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APPENDIX-1

GEOLOGICAL INSPECTIONS

NEWJEC Inc

GEOLOGICAL INVESTIGATION

ON

ADDIS ABABA TRANSMISSION AND DISTRIBUTION SYSTEM REHABILITATION AND UPGRADING PROJECT IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

ADDIS ABABA

MS Consultancy

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List of Abbreviations and symbols

BH	-	Boreholes
BS	-	British Standards
M	-	Meters
KPa	-	Kilo-Pascal (kN/m^2)
GWL	-	Ground water level
N-value	-	Number of blows for 300mm penetration
NMC	-	Natural moisture content
LL	-	Liquid limit
PI	-	Plasticity index
PL	-	Plastic limit
UCSC	-	Unified soil classification system
FS	-	Free Swell
D	-	Disturbed sample
UDS	-	Undisturbed sample

1. INTRODUCTION

1.1 Project Description

This report presents the findings of **subsurface exploration and geotechnical engineering studies** for Geological Investigation on Addis Ababa Transmission and Distribution System Rehabilitation and Upgrading Project which are located in different site of Addis Ababa, Ethiopia. The consultancy service agreement signed between the client (NEWJEC Inc) and consultant (MS Consultancy) on March 2018.

The field work of the geotechnical site investigation was conducted from April 03, 2018 to May 14, 2018.

1.2 Scope of Work

The site investigation has been carried out by drilling eleven exploratory bore holes at each proposed site location. .

1.3 Purposes of Exploration

The purposes of this exploration were to:

- Determine the type and extent of geological layers;
- Investigate the presence of ground water and identify its level if encountered;
- Develop engineering recommendations to guide design and construction of the project.

We accomplished these purposes by:

1. Borehole drilling to explore the subsurface soil and ground water conditions;
2. Performing field tests such as SPT;
3. Reviewing available geologic literature and soil mapping information;
4. Analyzing the field data to develop appropriate engineering recommendation, and
5. Preparing this geotechnical investigation report which contains, the general and particular geology of the project site, the methodologies employed the investigation and tests used to study the engineering properties of the subsurface strata and finally foundation recommendation with estimation of bearing capacity.

1.4 Location

The project sites are sub stations and transmission lines distributed in different locations of Addis Ababa.

Based on the area to be covered by the structures, eleven boreholes were selected for the investigation. The co-ordinates of drilled boreholes measured using UTM Adindan Datum are tabulated as follows:

Table 1: Coordinates of Boreholes

Borehole Location	Easting	Northing
Addis North Substation Site	0472157	1001077
Gergi-Mebrat Hail Site(Woreganu)	0478965	0995141
Salite-Mihiret Site	0481099	0996862
Kality Substation Site(Gantry)	0473123	0981871
Kality Tower-48 Site	0472789	0983421
Addis Center Substation, BH-1	0471934	0994303
Addis Center Substation, BH-2	0471909	0994283
Addis Center Substation, BH-3	0471945	0994246
Gofa Site	0472121	0990658
Lafto Tower-25 Site	0472138	0989739
Hana-Mariam (Near T-36)Site	0472493	0986519

1.5 Regional and Site Geology

1.5.1 Regional Geology

Addis Ababa city is situated in the western margin of the Main Ethiopian Rift and represents a transition zone between the Ethiopian Plateau and the rift with poorly defined escarpment.

The geology of Addis Ababa area is represented by four volcanic units dominated in the lower part by basaltic lava flows (Addis Ababa basalt), followed by a pyroclastic sequence, mainly formed by ignimbrites (Addis Ababa Ignimbrite), followed by central

composite volcanoes (Central Volcanoes unit), and finally small spatter cones and lava flows (Akaki unit).

Addis Ababa basalt extensively crops out along Akaki, Kebena, and Dukem rivers at the east to southeastern part of Addis Ababa, and represents the oldest unit of the area. It consists of essentially sub-horizontal lava flows with thickness ranging from few meters up to 20m. Maximum exposed thickness was found east of Addis Ababa, along the Kebena River. Addis Ababa basalt is predominantly constituted by alkaline and olivine basalts with three main textural attributes, that is, porphyritic, aphyric, and sub-aphyric.

Addis Ababa Ignimbrite is exposed close to Addis Ababa along the Akaki and Kebena rivers. It overlies the Addis Ababa basalt and locally covers the products of the composite central volcanoes of Wechecha and Furi. The sequence is constituted by different flow units, consisting of pale-green to pale-yellow welded and crystal rich ignimbrites.

Central volcanoes unit includes the Yerer volcano and the product of the two composite volcanoes Wechecha and Furi west and southeast of Addis Ababa, respectively. Wechecha and Furi volcanoes are two large edifices composed by predominant trachyte with minor pyroclastics. Yerer represents the largest volcanic edifice in the region, with a relief of 1000m from the plain and 14km wide along east-west direction. Products mainly consist of trachytes, even if pyroclastics are widespread mainly in the central part eastern sector. The highest part of Yerer volcano was affected by a more recent volcanic activity that produces spatter cones and associated basalt.

Akaki unit crops out east of Addis Ababa and consists of scoria and spatter cones with associated tabular lava flows and phreato- magmatic deposits. Alluvial deposits covering these units consists of regolith, reddish brown soils, talus and alluvium with maximum thickness of about two meters.

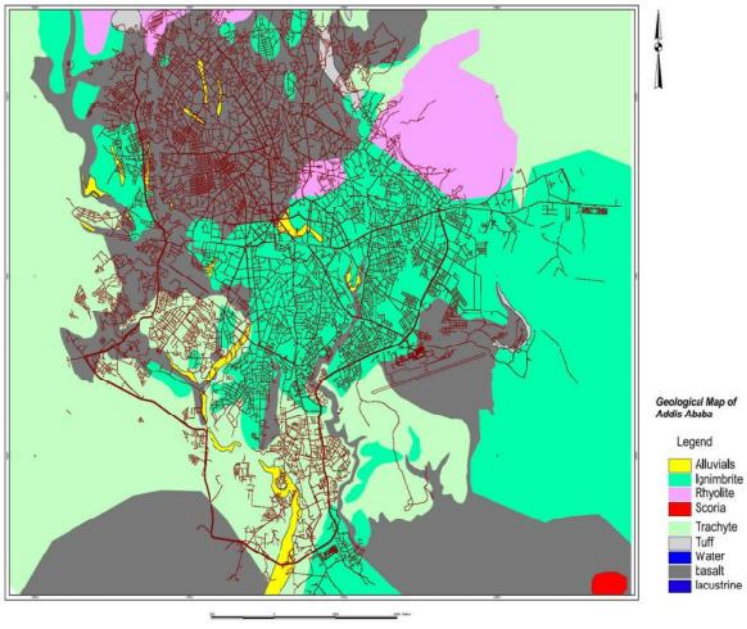


Fig 1: Geological Map of Addis Ababa

1.5.2 Site Geology

The project has nine distinct sites and the geology of each site is presented below:

Addis North Substation Site

The upper most layer of the site is covered with backfill material having a thickness of 0.60m. Beneath the backfill is stiff to medium stiff, light yellow to light gray, low to high plastic clayey SILT with sand soil which extends to a depth of 4.55m. The lowest profile of the explored depth is very stiff to medium stiff, reddish color, low to high plastic silty CLAY/clayey SILT soil.

Gergi-Mebrathail Site(Woreganu)

The top layer of the site is covered with backfill material having a thickness of 0.65m. Beneath the backfill silty CLAY and clayey SILT soil layers are found up to a depth of 9.150m. The lowest profile of the explored depth is extremely weak, light gray, moderately fractured IGNIMBRITE rock up to a depth of 10.20m.

Salite-Mihiret Site

The top layer of the site is covered with backfill material which extends to a depth of 1.90m below existing ground level. Beneath the backfill is weak, light gray, slightly weathered, closely spaced IGNIMBRITE rock layer which extends up the end of exploration depth, 6.00m.

Kality Substation Site (Gantry)

The upper most layer of the site is covered with backfill material extended to a depth of 3.00m. Beneath the backfill isvery weak, reddish brown, highly weathered, very closely fractured scoriaceous BASALT rock which extends to a depth of 7.00. The lowest profile of the explored depth is medium strong, dark gray, slightly weathered, moderately to closely joint vesicular BASALT rock.

Kality Tower-48 Site

The top soil layer of the site is covered with medium stiff to hard, black to dark gray, high plastic silty CLAY with occasional gravel which extends to a depth of 4.65m. Beneath the top soil layer is hard, variegated color, low to high plastic clayey SILT with sand and core-stone which has a thickness of 2.35m. The lowest profile of the explored depth is hard, variegated color, low to non-plastic sandy SILT with clay and core-stone.

Addis Center Substation Site

The upper most layer of the site is covered with backfill material/topsoil which extends to a depth of 0.40m below existing ground level. Beneath the backfill is medium stiff to very

stiff variegated color (black to light brown) layer which extends up the end of exploration depth, 10.00m.

Gofa Site

The top soil layer of the site is covered with backfill which extends to a depth of 0.40m. Beneath the backfill layer is stiff to very stiff, dark gray, high plastic clayey SILT soil which has a thickness of 3.00m. The lowest profile of the explored depth is Dense to very dense, variegated color, non-plastic silty GRAVEL soil.

Lafto Tower-25 Site

The upper most layer of the site is covered with backfill which extends to a depth of 0.70m. Beneath the backfill layer is extremely weak to weak, variegated color, slightly to highly weathered, IGNIMBRITE Rock which has a thickness of about 5.00m. The lowest profile of the explored depth is very stiff to hard, reddish color, non-plastic clayey SILT with core stone.

Hana-Mariam (Near T-36)Site

The upper most layer of the site is covered with backfill which extends to a depth of 0.60m. Beneath the backfill layer is extremely weak, light gray, slightly to highly weathered, IGNIMBRITE Rock which extends to a depth of 2.25m. Below the rock layer is stiff to hard, light gray, low to high plastic, clayey SILT soil which extends to a depth of 8.00m. The lowest profile of the explored depth is dense to very dense, variegated color, non-plastic silty gravel with core-stone.

Geological strata are presented in the borehole logs attached with this report Appendix 1).

2. METHODOLOGY OF INVESTIGATION

The site investigation was conducted by deploying one Spindle type core drilling rig having the capacity to perform boring operations to the required standard and quality.

The main tasks undertaken as per the requirements for the geotechnical investigation are:

1. Rotary core drilling and
2. Field testing

2.1Drilling

For the soil formation dry drilling method has been utilized using single core barrels fitted with appropriate size tungsten carbide bits at the bottom in order to achieve good quality core recovery. When the formation changed to rock, water was pumped down to the diamond bit through hollow drill rods, thus, lubricating the bit and flushing the debris up the borehole. Telescopic drilling was used whereby the drilling size was reduced progressively starting from 108mm hole-diameter through 89mm and remains till the completion depth.

In conjunction with drilling, the following activities were performed:

- Standard Penetration Testing (SPT) and
- Ground water observation,

2.2Drilling Equipment and Operation

The core drilling was carried out by using spindle type rotary core drilling rig. Equipment to conduct in-situ testing and sampling, such as SPT apparatus including split spoon sampler, water pump, rods, casings and a wide range of heavy-duty tools were used during the drilling operation.

Core samples recovered from core barrels were arranged in partitioned wooden core boxes having 1.0 m length, and are properly labeled indicating project name, client, borehole designation, depth, etc. The cores inside core boxes were logged and photographed (colored) and kept as part of the report document.

2.3 Field Testing

The Standard Penetration Test (SPT) utilizes a 51mm external diameter and 450mm long thick-walled split spoon tube sampler driven into the ground under the impact of semi-automatic sliding hammer weighing 63.5kg through a free fall height of 760mm in accordance with test procedure mentioned in test No. 19 of BS 1377; 19750. The 'N' value, which is the measure of the density or consistency of the ground under testing, is

recorded as the number of hammer blows required to achieve penetration of the last 300mm. The initial blows required to penetrate the first 150mm are normally regarded as seating blows to allow for any disturbed materials at the bottom of the borehole, and are discarded. Upon completion of the test, the sampler tube is removed and disassembled to obtain 'disturbed' but representative sample of the tested ground.

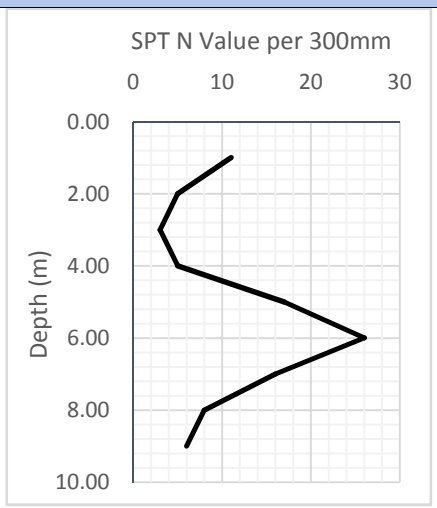
The N-values of the SPT are an indication of the relative density of cohesion less soils and the consistency of cohesive soil. General N-value ranges are correlated with relative density and consistency as shown in table 3 below. It is emphasized that for gravels and clays the correlations to relative density and consistency should serve only as general estimates.

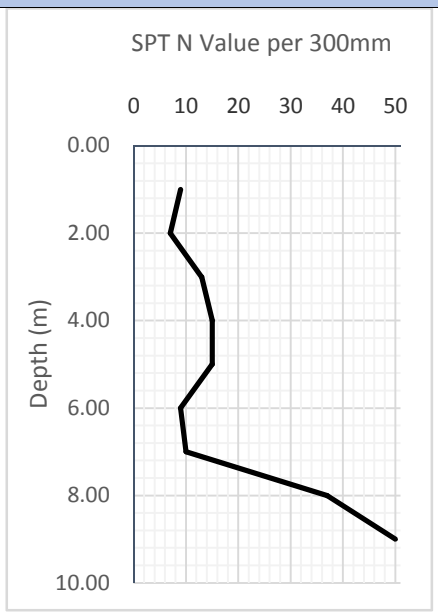
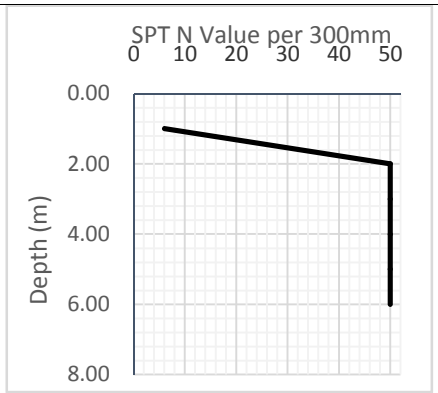
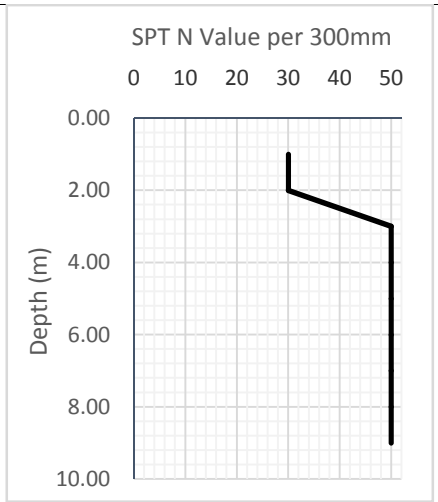
Table 2: Soil properties Correlated with Standard Penetration Test Values

