STANDARD GUIDELINE
FOR
UNDERGROUND UTILITY MAPPING

AM/FM Technical Sub-Committee
National Mapping and Spatial Data Committee

PREFACE

The continuous economic development generally experienced in this country has resulted in increasing demands for improvement in basic infrastructure facilities such as roads, transportation, utilities and other amenities. One of the often-repeated infrastructural improvements is road widening, and the ensuing relocation of utilities including those laid underground during these road works may result in damage to the underground utilities especially if proper care and systematic work approach are not observed. When these damages occur, delivery of utility services becomes disrupted, citizen's quality of life becomes compromised, monetary losses confronted and worst, fatal accidents may occur.

The Government views these disruptions very seriously and had on two occasions, through Cabinet decisions, directed for the establishment of a centralised underground utility database to be maintained by Jabatan Ukur dan Pemetaan Malaysia (JUPEM) in close cooperation with utility agencies. Orderly management of utility data between JUPEM and utility agencies requires the establishment of agreed mechanisms, procedures and specifications, and the first of these is this Standard Guideline for Underground Utility Mapping document.

This guideline covers various aspects of underground utility mapping such as the roles of various stakeholders, classification of underground utility quality levels, generic specifications for underground utility map as well as the creation of underground utility mapping database. It is the culmination of concerted efforts by members of the AM/FM Technical Committee comprising underground utility stakeholders functioning under the auspices of the National Committee for Mapping and Spatial Data, being the responsible body for the coordination of mapping activities in this country.

It is hoped that all stakeholders would adopt the noble tenets of this standard guideline in their respective underground utility mapping practices. It is further hoped that this standard guideline would become an important accessory in fulfilling the Malaysian Cabinet's directive.

(Dato' Hamid bin Ali)
Director General of Survey and Mapping Malaysia
Chairman
National Committee for Mapping and Spatial Data

May 2006

CONTENTS

COMMITTEE REPRESENTATION

The National Mapping and Spatial Data Committee under whose authority this standard guideline was developed, comprises representatives from the following organisations:

Department of Survey and Mapping Malaysia
Department of Land and Survey Sabah
Department of Land and Survey Sarawak
Ministry of Defence
Department of Mineral and Geosciences
Forestry Department of Peninsular Malaysia
Sabah Forestry Department
Forest Department of Sarawak
Department of Agriculture Peninsular Malaysia
Sabah State Department of Agriculture
Department of Agriculture Sarawak
Malaysian Centre for Remote Sensing
University Technology Malaysia

The AM/FM Technical Sub-Committee which developed this standard guideline consists of representatives from the following organisations:

Department of Survey and Mapping Malaysia
Ministry of Health
Ministry of Energy, Water and Communication
Department of Land and Survey Sabah
Department of Land and Survey Sarawak
Department of Works
Department of Town and Country Planning
Department of Irrigation and Drainage
Department of Sewerage Services
Department of Environment
Department of Fire and Rescue
Malaysian Centre for Geospatial Data Infrastructure
Implementation and Coordination Unit, Prime Minister's Department
Local Government Department, Ministry of Housing and Local Government
Kuala Lumpur City Hall
Malaysian Highway Authority
Syarikat Telekom Malaysia Berhad
Tenaga Nasional Berhad
Indah Water Konsortium Berhad
Gas Malaysia Sdn. Bhd.
Syarikat Bekalan Air Selangor Sdn. Bhd
Puncak Niaga Holdings Bhd.
Equarater (Penang) Sdn. Bhd.
Alam Flora Sdn. Bhd.
Radicare (M) Sdn. Bhd.
Southern Waste Management Sdn. Bhd.

FOREWORD

This guideline was developed through the consensus of the AM/FM Technical Sub-Committee of the National Mapping and Spatial Data Committee. The word "standard" used in conjunction with guideline serves to elevate the authority of this guideline from being a mere guideline as is usually applied in the normal context to being a collective concurrence of the committee members of this sub-committee.

STANDARD GUIDELINE FOR UNDERGROUND UTILITY MAPPING

1.0 INTRODUCTION

Maintaining reliable underground utility mapping information is an important task in the development, maintenance and upgrading of underground utility infrastructure. Taking into account the increasing instances of catastrophic damages of underground utilities and disruption of existing utility services resulting from excavation works, the Cabinet, in its meeting on 24th August 1994, has decided that the Department of Survey and Mapping, Malaysia (JUPEM) shall undertake the responsibility of maintaining a repository of all underground utility data, apart from those kept by the various utility agencies.

The data collected will then be provided to relevant parties involved in new underground utility projects to minimise the risks associated with construction activities that may affect existing underground utilities. In order to undertake this new responsibility, JUPEM is expected to embark on the creation and subsequently, the maintenance of the National Underground Utility Database.

This standard guideline is intended to be used by those involved in various capacities in underground utility mapping as well as in maintaining a reliable underground utility mapping information system.

2.0 SCOPE

This standard guideline addresses issues such as (a) the roles of stakeholders, (b) utility quality levels, (c) how utility information can be obtained, and (d) the formatting of the utility map.

This document also addresses the requirement for the National Underground Utility Database, which stores related utility data that can be made available to utility owners and all other relevant parties whenever existing underground utility information is required.

