Topographic & Geotechnical Investigation

Site Assessment Report

(New Land Plot)

Project: **Proposed New Solar PV Power Plant in Galkayo**

Client:

NATIONAL ELECTRIC POWER CO-OPERATION (NEPCO)

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Date: **15/05/2024**

Submitted by:

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1. Introduction

The client, National Electric Power Co-Operation (NEPCO), is planning to build a new solar power plant to meet the growing energy demand of Galkayo city. Previously, an empty land plot with relatively small area of around 11,000 sqm and situated next to NEPCO existing power plant was selected for the project and surveyed back in February 2024. After further analysis, the client has decided to move the project to a larger land plot, and has therefore recently acquired an undeveloped land plot with an area of over 2 million sqm. The new site is located in the northern outskirts of Galkayo city, 6km to the north of the existing NEPCO power plant and 2km to the west of Galkayo-Garowe tarmac road (6.868479° 47.422682°). The land is in its natural state and its boundary is only recently marked by surrounding it with a roughly 12m wide road cleared with the help of a wheel loader. The land is largely flat with an elevation range of around 10m. It has sparsely spaced natural shrub vegetation, which become denser in the few depressions that hold rainwater. The site is located in a valley known for its abundant limestone rock, and is widely used for extracting loose limestone rock outcrops in the surface layer by manual labor and transporting it by dump trucks to Galkayo city for wall construction purposes. Shallow and small holes left behind these extraction works are scattered around the site making the surface irregular, but don't pose major risks and can be treated easily.

Hubiye Lab Co. is an independent engineering lab based in Garowe, and has been contracted by the client to carry out the required topographic survey and geotechnical investigation of the new site to provide inputs for further project planning and design. Hubiye Lab Co. team has undertaken the planned fieldwork and sample collection on 2-6/2/2024 and has subsequently conducted the lab tests. This report presents the findings and recommendations of the topographic and geotechnical investigation of this greenfield site including establishing corners and boundary path, fencing with suitable material including entry points, selecting the area to be developed in the first phase, clearing the vegetation in the selected area and access roads, levelling the area with compacted soil, etc. The report also recommends design bearing capacity for the footings and other precautions for concrete works. If these recommendations are followed, the expected foundation design life is more than 50 years.

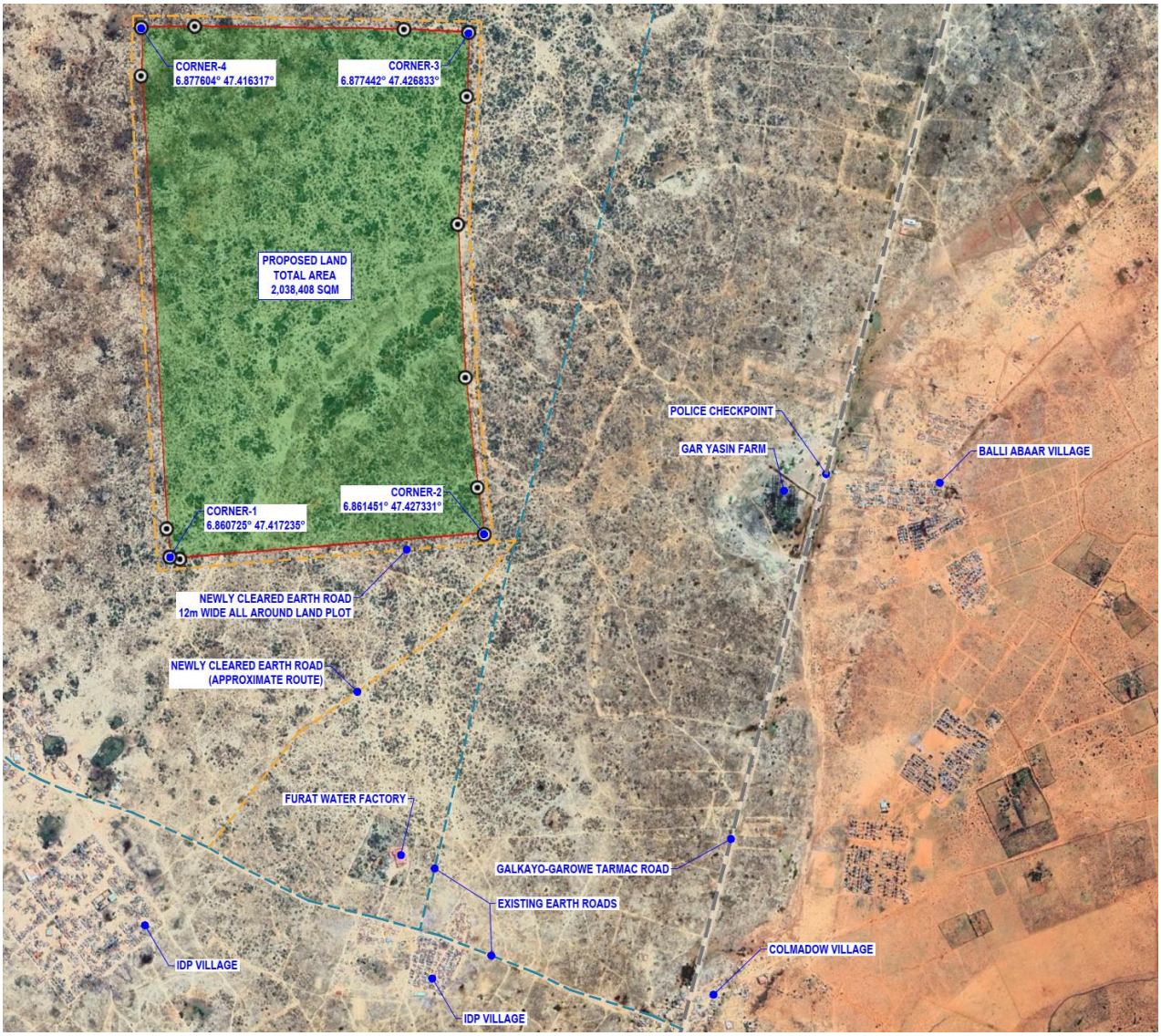

Fig-1: Site location map showing corner coordinats and access roads

Fig-2: Site view on May 4, 2024 showing the natural vegetation and shallow holes left behind after manual extraction operations of loose limestone rocks in the surface layer

2. Scope of Work

Based on available lab capabilities and discussions with the client representative; we have conducted the following tasks among client's requirements in the ToR:

a) Topographic Survey:

- Establish 5 permanent bench marks to be used in current and future surveys
- Survey the boundary of the land as well as taking ground spot levels sufficiently distributed through the land using Differential GNSS RTK method
- Processing the results to produce topo survey drawing and contour map.

b) Geotechnical Soil Investigation:

- Drilling of 4 trial pits, distributed across the site as shown in the drawing to allow for making visual observations and conducting further steps below.
- Conducting Dynamic Cone Penetrometer (DCP) tests at the surface and base of the trial pits, as shown in Table-2, which were deepened to 1m depth below natural ground surface.
- Collecting representative soil samples and transporting them to the lab.
- Conducting the lab tests shown in Table-3 on the collected samples.

c) Soil and Water Chemical Analysis:

- Conducting the basic tests of pH and Total Dissolved Solids (TDS) expressed as Electrical Conductivity (EC) to check salinity level of both soil and utility tap water used in Galkayo.

d) Data Analysis and Recommendations:

- Analyzing and interpreting the geotechnical test results.
- Recommending the appropriate foundation for PV structures and buildings.

3. Topographic Survey

Topographic survey of the site was conducted on 2-7/5/2024. As described in the introduction, the site is an undeveloped land which is recently marked by surrounding it with an earthen road cleared by a loader. It has sparse vegetation, and is roughly rectangular in shape with over 2 million square meter area. The topography is generally flat with mild slopes and local depressions, and observed ground elevations ranging from highest 292m to lowest 283m.

Fig-3: Survey team with RTK and drone survey kit at Bemch Mark BM1 on 4/5/2024

Fig-4: Partial view of site (26 hectares) captured by drone on 4/5/2024 showing its typical nature

3.1. Topographic Survey Methodology

a) **Reconnaissance & Benchmarks:** The surveyor has made a preliminary site visit on 2/5/2024 to get familiar with the site. The surveyor planned benchmark locations distributed near the four corners and one at the center of the plot as shown in the topo drawing, and then placed them on 3/5/2024 by excavating small holes, filling with concrete, embedding steel rods and marking them.

Fig-5: Typical view of the 5 concrete benchmarks casted on 3/5/2024

b) **Survey Method & Equipment:** Real-Time Kinematic (RTK) was used for this job. It is a modern satellite navigation technique that enhances the accuracy of position information derived from GNSS satellite systems (GPS, GLONASS…), achieves centimeter-level accuracy & sends real-time corrections from the base to the rover via NTRIP (Networked Transport of RTCM via Internet Protocol). The equipment used is as follows:

- Multi-band GNSS receivers Emlid Reach RS2: 1 Base + 1 Rover
- Android Controller with Data Collection Software LandStar7
- Tripods and other accessories

Moreover, a survey drone (DJI Phantom4 Pro with PPK attachment) was briefly used to compliment the above GNSS survey method, but was abandoned due to logistics difficulties in conducting multiple flights required for this large site. The test flight conducted at the center of the plot captured 195 images which were post-processed to produce the orthomosaic image in Fig-4 above.

c) **Survey Projection:**

- Map Projection: Universal Transverse Mercator (UTM)
- Datum: WGS 1984
- Zone: 38N
- Measurement Unit: Meters (M)

d) **Data Collection:** The surveyor first set up the base receiver on benchmark BM1 and established its position by aggregating satellite readings for around 10min, with an expected absolute accuracy of <1m. Then, he proceeded to take position readings of other benchmarks BM2-BM5, trial pits TP1-TP4 and all subsequent survey points with the rover receiver getting real-time corrections from the base via NTRIP with a relative accuracy of 1-2cm.

The surveyor recorded the approximate land boundary as marked with the cleared road, then took reasonably distributed natural ground spot levels. All points were recorded in northing, easting, and elevation format in metric units with multiple decimal points. Suitable labels were used to identify different survey features. Over 1,100 survey readings were made and the survey was conducted over a 3-day period on 4-6/5/2024.

e) **Data Processing:** Raw data was extracted from the RTK controller device in a .csv file format, which was then cleaned for further processing. The topographic data processing was made in Civil3D software, whereby collected data was converted into a topographic survey drawing and a contour map with major interval of 0.5m and minor interval of 0.1m. The output topographic survey drawings are attached along with this report.

Table-1: Established Control Point Details (WGS84 UTM ZONE 38N)

#	EASTING (m)	NORTHING (m)	ELEVATION (m)
BM1	767740.500	759887.932	289.327
BM2	767994.570	759377.697	288.106
BM3	767349.116	759403.482	289.818
BM4	767931.803	760490.134	291.138
BM5	767303.644	760542.356	290.898

4. Geotechnical Field Investigation - Dynamic Cone Penetrometer (DCP)

The field investigation for this job consisted of excavating 4 nos. trial pits each 1m deep and distributed near to the four edges of the land. The trial pits were used to make visual observations, collect soil samples for lab tests, and to conduct Dynamic Cone penetrometer (DCP) tests at the surface and at the base of the trial pits. DCP is a test that was developed by Transport and Road Research Laboratory (TRRL), England, and is used as a rapid means of assessing the sequence, thickness and in-situ California Bearing Ration (CBR) of the unbound pavement layers or ground strata. The DCP test type used is standardized by ASTM D 6951-03. The standard DCP apparatus was used, where an 8kg weight is dropped through a height of 575mm, and the cone type used is angled at 60° and has a diameter of 20mm.

Fig-6: Unassembled DCP apparatus in a box

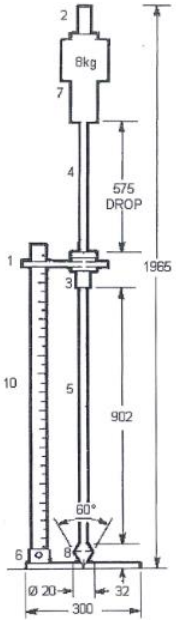

Fig-7: Assembled apparatus sketch

Fig-8: Trial pits excavated with jack hammer

Fig-9: DCP conducted at base of a trial pit

4.1. DCP Test Results Discussion

DCP tests were conducted on two consecutive days 4-5/5/2024 at the 4 trial pits whose details are shown in Table-2 below and the attached drawing. The tests were first conducted at the surfaces of the trial pits, and at 1m depth below the ground. The ground observed at all the trial pits was largely rocky in nature and excavation required using a powered jack hammer. The test crew consisted of one person conducting the test and one person noting down the number of blows needed to make successive penetrations of around 3mm. Tests were discontinued when hard ground was hit, with more than 10 blows required to produce a penetration reading of 1-3mm.

Table-2: Details of the trial pits

Trial Pit #	TP Depth (m)	TP Coordinates	DCP tests at different depths
TP1	1.0m	E767353.489 N759405.010	DCP Tests at surface & -1m
TP2	1.0m	E767999.115 N759377.250	DCP Tests at surface & -1m
TP3	0.8m	E767931.397 N760492.708	DCP Tests at surface & -0.8m
TP4	1.0m	E767311.139 N760542.765	DCP Tests at surface & -1m

All the pertinent DCP test data were recorded on DCP field log sheets, and were then transferred to an Excel spreadsheet, where the necessary calculations are made along with CBR correlation as per ASTM D 6951-03 (see Appendix-1). The DCP test results indicate the presence of highly dense gravelly and rocky soils, with CBR of the soil layers beyond the loose topsoil layer ranging from 30% to 100%. There are no significant changes of soil stratum types observed in the depths investigated. Similarly, no groundwater was encountered in the depths investigated.

4.2. DCP Test Results Correlation

Allowable soil bearing capacity is what we need for the design of foundations, and it is most commonly based on the N-value from Standard Penetration Test (SPT). There are a number of correlations between DCP, SPT and bearing capacity established over the years, as discussed in the research paper titled “Deriving SPT N-Values from DCP Test Results…” by Samuel I.K. Ampadu et. al. (2018). For this project, we use the following formulas to estimate allowable bearing capacity:

$N_{SPT} = 1.78(N_{DCP})^{0.77}$ for coarse-grained soils above groundwater table

Where N_{DCP} is the number of DCP blows per 100mm penetration, N_{SPT} is the standard SPT "N" value that is used in most of bearing capacity calculations.

Furthermore, according to Meyerhof (1976), the allowable bearing capacity based on the SPT "N" value for a shallow square foundation less than 1.2m in width is obtained from:

$$\mathbf{q_{allow} = N_{SPT} * K_d / 0.05}$$

(Note: this figure changes as per assumptions, and has a factor of safety of 3).

The estimated allowable bearing capacities are given in Appendix-1.

5. Soil Lab Tests

The samples were transported from the site in marked sacks. The tests were performed in Hubiye Lab, Garowe between 11th and 13th May 2024. Names of the tests conducted, and summary results are given in the tables below, whereas detailed test sheets are included in the appendix.

The lab test results indicate that the soil is mainly non-cohesive composed of sands and gravels, and cohesive content of silt and clay range from 2 to 5%. The soil generally has physical properties that are favorable to support building foundations.

Table-3: Conducted Lab Tests

#	Test Name	No. of Tests	Methodology
1	Grain size analysis	3	ASTM C136
2	Atterberg Limits (Plastic Limit & Liquid Limit Tests)	1	ASTM D4318
3	Optimum Moisture Content & Maximum Dry Density (Modified Proctor Test)	1	AASHTO T180
4	Natural Moisture Content of Soil	3	ASTM D2216
5	Natural Moisture Content of Soil	3	ASTM C128
6	Estimation of Soil Salinity by Electrical Conductivity	3	Tech. Literature

Table-4: Summary of Lab Test Results

Test		S1	S2	S3	S4	Remarks
Soil Particle Size Distribution	Gravel (%)	37	50	52	33	Also Cu>1 & Cc<1 Soil is classified as **poorly-graded sandy GRAVEL Or gravelly SAND**
	Sand (%)	61	48	44	62	
	Silt/Clay (%)	2	2	4	5	
Atterberg Limits	Liquid Limit	49	54.5	51.4	39.3	Samples S1-23 have high liquid limit & non-plastic, sample S4 has low plasticity
	Plastic Limit	-	-		33.8	
	PI	-	-		5.5	
Maximum Dry Density, Optimum Moisture Content	MDD (kg/m^3)	1,610	1,420		1,495	Soil with low to medium strength
	OMC (%)	22	24		20	
Natural Moisture Content (%)		64.2	61.7	46.6	49.2	Moisture content is high as sample was collected during rainy season. Specific gravity is in typical range
Specific Gravity (SG)		2.49	2.57	2.72	2.41	
Soil EC (mS/cm)		3.03 average				Slightly saline soil
Soil pH		7.52 average				Slightly alkaline soil
Galkayo tap water EC (mS/cm)		3.78				Highly brackish, unfit for use
Galkayo tap water pH		7.14				Acceptable pH for water

6. Soil & Water Chemical Analysis

We conducted basic tests of pH and Electrical Conductivity (EC) using hand-held meter on a water-soil solution prepared as per the guidelines. The results indicate the presence of slightly saline and alkaline sodic soils. This is in line with the known nature of the soils in Galkayo valley that are categorized as calcisols and gypsisols and are characterized as low-moisture and low-nutrient soils.

Similarly, a tap water sample extracted from NEPC Galkayo plant site was tested for EC and pH, and was found to be highly brackish unfit for human use as per WHO guidelines. It is also above the limit recommended by BS-3148 for water used in making concrete. Special precautions are needed for building interactions with both the soil and the water found in the project area as discussed in the recommendations section.

7. Lab Test Photos

Fig-10: samples transported to lab


Fig-11: Sieve analysis test in progress


Fig-12: Drying soil samples in the oven

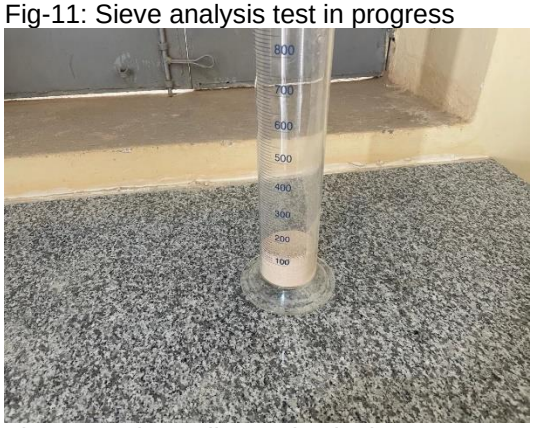

Fig-13: Drying soil samples in the oven


Fig-14: Checking soil salinity with EC & pH meter


Fig-15: Checking tap water EC & pH

8. Conclusions

Based on field and lab observations, the soil found in the site is a combination of highly dense gravelly and sandy soil mixed with limestone rock. The soil has density and strength properties that are favorable for foundations, in terms of their bearing capacity to withstand high loads with low settlement risks. Therefore, it is suitable for the proposed foundations in this PV power plant project. On the other hand, the soil found in the area

is slightly saline and sodic, while the public utility water is highly brackish. Special precautions are needed to overcome this issue as per the below recommendations.

9. Recommendations

Based on the above findings, we don't recommend inserting steel footing pads directly into the soil to avoid the risk of corrosion. However, we recommend the use of concrete footing types, both as plain concrete mass footings for very light structures and reinforced concrete for medium to high loads. We expect concrete footings to last for more than 50 years. The table below summarizes the conservative allowable bearing capacities and depths we recommend for the design of shallow foundations.

Moreover, general best practices shall be used for concrete works to ensure its durability such as:

- Using of treated non-brackish water for concrete mixing
- Using suitable sand for concrete making
- Using suitable concrete mix ratio and water content for good strength & durability
- Using sufficient cover around reinforcing steel
- Apply protective bituminous coating for subsurface concrete elements

Table-5: Summary of foundation design recommendations

Recommended Foundation Depth Range	Shallow Foundation Type	Recommended Design Bearing Capacity (kPa)
0.4m to 0.6m	Strip footings & light structures e.g. PV mounts	200 kN/m^2
0.8m to 1m	Isolated column footings	500 kN/m^2

Finally, it is worth noting that the extent of this geotechnical investigation was limited in nature. Therefore, the soil shall be evaluated again by a qualified engineer during foundation excavation in construction phase, and any discrepancies found shall be checked with the designer.

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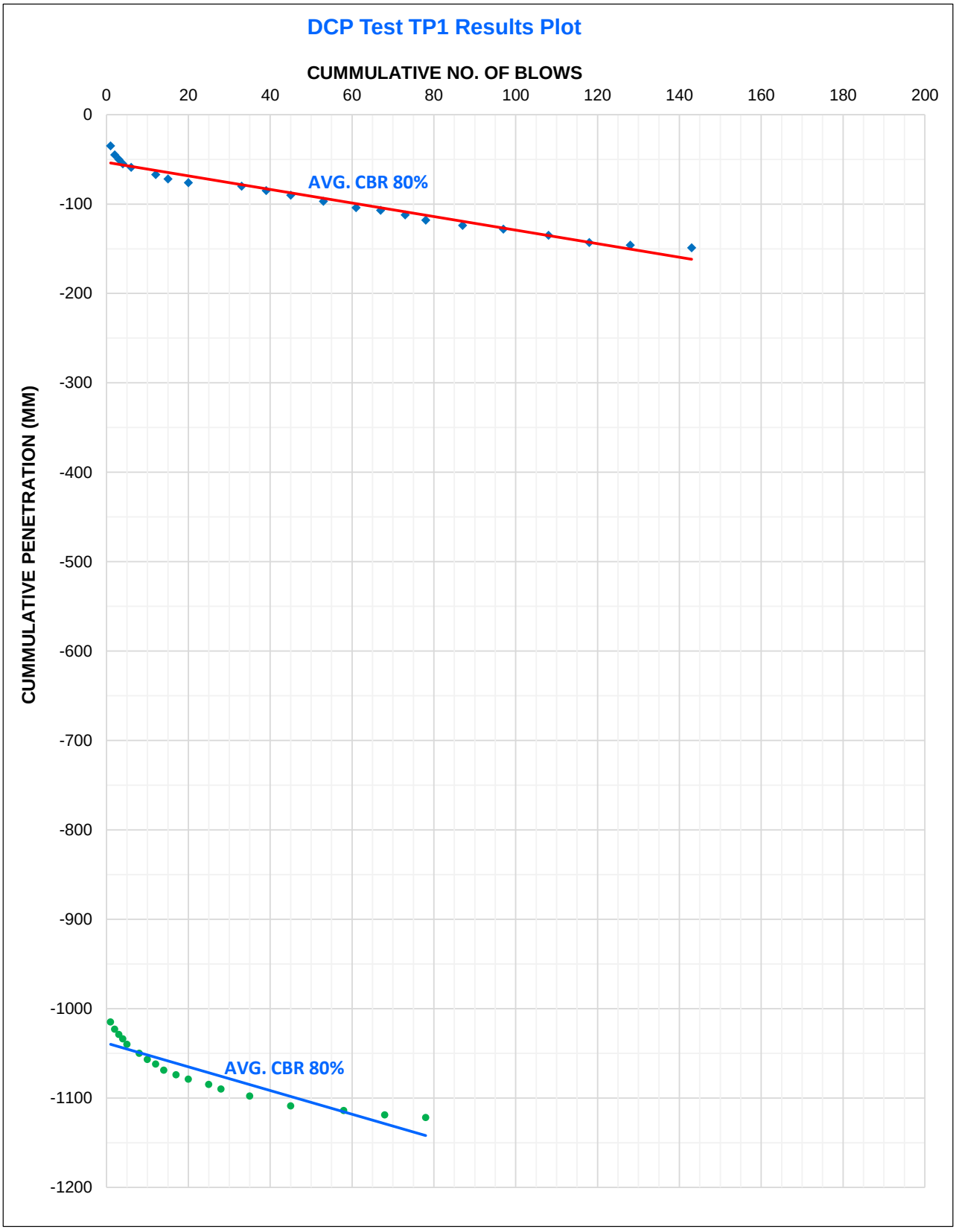
Appendix-1: Dynamic Cone Penetrometer (DCP) Test Report

