



KULIM TECHNOLOGY PARK CORPORATION SDN BHD

LUSAKA MULTI FACILITY ECONOMIC ZONE PREPARATION OF DEVELOPMENT MASTER PLAN



SOIL INVESTIGATION WORKS SPECIFICATIONS AND BILL OF QUANTITIES

(31 JULY 2007)

STANDARD TERMS OF REFERENCE FOR ENGINEERING SURVEY

TABLE OF CONTENTS

1.0	GENERAL	3
1.1	Objective.....	3
1.2	Scope of Works.....	3
1.3	Location	3
1.4	Area To Be Surveyed.....	3
1.5	Inspection of Sites.....	3
1.6	Scope of Services	3
1.7	Consultation With Client Before Commencing Work.....	3
1.9	Background Information of Surveyor.....	3
1.10	Care and Diligence.....	3
2.0	TOPOGRAPHICAL AND ALIGNMENT SURVEY	3
2.1	General.....	3
2.2	Site Survey	3
2.3	Pipeline Survey.....	3
2.4	Survey For Access Road.....	3
3.0	TEMPORARY BENCH MARKS	3
4.0	PEGGING OF ALIGNMENT, CORRIDOR, BOUNDARIES AND INTERSECTION POINTS	3
5.0	COLOUR CODES FOR PEG	3

6.0	BOOKING OF SURVEY.....	3
7.0	INSPECTION OF WORKS.....	3
8.0	ACCURACY OF SURVEY	3
9.0	PREPARATION OF SURVEY PLANS AND DRAWINGS	3
9.1	General.....	3
9.2	Location Plan	3
9.3	Contour Plan	3
9.4	Longitudinal Profile and Plan.....	3
9.5	Cross Sections For Road Survey.....	3
9.6	Land Acquisition Plans	3
9.7	Summary Of Survey Elements For Various Types Of Surveys	3
10.0	SUBMISSION OF SURVEY PLANS AND RECORDS.....	3
10.1	Format For Presentation.....	3
10.2	Photographic Process and Mechanical Scaling.....	3
10.3	Date of Submission of Drawings and Data.....	3
11.0	PROGRAMME OF SURVEY WORKS.....	3
12.0	GOVERNMENT INDEMNITY	3
14.0	AGREEMENT	3

DETAILED GROUND SURVEY FOR LUSAKA MULTIFACILITY ECONOMIC ZONE

1.0 GENERAL

1.1 Objective

The objective of the detailed ground survey is to provide all necessary data and information for undertaking the engineering of the proposed **Lusaka Multifacility Economic Zone** in Zambia.

1.2 Scope of Works

The Terms of Reference (TOR) here covers the following surveys :-

- (a) Boundary Surveys complete with coordinates.
- (b) Spot levels that extends 50m beyond boundaries
- (c) Records of existing streams, rivers, lakes, etc.
- (d) Records of existing structures within the areas to be surveyed.

Since very often all the above surveys are required simultaneously hence only the relevant sections shall apply. The TOR shall also be read in conjunction with the specifications and conditions stipulated in the schedule of payment approved by the **Government**

1.3 Location

Initially a location map in the form of a topographical sheet shall be provided by the Engineer wherein the approximate location of the proposed facilities shall be indicated. The exact location of the site shall be agreed to by Engineer before the Surveyor can proceed with detailed-survey.

1.4 Area To Be Surveyed

The extent of the site to be surveyed is given in the attached plan No.: 2007/P593/Lusaka/Survey/01. The Surveyor is required to mark out the boundary of the site permanently with 40mm (2 inch) diameter G.I. pipes embedded in concrete at 25m spacing to facilitate location and setting out in future.

The total area to be surveyed is about **1000 hectares**.

1.5 Inspection of Sites

The Surveyor shall be deemed to have visited the sites and to have inspected and examined the sites and their surroundings and to have acquainted himself with all factors, including weather conditions, terrain, means of access, etc which are likely to influence his rates and work schedule.

1.6 Scope of Services

The scope of services to be provided by the Surveyor shall be detailed hereunder and in the subsequent paragraphs and sections :-

- (a) obtain all necessary topographical maps, certified plans, revenue sheets and bear all cost thereof including two (2) copies of each to the Engineer.
- (b) discuss with the relevant authorities such PWD, Police and Land Office before commencing the Works
- (c) study all relevant information and maps provided / available and obtain additional data if necessary for the proper execution of the works
- (d) carry out field survey and traversing, including spot leveling and picking up of details

- (e) set out a control traverse for the proposed pipeline routes and access roads along with centre-line pegging and strip survey
- (f) establish on ground Special types of Reference Markers for survey control, and
- (g) compile data and prepare survey reports and plans necessary and suitable for design, tendering and land acquisition purpose in format approved by the Engineer.

1.7 Consultation With Client Before Commencing Work

Before commencing work, the Surveyor shall submit his proposal for the detailed survey to the Engineer for approval. Should any discrepancy be found at the site, the Surveyor shall immediately inform the Engineer who shall then issue further instructions as to how to proceed.

A professionally qualified shall be provided to take charge of the survey parties and provide day-to-day liaison with the Engineer.

1.9 Background Information of Surveyor

The Surveyor is required to submit together with his Bid the name, background and professional experience of each individual to be assigned to the project.

1.10 Care and Diligence

The surveyor shall exercise all reasonable skill, care and diligence in the discharge of the duties agreed to be performed by him.

2.0 TOPOGRAPHICAL AND ALIGNMENT SURVEY

2.1 General

(a) Planimetric Control

Planimetric control shall be provided by theodolite traversing. Traverses shall be tied up to any nearby cadastral survey marks with the maximum closing error of 1 in 4000. Property boundary stones, if found within the specified survey corridor shall be located and tied to the proposed control traverse line.

(b) Height Control

Height control shall be established by leveling from existing B.M.'s and for this purpose, the Surveyor shall take the shortest and most practical route. The position of any existing B.M.'s which has previously been established by others shall be indicated on the survey plans. The levels of such B.M.'s shall be obtained and recorded and their accuracy verified by the Surveyor.

All temporary Bench Marks (TBM) shall be connected by a closed leveling net which shall be tied to a minimum of 2 survey Bench Marks unless otherwise agreed by the Engineer.

The accuracy of the survey shall be as stated in Section 8.0.

(c) Monumenting

This involves the construction of special type of reference markers, TBM's and intersection points. Details are elaborated in Sections 3.0, 4.0 and 5.0.

(d) **Field Survey and Traversing**

The surveyor shall perform all field survey work necessary to locate accurately the locations and dimensions of the following existing features within the proposed area for survey :-

- (i) roads, tracks and paths, including pedestrian crossings and bridges, and road furnitures,
- (ii) railway tracks and level crossings,
- (iii) structures above and below the ground level. Indicate whether dwelling, industrial or other use, type of construction, tanks, sewage disposal works, etc.,
- (iv) water, sewer and gas mains including manholes and check valves, wells, etc,
- (v) water courses, drains and their discharge direction, lakes or mining pools,
- (vi) transmission line and supporting towers,
- (vii) land-use and vegetation, playing field, etc.
- (viii) prominent trees within the surveyed area, with girth greater than 188cm at 0.6m above ground,
- (ix) highest known flood level of the corridors surveyed
- (x) slopes and earthworks, including quarries, retaining walls and rock outcrop and
- (xi) any other features when requested by the Engineer.

2.2 Site Survey

Site survey covers Intake, Pumphouse, Booster Stations, Treatment Plants, Dam Sites and Reservoir sites and the scope shall include preparatory work, demarcation of boundaries, contours and details, grid leveling and details, height control and monumenting.

- (i) Spot levels by grid leveling shall be obtained at interval of 5m to produce contour lines of 0.5m on plan
- (ii) All spot levels taken at grid points shall be shown on drawings
- (iii) Existing features such as listed in Section 2.1 (d) shall be obtained
- (iv) Special attention shall be given to marking of prominent trees, and wherever private land is involved since this entails Land Acquisition.
- (vii) Property boundary stones within the specified area shall be located. The Surveyor shall determine the rectangular co-ordinates of all the boundary corners and the traverses shall be tied up to any nearby survey marks where necessary.

2.3 Pipeline Survey

- (a) The scope involves pipeline setting out, control traversing, longitudinal profiling and locating accurately, the locations and dimensions of existing feature within the corridor of survey as shown in Section 2.1 (d).
- (b) In general pipelines fall largely into two (2) categories :-
 - (i) **Pipelines Along Existing Roads**

In this case the Engineer shall specify where the pipelines shall be laid, i.e. whether on the right or left of the road or whether on the road reserve.

Having specified the pipe route the Surveyor shall survey the route to plot out the longitudinal section. Control traversing for the centre line is not necessary.

(ii) **Pipelines Which Are Cross-Country**

In this case there is no road centre line or road reserve to refer to. Centre line traversing is thus necessary to set out the pipe route. The longitudinal section shall also be surveyed.

- (c) The Surveyors has to set out the centre-line of the proposed pipeline alignment and peg out the centre-line of the route accurately at every 25m intervals using hardwood (h.w.) pegs.
- (d) For pipeline survey along existing road, suitable longitudinal sections, site plans and layout plans showing details of all existing features within a corridor of 10m and supplying all relevant data that are required for a good pipeline design shall be carried out by the Surveyor. The pipeline should avoid every electrical post, underground cable and sewer main.
- (e) For a cross-country pipeline route the survey corridor shall be 20m wide. All features existing are to be accurately depicted in the plans.
- (f) For the longitudinal profile along the proposed route centre-line, levels shall be taken at every 25m intervals. However in rolling and hilly terrain where the ground level changes more frequently, closer intervals for the profile section will be required. The Surveyor shall include levels of abrupt changing natural ground. Whenever possible, the Surveyor shall give the water levels in the Drainage canals, streams and paddy fields.
- (g) The Surveyor shall survey all streams and drains crossing the line of the routes. These include all possible water courses irrespective of whether there is water or no water flow at the time of the survey work. Cross section of streams at sufficiently close intervals to show salient features up to 15m on either side of the pipe route are to be taken. The location of channel edges and other significant features shall be recorded and levels shall be taken along the bank slopes and channel inverts at intervals of 2m.

A minimum of three cross-sections of the watercourse are required, one of which shall be taken along the route line.

- (h) For culvert and bridge crossings, a plan and a side elevation of the structures showing wingwalls, piers, abutments and other related details shall be shown. The Surveyor shall indicate on the plan and longitudinal profile the chainage and reduced level of the lowest point of all depressions along the route. In addition the following information shall be obtained :-
- (i) soffit level of the edge beam at the bridge together with their spans and location of the columns/piers
 - (ii) invert levels and crown levels of culverts and distances on inlet/outlet structures from edge of road pavement
 - (iii) level of water in the stream and date the level was taken, and
 - (iv) the type and location of services adjacent and along the span of the bridge

2.4 Survey For Access Road

- (a) The Surveyor shall be required to survey and plot the following :-
- (i) control traverse points
 - (ii) contours at 0.5m intervals over a corridor 40m wide
 - (iii) preliminary setting out of the centre line of the road from Intersection Point or IP, to IP at 25m interval without setting out curves
 - (iv) longitudinal profile at 25m intervals. Where abrupt changes in topography occurs this interval shall be reduced to 10m to show the profile more effectively

- (v) cross sections at 25m intervals over the 40m wide corridor, and
 - (vi) all existing features both natural as well as man-made shall be clearly shown in the drawings.
- (b) For cross-sectioning and sounding at proposed bridge and culvert sites, the work shall include :-
- (i) survey of proposed bridge sites of 30m x 30m of land on both sides of river and 10m x 10m for culvert sites
 - (ii) measurement of width and depth of river along the centerline of proposed bridge and along the section 20m upstream and 20m downstream of centre line,
 - (iii) measurement of width and depth of river, based on waterline at the time of survey, and
 - (iv) obtain the maximum flood level.