3.0 THE ROLES OF UTILITY OWNER, SURVEYOR, AND JUPEM IN UNDERGROUND UTILITY MAPPING

3.1 Utility Owner

The utility owner should:

3.1.1 Identify the scope of work and the specifications of deliverables for the surveyor and finalise work specifications with the surveyor.

3.1.2 Provide assistance when necessary in enabling a surveyor to obtain access to existing underground utility records.

3.1.3 Involve the surveyor in pre-bid and pre-construction meetings, pre-selection of contractors, and retain the surveyor to perform plan review.

3.1.4 Notify the surveyor within a reasonable time frame of any suspected deficiencies in the utility depictions at the specified quality level discovered during construction.

3.1.5 Furnish existing underground utility information together with its related metadata at quality levels A, B, C, and/or D to JUPEM for inclusion into the National Underground Utility Database.

3.1.6 Continually furnish JUPEM appropriate utility installation and relocation information to enable the said department maintain the National Underground Utility Database as mandated by the Government.

3.1.7 Ensure that all underground utility information for all new projects attain quality level A. For this purpose, a surveyor shall be engaged to perform as-built surveys during construction and emplacement of underground utilities.

3.1.8 Provide quality level A data to JUPEM for all new underground utility projects.

3.2 Surveyor

The surveyor should:

3.2.1 Provide information to the utility owner with regards to potential effects that a new project may have on existing underground utilities.

3.2.2 Advise the utility owner regarding utility quality levels and reliability of data for each quality level for existing datasets; and the need for acquiring new data if necessary. The costs and benefits associated with obtaining new quality level A data should also be discussed.

3.2.3 Identify and recommend a scope of utility investigations on the basis of project needs. It may include portions of the project area which may require existing utilities to be investigated and depicted at quality level A.

3.2.4 Recommend specifications of deliverables to clearly distinguish the various quality levels.

3.2.5 Discuss the steps of acquiring appropriate quality level data throughout the planning and design process of new projects, taking into account project design elements, design timetables, the type of project, the criticality of utility service, etc.

3.2.6 Conduct appropriate data acquisition and survey works and prepare underground utility maps in digital and hardcopy forms together with appropriate supporting documents according to the utility owner's specification by clearly identifying their appropriate quality levels.

3.2.7 Analyse data with utility owners.

3.2.8 Review plans during the design stage to assess the effects of design changes to current utility information, where necessary.

3.2.9 Recommend areas of underground utility survey for a quality level upgrade after review. Such an upgrade shall be to quality level A.

3.2.10 Comply with all applicable laws, regulations and guidelines.

3.2.11 Place note on the plans indicating the different utility quality levels for each underground utility.

3.2.12 Certify the plans that depict existing underground utility data at the indicated quality levels.

3.2.13 Discuss utility installation and utility relocation policies for the utility owner's implementation.

3.3 JUPEM

The department should:

3.3.1 Create, populate and maintain the National Underground Utility Database with:

a) surveyed parcel boundary data ingested from the Digital Cadastral Database (DCDB);
b) large scale digital topographic data from a new mapping programme;
c) existing and new underground utility information provided by utility owners;
d) existing and new underground utility information collected by JUPEM where necessary; and
e) associated metadata information.

3.3.2 Conduct random quality checks and control (QC) on utility survey and mapping information.

3.3.3 Provide underground utility map in digital or hardcopy form (as in **APPENDIX D**) to relevant parties involved in new underground utility projects to minimise the risks associated with construction activities that may affect existing underground utilities. The underground utility map shall follow JUPEM's Utility Map Specifications.

4.0 UTILITY QUALITY LEVEL ATTRIBUTES

4.1 Quality Level D

Typical tasks to be undertaken by the surveyor leading to utility quality level D are:

4.1.1 Search for existing utility records to assist in identifying utility owners that may have facilities on or be affected by the project. Sources of information may include, but are not limited to:

- Local authority
- Utility owners
- Visual site inspection

4.1.2 Collect relevant records from utility owner, including:

- Previous construction plans in the area
- Conduit maps
- Direct-buried cable records

- Distribution maps
- Transmission maps
- “As-built” and record drawings
- Appropriate geographic information system databases
- Circuit diagrams

4.1.3 Analyse records for:

Availability of additional information
Duplicate information and accuracy of such duplicate information
Need for further details from utility owner

4.1.4 Prepare utility composite drawing in digital and hardcopy. The surveyor should also make professional judgements regarding the validity and location of topographic features on records versus current topographic features (when available) and conflicting references of utilities.

4.2 Quality Level C

Typical tasks to be undertaken by the surveyor leading to utility quality level C are:

4.2.1 Perform tasks as prescribed for quality level D data acquisition. Quality level C and D tasks do not necessarily need to be performed in any particular order.

4.2.2 Locate surface features on existing records and ground surface that are surface appurtenances of existing underground utilities.

4.2.3 Survey such features if they have not been previously surveyed. Otherwise, check the accuracy of survey and completeness of information for applicability with the new project.

4.2.4 Correlate relevant utility records to the surveyed features, taking into account the shape, size and characteristics of these surface features.

4.2.5 Resolve discrepancies when records and features do not agree. This may be done by showing the underground utility feature at quality level D, hence disregarding a surveyed surface appurtenance of unknown origin. Consultation with utility owner may be required to resolve the discrepancies.

4.3 Quality Level B

Typical tasks to be undertaken by the surveyor leading to utility quality level B are:

4.3.1 Undertake tasks as described for quality level C data acquisition. Quality level C and B tasks do not necessarily need to be performed in any particular order.

4.3.2 Use an appropriate set of surface geophysical methods to search for underground utilities within the project area or to perform a utility trace for a particular utility system.

4.3.3 Interpret the surface geophysical data.

4.3.4 Mark and indicate the location of underground utilities on the ground surface for subsequent survey. Care should be taken to differentiate markings placed on the ground for design purposes from those used for damage prevention purposes.

4.3.5 Survey all markings that indicate the presence of an underground utility to the accuracies and precision dictated by the project's survey control.

4.3.6 Depict all designated underground utilities following the general guideline as presented in Section 5.0. Depiction may be accomplished via computer-aided design and drafting or geographic information systems.

4.3.7 Correlate the designated underground utilities' portrayal with existing utility records and/or surveyed appurtenances to identify underground utilities that may exist but were not able to be designated.

4.3.8 Resolve differences between designated underground utilities and existing underground utility records as well as with surveyed appurtenances. A choice will have to be made between undertaking additional surface geophysical surveys and depicting the underground utilities at a lower quality level. The survey may be done at appropriate points to quality level A; and judgement will have to be made to verify whether a designated underground utility and that existing in the utility record are actually identical, though they do not seem to be geographically coincident.

4.3.9 Recommend to the utility owner to take additional measures to resolve differences if they still exist such as using additional or different surface geophysical methods, exploratory excavation, or an upgrade to quality level A data.

4.4 Quality Level A

Typical tasks to be undertaken by the surveyor leading to utility quality level A are:

4.4.1 Perform tasks as described for quality level B data acquisition. Quality level B, C, and D tasks do not necessarily need to be performed in any particular order.

4.4.2 Use an appropriate method of data acquisition that will achieve the accuracies and precision required by the project. These accuracies are at 10 cm or better in vertical as well as in horizontal. Exposure and survey of the underground utility at each specific location where quality level A data are to be obtained may be performed whenever necessary.

4.4.3 Calibrated survey equipment and surface geophysical detection equipment will be used to acquire quality level A data in order to ensure that the expected accuracy of measurement is achieved. If need be, excavate test holes to expose the underground utility to be surveyed without affecting the underground utility to be measured. Exposure can be performed by minimally intrusive excavation method. Data collection during underground utility construction may eliminate the need for excavation, as it is already exposed.

4.4.4 Determine the following:

a) horizontal and vertical location of the top and/or bottom of the utility referenced to approved JUPEM's datum;
b) elevation of the existing underground utility at a test hole, whenever necessary, referenced to the project survey datum;
c) outside diameter of the utility and configuration of non-encased, multi conduit systems;
d) utility structure material composition, when reasonably ascertainable;
e) benchmarks and/or project survey data used to determine elevations;
f) paving thickness and type, where applicable; and
g) other relevant information.

4.4.5 Resolve differences between depicted quality level A data and other quality levels referring to the same underground utility. This can be done through additional surface geophysical survey or by depicting the adjacent or nearby data points for that underground utility at a lower quality level. On the other hand, utilities already depicted at quality level B, C, or D may also be re-depicted to coincide with the more accurate quality level A data provided upgrade surface geophysical survey is undertaken at appropriate points.

5.0 Equipment Calibration

All survey and surface geophysical detection equipment used to acquire quality level A data shall be appropriately calibrated to ensure that it is in good working order as well as to enable it to achieve the required accuracy as specified in this standard guideline.

6.0 DELIVERABLES FORMATTING

6.1 General

The main deliverable of an underground utility mapping is the map, whether in hardcopy or digital form. This part of the standard guideline describes some general guidelines on the preparation of the map either for general exchange of information or for inclusion into the National Underground Utility Database.

6.2 Basic Deliverable

The basic deliverable is in the form of mapping file and hardcopy sheet that contain utility information in plan view for data with quality levels A, B, C, and D. Quality level A data shall be furnished with additional information such as written reports and test hole summary sheet. This standard guideline does not address the quality of vertical information other than for quality level A data.

6.3 Quality Level Attributes

6.3.1 General

The quality level attribute of an underground utility feature is the most important information aside from its alignment or presence in a utility map. As such due care should be taken to precisely indicate the quality level of an underground feature especially in hardcopy maps given the fact that in any congested corridor, the horizontal and vertical separation between utility features could be reduced to several decimetres, and at plotting scale such separation may be difficult to discern.

Usage of the following cartographic elements can help in ensuring a reliable indication of the quality level of underground features.

6.3.2 Line Code and Style

Use of line code and style is one of the methods to differentiate between the various quality levels. The line code and style can differentiate not only quality levels but also utility type and/or ownership.