Project:	Proposed New PV Power Plant in Galkayo, Somalia	**Test Date:**	4/5/2024
Client:	NEPCO	**Report Date:**	15/5/2024
Test Location:	**Trial Pit TP#1** (E767353.489 N759405.010) Tests conducted at surface & -1m	**Hammer Weight:**	8 kg
		Test Standard:	ASTM D6951

Cummulative Test Depth (mm)	No. of Blows	Total Blows	Cummulative Penetration (mm)	Penetration b/w readings (mm)	Penetration per bow (mm/blow)	Estimated CBR (%)	Bearing Capacity Estimation		
							N_{DCP} (No. of Blows per appr. 100mm)	Correlated $N_{SPT} = 1.78(N_{DCP})^{0.77}$	$q_{allow} = N_{SPT}*1.33/0.05$
Test-1 starting from natural ground surface									
0	0	--	125	--	--	--	61	42	**1,122**
-35	1	1	160	35	35.0	5%			
-45	1	2	170	10	10.0	20%			
-50	1	3	175	5	5.0	50%			
-55	1	4	180	5	5.0	50%			
-59	2	6	184	4	2.0	100%			
-67	6	12	192	8	1.3	100%			
-72	3	15	197	5	1.7	100%			
-76	5	20	201	4	0.8	100%			
-80	13	33	205	4	0.3	100%			
-85	6	39	210	5	0.8	100%			
-90	6	45	215	5	0.8	100%			
-97	8	53	222	7	0.9	100%			
-104	8	61	229	7	0.9	100%			
-107	6	67	232	3	0.5	100%	Depth <100mm		
-112	6	73	237	5	0.8	100%			
-118	5	78	243	6	1.2	100%			
-124	9	87	249	6	0.7	100%			
-128	10	97	253	4	0.4	100%			
-135	11	108	260	7	0.6	100%			
-143	10	118	268	8	0.8	100%			
-146	10	128	271	3	0.3	100%			
-149	15	143	274	3	0.2	100%			
Test-2 starting from trial pit depth -1000 mm									
-1000	0	--	130	--	--	--	45	33	**888**
-1015	1	1	145	15	15.0	14%			
-1023	1	2	153	8	8.0	30%			
-1029	1	3	159	6	6.0	40%			
-1034	1	4	164	5	5.0	50%			
-1040	1	5	170	6	6.0	40%			
-1050	3	8	180	10	3.3	80%			
-1057	2	10	187	7	3.5	80%			
-1062	2	12	192	5	2.5	100%			
-1069	2	14	199	7	3.5	80%			
-1074	3	17	204	5	1.7	100%			
-1079	3	20	209	5	1.7	100%			
-1085	5	25	215	6	1.2	100%			
-1090	3	28	220	5	1.7	100%			
-1098	7	35	228	8	1.1	100%			
-1109	10	45	239	11	1.1	100%			
-1114	13	58	244	5	0.4	100%	Depth <100mm		
-1119	10	68	249	5	0.5	100%			
-1122	10	78	252	3	0.3	100%			



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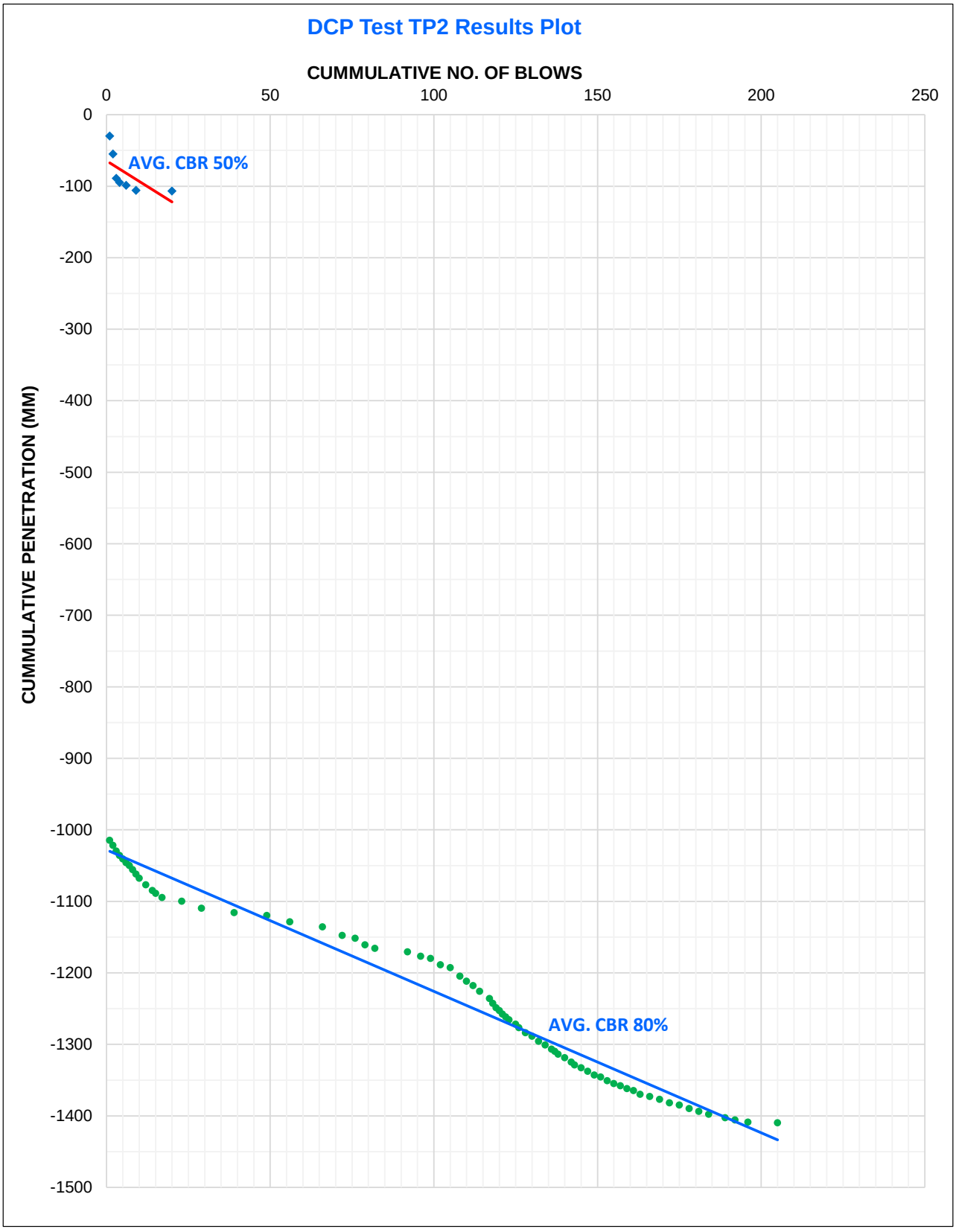
Appendix-1: Dynamic Cone Penetrometer (DCP) Test Report

Project:	Proposed New PV Power Plant in Galkayo, Somalia	**Test Date:**	4/5/2024
Client:	NEPCO	**Report Date:**	15/5/2024
Test Location:	**Trial Pit TP#2** (E767999.115 N759377.250) Tests conducted at surface & -1m	**Hammer Weight:**	8 kg
		Test Standard:	ASTM D6951

Cummulative Test Depth (mm)	No. of Blows	Total Blows	Cummulative Penetration (mm)	Penetration b/w readings (mm)	Penetration per bow (mm/blow)	Estimated CBR (%)	Bearing Capacity Estimation		
							N_{DCP} (No. of Blows per appr. 100mm)	Correlated $N_{SPT} = 1.78(N_{DCP})^{0.77}$	$q_{allow} = N_{SPT}*1.33/0.05$
Test-1 starting from natural ground surface									
0	0	--	135	--	--	--	20	18	**475**
-30	1	1	165	30	30.0	6%			
-55	1	2	190	25	25.0	8%			
-89	1	3	224	34	34.0	6%			
-95	1	4	230	6	6.0	40%			
-99	2	6	234	4	2.0	100%			
-106	3	9	241	7	2.3	100%			
-107	11	20	242	1	0.1	100%			
Test-2 starting from trial pit depth -1000 mm									
-1000	0	--	154	--	--	--	23	20	**529**
-1015	1	1	169	15	15.0	14%			
-1022	1	2	176	7	7.0	35%			
-1030	1	3	184	8	8.0	30%			
-1036	1	4	190	6	6.0	40%			
-1041	1	5	195	5	5.0	50%			
-1046	1	6	200	5	5.0	50%			
-1050	1	7	204	4	4.0	60%			
-1056	1	8	210	6	6.0	40%			
-1062	1	9	216	6	6.0	40%			
-1068	1	10	222	6	6.0	40%			
-1077	2	12	231	9	4.5	60%			
-1085	2	14	239	8	4.0	60%			
-1089	1	15	243	4	4.0	60%			
-1095	2	17	249	6	3.0	80%			
-1100	6	23	254	5	0.8	100%			
-1110	6	29	264	10	1.7	100%	85	54	**1,449**
-1116	10	39	270	6	0.6	100%			
-1120	10	49	274	4	0.4	100%			
-1129	7	56	283	9	1.3	100%			
-1136	10	66	290	7	0.7	100%			
-1148	6	72	302	12	2.0	100%			
-1152	4	76	306	4	1.0	100%			
-1161	3	79	315	9	3.0	80%			
-1166	3	82	320	5	1.7	100%			
-1171	10	92	325	5	0.5	100%			
-1177	4	96	331	6	1.5	100%			
-1180	3	99	334	3	1.0	100%			
-1189	3	102	343	9	3.0	80%			
-1193	3	105	347	4	1.3	100%			
-1205	3	108	359	12	4.0	60%			
-1212	2	110	366	7	3.5	80%			
-1218	2	112	372	6	3.0	80%			
-1226	2	114	380	8	4.0	60%			
-1236	3	117	390	10	3.3	80%			
-1243	1	118	397	7	7.0	35%			
-1249	1	119	403	6	6.0	40%			
-1253	1	120	407	4	4.0	60%			
-1258	1	121	412	5	5.0	50%			

-1262	1	122	416	4	4.0	60%	28	23	**616**
-1266	1	123	420	4	4.0	60%			
-1272	2	125	426	6	3.0	80%			
-1277	1	126	431	5	5.0	50%			
-1284	2	128	438	7	3.5	80%			
-1289	2	130	443	5	2.5	100%			
-1296	2	132	450	7	3.5	80%			
-1301	2	134	455	5	2.5	100%			
-1307	2	136	461	6	3.0	80%			
-1310	1	137	464	3	3.0	80%	69	46	**1,234**
-1314	1	138	468	4	4.0	60%			
-1319	2	140	473	5	2.5	100%			
-1325	2	142	479	6	3.0	80%			
-1329	1	143	483	4	4.0	60%			
-1333	2	145	487	4	2.0	100%			
-1338	2	147	492	5	2.5	100%			
-1343	2	149	497	5	2.5	100%			
-1346	2	151	500	3	1.5	100%			
-1351	2	153	505	5	2.5	100%			
-1355	2	155	509	4	2.0	100%			
-1358	2	157	512	3	1.5	100%			
-1362	2	159	516	4	2.0	100%			
-1365	2	161	519	3	1.5	100%			
-1370	2	163	524	5	2.5	100%			
-1373	3	166	527	3	1.0	100%			
-1377	3	169	531	4	1.3	100%			
-1382	3	172	536	5	1.7	100%			
-1385	3	175	539	3	1.0	100%			
-1390	3	178	544	5	1.7	100%			
-1394	3	181	548	4	1.3	100%			
-1398	3	184	552	4	1.3	100%			
-1403	5	189	557	5	1.0	100%			
-1406	3	192	560	3	1.0	100%			
-1409	4	196	563	3	0.8	100%			
-1410	9	205	564	1	0.1	100%			



Test Conducted By:
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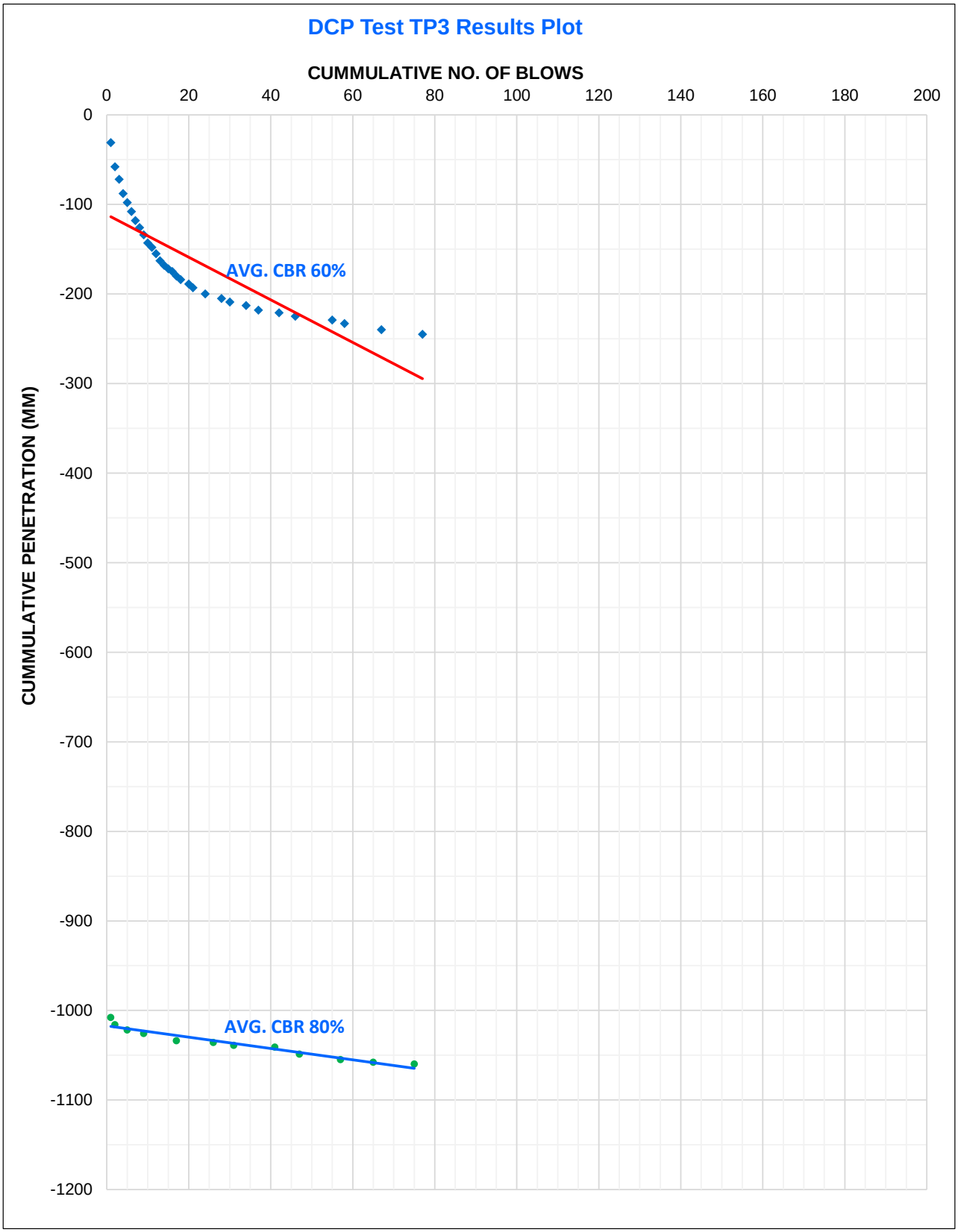
Appendix-1: Dynamic Cone Penetrometer (DCP) Test Report

Project:	Proposed New PV Power Plant in Galkayo, Somalia	**Test Date:**	5/5/2024
Client:	NEPCO	**Report Date:**	15/5/2024
Test Location:	**Trial Pit TP#3** (E767931.397 N760492.708) Tests conducted at surface & -0.8m	**Hammer Weight:**	8 kg
		Test Standard:	ASTM D6951

Cummulative Test Depth (mm)	No. of Blows	Total Blows	Cummulative Penetration (mm)	Penetration b/w readings (mm)	Penetration per bow (mm/blow)	Estimated CBR (%)	Bearing Capacity Estimation		
							N_{DCP} (No. of Blows per appr. 100mm)	Correlated $N_{SPT} = 1.78(N_{DCP})^{0.77}$	$q_{allow} = N_{SPT}*1.33/0.05$
Test-1 starting from natural ground surface									
0	0	--	141	--	--	--			
-31	1	1	172	31	31.0	6%			
-58	1	2	199	27	27.0	7%			
-72	1	3	213	14	14.0	15%	6	7	**188**
-88	1	4	229	16	16.0	13%			
-98	1	5	239	10	10.0	20%			
-108	1	6	249	10	10.0	20%			
-118	1	7	259	10	10.0	20%			
-126	1	8	267	8	8.0	30%			
-134	1	9	275	8	8.0	30%			
-143	1	10	284	9	9.0	25%			
-148	1	11	289	5	5.0	50%			
-155	1	12	296	7	7.0	35%			
-163	1	13	304	8	8.0	30%			
-168	1	14	309	5	5.0	50%			
-172	1	15	313	4	4.0	60%	24	21	**547**
-175	1	16	316	3	3.0	80%			
-180	1	17	321	5	5.0	50%			
-184	1	18	325	4	4.0	60%			
-189	2	20	330	5	2.5	100%			
-193	1	21	334	4	4.0	60%			
-200	3	24	341	7	2.3	100%			
-205	4	28	346	5	1.3	100%			
-209	2	30	350	4	2.0	100%			
-213	4	34	354	4	1.0	100%			
-218	3	37	359	5	1.7	100%			
-221	5	42	362	3	0.6	100%			
-225	4	46	366	4	1.0	100%			
-229	9	55	370	4	0.4	100%	Depth <100mm		
-233	3	58	374	4	1.3	100%			
-240	9	67	381	7	0.8	100%			
-245	10	77	386	5	0.5	100%			
Test-2 starting from trial pit depth -800 mm									
-1000	0	--	165	--	--	--			
-1008	1	1	173	8	8.0	30%			
-1016	1	2	181	8	8.0	30%			
-1022	3	5	187	6	2.0	100%			
-1026	4	9	191	4	1.0	100%			
-1034	8	17	199	8	1.0	100%			
-1036	9	26	201	2	0.2	100%	Depth <100mm		
-1039	5	31	204	3	0.6	100%			
-1041	10	41	206	2	0.2	100%			
-1049	6	47	214	8	1.3	100%			
-1055	10	57	220	6	0.6	100%			
-1058	8	65	223	3	0.4	100%			
-1060	10	75	225	2	0.2	100%			



Test Conducted By:
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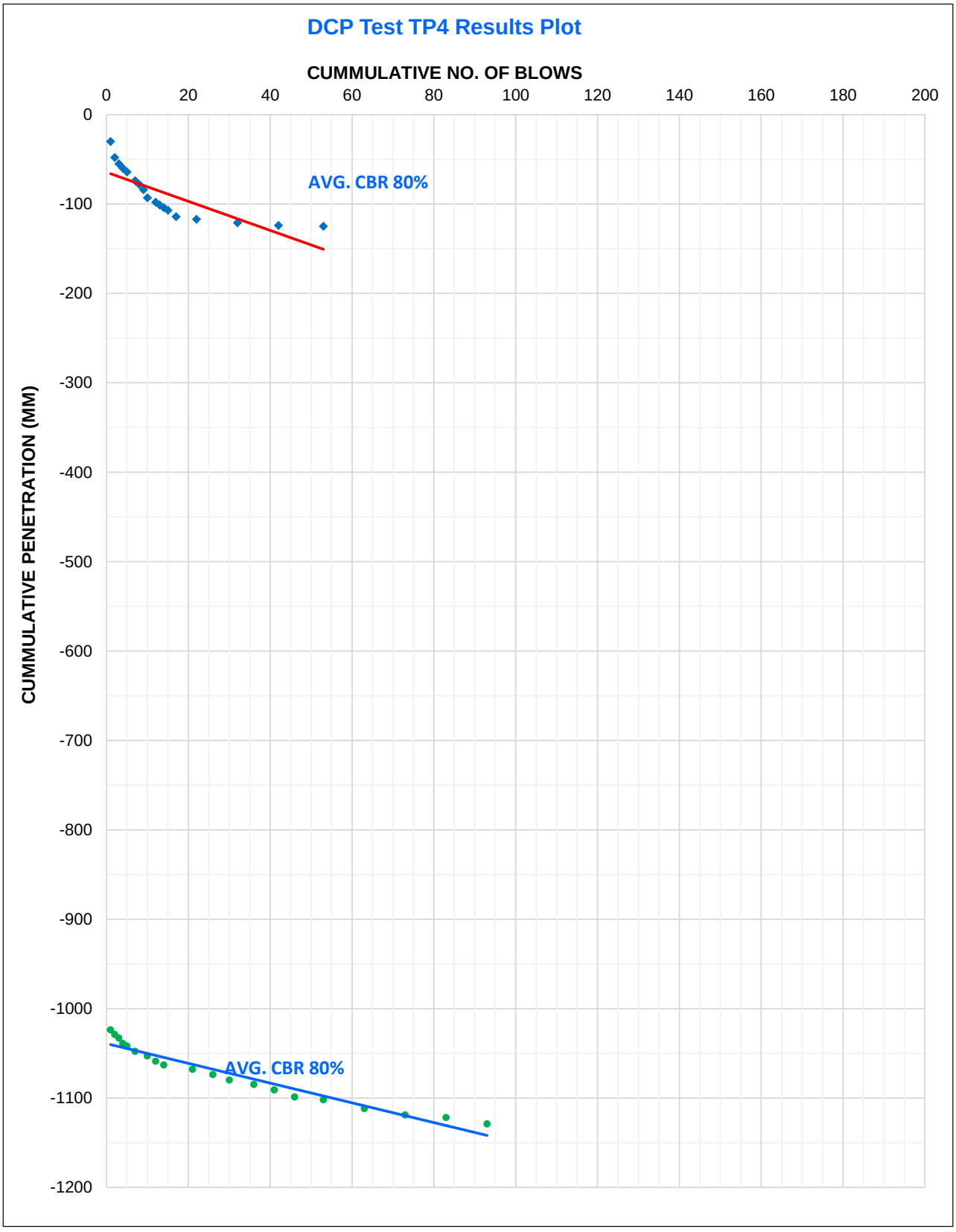
Appendix-1: Dynamic Cone Penetrometer (DCP) Test Report

Project:	Proposed New PV Power Plant in Galkayo, Somalia	**Test Date:**	5/5/2024
Client:	NEPCO	**Report Date:**	15/5/2024
Test Location:	**Trial Pit TP#4** (E767311.139 N760542.765) Tests conducted at surface & -1m	**Hammer Weight:**	8 kg
		Test Standard:	ASTM D6951

Cummulative Test Depth (mm)	No. of Blows	Total Blows	Cummulative Penetration (mm)	Penetration b/w readings (mm)	Penetration per bow (mm/blow)	Estimated CBR (%)	Bearing Capacity Estimation		
							N_{DCP} (No. of Blows per appr. 100mm)	Correlated $N_{SPT} = 1.78(N_{DCP})^{0.77}$	$q_{allow} = N_{SPT}*1.33/0.05$
Test-1 starting from natural ground surface									
0	0	--	126	--	--	--	15	14	**381**
-30	1	1	156	30	30.0	6%			
-48	1	2	174	18	18.0	11%			
-55	1	3	181	7	7.0	35%			
-60	1	4	186	5	5.0	50%			
-64	1	5	190	4	4.0	60%			
-74	2	7	200	10	5.0	50%			
-78	1	8	204	4	4.0	60%			
-84	1	9	210	6	6.0	40%			
-93	1	10	219	9	9.0	25%			
-98	2	12	224	5	2.5	100%			
-101	1	13	227	3	3.0	80%			
-104	1	14	230	3	3.0	80%	Depth <100mm		
-107	1	15	233	3	3.0	80%			
-114	2	17	240	7	3.5	80%			
-117	5	22	243	3	0.6	100%			
-121	10	32	247	4	0.4	100%			
-124	10	42	250	3	0.3	100%			
-125	11	53	251	1	0.1	100%			
Test-2 starting from trial pit depth -1000 mm									
-1000	0	--	140	--	--	--	53	38	**1,007**
-1024	1	1	164	24	24.0	8%			
-1029	1	2	169	5	5.0	50%			
-1033	1	3	173	4	4.0	60%			
-1039	1	4	179	6	6.0	40%			
-1042	1	5	182	3	3.0	80%			
-1048	2	7	188	6	3.0	80%			
-1053	3	10	193	5	1.7	80%			
-1059	2	12	199	6	3.0	80%			
-1063	2	14	203	4	2.0	100%			
-1068	7	21	208	5	0.7	100%			
-1074	5	26	214	6	1.2	100%			
-1080	4	30	220	6	1.5	100%			
-1085	6	36	225	5	0.8	100%			
-1091	5	41	231	6	1.2	100%			
-1099	5	46	239	8	1.6	100%			
-1102	7	53	242	3	0.4	100%			
-1112	10	63	252	10	1.0	100%	Depth <100mm		
-1119	10	73	259	7	0.7	100%			
-1122	10	83	262	3	0.3	100%			
-1129	10	93	269	7	0.7	100%			



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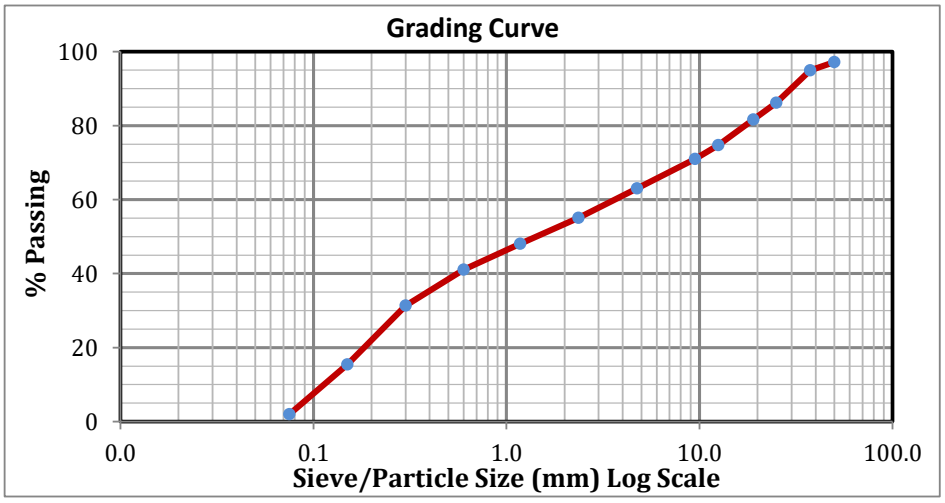
Garowe, Somalia

Sieve Analysis & Soil Classification

Project:	Proposed New Solar Power Plant in Galkayo, Somalia	**Sample Received:**	6 May 2024
Client:	NEPCO	**Test Date:**	11 May 2024
Location:	Trial Pit TP#1 (E767353.489 N759405.010)	**Test Standard:**	ASTM C136
Sample #:	S1	**Sample Mass (g):**	**5,000.0**

ASTM Sieve Designation	Sieve Size (mm)	Mass retained (g)	Cummulative mass retained (g)	Cummulative retained (%)	Cummulative Passing (%)
2 in	50.0	141.0	141.0	2.8	97.2
1 1/2 in	37.50	111.0	252.0	5.0	95.0
1 in	25.00	438.5	690.5	13.8	86.2
3/4 in	19.00	225.5	916.0	18.3	81.7
1/2 in	12.500	348.5	1,264.5	25.3	74.7
3/8 in	9.500	185.0	1,449.5	29.0	71.0
No. 4	4.750	398.0	1,847.5	37.0	63.1
No. 8	2.360	398.0	2,245.5	44.9	55.1
No. 16	1.180	350.5	2,596.0	51.9	48.1
No. 30	0.600	351.0	2,947.0	58.9	41.1
No. 50	0.300	486.0	3,433.0	68.7	31.3
No. 100	0.150	794.0	4,227.0	84.5	15.5
No. 200	0.075	674.5	4,901.5	98.0	2.0
	Pan	84.5	4,986.0	99.7	0.3
	Total	**4,986.0**			



D_{10} = 0.12
D_{30} = 0.3
D_{60} = 3.5
C_u = 29.2
C_c = 0.2

Unified Soil Classification System (as per ASTM D-2487)

Soil is coarse-grained as more than 50% is retained on No. 200 sieve. Soil is SAND as 50% or more of coarse fraction passes on No. 4 sieve. It has less than 5% fines and more than 15% gravel, $C_u > 6$ but $C_c < 1$.

Hence, Soil is classified as Poorly Graded SAND with Gravel (SP)

Tested & Reported by:
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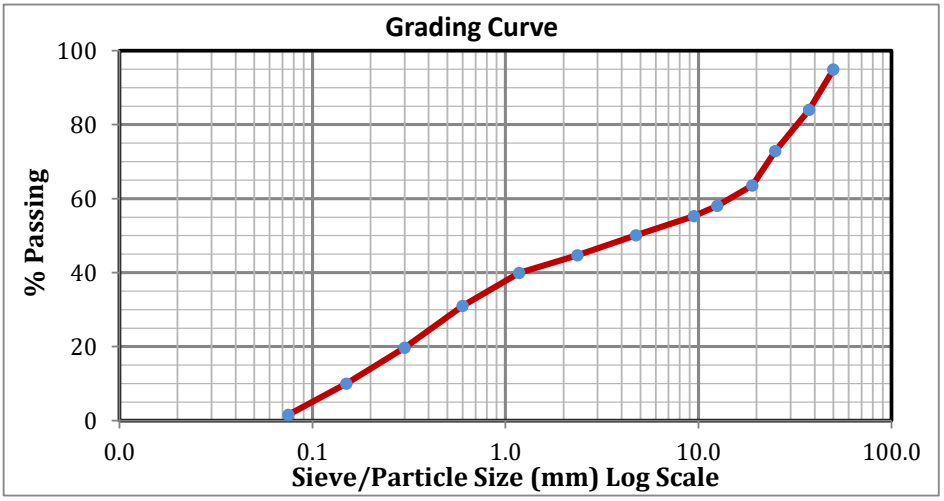
Sieve Analysis & Soil Classification

Project:	Proposed New Solar Power Plant in Galkayo, Somalia	**Sample Received:**	6 May 2024
Client:	NEPCO	**Test Date:**	11 May 2024
Location:	Trial Pit TP#2 (E767999.115 N759377.250)	**Test Standard:**	ASTM C136
Sample #:	S2	**Sample Mass (g):**	**5,000.0**

ASTM Sieve Designation	Sieve Size (mm)	Mass retained (g)	Cummulative mass retained (g)	Cummulative retained (%)	Cummulative Passing (%)
2 in	50.0	255.0	255.0	5.1	94.9
1 1/2 in	37.50	543.5	798.5	16.0	84.0
1 in	25.00	556.0	1,354.5	27.1	72.9
3/4 in	19.00	467.0	1,821.5	36.4	63.6
1/2 in	12.500	273.5	2,095.0	41.9	58.1
3/8 in	9.500	140.0	2,235.0	44.7	55.3
No. 4	4.750	258.0	2,493.0	49.9	50.1
No. 8	2.360	270.0	2,763.0	55.3	44.7
No. 16	1.180	238.5	3,001.5	60.0	40.0
No. 30	0.600	446.0	3,447.5	69.0	31.1
No. 50	0.300	565.0	4,012.5	80.3	19.8
No. 100	0.150	487.5	4,500.0	90.0	10.0
No. 200	0.075	420.5	4,920.5	98.4	1.6
	Pan	45.0	4,965.5	99.3	0.7
	Total	**4,965.5**			



D_{10} = 0.17
D_{30} = 0.6
D_{60} = 15
C_u = 88.2
C_c = 0.1

Unified Soil Classification System (as per ASTM D-2487)

Soil is coarse-grained as more than 50% is retained on No. 200 sieve. Soil is GRAVEL as 50% or more of coarse fraction retains on No. 4 sieve. It has less than 5% fines and more than 15% sand, $C_u > 6$ but $C_c < 1$.

Hence, Soil is classified as Poorly Graded GRAVEL with Sand (GP)

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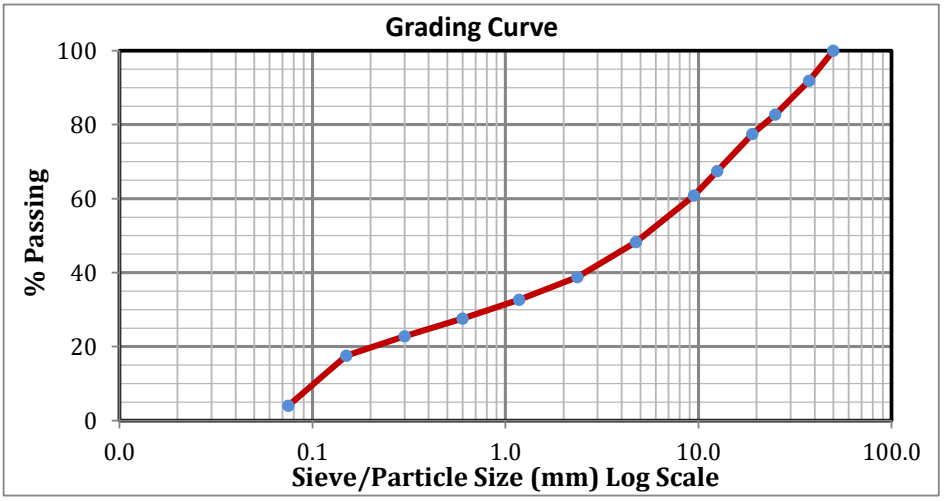
Sieve Analysis & Soil Classification

Project:	Proposed New Solar Power Plant in Galkayo, Somalia	**Sample Received:**	6 May 2024
Client:	NEPCO	**Test Date:**	11 May 2024
Location:	Trial Pit TP#3 (E767931.397 N760492.708)	**Test Standard:**	ASTM C136
Sample #:	S3	**Sample Mass (g):**	**5,000.0**

ASTM Sieve Designation	Sieve Size (mm)	Mass retained (g)	Cummulative mass retained (g)	Cummulative retained (%)	Cummulative Passing (%)
2 in	50.0	0.0	0.0	0.0	100.0
1 $^{1}/_{2}$ in	37.50	407.0	407.0	8.1	91.9
1 in	25.00	454.0	861.0	17.2	82.8
$^{3}/_{4}$ in	19.00	266.0	1,127.0	22.5	77.5
$^{1}/_{2}$ in	12.500	500.5	1,627.5	32.6	67.5
$^{3}/_{8}$ in	9.500	330.0	1,957.5	39.2	60.9
No. 4	4.750	626.5	2,584.0	51.7	48.3
No. 8	2.360	476.0	3,060.0	61.2	38.8
No. 16	1.180	305.0	3,365.0	67.3	32.7
No. 30	0.600	254.0	3,619.0	72.4	27.6
No. 50	0.300	241.0	3,860.0	77.2	22.8
No. 100	0.150	259.5	4,119.5	82.4	17.6
No. 200	0.075	678.5	4,798.0	96.0	4.0
	Pan	156.0	4,954.0	99.1	0.9
	Total	**4,954.0**			



D_{10} = 0.1
D_{30} = 0.9
D_{60} = 9.5
C_u = 95.0
C_c = 0.9

Unified Soil Classification System (as per ASTM D-2487)

Soil is coarse-grained as more than 50% is retained on No. 200 sieve. Soil is GRAVEL as 50% or more of coarse fraction retains on No. 4 sieve. It has less than 5% fines and more than 15% sand, $C_u > 6$ but $C_c < 1$.

Hence, Soil is classified as Poorly Graded GRAVEL with Sand (GP)

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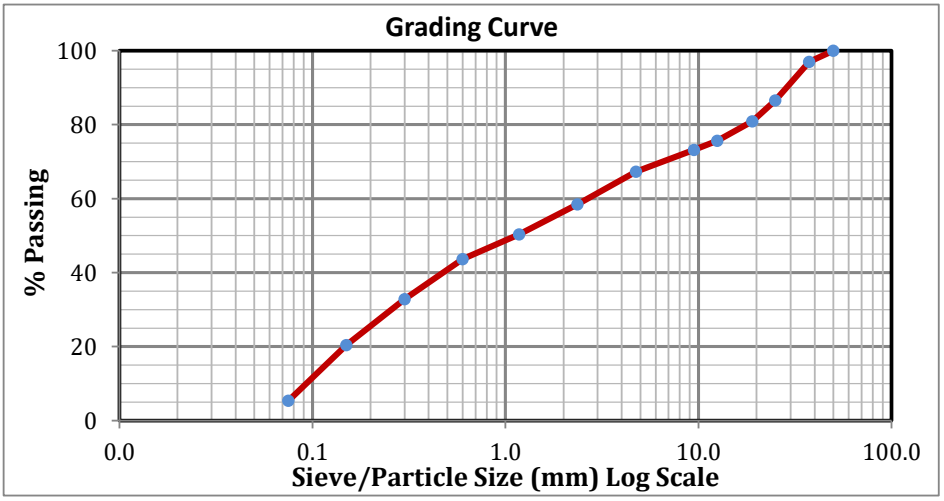
Garowe, Somalia

Sieve Analysis & Soil Classification

Project:	Proposed New Solar Power Plant in Galkayo, Somalia	**Sample Received:**	6 May 2024
Client:	NEPCO	**Test Date:**	10 May 2024
Location:	Trial Pit TP#4 (E767311.139 N760542.765)	**Test Standard:**	ASTM C136
Sample #:	S4	**Sample Mass (g):**	**5,000.0**

ASTM Sieve Designation	Sieve Size (mm)	Mass retained (g)	Cummulative mass retained (g)	Cummulative retained (%)	Cummulative Passing (%)
2 in	50.0	0.0	0.0	0.0	100.0
1 $^{1}/_{2}$ in	37.50	151.0	151.0	3.0	97.0
1 in	25.00	522.5	673.5	13.5	86.5
$^{3}/_{4}$ in	19.00	279.5	953.0	19.1	80.9
$^{1}/_{2}$ in	12.500	264.5	1,217.5	24.4	75.7
$^{3}/_{8}$ in	9.500	122.0	1,339.5	26.8	73.2
No. 4	4.750	295.0	1,634.5	32.7	67.3
No. 8	2.360	443.5	2,078.0	41.6	58.4
No. 16	1.180	404.0	2,482.0	49.6	50.4
No. 30	0.600	334.5	2,816.5	56.3	43.7
No. 50	0.300	541.5	3,358.0	67.2	32.8
No. 100	0.150	621.5	3,979.5	79.6	20.4
No. 200	0.075	752.5	4,732.0	94.6	5.4
	Pan	217.0	4,949.0	99.0	1.0
	Total	**4,949.0**			



D_{10} = 0.09
D_{30} = 0.27
D_{60} = 2.5
C_u = 27.8
C_c = 0.3

Unified Soil Classification System (as per ASTM D-2487)

Soil is coarse-grained as more than 50% is retained on No. 200 sieve. Soil is SAND as 50% or more of coarse fraction passes on No. 4 sieve. It has less around 5% fines and more than 15% Gravel, $C_u > 6$ but $C_c < 1$.

Hence, Soil is classified as Poorly Graded SAND with Gravel (SP)

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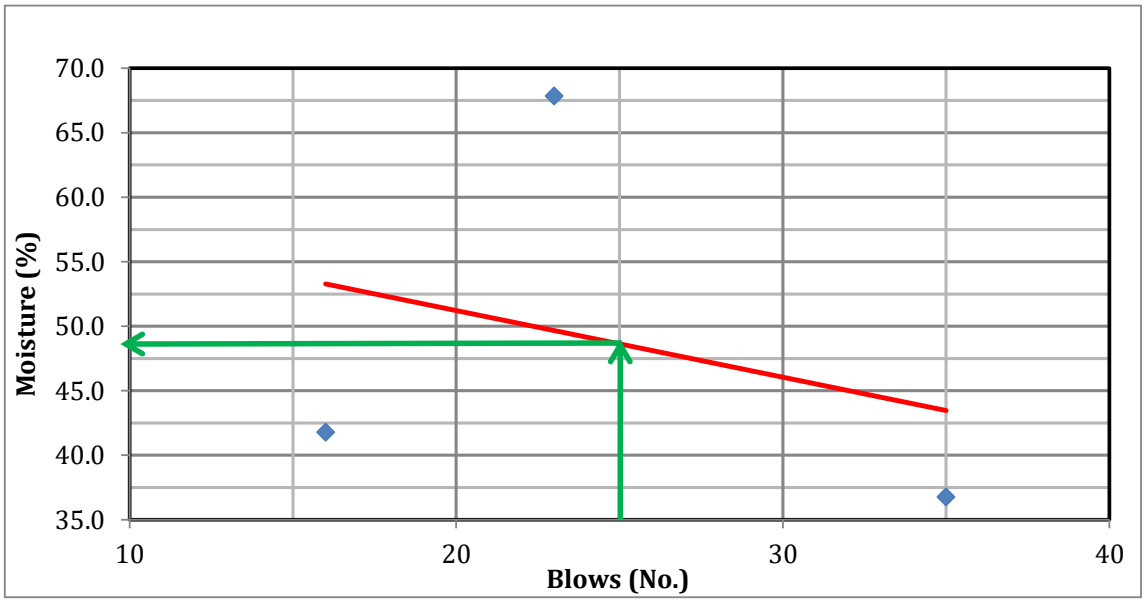
Determination of Atterberg Limits

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Date:**	6 May 2024
Client:	NEPCO	**Test Date:**	11 May 2024
Sample #:	S1 (from Trial Pit TP#1)	**Test Standard:**	ASTM D4318

		LIQUID LIMIT			PLASTIC LIMIT
Test No.		**1**	**2**	**3**	Non Plastic
Number of blows		16	23	35	
Tin No.		6A	T2	T6	
Mass of tin and wet soil (A)		104.0	104.0	102.0	
Mass of tin and dry soil (B)		90.0	85.0	89.5	
Mass of tin (C)		56.5	57.0	55.5	
Mass of moisture (D)	A-B	14.0	19.0	12.5	
Mass of dry soil (E)	B-C	33.5	28.0	34.0	
Moisture content (F)	(D/E)x100	41.8	67.9	36.8	
Averages		**48.8**			



RESULTS:

LIQUID LIMIT LL (%)	**49.0**
PLASTIC LIMIT PL (%)	**-**
PLASTICITY INDEX PI=LL-PL (%)	**-**

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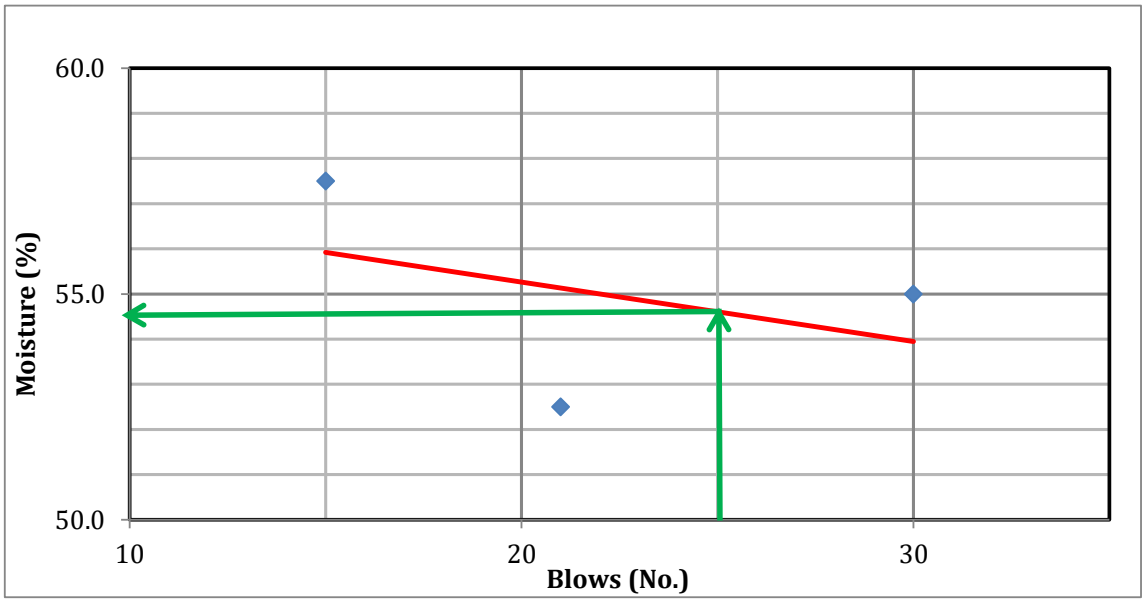
Determination of Atterberg Limits

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Date:**	6 May 2024
Client:	NEPCO	**Test Date:**	11 May 2024
Sample #:	S2 (from Trial Pit TP#2)	**Test Standard:**	ASTM D4318

		LIQUID LIMIT			PLASTIC LIMIT
Test No.		**1**	**2**	**3**	Non Plastic
Number of blows		15	21	30	
Tin No.		5A	DD	T4	
Mass of tin and wet soil (A)		110.5	87.5	88.0	
Mass of tin and dry soil (B)		99.0	77.0	77.0	
Mass of tin (C)		79.0	57.0	57.0	
Mass of moisture (D)	A-B	11.5	10.5	11.0	
Mass of dry soil (E)	B-C	20.0	20.0	20.0	
Moisture content (F)	(D/E)x100	57.5	52.5	55.0	
Averages		**55.0**			



RESULTS:

LIQUID LIMIT LL (%)	**54.5**
PLASTIC LIMIT PL (%)	**-**
PLASTICITY INDEX PI=LL-PL (%)	**-**

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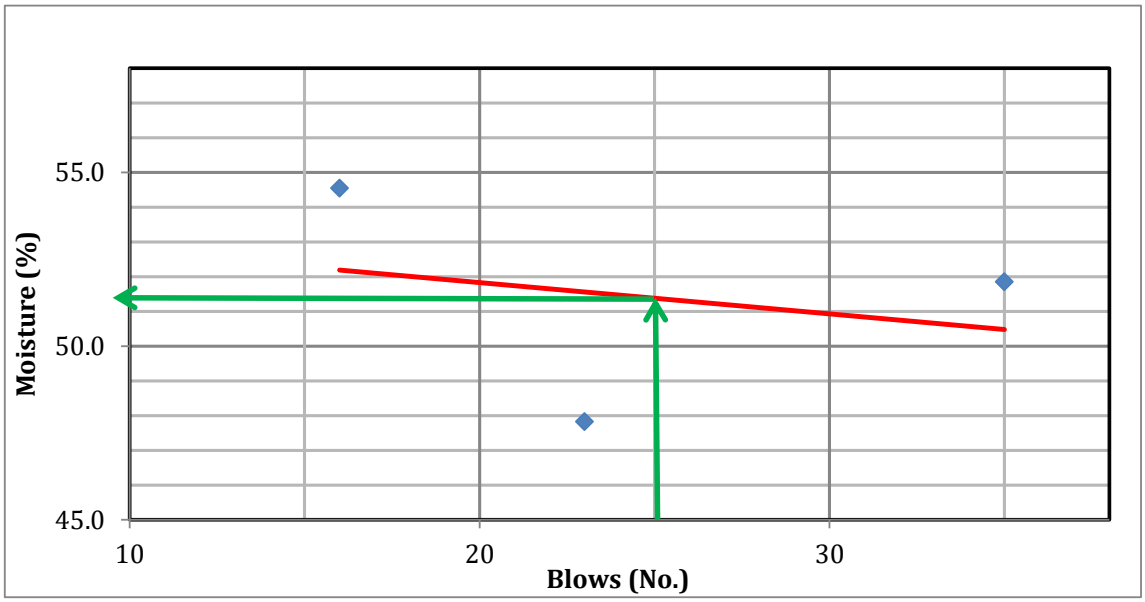
Determination of Atterberg Limits

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Date:**	6 May 2024
Client:	NEPCO	**Test Date:**	11 May 2024
Sample #:	S3 (from Trial Pit TP#3)	**Test Standard:**	ASTM D4318

		LIQUID LIMIT			PLASTIC LIMIT
Test No.		**1**	**2**	**3**	Non Plastic
Number of blows		16	23	35	
Tin No.		5A	DD	T4	
Mass of tin and wet soil (A)		90.0	91.0	98.0	
Mass of tin and dry soil (B)		78.0	80.0	84.0	
Mass of tin (C)		56.0	57.0	57.0	
Mass of moisture (D)	A-B	12.0	11.0	14.0	
Mass of dry soil (E)	B-C	22.0	23.0	27.0	
Moisture content (F)	(D/E)x100	54.5	47.8	51.9	
Averages		**51.4**			



RESULTS:

LIQUID LIMIT LL (%)	**51.4**
PLASTIC LIMIT PL (%)	**-**
PLASTICITY INDEX PI=LL-PL (%)	**-**

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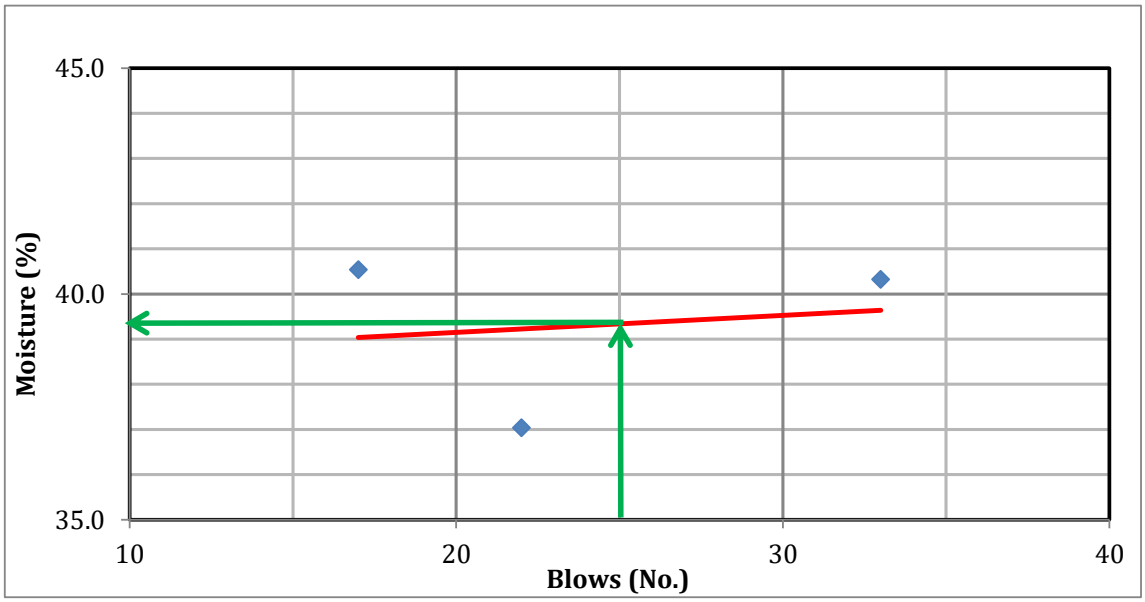
Determination of Atterberg Limits

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Date:**	6 May 2024
Client:	NEPCO	**Test Date:**	11 May 2024
Sample #:	S4(from Trial Pit TP#4)	**Test Standard:**	ASTM D4318

		LIQUID LIMIT			PLASTIC LIMIT	
Test No.		**1**	**2**	**3**	**4**	**5**
Number of blows		17	22	33		
Tin No.		2	9J	T5	1	3
Mass of tin and wet soil (A)		56.5	92.0	100.5	42.5	48.5
Mass of tin and dry soil (B)		49.0	82.0	88.0	39.0	43.5
Mass of tin (C)		30.5	55.0	57.0	28.0	29.5
Mass of moisture (D)	A-B	7.5	10.0	12.5	3.5	5.0
Mass of dry soil (E)	B-C	18.5	27.0	31.0	11.0	14.0
Moisture content (F)	(D/E)x100	40.5	37.0	40.3	31.8	35.7
Averages		**39.3**			**33.8**	



RESULTS:		
	LIQUID LIMIT LL (%)	**39.3**
	PLASTIC LIMIT PL (%)	**33.8**
	PLASTICITY INDEX PI=LL-PL (%)	**5.5**

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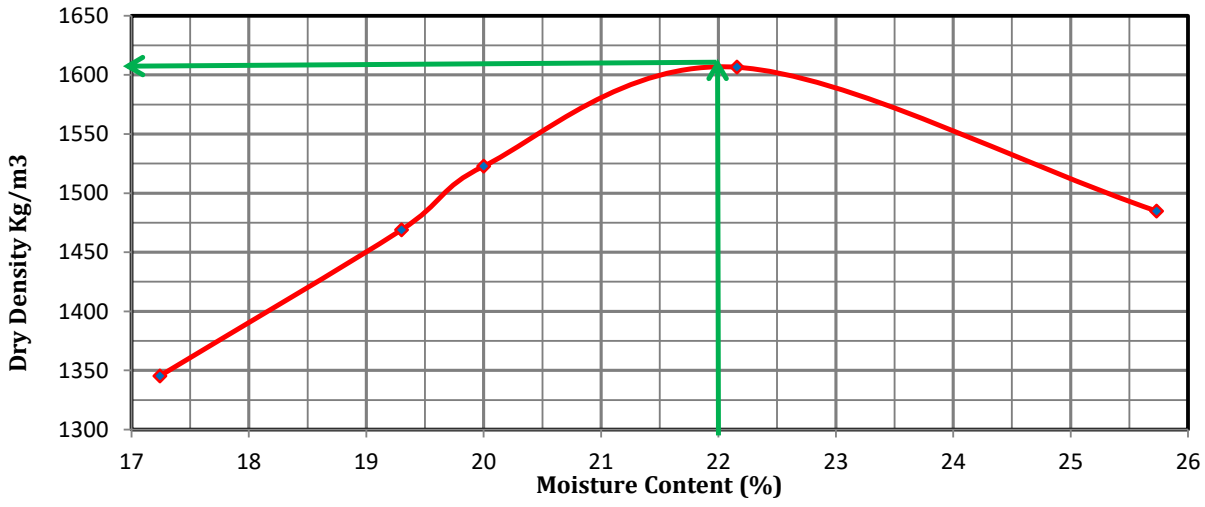
Determination of Moisture-Density Relationship

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Received:**	6 May 2024
Client:	NEPCO	**Test Date:**	10 May 2024
Location:	Trial Pit TP#1	**Test Standard:**	AASHTO T180
Sample #:	**S1**	**Apparatus:**	Modified Proctor

	BULK DENSITY DETERMINATION							
	Mass of sample		(g)	8,000.0	8,000.0	8,000.0	8,000.0	8,000.0
A	Mass of mould + sample		(g)	8,790.0	9,161.0	9,320.0	9,606.5	9,404.0
B	Mass of mould		(g)	5,445.0	5,445.0	5,445.0	5,445.0	5,445.0
C	Mass of sample	A-B	(g)	3,345.0	3,716.0	3,875.0	4,161.5	3,959.0
D	Volume of mould		(cm^3)	2,120.6	2,120.6	2,120.6	2,120.6	2,120.6
E	Bulk density	C/D	(g/cm^3)	1.577	1.752	1.827	1.962	1.867
	MOISTURE & DRY DENSITY DETERMINATION							
	Tin No.			T6	T3	6A	T2	4F
F	Mass of wet soil + tin		(g)	158.0	159.0	170.0	161.0	166.5
G	Mass of dry soil + tin		(g)	143.0	142.5	151.0	142.5	144.5
H	Mass of tin		(g)	56.0	57.0	56.0	59.0	59.0
I	Mass of water	F-G	(g)	15.0	16.5	19.0	18.5	22.0
J	Mass of dry soil	G-H	(g)	87.0	85.5	95.0	83.5	85.5
K	Moisture content	(I/J)x100	(%)	17.2	19.3	20.0	22.2	25.7
L	Dry Density	((E/(100+K))x100)x1000	(Kg/M^3)	1,345.4	1,468.9	1,522.8	1,606.5	1,484.9

From Graph Below:

Maximum Dry Density (MDD) = 1,610 Kg/m^3 **Optimum Moisture Conent (OMC) = 22%**



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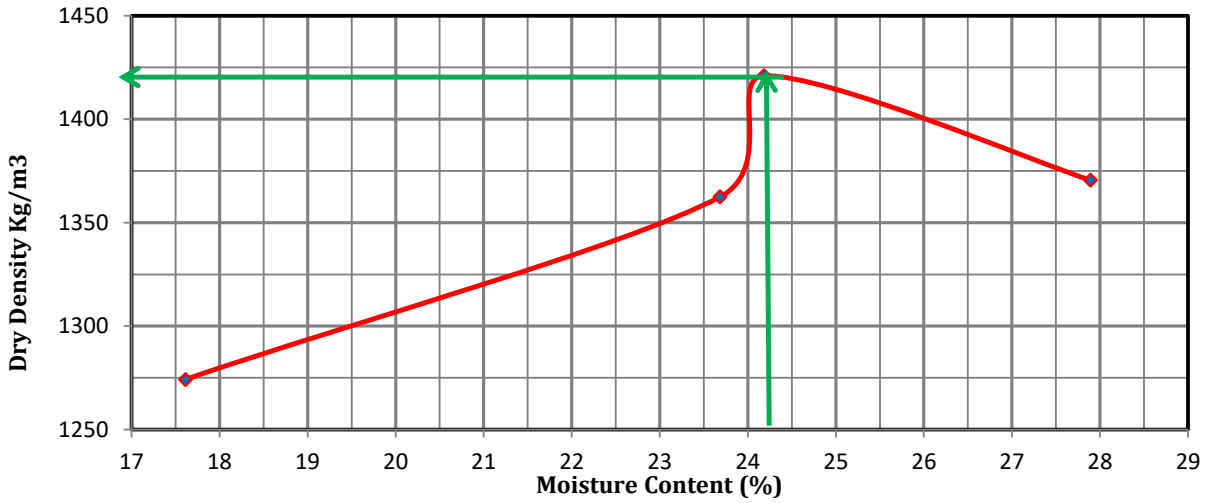
Determination of Moisture-Density Relationship

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Received:**	6 May 2024
Client:	NEPCO	**Test Date:**	10 May 2024
Location:	Trial Pit TP#2	**Test Standard:**	AASHTO T180
Sample #:	**S2**	**Apparatus:**	Modified Proctor

	BULK DENSITY DETERMINATION						
	Mass of sample		(g)	8,000.0	8,000.0	8,000.0	8,000.0
A	Mass of mould + sample		(g)	8,623.0	9,018.5	9,187.0	9,162.0
B	Mass of mould		(g)	5,445.0	5,445.0	5,445.0	5,445.0
C	Mass of sample	A-B	(g)	3,178.0	3,573.5	3,742.0	3,717.0
D	Volume of mould		(cm^3)	2,120.6	2,120.6	2,120.6	2,120.6
E	Bulk density	C/D	(g/cm^3)	1.499	1.685	1.765	1.753
	MOISTURE & DRY DENSITY DETERMINATION						
	Tin No.			T6	T2	7B	6A
F	Mass of wet soil + tin		(g)	150.0	150.0	150.5	150.0
G	Mass of dry soil + tin		(g)	136.0	132.0	132.0	129.5
H	Mass of tin		(g)	56.5	56.0	55.5	56.0
I	Mass of water	F-G	(g)	14.0	18.0	18.5	20.5
J	Mass of dry soil	G-H	(g)	79.5	76.0	76.5	73.5
K	Moisture content	(I/J)x100	(%)	17.6	23.7	24.2	27.9
L	Dry Density	((E/(100+K))x100)x1000	(Kg/M^3)	1,274.2	1,362.5	1,421.0	1,370.5

From Graph Below:

Maximum Dry Density (MDD) = 1,420 Kg/m^3 **Optimum Moisture Conent (OMC) = 24.2%**



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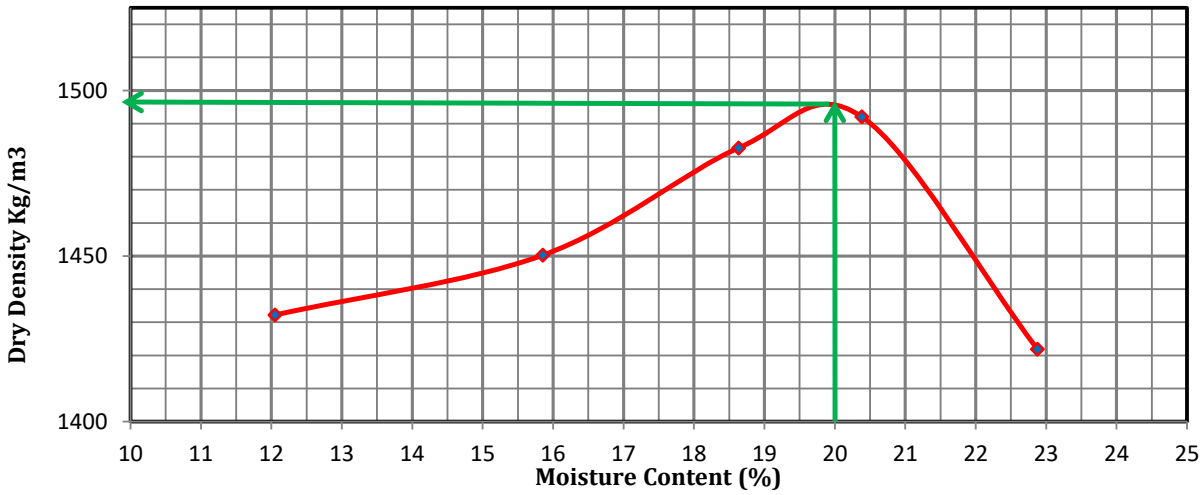
Determination of Moisture-Density Relationship

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Received:**	6 May 2024
Client:	NEPCO	**Test Date:**	11 May 2024
Location:	Trial Pit TP#4	**Test Standard:**	AASHTO T180
Sample #:	**S4**	**Apparatus:**	Modified Proctor

	BULK DENSITY DETERMINATION							
	Mass of sample		(g)	8,000.0	8,000.0	8,000.0	8,000.0	8,000.0
A	Mass of mould + sample		(g)	8,848.0	9,008.0	9,175.0	9,254.0	9,150.0
B	Mass of mould		(g)	5,445.0	5,445.0	5,445.0	5,445.0	5,445.0
C	Mass of sample	A-B	(g)	3,403.0	3,563.0	3,730.0	3,809.0	3,705.0
D	Volume of mould		(cm^3)	2,120.6	2,120.6	2,120.6	2,120.6	2,120.6
E	Bulk density	C/D	(g/cm^3)	1.605	1.680	1.759	1.796	1.747
	MOISTURE & DRY DENSITY DETERMINATION							
	Tin No.			T6	T2	7B	6A	6A
F	Mass of wet soil + tin		(g)	149.5	151.0	151.0	150.5	150.0
G	Mass of dry soil + tin		(g)	139.5	138.0	136.0	134.5	132.5
H	Mass of tin		(g)	56.5	56.0	55.5	56.0	56.0
I	Mass of water	F-G	(g)	10.0	13.0	15.0	16.0	17.5
J	Mass of dry soil	G-H	(g)	83.0	82.0	80.5	78.5	76.5
K	Moisture content	(I/J)x100	(%)	12.0	15.9	18.6	20.4	22.9
L	Dry Density	((E/(100+K))x100)x1000	(Kg/M^3)	1,432.2	1,450.3	1,482.7	1,492.1	1,421.9

From Graph Below:

Maximum Dry Density (MDD) = 1,495Kg/m^3 **Optimum Moisture Conent (OMC) = 20%**



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Natural Moisture Content of Soil

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Date:**	6 May 2024
Client:	**NEPCO**	**Test Date:**	12 May 2024
Sample #:	Samples S1-S4 (From Trial Pits TP1-TP4)	**Test Standard:**	ASTM D2216

Description	**Sample No.**				**Average**
	S1	**S2**	**S3**	**S4**	
Can no	1	3	9J	2	
Weight of Can …….. (W1)	28.5	29.5	55.5	30.5	
Weight of Can + Wet Soil…….. (W2)	72	67.5	131	77.5	
Weight of Can +Dry Soil …….. (W3)	55	53	107	62	
Weight of Water in the Soil Sample (Mw)	17	14.5	24	15.5	
Weight of the Dry Soil (Ms)	27	24	52	32	
Moisture Content of the Soil = Mw/Ms×100%	**64.2**	**61.7**	**46.6**	**49.2**	**55.4**

Remarks: Natural moisture content is high, because soil was saturated due to being in rainy season

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Specific Gravity of Fine Aggregates

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Date:**	6 May 2024
Client:	NEPCO	**Test Date:**	12 May 2024
Sample #:	Samples S1-S4 (From Trial Pits TP1-TP4)	**Test Standard:**	ASTM C128

Description	**Sample No.**				**Average**
	S1	**S2**	**S3**	**S4**	
(A) Weight of oven-dry sample in air (g)	271.0	276.0	287.0	285.5	
(B) Weight of pycnometer filled with water (g)	1498	1500	1489	1499	
(C) Weight of pycnometer filled with sample in water (g)	1660	1668	1671	1666	
(S) Weight of Saturated Surface Dry (SSD) sample in air (g)	300	300	300	300	
Bulk Specific Gravity (SSD) = S/(B+S-C)	2.17	2.28	2.53	2.26	
Apparent Specific Gravity = A/(B+A-C)	**2.49**	**2.57**	**2.72**	**2.41**	
Water Absorption = (S-A)/A*100	**10.70**	**8.70**	**4.53**	**5.08**	**7.25**

Remarks: Specific gravity is within the typical range, water absorption is relatively high due to soil from porous limestone roc

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Estimation of Soil Salinity by Electrical Conductivity Method

Project:	Proposed New Solar Power Plant in Galkayo	**Sample Received:**	6 May 2024
Client:	NEPCO	**Test Date:**	13 May 2024
Sample #:	Samples S1-S4 (From Trial Pits TP1-TP4)	**Test Standard:**	Literature

Description	**Sample No.**				**Average**
	S1	**S2**	**S3**	**S4**	
Electrical Conductity of Distilled Water used (mS/cm)	0.19	0.19	0.19	0.19	**0.19**
Electrical Conductity of water mixed 1:2 with soil (mS/cm)	2.95	3.07	2.91	3.21	**3.03**
pH of water mixed with soil	7.43	7.47	7.61	7.55	**7.52**

Remarks: **Observed soil EC is between 2 & 4, hence soil is Slightly Saline. pH result indicates slightly alkaline soil.**

Estimation of Galkayo Utility Water Electrical Conductivity & pH

Sample collected from NEPCO Galkayo power plant tap water on 6 May 2024

Electrical Conductity of Galkayo tap water (mS/cm)	3.78
pH of Galkayo tap water	7.14

Remarks: **Observed EC indicates highly brackish water not suitable for use. pH result is in acceptable range.**

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