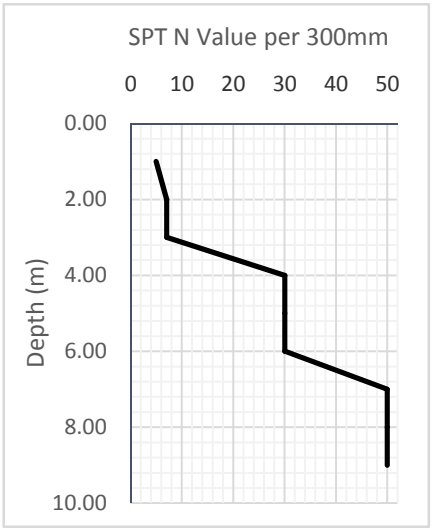
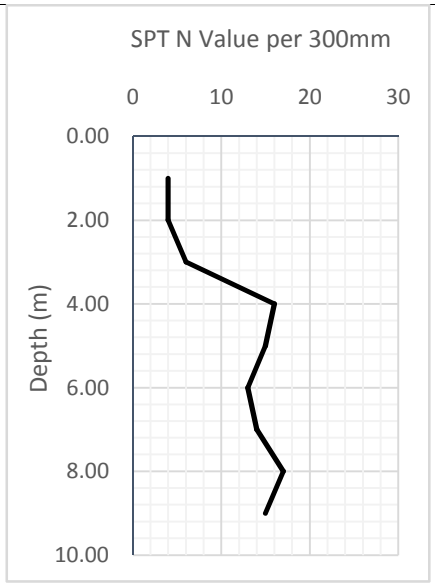
Cohesionless Soil		Cohesive Soil	
Number of Blows per 0.3 m (1 ft), N	Relative Density	Number of Blows per 0.3 m (1 ft), N	Consistency
0 – 4	Very loose	Below 2	Very soft
4 – 10	Loose	2 – 4	Soft
10 – 30	Medium	4 – 8	Medium
30 – 50	Dense	8 – 15	Stiff
Over 50	Very dense	15 – 30	Very stiff

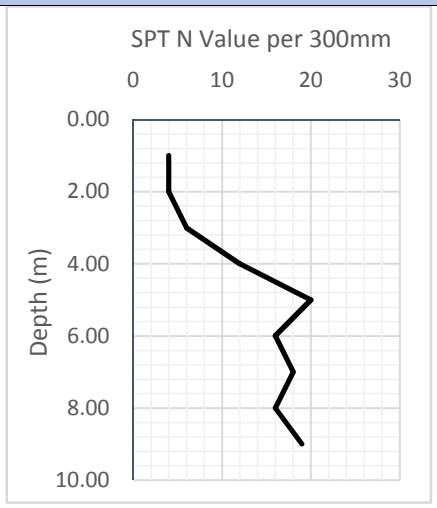
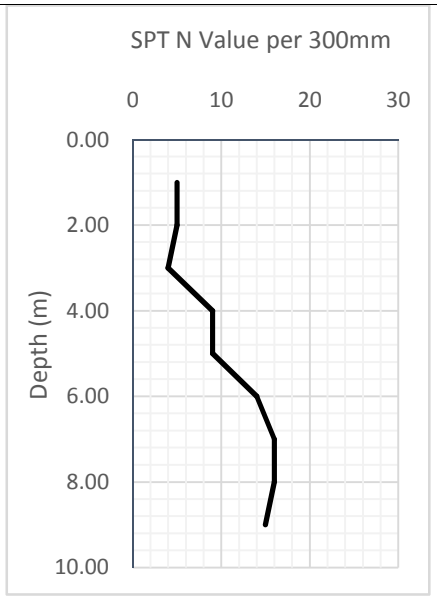
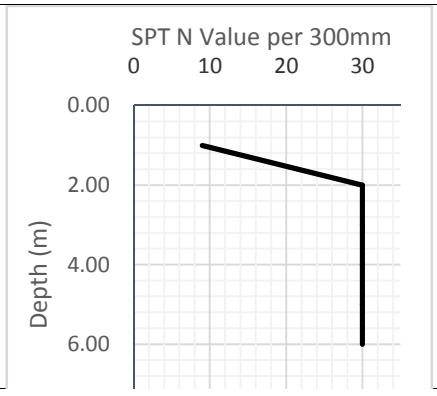
Standard Penetration Testing (SPT) in the borehole was conducted starting from a depth of 1.50m below the ground level. The following table summarizes the representative SPT N-value.

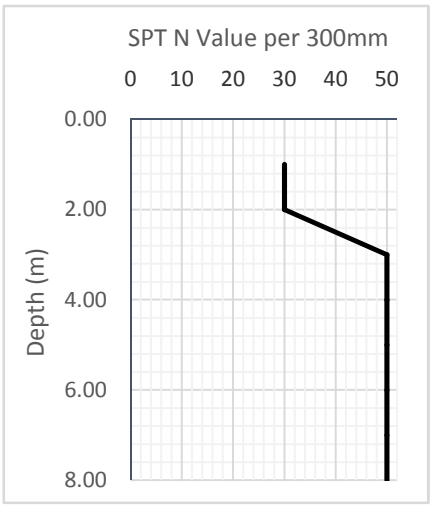
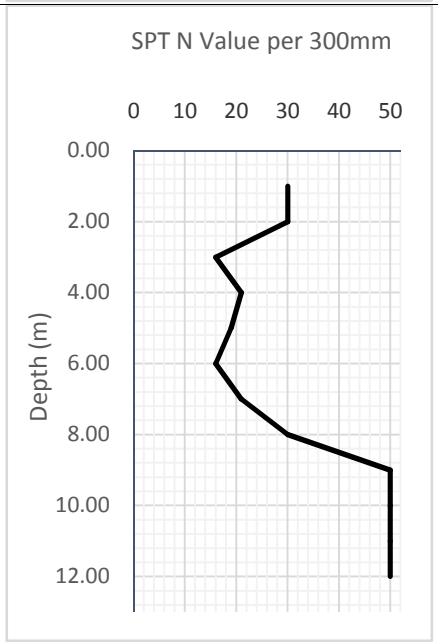
Table 3: Representative SPT N-values

BH-ID	Depth (m)	SPT N-value	SPT N-value Vs depth Plot	Layer Description
Addis North Substation Site	1.00 – 1.45	2/4/7		Stiff to medium stiff, light yellow to light gray, low to high plastic clayey SILT with sand soil layer.
	2.00 – 2.45	1/3/2		
	3.00 – 3.45	1/1/2		
	4.00 – 4.45	2/2/3		
	5.00 – 5.45	3/6/12		Very stiff to medium stiff, reddish color, low to high plastic silty CLAY/clayey SILT soil layer.
	6.00 – 6.45	7/16/10		
	7.00 – 7.45	5/8/8		
	8.00 – 8.45	3/4/4		
	9.00 – 9.45	2/2/4		
GergiMebratHa	1.00 – 1.45	2/4/5		Stiff, dark gray, high plastic silty CLAY soil

BH-ID	Depth (m)	SPT N-value	SPT N-value Vs depth Plot	Layer Description
il Site(Woreganu)	2.00 – 2.45	2/4/3		Stiff to very stiff, light gray, low to high plastic clayey SILT soil.
	3.00 – 3.45	3/6/7		
	4.00 – 4.45	4/7/8		
	5.00 – 5.45	5/6/9		
	6.00 – 6.45	3/4/5		Stiff, light yellow, low to non-plastic clayey SILT soil.
	7.00 – 7.45	2/4/6		
	8.00 – 8.45	6/17/20		Hard, reddish, low to high plastic, clayey SILT soil
	9.00 – 9.30	50		Extremely weak, light gray, moderately fractured IGNIMBRITE rock.
Salitemihiret Site	1.00 – 1.45	2/3/3		Backfill material
	1.90 – 6.00	>50		Weak, light gray, slightly weathered, closely spaced IGNIMBRITE rock layer.
Kality Substation Site(Gantry)	1.00 – 1.15	30		Backfill with compacted sub base and base course materials.
	2.00 – 2.15	30		
	4.00 – 4.45	10/14/50		Very weak, reddish brown, highly weathered, very closely fractured scoriaceous BASALT rock
	5.00 – 5.45	50		
	6.00 – 6.45	50		
	7.00 – 10.00	50		Medium strong, dark gray, slightly weathered, moderately to closely

BH-ID	Depth (m)	SPT N-value	SPT N-value Vs depth Plot	Layer Description
				jointed vesicular BASALT rock
Kality Tower-48 Site	1.00 – 1.45	1/2/3		Medium stiff to hard, black to dark gray, high plastic silty CLAY with occasional gravel (from 4.00m - 4.65m).
	2.00 – 2.45	1/3/4		
	3.00 – 3.45	2/3/4		
	4.00 – 4.15	30		
	5.00 – 5.15	30		Hard, variegated color, low to high plastic clayey SILT with sand and core-stone.
	6.00 – 6.30	30		
	7.00 – 7.15	50		hard, variegated color, low to non-plastic sandy SILT with clay and core-stone.
	8.00 – 8.15	50		
	9.00 – 9.15	50		
Addis Center Substation, BH-1	1.00 – 1.45	2/2/2		Medium stiff, dark gray, high plastic silty CLAY soil
	2.00 – 2.45	1/2/2		
	3.00 – 3.45	2/2/4		Medium stiff to stiff, reddish brown, high plastic clayey SILT soil.
	4.00 – 4.45	3/7/9		
	5.00 – 5.45	4/6/9		
	6.00 – 6.45	4/5/8		
	7.00 – 7.45	5/5/9		
	8.00 – 8.45	6/7/10		Stiff to very stiff, light brown, high plastic clayey SILT with trace gravel and sand soil.
	9.00 – 9.45	5/6/9		
Addis Center Substati	1.00 – 1.45	1/2/2		Medium stiff, dark gray, high plastic silty CLAY/clayey SILT soil.
	2.00 – 2.45	2/2/2		

BH-ID	Depth (m)	SPT N-value	SPT N-value Vs depth Plot	Layer Description
on, BH-2	3.00 – 3.45	2/2/3		Stiff, reddish brown, high plastic clayey SILT soil.
	4.00 – 4.45	4/6/6		
	5.00 – 5.45	6/9/11		
	6.00 – 6.45	5/7/9		
	7.00 – 7.45	5/8/10		
	8.00 – 8.45	6/6/9		Very stiff, light brown, high plastic clayey SILT with sand and trace gravel soil.
	9.00 – 9.45	6/8/11		
Addis Center Substation, BH-3	1.00 – 1.45	1/2/3		Medium stiff to very stiff, black to dark gray, high plastic clayey SILT/silty CLAY soil.
	2.00 – 2.45	2/2/3		
	3.00 – 3.45	2/2/2		
	4.00 – 4.45	3/4/5		
	5.00 – 5.45	2/4/5		
	6.00 – 6.45	4/6/8		Stiff to very stiff, variegated color, low to high plastic clayey SILT soil.
	7.00 – 7.45	5/7/9		
	8.00 – 8.45	6/7/9		
	9.00 – 9.45	6/6/9		
Gofa Site	1.00 – 1.45	3/4/5		Stiff to very stiff, dark gray, high plastic clayey SILT soil.
	2.00 – 2.30	30		
	3.00 – 3.15	30		Dense to very dense, variegated color, non-plastic silty GRAVEL soil.
	4.00 – 4.15	30		
	5.00 – 5.15	30		

BH-ID	Depth (m)	SPT N-value	SPT N-value Vs depth Plot	Layer Description
	6.00 – 6.15	30		
Lafto Tower-25 Site	1.00 – 2.00	30		
	3.00 – 5.55	50		Extremely weak to weak, variegated color, slightly to highly weathered, IGNIMBRITE Rock.
	6.00 – 6.15	50		Very stiff to hard, reddish color, non-plastic clayey SILT with core stone.
	7.00 – 7.15	50		
	8.00 – 8.15	50		
Hana mariam (Near T-36)Site	1.00 – 1.15	30		Extremely weak, light gray, slightly to highly weathered, IGNIMBRITE Rock.
	3.00 – 3.45	5/7/9		Stiff to hard, light gray, low to high plastic, clayey SILT soil.
	4.00 – 4.45	7/9/12		
	5.00 – 5.45	6/8/11		
	6.00 – 6.45	5/6/10		
	7.00 – 7.45	7/9/12		
	8.00 – 8.15	30		Dense to very dense, variegated color, non-plastic silty gravel with corestone.
	9.00 – 9.15	50		
	10.00 – 10.15	50		
	11.00 – 11.15	50		
	12.00 – 12.15	50		

3. GEOTECHNICAL CHARACTERISTICS

3.1 Description of Geotechnical Layer

Description of geotechnical layer is made for each site since the location of site is far apart from each other. Descriptive analysis was made on the soil and rock samples derived from eleven boreholes. This was used together with relative compactions as indicated from the SPT tests, and the following generalized geo-technical layers are identified. Details on type and extent of the geotechnical layers are given in Appendix 1 (Borehole logs).

Addis North Substation Site

A. Backfill Layer

The upper most layer of the site is covered with backfill material consists of silt, sand and gravel which extends up to a depth of 0.60m below existing ground level.

B. Stiff to medium stiff, light yellow to light gray, low to high plastic clayey SILT with sand soil layer

This layer is found below backfill characterized by stiff to medium stiff, light yellow to light gray, low to high plastic clayey SILT with sand soil layer which extends up to a depth of 4.55m below existing ground level.

The standard penetration tests were conducted on this layer in which SPT blow counts are from 5 to 11blows/300mm, shows stiff to medium stiff degree of consistency.

C. Very stiff to medium stiff, reddish color, low to high plastic silty CLAY/clayey SILT soillayer

This is lowest profile of the explored depth characterized by very stiff to medium stiff, reddish color, low to high plastic silty CLAY/clayey SILT soil.

The standard penetration tests were conducted on this layer in which SPT blow counts are from 6 to 26 blows/300 mm, shows very stiff to medium stiff degree of consistency.

Gerjimebrat Hail Site(Woreganu)

A. Backfill Layer

The upper most layer of the site is covered with backfill material consists of reddish ash which extends up to a depth of 0.65m below existing ground level.

B. Stiff, dark gray, high plastic silty CLAY soillayer

This layer is found beneath backfill characterized Stiff, dark gray, high plastic silty CLAY soil layer which extends up to a depth of 1.90m below existing ground level.

The standard penetration tests were conducted on this layer in which SPT blow counts is 9 blows /300 mm, shows stiff degree of consistency.

C. Stiff to very stiff, light gray, low to high plastic clayey SILT soil layer

This layer is characterized by stiff to very stiff, light gray, low to high plastic clayey SILT soil and extends up to a depth of 6.00m.

The standard penetration tests were conducted on this layer in which SPT blow counts are from 7 to 15blows/300mm, shows stiff to very stiff degree of consistency.

D. Stiff, light yellow, low to non-plastic clayey SILT soil layer

This layer is characterized bystiff, light yellow, low to non-plastic clayey SILT soil and extends up to a depth of 7.90m.

The standard penetration tests were conducted on this layer in which SPT blow counts are from 9 to10 blows/300mm, shows stiff degree of consistency.

E. Hard, reddish, low to high plastic, clayey SILT soillayer

This layer is characterized by hard, reddish; low to high plastic, clayey SILT soil and extends up to a depth of 9.15m.

The standard penetration tests were conducted on this layer in which SPT blow count is 37 blows /300 mm, shows hard degree of consistency.

F. Extremely weak, light gray, moderately fractured IGNIMBRITE rock layer

This is lowest profile of the explored depth is extremely weak, light gray, moderately fractured IGNIMBRITE rock.

