

KINGDOM OF SAUDI ARABIA

Ministry of Municipal & Rural Affairs

AL MADINAH AL MUNAWARAH REGIONAL MUNICIPALITY



Inception Report

***“Establishment of a Comprehensive Geospatial Database
and Geoportal”***



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1 INTRODUCTION

Geo Tech Consulting, a foreign investment company registered in Saudi Arabia and hereafter to be referred as **GTC**, has signed the Contract titled “Establishment of a Comprehensive Geospatial Database and Geoportal for Madinah Regional Municipality” to develop a comprehensive geospatial data, portal and applications for Madinah Regional Municipality, hereafter to be referred as **the CLIENT or MM**.

This is the Inception Report prepared by GTC addressing the methodologies and implementation of the project, including project management, manpower and resources allocated for the Project.

The MM has decided to develop a comprehensive Geographic Information System (GIS) Infrastructure through dynamic, practical, and priority-driven collaborative approach that will involve cooperation across its departments, sub-municipalities, municipalities of the governorate, users, contractors and consultants. This project is conceived as an initiative to harmonize, integrate and optimize the development and sharing of fundamental geographical information across MM departments and its clients.

The following sections provide information concerning the background and purpose of this study, and an explanation of how this document is organized.

The objective of this project is to perform the following services for the urban area (determined according to Urban Development Plan - Figure 1) of Regional Madinah Municipality more than 1,000 km²:

- 1) Carrying out a comprehensive user study within the Municipality and associated government and private agencies for data conversion, integration and sharing,
- 2) Designing and implementing ONE DOOR – ONE DATABASE concept in the Municipality followed by data conversion and integration to the national standards and formats,
- 3) Designing and establishing the Madinah Municipality Geospatial Information System (MMGIS),
- 4) Carrying out capacity building and training.

Geographic Information System is a computer system build to capture, store, manipulate, analyze, manage and display all kinds of spatial or geographical data. GIS applications are tools that allow end users to perform spatial query, analysis, edit spatial data and create hard copy maps. In simple way GIS can be defined as an image that is referenced to the earth or has x and y coordinate and its attribute values are stored in the **tables**. These x and y coordinates are based on different projection systems and there are various types of projection

systems. Most of the time GIS is used to create maps and to print. To perform the basic task in GIS, layers are combined, edited and designed.

GIS can be used to solve the location-based questions such as “What is located here” or “Where to find particular features” GIS User can reach the value from the map, such as how much the desert area on the land use map is. This can be done using the query builder tool. Next important benefit of the GIS is the capability to combine different layers to show new information. For example, you can combine elevation data, wadi data, land use data and many more to show information about the landscape of the area. From map you can tell where high lands are or where is the best place to build house, which has the valley view. GIS helps to find new information.

Analysis of existing situations: GIS can store, manipulate, and analyze physical, social, and economic data of a city. Planners can then use the spatial query and mapping functions of GIS to analyze the existing situation in the city. Through map overlay analysis, GIS can help to identify areas of conflict of land development with the environment by overlaying existing land development on land suitability maps. Areas of environmental sensitivity can be identified using remote sensing and other environmental information. This data and analysis can then be used to inform important decisions that affect the current and future planning of an area.

Modeling and projection: A key function of planning is the projection of future population and economic growth. GIS can be used for prediction and projection. Spatial modeling of spatial distributions makes it possible to estimate the widest range of impacts of existing trends of population, and of economic and environmental change. For example, a range of environmental scenarios can be investigated through the projection of future demand for land resources from population and economic activities, modeling of the spatial distribution of such demand, and then using GIS map overlay analysis to identify areas of conflict. Using socioeconomic and environmental data stored in GIS, environmental planning models have been developed to identify areas of environmental concern and development conflict.

Development of planning options: Land suitability maps are very useful in the development of planning options. They can be used to identify the solution space for future development. The association of spatial optimization models with GIS can help to formulate and develop planning options which try to maximize or minimize some objective functions. The simulation of different scenarios of development with GIS can help in developing planning options.

Selection of planning options: The final selection of a planning option is increasingly a political process, but planners can provide technical inputs to this process in order to help the community in making their collective choices. The integration of spatial and non-spatial models within GIS can help to evaluate different planning scenarios. The use of GIS with multi-criteria decision analysis can provide the technical inputs in the selection of planning options. The data provided by GIS and the subsequent analysis done can be used to inform the decisions of the political class to ensure that the planning is designed and implemented the right way at the very first instance.

Plan implementation: GIS can be used in the implementation of urban plans by carrying out environmental impact assessment of proposed projects to evaluate and minimize the impact of development on the environment. Following such work, corrective measures can be recommended to decrease the impacts. Environmental impact assessments are usually a detailed process that require accurate estimations of data and impact analyses and GIS will come in handy in ensuring the same is achieved.

GIS technology should provide functionality support that MM should use it to create a comprehensive **geospatial database and geoportal** that will support all its critical business processes like enterprise resource planning, asset management, and decision support systems. The list below identifies the major functions or disciplines in which GIS should be deployed in MM.

- Land-use planning
- Determine land use/land cover changes
- Transportation Planning
- Subdivision review
- Permit tracking
- Parcel/tax mapping
- Engineering design
- Road and utility maintenance
- Event (crime, fires, accidents)
- Reporting
- Emergency management
- Infrastructure assessment and development
- Cartography
- Environment
- Property management
- Environmental Impact Analysis
- Agricultural Applications
- Natural Resources Management
- Soil Mapping
- Land Information System
- Assets Management and Maintenance
- Tourism Information System
- Traffic Density Studies
- Development of Public Infrastructure Facilities

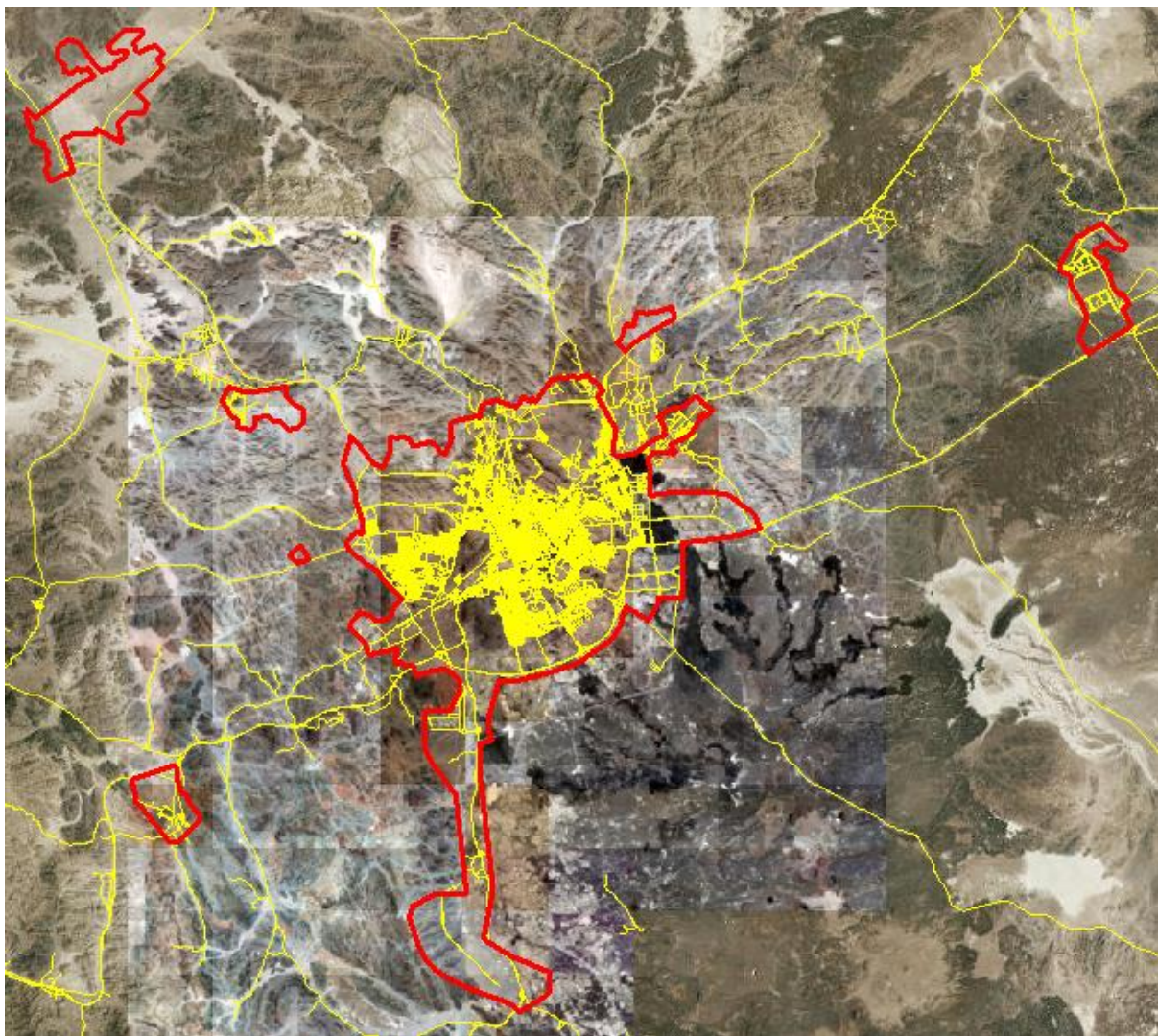


Figure 1 Project area of Al Madinah Al Munawarah

2 SCOPE OF THE PROJECT

The scope of the project consists of the following packages:

- 1) **LOT-1 (To-Be Phase):** Designing all the components of Smart Madinah Municipality
- 2) **LOT-2:** Developing Integrated Smart Municipal Geospatial Database Phase
- 3) **LOT-3:** Developing Smart Geoportal for Internal Users and External Users Phase
- 4) **LOT-4:** Capacity Building and Training Phase
- 5) **LOT-5:** Operation and Maintenance Phase

All the tasks and detailed descriptions are presented in Table 1.

Table 1 The tasks of MMGIS Project

NO	TASK	Qty
LOT-1	To-Be Phase: Designing all the components of Smart Madinah Municipality	
1.1	Designing a comprehensive Geodatabase	1
1.2	Designing a comprehensive Madinah Geoportal for internal and external users	1
1.3	Designing capacity building and training requirements for the Municipality	1
1.4	Preparing geodatabase and geoportal standards and guidelines	1
LOT-2	Developing Integrated Smart Municipal Geospatial Database	
2.1	Data Collection	1000 km ²
2.2	Densification / Updating Geodetic Network & CORS	20
2.3	Development of seamless DEMs	1000 km ²
2.4	Development of seamless Base Maps	1000 km ²
2.5	Development of seamless Image Maps	1000 km ²
2.6	Development of seamless Municipality Special Layers and other thematic layers	1000 km ²
2.7	Development of 3D City Models	1000 km ²
2.8	Data Conversion, Integration and establishment of Geodatabase	1000 km ²
LOT-3	Developing Smart Geoportal for Internal Users and External Users	1
3.1	Queries and search (addresses, major landmarks, POIs, etc.)	
3.2	Applications for major activities of the Municipality (commercial licenses, building permits, and other applications of spatially working departments, etc.)	
3.3	Updating graphical and attribute information by assigning authorizations	
3.4	Tendering and purchasing	
3.5	Property and License management	
3.6	Environmental management	
3.7	Analysis and reporting	
3.8	Web-based, tablet and mobile applications	
3.9	Bulk e-mail and mobile SMS messages	
LOT-4	Capacity Building and Training	
4.1	Formal Education of Municipality Staff Abroad on Geomatics Engineering (Higher Education) and IT	
4.2	Training of Municipality Staff on Geomatics Engineering and IT (Abroad & KSA)	2
4.3	Periodical Workshops and Conferences on Smart Municipality	2
LOT-5	Operation and Maintenance	
5.1	Operation and Maintenance of geospatial data updating	1
5.2	Operation and Maintenance of Geodatabase	1
5.3	Operation and Maintenance of Geoportal	1

2.1 Structure of this Document

This document consists of the following sections:

- SECTION 1: Introduction. This Introductory section outlines the background and purpose of the MMGIS project, the methodology being followed, and other general reference information.
- SECTION 2: Scope of The Project.
- SECTION 3: Assessment of Current Situation. This section provides the written text outlining the results of interviews that were conducted with representatives from all the participating departments. Conclusion of interviews, summary of current situation of geodatabase.
- SECTION 4: Project Methodology and Execution.
- SECTION 5: Deliverables and Project Management Team.
- SECTION 6: Work Program.
- Appendix A - Organizational Chart. This Appendix includes a detailed general organizational chart of Al Madinah Regional Municipality.
- Appendix B - Tables and Data Types of Columns. This Appendix includes data types of columns of tables which are using in MM current geodatabase.
- Appendix C - Work Program. This Appendix includes work program of project.

3 CURRENT SITUATION ASSESSMENT

GTC intends to follow a systematic process to develop a well-structured GIS design and implementation strategy that is specifically tailored to the current situation in MM and participating departments. A team of GTC was mobilized to support the initial program activities and an extensive process was undertaken to identify the departments that will play a major role in the initial formulation and implementation of the MMGIS. This Project Team has carried out interviews with management and representatives in participating department.

Information collected in the interview process has been used to understand the current information management situation in each department, and to develop a comprehensive digital catalog of all the fundamental information sources being used or generated in the context of their work. Information has also been collected regarding technical infrastructure in each department, and the identification of any special issues, opportunities or constraints that need to be addressed through the MMGIS building process.

3.1 STAKEHOLDERS INTERVIEWS

This section provides the written text outlining the results of interviews that were conducted with representatives from all the participating departments and data consumers.

3.1.1 Organizational Chart

A Detailed General Organizational Chart of Al Madinah Regional Municipality is in Appendix A.

3.1.2 General Department of IT, Department of GIS

General Department of IT Department of GIS is established 2006 and being managed by Mr. Akram Al SARANY.

GTC gave a presentation in this department about details of MMGIS project and interviewed with Mr.Akram Al SARANY, Department Manager, Mr.Abdullah Al MUHAMMEDI, Leader Group Representative, and Mr.Oğuzhan DABANLI, Leader Group Representative listed below.

Name and Title of persons interviewed:

#	Name	Section	Position	e-mail
1	Akram Al SARANY	GIS	Manager	akrams@amana-md.gov.sa
2	Abdullah Al MUHAMMEDI	GIS	Leader Group Representative	
3	Oğuzhan DABANLI	GIS	Leader Group Representative	

This department is the main and key stakeholder for MMGIS project, developing applications for all municipality, providing all GIS services and managing data. Department using MapInfo

software for data manipulation and managing database with Oracle 10g but planning upgrade to Oracle 11g. Department is executing approximately 500 transactions in every month and using customized applications.

All plan changes, control and adding changes to database are in the responsibility of this department.

They are planning to move to ESRI platform and need training about ESRI applications and products.

3.1.3 Construction and Development Agency, General Department of Urban Planning, Central Plans Department

Central Plans Department is responsible from more than 800 district plans of Madinah city and managed by Mr. Maher Mahmud Kazanli.

GTC interviewed with Mr. Maher Mahmud Kazanli, Department Manager and Mr. Muhammed Ramadan, Dar Al Riyadh Representative listed below.

Name and Title of persons interviewed:

#	Name	Section	Position	e-mail
1	Maher Mahmud Kazanli	Central Plans Dept.	Manager	
2	Muhammed Ramadan	Central Plans Dept.	Dar Al Riyadh Representative	

This department is responsible for planning public areas and public properties, but they can edit only parcels within the blocks, cannot edit blocks because block level editing is done by Ministry of Municipal and Rural Affairs (MOMRA). This department uses MapInfo software and TAB format for data manipulation. Department is receiving approximately 500 cases in a month, but they can solve only 350 ~ 400 of them. They send changed data to GIS/IT department for control and being added to the Municipality geodatabase.

3.1.3.1 Working Layers

TABLE_NAME	Description
DELETED_PARCEL	Deleted parcels
DELETED_PAR_BOUNDARY	Deleted plans boundaries
DELETE_GOV_LANDS	Deleted government lands
ELC_BLD_DETAILS_LINE	Sketch for non-registered deed
ELC_BLD_DETAILS_POLYGON	Sketch for non-registered deed
ELC_BLD_DETAILS_TEXT	Sketch for non-registered deed
ELC_BLD_LINE_REJECTED	Rejected
ELC_BLD_POLYGON_REJECTED	Rejected
ELC_BLD_TEXT_REJECTED	Rejected
ELC_BUILDINGS	Non-Registered Deed area
ELC_BUILDINGS_REJECTED	Rejected non-registered Areas
ELC_FORBIDEN_AREA	Forbidden area for non-registered deeds
GOV_LANDS	Government lands
GOV_LAND_TEMP	Temp layer for Government lands
IKHTIZAL_AREA	Expropriation of land for roads
IKHTIZAL_AREA_TEMP	Temp layer expropriation of land for roads
IKHTIZAL_WADI	Expropriation of land for valley
IKHTIZAL_WADI_TEMP	Temp layer expropriation of land for valley
NEW_PARCEL	Deed after re planned and approved

NEW_PARCEL_TEMP	Temp layer for new parcel
PARCEL	Parcels for planned area
PARCEL_IFRAZ	Divisions of parcel
PARCEL_IFRAZ_HISTORY	Backup of parcel which is divided
PAR_BOUNDRY	Plan Boundaries for Parcel
PLAN_FORBIDEN_AREA	Forbidden area for Deed

3.1.3.2 Applications

Application	Type	Related Tables
Plan dept. application (for re planning deed)	Oracle- Mapinfo	New_Parcel, Iktizal_area, Zaidah_area, Ikhtizal_wadi
Parcel Ifraz Application	Oracle- Mapinfo	Parcel_ifraz
Kahriba Bedun Sak Application	Oracle- Mapinfo	Elc_Buildings

3.1.4 Construction and Development Agency, General Department of Urban Planning, Allocation of Land to Government Agencies Department (Takhsis)

Allocation of Land to Government Agencies Department is responsible for allocating land for public use of government agencies and managed by Mr. Abdullah Al Turki.

GTC interviewed with Mr. Abdullah Al Turki, Department Manager and Mr. Yousef Al Ammri listed below.

Name and Title of persons interviewed:

#	Name	Section	Position	e-mail
1	Eng. Abdullah Al Turki	Allocation of Land to Government Agencies Dept.	Manager	
2	Yousef Al Ammri	Allocation of Land to Government Agencies Dept.		

This department can view Urban Plan layer without editing and no other GIS layers and applications are being used. They use Oracle form 6080 for query of incoming internal transaction and Oracle form 2030 for query of Registration Requests.

Basic requirements of this department are;

- Full coverage of Madinah region with the latest satellite images,
- Standardized data type,
- Identification of government plans,
- Identification of sensitive places in plans.

3.1.5 Investment & Land Agency, General Department of Land & Property

General Department of Land and Property is responsible for detection of land violation, land acquisition and donation of land operations and managed by Mr. Abdulaziz Al Saffar.

GTC interviewed with 5 people listed below.

Name and Title of persons interviewed:

#	Name	Section	Position	e-mail
1	Abdulaziz Al Saffar	General Department of Land & Property	Manager	
2	Abdullah Al Gabri	Grants department	Manager	
3	Mohammed Al Sahami	Istihkam department	Manager	
4	Maher Al Ahmadi	Istimlak department	Manager	
5	Tarek Al Rehali	Infringements department	Manager	

3.1.5.1 Working Layers

TABLE_NAME	Description
ILLEGAL_USAGE	Land violations layer
ISTIHKAM	Deed from Court
ISTIHKAM_OFF	Deed from Court office data
ISTIHKAM_OFF_TEXT	Sketch for Istihkam layer
IST_OFF_LINE	Sketch for Istihkam layer
IST_OFF_POINT	Sketch for Istihkam layer
IST_OFF_POLYGON	Sketch for Istihkam layer
LAND_DONATION	Land donations layer

3.1.5.2 Applications

Application	Type	Related Tables
Istihkam Application (for new Istihkam)	Oracle	Istihkam
Land Violation APPLICATION	Oracle	Illegal_Use
Land Acquisition APPLICATION	Oracle	Land_Acquisition
Land Donation APPLICATION	Oracle	LAND_DONATION

Basic requirement of this department is full coverage of Madinah Al Munawarah region with the latest satellite images.

3.1.6 Construction and Development Agency, General Department of Urban Planning, Naming and Numbering Department

Naming and Numbering Department is responsible for street naming and numbering and managed by Mr. Mohammed Al Jabiri.

GTC interviewed 2 persons listed below.

Name and Title of persons interviewed:

#	Name	Section	Position	e-mail
1	Mohammed Al Jabiri	Naming and Numbering Department	Manager	
2	Ibraheem Saad			

3.1.6.1 Working Layers

TABLE_NAME	Description
BUILDING	Building data
STREETCENTERS	Street center lines

3.1.6.2 Applications

Application	Type	Related Tables
Naming and numbering application	Oracle-Mapinfo	Streetcenters, Buildings
Entering new parcel street number and building number application	Oracle-Mapinfo	New_Parcel

Oracle Input Forms

- 1010 registration of municipalities and region
- 1020 registration of district data
- 1040 registration of street data
- 1045 geographic location and aerial photo
- 1050 record street data outside the city
- 1070 complete main street data
- 1030 registration of boards
- 8010 add street labels
- 1001 comparison of the street names with the ministry

Oracle Query Forms

- 1010 general query for street
- 1020 query by district and region
- 1030 statistical queries about streets

Oracle Report Forms

- 1010 general report for municipalities, region and districts

- 1020 detailed report for municipalities, region and districts
- 1030 report for streets and boards
- 1040 report for street by region
- 1043 general report for streets

Basic requirement of this department is full coverage of Madinah region with the latest satellite images.

3.1.7 Construction and Development Agency, General Department of Construction Licenses, Construction Licenses Department

Construction Licenses Department is responsible for building permits and managed by Mr. Moied Birri.

GTC interviewed with manager of the department listed below.

Name and Title of persons interviewed:

#	Name	Section	Position	e-mail
1	Moied Birri	Construction Licenses Dept.	Manager	

3.1.7.1 Working Layers

TABLE_NAME	Description
ABND_BUILDING	Abandoned Buildings
BLD_PENALTY	Building Penalty
BLD_PERMITS	Building Permits
BLD_PER_OFF	Building Permits from Office
DEMOLISH_BLD	Demolished building layers

3.1.7.2 Applications

Application	Type	Related Tables
Building permits application	Oracle	Building permits
DEMOLISH_BUILDING application	Oracle	DEMOLISH_BUILDING
BUILDING_PENALTY application	Oracle	BUILDING_PENALTY
Abandoned_Building application	Oracle	ABND_BUILDING

Basic requirement of this department is full coverage of Madinah region with the latest satellite images.

3.1.8 Construction and Development Agency, General Department of Urban Planning, Merging & Splitting Department

Merging and Splitting Department is responsible for finalizing the disputed parcels according to the municipality decisions or according to the agreement between two parties and managed by Mr. Merwan Snaini.

GTC interviewed with manager of the department listed below.

Name and Title of persons interviewed:

#	Name	Section	Position	e-mail
1	Merwan Sniani	Merging & Splitting Dept.	Manager	

3.1.8.1 Working Layers

TABLE_NAME	Description
PARCEL	Parcels for planed area
PAR_BOUNDARY	Plan Boundaries for Parcel
LANDUSE	Land uses
STREETCENTERS	Street centers lines
STREETNETWORK	Street network line
WADI	Valley

3.1.8.2 Applications

This department using oracle forms but needs applications according to their work flow. Basic requirement is full coverage of Madinah region with the latest satellite images.

3.1.9 Construction & Development Agency, General Department of Survey and Land Issues, Surveying Department

Surveying Department is responsible mainly for field survey and managed by Mr. Ahmed Al Rashid Al Ahmdy.

GTC interviewed with manager of the department listed below.

Name and Title of persons interviewed:

#	Name	Section	Position	e-mail
1	Ahmed Al Rashid Al Ahmdy	Surveying Dept.	Manager	

3.1.9.1 Working Layers

TABLE_NAME	Description
DEED	Sak table after Approved from Survey Dept.
DELETED_DEED	Deleted Deed
DELETED_IKHTIZAL_AREA	Deleted Ikhtizal (expropriation of land for roads)
DELETED_IKHTIZAL_WADI	Deleted Ikhtizal wadi (expropriation of land for valley)
DELETED_ISTHKAM	Deleted Deed from which is coming Court
DELETED_NEW_PARCEL	Deleted Deed After re planed according to roads
DELETED_ZAIDAH_AREA	Deleted zaidah area
KARAR_IKHTIZAL	Data for approve which re planed area (Deed)
KARAR_IKHWADI	Data for approve which re planed area (Deed)
KARAR_NEW_PARCEL	Data for approve which re planed area (Deed)
KARAR_REMAIN	Data for approve which re planed area (Deed)
KARAR_ZAIDAH	Data for approve which re planed area (Deed)
SAK	Pre-Deed which prepared by Eng. Office
SAK_DETAILS_LINE	Sketch of SAK
SAK_DETAILS_POINT	Sketch of SAK
SAK_DETAILS_POLYGON	Sketch of SAK
SAK_DETAILS_TEXT	Sketch of SAK

3.1.9.2 Applications

Application	Type	Related Tables
Survey application (for new deed)	Oracle	Deed
Karar Zreaa Application	Oracle	New_Parcel, Iktizal_area, Zaidah_area, Ikhtizal_wadi
Beyanat mevkia Application	Oracle	New_Parcel, Iktizal_area, Zaidah_area, Ikhtizal_wadi

Basic requirement of this department is GPS hardware and GIS training along with more skilled staff. Using 1010 and 2010 oracle forms

3.1.10 Projects Agency, General Department for Studies and Designs

Studies and Designs Department is responsible for designing streets, wadis, wadi paths, bridges, tunnels, public utilities, lighting and gardens and managed by Mr. Raed Hidar.

GTC interviewed with manager of the department listed below.

Name and Title of persons interviewed:

#	Name	Section	Position	e-mail
1	Raed Hidar	Studies and Designs Dept.	Manager	

3.1.10.1 Working Layers

TABLE_NAME	Description
ELECT_STATIONS	Electric Stations
HEJAZ_RAILWAY	Hijaz railway
HISTORICAL_PLACES	Historical places
LANDUSE	Land uses
LANDUSE_MODIFICATIONS	Land uses modifications
LANDUSE_TEMP	Temp layer for land use
MAINRDCURB	Main road curb
MAIN_ROADS	Main Roads
MAX_BUILDING_HIGH	Maximum building floor number
MP_BOXED_CHANNEL	Master plan boxed channel
MP_CENTERLINE	Master plan street centers lines (old)
MP_CURB	Master plan sidewalk lines
MP_CURB_MODIFICATIONS	Modifications of master plan curb
MP_CURB_TEMP	Temp layer for master plan curb
MP_ELEC_LINE	Master plan electric lines
MP_ELEC_TOWER	Master plan electric towers
MP_TANZEEM	Master plan areas for constructions
MP_TANZEEM_MODIFICATIONS	Modifications of master plan tanzeem
MP_TANZEEM_TEMP	Temp layer for master plan tanzeem
MP_WATER_LINE	Master plan water lines
STUDIES_CHANGES	Master plan tanzeem and Master plan Curb modifications area

3.1.10.2 Applications

Application	Type	Related Tables
Tanzeem, Curb and Land use modification App.	Oracle-Mapinfo	Mp_tanzeem, Mp_curb, Landuse

Basic requirement of this department is full coverage of Madinah region with the latest satellite images and need GIS applications.

3.2 CONCLUSIONS

Geographic Information System (GIS) is one of the most important component to support and consolidate multiple systems. GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. GIS allows us to view, understand, query, interpret and visualize data in many ways that reveal relationships, patterns and trends in the form of maps, globes, reports, and charts. GIS technology can be integrated into any enterprise information system framework.

3.2.1 Table Description and Department Usage

Summary descriptions of all tables and editing layers for which department, also base map situation of tables is in Table 2.

In this table “Table Name” column states data which is used by departments, “Working Layer” column states which department can edit and change data and “Base Map” column states that table is being used as a base map or not.

Table 2 Table Description and Department Usage

TABLE NAME	Description	Working Layer	Base Map
ABND_BUILDING	Abandoned Buildings	Building Permits Dept.	NA
AIRPORT_BUILDING_HEIGHTS	Airport Max building heights		ALL
ATM_BANK	Atms		ALL
BAQI_NEW_PLOT	Baqi Plots	Baqi Dept.	NA
BAQI_NEW_POLY	Baqi Areas	Baqi Dept.	NA
BELAG_940	Complaint cleaning points	Cleaning Dept.	NA
BELEDIYE	Municipalities Area		ALL
BENCH_MARKS_FOR_ROADS	Road Control Points		ALL
BLD_PENALTY	Building Penalty	Building Permits Dept.	NA
BLD_PERMITS	Building Permits	Building Permits Dept.	NA
BLD_PER_OFF	Building Permits from Office	Building Permits Dept.	NA
BUILDING	Building data	Street Dept.	ALL
BUILDING_NO	Building no		ALL
DEED	Sak table after Approved from Survey Dept.	Survey Dept.	ALL
DELETED_DEED	Deleted Deed	Survey Dept.	NA
DELETED_IKHTIZAL_AREA	Deleted Ikhtizal (expropriation of land for roads)	Survey Dept.	NA

TABLE NAME	Description	Working Layer	Base Map
DELETED_IKHTIZAL_WADI	Deleted Ikhtizal wadi (expropriation of land for valley)	Survey Dept.	NA
DELETED_ISTHKAM	Deleted Deed from which is coming Court	Survey Dept.	NA
DELETED_NEW_PARCEL	Deleted Deed After re planed according to roads	Survey Dept.	NA
DELETED_PARCEL	Deleted parcels	Planning Dept.	NA
DELETED_PAR_BOUNDRY	Deleted plans boundaries	Planning Dept.	NA
DELETED_ZAIDAH_AREA	Deleted zaidah area	Survey Dept.	NA
DELETE_GOV_LANDS	Deleted government lands	Planning Dept.	NA
DEMOLISH_BLD	Demolished building layers	Building Permits Dept.	NA
DIGGING_FORBIDDEN_AREA	Forbidden area for digging	Digging Dept.	NA
DIGG_LOGO	Digging Logo for departments	Digging Dept.	NA
DIGG_PERMITS	Digging layer	Digging Dept.	NA
DIGG_PERMITS_COMPLETED	Digging completed	Digging Dept.	NA
DIGG_PERMITS_REJECTED	Digging rejected	Digging Dept.	NA
DISTRICT	District		ALL
DRAFT_PLAN	Old Deeds		ALL
ELC_BLD_DETAILS_LINE	Sketch for non-registered deed	Planning Dept.	NA
ELC_BLD_DETAILS_POLYGON	Sketch for non-registered deed	Planning Dept.	NA
ELC_BLD_DETAILS_TEXT	Sketch for non-registered deed	Planning Dept.	NA
ELC_BLD_LINE_REJECTED	Rejected	Planning Dept.	NA
ELC_BLD_POLYGON_REJECTED	Rejected	Planning Dept.	NA
ELC_BLD_TEXT_REJECTED	Rejected	Planning Dept.	NA
ELC_BUILDINGS	Non-Registered Deed area	Planning Dept.	NA
ELC_BUILDINGS_REJECTED	Rejected non-registered Areas	Planning Dept.	NA
ELC_FORBIDEN_AREA	Forbidden area for non-registered deeds	Planning Dept.	NA
ELECT_STATIONS	Electric Stations	Studies Dept.	ALL
EXECUTIVE_COMMITTEE	Executive committee		ALL
FENCE	Fence		ALL
FORBIDEN_LND	Forbidden lands for building permits		ALL
GAS_STATION	Gas Stations points		ALL
GOV_LANDS	Government lands	Planning Dept.	ALL

TABLE NAME	Description	Working Layer	Base Map
GOV_LAND_TEMP	Temp layer for Government lands	Planning Dept.	NA
GREATMADINAH AL MUNAWARAH	Madinah center Municipality Area		ALL
GRID1000	As-is 1000 scale grids		ALL
GRID10K	As-is 10K scale grids		ALL
GRID2500	As-is 2500 scale grids		ALL
GRID_OLDMAPS1387	Old maps 1387 grid		ALL
HAJLIC	Hotel licenses for Haj	Licenses Dept.	ALL
HARAM_NEW_EXTENSION	Demolish Area Extension for Mescid al Nebevi		ALL
HEJAZ_RAILWAY	Hijaz railway	Studies Dept.	ALL
HISTORICAL_PLACES	Historical places	Studies Dept.	ALL
HUDUDALHARAM	Haram Area		ALL
IKHTIZAL_AREA	Expropriation of land for roads	Planning Dept.	ALL
IKHTIZAL_AREA_TEMP	Temp layer expropriation of land for roads	Planning Dept.	NA
IKHTIZAL_WADI	Expropriation of land for valley	Planning Dept.	ALL
IKHTIZAL_WADI_TEMP	Temp layer expropriation of land for valley	Planning Dept.	NA
ILLEGAL_USAGE	Land violations	Land Dept.	ALL
ISTIHKAM	Deed from Court	Land Dept.	ALL
ISTIHKAM_OFF	Deed from Court office data	Land Dept.	NA
ISTIHKAM_OFF_TEXT	Sketch for Istihkam layer	Land Dept.	NA
IST_OFF_LINE	Sketch for Istihkam layer	Land Dept.	NA
IST_OFF_POINT	Sketch for Istihkam layer	Land Dept.	NA
IST_OFF_POLYGON	Sketch for Istihkam layer	Land Dept.	NA
KARAR_IKHTIZAL	Data for approve which re planned area (Deed)	Survey Dept.	NA
KARAR_IKHWADI	Data for approve which re planned area (Deed)	Survey Dept.	NA
KARAR_NEW_PARCEL	Data for approve which re planned area (Deed)	Survey Dept.	NA
KARAR_REMAIN	Data for approve which re planned area (Deed)	Survey Dept.	NA
KARAR_ZAIDAH	Data for approve which re planned area (Deed)	Survey Dept.	NA
LANDMARK	Landmarks		ALL
LANDUSE	Land uses	Studies Dept.	ALL
LANDUSE_MODIFICATIONS	Land uses modifications	Studies Dept.	NA
LANDUSE_TEMP	Temp layer for land use	Studies Dept.	NA

TABLE NAME	Description	Working Layer	Base Map
LAND_DONATION	Land donations	Land Dept.	NA
LOCATION	Location according to ring roads		NA
MAINRDCURB	Main road curb	Studies Dept.	ALL
MAIN_ROADS	Main Roads	Studies Dept.	ALL
MARHUM	Dead People grave	Baqi Dept.	NA
MAX_BUILDING_HIGH	Maximum building floor number	Studies Dept.	ALL
MP_BOXED_CHANNEL	Master plan boxed channel	Studies Dept.	ALL
MP_CENTERLINE	Master plan street centers lines (old)	Studies Dept.	ALL
MP_CURB	Master plan sidewalk lines	Studies Dept.	ALL
MP_CURB_MODIFICATIONS	Modifications of master plan curb	Studies Dept.	ALL
MP_CURB_TEMP	Temp layer for master plan curb	Studies Dept.	ALL
MP_ELEC_LINE	Master plan electric lines	Studies Dept.	ALL
MP_ELEC_TOWER	Master plan electric towers	Studies Dept.	ALL
MP_TANZEEM	Master plan areas for constructions	Studies Dept.	ALL
MP_TANZEEM_MODIFICATIONS	Modifications of master plan tanzeem	Studies Dept.	Na
MP_TANZEEM_TEMP	Temp layer for master plan tanzeem	Studies Dept.	Na
MP_WATER_LINE	Master plan water lines	Studies Dept.	ALL
MUSEUMS	Museums		ALL
NEIGH	Neighborhood		ALL
NEW_PARCEL	Deed after re planned and approved	Planning Dept.	ALL
NEW_PARCEL_TEMP	Temp layer for new parcel	Planning Dept.	NA
OLDGRID1000	Old maps 1000 scale grid		ALL
OLD_SHOPS	Deleted shops	Licenses Dept.	Na
PARCEL	Parcels for planned area	Planning Dept.	ALL
PARCEL_IFRAZ	Divisions of parcel	Planning Dept.	NA
PARCEL_IFRAZ_HISTORY	Backup of parcel which is divided	Planning Dept.	NA
PARKING_LINES	Parking lines		ALL
PAR_BOUNDRY	Plan Boundaries for Parcel	Planning Dept.	ALL
PETROL_STATION	Petrol Stations		ALL
PLAN_FORBIDEN_AREA	Forbidden area for Deed	Planning Dept.	NA
RAILWAY	Railway		ALL
RP_MARAKIZ_SHADED	Centers of residential Madinah regions		ALL

TABLE NAME	Description	Working Layer	Base Map
RP_MUHAFAZAT_SHADED	Muhafazat areas for Madinah regions		ALL
SAK	Pre-Deed which prepared by Eng. Office	Survey Dept.	NA
SAK_DETAILS_LINE	Sketch of SAK	Survey Dept.	NA
SAK_DETAILS_POINT	Sketch of SAK	Survey Dept.	NA
SAK_DETAILS_POLYGON	Sketch of SAK	Survey Dept.	NA
SAK_DETAILS_TEXT	Sketch of SAK	Survey Dept.	NA
SHOPS	Shops points	Licenses Dept.	Na
SIDEWALK	Sidewalk (old)		ALL
STREETCENTERS	Street centers lines	Street Dept.	ALL
STREETNETWORK	Street network line		ALL
STUDIES_CHANGES	Master plan tanzeem and Master plan Curb modifications area	Studies Dept.	NA
SURVEY_CAUTION_AREA	Survey caution area		ALL
TARMEEM	Restoration of building	Tarmeem Dept.	Na
TICARI_ROAD_BUFFER	Commercial streets buffer		ALL
VALVES	Valves		ALL
WADI	Valley	Wadi Dept.	ALL
WADI_CENTER	Center lines of valley	Wadi Dept.	NA
WADI_MODIFICATIONS	Modifications of valley	Wadi Dept.	NA
WADI_PERMITS	Permits for sand in valley	Wadi Dept.	NA
WADI_TEMP	Temp layer for valley	Wadi Dept.	NA
WADI_VIOLATIONS	Violations for valley	Wadi Dept.	NA
ZAIDAH_AREA	Addition area for new_parcel	Planning Dept.	ALL
ZAIDAH_AREA_TEMP	Temp layer for zaidah		ALL
ZAIDAH_EXPROPRIATION	Zaidah expropriation		ALL

3.2.2 Applications by Departments and Related Tables

Applications used by departments and related tables are in Table 3. This table explains summary of applications that are used by which department and with which tables.

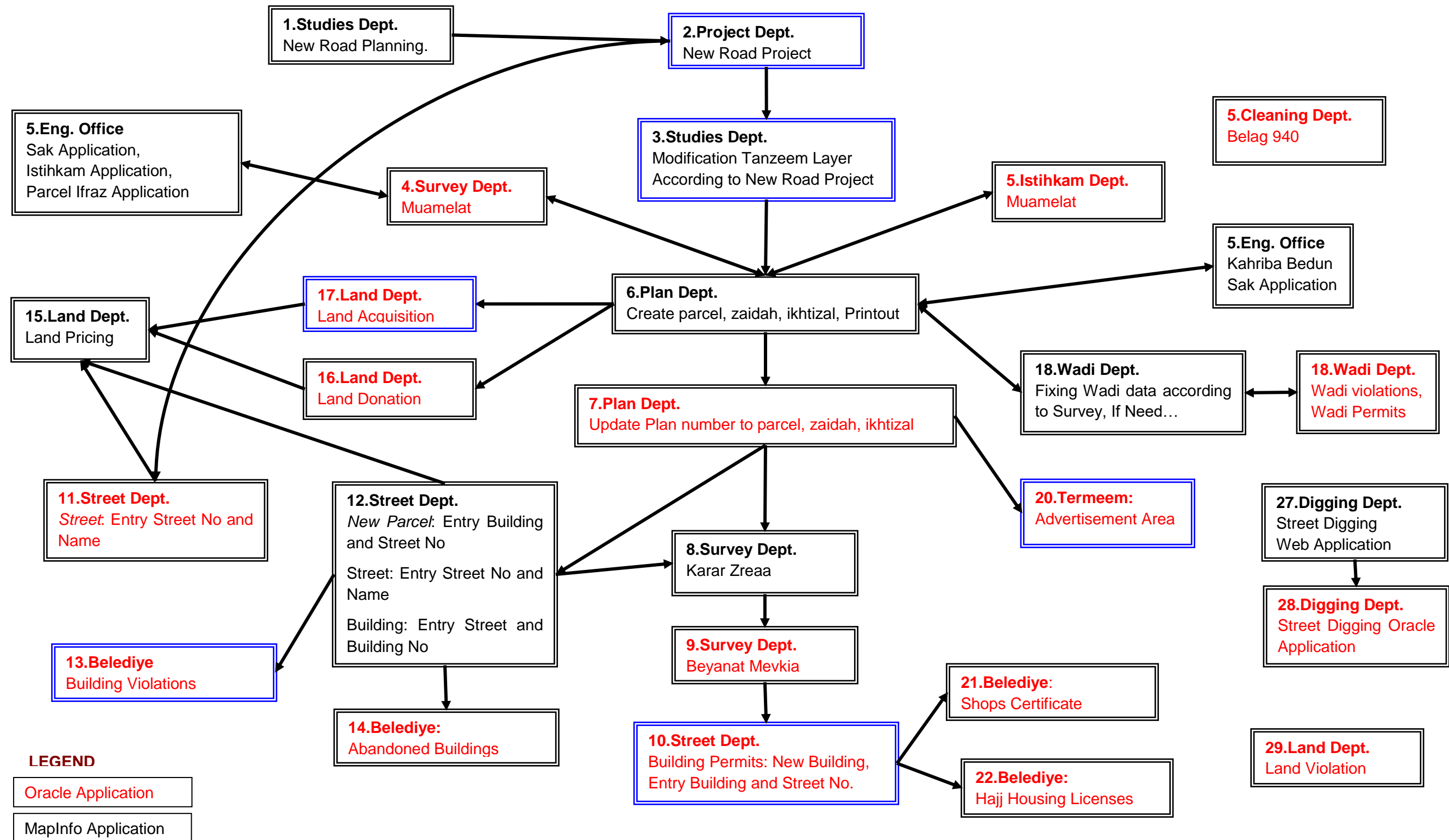
Table 3 Applications by Departments and Related Tables

NO	DEPARTMENT	Type	Related Tables
A	GENERAL AMANAH APP.		
1	MAPOLE	Ole Application	All tables
B	GENERAL DEPT. FOR STUDIES AND DESIGNS		
2	Tanzeem, Curb and Land use modification App.	Oracle-Mapinfo	Mp_tanzeem, Mp_curb, Landuse
C	SURVEYING DEPT.		
3	Survey application (for new deed)	Oracle	Deed
4	Karar Zreaa Application	Oracle	New_Parcel, Iktizal_area, Zaidah_area, Ikhtizal_wadi
5	Beyanat mevkia Application	Oracle	New_Parcel, Iktizal_area, Zaidah_area, Ikhtizal_wadi
D	CENTRAL PLANS DEPT.		
6	Plan dept. application (for re planning deed)	Oracle-MapInfo	New_Parcel, Iktizal_area, Zaidah_area, Ikhtizal_wadi and Temp
7	Parcel Ifraz Application	Oracle-MapInfo	Parcel_ifraz
8	Kahriba Bedun Sak Application	Oracle-MapInfo	Elc_Buildings
E	NAMING AND NUMBERING DEPT.		
9	Naming and numbering application	Oracle-MapInfo	Streetcenters, Buildings
10	Entering new parcel street no and building number app	Oracle-MapInfo	New_Parcel
F	GENERAL DEPT. FOR LAND & PROPERTY		
11	Istihkam Application (for new istihkam)	Oracle	Istihkam
12	Land Violation APPLICATION	Oracle	Illegal_Use

NO	DEPARTMENT	Type	Related Tables
13	Land Acquisition APPLICATION	Oracle	Land_Acquisition
14	Land Donation APPLICATION	Oracle	LAND_DONATION
G	Wadis Permits Dept.		
15	Wadi Application (for modification wadi layer)	Oracle-MapInfo	Wadi, Wadi_centers
16	Wadi Violation application	Oracle	Wadi Violation
17	Wadi Permits application	Oracle	Wadi Permits
H	Supervision of Excavations Dept.		
18	Digging internet application (for new digging)	Web Based Application	Digg_Permits, Digg_Logo
19	Digging desktop application (for approve)	Oracle-MapInfo	Digg_permits
I	Termeem Dept.		
20	Termeem application	Oracle	Tarmeem
J	ENG OFFICES APPLICATION		
21	Survey application for offices	MapInfo	Sak, Sak_details_point, Sak_details_line, Sak_details_polygon, Sak_details_text
22	Istihkam application for offices	MapInfo	Ishtihkam_off, Ishtihkam_details_point, