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3902
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

Sample Ref. No.	BH04	**Weight in Air (g):**	1712	**Density (kg/m^3):**	2605
Load at Failure (KN) :	236.7	**Compressive Strength N/mm^2:**	59.8	**Remarks:**	-
Depth(M):	14.87 -14.99m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	166



CORE DESCRIPTION:
S/Ref. No. BH04 (Depth: 14.87-14.99)m
FAILURE MODE



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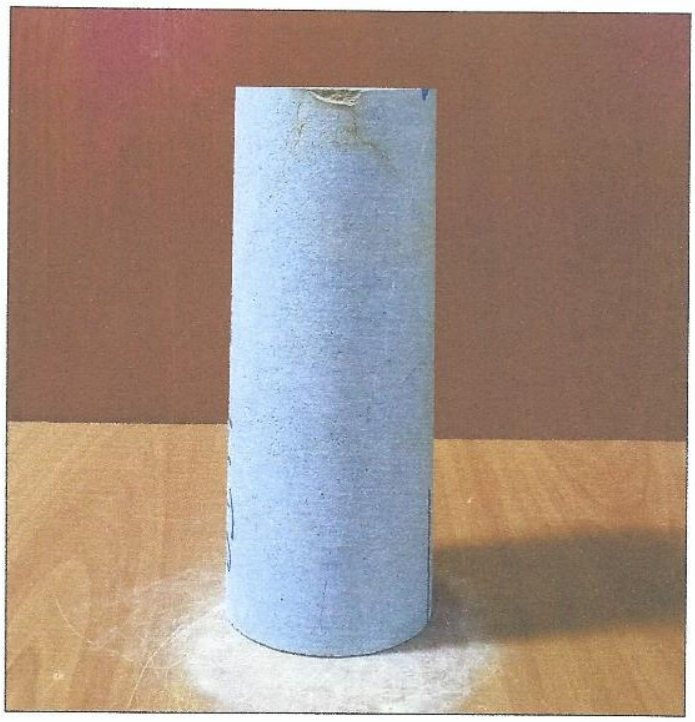
REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3903
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

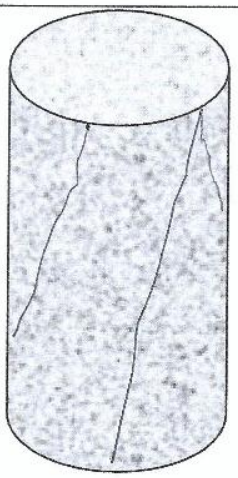
Sample Ref. No.	BH04	**Weight in Air (g):**	1847	**Density (kg/m^3):**	2636
Load at Failure (KN) :	327.3	**Compressive Strength N/mm^2:**	82.7	**Remarks:**	-
Depth(M):	19.23 -19.74m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	177



CORE DESCRIPTION:

S/Ref. No. BH04 (Depth: 19.23-19.74)m

FAILURE MODE



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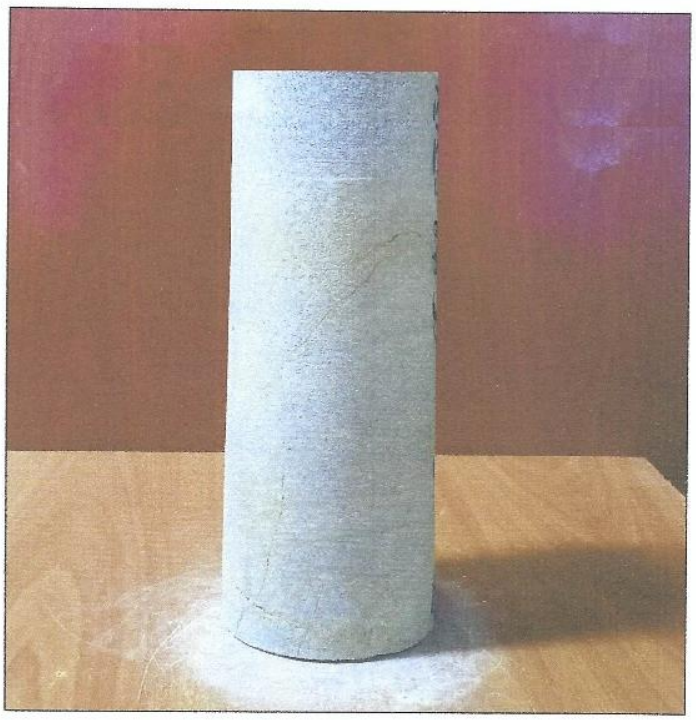
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3905
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

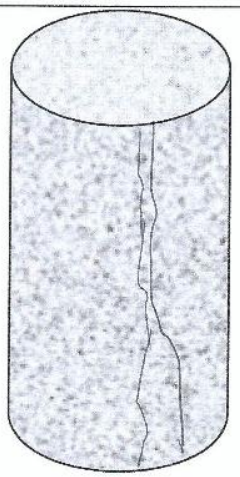
Sample Ref. No.	BH05	**Weight in Air (g):**	1687	**Density (kg/m^3):**	2449
Load at Failure (KN) :	241.7	**Compressive Strength N/mm^2:**	61.0	**Remarks:**	-
Depth(M):	5.32 -6.65m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	174



CORE DESCRIPTION:

S/Ref. No. BH05 (Depth: 5.32-5.65)m

FAILURE MODE



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REGIONAL GEOPHYSICAL SURVEY
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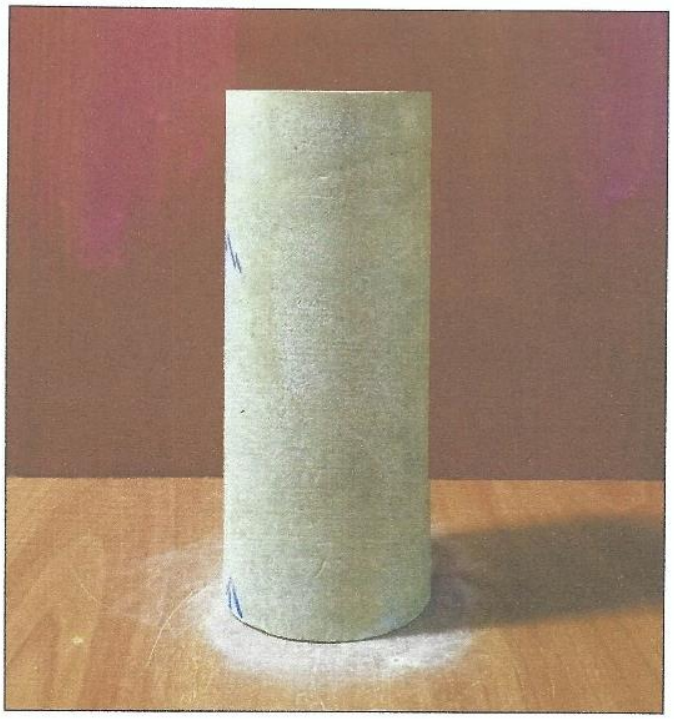
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3906
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

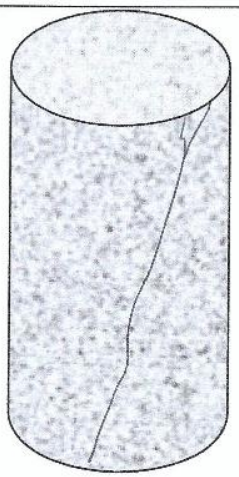
Sample Ref. No.	BH05	**Weight in Air (g):**	1705	**Density (kg/m^3):**	2475
Load at Failure (KN) :	325.2	**Compressive Strength N/mm^2:**	82.1	**Remarks:**	-
Depth(M):	5.69 -5.90m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	174



CORE DESCRIPTION:

S/Ref. No. BH05 (Depth: 5.69-5.90)m

FAILURE MODE



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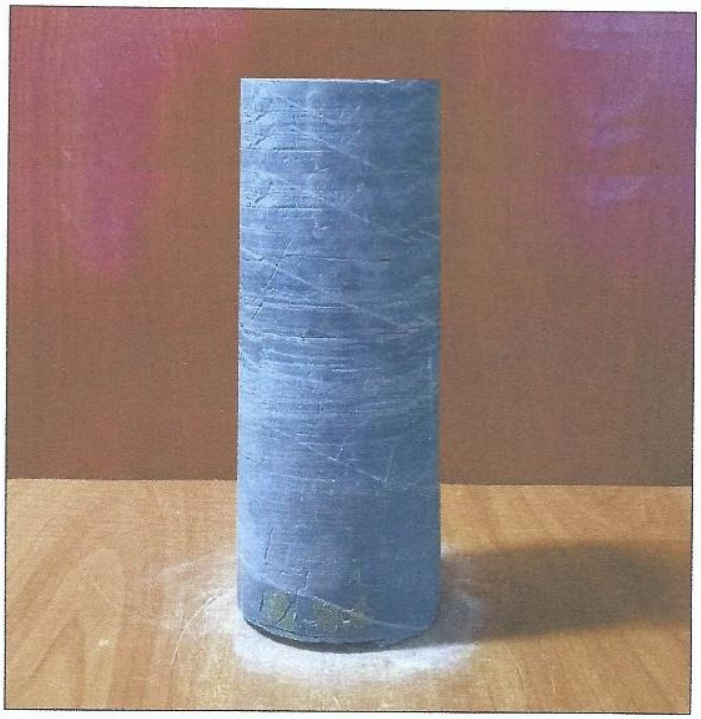
REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3907
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

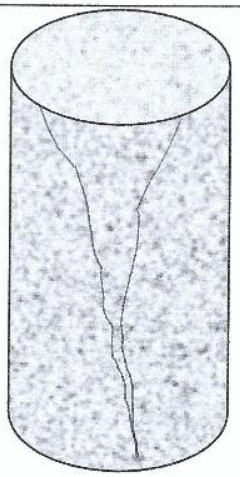
Sample Ref. No.	BH05	**Weight in Air (g):**	1600	**Density (kg/m^3):**	2510
Load at Failure (KN) :	62.1	**Compressive Strength N/mm^2:**	15.7	**Remarks:**	-
Depth(M):	14.08 -14.47m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	161



CORE DESCRIPTION:

S/Ref. No. BH05 (Depth: 14.08-14.47)m

FAILURE MODE



Tested by: KEVIN

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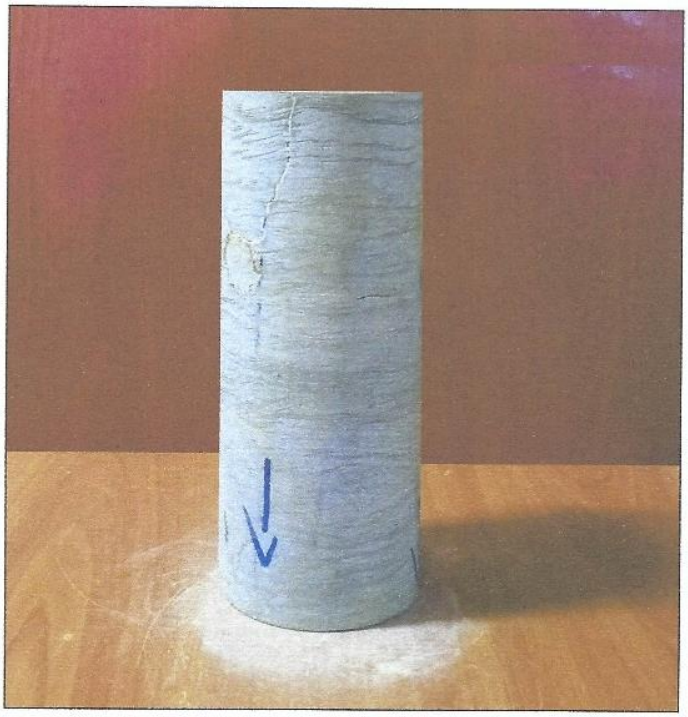
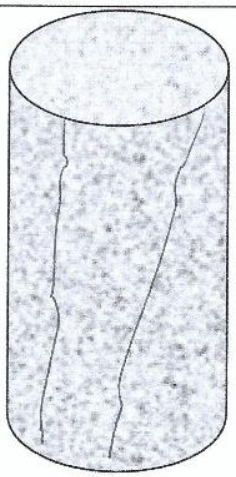
REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3908
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

Sample Ref. No.	BH05	**Weight in Air (g):**	1797	**Density (kg/m^3):**	2624
Load at Failure (KN) :	481.9	**Compressive Strength N/mm^2:**	121.7	**Remarks:**	-
Depth(M):	16.36 -16.50m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	173



CORE DESCRIPTION:
S/Ref. No. BH05 (Depth: 16.36-16.50)m
FAILURE MODE



Tested by: KEVIN

Date Reported: 05-08-21

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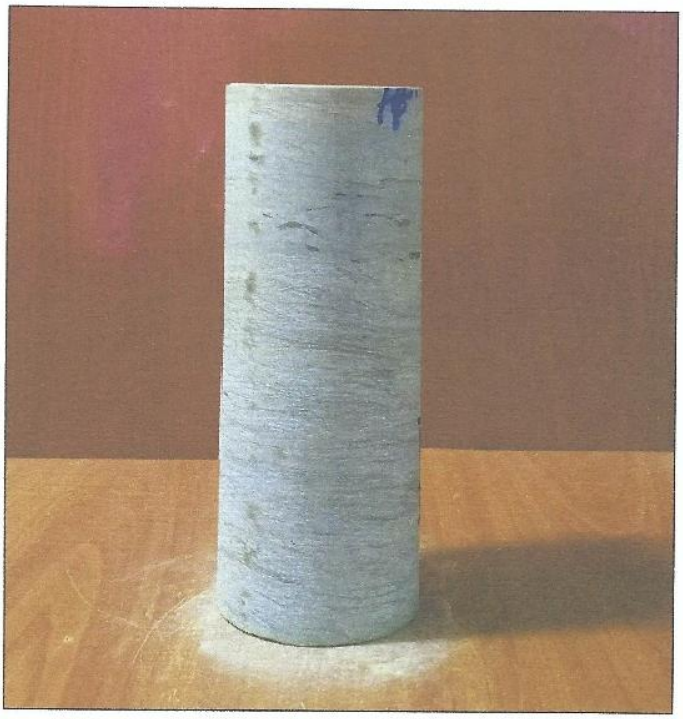
REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3909
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

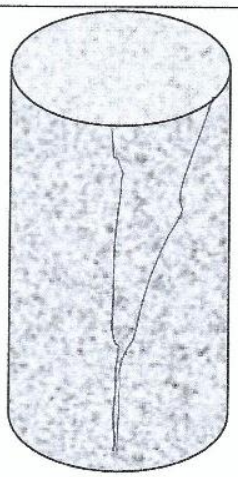
Sample Ref. No.	BH05	**Weight in Air (g):**	1889	**Density (kg/m^3):**	2696
Load at Failure (KN) :	460.8	**Compressive Strength N/mm^2:**	116.4	**Remarks:**	-
Depth(M):	17.16 -17.36m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	177



CORE DESCRIPTION:

S/Ref. No. BH05 (Depth: 17.16-17.36)m

FAILURE MODE



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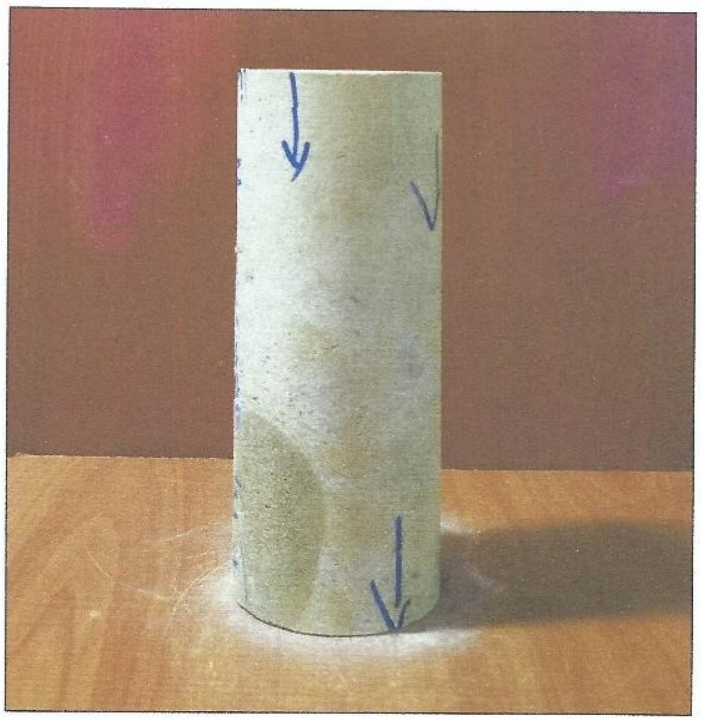
REGIONAL GEOPHYSICAL SURVEY
MWACHE WATER TREATMENT PLANT
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3911
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

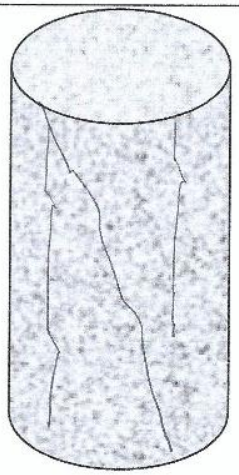
Sample Ref. No.	BH06	**Weight in Air (g):**	1605	**Density (kg/m^3):**	2371
Load at Failure (KN) :	126.8	**Compressive Strength N/mm^2:**	32.0	**Remarks:**	-
Depth(M):	6.47 - 6.77m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	171



CORE DESCRIPTION:

S/Ref. No. BH06 (Depth: 6.47-6.77)m

FAILURE MODE



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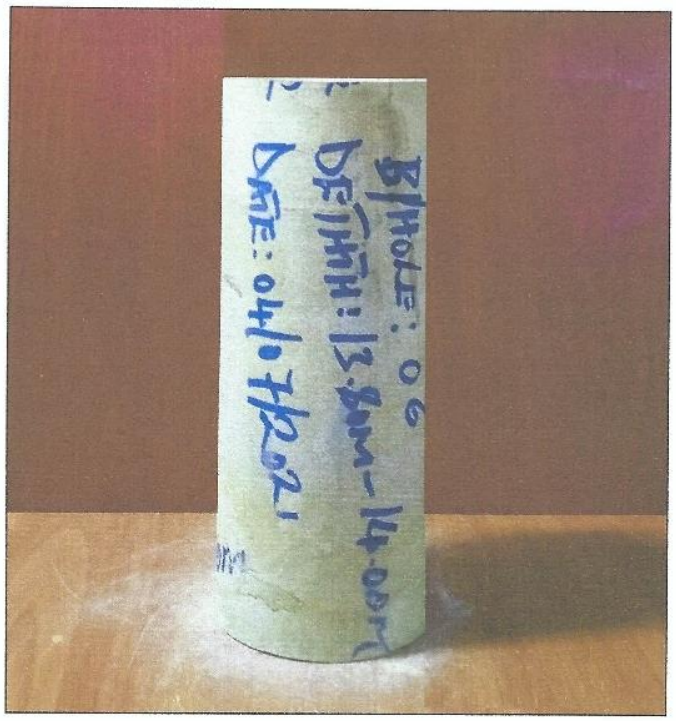
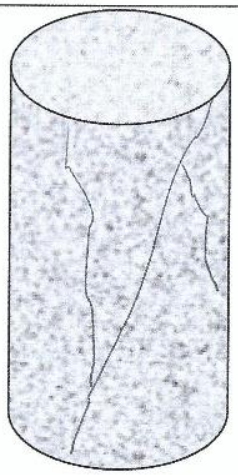
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3912
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

Sample Ref. No.	BH06	**Weight in Air (g):**	1624	**Density (kg/m^3):**	2399
Load at Failure (KN) :	139.0	**Compressive Strength N/mm^2:**	35.1	**Remarks:**	-
Depth(M):	13.80 - 14.0m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	171



CORE DESCRIPTION:
S/Ref. No. BH06 (Depth: 13.80-14.00)m
FAILURE MODE



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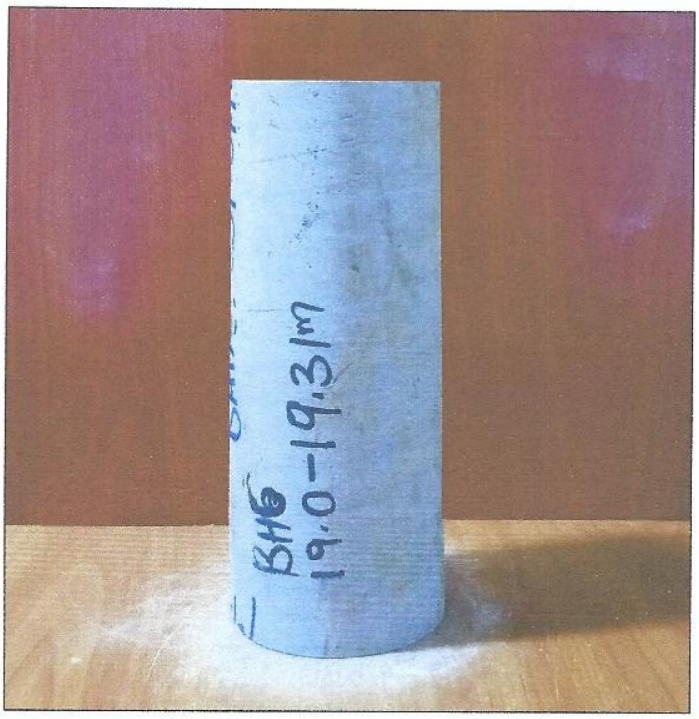
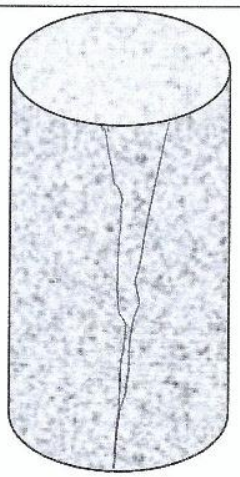
UNCONFINED COMPRESSIVE STRENGTH OF NATURAL ROCK CORES
ASTM D 7012 - 04

Site:	MWACHE WTP	**Location:**	KWALE	**Date Received:**	23-07-21
Client:	REGIONAL GEOPHYSICAL SURVEY	**County:**	KWALE	**Lab Ref:**	CORE/RGS–MWACHE/3913
Sampled By:	REGIONAL GEOPHYSICAL SURVEY			**Date Tested:**	03-08-21

Sample Ref. No.	BH06	**Weight in Air (g):**	1760	**Density (kg/m^3):**	2540
Load at Failure (KN) :	458.4	**Compressive Strength N/mm^2:**	115.8	**Remarks:**	-
Depth(M):	19.0 - 19.31m	**Core Diameter (mm) :**	71	**Core Height (mm) :**	175



CORE DESCRIPTION:
S/Ref. No. BH06 (Depth: 19.00-19.31)m
FAILURE MODE



Tested by: KEVIN

Date Reported: 05-08-21

Checked by:

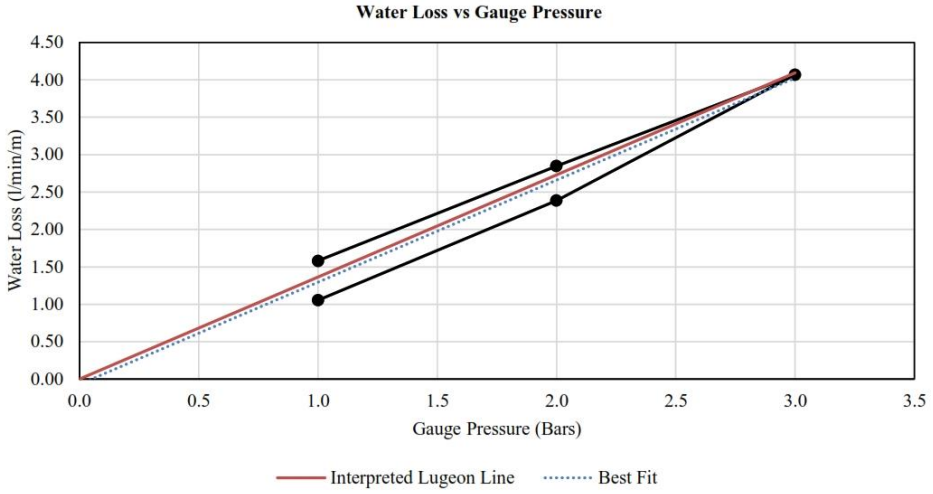
APPENDIX D

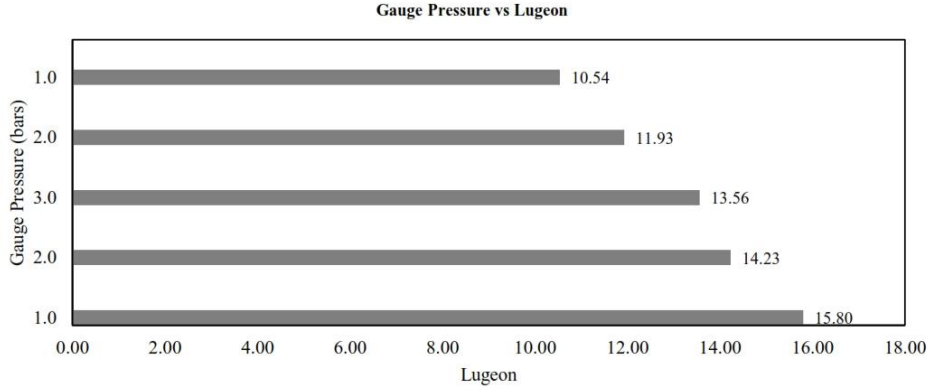
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH1	**DATE:**	23/5/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		9	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	4	**TO (m):** 9	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		7	**WATER LEVEL AFTER (m):**		6
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	11:07	0	4.0410				
		5	4.0762	0.00704	1.58	15.80	2.05E-05
		5	4.1200	0.00876			
2		0	4.1216				
		5	4.1937	0.01442	2.85	14.23	1.85E-05
		5	4.2639	0.01404			
3		0	4.2654				
		5	4.3628	0.01948	4.07	13.56	1.76E-05
		5	4.4688	0.02120			
2		0	4.4727				
		5	4.5313	0.01172	2.39	11.93	1.55E-05
		5	4.5920	0.01214			
1		0	4.5922				
		5	4.6211	0.00578	1.05	10.54	1.37E-05
	12:07	5	4.6449	0.00476			
				Interpreted Lugeon Value =		**13.65**	





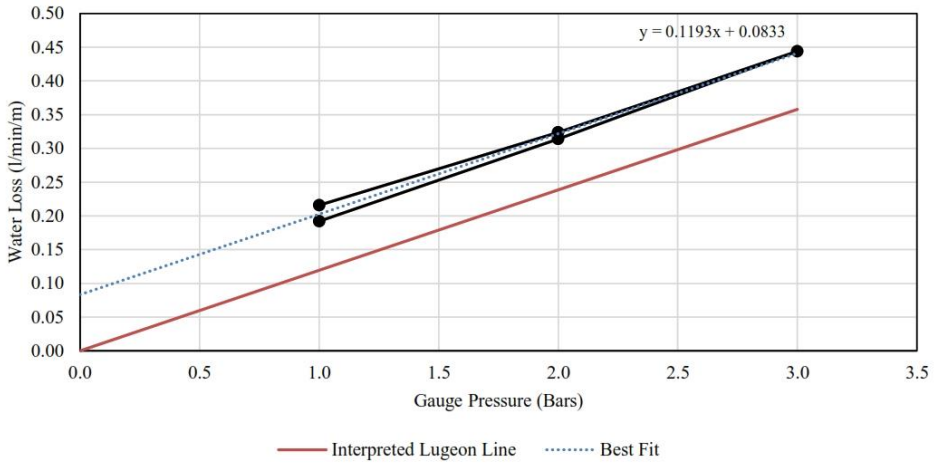
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

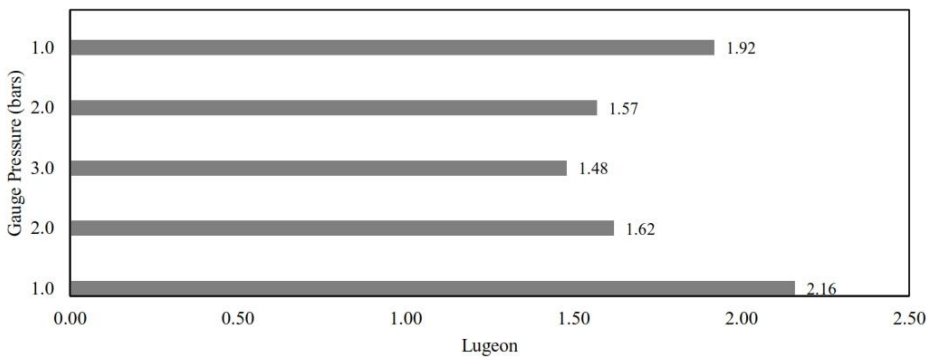
PROJECT:	MWACHE DAM	**BH NO.:**	BH1	**DATE:**	24/5/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		14	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	9	**TO (m):** 14	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		8.9	**WATER LEVEL AFTER (m):**		7.5
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	8:03	0	4.6583				
		5	4.6639	0.00112	0.22	2.16	2.81E-06
		5	4.6691	0.00104			
2		0	4.6699				
		5	4.6779	0.00160	0.32	1.62	2.11E-06
		5	4.6861	0.00164			
3		0	4.6871				
		5	4.6983	0.00224	0.44	1.48	1.92E-06
		5	4.7093	0.00220			
2		0	4.7101				
		5	4.7179	0.00156	0.31	1.57	2.04E-06
		5	4.7258	0.00158			
1		0	4.7265				
		5	4.7312	0.00094	0.19	1.92	2.50E-06
	9:03	5	4.7361	0.00098			
				Interpreted Lugeon Value =		**1.19**	

Water Loss vs Gauge Pressure



Gauge Pressure vs Lugeon

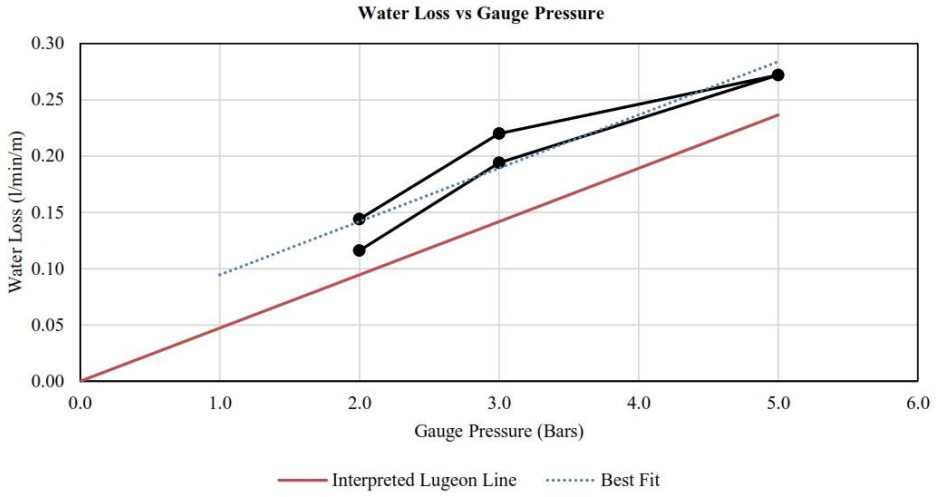


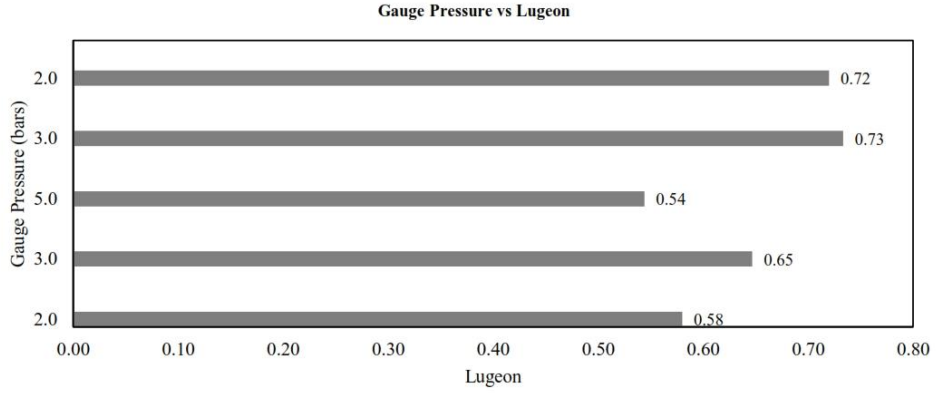
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH1	**DATE:**	24/5/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		14	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	14	**TO (m):**	19	**SINGLE PARKER/ DOUBLE PACKER:**	SINGLE
WATER LEVEL BEFORE (m):		9.1	**WATER LEVEL AFTER (m):**		8.8
SUPERVISOR:		SOLOMON KIMONGE	**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
2	14:17	0	4.7464				
		5	4.7494	0.00060	0.12	0.58	7.54E-07
		5	4.7522	0.00056			
3		0	4.7528				
		5	4.7575	0.00094	0.19	0.65	8.41E-07
		5	4.7625	0.00100			
5		0	4.7635				
		5	4.7703	0.00136	0.27	0.54	7.07E-07
		5	4.7771	0.00136			
3		0	4.7779				
		5	4.7833	0.00108	0.22	0.73	9.53E-07
		5	4.7889	0.00112			
2		0	4.7895				
		5	4.7932	0.00074	0.14	0.72	9.36E-07
	15:17	5	4.7967	0.00070			
				Interpreted Lugeon Value =		**0.47**	





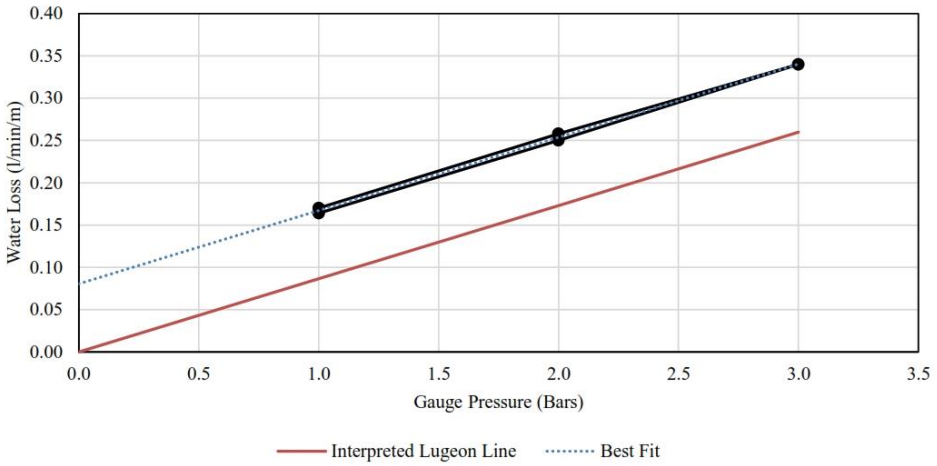
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

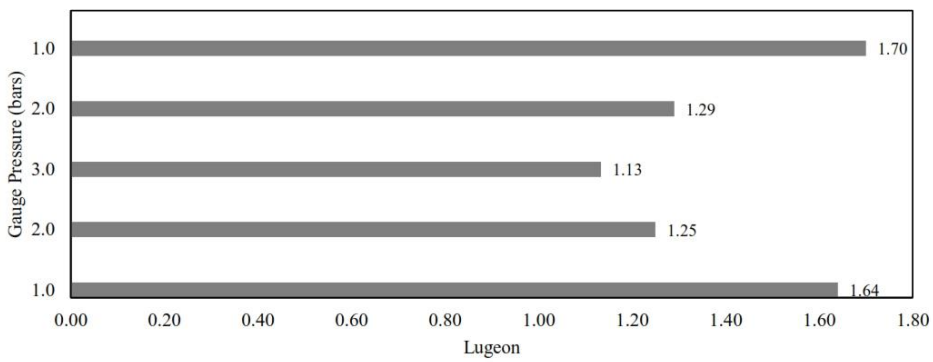
PROJECT:	MWACHE DAM	**BH NO.:**	BH2	**DATE:**	22/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		8	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	3	**TO (m):** 8	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		3.6	**WATER LEVEL AFTER (m):**		3.2
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	9:08	0	8.0344				
		5	8.0385	0.00082	0.16	1.64	2.13E-06
		5	8.0426	0.00082			
2		0	8.0430				
		5	8.0492	0.00124	0.25	1.25	1.63E-06
		5	8.0555	0.00126			
3		0	8.0561				
		5	8.0646	0.00170	0.34	1.13	1.47E-06
		5	8.0731	0.00170			
2		0	8.0736				
		5	8.0800	0.00128	0.26	1.29	1.68E-06
		5	8.0865	0.00130			
1		0	8.0867				
		5	8.0909	0.00084	0.17	1.70	2.21E-06
	10:08	5	8.0952	0.00086			
				Interpreted Lugeon Value =		**0.87**	

Water Loss vs Gauge Pressure



Gauge Pressure vs Lugeon

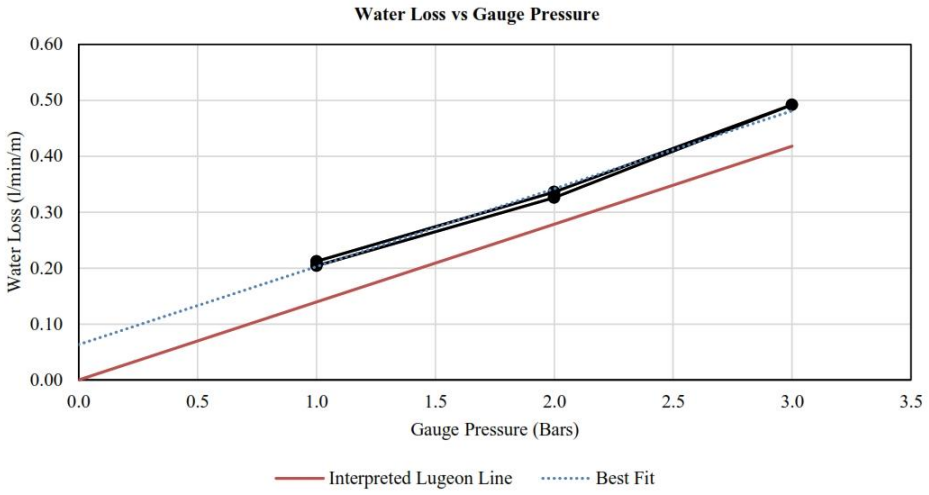


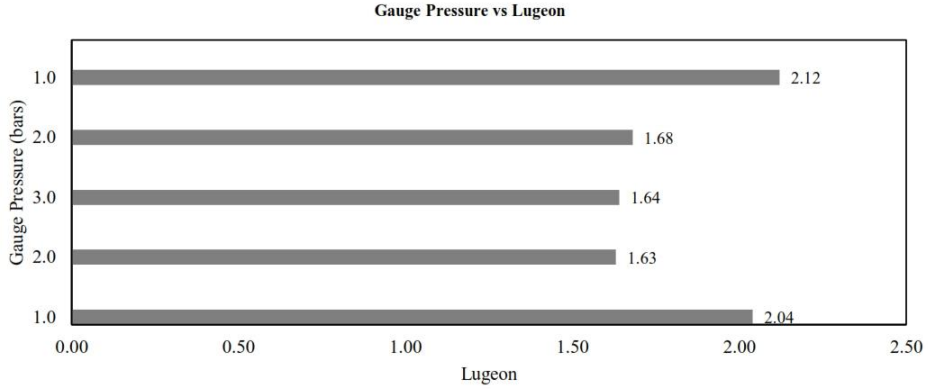
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH2	**DATE:**	22/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		13	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	8	**TO (m):** 13	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		4.9	**WATER LEVEL AFTER (m):**		4.5
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	14:03	0	8.0993				
		5	8.1044	0.00102	0.20	2.04	2.65E-06
		5	8.1095	0.00102			
2		0	8.1098				
		5	8.1179	0.00162	0.33	1.63	2.12E-06
		5	8.1261	0.00164			
3		0	8.1269				
		5	8.1391	0.00244	0.49	1.64	2.13E-06
		5	8.1515	0.00248			
2		0	8.1520				
		5	8.1603	0.00166	0.34	1.68	2.18E-06
		5	8.1688	0.00170			
1		0	8.1694				
		5	8.1746	0.00104	0.21	2.12	2.76E-06
	15:03	5	8.1800	0.00108			
				Interpreted Lugeon Value =		**1.39**	



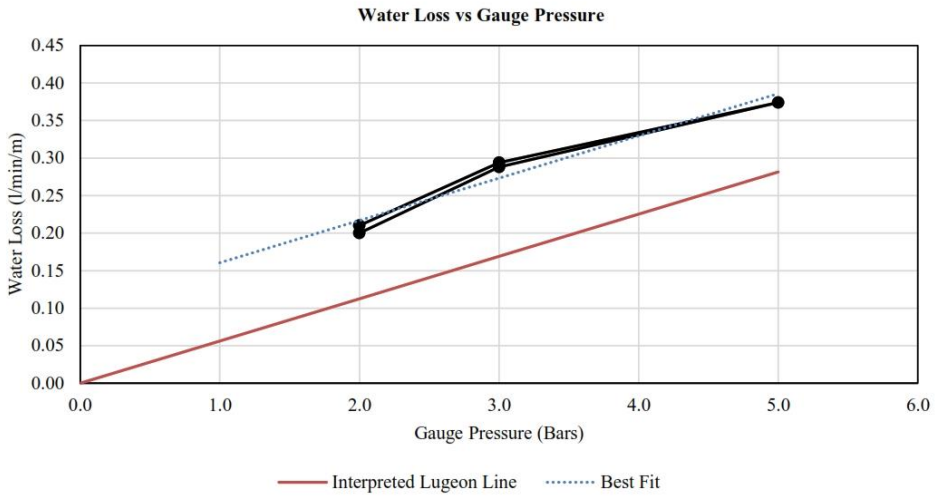


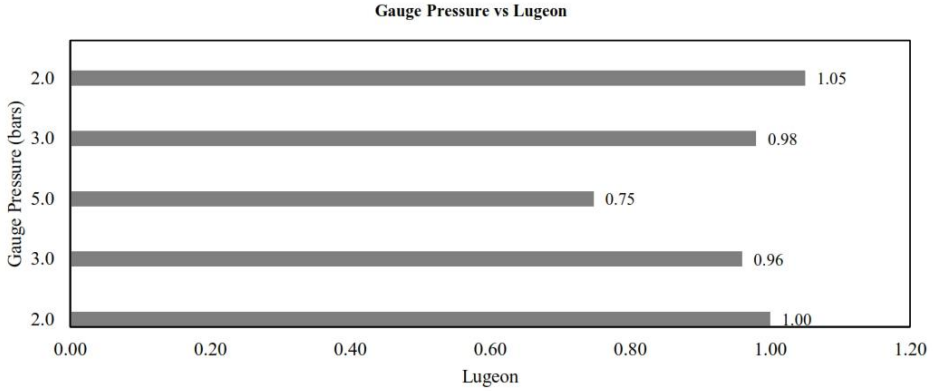
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH2	**DATE:**	22/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		18	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	13	**TO (m):** 18	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		5	**WATER LEVEL AFTER (m):**		4.8
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
2	17:29	0	8.2127				
		5	8.2177	0.00100	0.20	1.00	1.30E-06
		5	8.2227	0.00100			
3		0	8.2233				
		5	8.2304	0.00142	0.29	0.96	1.25E-06
		5	8.2377	0.00146			
5		0	8.2382				
		5	8.2474	0.00184	0.37	0.75	9.72E-07
		5	8.2569	0.00190			
3		0	8.2573				
		5	8.2646	0.00146	0.29	0.98	1.27E-06
		5	8.2720	0.00148			
2		0	8.2722				
		5	8.2774	0.00104	0.21	1.05	1.37E-06
	18:29	5	8.2827	0.00106			
				Interpreted Lugeon Value =		**0.56**	



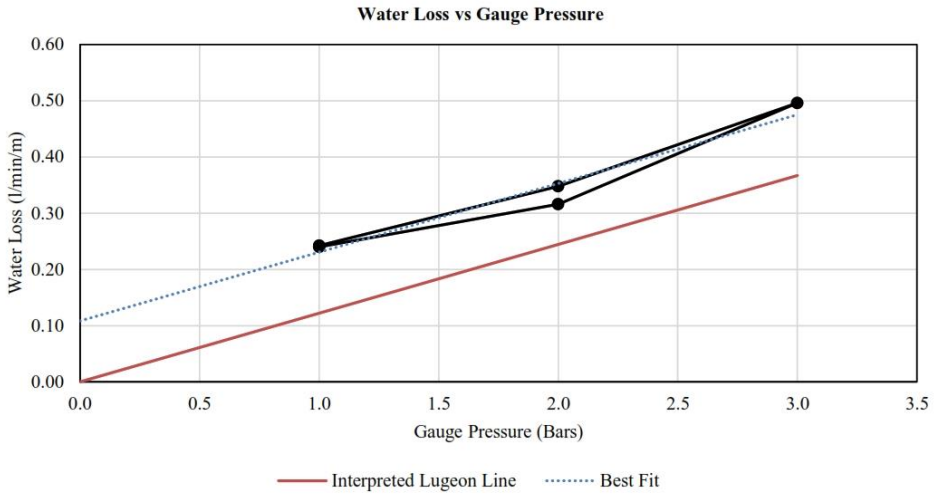


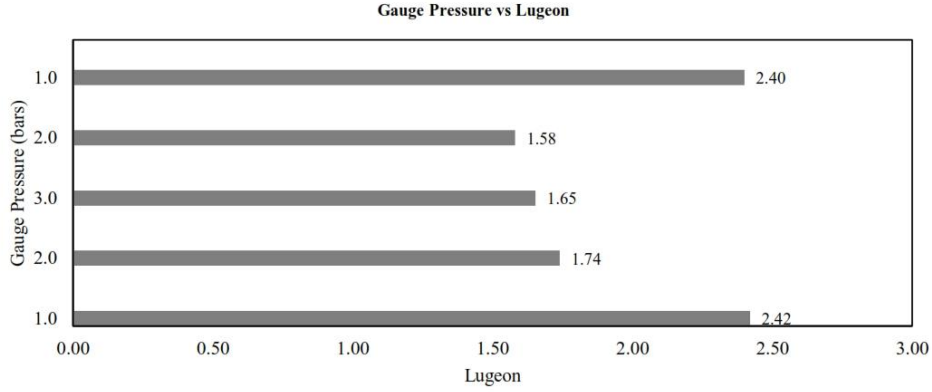
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH3	**DATE:**	21/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		9	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	4	**TO (m):** 9	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		3.2	**WATER LEVEL AFTER (m):**		2.8
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	8:38	0	0.4321				
		5	0.4382	0.00122	0.24	2.42	3.15E-06
		5	0.4442	0.00120			
2		0	0.4447				
		5	0.4533	0.00172	0.35	1.74	2.26E-06
		5	0.4621	0.00176			
3		0	0.4629				
		5	0.4752	0.00246	0.50	1.65	2.15E-06
		5	0.4877	0.00250			
2		0	0.4881				
		5	0.4959	0.00156	0.32	1.58	2.05E-06
		5	0.5039	0.00160			
1		0	0.5042				
		5	0.5102	0.00120	0.24	2.40	3.12E-06
	9:38	5	0.5162	0.00120			
				Interpreted Lugeon Value =		**1.22**	



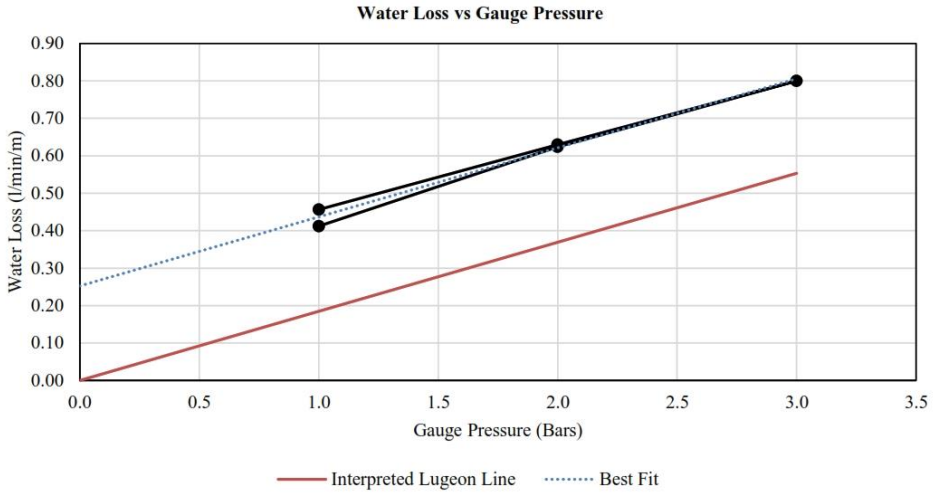


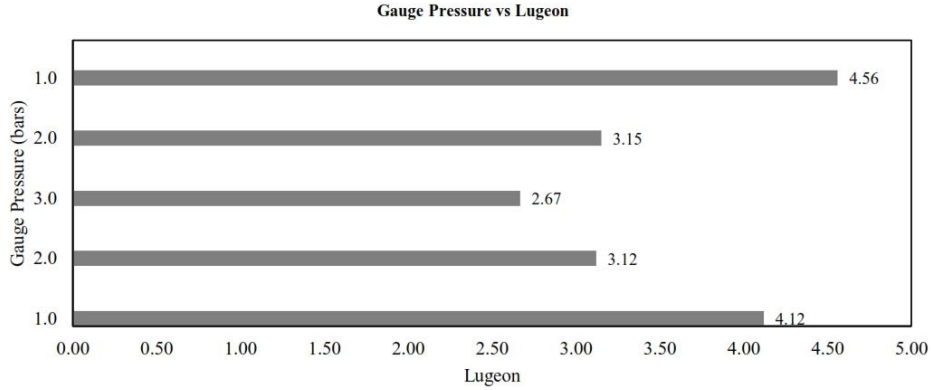
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH3	**DATE:**	22/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		14	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	9	**TO (m):** 14	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		3.9	**WATER LEVEL AFTER (m):**		3.5
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	10:15	0	0.5647				
		5	0.5749	0.00204	0.41	4.12	5.36E-06
		5	0.5853	0.00208			
2		0	0.5860				
		5	0.6016	0.00312	0.62	3.12	4.06E-06
		5	0.6172	0.00312			
3		0	0.6184				
		5	0.6384	0.00400	0.80	2.67	3.47E-06
		5	0.6584	0.00400			
2		0	0.6589				
		5	0.6746	0.00314	0.63	3.15	4.10E-06
		5	0.6904	0.00316			
1		0	0.6908				
		5	0.7011	0.00206	0.46	4.56	5.93E-06
	11:15	5	0.7136	0.00250			
				Interpreted Lugeon Value =		**1.84**	



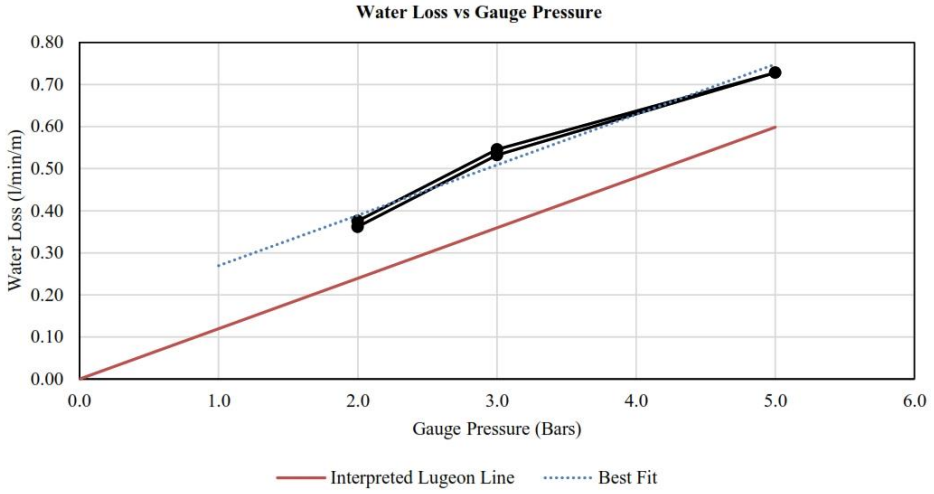


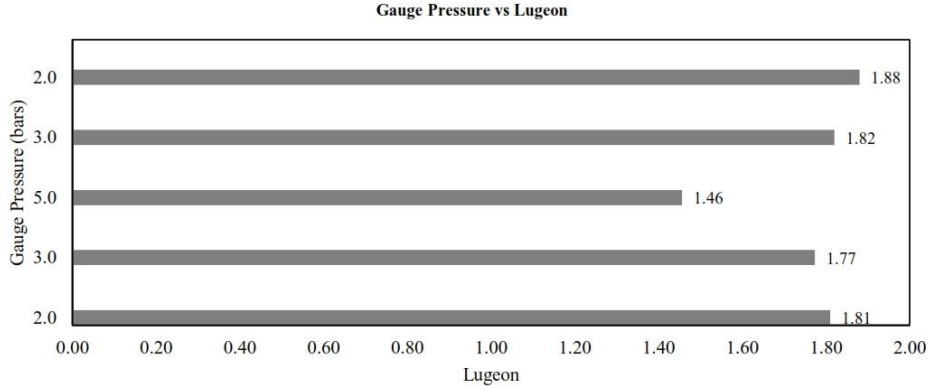
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH3	**DATE:**	23/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		19	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	14	**TO (m):** 19	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		6.2	**WATER LEVEL AFTER (m):**		5.7
SUPERVISOR:		SOLOMON KIMONGE	**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
2	14:06	0	0.7299				
		5	0.7388	0.00178	0.36	1.81	2.35E-06
		5	0.7480	0.00184			
3		0	0.7492				
		5	0.7624	0.00264	0.53	1.77	2.31E-06
		5	0.7758	0.00268			
5		0	0.7772				
		5	0.7954	0.00364	0.73	1.46	1.89E-06
		5	0.8136	0.00364			
3		0	0.8144				
		5	0.8280	0.00272	0.55	1.82	2.37E-06
		5	0.8417	0.00274			
2		0	0.8425				
		5	0.8519	0.00188	0.38	1.88	2.44E-06
	15:06	5	0.8613	0.00188			
				Interpreted Lugeon Value =		**1.20**	





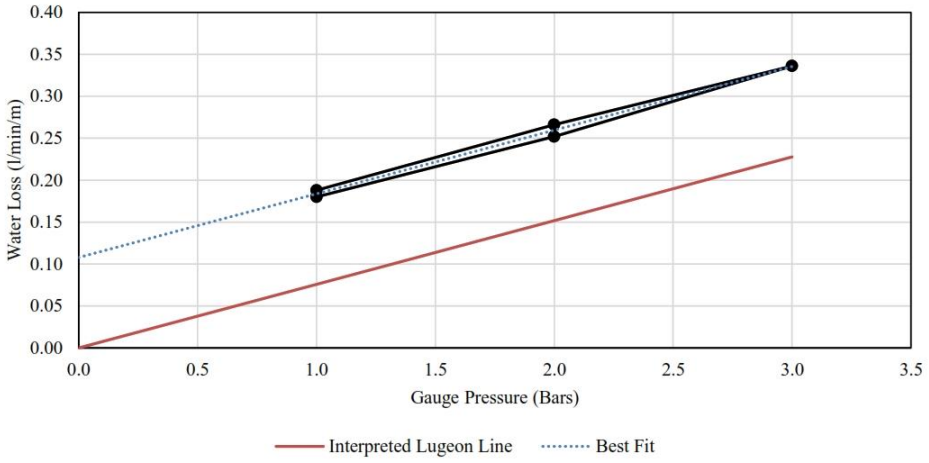
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

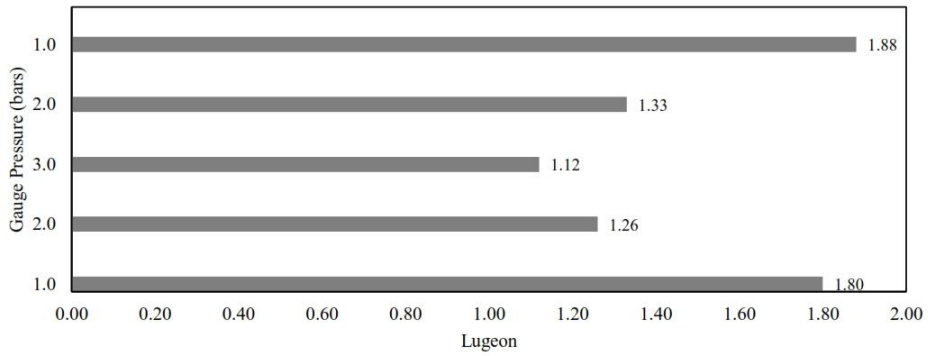
PROJECT:	MWACHE DAM	**BH NO.:**	BH4	**DATE:**	1/7/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		8	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	3	**TO (m):** 8	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		3.3	**WATER LEVEL AFTER (m):**		2.8
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	16:30	0	0.1292				
		5	0.1337	0.00090	0.18	1.80	2.34E-06
		5	0.1382	0.00090			
2		0	0.1384				
		5	0.1446	0.00124	0.25	1.26	1.64E-06
		5	0.1510	0.00128			
3		0	0.1514				
		5	0.1598	0.00168	0.34	1.12	1.46E-06
		5	0.1682	0.00168			
2		0	0.1685				
		5	0.1751	0.00132	0.27	1.33	1.73E-06
		5	0.1818	0.00134			
1		0	0.1820				
		5	0.1867	0.00094	0.19	1.88	2.44E-06
	17:30	5	0.1914	0.00094			
				Interpreted Lugeon Value =		**0.76**	

Water Loss vs Gauge Pressure



Gauge Pressure vs Lugeon



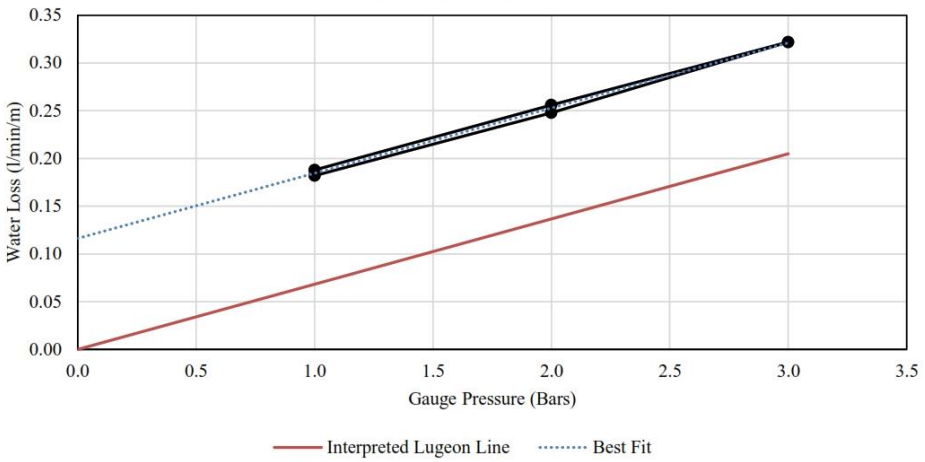
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

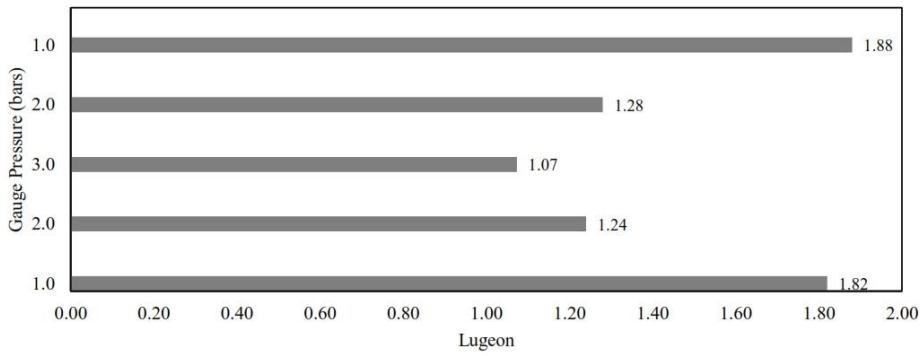
PROJECT:	MWACHE DAM	**BH NO.:**	BH4	**DATE:**	3/7/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		14	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	9	**TO (m):** 14	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		4	**WATER LEVEL AFTER (m):**		3.8
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	12:10	0	0.2420				
		5	0.2465	0.00090	0.18	1.82	2.37E-06
		5	0.2511	0.00092			
2		0	0.2517				
		5	0.2578	0.00122	0.25	1.24	1.61E-06
		5	0.2641	0.00126			
3		0	0.2646				
		5	0.2726	0.00160	0.32	1.07	1.40E-06
		5	0.2807	0.00162			
2		0	0.2811				
		5	0.2875	0.00128	0.26	1.28	1.66E-06
		5	0.2939	0.00128			
1		0	0.2941				
		5	0.2988	0.00094	0.19	1.88	2.44E-06
	13:10	5	0.3035	0.00094			
				Interpreted Lugeon Value =		**0.68**	