6.3.3 Labelling

This is also one of the methods of differentiating between the quality levels, utility type, ownership, date of depiction, accuracy of surveyed appurtenances, end points of any utility data, active, abandoned, or out-of-service status, size, condition, number of jointly buried cables, and encasement.

6.3.4 Symbol Embedding

Symbol embedding can also be used to indicate the different quality levels of underground utility data.

6.3.5 Colour

Colour may be used to indicate utility type and can be used in conjunction with other methods.

6.3.6 Line Weight

Line weight can be used at actual scale to depict the size of the utility. However, it has the effect of obscuring other data if the line size is large.

6.3.7 Layer

This method is to be used to portray various attributes. For example, quality level A data could be on one layer, quality level B data on another, and etc. All layers must be turned be on to present the complete utility information particularly in a geographic information system.

6.3.8 Annotation

Annotation should be appropriately used to ensure that it does not obscure other utility data.

6.4 Utility Depiction Legend

Underground utility map may be provided with a separate utility legend to clearly indicate the methods of quality level differentiation and other utility attributes.

6.5 Parcel Boundaries

Parcel boundaries shown shall be derived from the Digital Cadastral Database (DCDB) currently maintained by JUPEM.

6.6 Lot Numbers

Lot numbers of all parcels as derived from the DCDB shall be shown whenever possible.

6.7 Names of Building, Street, Road and River

Official names of buildings as well as names of streets, roads and rivers shall be shown.

6.8 North Arrow

An arrow-like symbol indicating the direction of the grid north and the true north shall be shown.

6.9 Scale Representation

Since maps must necessarily be smaller than the areas mapped, their use requires that the ratio or proportion between comparable measurements be expressed on the map. This is called map scale and should be the first thing of which the map user becomes aware. Scale should be expressed as a statement of map distance in relation to earth distance or a graphic (or bar) scale or both.

6.10 Map Date

The publication date of the map should be prominently displayed.

6.11 Marginal Information

Marginal information may among others include such items as section, town, city and state names, scale, north arrow, legend, published date, disclaimer, and map index.

6.12 Disclaimer

Disclaimers are used to limit and define the map author's responsibility for the content, accuracy, and currency of a map. Although some maps may require specialised disclaimers, the following disclaimer represents one suggestion:

"Not to be treated as a map depicting property boundaries”

7.0 CREATION AND MAINTENANCE OF THE NATIONAL UNDERGROUND UTILITY DATABASE

7.1 Database Design

The National Underground Utility Database shall be created and maintained by JUPEM. The database would be seamless but shall utilise the JUPEM National Map Index for ease of reference and easy data retrieval. The database shall also utilise the MS1759 database schema and will consist of feature layers which include the following:

- Digital cadastral data (providing the primary base map)
- Large scale topographic data (providing the secondary base map)
- High-resolution satellite imagery (desirable)
- Underground utility

7.2 Base Map Development

A base map is a geometric control feature in a digital mapping system that permits many other specialised theme layers to be brought into absolute position by registration on the base map. Certain themes or layers of base map content will be utilised to register the utility themes or layers.

The primary base map will be provided by the Digital Cadastral Database (DCDB) currently being maintained by JUPEM. The database comprises coordinate geometry of every surveyed land parcel generated by keyboard entry of survey accurate data resulting from actual ground surveys. As such it provides the most accurate base map available and suited to be used at a scale of 1:500 or even larger.

The secondary base map will be provided by a large scale Digital Topographic Database to be newly created by JUPEM at the scale of 1:500 by aerial photography. An interim topographic base map may however be provided in raster using suitable high resolution remotely-sensed imagery.

7.2.1 Paper to Digital Conversion

Many of the existing underground utility maps may be in paper form. There are several methods of converting these paper maps into digital form. Each method must follow certain fundamental principles to be successful. The alternatives of scanning, board digitising and coordinate geometry must be evaluated to determine the most desirable method to be employed for each portion of a mapping project. Most mapping strategies will probably use a combination of conversion methods to provide the optimum conversion strategy for an entire project. Care should be taken to plan each project with adequate time and resources to ensure a final product that will meet the standard of accuracy required.

The following aspects are to be given due consideration:

- The available source documents are legible or restorable.
- Source documents are relatively accurate (in scale and direction).
- There is adequate control to locate the map in the real world.
- The frequency of the control ensures that all map portions are fitting properly.
- The distribution of the control ensures that there is no distortion in areas of difficult fits.

Scanners should be of adequate resolution to convert source documents to a pixel size that will support desired accuracy. They should support an adequate number of shading levels to reproduce the detail of the original document to the screen. Additionally, they should be of adequate size to accommodate source material with a minimum of cutting or folding. Digitiser resolution too should support accuracy required. Computer processing and storage must have the capacity to process and store large raster files. The video adapter and monitor of the system must allow clear viewing of digitised materials. The software employed must offer adequate manipulation tools to capture and enhance source documents, as well as friendly enough to ensure consistent, accurate use by trained operators. Software employed too must provide all the tools required to ensure accurate fitting of digitised source to project, apart from facilitating quality control procedures. Operators should be well trained and follow sound conversion procedures. Quality control should be frequent and thorough.

7.2.2 Accuracy

Map accuracy is the degree toward which any given feature(s) on a map conforms to its true position on the ground. The direct benefit of map accuracy is to ensure accurate spatial representation of mapped features not only on base maps, but also for features included in other utility map themes.

Positional accuracy of underground features is to be of paramount importance, considering the risks associated with low accuracy position determination. This importance is further amplified by the use of very large scale presentation of the National Underground Utility Database and therefore requires that 90% of all randomly chosen samples of well-defined map features shall be within 0.5mm (at scale on the map) of their true planimetric location on the ground while the accuracy in vertical shall be within 10 cm.

7.3 Projections and Coordinate Systems

The following projections and coordinate systems are required for the input, storage, and in particular, the exchange of digital map data. All underground utility maps in Malaysia should be based on the Rectified Skew Orthomorphic (RSO) coordinates, referenced to the Geocentric Datum of Malaysia 2000 (GDM2000) horizontal datum.

7.3.1 Cassini-Soldner State Plane Coordinate Systems

The Cassini-Soldner State Plane Coordinate Systems is currently utilised for cadastral surveys in the states of Peninsular Malaysia. As such the primary base map provided by the DCDB needs to be re-projected onto RSO (Malaya) referenced to GDM2000 for use in utility mapping. These systems are to be used for the input, storage, and exchange of digital map data, as well as for the output of hardcopy maps.

7.3.2 RSO (Malaya) Kertau Datum / RSO (Borneo) Timbalai Datum

The RSO (Malaya) map projection system based on Kertau datum is currently used for topographic mapping in Peninsular Malaysia while the RSO (Borneo) projection system based on Timbalai datum is used for cadastral surveying as well as topographic mapping in Sabah and Sarawak. However, for the purpose of underground utility mapping, the projection systems to be used shall be RSO (Malaya) on GDM2000 and RSO (Borneo) on GDM2000 respectively.

7.3.3 Height Datum

All heights shall be based on the National Geodetic Vertical Datum.

7.4 Data Exchange Standards

In order to facilitate efficient exchange of underground utility data between the surveyor, utility owner, JUPEM and the data users, the Malaysian geographic information exchange standard namely, MS 1759:2004 Geographic Information – Features and Attributes Codes shall be utilised.

7.4.1 Data Exchange Formats

All common vector data exchange formats supported by Feature Manipulation Engine (FME) software can be used.

7.4.2 Data Exchange Media

Various data exchange media are available, depending on the hardware systems installed at the source and target organisations. The users exchanging data will determine the best media based on available network connections, modem connections, available input and output devices, CD-ROM or other transfer media.

7.5 Metadata

Metadata are commonly defined as the data about data or the data about the processes performed on data. The major uses of metadata are:

i. To provide information about an organisation's data holdings to data catalogues and clearinghouses;
ii. To provide information needed to process and interpret data to be received through a transfer from an external source; and
iii. To maintain an organisation's investment in geospatial data.

In order to facilitate their use, underground utility maps produced shall be accompanied with appropriate metadata which complies with the Malaysian Standard for Geographic Information - Metadata.

Dept. of Survey and Mapping Malaysia
May 2006

APPENDICES

APPENDIX A: GLOSSARY OF TERMS

Absolute map accuracy: The accuracy of a map in relationship to the earth's geoid. The accuracy of locations on a map that are defined relative to the earth's geoid are considered absolute because their positions are global in nature and accurately fix a location that can be referenced to all other locations on the earth.

Base map: A map showing certain fundamental information used as a base upon which additional specialised data are compiled.

Cadastral Database: A database showing the boundaries of subdivisions of land, for the purposes of describing and recording ownership; containing particulars such as land parcel dimensions, its area as well as its unique parcel identification number.

Coordinates: Linear or angular quantities that designate the position of a point in a given reference frame or system. Also used as a general term to designate the particular kind of reference frame or system, such as state plane coordinates or spherical coordinates.

Coordinate geometry: Automated mapping software that translates the alphanumeric data associated with a survey (distances, bearings, coordinates, etc.) into digital map information for creating and updating a digital cartographic data base.

Designating: The process of using a surface geophysical method or methods to interpret the presence of a underground utility and to mark its approximate horizontal position on the ground surface. Also termed as “locating.”

Geodetic coordinates: The quantities of geodetic latitude or longitude that define the position of a point on the surface of the earth with respect to the reference spheroid.

Geographic coordinates: A system of spherical coordinates for defining the position of points on the earth. The declinations and polar bearings in this system are the geographic latitudes and longitudes respectively.

Geographic Information System (GIS): A computerised data-base system for capture, storage, retrieval, analysis, and display of spatial data.

Global Positioning System (GPS): Determination of coordinates of points using a network of satellites intended for this purpose.

Index map: A map of smaller scale on which are depicted the locations (with accompanying designations) of specific data, such as larger-scale topographic quadrangles.

Minimally intrusive excavation method: A method of excavation that minimises the potential for damage to the structure being uncovered. Factors such as utility material and condition may influence specific techniques. Typical techniques for utility exposures include air-entrainment/vacuum-extraction systems, water-jet/vacuum-extraction systems, and careful hand usage.

Parcel: A single, discrete piece of land having defined physical boundaries and capable of being separately conveyed.

Photogrammetry: The art, science, and technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring, and interpreting images and patterns of electromagnetic radiant energy and other phenomena.

Projection: A systematic representation of all or part of the surface of a sphere onto a plane.

Relative map accuracy: The accuracy of a map in relation to a local survey network that is not tied to the earth's geoid. The accuracy of locations on a map defined relative to a local survey network is considered relative because the positions are accurate only within a certain geographic area covered by the network.

Scope of work: All services and actions required of the consultant by the obligations of the contract.

State plane coordinate systems: A series of grid coordinate systems prepared by the Department of Survey and Mapping Malaysia for all the states in Peninsular Malaysia, with basically a separate system for each state, based on the Cassini-Soldner projection.

Underground Utility Mapping: A branch of mapping practice that involves managing certain risks associated with utility mapping at appropriate quality levels, utility coordination, utility condition assessment, communication of utility data to concerned parties, and utility map design.

Surface geophysical method: Any of a number of methods designed to utilise and interpret ambient or applied energy fields for the purpose of identifying properties of, and structure within the earth. Such methods typically include variants of electromagnetic, magnetic, elastic wave, gravitational, and chemical energies.

Survey datum: The points of reference used to define a specific geographic location in three-dimensional space.

Surveyor: A survey officer serving with the Department of Survey and Mapping, Malaysia or the person whose name has been placed upon the register of licensed land surveyors and to whom a license to practice has been issued by the Land Surveyors Board of Peninsular Malaysia, Sabah or Sarawak.

Test hole: The excavation made to determine, measure, and record the presence of a utility structure.

Utility: A privately or publicly owned line, facility, or system for producing, transmitting, or distributing communications, cable television, power, electricity, light, gas, oil, crude products, water, waste, or any other similar commodity, including any fire or police signal system or street lighting system.

Utility attribute: A distinctive documented characteristic of a utility that may include, but is not limited to, elevation, horizontal position, configurations of multiple non-encased pipes or cables, shape size, material type, condition, age, quality level, and date of measurement.

Utility depiction: A visual image of existing utility information using a computer-aided design and drafting system or on project plan sheets.

Utility quality level: A professional opinion of the quality and reliability of utility information. Such reliability is determined by the means and methods of the professional. Each of the four existing utility data quality levels is established by the different methods of data collection and interpretation.

Utility quality level A: Precise horizontal and vertical location of utilities through the application of appropriate surface geophysical methods using calibrated equipment or if necessary by actual exposure and subsequent measurement of underground utilities, at a specific point. Minimally intrusive excavation may be undertaken to reduce the potential damage to the underground utility installation. Precise horizontal and vertical locations to an accuracy of 10 cm. as well as other utility attributes are shown on plan documents to applicable horizontal survey and mapping accuracy specified in this standard guideline.

Utility quality level B: Information obtained using appropriate surface geophysical methods to locate the approximate horizontal position of underground utilities. Quality level B data should be reproducible using surface geophysical techniques at any point of their depiction. This information is surveyed to applicable tolerances defined by the project.

Utility quality level C: Information obtained by surveying and plotting visible above-ground utility features and correlating this information to quality level D information.

Utility quality level D: Information solely derived from existing records.

Utility search: The search for a specific or unknown utility or utilities using a level of effort in accordance with the specified quality level, within a defined area.

Utility trace: The process of using surface geophysical methods to image and track a particular utility.

APPENDIX B: NORMATIVE REFERENCES

The following normative references are indispensable for the application of the standard.

Terma Rujukan Jawatankuasa Pemetaan dan Data Spatial Negara

MS 1759:2004 – Geographic Information/Geomatics – Feature and Attribute Codes

ISO 19115:2003 - Geographic Information/Geomatics – Metadata

Pekeliling Ketua Pengarah Ukur dan Pemetaan Bil. 6/1999: Garis Panduan Pengukuran Menggunakan Alat Sistem Penentududukan Sejagat (GPS) Bagi Ukuran Kawalan Kadaster dan Ukuran Kadaster

Pekeliling Ketua Pengarah Ukur dan Pemetaan Bil. 1/2003: Sela Masa Ujian Alat Ukur Jarak Elektronik (EDM) / Total Station

Pekeliling Ketua Pengarah Ukur dan Pemetaan Bil. 9/2005: Garis Panduan Mengenai Penggunaan Perkhidmatan Malaysian RTK GPS Network (MyRTKnet)

APPENDIX C: ACKNOWLEDGEMENTS

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Puan Doria Tai Yun Tyng	Department of Land and Survey Sabah
Encik Ting Sii Chiong	Department of Land and Survey Sarawak
Encik Muhamad Rahimi Abdullah	Department of Works
Encik Abbas Abdul Wahab	Department of Town and Country Planning
Puan Rozaini Abdullah	Department of Irrigation and Drainage
Ir. Hj. Mohd. Yusop Zahidin	Department of Sewerage Services
Puan Norlin Jaafar	Department of Environment
PPjB Zamri Ibrahim	Department of Fire and Rescue
Encik Rahim Hj. Mohamed Saleh	Malaysian Centre for Geospatial Data Infrastructure
Puan Nurulhalina Jalaludin	Kuala Lumpur City Hall
Encik Tan Yong Teck	Telekom Malaysia Berhad
Puan Kamariah Jaafar	Tenaga Nasional Berhad
Puan Harliza Abd. Rauf	Gas Malaysia Sdn. Bhd.
Ir. Dorai Narayana	Indah Water Consortium Sdn. Bhd.
Ir. Loh Kit Mun	Puncak Niaga Holdings Bhd.
Dato' Mohd Noor Kamaludin	Equarater (Penang) Sdn. Bhd

APPENDIX D: SAMPLE OF UNDERGROUND UTILITY MAP

TERHAD - RESTRICTED

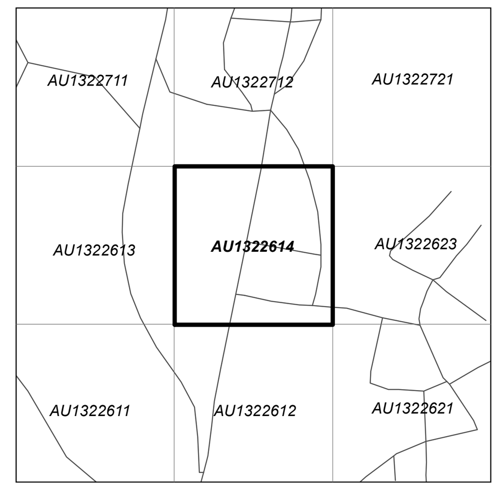
MAHKAMAH PERSEKUTUAN

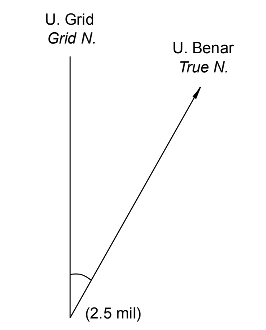
Siri *(Series)* MY90001U
Lembar *(Sheet)* AU1322614
Edisi *(Edition)* 1

Appendix D

Sample Of Underground Utility Map

PETA INDEKS MENUNJUKKAN LEMBAR-LEMBAR BERSEBELAHAN
INDEX MAP SHOWING ADJOINING SHEETS





Tumpuan Grid 08' 10" ke Barat
Grid Convergence 08' 10" Westerly

Persekitaran Terbina *Built Environment*
- Pagar / *Fence*
- Tembok / *Wall*
- Bangunan / *Building*

Sempadan *Demarcation*
- Antarabangsa / *International*
- Negeri / *State*
- Bahagian / *Division*
- Daerah / *District*
- Mukim / *Mukim*
- Majlis Perbandaran / Bandaran *Municipality / Town Council*
- Seksyen / *Section*
- Lot Terukur / *Surveyed Lot*
- Kawasan Simpanan Utiliti / *Utility Reserve Area*

Hidrografi *Hydrography*
- Penutup Lurang Saliran / *Drain Manhole Cover*
- Pesisiran Pantai / *Shoreline*
- Saliran / *Drain*
- Pembentung / *Culvert*
- Sungai / Tasik / Kolam *River / Lake / Pond*

Relief *Relief*
- Pemotongan / *Cutting*
- Benteng / *Embankment*
- Kawasan Hijau / *Green Area*

Elektrik *Electricity*
- Tiang Lampu / *Lamp Post*
- Tiang Dawai Elektrik / *Electric Post*
- Tiang Transformer / *Transformer Post*
- Pilon / *Pylon*
- Peti Pembekal / *Feeder Pillar*
- Penanda Kabel Elektrik / *Electric Cable Marker*
- Penutup Kebuk Elektrik / *Electric Chamber Cover*
- Kabel Elektrik Bawah Tanah / *Underground Electric Cable*
- Kabel Elektrik Permukaan / *Surface Electric Cable*
- Stesen Pencawang Elektrik / *Power Station*
- Substesen / *Substation*

Petroleum dan Gas *Oil and Gas*
- Penanda Saluran Petroleum dan Gas / *Oil and Gas Line Marker*
- Injap Petroleum dan Gas / *Oil and Gas Valve*
- Stesen Pemeteran Petroleum dan Gas / *Oil and Gas Metering Station*
- Saluran Paip Petroleum dan Gas / *Oil and Gas Pipeline*

Bekalan Air *Water Supply*
- Injap Air / *Water Valve*
- Penutup Injap Air / *Water Valve Cover*
- Kebuk Air / *Water Chamber*
- Penutup Kebuk Air / *Water Chamber Cover*
- Pili Bomba / *Fire Hydrant*
- Paip Air / *Water Pipe*
- Tangki Air / *Water Tank*

Pengangkutan *Transportation*
- Lampu Lalu Lintas / *Traffic Light*
- Isyarat Lalu Lintas / *Traffic Sign*
- Tanda Kilometer / *Kilometre Post*
- Hentian Bas / *Bus Stop*
- Jejantas / *Overhead Crossing*
- Landasan Kereta Api / *Railway Track*
- Jalan Persekutuan / *Federal Road*
- Jalan Negeri / *State Road*
- Jalan Pihak Berkuasa Tempatan / *Local Authority Road*
- Jalan-Jalan Lain / *Other Road*
- Jambatan / *Bridge*

Telekomunikasi *Telecomunication*
- Tiang Telefon / *Telephone Post*
- Pondok Telefon / *Telephone Booth*
- Penanda Kabel Telekomunikasi / *Telecomunication Cable Marker*
- Penutup Kebuk Telekomunikasi / *Telecomunication Chamber Cover*
- Kabel Telekom / *Telecom Cable*
- Kabel Fiber Optik / *Fibre Optic Cable*
- Kabel Kawalan / *Control Cable*
- Saluran Kabel / *Cable Duct*
- Paip Pelindung / *Protection Pipe*

Pembetungan *Sewerage*
- Penutup Lurang Pembetungan / *Sewerage Manhole Cover*
- Terowong Bata / *Brick Tunnel*
- Saluran Pembetungan / *Sewer Line*
- Stesen Pengepam Rangkaian / *Network Pump Station*
- Loji Rawatan Pembetungan/ *Sewerage Treatment Plant*

Nota :
Maklumat tambahan di dalam peta diperlukan bagi menunjuk tahap kualiti bagi setiap simbol titik dan garisan bawah tanah, dengan nilai-nilai A, B, C atau D.

Note :
In addition to the portrayal of the symbol of each underground point and linear feature, this map also portrays the value of the Quality Level attribute of each feature as indicated either by A, B, C or D.

UNJURAN

Peta ini disusun di atas Unjuran Bentuk Benar Serong Ditepati Sferoid GRS80, Datum GDM2000

PROJECTION

This map is compiled on the Rectified Skew Orthomorphic Projection GRS80 Spheroid, GDM2000 Datum

GRID

Grid Bentuk Benar Serong Ditepati (Meter)

GRID

Rectified Skew Orthomorphic Grid (Metres)

CARA MEMBERI RUJUKAN PIAWAI DI ATAS PETA INI SEHAMPIR 100 METER
TO GIVE A STANDARD REFERENCE ON THIS MAP TO THE NEAREST 100 METRES

1. Lihat garisan grid TEGAK yang pertama di sebelah kiri titik tersebut dan baca angka BESAR nilai garisan grid itu: Anggarkan beberapa per sepuluh daripada garisan grid ke titik: *1. Locate the first VERTICAL grid line to the left of the point and read the LARGE figures value of that grid line: Estimate tenths from the grid line to the point::*	41 5	
2. Lihat garisan grid MENDATAR yang pertama di sebelah kiri titik tersebut dan baca angka BESAR nilai garisan grid itu: Anggarkan beberapa per sepuluh daripada garisan grid ke titik: *2. Locate the first HORIZONTAL grid line to the left of the point and read the LARGE figures value of that grid line: Estimate tenths from the grid line to the point::*		97 5
RUJUKAN GRID ***(GRID REFERENCE)***	**415975**	
Jika melapor lebih daripada 100 000 meter, dahului dengan Huruf Pengenalan Segiempat Tepat 100 000 meter seperti : *If reporting beyond 100 000 metres, prefix with 100 000 metres Square Indentification Letter as :*	**U1322614**	
Jika melapor lebih daripada 500 000 meter, dahului dengan Huruf Pengenalan Segiempat Tepat 500 000 meter seperti : *If reporting beyond 500 000 metres, prefix with 500 000 metres Square Indentification Letter as :*	**AU1322614**	
HURUF PENGENALAN SEGIEMPAT TEPAT 500 000 METER (Huruf Kecil) dan 100 000 METER (Huruf Besar) *SQUARE IDENTIFICATION LETTERS* *500 000 METRE (Small Letter) and 100 000 METRE (Capital Letter)*	**AU**	

Bandar : Kuala Lumpur
Seksyen : 3

PETA UTILITI

Skala 1 : 500

Pengguna yang menjumpai sebarang kesilapan atau ketersingkiran di atas peta ini adalah diminta melaporkannya kepada Pengarah Pemetaan Negara, Malaysia.

Users noting errors or omissions on this map are requested to inform the Director of National Mapping, Malaysia.

Peta ini bukanlah kuasa bagi penentuan sempadan pentadbiran mahupun sempadan hakmilik.

This map is neither an authority on administrative boundaries nor property boundaries.

NOTA KOMPILASI:
1. Disusun daripada Ortofoto - 2004
2. Maklumat tambahan diperolehi dari agensi-agensi Kerajaan
3. Maklumat tambahan dilakukan menerusi kerjaluar - 2005
4. Kerja-kerja peningkatan kartografi dijalankan secara berdigit - 2006

COMPILATION NOTE:
1. *Compiled from Orthophoto - 2004*
2. *Information obtained from others Government agencies*
3. *Information obtained from field survey - 2005*
4. *Cartographic enhancement was done by digital method - 2006*

MAHKAMAH PERSEKUTUAN

Siri *(Series)* MY90001U
Lembar *(Sheet)* AU1322614
Edisi *(Edition)* 1

Skala *(Scale)* 1 : 500

0 12.5 25 50 75 100 Meter

Diterbitkan oleh Pengarah Pemetaan Negara, Malaysia 2005
Published by the Director of National Mapping, Malaysia 2005

TERHAD - RESTRICTED