3.0 TEMPORARY BENCH MARKS

- (a) The Surveyor is required to establish temporary bench marks at the proposed facilities. The number required is as shown below unless instructed otherwise.

No.	Facility	No. Of TBM Required
1.	Intake	1
2.	Pumphouse / Booster Station	1
3.	Pipeline	Beginning and End Point In between, 1 per kilometre
4.	Treatment	1
5.	Reservoir	1
6.	Access Road	As For Pipeline

- (b) All temporary bench marks (TBM's) shall be constructed out of a 1m length of 40mm dia. galvanised iron pipe set in concrete of dimension 300mm x 300mm x 150mm. The pipe shall be filled with concrete or cement, and a brass bolt or stud shall affixed onto the mortar at the top of the pipe or nails (on torred or concrete surfaces).
- (c) The TBM number and the reduced level of the TBM must be inscribed on the concrete. All TBM's shall be related to the ordinance datum.
- (d) In cases where the intake and the pumphouse are near to each other, a single temporary bench mark shall suffice. The TBM's must be well away from disturbance and/or construction limit.

4.0 PEGGING OF ALIGNMENT, CORRIDOR, BOUNDARIES AND INTERSECTION POINTS

The Surveyor shall peg according to the following manner :-

- (a) At all Intersection Points (IPs), permanent markers using 40mm dia. G.I. pipe shall be embedded in concrete and tied to at least 2 reference markers placed at least 25m away from the IP. The base of the triangle which they form with the apex shall be at least 15m apart.
- (b) Centre line shall be pegged at 25m intervals using 50mm x 50mm x 450mm hardwood pegs painted red and projecting not less than 50mm above ground.
- (c) For setting of centre lines along existing roads; intermediate points shall be marked with steel spikes. These spikes once driven into the pavement shall be marked with circle of red paint and shall remain permanent in nature.
- (d) For the demarcation of Right-Of-Way (R.O.W) and reserves, h.w. pegs are to be planted at change points and jungle roller pegs at intermediate points at a spacing of 100m.

5.0 COLOUR CODES FOR PEG

All pegs shall be colour-coded with paint on site to indicate their purpose. A consistent colour code must be maintained throughout the survey to avoid confusion. A recommended system is shown in the table below :-

Peg Function	Colour
Centre line for all works	Red
Off-set peg from centre line e.g. IP & Reference Markers	White
Right-Of-Way	Yellow
Boundary of Site eg. Treatment Plant Compound	Yellow
Temporary Bench mark (reduced level shall be inscribed on the concrete base)	Red

6.0 BOOKING OF SURVEY

- (a) The field books must be properly kept in accordance with good practices and shall record truthfully all the survey work carried out. The Project Engineer or his authorized representative may check the field books now and then to ensure that a high standard of work is maintained. He may request the Surveyor to carry out some spot checks if he has reasonable doubt on the accuracy of the survey work. The Surveyor shall comply with such request unless he can prove to the Project Engineer's satisfaction that such checks are unnecessary.
- (b) The Surveyor shall record all workings in proper books written in INK. Errors in field books shall be struck off and there shall be no erasure or superimposition of writing on top existing words or figures. On completion, all field books and computer data, drawings, calculations and work sheets shall be properly labeled, certified and submitted to the Engineer. It shall remain as Government property thereafter. All records, calculations, drawings, etc., shall be in metric units.
- (c) The Surveyor may propose the use of electronic equipment for the purpose of booking, The type of equipment is subjected to the Engineer's approval.
- (d) All field books and computer data shall be certified by the Licensed surveyor in a format as shown in **Appendix A**.

7.0 INSPECTION OF WORKS

Upon completion of the field works, the Surveyor shall be required to conduct a site visit for the Engineer or his Representatives to shown them the positions of all Bench Marks and permanent monuments which have been established and located.

8.0 ACCURACY OF SURVEY

8.1 General

Where accuracies or tolerances are specified herein, they are defined as maximum Errors or statistically based root mean square errors (r.m.s.e) as in the following :-

(a) Maximum Errors

Maximum errors are only used for fieldwork misclosures and plotting of Map grids and control points.

All errors exceeding the maximum allowable tolerance including consequential errors, shall be corrected by the Surveyor at his own expense.

(b) Root mean Square Errors

The root mean square errors (r.m.s.e) are related to checks on representative dimensions or levels and the following conditions have to be satisfied.

- (i) at least 67% of all readings must be correct to or better than the r.m.s.e.
- (ii) at least 90% of all readings must be correct to or better than 1.65 times the r.m.s.e., and
- (iii) all readings must be correct to or better than 3 times the r.m.s.e.

8.2 Distance Misclosure

The maximum allowable error for all measured distance shall not exceed 1 in 4000.

8.3 Vertical Misclosure

Vertical misclosure within the leveling net and between the Survey Department's BMs shall not exceed the lesser of the following :-

- (i) $\pm 16\text{mm}$, or
- (ii) $\pm 20\sqrt{k}\text{mm}$, where k is sum of distances leveled in kilometers.

Everyday's work shall be tied back to the starting point of the day.

9.0 PREPARATION OF SURVEY PLANS AND DRAWINGS

9.1 General

- (a) The plans shall be prepared in an approved format with title blocks approved by the Engineer. All legends and symbols used in the plans shall be those currently used by the Government. The plans shall where necessary, have an overlap of not less than 100mm with match line shown.
- (b) The surveyor shall plot his survey relative to the State Grid. If so required by the Engineer, the National Grid used shall be the **Zambia National Grid**. For digital modelling purposes, the National Grid shall be used.
- (c) The azimuth shall be checked by astronomical observations at suitable intervals and the traverses shall be tied up to nearby trigonometrical stations or cadastral survey marks whenever possible.

9.2 Location Plan

The location plan of the survey are shall be drawn to a suitable scale that the area being surveyed can be accommodate into a single standard sheet of A1 size. Where applicable, the chainage of the centre line shall be indicated to facilitate cross reference to detail plans.

9.3 Contour Plan

- (a) All contour plans must show spot levels taken on a grid of 5m square. Contour lines at 0.5m intervals shall be drawn on the plan which shall be to a scale of 1:500 or 1:1000 as instructed by the Engineer. In case where a site is too large to be accommodated in a single A1 size drawing then the plan may be divided into a number of sections with match lines linking them together.
- (b) Contours shall be correct to within the tolerances given below when a representative sample of points on contour lines is checked by measurement from the nearest Survey Department BM or height control point.

Contour Interval	r.m.s.e	90% Tolerance
0.5 m	+/- 0.15 m	+/- 0.25m
1.0 m	+/- 0.30 m	+/- 0.30 m
2.0 m	+/- 0.60 m	+/- 1.00 m
5.0 m	+/- 1.50 m	+/- 2.50 m

- (c) Any contour which can be brought within this vertical tolerance by moving its plotted position in any direction by not more than 0.5mm or one-tenth of the horizontal distance between contours, whichever is the greater, shall be considered acceptable.

- (d) Spot Heights shall be correct to within the tolerances given below a representative sample is checked by measurement from the nearest Survey Department BM or height control point:

Map Scale	r.m.s.e	90% Tolerance
1 : 1500	+/- 0.06 m	+/- 0.1 m
1 : 1000	+/- 0.12 m	+/- 0.2 m
1 : 2500	+/- 0.30 m	+/- 0.5 m
1 : 10000	+/- 1.0 m	+/- 1.6 m

9.4 Longitudinal Profile and Plan

- (a) The longitudinal profile and plan shall shown details of ground levels, chainage, existing physical features, survey stations, intersection points, location of cross-sections, reference points and bench marks: The longitudinal profile shall be drawn to a scale of 1:1000 horizontally and 1:100 vertically.
- (b) All base stations such as cadastral survey boundary stones, ordinance datum bench marks and trigonometrical stations upon which the survey was based shall be indicated clearly on the drawings. For plans the scale shall be 1:1000.
- (c) When the proposed pipeline is located also along an existing track, sufficient spot levels shall be shown.
- (d) The coordinates of all horizontal intersection points shall be tabulated in the format approved by the Engineer.

9.5 Cross Sections For Road Survey

The Surveyor shall submit drawings of all cross sections at 25m intervals along the centre line of the proposed road plotted in order of increasing chainage to a scale of 1:100 both

horizontally and vertically. The drawings shall show details of ground levels and distances from the centre line of pavements, shoulders, etc or alternatively submit presentation of cross sectional data in an acceptable computer format.

9.6 Land Acquisition Plans

- (a) The Surveyor shall compile and prepare base plans for property and land acquisition purpose from the Survey Department cadastral sheets and latest revenue sheets from the Land Office and other Government land scheme agencies where relevant at his own cost.

The Land Acquisition Plans shall show :-

- (i) lot boundaries within the area surveyed / districts
- (ii) lot numbers and name of mukims
- (iii) lot areas computed based on coordinates method (Determination of areas by measurement is not acceptable)
- (iv) land use indicating type of cultivation or activity
- (v) types of buildings indicating permanent or semi-permanent and usage of the building (commercial, industrial, religious, communal, school, etc.)
- (vi) all buildings shall be plotted to scale and shall be of correct size, shape and orientation
- (vii) whether the affected buildings are within the construction limits or within the R.O.W.
- (viii) special attention to burial grounds, if any, within the survey corridor / area

- (ix) computation of areas to be acquired, and
 - (x) schedule of losts to be acquired, including dimensions of lots and coordinates of the bounding of the lots, etc.
- (b) The Surveyor shall also prepare the final land acquisition plans to the scale approved, which must comply with Land Office requirement.

9.7 Summary Of Survey Elements For Various Types Of Surveys

Purpose	Grid Level Contour	Long. Sect	Cross. Sect.	Traverse
Intake, Pump House, Treatment Plant, Reservoir, Booster Station, Dam Sites	Yes	No	No	Yes for Boundary
Pipelines:				
i) Along Road	No	Yes	No	No
ii) Cross-Country	No	Yes	No	Yes
Access Road	Yes	Yes	Yes	Yes

10.0 SUBMISSION OF SURVEY PLANS AND RECORDS

10.1 Format For Presentation

- (a) Upon the completion of the whole works, the Surveyor shall submit to the Engineer the survey plans, drawings and records as follows :-
- (i) one (1) complete set of Master Transparencies
 - (ii) two (2) complete sets of paper copies (printed by diazo process)

- (iii) two (2) sets of 3 ½ inch diskettes or CD-Rom of all survey plans drawn using Autocad Release 12 (or newer version)
 - (iv) all relevant data, field books, drawings, calculation sheets, etc, including schedules of all permanent ground markers, giving reference numbers and coordinates, and schedules of prominent trees with girth > 0.3m diameter (300 cm), properly numbered with girth size and referenced to plans, and
 - (v) eight (8) copies of Final survey report in an approved format.
- (b) Notwithstanding the above, the Surveyor shall issue to the Engineer part of any of the above items as and when required by the Engineer. All data and drawings shall be recorded and plotted in a format required and approved by the Engineer.
- (c) All drawing shall be to A1 size unless otherwise agreed.
- (d) National Grid Lines shall be shown by symmetrical lines at 100mm intervals. Cassini or State lines (if so required) shall be shown at 100mm intervals by symmetrical crosses 910mm North-South and 10mm East-West). Co-ordinate values shall be shown outside the band of detail or at the sheet edges at 100 metres intervals.
- (e) Master Transparencies shall consist of positive transparencies of the approved Final Drawings plotted stable based material, not less than 0.1mm (0.004 inch) in thickness with matt drawing surfaces on both sides. A tolerance for shrinkage of the stable based material not exceeding +/-0.3mm per metre is permitted.
- (f) All Master Transparencies shall bear the name, signature (not sign on intermediate) and qualifications of the Licensed Surveyor as well as the name and address of the company.
- (g) All the above mentioned items shall become the property of the Government upon submission to the Engineer.

10.2 Photographic Process and Mechanical Scaling

All plans shall be drawn from fieldwork data. No photo-mechanical process or mechanical scaling (e.g. pentagraph) are allowed for any reduction or enlargement of drawings without the prior approval from the Engineer.

10.3 Date of Submission of Drawings and Data

All drawings, data and Final Survey Reports are to be prepared and submitted to the Engineer within four (4) weeks after completion of the relevant fieldworks.

11.0 PROGRAMME OF SURVEY WORKS

- (a) The Surveyor shall submit to the Engineer a work programme chart for work both in the field and the drawing office.
- (b) The work programme shall be such that the surveyor can execute the job within the specified time without sacrificing accuracy. It is not uncommon to work in security areas where working hours are limited. Such circumstance must be considered when stipulating the time allocated. On his part the surveyor shall submit his proposed work schedule describing in detail the following:
 - (i) identify the approach he proposed to follow and the various component activities that make up the survey, and
 - (ii) indicated on a chart the sequence of such activities, the time required for each activity and the total time required to complete the entire survey, and
 - (iii) the date of submission of survey reports and final drawings.

12.0 GOVERNMENT INDEMNITY

The Surveyor shall be solely responsible for any Injury or damage to life and property arising out of or caused by the execution of the Works and shall take out all necessary insurance covers to indemnify the Engineer and the Government in respect of any liability, claim, loss or proceedings whatsoever arising out of such Injury of damage.

13.0 REMUNERATION

- (a) The Surveyor shall provide an approximate total fee based on the latest Schedule of Fees for Engineering Surveys approved by the Government for rendering services mentioned under this Terms of Reference and shall be deemed to cover all materials, services, wages, allowances, investigations, field surveys, equipment, transport, computations, plans, overheads, profits and any other incidental fees and expenses.
- (b) Payment shall be made based on the Schedule of Fees mentioned above and the actual length of route and/or extent of site surveyed.
- (c) Ten percent (10%) of total cost of the survey shall be retained until the Engineer is fully satisfied that the survey has been carried out in compliance with the Specifications stated in the Terms of Reference.

14.0 AGREEMENT

An agreement shall be drawn up and signed between the surveyor and the Government before any survey work can begin. Remuneration shall be made based on the **Memorandum of Agreement Between The Government and The Consulting Surveyor For Professional Services** and shall be deemed to cover all expenses required for the successful completion of the survey.

APPENDIX 'A'

I certify that these field notes consisting of..... volumes, numbered.....to.....are a correct and complete record of the observations and measurements made by or under the immediate personal direction and supervision in the field of ⁽¹⁾....., that the survey was effected in strict conformity with the Licensed Land Surveyor Regulations, that the standard of accuracy of the survey is Class as defined in those Regulations and that the survey was completed on theday of..... 20.....

I undertake to accept full responsibility for the correctness of the survey.

.....
(Signature)

Name of Licensed Surveyor :.....

Qualifications :.....

Name of Company :.....

Licensed Under Ordinance No.11 of 1958

Note:

⁽¹⁾ Name and Qualification of Qualified surveyor in-charge of the survey parties.

SPECIFICATION ON SITE INVESTIGATION WORKS**TABLE OF CONTENTS**

1.0	PRELIMINARIES	4
1.1	Scope of Works.....	4
1.2	Documents Mutually Explanatory.....	4
1.3	Inspection of Site.....	4
1.4	Programme To Be Furnished.....	4
1.5	Setting-Out and Taking Levels.....	5
1.6	Supply of Plant, Materials and Labours.....	5
1.7	Watching and Lighting.....	5
1.8	Interference With Traffic.....	5
1.9	Facilities For Other Contractors.....	6
1.10	Temporary Access.....	6
1.11	Workmen's Accommodation.....	6
1.12	Water Supply.....	6
1.13	Electrical Power Supply.....	6
1.14	Storage Facilities.....	6
1.15	Removal Of Improper Plant, Etc.....	7
1.16	Damage To Overhead And Underground Mains And Services.....	7
1.17	Mobilisation and Demobilisation.....	7
1.18	Scaffolding, Staging and Ponthoon On Water Body.....	7
1.19	Staging of the Works - Maintenance of Existing Facilities.....	8
1.20	Clearance Of Site On Completion.....	9
1.21	Laboratory Testing Facilities.....	9
1.22	Progress Photographs.....	9
1.23	Location At Site.....	9
1.24	Restricted Area.....	9
1.25	Method Of Measurement.....	10
1.26	Submission of Reports.....	10

2.0	DEEP BORING	10
2.1	Boring Plants	10
2.2	Method of Advancing Boreholes	10
2.3	Uncased And Cased Boreholes	11
2.4	Other Methods Of Stabilisation Of The Boreholes.....	11
2.5	Heaving Of The Bottom Of The Boreholes.....	11
2.6	Size And Depth Of Boreholes	11
2.7	Rock Drilling.....	12
2.8	Core Recovery Ratio (CRR) And Rock Quality Designation (RQD).....	12
2.9	Unnatural Obstruction And Abandoned Boring.....	12
2.10	Backfilling Of Boreholes	12
2.11	Marking Of Borehole Position.....	13
3.0	SAMPLING IN BOREHOLES	13
3.1	Obtaining Disturbed Samples.....	13
3.2	Obtaining Undisturbed Samples With The Thin-Walled Tube.....	13
3.3	Obtaining Undisturbed Samples With The Thin-Walled Stationery Piston Samplers ...	14
3.4	Obtaining Undisturbed Sample With The Triple Tube Core Barrel (Mazier Sampler) ..	14
3.5	Preservation Of Disturbed Samples	15
3.6	Preservation Of Undisturbed Samples	15
3.7	Labeling Of Soil Samples.....	15
3.8	Storage And Transportation Of Soil Samples.....	16
3.9	Preservation, Storage And Transportation Of Rock Cores.	16
4.0	FIELD TESTING	16
4.1	Standard Penetration Test (SPT).....	16
4.2	Dynamic Cone Penetration Test (CPT).....	17
4.3	Field Vane Test.....	17
4.4	Deep Sounding Test	17
4.5	Mackintosh Probes	18
4.6	Hand Auger Holes.....	18
4.7	Groundwater Level Observation.....	19

4.8	Collection Of Bulk Samples.....	19
4.9	Collection Of Groundwater Sample.....	20
4.10	Boreholes For Installation Of Monitoring Instruments.....	20
4.10.1	Stand Pipe Piezometers.....	21
4.10.2	Pressuremeter Tests.....	21
4.11	Field Permeability Tests.....	22
5.0	LABORATORY TESTING OF SAMPLES.....	22
5.1	Tests.....	22
5.2	On Disturbed and Undisturbed Samples (including Continuous Samples).....	22
5.3	On Undisturbed Samples.....	23
5.4	Other Tests.....	23
5.5	Cyclic Wetting and Drying Test Aggregate As Described Herein.....	24
5.6	Laboratory Report.....	25
6.0	REPORTING OF RESULT.....	25
6.1	Submission of Preliminary Field Log.....	25
6.2	Submission Of Final Reports.....	26
6.3	Presentation Of The Final Report.....	27
6.4	Details In The Drawings.....	29
6.5	Standard Tracing/Drawing Size.....	30
6.6	Details Required In The Ordinary Copy.....	30

SPECIFICATION ON SITE INVESTIGATION WORKS

1.0 PRELIMINARIES

1.1 Scope of Works

The Works in this Contract comprise site investigation: deep boring/deep sounding/Mackintosh Probes/hand auger/sample collection/laboratory testing as shown in the Bill of Quantities and Drawings.

Any Clauses in this Specification and the Bill of Quantities which relate to work or materials not required by the Works shall be deemed not to apply.

1.2 Documents Mutually Explanatory

The several documents forming the Contract are to be taken as mutually explanatory of one another and in case of ambiguities or discrepancies the provisions of the Conditions of Contract shall prevail over those of any other document forming part of the Contract.

Provided always that any ambiguities or discrepancies shall be referred as soon as possible to the S.O. who shall issue to the Contractor instructions directing in what manner the work is to be carried out in accordance with the provisions of this tender.

1.3 Inspection of Site

The Contractor shall inspect and examine the Site and its surrounding and shall satisfy himself before submitting his tender as to the nature of the Site, the Scope and nature of the Works, equipment, plants and materials necessary for the completion of the Works, and in general shall himself obtain all necessary information (subject as above mentioned) as to risks, contingencies and other circumstances which may affect his tender.

1.4 Programme To Be Furnished

As soon as practicable after the acceptance of his Tender the Contractor shall, if required, submit to the S.O. for his approval a programme showing the order of procedure and method in which he purposes to carry out the Works and particulars of

Plant and Temporary Works which the Contractor intends to supply, use or construct as the case may be. The submission and approval by the S.O. of such programme or the furnishing of such particulars shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

1.5 Setting-Out and Taking Levels

The provision on setting out has been specified in the Conditions of Contract.

Reduced levels shall be taken for all locations of investigations. The temporary bench marks used shall follow those given in the original site plan if the benchmark is given. Otherwise they shall be based on permanent features on the Site. Under no circumstances shall reduced levels be given by interpolating contour lines on the site plan. Contractors are also advised to check field data to ensure that the result is correct before the survey teams goes away from the Site.

1.6 Supply of Plant, Materials and Labours

Except where otherwise specified the Contractor shall at his own expense supply and provide all the plant, labour and materials both for temporary and for permanent works, including the supervision thereof, transport to or from the Site and in and about the Works and other things of every kind required for the construction, completion and maintenance of the Works.

1.7 Watching and Lighting

The Contractor shall in connection with the Works provide and maintain at his own cost all lights, guards, fencing and watching when and where necessary or required by the S.O. or by any competent statutory or other authority for the protection of the Works or for the safety and convenience of the public or others.