Salite-Mihiret Site

A. Backfill Layer

The upper most layer of the site is covered with backfill material consists of concrete, gravel and sand which extend up to a depth of 1.90m below existing ground level.

B. Weak, light gray, slightly weathered, closely spaced IGNIMBRITE rock layer

This layer is found below backfill characterized by weak, light gray, slightly weathered, closely spaced IGNIMBRITE rock layer which extends up to the end of explored depth.

The rock quality designation (RQD) is taken and gives values in a range from 0%. The RQD measurements show that the rock is in very poor quality in terms of RQD measurement.

Kality Substation Site (Gantry)

A. Backfill Layer

The upper most layer of the site is covered with backfill material consists of clayey SILT, basaltic boulder and sandy SILT which extends up to a depth of 3.00m below existing ground level.

B. Very weak, reddish brown, highly weathered, very closely fractured scoriaceous BASALT rock layer

This layer is found below backfill characterized by very weak, reddish brown, highly weathered, very closely fractured scoriaceous BASALT rock which extends up to a depth of 7.00m below existing ground level.

The rock quality designation (RQD) is taken and gives values in a range from 0%. The RQD measurements show that the rock is in very poor quality in terms of RQD measurement.

C. Medium strong, dark gray, slightly weathered, moderately to closely jointed vesicular BASALT rocklayer

This is lowest profile of the explored depth characterized by medium strong, dark gray, slightly weathered, moderately to closely jointed vesicular BASALT rock.

The Quality Designation (RQD) of this layer varies from 23% – 50% which indicates the rock mass is in poor quality terms of RQD.

Kality Tower-48 Site

A. Medium stiff to hard, black to dark gray, high plastic silty CLAYLayer

The upper most layer of the site is covered with medium stiff to hard, black to dark gray, high plastic silty CLAY which extends up to a depth of 4.650m below existing ground level.

The standard penetration tests were conducted on this layer in which SPT blow counts are from 5blows/300mm to refusal, shows medium stiff to hard degree of consistency.

B. Hard, variegated color, low to high plastic clayey SILT with sand and core stone soil layer

This layer characterized by Hard, variegated color, low to high plastic clayey SILT with sand and core stone soil which extends up to a depth of 7.0m below existing ground level.

The standard penetration tests were conducted on this layer in which SPT blow counts are refusal, shows hard degree of consistency.

C. Hard, variegated color, low to non-plastic sandy SILT with clay and core-stone layer

This is lowest profile of the explored depth characterized by hard, variegated color, low to non-plastic sandy SILT with clay and core-stone soil.

The standard penetration tests were conducted on this layer in which SPT blow counts are refusal, shows hard degree of consistency.

Addis Center Substation Site

A. Backfill/top soilLayer

The upper most layer of the site is covered with backfill material/topsoil which extends to a depth of 0.40m below existing ground level.

B. Stiff to very stiff variegated color, low to high plastic clayey SILT layer

This layer is characterized by stiff to very stiff variegated color, low to high plastic clayey SILT which extends up to a depth of exploration.

The standard penetration tests were conducted on this layer in which SPT blow counts are from 8 to 19blows/300mm, shows stiff to very stiff degree of consistency.

Gofa Site

A. Backfill Layer

The upper most layer of the site is covered with backfill material consists of silt, clay and gravel which extend up to a depth of 0.40m below existing ground level.

B. Stiff to very stiff, dark gray, high plastic clayey SILT soil layer

This layer is found below backfill characterized by Stiff to very stiff, dark gray, high plastic clayey SILT soil which extends up to a depth of 3.00m below existing ground level.

The standard penetration tests were conducted on this layer in which SPT blow counts are from 9blows/300mm to refusal, shows stiff to very stiff degree of consistency.

C. Dense to very dense, variegated color, non-plastic silty GRAVEL soil layer

This is lowest profile of the explored depth characterized by dense to very dense, variegated color, non-plastic silty GRAVEL soil.

The standard penetration tests were conducted on this layer in which SPT blow refusal shows dense to very dense degree of relative density.

Lafto Tower-25 Site

A. Backfill Layer

The upper most layer of the site is covered with backfill material consists of gravel and boulder which extends up to a depth of 0.70m below existing ground level.

B. Extremely weak to weak, variegated color, slightly to highly weathered, IGNIMBRITE Rock layer

This layer is found below backfill characterized by extremely weak to weak, variegated color, slightly to highly weathered, IGNIMBRITE Rock which extends up to a depth of 5.55m below existing ground level.

The Quality Designation (RQD) of this layer varies from 0% – 95% which indicates the rock mass is in poor to good quality terms of RQD.

C. Very stiff to hard, reddish color, non-plastic clayey SILT with core stone layer

This is lowest profile of the explored depth characterized by Very stiff to hard, reddish color, non-plastic clayey SILT with core stone.

The standard penetration tests were conducted on this layer in which SPT blow are refusal, shows dense to very stiff to hard degree of consistency.

Hana-mariam (Near T-36)Site

A. Backfill Layer

The upper most layer of the site is covered with backfill material consists of gravel and boulder which extends up to a depth of 0.60m below existing ground level.

B. Extremely weak, light gray, slightly to highly weathered, IGNIMBRITE Rocklayer

This layer is found below backfill characterized by extremely weak, light gray, slightly to highly weathered, IGNIMBRITE Rock which extends up to a depth of 2.25 below existing ground level.

The rock quality designation (RQD) is taken and gives values in a range from 0%. The RQD measurements show that the rock is in very poor quality in terms of RQD measurement.

C. Stiff to hard, light gray, low to high plastic, clayey SILT soil layer

This layer is characterized by stiff to hard, light gray, low to high plastic, clayey SILT soil which extends to a depth of 8.00m below existing ground level.

The standard penetration tests were conducted on this layer in which SPT blow counts are 16blows/300m to refusal, shows stiff to hard degree of consistency.

D. Dense to very dense, variegated color, non-plastic silty gravel with core-stone soil layer

This layer is the lowest profile characterized dense to very dense, variegated color, non-plastic silty gravel with core-stone soil layer

The standard penetration tests were conducted on this layer in which SPT blow counts are refusal, shows dense to very dense degree relative density.

3.2 Groundwater Observation

Ground water was encountered in some boreholes during the course of drilling at a depth of 10.00m, 0.50m, 3.50m, 3.00m and 3.50m in Addis North substation borehole, Kality T-48 borehole, Addis Center BH-1, Addis Center BH-2 and Addis Center BH-3 respectively, However, it should be noted that variation in the location of the long-term water table may occur as a result of changes in precipitation, evaporation, seepage and other factors not immediately apparent at the time of this exploration.

4. FOUNDATION RECOMMENDATION

Foundation recommendation refers to the determination of the bearing layer and depth, allowable bearing capacity of the bearing layer and type of foundation that could be adopted safely and economically.

In selecting the appropriate type of foundation, numerous factors have to be taken into account. Basic design considerations include insuring the load from the superstructure not to exceed the allowable bearing pressure on the soil and reducing the settlement of the foundation.

For the study area, Spread Footing Foundation is considered appropriate to support the proposed structures and the allowable bearing capacity of the bearing layers are computed for respective site.

The following section discusses the methodology for determination of the allowable bearing capacity for the selected types of foundation. Geotechnical characteristics of the sub surface geology mentioned on section 3 of this report will be used for this purpose.

4.1 Allowable Bearing Capacity based on SPT Values

<u>Spread Footing Foundation at variable depths (i.e. at 2.0m, 2.5m, and 3.00 below NGL)</u>

Allowable bearing capacity for the selected foundation layer shall be discussed based on correlation of the consistency/ relative compaction of the in-situ ground as indicated from SPT. Then, all the necessary adjustments are made to determine the actual SPT values. The depths at which the SPT N-values are obtained, the SPT N-values and the adjusted N-values (i.e., N'_{55}) are given below and they are considered for determining the design N-values.

Before using in-situ SPT values, the site N-values shall be adjusted to N_{55} standard energy ratio value using the following formula (Bowles, 1988).

$N'_{55} = C_N \times N \times \eta_1 \times \eta_2 \times \eta_3 \times \eta_4$

Where N'_{55} = adjusted N

C_N = adjustment for overburden pressure $= (\frac{P''_O}{P'_O})^{1/2}$

P'_O = overburden pressure

P''_O = reference overburden pressure (95.76 kPa or 1.0kg/cm²)

$\eta_1 = E_r/E_{rb}$ (where E_r is average energy ratio that depends on the drill system and E_{rb} is the standard energy ratio). E_r is taken as 50 and E_{rb} as 70.

η_2 = Rod length correction
Rod length > 10 m = 1,
Rod length 6-10 m = 0.95,
Rod length 4-6 m = 0.85,
Rod length 0-4 m = 0.75

η_3 = sampler correction (1.00 in our case)

η_4 = borehole diameter correction (1.00 in our case)

Table 4: Representative and adjusted SPT - N values

BH ID.	Depth (m)	Record of SPT N-value	Design N-value
Addis North Substation Site	1.00	11	11
	2.00	5	5
	3.00	3	3
	4.00	5	5
	5.00	17	14
	6.00	26	22
	7.00	16	12
	8.00	8	6
	9.00	6	4
GergiMebrat Hail Site(Woreganu)	1.00	9	9
	2.00	7	7
	3.00	13	12
	4.00	15	14
	5.00	15	12
	6.00	9	8

BH ID.	Depth (m)	Record of SPT N-value	Design N-value
	7.00	10	8
	8.00	37	27
	9.00	*50	32
Salite- Mihiret	1	6	6
	1.90 – 6.00	*50	50
Kality Substation Site(Gantry)	1.00	*30	24
	2.00	*30	24
	3.00	*50	43
	4.00	*50	42
	5.00	*50	38
	6.00	*50	38
	7.00	*50	35
	8.00	*50	33
	9.00	*50	31
Kality Tower-48 Site	1.00	5	5
	2.00	7	7
	3.00	7	7
	4.00	*30	27
	5.00	*30	24
	6.00	*30	24
	7.00	*50	37

BH ID.	Depth (m)	Record of SPT N-value	Design N-value
	8.00	*50	34
	9.00	*50	32
Addis Center Substation, BH-1	1.00	4	4
	2.00	4	4
	3.00	6	6
	4.00	16	15
	5.00	15	12
	6.00	13	11
	7.00	14	11
	8.00	17	12
	9.00	15	10
Addis Center Substation, BH-2	1.00	4	4
	2.00	4	4
	3.00	5	5
	4.00	12	11
	5.00	20	16
	6.00	16	13
	7.00	18	14
	8.00	15	11
	9.00	19	13
Addis Center	1.00	5	5

BH ID.	Depth (m)	Record of SPT N-value	Design N-value
Substation, BH-3	2.00	5	5
	3.00	4	4
	4.00	9	8
	5.00	9	7
	6.00	14	12
	7.00	16	12
	8.00	16	12
	9.00	15	10
Gofa Site	1.00	9	9
	2.00	*30	30
	3.00	*30	27
	4.00	*30	27
	5.00	*30	24
	6.00	*30	24
Lafto Tower-25 Site	1.00	*30	30
	2.00	*30	30
	3.00	*50	43
	4.00	*50	42
	5.00	*50	38
	6.00	*50	39
	7.00	*50	36

BH ID.	Depth (m)	Record of SPT N-value	Design N-value
	8.00	*50	33
Hana mariam (Near T-36)Site	1.00	*30	30
	2.00	*30	30
	3.00	16	15
	4.00	21	19
	5.00	19	16
	6.00	16	13
	7.00	21	16
	8.00	*30	21
	9.00	*50	32
	10.00	*50	31
	11.00	*50	31
	12.00	*50	29

(*) indicates assumed minimum refusal SPT value for stiff/dense soil and weak rock material, N=30/300mm is assumed for stiff/dense soil and N=50/300mm is assumed for weak rock in the analysis of bearing capacity where SPT tests ended with refusal. However, Gofa site soil profile with SPT N value of refusal has to be inferred to 30blows/300mm.

After adjusting the N-values, a design N-values are chosen from consecutive depths where the test is performed. The design N-values are taken as the average of adjusted N-values which are found in between ½ B above and 2B below the proposed footing depths where B is the width of the foundation.

The bearing capacity for Isolated footing foundation is calculated from the SPT N- values using Meyerhof's equation as follows (Bowles, 1997):

SPT N- values using Meyerhof's equation as follows (Bowles, 1997): -

$$q_{all} = \frac{N'}{F_2} * (1 + F_3/B)^2 * K_d$$

Where,

q_{all} = Allowable bearing pressure for settlement limited to 25 mm.

B > F_4

K_d = 1+0.33D/B,≤ 1.33

F_2 = 0.08

F_3 = 0.3

F_4 = 1.2

B = Width of foundation

D = Depth of foundation

The following allowable bearing capacity values below illustrates the computations made.

Table 5: Allowable Bearing Capacity for Isolated Footing Foundation

Site	Footing Width (m)	1.5	2.0	2.5	3.0	3.5	4.0
	Footing depth(m)	Allowable Bearing Capacity (kPa)					
Addis North Substation Site	2.00	239	220	198	185	175	168
	2.50	239	220	209	193	182	174
	3.00	263	242	229	221	208	198
GerjiMebrat Hail Site(Woreganu)	2.00	311	286	258	240	228	219
	2.50	335	308	292	270	255	244
	3.00	359	330	313	302	284	270
Salite- Mihiret	2.00-2.50	1000kPa					
Kality Substation Site(Gantry)	2.00	838	770	694	646	613	589
	2.50	838	770	730	675	637	610
	3.00	862	792	751	724	680	649
Kality Tower-48 Site	2.00	575	528	476	443	420	404
	2.50	575	528	501	463	437	418
	3.00	622	572	542	523	491	469
Addis Center	2.00	263	242	218	203	193	185

Site	Footing Width (m)	1.5	2.0	2.5	3.0	3.5	4.0
	Footing depth(m)	Allowable Bearing Capacity (kPa)					
Substation, BH-1	2.50	263	242	229	212	200	192
	3.00	263	242	229	221	208	198
Addis Center Substation, BH-2	2.00	287	264	238	221	210	202
	2.50	287	264	250	231	218	209
	3.00	287	264	250	241	227	216
Addis Center Substation, BH-3	2.00	215	198	178	166	158	151
	2.50	215	198	188	174	164	157
	3.00	215	198	188	181	170	162
Gofa Site	2.00	599	550	495	461	438	421
	2.50	599	550	521	482	455	436
	3.00	599	550	521	503	473	451
Lafto Tower-25 Site	2.00	910	835	753	701	666	639
	2.50	910	835	792	733	692	662
	3.00	910	835	792	764	718	685
Hanamariam (Near T-36)Site	2.00	455	418	377	351	333	320
	2.50	455	418	396	366	346	331
	3.00	479	440	417	402	378	360

From the above analysis, the allowable bearing capacity range in values from 151kPa to 910kPa at a variable depth (2.00m, 2.50m & 3.00m) based on various footing width.

4.2 Presumptive Allowable Bearing Capacity of Rock Layer

From investigation result the ground formation of Salitemihiret site is rock. The rock basically can carry the anticipated imposed load coming both from the super structure and the foundation since it extends to sufficient depth below the anticipated foundation level.

Presumed bearing capacity values shall be obtained for weak and broken rocksbeneath the foundation from ES EN 1997:2015 code. According to this local code annex G, the rock layer found in this project site is grouped under Group type 2 - since ignimbrite is a type of igneous rock.

Table 6: Grouping of weak and broken rocks

Group	Types of rock
1	Pure limestones and dolomites Carbonate sandstones of low porosity
2	Igneous Oolitic and marlylimestones Well cemented sandstones Indurated carbonate mudstones Metamorphic rocks, including slates and schist (flat cleavage/foliation)
3	Very marlylimestones Poorly cemented sandstones Slates and schists (steep cleavage/foliation)
4	Uncemented mudstones and shales

The rock layer is weak, light gray, slightly weathered, closely spaced IGNIMBRITE rock as stated in section 3 – description of geotechnical layers. From the chart (weak rock and closely spaced discontinuities) presumed allowable bearing capacity value about **1MPa (1000kPa)**can be read and used for safe design.

4.3 Recommended Allowable Bearing Capacity

In order to determine the type of foundation and the corresponding allowable bearing capacity, two criteria are evaluated. These criteria are bearing failure and settlement. For the proposed structure, isolated footing foundation systemis considered. The foundation designer can use any of the recommended values depending on the superstructure loads.

The following table shows the recommended allowable bearing capacity valuesfor the given foundation.

Table 7: Recommended Allowable Bearing Capacity for Isolated Footing Foundation

Site	Footing depth(m)	Recommended Allowable Bearing Capacity (kPa)					
Addis North Substation Site	2.00	239	220	198	185	175	168
	2.50	239	220	209	193	182	174
	3.00	263	242	229	221	208	198
GerjiMebrat	2.00	311	286	258	240	228	219

Site	Footing depth(m)	Recommended Allowable Bearing Capacity (kPa)					
Hail Site(Woreganu)	2.50	335	308	292	270	255	244
	3.00	359	330	313	302	284	270
Salitemihiret Site	2.00 – 2.50	1000kPa					
Kality Substation Site(Gantry)	2.00	838	770	694	646	613	589
	2.50	838	770	730	675	637	610
	3.00	862	792	751	724	680	649
Kality Tower-48 Site	2.50	575	528	501	463	437	418
	3.00	622	572	542	523	491	469
Addis Center Substation	2.50	215	198	188	174	164	157
	3.00	215	198	188	181	170	162
Gofa Site	2.00	599	550	495	461	438	421
	2.50	599	550	521	482	455	436
	3.00	599	550	521	503	473	451
Lafto Tower-25 Site	2.00	910	835	753	701	666	639
	2.50	910	835	792	733	692	662
	3.00	910	835	792	764	718	685
Hanamariam (Near T-36)Site	2.00	455	418	377	351	333	320
	2.50	455	418	396	366	346	331
	3.00	479	440	417	402	378	360

Note:

- The above mentioned bearing capacity values are provided before settlement criteria is checked, since it demands laboratory test to determine settlement parameters. Specially, Kality Tower-48 Site and Addis Center Substation site has ground water table located near to the existing ground level in which consolidation settlement will be expected.
- If loose/soft soil is found at the foundation level, the foundation of proposed structures shall be placed on 50cm thick compacted appropriate material that is granular material with few fines, i.e. Gravel, Gravel – sand mixtures few silt/clay – GW-GC/SW-SC.

5. CONCLUSION

Sub-surface geotechnical investigation was work was conducted forelectric transformation line towers and substations project. The investigation included rotary core drilling of eleven boreholes, visual identification and in-situ tests.

Recommendations are made on the type, depth and allowable bearing values under section 4 of this report. The foundation designer can use any of the recommended values for the respective structure depending on the superstructure loads.

The Geotechnical Engineer in charge shall conduct intermittent supervision of the foundation excavation works during construction to verify/check the actual subsurface conditions, and shall make adjustments to the foundation recommendation as given in this report, where actual site conditions warrant such changes.

APPENDICES

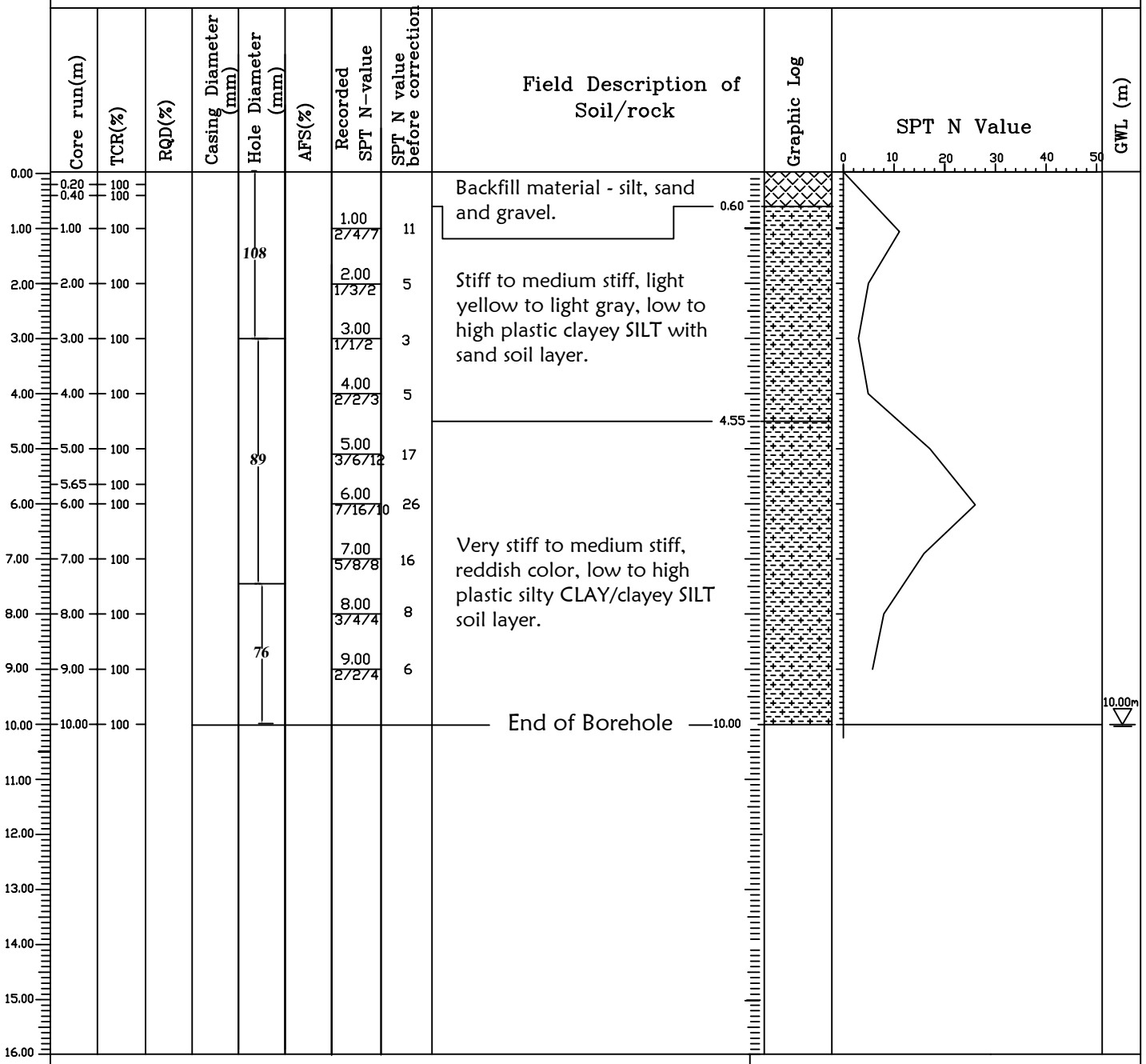
Appendix 1

BoreholeLogs

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Addis North

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, Gulele Sub city, Addisu Gebeya (Addis North Subst.)
BH Coordinates (UTM– Adindam Datum)
Easting (X): 0472157
Northing (Y): 1001077

Ground Elevation (m): 2563
BH Inclination: Vertical
Flushing System: Water
Date started: 03/04/2018
Date completed: 05/04/2018
Total depth drilled(m): 10.00



1.00	2/4/7	11	2.00	1/3/2	5	3.00	1/1/2
3	4.00	2/2/7/3	5	5.00	3/7/6/12	17	6.00
7/16/10	26	7.00	5/7/8	16	8.00	3/4/7/4	8
9.00	2/7/2/4	6					

Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY–200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Woreganu

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, Bole sub city, Gerji Mebrat hail (Woreganu Substation)
BH Coordinates (UTM– Adindam Datum)
Easting (X): 0478965
Northing (Y): 0995141

Ground Elevation (m): 2357
BH Inclination: Vertical
Flushing System: Water
Date started: 10/04/2018
Date completed: 11/04/2018
Total depth drilled(m): 10.00

Core run(m)	TCR(%)	RQD(%)	Casing Diameter (mm)	Hole Diameter (mm)	AFS(%)	Recorded SPT N-value	SPT N value before correction	Field Description of Soil/rock	Graphic Log	SPT N Value	GWL (m)
0.30	100							Backfill material - reddish ash			
								0.65			
1.00	100			108		1.00 2/4/5	9	Stiff, dark gray, high plastic silty CLAY soil			
1.65	100										
2.00	100					2.00 2/4/3	7				
								1.90			
2.70	100										
3.00	100					3.00 3/6/7	13	Stiff to very stiff, light gray, low to high plastic clayey SILT soil.			
4.00	100					4.00 4/7/8	15				NIL
5.00	100					5.00 5/6/9	15				
6.00	100			89		6.00 3/4/5	9				
								6.00			
7.00	100					7.00 2/4/6	10	Stiff, light yellow, low to non-plastic clayey SILT soil.			
8.00	100					8.00 6/17/20	37				
								7.90			
								Hard, reddish, low to high plastic, clayey SILT soil.			
9.00	100					9.00 23/R	50				
								9.15			
9.60	100							Extremely weak, light gray, moderately fractured IGNIMBRITE rock.			
10.00	100							10.20			
								End of Borehole			

Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY–200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Salitemihiret

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, Bole Sub city, CMC (Salitemihiret)
BH Coordinates (UTM– Adindam Datum)
Easting (X): 0481099
Northing (Y): 0996862

Ground Elevation (m): 2385
BH Inclination: Vertical
Flushing System: Water
Date started: 12/04/2018
Date completed: 14/04/2018
Total depth drilled(m): 6.00

Core run(m)	TCR(%)	RQD(%)	Casing Diameter (mm)	Hole Diameter (mm)	AFS(%)	Recorded SPT N-value	SPT N value before correction	Field Description of Soil/rock	Graphic Log	SPT N Value (0 10 20 30 40 50)	GWL (m)
1.00	100			108		1.00 2/3/3	6	Backfill material - Concrete, gravel and sand.			
1.55	100										
1.90	100										
2.25	100					SPT is not conducted due to rock formation.	>50	Weak, light gray, slightly weathered, closely spaced IGNIMBRITE rock layer. *from 2.00m - 2.25m is BASALT rock.			
3.50	100						>50				NIL
4.00	100			89			>50				
5.00	100						>50	*there was no return of water used for drilling.			
6.00	100						>50	End of Borehole			

1.90 (bottom of backfill)
6.00 (End of Borehole)

Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY–200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

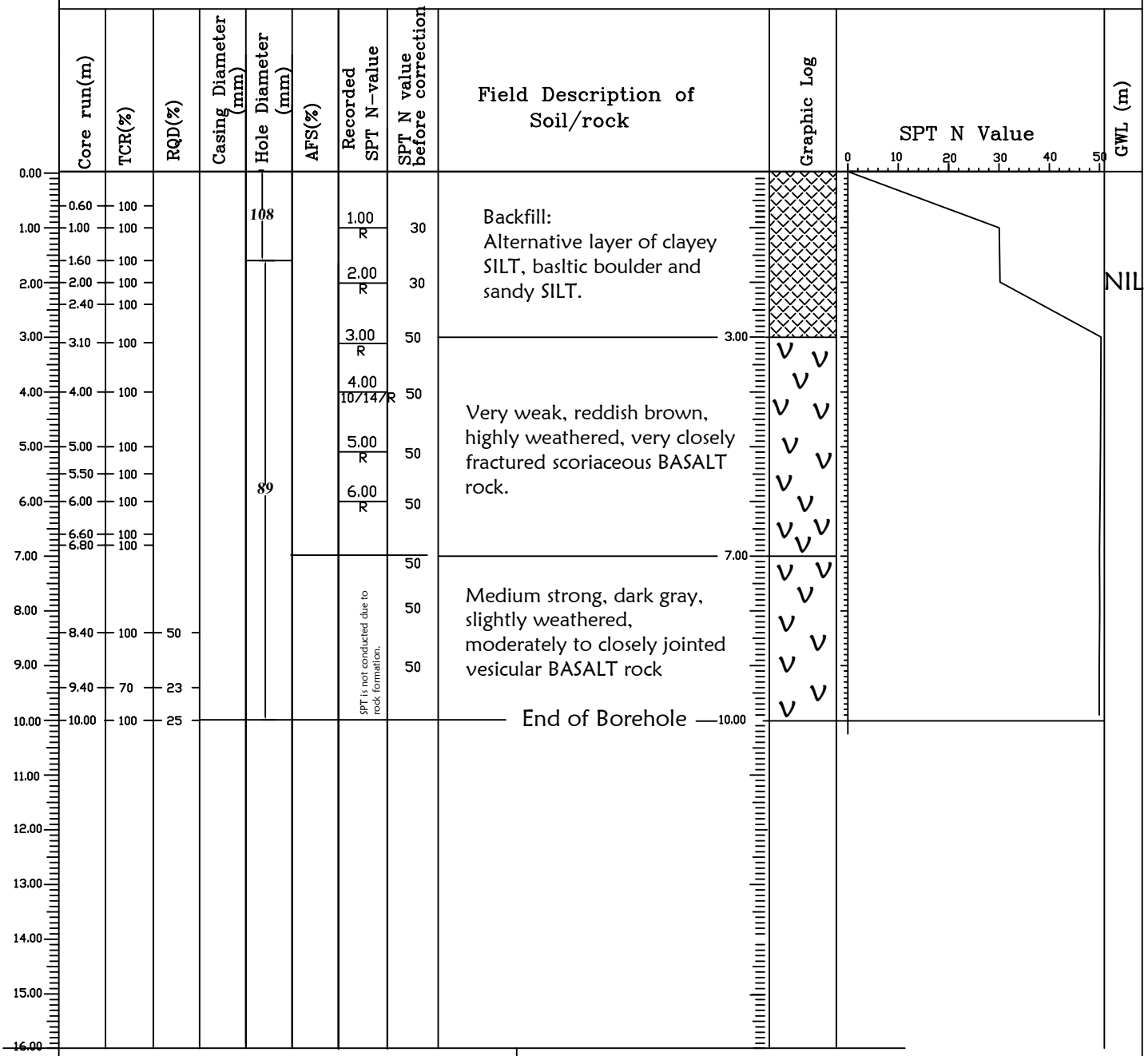
Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Kality Sub.