Water Loss vs Gauge Pressure



Gauge Pressure vs Lugeon



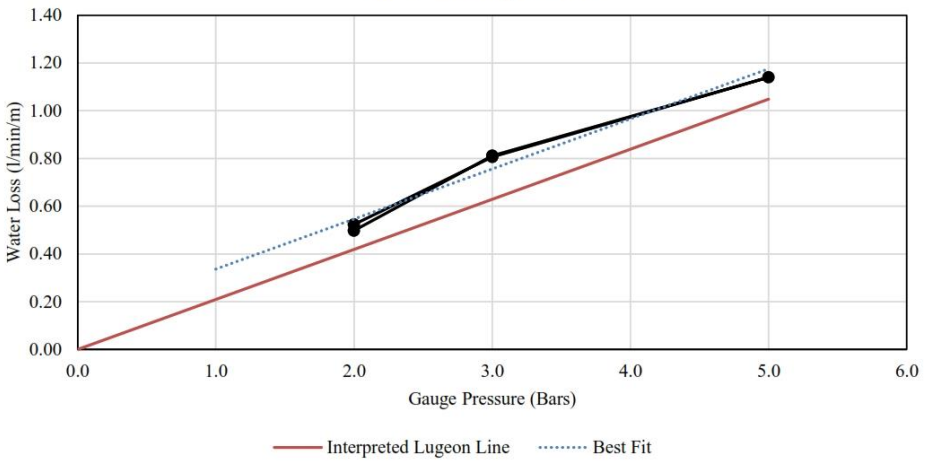
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

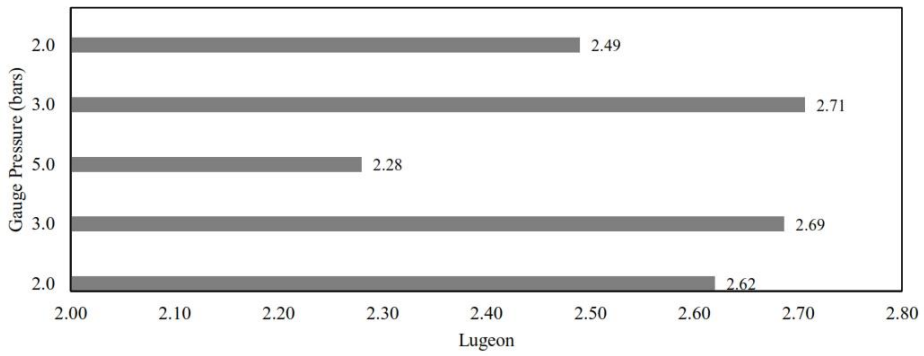
PROJECT:	MWACHE DAM	**BH NO.:**	BH4	**DATE:**	4/7/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		19	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	14	**TO (m):** 19	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		4.7	**WATER LEVEL AFTER (m):**		4.3
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
2	9:06	0	0.3332				
		5	0.3462	0.00260	0.52	2.62	3.41E-06
		5	0.3594	0.00264			
3		0	0.3606				
		5	0.3806	0.00400	0.81	2.69	3.49E-06
		5	0.4009	0.00406			
5		0	0.4021				
		5	0.4301	0.00560	1.14	2.28	2.96E-06
		5	0.4591	0.00580			
3		0	0.4599				
		5	0.4801	0.00404	0.81	2.71	3.52E-06
		5	0.5005	0.00408			
2		0	0.5011				
		5	0.5135	0.00248	0.50	2.49	3.24E-06
	10:06	5	0.5260	0.00250			
					Interpreted Lugeon Value =	**2.10**	

Water Loss vs Gauge Pressure



Gauge Pressure vs Lugeon



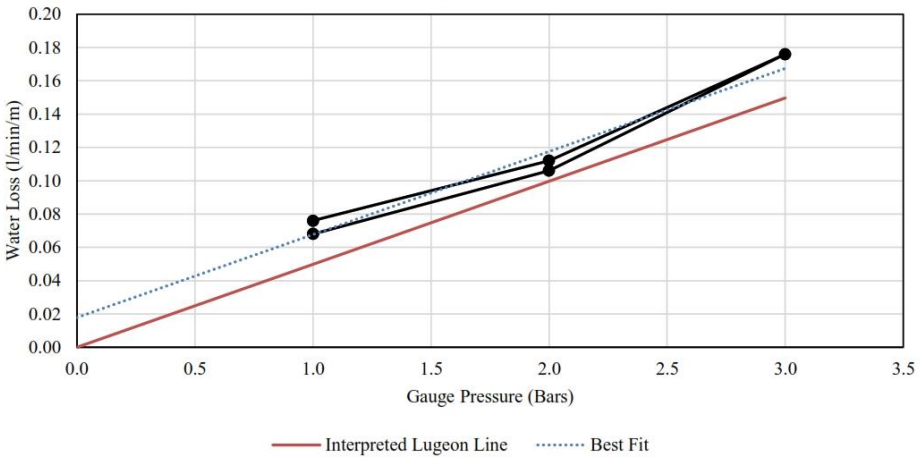
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

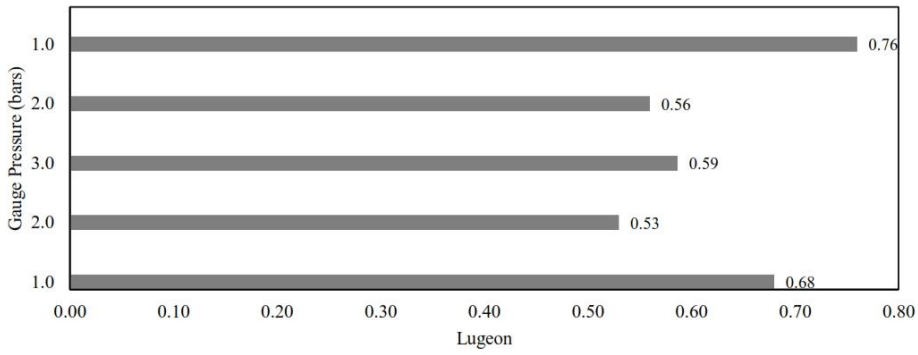
PROJECT:	MWACHE DAM	**BH NO.:**	BH5	**DATE:**	26/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		9	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	4	**TO (m):** 9	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		3.6	**WATER LEVEL AFTER (m):**		3
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	16:30	0	0.2603				
		5	0.2620	0.00034	0.07	0.68	8.84E-07
		5	0.2637	0.00034			
2		0	0.2639				
		5	0.2665	0.00052	0.11	0.53	6.89E-07
		5	0.2692	0.00054			
3		0	0.2694				
		5	0.2732	0.00076	0.18	0.59	7.63E-07
		5	0.2782	0.00100			
2		0	0.2784				
		5	0.2812	0.00056	0.11	0.56	7.28E-07
		5	0.2840	0.00056			
1		0	0.2841				
		5	0.2860	0.00038	0.08	0.76	9.88E-07
	17:30	5	0.2879	0.00038			
					Interpreted Lugeon Value =	**0.50**	

Water Loss vs Gauge Pressure



Gauge Pressure vs Lugeon



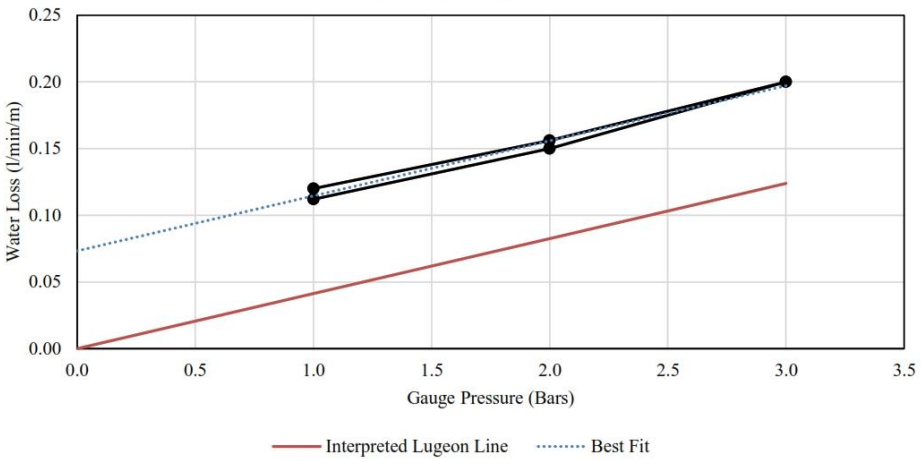
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

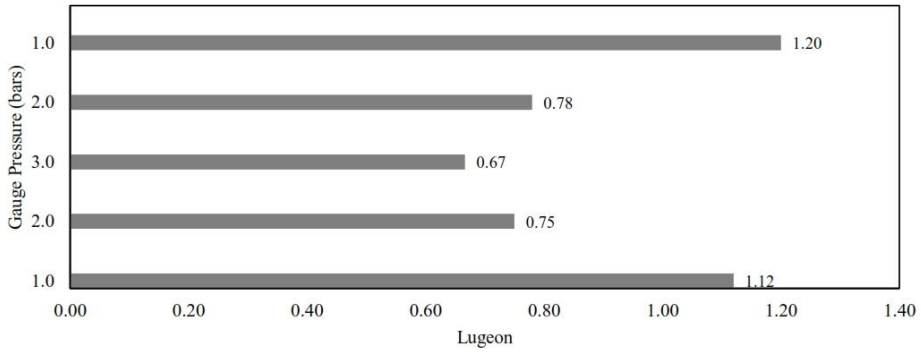
PROJECT:	MWACHE DAM	**BH NO.:**	BH5	**DATE:**	27/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		14	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	9	**TO (m):** 14	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		4	**WATER LEVEL AFTER (m):**		3.7
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	12:10	0	0.2987				
		5	0.3015	0.00056	0.11	1.12	1.46E-06
		5	0.3043	0.00056			
2		0	0.3046				
		5	0.3085	0.00078	0.15	0.75	9.75E-07
		5	0.3121	0.00072			
3		0	0.3125				
		5	0.3174	0.00098	0.20	0.67	8.67E-07
		5	0.3225	0.00102			
2		0	0.3227				
		5	0.3265	0.00076	0.16	0.78	1.01E-06
		5	0.3305	0.00080			
1		0	0.3306				
		5	0.3336	0.00060	0.12	1.20	1.56E-06
	13:10	5	0.3366	0.00060			
				Interpreted Lugeon Value =		**0.41**	

Water Loss vs Gauge Pressure



Gauge Pressure vs Lugeon



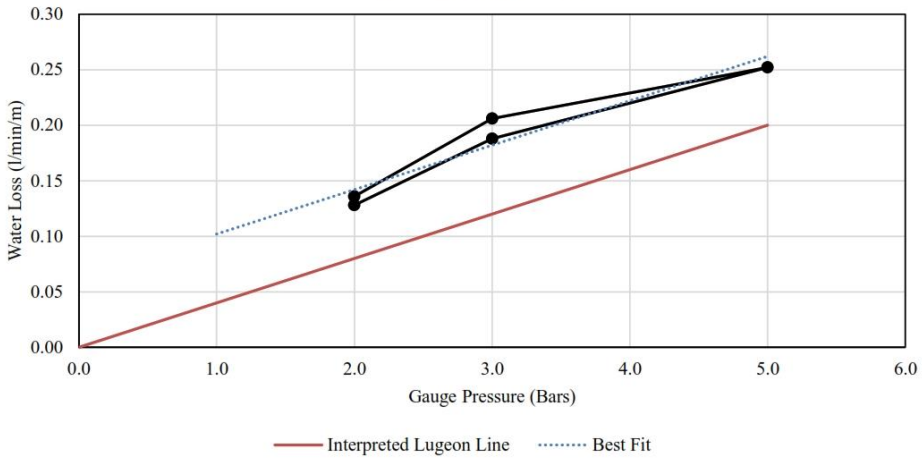
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

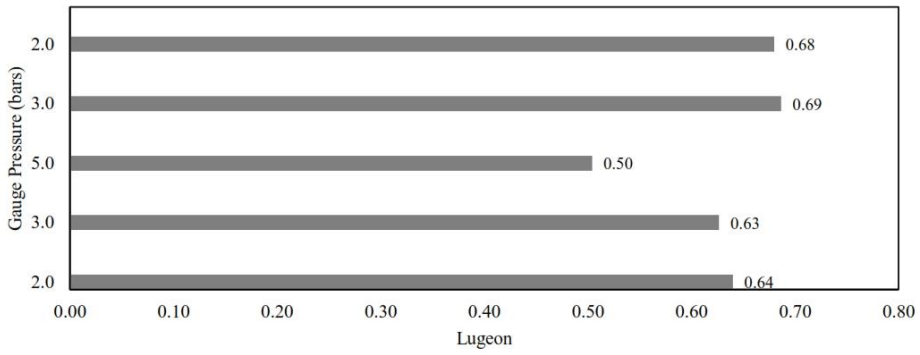
PROJECT:	MWACHE DAM	**BH NO.:**	BH5	**DATE:**	28/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		19	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	14	**TO (m):** 19	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		5	**WATER LEVEL AFTER (m):**		4.7
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
2	9:06	0	2.4692				
		5	2.4725	0.00066	0.13	0.64	8.32E-07
		5	2.4756	0.00062			
3		0	2.4759				
		5	2.4805	0.00092	0.19	0.63	8.15E-07
		5	2.4853	0.00096			
5		0	2.4858				
		5	2.4921	0.00126	0.25	0.50	6.55E-07
		5	2.4984	0.00126			
3		0	2.4988				
		5	2.5037	0.00098	0.21	0.69	8.93E-07
		5	2.5091	0.00108			
2		0	2.5094				
		5	2.5128	0.00068	0.14	0.68	8.84E-07
	10:06	5	2.5162	0.00068			
				Interpreted Lugeon Value =		**0.40**	

Water Loss vs Gauge Pressure



Gauge Pressure vs Lugeon

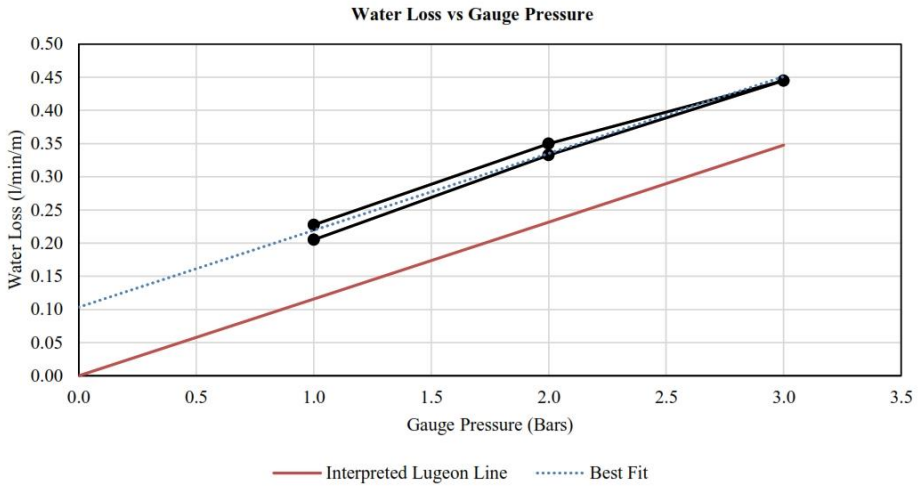


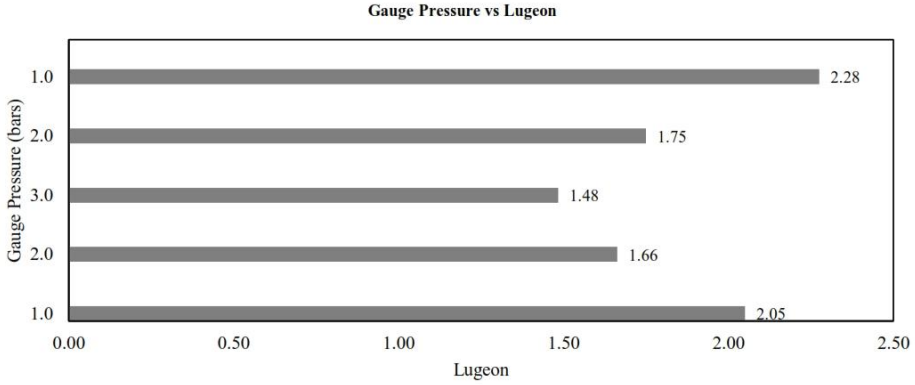
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH6	**DATE:**	4/7/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		10	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	6	**TO (m):** 10	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		4.4	**WATER LEVEL AFTER (m):**		4.3
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	8:30	0	5.1926				
		5	5.1966	0.00080	0.21	2.05	2.67E-06
		5	5.2008	0.00084			
2		0	5.2012				
		5	5.2078	0.00132	0.33	1.66	2.16E-06
		5	5.2145	0.00134			
3		0	5.2149				
		5	5.2237	0.00176	0.45	1.48	1.93E-06
		5	5.2327	0.00180			
2		0	5.2330				
		5	5.2400	0.00140	0.35	1.75	2.28E-06
		5	5.2470	0.00140			
1		0	5.2473				
		5	5.2518	0.00090	0.23	2.28	2.96E-06
	9:30	5	5.2564	0.00092			
				Interpreted Lugeon Value =		**1.16**	



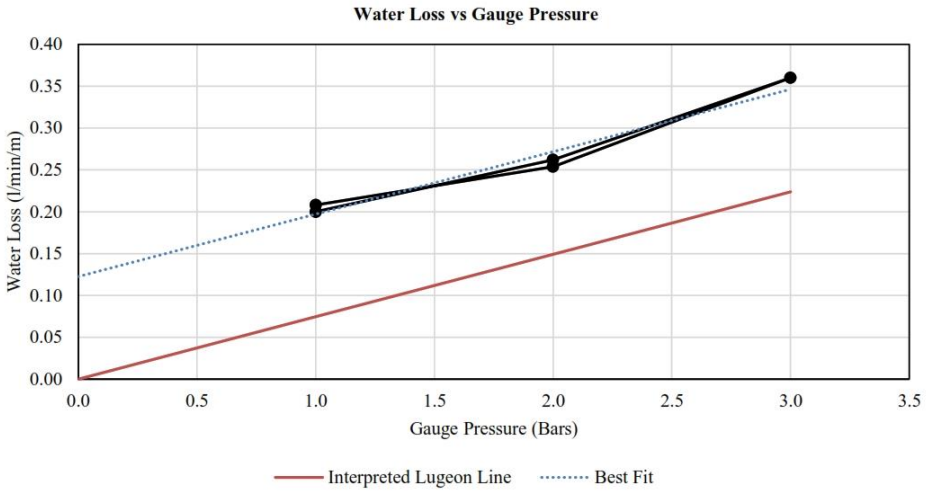


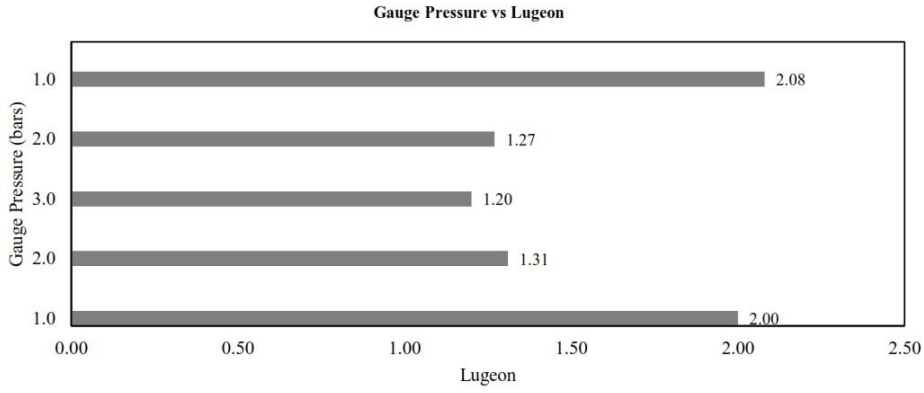
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH6	**DATE:**	27/6/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		15	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	10 **TO (m):**	15	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		4.9	**WATER LEVEL AFTER (m):**		4.6
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
1	12:22	0	5.3902				
		5	5.3952	0.00100	0.20	2.00	2.60E-06
		5	5.4002	0.00100			
2		0	5.4005				
		5	5.4074	0.00138	0.26	1.31	1.70E-06
		5	5.4136	0.00124			
3		0	5.4142				
		5	5.4231	0.00178	0.36	1.20	1.56E-06
		5	5.4322	0.00182			
2		0	5.4326				
		5	5.4389	0.00126	0.25	1.27	1.65E-06
		5	5.4453	0.00128			
1		0	5.4455				
		5	5.4507	0.00104	0.21	2.08	2.70E-06
	13:22	5	5.4559	0.00104			
				Interpreted Lugeon Value =		**0.75**	



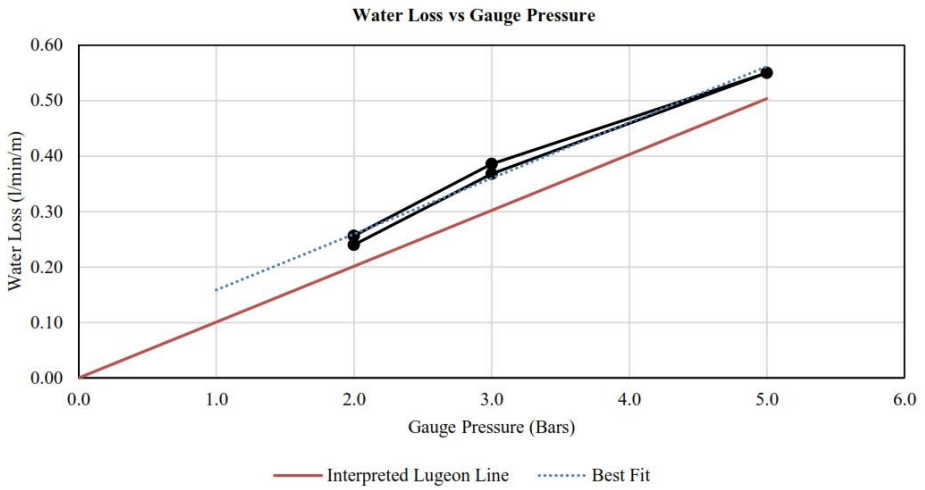


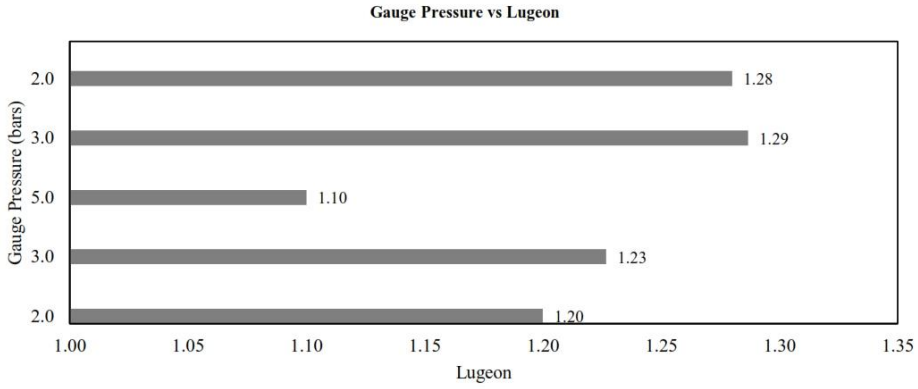
REGIONAL GEOPHYSICAL SURVEY

Lugeon Test

PROJECT:	MWACHE DAM	**BH NO.:**	BH6	**DATE:**	5/7/2021
CLIENT:	MIBP				
BOREHOLE DEPTH: BELOW GL (m):		20	**GROUND LEVEL:**		-
BOREHOLE DIAMETER (mm)		86	**BOREHOLE INCLINATION AND DIRECTION:**		90°
FROM (m):	15	**TO (m):** 20	**SINGLE PARKER/ DOUBLE PACKER:**		SINGLE
WATER LEVEL BEFORE (m):		5.8	**WATER LEVEL AFTER (m):**		5.6
SUPERVISOR:	SOLOMON KIMONGE		**OPERATOR:**		JULIUS

Pressure Gauge (Bars)	Time	Time Interval (min)	Flow Meter Reading (m^3)	Rate of Flow per min (m^3/min)	Water Loss (l/min/m)	Lugeon	Permeability (ms^{-1})
2	11:06	0	5.5128				
		5	5.5188	0.00120	0.24	1.20	1.56E-06
		5	5.5248	0.00120			
3		0	5.5254				
		5	5.5345	0.00182	0.37	1.23	1.59E-06
		5	5.5438	0.00186			
5		0	5.5449				
		5	5.5585	0.00272	0.55	1.10	1.43E-06
		5	5.5724	0.00278			
3		0	5.5731				
		5	5.5827	0.00192	0.39	1.29	1.67E-06
		5	5.5924	0.00194			
2		0	5.5927				
		5	5.5990	0.00126	0.26	1.28	1.66E-06
	12:06	5	5.6055	0.00130			
					Interpreted Lugeon Value =	**1.01**	

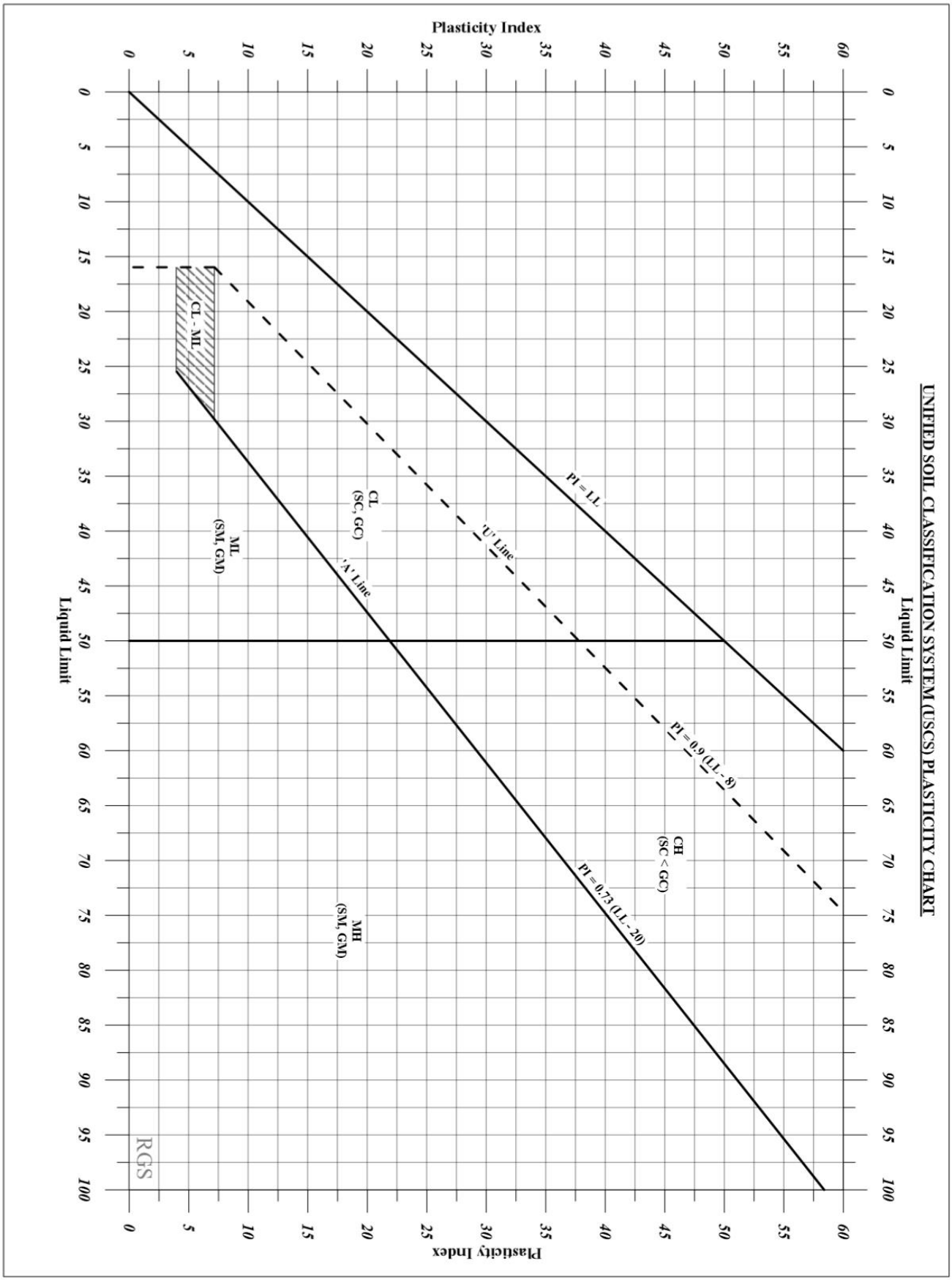




APPENDIX E

Site Photographs

USCS Plasticity Chart



Unified Soil Classification Chart (after ASTM, 2011) (Based on ASTM D2487-10: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification).

Criteria for assigning group symbols and group names using laboratory tests[a]				Soil classification	
				Group symbol	Group name[b]
Coarse-grained soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[c]	$C_u \geq 4$ and $1 \leq C_c \leq 3$[e]	GW	Well-graded gravel[f]
			$C_u < 4$ and/or $1 > C_c > 3$[e]	GP	Poorly graded gravel[f]
		Gravels with Fines More than 12% fines[c]	Fines classify as ML or MH	GM	Silty gravel[f,g,h]
			Fines classify as CL or CH	GC	Clayey gravel[f,g,h]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[d]	$C_u \geq 6$ and $1 \leq C_c \leq 3$[e]	SW	Well-graded sand[i]
			$C_u < 6$ and/or $1 > C_c > 3$[e]	SP	Poorly graded sand[i]
		Sand with Fines More than 12% fines[d]	Fines classify as ML or MH	SM	Silty sand[g,h,i]
			Fines classify as CL or CH	SC	Clayey sand[g,h,i]
Fine-grained soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line[j]	CL	Lean clay[k,l,m]
			PI < 4 or plots below "A" line[j]	ML	Silt[k,l,m]
		Organic	$\frac{\text{Liquid limit—oven dried}}{\text{Liquid limit—not dried}} < 0.75$	OL	Organic clay[k,l,m,n] / Organic silt[k,l,m,o]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay[k,l,m]
			PI plots below "A" line	MH	Elastic silt[k,l,m]
		Organic	$\frac{\text{Liquid limit—oven dried}}{\text{Liquid limit—not dried}} < 0.75$	OH	Organic clay[k,l,m,p] / Organic silt[k,l,m,q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[a] Based on the material passing the 75-mm. (3-in) sieve.
[b] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[c] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt; GW-GC well-graded gravel with clay; GP-GM poorly graded gravel with silt; GP-GC poorly graded gravel with clay.
[d] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt; SW-SC well-graded sand with clay; SP-SM poorly graded sand with silt; SP-SC poorly graded sand with clay.
[e] $C_u = D_{60}/D_{10} \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[f] If soil contains ≥15% sand, add "with sand" to group name.
[g] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
[h] If fines are organic, add "with organic fines" to group name.
[i] If soil contains ≥15% gravel, add "with gravel" to group name.
[j] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
[k] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[l] If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
[m] If soil contains ≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[n] PI ≥ 4 and plots on or above "A" line.
[o] PI < 4 or plots below "A" line.
[p] PI plots on or above "A" line.
[q] PI plots below "A" line.

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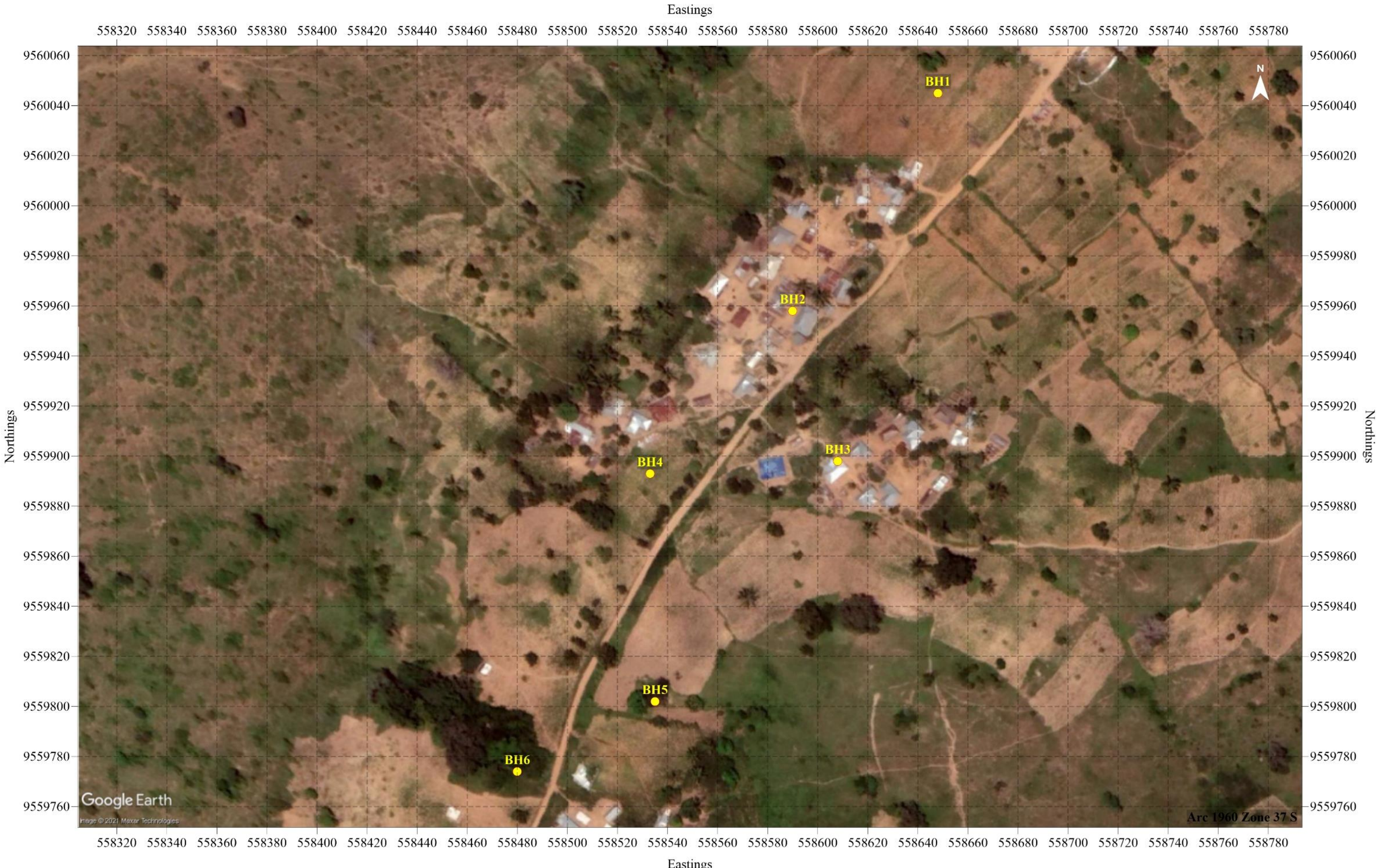
Satellite Map of the Site



Ge

Project: Mwache WTP

Location: Kwale County

Client: MIBP

INFERRED GEOTECHNICAL CROSS SECTION

Regional Geophysical Survey

Understanding earth's subsurface through geological, geophysical and geotechnical investigations

BH1D	BH1		BH2		BH3		BH4		BH5		BH6
Easting	558648.00		558590.00		558608.00		558533.00		558535.00		558480.00
Northing	9560045.00		9559958.00		9559898.00		9559893.00		9559802.00		9559774.00
Distance (m)		104.56 m		62.64 m		75.17 m		91.02 m		61.72 m	
Elevation (m)	129.29		122.09		118.29		119.15		116.87		118.71
Cored Depth (m)	20.00		20.00		20.00		20.00		20.00		20.00