1.8 Interference With Traffic

All operations necessary for the execution of the Works and for the construction of any Temporary Works shall so far as compliance with the requirements of the Contract permits, be carried on so as not to interfere unnecessarily or improperly with the public convenience or the access to use and occupation of public or private roads, footpaths and waterways.

1.9 Facilities For Other Contractors

The Contractor shall in accordance with the requirements of the S.O. afford all reasonable facilities for any other contractors employed by the Employer and their workmen and for the workmen of the Employer and of any other properly authorized authorities or statutory bodies who may be employed in the execution on or near the Site of any work not included in the Contractor or of any Contract which the Employer may enter in connection with or ancillary to the Works.

1.10 Temporary Access

The Contractor shall provide all temporary roads and gangways required for the execution of the Works. He shall provide at all times during the progress of the Works, proper means of access with ladders, gangways, boats, etc. and the necessary attendance for inspection of the Works by the S.O. or his representatives as directed.

1.11 Workmen's Accommodation

The Contractor shall be responsible for the proper housing at site of his labour force to the satisfaction of the relevant health authorities. Alternatively the Contractor may provide housing in hotels.

1.12 Water Supply

The Contractor shall provide water required in connection with the Works, including the supply and fixing of all fittings, maintenance of the supply, payment of all fees, removal of all fittings and making good all disturbances after completion of the Works

1.13 Electrical Power Supply

Should the Contractor require any electricity supply, he should make his own arrangement with the authority concerned, comply with all safety regulations and pay all fees in connection with the installation and supply.

1.14 Storage Facilities

The Contractor shall provide proper facilities for the storage and protection of soil, rock and water samples.

1.15 Removal Of Improper Plant, Etc.

The S.O. shall during the course of the Works have the power to order in writing from time to time :-

- (a) the removal from the site any plant not conforming to the requirements of the Specification, and the replacement of such plant at the Contractor's own cost.
- (b) the dismissal from the site any technician, supervisor, plant operator, or any workmen of the Contractor found incapable of work as specified, and replacement of such workmen at the Contractor's own cost. The Contractor's attention is drawn particularly to the technician's or supervisor's capability to identify and describe correctly soil and rock samples in the field, and to do survey work including taking reduced levels and setting-out.

1.16 Damage To Overhead And Underground Mains And Services

The Contractor's attention is specially drawn to his responsibilities under the Conditions of Contract. Particular care should be taken to avoid damages to electricity mains, water mains, telephone lines, sewage mains, gas mains and the like.

The Contractor is fully responsible to ascertain the positions of all mains or services in the vicinity of the boreholes and all other tests. He shall be fully responsible for any damage and for claims for consequential damages.

The S.O. shall be immediately informed if any of the original locations of the boreholes or other tests coincide with the positions of the mains or services. It will be the S.O.'s responsibility to change the locations of the locations of the affected boreholes or other tests.

1.17 Mobilisation and Demobilisation

The Contractor shall mobilise his staff, plant, equipment and everything else necessary in a manner that will meet the date of completion set in this contract and the time schedule of the programme.

The demobilisation shall be in proper manner and to the satisfaction of the S.O.

1.18 Scaffolding, Staging and Ponthoon On Water Body

Provide and maintain all necessary temporary scaffolding together with planks, battens, catwalks, gangways, ladder, etc. Provide special staging/depth construction, for the proper execution and compilation of the Works including the Works carried out by

Nominated Sub-Contractors and pays all costs and charges in connection therewith whether or not such scaffolding is required for the Main Contractor's own use.

If the Contractor should strike any of his additional scaffolding before ascertaining whether it is required by any Nominated Sub-Contractor he must re-erect it if so required at his own expense.

The Contractor must indemnify the Employer against any claim arising out of defective or improperly constructed scaffolding and staging.

1.19 Staging of the Works - Maintenance of Existing Facilities

The Contractor shall stage his works in such a way as to meet all the engineering requirements of his contract. In particulars, he has to take into account the following :-

- (a) Maintenance of Traffic Flows -Temporary Diversions.
- (b) Maintenance of existing facilities.

No public or private facilities shall be extinguished or interrupted without the written permission of the S.O. Such permission will not be given until suitable permanent or temporary alternatives, approved by the S.O. have been provided by the Contractor or, in the case of accommodation works, by the owner of the facility or his agents.

The Works shall be staged so as to achieve the minimum of interference with traffic using the existing roads or its cross roads and be constructed in such a way that all existing public and private Right-of-Ways are maintained. Except where specifically stated to the contrary in the Contract, no access or Right-of-Ways may be closed unless an alternative facility, either permanent or temporary has been provided. All temporary access arrangements shall be to the approval of the S.O. and of the local authority. All temporary diversions of traffic shall be subjected to the approval of the S.O.

The Contractor shall maintain all existing drainage flows. Where the Contractor proposes to construct temporary channels, culverts or out-falls, he shall submit full details to the S.O. No temporary drainage, channels, culverts or out-falls may be put into operation without the written permission of the S.O.

During the construction of the Works the Contractor shall provide directional signs at least to the standard already pertaining. All temporary works shall be provided with signs in accordance with the drawings. Permanent signs shall be erected in their permanent positions as soon as the whole or part of the sign becomes applicable. Any part of a permanent sign which is not applicable to the traffic movements at any time shall be covered over in a manner approved by the S.O.

Payment of works under this Clause shall be Lump Sum item to cover all times to temporary work and staging not covered elsewhere in the Contract and to include for all overheads, labour and equipment and for all liaison and compliance with the local authorities regulation, this Clause and Clause 1.16.

1.20 Clearance Of Site On Completion

As soon as the investigation work is completed, all test pits, boreholes, etc. shall be backfilled to the satisfaction of the S.O. On completion, the Contractor shall remove from site all plants, surplus materials, condemned equipment, temporary works and rubbish or any kind and leave the Site and Works clean and tidy to the satisfaction of the S.O.

1.21 Laboratory Testing Facilities

The Contractor shall carry out laboratory tests at his own testing laboratories. If the testing facilities of other laboratories are to be made use of the prior permission of the S.O. is required.

1.22 Progress Photographs

The Contractor shall submit three photographs for each boreholes location as record of progress of work. These photographs shall be coloured prints of 3R sizes measuring 125mm x 75mm. Each of these prints shall be incorporated in the special and ordinary copies of the Soil Investigations reports and they shall be suitably titled and dated.

1.23 Location At Site

The proposed site is as shown in the attached plan. Semi-Permanent and Temporary Homes may be located at the vicinity of the Site. Safety measures shall be taken on the public who are using the road and bridge within the Works area.

The Contractor shall take account in the planning of the execution of the Works on the accessibility of the site and shall include all expected cost to be incurred in the Quotation. No claim in respect of difficulty of access to site or the terrain of the site shall be entertained.

1.24 Restricted Area

The site may be within the restricted area. The Contractor is advised to obtain adequate information on the Working hours permitted and movement on and about the site.

Where required the Contractor will be required to arrange and obtain security passes for him and his workmen and pay all charges incurred therewith.

1.25 Method Of Measurement

Except where any description of the work in the Specification, Drawings or Bill of Quantities expressly shown the Contrary, measurement shall be made in accordance to the procedure set forth in the latest edition of the Standard Method of Measurement of Civil Engineering Quantities published by the Institution of Civil Engineers.

1.26 Submission of Reports

The Contractor shall submit a preliminary field log to the S.O. once the tests at a single testing location within the Site are completed. On completion of the total works, the Contractor shall submit one special copy and six other ordinary copies of the investigations report to the S.O. The procedure of submission shall follow that stated in the relevant clause of this Specification.

2.0 DEEP BORING

2.1 Boring Plants

The plants used shall be capable of boring/drilling to the maximum depth indicated in the Bill of Quantities/Drawings, etc. For work carried out under Schedule of Rates, the plants used shall be capable of boring/drilling up to a depth of 50m from existing ground level.

The plants used shall be suitable for advancing the bore, sampling, in-situ testing and rock drilling in accordance with the relevant specification of each of these operations.

2.2 Method of Advancing Boreholes

The method used shall be such that an accurate and continuous observation of the soils encountered is possible throughout the process. No mingling of soils from different levels shall be allowed to occur. When an undisturbed sample is to be taken, a reasonably clean hole shall be provided and the portion of soil to be samples is not unduly disturbed.

Recommended methods are wash boring, continuous augering, continuous sampling

and rotary drilling or a combination of these methods. Percussion boring shall not normally be permitted unless otherwise specified. When it is allowed such information will be clearly stated in the Bill of Quantities/Drawings etc.

2.3 Uncased And Cased Boreholes

Unless otherwise stated boring without casing may be permitted provided that there is collapse of the borehole. A collapse is considered to have occurred when, in the opinion of the S.O. there is a mingling of soil or rock from difference depths inside the borehole.

Casing shall be provided as soon as there are signs that the walls of the boreholes are collapsing.

2.4 Other Methods Of Stabilisation Of The Boreholes

Other methods of stabilization of the boreholes may be carried out subject to the prior approval of the S.O. on the procedure used. Nevertheless, casing shall be used when, in the opinion of the S.O., there is considerable doubt on the effectiveness of the method of stabilization proposed or practiced.

2.5 Heaving Of The Bottom Of The Boreholes

To prevent heave and disturbance of the soil at the bottom of the borehole, the level of drilling fluid in the hole must at all times be equal to or higher than the elevation of the ground water. This condition shall be strictly observed in formations of fine sand or silt, or in operations involving undisturbed sampling.

2.6 Size And Depth Of Boreholes

The size of the boreholes shall be such that the requirements of size in sampling, in-situ testing, etc. are satisfied.

In general, boring in soil shall be stopped when the standard penetration test values over a depth of 1.5m are equal to or greater than 50 blows/0.30m. The S.O. shall modify those general rule depending on the actual site conditions.

When rock is encountered, drilling shall be carried out to penetrate at least 3.0m into rock if the rock is limestone, or 1.5m if the rock is not limestone. Additional drilling shall be carried out if instructed by the S.O.

2.7 Rock Drilling

The procedure for rock drilling shall be in accordance with ASTM. D2113-70 (1976) "Diamond Core Drilling for Site Investigations".

The minimum diameter of cores acceptable shall be 30.2mm (AWX, AWM Core Barrels). However, when directed by the S.O. cores of 54.0mm diameter (NWX, NWM core barrels) shall be taken.

The Core Recovery Ratio (CRR) and the Rock Quality Designation (RQD) as described below shall be reported for each core run.

2.8 Core Recovery Ratio (CRR) And Rock Quality Designation (RQD)

Good quality core is defined as intact core having a fully circular circumference or in the case of broken rock fragments assembled to form cores with a fully circular circumference. The CRR shall mean the ratio of the total length of the good quality cores over the drilling, expressed to the nearest 5%. The RQD is the exceeding 100mm in length, over the drilling run correct to the nearest 5%.

2.9 Unnatural Obstruction And Abandoned Boring

Should unnatural obstructions to boring be encountered, the S.O. shall be informed immediately so that a decision may be made regarding the use of any special technique, including chiseling or diamond drilling or termination of the borehole. Boreholes terminated with the consent of the S.O. shall be measured.

Under no circumstances shall the Contractor abandon or terminate a borehole without the approval of the S.O. Boreholes so abandoned or terminated will not be measured.

However, should the Contractor be unable to complete any borehole due to encountering underground services or structures which cannot be reasonably foreseen after the Clause in the Preliminaries "Damage of Overhead and Underground Mains and Services" has been complied with the completed borehole may be allowed to be measured.

2.10 Backfilling Of Boreholes

Boreholes shall be backfilled with free flowing sand or silt as the borehole casing is withdrawn, in such a manner that collapse of the sides of the boreholes is precluded. The cost of backfilling shall be deemed to be included in the rates for boring.

2.11 Marking Of Borehole Position

Location of Boreholes shall be marked with 50 x 50 x 450 timber piece painted with suitable colour. The colour used shall be different from colours used by land surveyor for marking pegs.

3.0 SAMPLING IN BOREHOLES

3.1 Obtaining Disturbed Samples

Disturbed samples may be obtained by any means as long as the soil sample obtained is representative and unchanged in the constituent contents. Samplers with flap retainer or bucket retainer or other attachment may be necessary for cohesion less soils.

The minimum amount of soil sample required shall be that quantity sufficient for the soils to be tested in the various classification tests, such as moisture content, Atterberg limits and particle size distribution.

When sufficient quantity of soil is not obtained in the first instance, the sampling operation shall be repeated at no extra cost. It is the Contractor's responsibility to choose whatever appropriate samplers so that enough samples will be obtained in the least number of sampling operation. However, when the operation has been repeated for a total 3 times and a sampler with a retaining device has been used at least once, the operation need not be continued. The operation shall be measured.

3.2 Obtaining Undisturbed Samples With The Thin-Walled Tube

Undisturbed samples shall be taken with the thin-walled tube sampler described in ASTM. D 1587-74, "Thin-Walled Tube Sampling Of Soils". The minimum outside diameter of the tube used shall be 63.5mm (2½ inches) and the minimum length of the tube 610mm (24 inches).

In soft to stiff cohesive soils the thickness of the wall of the tube shall not be greater than 1.59mm (one sixteenth of an inch). The tube shall be pushed into the ground at a rate of 100 to 200mm per minute, without impact or twisting. Under no circumstances should driving of the sampler be permitted. For successful sampling without driving of the sampler, the boring plant used shall be weighted to exert hydraulically a force up to 25KN without uplifting the plant. Should be considered as an improper plant and be replaced under the Clause of the preliminaries "Removal of Improper Plant".

When sampling is required in cohesion less soils and very stiff to hard cohesive soils as directed by the S.O., light driving of the sampler may be allowed. Samplers for such purpose may have a wall thickness up to 3.18mm (one eighth of an inch). The weight of

the hammer, height of drop and the number of blows per 0.30m penetration of the tube shall be recorded.

Soft to stiff cohesive soils the last 0.30m of soil in a hole left overnight shall be removed before attempting to take the undisturbed sample.

3.3 Obtaining Undisturbed Samples With The Thin-Walled Stationery Piston Samplers

When instructed by the S.O. stationary piston samplers of an approved type shall be used to secure the undisturbed samples. The minimum outside diameter of the tube shall be 63.5mm and the minimum tube length 610mm. The maximum wall thickness shall be 1.59mm.

The tubes be pushed into the ground at a rate of 100 to 200mm per minute. Under no circumstances shall the sampler be advanced into soil by rotation, hammering, jarring or other dynamic method.

3.4 Obtaining Undisturbed Sample With The Triple Tube Core Barrel (Mazier Sampler)

In residual soils in which the SPT values "N" are greater than 15 rotary drilling shall be carried out using Mazier type triple tube retractable core barrels to obtain cored samples of diameter of nor less than 76mm diameter (H size). The detachable inner liner shall be used to transport and store the sample.

Drilling shall be carried out in such a manner and using such sizes of bits including any required modification to the drill bit such that the maximum amount of core is recovered. This requires close surveillance of drilling fluid, drilling pressures, lengths of runs and all other factors relevant to the nature of the material being drilled.

The core barrel shall be withdrawn and the core removed as often as may be necessary to secure the maximum possible amount of core.

Coring runs shall be limited to a maximum length of 1.5m. When less than 95% of the core is recovered from a run, the length of the following run shall be reduced by 50% unless otherwise directed by the Engineer. If less than 50% recovery is achieved, the following run shall not exceed 0.5m until full recovery is achieved from the consecutive runs.

The core barrel shall be provided with the full range of bit types to cope with the various ground conditions encountered at the site. Spares for each bit type shall be available for use on site without causing any delay to drilling operations. An adequate

supply of short, medium and long plain retractor shoes shall be available for use with maxier type triple tube retractable core barrels.

Triple tube core barrels shall be equipped with built-in ball check pistons to ensure that the core is not subjected to water flushing when extracting the inner barrel containing the core. Casing shall be used to prevent collapse of the sides of the hole. The size of casing and drill rods shall be appropriate for the appropriate size of core barrel in use.

3.5 Preservation Of Disturbed Samples

Disturbed samples shall be preserved, immediately after being recovers in a wide-mouth, air-tight, screw-top, clear glass jar sealed with a non-shrinking microcrystalling wax. Alternatively, samples may be placed in bags made of heavy-gauge polyethylene sheeting of an approved thickness. Each sample shall be placed in 2 layers of such sheeting, each layer sealed to form an air-tight bag.

3.6 Preservation Of Undisturbed Samples

About 40m of soil shall be removed from the top and bottom of the sample tube and preserved as a disturbed sample. The ends of the sample tube shall then be filled with a non-shrinking microcrystalling wax in suitable layers to a thickness of about 40mm. The voids at the ends shall then be completely filled with moist sand or other suitable fillers. Sealing of the tube is completed by capping the tube with suitable tight-fittings caps and the caps sealed with wax.

3.7 Labeling Of Soil Samples

For disturbed samples, a label clearly and indelibly marked with the name of the project, borehole number, depth or sampling, date taken and type of sample (e.g. split-barrel tube samples) shall be placed inside the jar or polyethylene bag. The outside of the jar or bag shall also be marked with the sample number, borehole number and project number with the same legend used in the borelog. A suggested format is DX (UX/y/z where x is the sample number, y the borehole number, z the project number, D for disturbed samples and U for undisturbed samples.

For undisturbed samples, additional information required in the label includes the recovery ratio and the maximum hydraulic force/dynamic force used to secure the sample. The label shall be placed just below the cap at the top of the sample. The marking on the outside of the tube shall be similar to that for the disturbed samples. In addition, the top and bottom of the sample shall be indicated.

3.8 Storage And Transportation Of Soil Samples

All soil samples shall be stored orderly at site in protective boxes in a dry place and under cover until they are dispatched to the designated laboratories. The undisturbed samples shall be placed in wooden boxes, preferably with partitions, and packed with saw-dust, paper, etc. to prevent damage during transit. Under no circumstances should the undisturbed samples be transported without proper packing.

3.9 Preservation, Storage And Transportation Of Rock Cores.

The procedure of preservation and storage of rock cores shall be in accordance with ASTM. D 2113-70 (1976) "Diamond Core Drilling for Site Investigation". The JKR standard core box as shown in Figure 1 shall be used. The name of the project and boreholes number of numbers shall be printed on the cover. The labelling inside the box shall follow that recommended in the above ASTM standard. Each box shall contain cores from the same project.

4.0 FIELD TESTING

4.1 Standard Penetration Test (SPT)

SPT shall be carried out in accordance with Test No. 19 BS 1377:1975, "Determination of the penetration resistance using the split-barrel sampler". Using a self-tripping hammer of an approved design. In general it shall be carried out in all types of soil except the very soft and soft clays. It shall be carried out at 2.0m intervals.

The value of N as defined in the B.S. standard method shall be reported together with the number of blow counts for each 75mm penetration of the sampling tube in bracket. The blow counts for the first 150mm penetration (the seating drive) which do not contribute to the value of N shall be included in the bracket. Two examples are N=42 (2,3,6,7,10, 19) and N = 50/100mm (28, 30, 35, 15/25mm).

When a penetration resistance of 60 blows for 25mm penetration is encountered in the seating drive the test shall be stopped and the standard penetration test value reported as N = 50/25mm.

The soil samples recovered from the split-barrel tube shall be preserved as a disturbed sample for subsequent testing.

4.2 Dynamic Cone Penetration Test (CPT)

The dynamic cone shall consist of a 60mm solid steel cone 51mm in base diameter fitted to a steel shaft of the same diameter not less than 600mm long. The driving mechanism shall be the same as for the standard penetration test. CPT shall generally be used in place of the SPT to test the relative hardness of weathered rocks or boulders, as and when directed by the S.O.

The blow counts for each 75mm of penetration shall be reported. The test may be stopped when the total penetration is 450mm or a resistance or 150 blows in less than 75mm penetration is encountered whichever is reached earlier. The test shall be reported as CPT =(85, 102, 138, 150/65mm).

4.3 Field Vane Test

Vane tests shall be carried out in accordance with Test No. 18 B.S. 1377:1975 "Determination of shear strength in the field by the vane test". In general it shall be carried out in very soft to stiff non-fissured cohesive soils, and at 1.5m interval. Each operation shall include the determination of both the undisturbed and remoulded strength.

The minimum diameter of the field vane shall be 63.5mm.

The full operation of the field vane test shall include the taking of a representative disturbed sample after the completion of the shearing operation with a split-barrel sampler or otherwise.

The gauges for the measurement of strength shall be calibrated regularly, at least once a year. Calibration certificates from an acceptable standards agency shall be given to the S.O. in the particular gauge is used for the S.O.'s inspection. Any gauge calibrated more than 1 year earlier shall not be allowed to be used.

4.4 Deep Sounding Test

Deep sounding test shall mean the "Dutch Cone Test" using a mechanical friction-cone penetrometer described in ASTM D 3441-75 T "Deep, quasistatic, Cone and Friction-Cone penetration Tests of soil". The plant used shall be of an approved type with a vertical thrust capacity of 100KN on the cone cross-sectional area of 10 square cm.

In general measurement of cone resistance, friction resistance and total friction shall be taken at 0.25m interval up to a depth of 5m and at 0.50m interval for depths greater than 5m. Total frictional which is not defined in the ASTM standard shall mean the total frictional resistance developed along the full length of the sounding rod up to that depth.

Sounding can be considered to be completed when the total resistance exerted on the rods exceeds 90KN or that the cone resistance exceeds 20 MN/m unless instructed otherwise.

When instructed by the S.O. sounding shall be continued when the total resistance exerted on the rod exceeds 90 KN with the use of a friction reducer. In such a case only the cone resistance needs to be measured and the operation shall be stopped when the cone resistance reaches 30 MN/m.

Cones with electrical recording mechanism shall only be used with the prior approval of the S.O. Contractors shall seek the approval before the mobilisation of the plant to the site. Contractors who are able to supply only the electrical cones must submit the information in their tenders.

The units to be reported are KN for the total friction, KN/m for the friction resistance and KN/m for the cone resistance, all to 3 significant figures.

4.5 Mackintosh Probes

The apparatus used shall be the standard 'Mackintosh' probes.

Probing shall be stopped when the resistance has reached 400 blows/0.30m penetration or the depth has reached 15 metres, whichever is reached earlier, unless directed otherwise by the S.O.

All Mackintosh Probes location shall be marked with timber pegs 50mm x 50mm size, 450mm long and painted with suitable colour.

4.6 Hand Auger Holes

Hand auger holes should be carried out with an auger of approved design to ASTM D 1452-65 (1972) "Soil Investigation and sampling by auger boring". The auger stem shall be of a design that thin-walled tuber sampler can be fitted at the auger end and undisturbed samples may be taken. The minimum diameter of the holes shall be 100mm.

No casing needs to be provided for hand auger holes. It shall be stopped when the sides of the hole start to collapsed or when the resistance to augering is so great that the auger cannot be advanced with the force of 2 healthy workers. It is not expected to auger more than 7.50 meters.

Disturbed samples recovered from the auger shall be collected at 1.50 metres interval or when there is a change of the material encountered.

Undisturbed samples may be required in very soft to stiff cohesive soils, taken with a thin-walled sampler of minimum outside diameter of 76.2mm and a nominal tube length of 610mm. The maximum wall thickness shall be 3.18mm. The sampler shall be pushed into the soil with the body weight of the operators or with the use of hydraulic forces. Light dynamic tapping of the tube may be allowed with the prior approval of the S.O. Any use of dynamic force shall be reported.

All Hand Auger locations shall be marked with timber begs 50 x 50 x 450 and painted with suitable colour.

4.7 Groundwater Level Observation

The observation of groundwater level in all types of boreholes shall be made with a tape, rod diameter or rule that permits measurements with 50mm accuracy. In a cased borehole, before the day work is completed the casing shall be rolled up by about 0.30m and left in such a position overnight. The groundwater level shall be recorded early the next morning. The recording shall be repeated daily while boring for that particular boreholes is in progress. In boreholes involving impervious stratum, or whenever directed by the S.O. the casing shall be capped overnight by the Contractor to prevent the entry of rainwater and surface water.

In hand auger holes the groundwater level shall be recorded early in the morning on the next day after the auger hole is completed. For the purpose of such groundwater level observation holes shall be suitably covered and protected from the entry of rainwater and surface water once they are completed.

If the sides of the holes has collapsed over the night, the "apparent" depth of the hole shall also be recorded. At least one observation of the groundwater level and the "apparent" depth of auger holes, if applicable, is necessary for all hand auger holes.

In hand auger holes, the depth where water first appears in the holes during the augering operation shall also be recorded.

4.8 Collection Of Bulk Samples

Bulk samples collected shall be representative and free of roots and other organic matter. A test pit up to 1m x 1m x 1.50m deep shall be excavated to expose the soil strata. Representative soil samples within the depth of 0.50m to 1.5m shall be collected. Under no circumstances shall the top soil within 0.5m depth be collected.

The excavation for the test pits for the sub-soil investigation will be made in natural ground and where the existing road is retained, on the side table.

~~Where required excavations may be made on the existing pavement and undisturbed~~

sample shall be taken at subgrade level in these pits. This sample shall be used to obtain the in-situ soaked CBR test. At the same time the dry density of the soil should be calculated. A sample shall be collected for moisture content test.

Where undisturbed samples are collected for CBR test, both ends of the molds should be protected with paraffin or wooden discs or similar to prevent moisture loss while transporting to the laboratory. The samples shall be packed, marked and stored as described in Clause 2.2a of these Specifications.

The extracted samples shall weight not less than 21 lbs. for fine-grained soils, 10 lbs for medium samples and 50 lbs for coarse-grained soil for classification tests, and 150kgs for compaction and strength testing.

In association with bulk sampling, or as and when directed by the S.O. two separate samples for natural moisture content determination shall be collected, preserved and stored as disturbed samples in accordance with Clause 3.4 of this Specification.

In cuts and at material sources supplementary auger boring shall be carried out from the natural ground level to a depth given by the S.O.

4.9 Collection Of Groundwater Sample

Groundwater samples collected shall be representative of the groundwater found in the borehole. It shall be taken as soon as practicable after groundwater is first encountered. About 1 litre shall be collected by bailing with a clean container or otherwise, and stored in a clean water-tight glass or plastic container. Metal container shall not be used. The name of the project, borehole number and the date of sampling shall be indicated on the outside of the container.

4.10 Boreholes For Installation Of Monitoring Instruments

The Contractors shall form :-

- i) Boreholes using HW casings for installing inclinometers access tubes;
- ii) Boreholes using NW casings for installing standpipe piezometers and pneumatic piezometers;
- iii) Hand Auger holes for installing deep settlement gauges;

to depths determined by the S.O.

All the above shall be supplied and installed by others within the boreholes and hand auger holes formed by the Contractor.

The Contractor shall provide all necessary cooperation, assistance and attendance including necessary pumps, water supply, power, etc., to others involved in the installation of the instruments. The Contractor's rates shall be deemed to include for the above and any delays to his works and waiting time as a result of the installation of the instruments.

In the case of pneumatic and standpipe piezometers, subsequent to forming the bentonite seal by others, the Contractor shall grout the borehole using cement/bentonite grout with a mix proportion of 1 part bentonite to 2 parts cement.

In the case of the inclinometer access tube, subsequent to the positioning of the inclinometer access tube by others, the Contractor shall grout the borehole using cement/bentonite grout with a mix proportion of 1 part bentonite to 2 parts cement.

4.10.1 Stand Pipe Piezometers

The stand pipe piezometer shall consist of the Casagrande type ceramic piezometer tip of the low air entry variety protected by P.V.C. end caps and connected to P.V.C. riser pipes extending to approximately 0.5m above ground level and screw-capped. The top end of the P.V.C. riser pipe shall have a screw connection to enable extension of the pipe to above ground level, as shown in Fig. 1.

The length and outer diameter of the ceramic piezometer tip shall be a minimum of 210mm and 50mm respectively. The minimum internal diameter of riser pipes shall be 14mm. All connections between the piezometer and riser pipes shall be by the use of P.V.C connectors designed to ensure perfect sealing against leakage.

Before installation the borehole shall be grouted to the required level using clean sand filter all the way up to the concrete sealer from the sand plug as in the Fig. 1. The consistency of the clean sand filter shall be approved by the S.O.

Prior to installation the ceramic piezometer tip shall be soaked in water for at least 24 hours and brushed clean to free the ceramic surface of any air bubbles. Subsequently the piezometer shall not be exposed to air.

4.10.2 Pressuremeter Tests

Unless otherwise specified pressuremeter tests shall be performed within boreholes which have been made specifically for the purpose of carrying out pressuremeter tests.

The boreholes shall be formed by rotary drilling with injection of bentonite slurry. The volume and injection pressure of the bentonite slurry shall be such magnitudes as to avoid piping and erosion of the boreholes.

The pressuremeter test at any one depth shall be performed within one hour of the

hole being made at that particular depth. The time lag between completion of the hole and the pressuremeter test at all depths throughout the entire depth of the borehole shall be the same.

The equipment used for pressuremeter test shall be of the type approved by the S.O. In general the Menard Pressuremeters Types Ga and Gc or similar will be acceptable.

Each pressuremeter test shall generally be carried out with a minimum of ten (1) equal loading increments up to the point of failure. At least two unload/reload cycles are to be incorporated as part of the loading program. Readings of deformations with respect to time for each pressure increment shall be taken at 15 second and 1 minute after the application of the pressure increment. Subject to the approval of the Engineer the above procedure may be varied.

Interpretation of the results shall be carried out by the Contractor to provide information on soil Type, Pressuremeter Modulus and Limit Pressure.

4.11 Field Permeability Tests

Permeability tests performed within boreholes shall be carried out as required by the S.O. The method shall be the "Open Test" and "Packer Test" as described in Designation E-18, 4 and 5 Earth Manual, U.S.B.R 1974 or equivalent. The number and location of the tests shall be determined by the S.O. A provisional quantity is shown in the Bill of Quantities.

5.0 LABORATORY TESTING OF SAMPLES

5.1 Tests

The continuous, disturbed and undisturbed samples taken from the site investigation and prepared as described in Clause 3.3, 3.4 of this Specification shall be delivered to a laboratory which is approved by the S.O. for Laboratory Tests as stated in Clause 3.7 of this Specification.

The following tests shall be carried out when required by the Contract. The test method to be followed are shown within brackets against each test :-

5.2 On Disturbed and Undisturbed Samples (including Continuous Samples)

1. Visual and manual examination (ASTM D2488 - 69 : 1975)
2. Natural or in-situ moisture content (Test 1(a)- B.S.1377:1975)

3. Liquid Limit (Test 2(B) - B.S.1377:1975).
4. Plastic Limit (Test 3 - B.S.1377:1975)
5. Determination of Plasticity Index (Test 4-B.S.1377:1975)
6. Linear Shrinkage (Test 5-B.S. 1377:1975)
7. Specific Gravity (Test 6-B.S.1377:1975)
8. Particle Size Distribution:-
 - (a) Wet Sieving (Test 7(A) - B.S. 1377:1975)
 - (b) Pipette Method (Test 7(C) - 1377:1975)
9. When specified, other tests specified in B.S. 1377:1975

5.3 On Undisturbed Samples

1. Unconfined Compressive Strength (Test 20 - B.S. 1377:1975).
2. Undrained Triaxial Compression (Test 21 - B.S. 1377:1975)
3. One-Dimensional Consolidation (Test 17-B.S.1377:1975)
4. Isotropically Consolidated Undrained Triaxial Compression Test with pore water pressure measurements (Bishop and Henkel, 1969, "The Measurement of Soil Properties in the Triaxial Test", Edward Arnold (Publishers) Ltd., 2nd. Edition, pp 106-121).
5. Isotropically Consolidated Drained Triaxial Compression Test with volume change measurements (Bishop and Henkel, 1969, "The Measurement of Soil Properties in the Triaxial Test", Edward Arnold Properties in the Triaxial Test", Edward Arnold (Publishers) Ltd., 2nd. Edition, pp 122-131.

5.4 Other Tests

1. Compaction Test (Test 12 or 13 or 14 - B.S. 1377:1975).

2. California Bearing Ration (Test 16-B.S.1377:1975).
3. Permeability Test for granular soils (ASTM D2434-68:1974).
4. Determination of the organic matter content (Test 8 - B.S. 1377:1975)
5. Determination of the total sulphate content of soil (Test 9-B.S. 1377:1975).
6. Determination of PH value (Test 11-B.S. 1377:1975).
7. Test for Carbonate Soils and Rocks using dilute hydrochloric acid of Normality of 0.1N.
8. Los Angeles Abrasion Test (ASTM C131-81 AASHO T96-1982)
9. CBR Test (AASHO C88 - 76)
10. Soundness Test Using Sodium Sulphate (ASTM C88-76 AASHO-77-1982).
11. Specific Gravity and Water Absorption (B.S. 812 Part 2:1975 Method 5).
12. 10% Fines Test (B.S. 812 Part 3 : 1975 Method 8).
13. Aggregate Impact Test (B.S. 812 Part 3 : 1975 Method 6).
14. Aggregate Crushing Value (B.S. 812 Part 3 : 1975 Method 7).
15. Sieve Analysis (B.S. Part 1 : 1975 Method 7.1)
16. Flakiness Index (B.S. 812 Part 1:1975 Method 7.3).

5.5 Cyclic Wetting and Drying Test Aggregate As Described Herein

Procedure for Cyclic Wetting and Drying Tests of Aggregates

1. Aggregate Samples

The aggregates shall be greater than 2mm and smaller than 50mm with the normal size of 25mm.

2. Mould Size

The mould should be metal 150mm width and 75mm deep.

3. Wetting and Drying Cycles

One cycle will consist a wetting and drying process over 24 hours as follows :-

Wetting

0900 hours to 1700 hours (8 hours) - immerse aggregate in water in the mould.

Drying

1700 hours to 0900 hours (16 hours) - decant water and stir with metal rod 25 times in a circular motion. Then, place in oven at 150°C. At the end of the drying cycle, the aggregate shall be cooled to air temperature before immersing in water for the wetting cycle.

4. Number of Cycle

Repeat for 12 cycles.

5. Sieving Test

The aggregate samples shall be sieved and the grading determined before the 12 wetting and drying cycles and the grading compared.

5.6 Laboratory Report

One translucent copy in reproducible form and six reproduced copies of the Laboratory Test Report with form design previously approved by the S.O. shall be prepared for submission in accordance with Clause 6.2 of this Specification.

One copy of all recordings and computation of Laboratory Tests shall be submitted to the S.O. before the finished Laboratory Test Report is prepared.

6.0 REPORTING OF RESULT

6.1 Submission of Preliminary Field Log

The preliminary field log shall contain information listed below, wherever applicable :
type make and model of deep sounding/boring machine, type and size of casing and rods, details of cones and rods in deep sounding, names or supervisor and operator,

dates and times of work, depth of casing, results of in-situ testing or sampling, recovering ratios, visual-manual description of soil or rock, groundwater level observation, reduced level and other remarks. Laboratory testing results are not required to be entered in the field log later. Space for laboratory testing result is thus not required in the field log.

A copy of the preliminary field log and the site plan/location plan where the position of investigation is indicated shall be formally submitted to the S.O. at the latter's office by the Contractor as soon as the field work is completed.

The instruction of laboratory testing, whenever applicable, shall be issued by the S.O. only after receipt of such preliminary field log. It is thus the responsibility of the Contractor to submit the log early, especially in Contract Works. As a guide to contractors in their estimates of the time of completion, it may be assumed that the first instruction on laboratory testing shall be issued within one week after receiving the preliminary field logs of half of the total number of boreholes of the project. Subsequent instructions on laboratory testing shall be promptly issued when preliminary field logs of additional boreholes are received and the last instruction shall be issued within one week after receiving the preliminary field log of the last borehole.

The preliminary field log is required of all types of investigation whether deep boring, hand augering, deep sounding or probes.

6.2 Submission Of Final Reports

The final report shall consist of a special copy and 6 other ordinary copies. Prints of all drawings as described in Clause 6.3 and 6.4 of this Specification shall be included in all the 7 copies. The original tracing of the drawing shall be submitted to the S.O. and shall remain the property of the S.O.

The final report shall be in A4 size with suitable cover and spiral ring binding. Stapled binding is not acceptable. The title on the cover shall be in stencil lettering, of 5mm nominal size and in capital letters. The title shall contain information on the scope and type of investigation, name of project, year and month of investigation and name of Contractor. An example is "12 NUMBERS OF DEEP SOUNDING AND 2 NUMBERS OF HAND AUGERING, HIGH COURT BUILDING, TEHRAN, IRAN, APRIL 2007: CONSORTIUM SITE INVESTIGATION PRIVATE LTD." suitably spaced. The word "SPECIAL COPY" shall be written on the top right hand corner on the cover of the special copy.

The Contractor shall submit a Draft of his investigation report including the drawing to the S.O. for his approval. It may be expected that the S.O. shall give the Comment within a week after receiving the draft.

If only minor corrections are necessary, the Contractor shall be allowed to take back

the draft report, correct it and immediately reproduce the required 7 copies. If the corrections required are major and numerous the Contractor shall be required to re-submit the amended draft for approval.

For Contract Works, the date of completion shall be taken as the date the final reports are accepted by the S.O.

6.3 Presentation Of The Final Report

The final Engineering Report submitted should include the factual presentation of the results and the conceptual engineering interpretations made of the field and laboratory test result.

The following format is recommended :-

6.3.1 GENERAL

6.3.1.1 Introduction

This should include the object of the subsurface soil investigations.

6.3.1.2 Site Conditions

A general appraisal on the geology of the area should be presented.

6.3.1.3 Scope of Works

A detailed list of Works carried out comprising all subsurface site investigations should be enlisted.

6.3.2 SITE INVESTIGATIONS

6.3.2.1 General

A site plan indicating the exact positions of the boreholes and/or hand augers should be presented. A table showing the coordinates of these boreholes and/or hand augers should also be submitted.

6.3.2.2 Field Investigations

A summary on the machinery and methods employed in the field exploration should be presented.

6.3.3 LABORATORY TESTING

6.3.3.1 Type Of Test

A summary of the types of laboratory tests conducted as specified by the Employer should be presented.

6.3.4 SUB-SOIL CONDITIONS

6.3.4.1 General

This should include a summary on the soil properties and soil profiles.

6.3.4.2 Interpolated Soil Profiles

This interpolated soil profiles shall be simplified and the following parameters are to be included.

- (a) The Standard Penetration Blow Counts of the soft and hard strata.
- (b) Filed Vane Shear Results of the clay layer.
- (c) Physical identification of the subsoil based on the Unified Classification System.

The interpolated soil profile shall be presented on standard A2 paper.

6.3.5 THE CONCEPTUAL ENGINEERING INTERPRETATIONS BASED ON THE FIELD AND LABORATORY TEST RESULTS.

Emphasis should be based on the Engineering Properties of the Sub-Soil Conditions as obtained from the field and laboratory result. Recommendations should be made as to any likely problems to be encountered in the design and construction process.

6.3.6 SUMMARY

This should summarize the main points of the Engineering Reports.

6.3.7 **ILLUSTRATIONS**

- Appendix A - Summary of Geotechnical Investigation Data. This Should be presented as on the recommended Data Presentation sheet as attached on page.
- Appendix B - Borelogs
- Appendix C - Laboratory Test Results
- Appendix D - Photographs of Rock Coring Samples and Undisturbed Soil Samples.

6.4 **Details In The Drawings**

Summarised test result and the location of testing shall be presented in the drawing. The site plan/location plan shall be traced from the plan supplied by the S.O. with suitable extraction of relevant data. The drawing number of the original drawing used for the tracing shall be noted. The site plan/location plan shall be provided for all types of investigation with the location of testing indicated. The temporary bench mark used for the reduced levels shall be marked and described in the site plan/location plan. Reference points used in the setting out of the locations of investigations shall also be indicated.

For deep boring or hand augering, the final borelog shall be presented in the drawing, with a suitable as SPT, vane shear, atterberg limits, natural moisture content, soil classification grouping, sieving results in terms of gravel/sand/silt/clay content, cohesion/friction angle and groundwater level. The preferred order of plotting is depth (including groundwater level), legend, soil description, soil group classified according to ASTM D 3282-73 (1978) or ASTM D 2487-69 (1975), field test result and laboratory tests result. The recommended scale for depths is 1:100 for deep boring.

For deep sounding, the cone resistance, friction resistance and total friction shall be plotted against depth on the same drawing. The size of the cones, rods, tubes and friction jacket shall be given on the drawing. The recommended scale for depth is 1:100.

The Mackintosh probe results need not be plotted in the Drawings.

6.5 Standard Tracing/Drawing Size

The original tracing shall be in standard A1 size, of an approval gauge and with a title block of proper dimension at the lower right hand corner. The arrangement of the title block shall follow that given in the sketch.

The use of suitable translucent graph paper to facilitate drawing work may be permitted. However, such paper must be of suitable gauge approved by the S.O. The use of small sheets of translucent graph paper pasted onto ordinary tracing paper shall not be allowed.

Stencil lettering shall be used for the title block, sub-titles of any part of the drawing, site plan/location plan and the key words in a table of results. Freehand lettering may be used in other parts of the drawing, if it is legibly and expertly written. However, the S.O. may insist that all drawings be carried out with stencil lettering.

The Contractor shall ensure that details in the A1 size tracing are still legible in A2 size drawing. These drawings shall be properly folded, trimmed of unwanted margins if necessary, and bound in the final reports in such a manner that the whole sheet can be flatly laid out in the bound condition. Alternatively, the drawings shall be properly folded and placed in paper or plastic envelopes bound in the final reports. Each envelop may contain up to a maximum of 3 drawings.

6.6 Details Required In The Ordinary Copy

For deep boring, the final field log to be included in the ordinary reports shall contain all information listed for the preliminary field log in Clause 6.1. However, the soil description presented in the preliminary field log shall be revised according to the laboratory test result and the amended description presented in the final field log.

Appropriate items from the list for deep boring shall be included in the borelog for hand augering.

For deep sounding the log sheet shall contain tabulated field gauge readings and results of cone resistance, friction resistance and total friction, together with the reduced levels.

For Mackintosh probes, the resistance in blows/0.30m penetration shall be reported. Details of laboratory test results required to be included in the report are given below :-

- (a) Moisture Content : value only
- (b) Atterberg limits : value only
- (c) Linear shrinkage : value only

- (d) Specific gravity : average value only
- (e) Particle size distribution: semi-logarithmic chart of the type shown in Fig. 10, B.S. 1377:1975. A maximum of 3 curves (3 samples) of the same boreholes are allowed on a single chart.
- (f) Compaction test (single moisture content) : compaction energy, dry density and moisture content.
- (g) Detailed compaction test (5 or more moisture contents) : plot of dry density against moisture content, maximum dry density, optimum moisture content, classification result, and items in (f).
- (h) CBR test (single moisture content) : CBR (soaked or/hand unsoaked), moisture contents for the top and bottom of the sample, and items in (f).
- (i) CBR test (5 or more moisture contents) : plot of CBR (soaked or/and unsoaked) against moisture content, and items in (g)
- (j) Unconfined compression test: unconfined compressive strength, strain at failure, moisture content and bulk density.
- (k) Unconsolidated undrained triaxial compression test without porewater pressure measurement (3 or more specimen) : plot of Mohr circles and the failure envelope, cohesion, angle of shearing resistance, and items in (k)
- (l) Unconsolidated undrained triaxial compression test without porewater pressure measurement (single specimen) : bulk density, moisture contents.
- (m) Consolidated triaxial compression test of various types : items in (1) and others as directed by the S.O.
- (n) One dimensional consolidated test : specific gravity, initial and final bulk densities and moisture contents, plot of void ratio against the logarithm of applied pressure, table of coefficient of consolidation, initial compression ratios, primary compression ratios and secondary compression ratios against pressure increment, and also table of coefficient of volume compressibility against pressure increment.
- (o) Organic matter content : value only
- (p) Total sulphate content : value only
- (q) Sulphate content of groundwater : value only
- (r) PH-value : value only

- (s) Constant head permeability test : completed test data sheet in Fig. 3 ASTM D 2434 - 68 (1974) and plots of velocity against hydraulic gradient.

~~~~~  
**END OF SPECIFICATION ON SITE INVESTIGATIONS WORKS**  
~~~~~

Image of JICA's Cooperation on Industrial Estate Development

2007 July

Economic Development Department
Japan International Cooperation Agency

Master Plan



Feasibility Study

Without clear MFEZ development strategy,
no F/S could be conducted!

Why is M/P needed?

M/P is necessary in order to

- **Analyze Zambia's economy and her comparative advantage from regional perspectives**
- **Clarify industrial development strategy in Zambia**
- **Justify concept of MFEZ from Zambia's economic and social development perspectives**

Why is M/P needed?

M/P is necessary in order to

- **Clarify the needs of investors toward Zambia**
- **Customize MFEZ to Zambian circumstances**
- **Conduct F/S efficiently and effectively**

What does M/P contain?

M/P contains basic data collection and analysis such as....

- **Macro Economy analysis**
- **National Strategy of Trade, Industry etc.**
- **Current Industrialization, Infrastructure**
- **Investment Demand Survey**
- **MFEZ Development Plan Formulation**
- **Environment Protection and Management**
- **Human Resource Requirement**

What does M/P recommend?

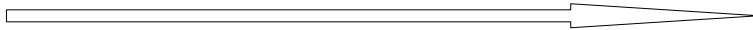
- Justification of MFEZ's concept
- Comparative advantage of Zambia
- Conceptual plan of MFEZ
 - Suitable industries
 - Size
 - Industrial development strategy
 - Development schedule

How can KTPC and JICA collaborate?

ASAP

F/S by KTPC

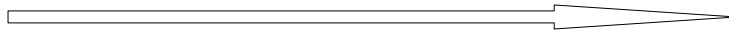
M/P Study by JICA



How can KTPC and JICA collaborate?

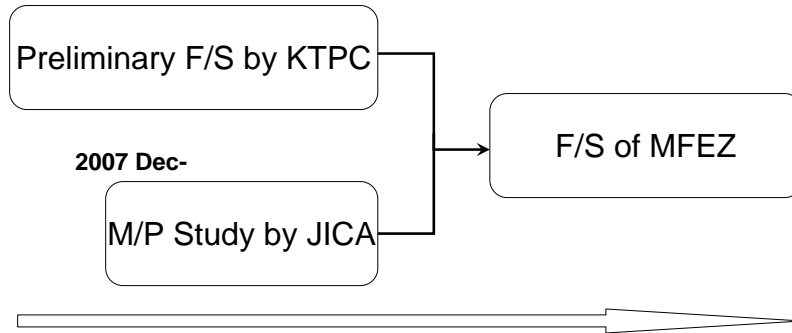
2007 Dec-

M/P → F/S by JICA
(KTPC staff will take part in JICA's Study team)

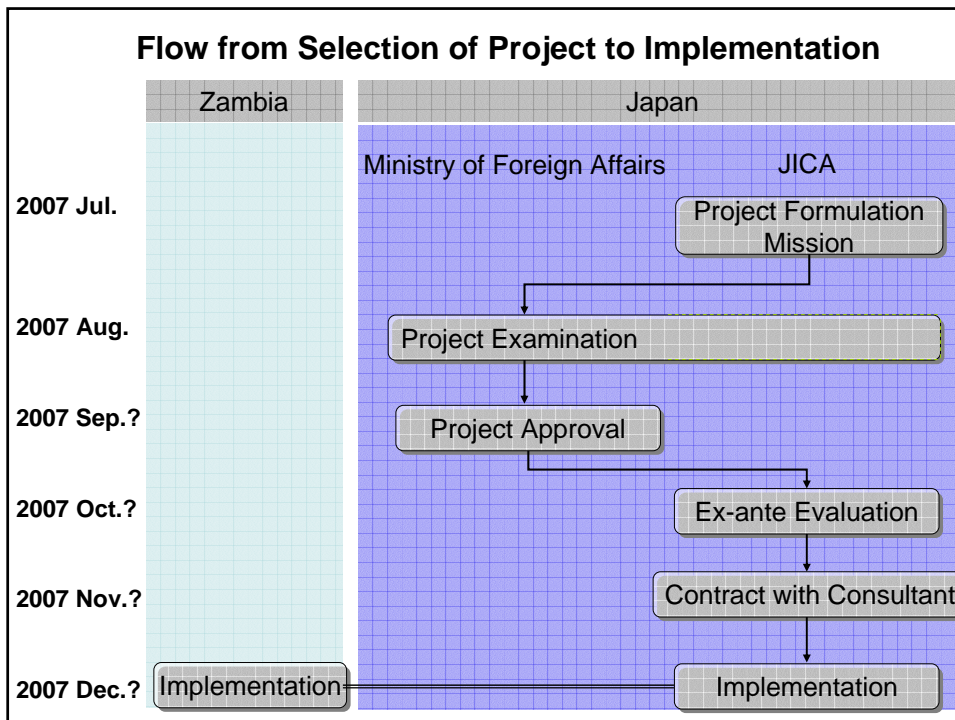


How can KTPC and JICA collaborate?

ASAP



Flow from Selection of Project to Implementation



Work assignment between JICA and Kulim (darft)

Items proposed by KTPC	Items proposed by JICA	JICA	Kulim
Regional and Macroeconomic Framework			
Regional Analysis			
Global and regional perspectives		<input type="radio"/>	
National perspectives		<input type="radio"/>	
Government policies and national plans	National development	<input type="radio"/>	
	Industrial development	<input type="radio"/>	
	Export promotion	<input type="radio"/>	
	Investment promotion	<input type="radio"/>	
	Human resource development	<input type="radio"/>	
	R/D development	<input type="radio"/>	
Macroeconomic Perspective		<input type="radio"/>	
Economic trends and GDP performance		<input type="radio"/>	
Import and Export trade		<input type="radio"/>	
Resource availability		<input type="radio"/>	
Industrial Clustering	Current industrial situation should be further investigated in order to formulate industrial development plan	<input type="radio"/>	
Identifying key strategic industrial clusters based on regional analysis and macroeconomic perspectives		<input type="radio"/>	
Cluster analysis		<input type="radio"/>	
	Industrial subsectors	<input type="radio"/>	
	Industrial products	<input type="radio"/>	
	Existing industrial estates	<input type="radio"/>	
	Population and labour force	<input type="radio"/>	
	Industrial finance	<input type="radio"/>	
	FDI trends	<input type="radio"/>	
Investment demand survey		<input type="radio"/>	
	Potential investors to Zambia	<input type="radio"/>	
	Potential investors to MFEZ	<input type="radio"/>	
	Investors' perception toward MFEZ	<input type="radio"/>	
	Demand projection	<input type="radio"/>	
Conceptual design of MFEZ		<input type="radio"/>	<input type="radio"/>
	Potential industries	<input type="radio"/>	
	Development scale	<input type="radio"/>	
	Land utilization		<input type="radio"/>
	Transportation		<input type="radio"/>
	Land reclamation		<input type="radio"/>
	Infrastructure		<input type="radio"/>
	Operation and management system		<input type="radio"/>
	Construction schedule		<input type="radio"/>
	Cost estimation		<input type="radio"/>

Work assignment between JICA and Kulim (draft)

Items proposed by KTPC	Items proposed by JICA	JICA	Kulim
Physical and Infrastructure Analysis			○
Project Components and Land Use			○
Determine the various land use components of MFEZ			○
Prepare the MFEZ land budget			○
Prepare subdivision layout plan depicting the land use parcellations circulation and open space network			○
Prioritization of project components and land use			○
Site Planning and Design			○
Determine site potential and constraints			○
Formulate overall planning concept of the MFEZ			○
Determine the location and distribution of the key functional zone			○
Phasing plan			○
	Topography and land utilities		○
	Urban amenities		○
Infrastructure and Utilities			○
Road and traffic management			○
Power supply, water and telecommunication systems analysis and			○
Drainage, sewerage and solid and hazardous waste management			○
Formulate and prepare concept plans as appropriate			○
Transportation			○
Interregional transportation network, linkages and movement pattern			○
Inter and intra-regional travel supply and demand			○
Analysis of freight transport, and movement for interregional travel			○
Movement, circulation, parking and storage within MFEZ			○
Landscape			○
Formulation of overall landscape concept for MFEZ			○
Schematic MFEZ design of selected spaces and enclosures			○
Recommendation on landscape zones			○
Landscape policy and guidelines			○
Architectural Design			○
Formulation of various schematic building designs for MFEZ			○
Building types and accommodation schedules			○
Building form and design			○
Architectural building guidelines			○
Environment		Environment and Social Impact Assessment	○
Study on te existing environment within and around MFEZ			○
Identification of environmental changes and the impacts to the environment			○
Determine mitigation measures			○
Recommend environmental guidelines to be adopted for the development of MFEZ			○
	Land Acquisition		○
	Employment related issues		○
	Water rights		○
	Access roads		○
	Traffic conditions		○
	Waste management		○

Work assignment between JICA and Kulim (draft)

Items proposed by KTPC	Items proposed by JICA	JICA	Kulim
Market and Financial Analysis		<input type="radio"/>	<input type="radio"/>
Human Resources Requirement			<input type="radio"/>
Overview of the global trends and assessment of current human resource			<input type="radio"/>
Identify issues and challenges on human resource			<input type="radio"/>
Assessment of technology capability and the technological map for MFEZ			<input type="radio"/>
Strategies and policies for human resource development			<input type="radio"/>
Housing and Community Services Appraisal			<input type="radio"/>
Housing needs survey to gauge existing situation and issues			<input type="radio"/>
Related needs survey on relevant aspects of housing, including demographic characteristic, delivery system, financing sources			<input type="radio"/>
Planning for community, facilities and services			<input type="radio"/>
Market Assessment		<input type="radio"/>	
Environmental screening of the critical sectors influencing markets		<input type="radio"/>	
Cross impact analysis and key external driving forces		<input type="radio"/>	
Assessment of market opportunity for specific properties		<input type="radio"/>	
Financial Analysis			<input type="radio"/>
Identification of investment opportunities			<input type="radio"/>
Diversification and harvest strategy			<input type="radio"/>
Formulate investment planning strategies for MFEZ			<input type="radio"/>
Business process management, marketing and sales strategies			<input type="radio"/>
Implementation			<input type="radio"/>
Organization and Management			<input type="radio"/>
Identify the type of organization or entity for project management			<input type="radio"/>
Analyse the requirements of the organizational structure			<input type="radio"/>
Recommendations for effective management and execution of responsibilities			<input type="radio"/>
Legal Framework and Incentives			<input type="radio"/>
Intellectual property, property rights and protection			<input type="radio"/>
Government policies on FDI, trade regulations, foreign exchange controls			<input type="radio"/>
Incentive packages			<input type="radio"/>
Implementation, Phasing and Scheduling			<input type="radio"/>
Practical, operational implementation schedule, plans and targets to be			<input type="radio"/>
Business plan			<input type="radio"/>
	Economic and financial evaluation	<input type="radio"/>	<input type="radio"/>
	Social and environmental impacts	<input type="radio"/>	<input type="radio"/>

The items to be studied are subject to change. And the order of items above is also subject to change in order to conduct the Study effectively and efficiently.