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, Akaki Kality s/city, Kality Substation (Gantry)
BH Coordinates (UTM– Adindam Datum)
Easting (X): 0473123
Northing (Y): 0981871

Ground Elevation (m): 2119
BH Inclination: Vertical
Flushing System: Water
Date started: 17/04/2018
Date completed: 19/04/2018
Total depth drilled(m): 10.00



Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY–200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

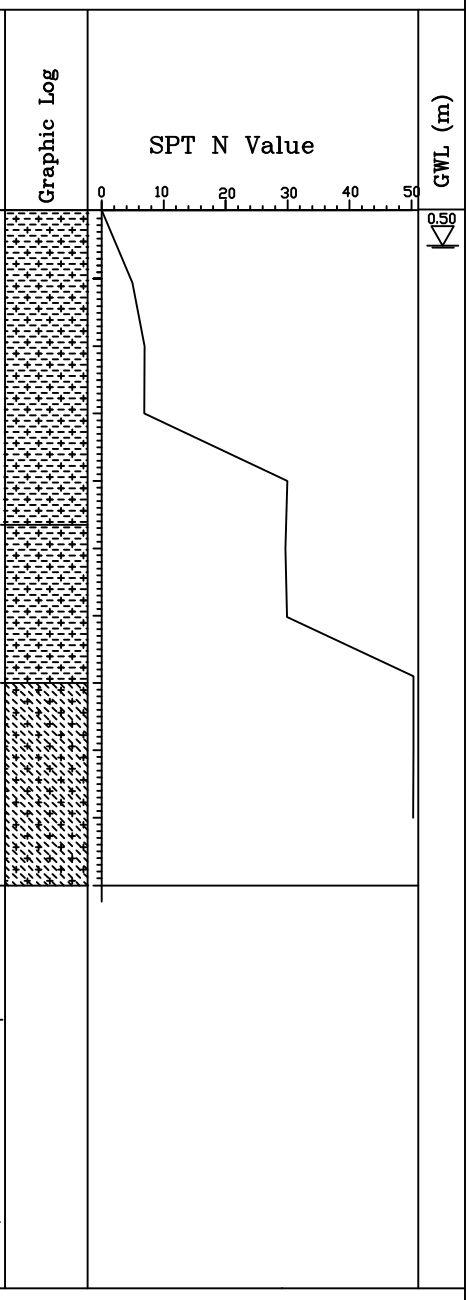
REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Tower–48

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, Akaki Kality s/city, kality (Tower–48)
BH Coordinates (UTM– Adindam Datum)
Easting (X): 0472970
Northing (Y): 0982033

Ground Elevation (m): 2123
BH Inclination: Vertical
Flushing System: Water
Date started: 21/04/2018
Date completed: 24/04/2018
Total depth drilled(m): 10.00

Core run(m)	TCR(%)	RQD(%)	Casing Diameter (mm)	Hole Diameter (mm)	AFS(%)	Recorded SPT N–value	SPT N value before correction	Field Description of Soil/rock
0.60	100			108		1.00 1/2/3	5	Medium stiff to hard, black to dark gray, high plastic silty CLAY with occasional gravel (from 4.00m - 4.65m).
1.00	100							
1.45	100					2.00 1/3/4	7	
2.00	100							
2.45	100					3.00 2/3/4	7	
3.00	100							
3.45	100					4.00 R	30	
4.00	100							
4.65	100							4.65
5.00	100					5.00 R	30	Hard, variegated color, low to high plastic clayey SILT with sand and corestone.
6.00	100					6.00 13/R	30	
6.70	100			89				
7.00	100					7.00 R	50	7.00
8.00	100					8.00 R	50	hard, variegated color, low to non plastic sandy SILT with clay and core-stone. (weathering product of pyroclastic rock)
8.70	100							
9.00	9.10	100				9.00 R	50	
10.00	10.00	100						End of Borehole 10.00



Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY–200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

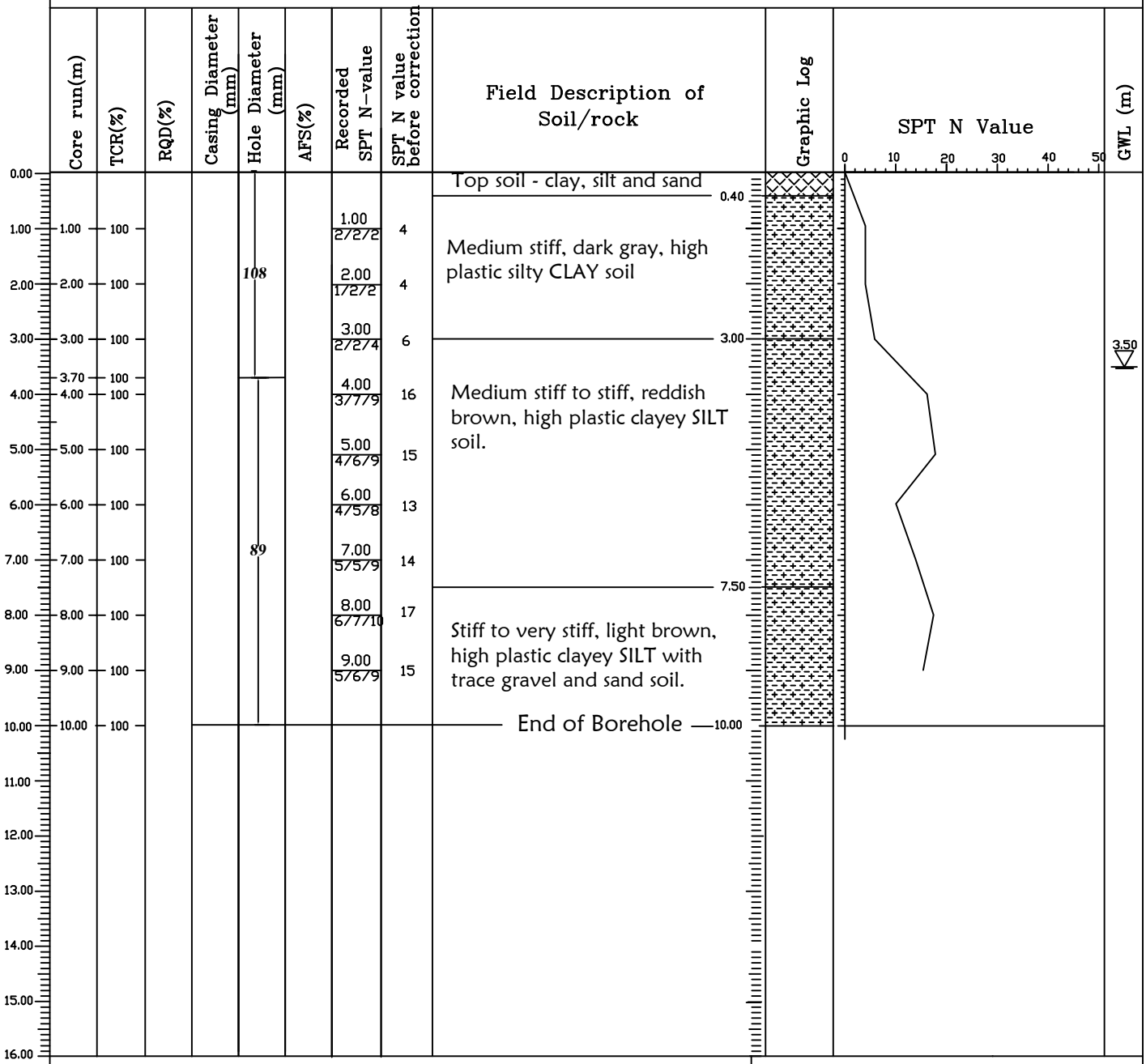
Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Addis Center, BH-1

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, Kirkos sub city, around AU(Addis Center Substation)
BH Coordinates (UTM- Adindam Datum)
Easting (X): 0471934
Northing (Y): 0994303

Ground Elevation (m): 2300
BH Inclination: Vertical
Flushing System: Water
Date started: 27/04/2018
Date completed: 28/04/2018
Total depth drilled(m): 10.00



Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY-200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Addis Center, BH-2

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, Kirkos sub city, around AU(Addis Center Substation)
BH Coordinates (UTM- Adindam Datum)
Easting (X): 0471909
Northing (Y): 0994283

Ground Elevation (m): 2300
BH Inclination: Vertical
Flushing System: Water
Date started: 30/04/2018
Date completed: 01/05/2018
Total depth drilled(m): 10.00

Core run(m)	TCR(%)	RQD(%)	Casing Diameter (mm)	Hole Diameter (mm)	AFS(%)	Recorded SPT N-value	SPT N value before correction	Field Description of Soil/rock
0.40	100			108		1.00 1/2/2	4	Backfil - silt and gravel (0.40)
1.00	100					2.00 2/2/2	4	Medium stiff, dark gray, high plastic silty CLAY/clayey SILT soil.
2.00	100					3.00 2/2/3	5	(2.60)
3.00	100					4.00 4/6/6	12	Stiff, reddish brown, high plastic clayey SILT soil.
4.00	100					5.00 6/9/11	20	
5.00	100					6.00 5/7/9	16	
6.00	100			89		7.00 5/8/10	18	
7.00	100					8.00 6/6/9	15	(7.45)
8.00	100					9.00 6/8/11	19	Very stiff, light brown, high plastic clayey SILT with sand and trace gravel soil.
9.00	100							
10.00	100							End of Borehole (10.00)

Graphic Log

SPT N Value: 0 10 20 30 40 50

GWL (m): 3.00

Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY-200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Addis Center, BH-3

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, Kirkos sub city, around AU(Addis Center Substation)
BH Coordinates (UTM- Adindam Datum)
Easting (X): 0471945
Northing (Y): 0994246

Ground Elevation (m): 2298
BH Inclination: Vertical
Flushing System: Water
Date started: 02/05/2018
Date completed: 03/05/2018
Total depth drilled(m): 10.00

Core run(m)	TCR(%)	RQD(%)	Casing Diameter (mm)	Hole Diameter (mm)	AFS(%)	Recorded SPT N-value	SPT N value before correction	Field Description of Soil/rock	Graphic Log	SPT N Value	GWL (m)
0.55	100							Top soil - gravel and cobble (0.40)			
1.00	100					1.00 1/2/3	5				
2.00	100			108		2.00 2/2/3	5	Medium stiff to very stiff, black to dark gray, high plastic clayey SILT/silty CLAY soil.			
3.00	100					3.00 2/2/2	4				3.50
4.00	100					4.00 3/4/5	9				
5.00	100					5.00 2/4/5	9				
6.00	100					6.00 4/6/8	14	(5.65)			
7.00	100			89		7.00 5/7/9	16	Stiff to very stiff, variegated color, low to high plastic clayey SILT soil.			
8.00	100					8.00 6/7/9	16				
9.00	100					9.00 6/6/9	15				
10.00	100							End of Borehole (10.00)			

Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY-200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

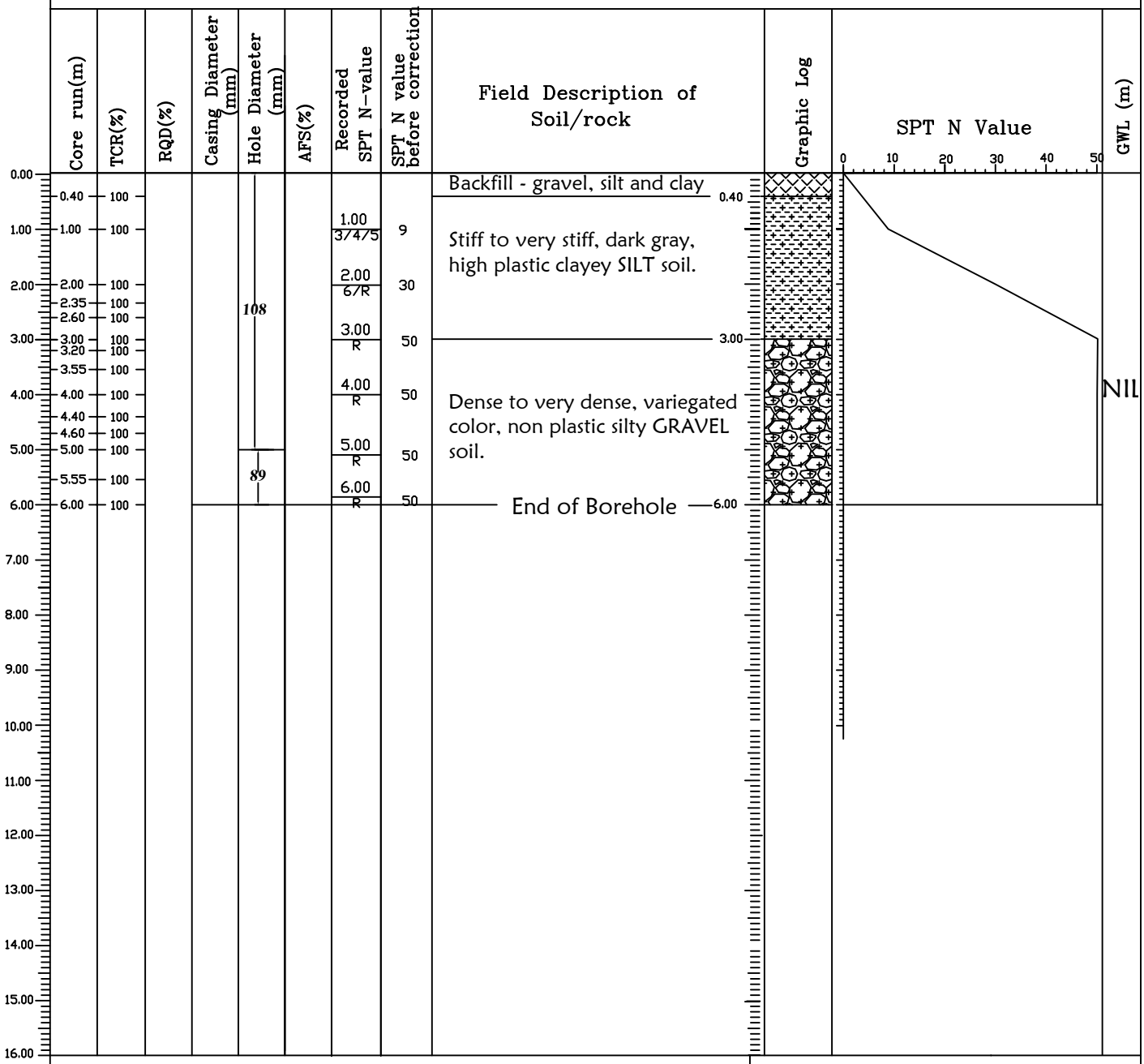
Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Gofa

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, N/S/L sub city, around Gofa Mebrathail
BH Coordinates (UTM– Adindam Datum)
Easting (X): 0472121
Northing (Y): 0990658

Ground Elevation (m): 2238
BH Inclination: Vertical
Flushing System: Water
Date started: 05/05/2018
Date completed: 07/05/2018
Total depth drilled(m): 6.00



Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY–200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

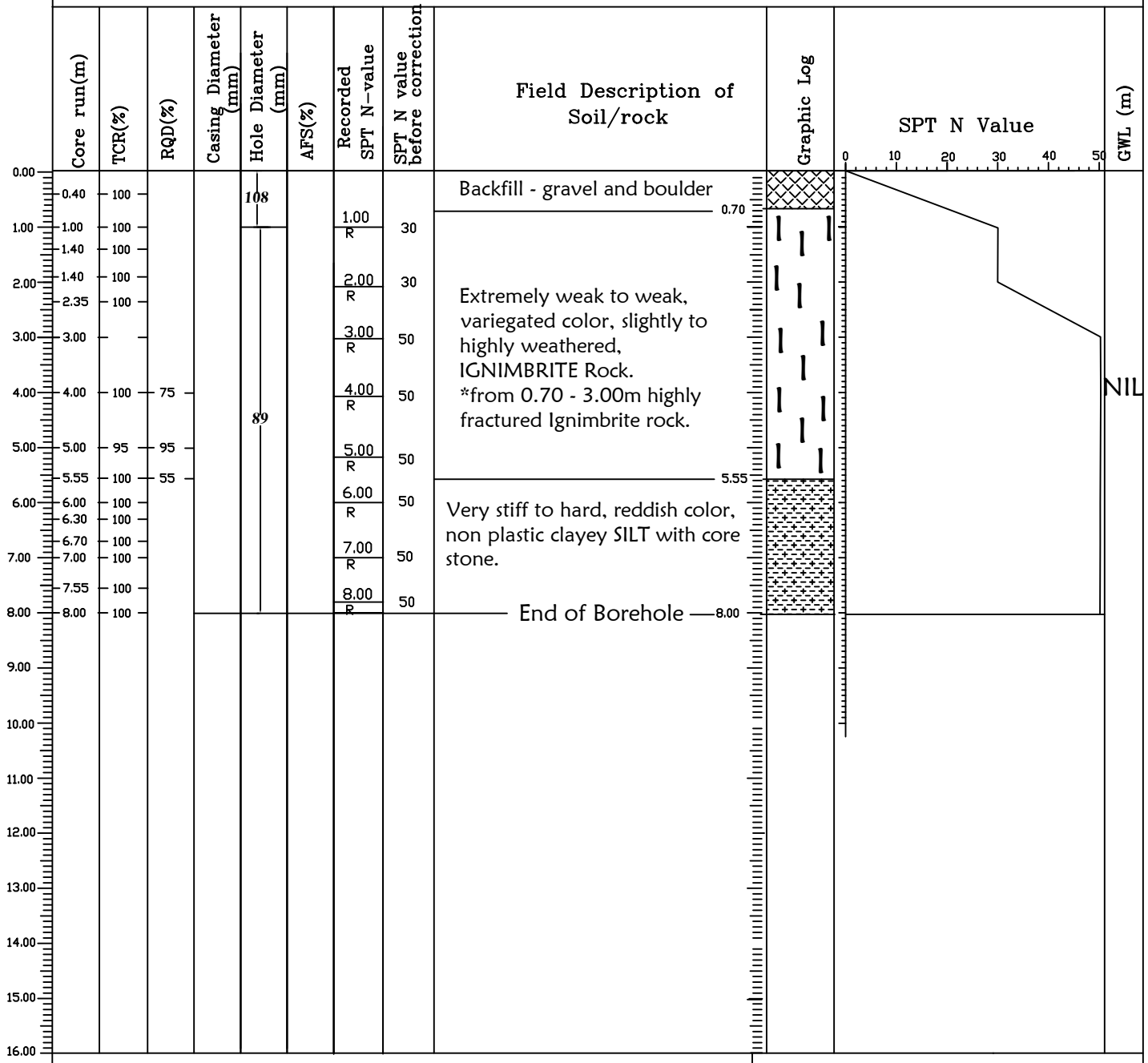
Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Tower 25

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, N/S/L sub city, around Lafto
BH Coordinates (UTM– Adindam Datum)
Easting (X): 0472138
Northing (Y): 0989739

Ground Elevation (m): 2238
BH Inclination: Vertical
Flushing System: Water
Date started: 09/05/2018
Date completed: 10/05/2018
Total depth drilled(m): 8.00



Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY–200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

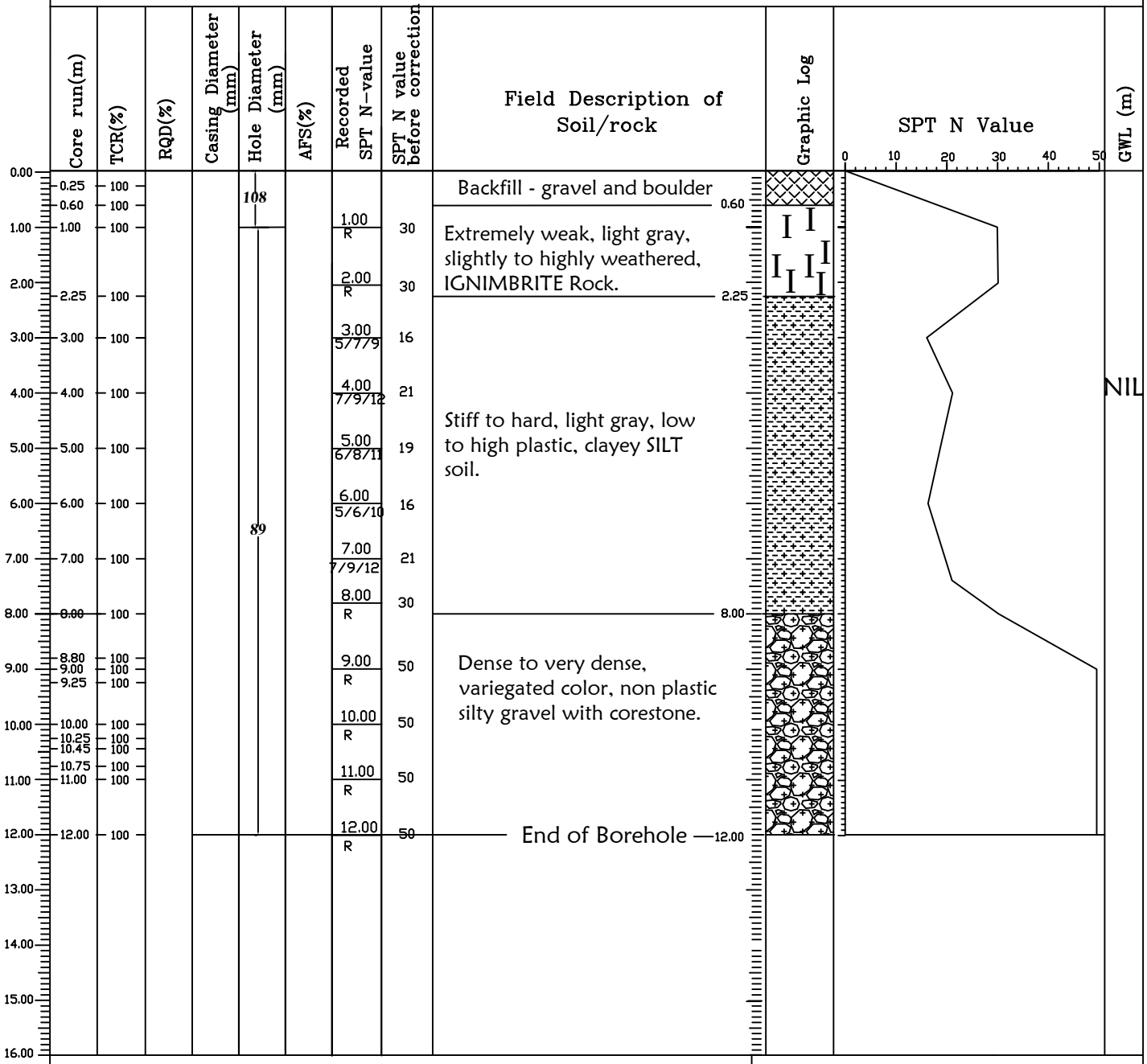
Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

BOREHOLE LOG	Geotechnical Engineering Service	Sheet 1 of 1
		BH ID No: Near to T-36

Project: Geotechnical Inv. for Electric Transmission Tower & Substation
Client: MS Consultancy
Location: A.A, N/S/L sub city, around Hanamariam
BH Coordinates (UTM- Adindam Datum)
Easting (X): 0472493
Northing (Y): 0986519

Ground Elevation (m): 2119
BH Inclination: Vertical
Flushing System: Water
Date started: 12/05/2018
Date completed: 14/05/2018
Total depth drilled(m): 12.00



Consultant: _____
Subcontractor: _____
Supervisor: _____
Logged By: _____
Approved By: _____

Drilling Method: Rotary Core Drilling
Type of Rig: XY-200 (China Made)
Bit Type: Tungsten Carbide & Dimond
Bit diameter(mm): 108 & 89

BH=Borehole
N=Blows/300mm
SPT=Standard Penetration Test
USCS=Unified Soil Classification System
RQD=Rock quality designation
TCR=Total core recovery
AFS=Averge fracture spacing

Disturbed sample
Undisturbed sample
Rock sample
Static groundwater level

REMARK: _____

Appendix 2

Plates of Core Boxes

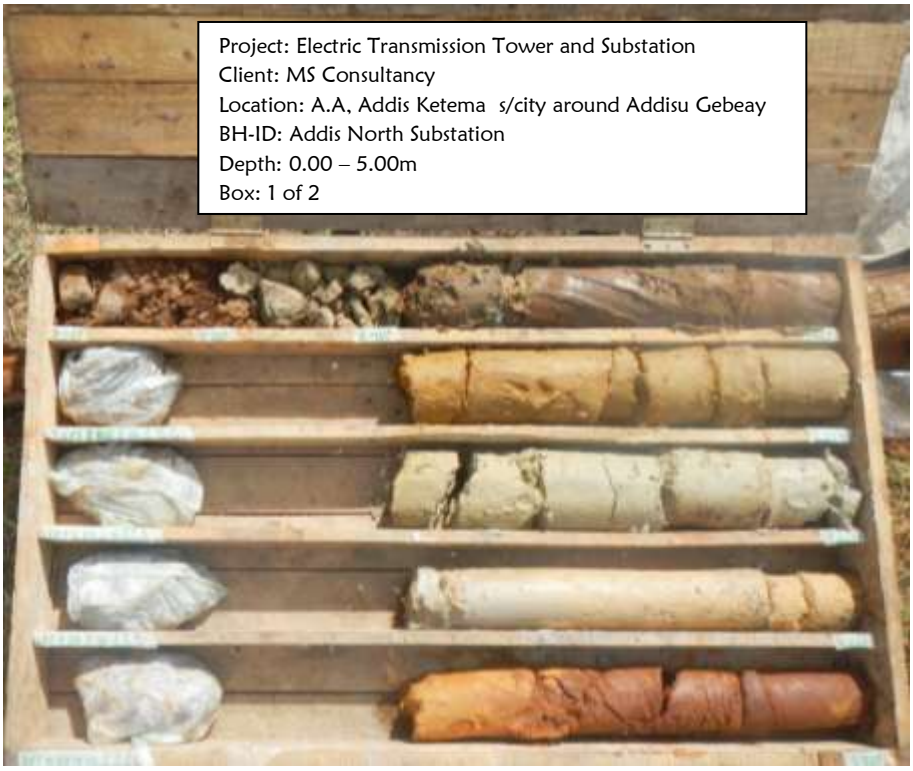


Plate 1: Depth: 0.00m – 5.00m, Box: 1 of 2

Plate 2: Depth: 5.00m – 10.00m, Box: 2 of 2

Plate 3: Depth: 0.00m – 5.00m, Box: 1 of 2

Plate 4: Depth: 5.00m – 10.00m, Box: 2 of 2

Plate 5: Depth: 0.00m – 5.00m, Box: 1 of 2

Plate 6: Depth: 5.00m – 6.00m, Box: 2 of 2

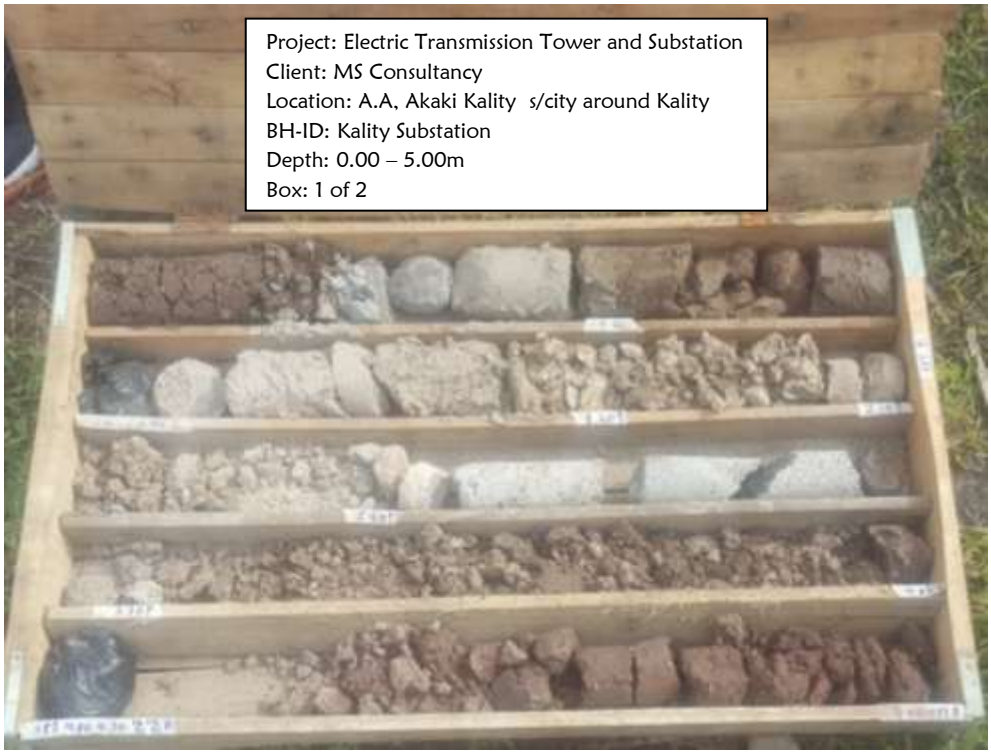


Plate 7: Depth: 0.00m – 5.00m, Box: 1 of 2

Plate 8: Depth: 5.00m – 10.00m, Box: 2 of 2

Plate 9: Depth: 0.00m – 5.00m, Box: 1 of 2

Plate 10: Depth: 5.00m – 10.00m, Box: 2 of 2

Plate 11: BH-1, Depth: 0.00m – 5.00m, Box: 1 of 2

Plate 12:BH-1, Depth: 5.00m – 10.00m, Box: 2 of 2

Plate 13: BH-2, Depth: 0.00m – 5.00m, Box: 1 of 2

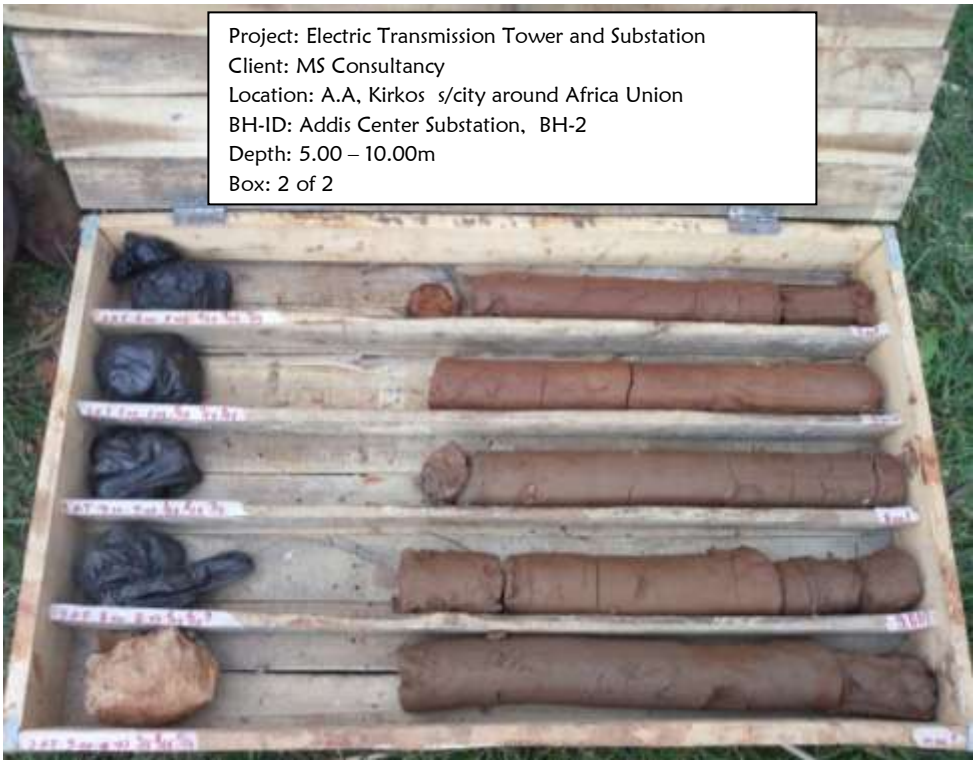


Plate 14: BH-2, Depth: 5.00m – 10.00m, Box: 2 of 2

Plate 15: BH-3, Depth: 0.00m – 5.00m, Box: 1 of 2

Plate 16: BH-3, Depth: 5.00m – 10.00m, Box: 2 of 2

Plate 17: BH-1, Depth: 0.00 – 5.00m, Box: 1 of 2

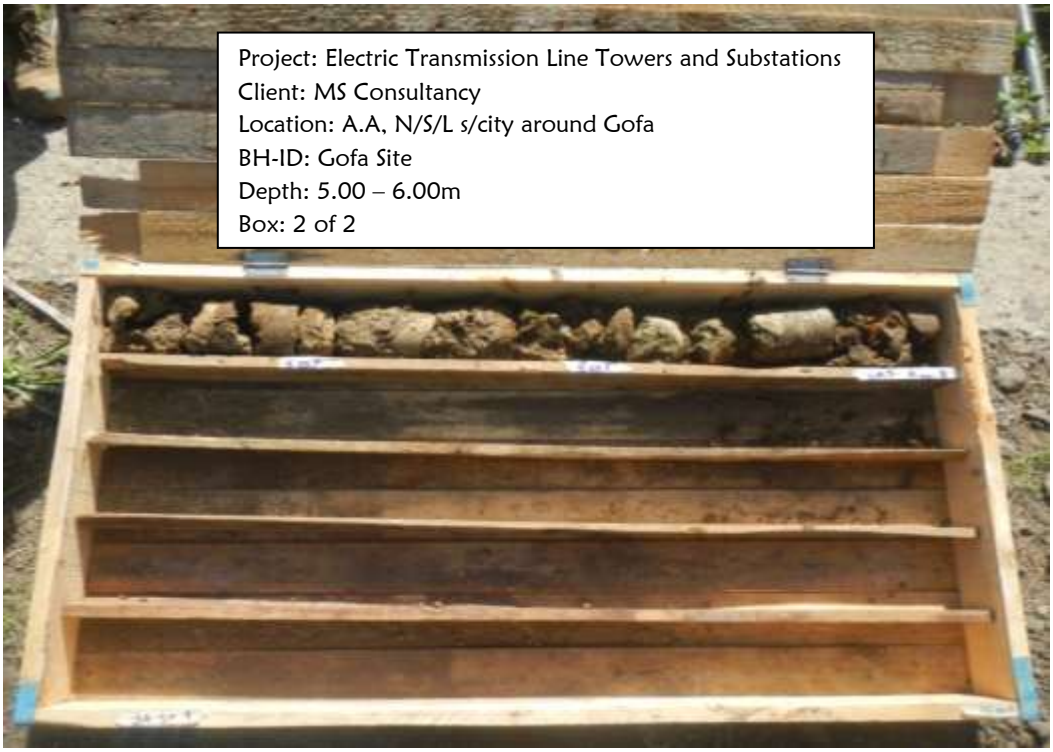


Plate 18: BH-1, Depth: 5.00 – 6.00m, Box: 2 of 2

Plate 19: BH-1, Depth: 0.00 – 5.00m, Box: 1 of 2

Plate 20: BH-1, Depth: 5.00 – 8.00m, Box: 2 of 2

Plate 21: BH-1, Depth: 0.00 – 5.00m, Box: 1 of 3

Plate 22: BH-1, Depth: 5.00 – 10.00m, Box: 2 of 3

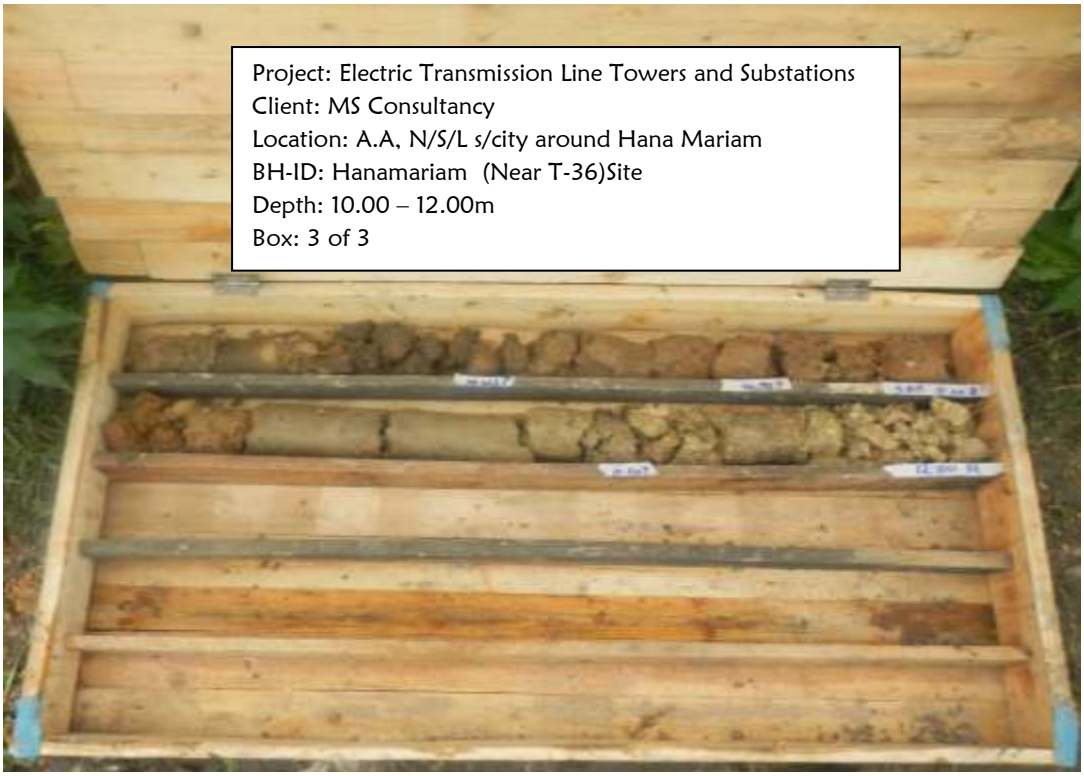


Plate 23: BH-1, Depth: 10.00 – 12.00m, Box: 3 of 3

APPENDIX-2

MINUTES OF MEETING

THE MINUTES OF MEETINGS

ON

THE PREPARATORY SURVEY

ON

ADDIS ABABA TRANSMISSION AND DISTRIBUTION SYSTEM REHABILITATION AND UPGRADING PROJECT

IN

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

AGREED UPON BETWEEN

THE GOVERNMENT OF FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

Addis Ababa, 23rd March

Mekuria Lemma
Director of Strategy and Investment
Ethiopian Electric Power

Ken Yamada
Mission Leader
Japan International Cooperation Agency

Witness

Gosaye Mengistie Abayneh
Chief Executive Officer
Ethiopian Electric Utility

Kokeb Misrak
Director
Bilateral Cooperation Directorate
Ministry of Finance and Economic Cooperation

The Government of Federal Democratic Republic of Ethiopia (hereinafter referred to as "GOE") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") have made several preliminary discussions in order to identify priority projects in the field of energy sector, and agreed to make preparation for Addis Ababa Transmission and Distribution System Rehabilitation and Upgrading Project (hereinafter referred to as "the Project"). Accordingly, JICA dispatched a mission on the Project (hereinafter referred to as "JICA Mission team") to Federal Democratic Republic of Ethiopia from 19th to 22nd March in order to develop scope and implementing arrangements of a further survey which will carry out basic design and study feasibility of the Project (hereinafter referred to as "the Preparatory Survey"). The scope and implementing arrangements of the Preparatory Survey are described in the Appendix 1. The main points discussed during its visit are described in the Appendix 2.

It should be noted that implementation of the Preparatory Survey does not imply any decision or commitment by JICA to extend its loan for the project at this stage.

Appendix 1: Scope and Implementing Arrangements of the Preparatory Survey
Appendix 2: Main Points Discussed
Appendix 3: List of Attendants

SCOPE AND IMPLEMENTING ARRANGEMENTS OF THE PREPARATORY SURVEY

I. BACKGROUND AND OBJECTIVES OF THE PREPARATORY SURVEY

Federal Democratic Republic of Ethiopia (hereinafter called "Ethiopia") has the second largest population in Africa of 99.4 million people (World Bank 2015). Average GDP growth rate in the last 10 years is above 10% because of the industrial policies, aims to become a low middle-income country by 2025.
Such being the situation, Infrastructure Quality Improvement including Power Development is one of the most prioritized policies in the Growth and Transformation Plan II (2015/16～2019/20) (GTP2).

GTP2 emphasizes the necessity of an investment to increase power generation capacity as well as expansion of the transmission and distribution network. In addition, expansion of the transmission network from 16,018km (2014/15) to 21,728km (2019/20) is one of the prioritized targets.

Target area of this preparatory survey (hereinafter called "The Preparatory Survey") is Addis Ababa administration area and an approximate 50km radius area around the city (hereinafter called "Addis Ababa Capital Region").
Moreover, along with the economic and population growth, many development of housing and industrial field are planned. According to the Addis Ababa Distribution Master Plan (hereinafter called "AADMP") prepared by African Development Bank (hereinafter called "AfDB") in 2015, the power demand in Addis Ababa capital region is expected to increase from 800MW in 2014 to 3,576MW in 2034 continuously. However, such as much of the medium voltage distribution network and the utilization ratio of distribution transformer is beyond 100 % of rated capacity. Moreover, capacity of power network including substation is reaching a breaking point already.
Concretely, 1) approximately 19% loss in distribution system occurs due to lack of capacity and equipment deterioration, 2) capacity of transformer and distribution line is becoming overloaded because of rapid demand increase, and 3) aging degradation of equipment, are causing the problem of frequent power outage and voltage drop in distribution network.
Therefore, upgrading of transmission and substations, and rehabilitation of distribution network are required.
Considering these situations, JICA implemented the Data collection survey on Addis Ababa Transmission and Distribution System (hereinafter called "Data Collection Survey") from June 2017 through August 2017.

The data collection survey conducted includes 1) verifying the project component for expected package as Japanese Yen Loan, 2) study on Applicable Quality Infrastructure, 3) project finding for transmission, substation and distribution system in Addis Ababa. Based on the result of the Data Collection Survey, Addis Ababa Transmission and Distribution System Rehabilitation and Upgrading Project are scheduled to be implemented.

II. OBJECTIVES OF THE PROJECT

To contribute to the promotion of industrialization and socioeconomic development of Ethiopia through improving stability of power supply in Addis Ababa and surrounding area by rehabilitating and upgrading transmission and distribution systems.

IV. SURVEY AREA

Addis Ababa administration and Addis Ababa Capital Region

V. SCOPE OF THE PREPARATORY SURVEY

1. Terms of Reference

The Preparatory Survey shall cover the following items:

(1) Scope of Work

1) Preliminary Design for Overhead / Underground Transmission and Substation Facility

① 132kV Overhead Transmission line

No.	From	To	Voltage (kV)	Number of the circuit	Distance (km)
OH_Route1	Connection Point 1	Connection Point 2	132	2	11

* Connection point : Connection point between Overhead transmission line and underground cable.
** Location of the connection points and distance of transmission line are subject to change according to the result of the Preparatory Survey.

② 132kV Underground Transmission

No.	From	To	Voltage (kV)	Number of the circuit	Distance (km)
UG_Route1	Addis Centre Substation	Connection Point 1	132	2	3.2
UG_Route2	Connection Point 2	Kaliti I Substation	132	2	0.1
UG_Route3	Addis Centre Substation	Black Lions Substation	132	1	2.4
UG_Route4	Weregenu Station	Connection Point 3	132	2	3.8

* Location of the connection points and distance of transmission line are subject to change according to the result of the Preparatory Survey.

③ Upgrading the substation facilities including outdoor type GIS.

Name	Main component	Primary Voltage
Addis Centre Substation	Full replacement of substation (Outdoor type GIS) Transformers 200MVA(50MVA x 4units)	132 kV
Kaliti I Substation	Reinforcement of receiving equipment (2 c.c.t./ AIS)	132 kV
Black Lion Substation	Reinforcement of receiving equipment (1 c.c.t./ Indoor type GIS)	132 kV
Addis North Substation	Upgrading of transformers 100MVA(50+50)	132 kV
Weregenu Substation	Reinforcement of receiving equipment (2 c.c.t./ AIS) and installation of one transformer (50MVA 132/33kV)	132 kV

* The number of transformers installed in the substations is subject to change according to the result of the Preparatory Survey.

2) Preliminary Design for Distribution Network

① Rehabilitation of 33kV/15kV medium voltage network and Distribution transformers

Amount of Survey Facilities

No.	Main component	Length of Middle voltage (km)	Distribution transformer (Unit)
Item A	3 areas including the city center	—	1,290
Item B	Feeders of highest number of outages	275	757
Item C	Feeders of outside of city	100	120

Location of target facilities is shown in the annex 1.

3) Environmental and Social Survey (Resettlement Action Plan, Screening and Initial Environmental Examination))

4) Social Survey (Baseline Survey)

5) Invitation program in Japan

(2) Survey Activities

1) 1st stage: Confirmation of Present Condition of Power Network and Preliminary Design of the Project

① Kick off Meeting (Explanation and discussion on IcR)

② Confirmation of background of the Project

③ Present Condition and Issue of project components

④ Power Supply and Demand

⑤ Determination of the Project component targeting for Preliminary Design

⑥ Natural Conditions Survey

⑦ Preliminary Design, Overhead / Underground Transmission and Substation Facility

⑧ Environmental Survey

⑨ Social Survey(Baseline Survey)

⑩ System Analysis

⑪ Explanation and discussion on It/R to the related Parties

⑫ Construction Method

⑬ Implementation Schedule for the Project

⑭ Project Implementation Organization

⑮ Operation and Maintenance Organization

⑯ Study of temporary construction plan for transmission and substation

2) 2nd stage: Evaluation of the Project

① Preliminary Design / Distribution Network

② Study of temporary construction plan for transmission and substation

③ Environmental Survey
④ Training in Japan
⑤ Project Plan
⑥ Points to be noted for the Project implementation
⑦ TOR for Consulting Services in DD/CS
⑧ Project Cost Estimation
⑨ Evaluation of Project

2. Specialists for the Preparatory Survey

JICA selected a survey team to carry out the Preparatory Survey. The team includes the following specialists.

(1) Team Leader/ Transmission and Distribution Planning
(2) Deputy Team Leader/ System Analysis
(3) Transmission Facility(1) (Overhead Line)
(4) Transmission Facility (2) (Underground Cable)
(5) Substation Facility
(6) Distribution Planning (1)
(7) Distribution Planning (2)
(8) Distribution Facility
(9) Electric Power Civil Engineering
(10) Economic and Financial Analysis
(11) Environmental and Social Consideration(1)
(12) Environmental and Social Consideration(2)
(13) Facility Planning/ Project Coordinator

The assignment of the specialists may be subject to change. The survey team will engage local consultants, NGOs, and/or other supporting staffs.

VI. SCHEDULE OF THE PREPARATORY SURVEY

The Preparatory Survey will be carried out in accordance with the tentative schedule attached in the Annex 2. The schedule may be subject to change during the preparation and the course of the Preparatory Survey.

VII. REPORTS

The survey team will prepare and submit the following reports in English to Ethiopian side.

1. Inception Report: 6 copies will be submitted at the time of the commencement of the study
2. Interim Report: 6 copies will be submitted at the end of May 2018.
3. Draft Final Report: 6 copies will be submitted at the end of August 2018.
4. Final Report: 10 copies will be submitted by the end of October 2018.

IIX. UNDERTAKINGS OF THE GOVERNMENT OF FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

The GOE including EEP, EEU and MOFEC shall act as a counterpart agency to the survey team and also as a coordinating body with other organizations concerned for the smooth implementation of the Preparatory Survey.

GOE shall, at its own expense, provide the survey team with the following items in cooperation with other organizations concerned:

(1) security-related information as well as measures to ensure the safety of the survey team;
(2) information as well as support in obtaining emergency medical service;
(3) data and information related to the Preparatory Survey;
(4) counterpart personnel and related all expense including allowance ;
(5) suitable office space with necessary equipment in EEP and EEU;
(6) entry permits necessary for the survey team members to conduct field surveys;
(7) support in making transportation arrangements; and
(8) support in obtaining other privileges and benefits if necessary.

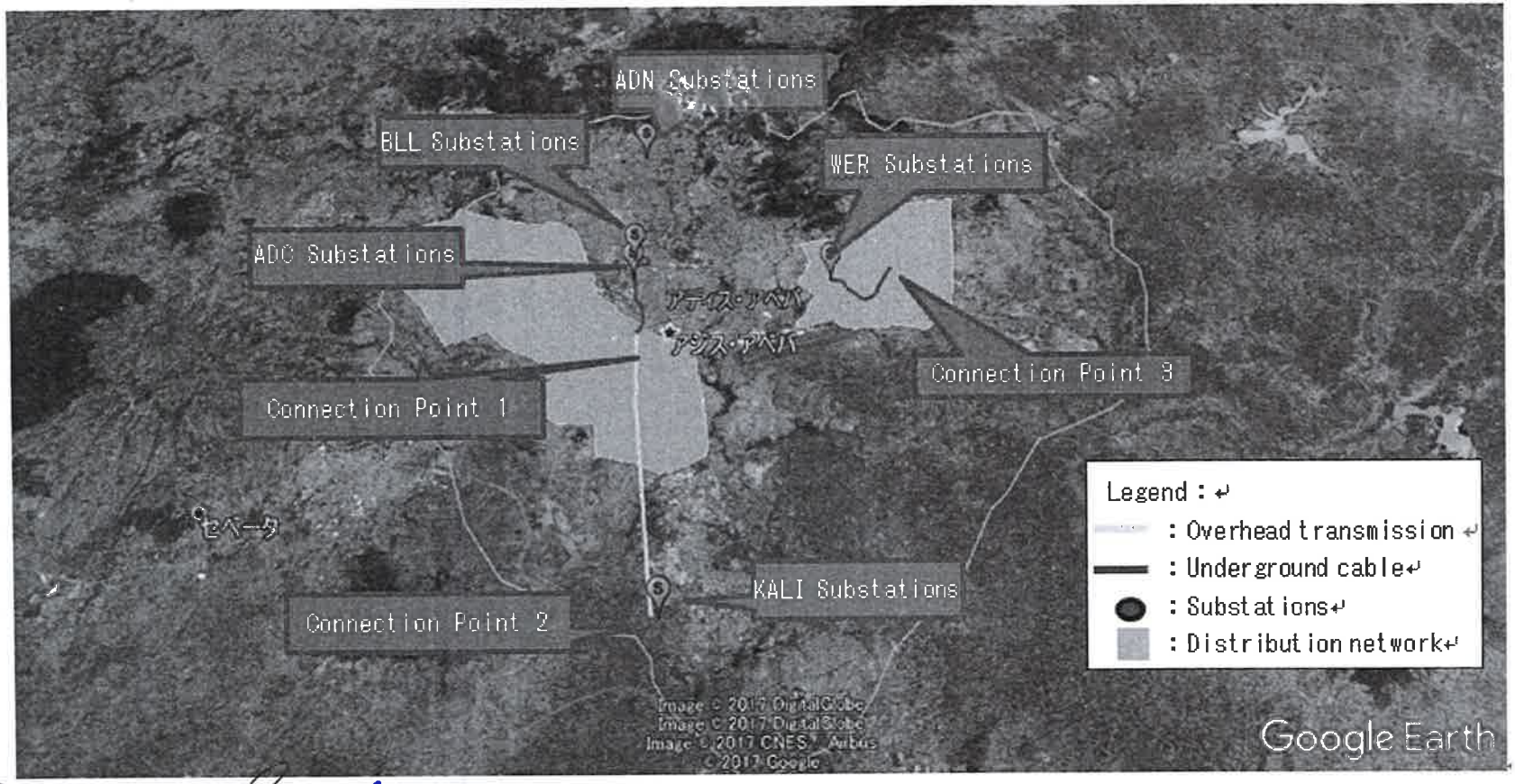
GOE shall bear claims, if any arises, against the members of the survey team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in implementation of the Preparatory Survey, except when such claim arise from gross negligence or willful misconduct on the part of the member of the survey team.

IX. CONSULTATION

JICA and GOE shall consult with each other in respect of any matter that may arise from or in connection with the Preparatory Survey.

END

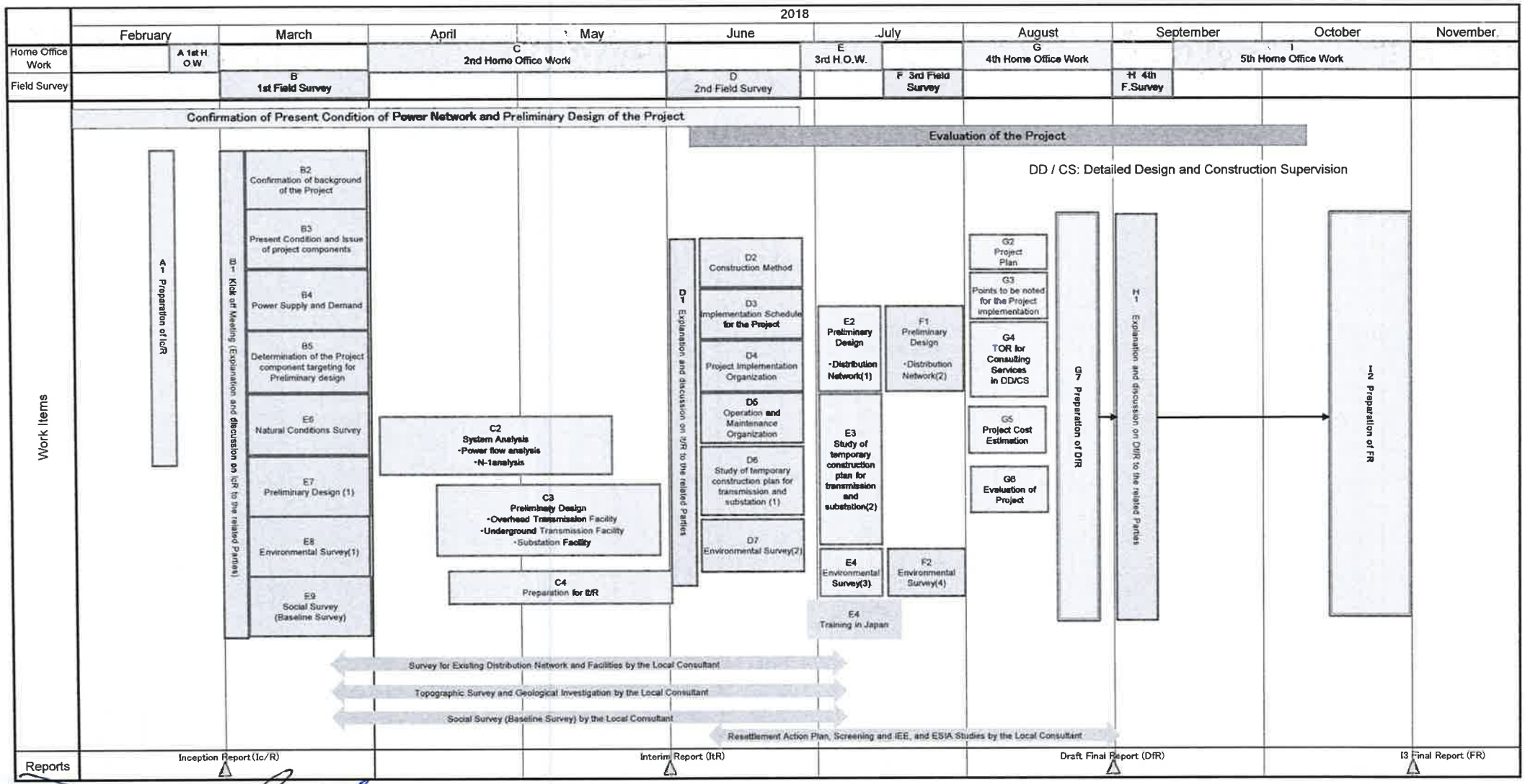
Annex 1: Location of target facilities
Annex 2: Tentative Schedule



Location of target facilities

Annex 2

Tentative Schedule of the Preparatory Survey



Tentative Schedule of Financing

for

as of March 2018

Addis Ababa Transmission and Distribution System Rehabilitation and Upgrading Project

Procedure/Year	2018										2019					
Month	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
JICA Procedure																
1. Preparation Study for Appraisal	▬	▬	▬	▬	▬	▬	▬	▬								
2. Internal Project Committee									▲							
3. Consultation with Government										▲						
4. JICA Appraisal Mission											▬					
5. JICA Board Meeting and Approval												▲	ACFA Final Concurence			
6. Consultation with Government												▲				
7. Pledge / Final Concurrence to AfDB													▲			
8. L/A Negotiation													▬			
9. E/N, L/A														▲		

※NOTE: The schedule is tentative and would be revised according to the unforeseeable findings of the following survey and further coordination.

THE MAIN POINTS DISCUSSED

1. Project Schedule

JICA Mission team explained on the revised schedule. The main point of the revision is including a preliminary design in the Preparatory Survey due to the following reasons;

(1) The site for Addis Center Substation has been changed from the one proposed in the Master Plan and the prepared draft tender documents, therefore a preliminary design should be carried out in the Preparatory Survey.

(2) Procurement method for Package 5 (Pilot Project for Distribution) proposed by Master Plan study leaves much room for the elaboration, thus further data collection works by field survey and consultancy service in the Preparatory Survey are required.

2. Addis Center Project Site

The Project site for Addis Center Substation was decided by EEP's official letter dated on 9th March, 2018 to be the land adjoining the AU Headquarters.

3. Project Scope

(1) JICA side and Ethiopian side agreed that upgrading of two substations namely, Addis North and Weregenu are added as the Project component candidates based on the suggestion from Ethiopian side in last mission of Data Collection Survey on Addis Ababa Transmission and Distribution System in July 2017.

(2) With regard to the distribution network rehabilitation in Package 5, the Ethiopian Electric utility stated that in order to supply reliable power and quality service the rehabilitation work should include MV feeder, Distribution transformers and LV networks. In addition to that rehabilitating MV feeders, distribution transformers and LV networks will give a full end to end solution for customer by improving deteriorated MV feeders, LV feeders and Overloaded transformers.

JICA Mission team, while recognizing the importance, stated that the Preparatory Survey should focus on the medium voltage lines and transformers and exclude low voltage networks, due to the following reasons.

- As the project cost with the current project components stated above has already been beyond the budget allocated for the Project, setting priorities should be required.
- The upgrading of the low voltage facilities, if included in the Project, requires additional surveys, such as topological surveys on the existing low voltage feeders, identification of the deteriorated facilities and system/reliability analysis on the low voltage networks. Such works may take six months at minimum, and will cause delay in implementing the Project.
- By rearranging the middle voltage distribution network, installing and/or relocating distribution transformers, major parts of issues in low voltage distribution network such as voltage depression and overloading are expected to be improved.

In conclusion, both sides agreed that the rehabilitation of low voltage feeder is not included in the project scope.

(3) Beside the project scope stated in the appendix 1, the Ethiopian side requested JICA side to add the below items.

- Replacement of receiving equipment (2 c.c.t./ AIS) including power transformer in Addis North substation
- Installation of new transmission line from Kaliti I to Gofa substation and receiving equipment (1 c.c.t./ AIS) in Gofa substation

JICA Mission team acknowledged the necessity of implementing these components together with the components described in Appendix 1, and decided to conduct a further study in the preparatory survey.

(4) The number of transformers installed in the substations needs to be determined based on the N-1 criteria and forecast for power demand. Therefore, it is subject to change according to the result of the Preparatory Survey. Both sides confirmed to give preference to the installation of transformers in Addis Centre Substation, rather than the installation of a transformer in Wereganu Substation.

4. Coordination with the construction of Black Lions substation

Both sides acknowledged that the completion of the Black Lions substation is critical for the installation of the 132kV underground cable from Addis Centre substation to Black Lions substation which is planned in the project. The Ethiopian side confirmed to complete the underground cable construction work between Black Lions substation and Addis North Substation before the tender float of the project.

5. Co-finance Arrangement

Both sides confirmed that the Project is expected to be implemented jointly with African Development Bank under ACFA co-finance scheme. Although arrangement is in parallel financing, to maximize project effect as early as possible, considering AFDB project was already approved in 22nd November, 2017, JICA makes the best effort to accelerate its process toward project approval and early implementation.

Appendix 3

List of Attendants

Ethiopian Side

MOFEC

Kokeb Misrak, Director of Bilateral Cooperation Directorate

EEP

Mekuria Lemma, Director of Strategy and Investment

Abinet Ahmed, Addis Ababa Power System Master Plan Project Manager

EEU

Gosaye Mengistie Abayneh, Chief Executive Officer

Adefris Merid, Senior Technical Advisor for CEO

Solomon Kenaw, Technical Advisor for CEO

Japanese Side

Mission Members

Ken Yamada, Mission Leader

Kaoru Ozeki, Cooperation Planning

Akihiro Kashiwagi, Distribution Planning

Preparatory Survey Team

Kenichiro Yagi, Team Leader/ Transmission and Distribution Planning

Kiyotaka Ueno, Deputy Team Leader/ System Analysis

Shinichi Kawabe, Distribution Planning (1)

Takao Suzuki, Transmission Facility(1) (Overhead Line)

Ryosuke Ishii, Transmission Facility (2) (Underground Cable)

Akira Kawabe, Substation Facility

Fumihiro Tamura, Distribution Planning (2)

Yoshinori Yoneda, Distribution Facility

Yuki Nakamura, Facility Planning/ Project Coordinator

Yukihiro Mikumo, Economic and Financial Analysis

Akihiro Osada, Environmental and Social Consideration(1)

Takeshi Abe, Electric Power Civil Engineering

Naoko Furusawa, Environmental and Social Consideration(2)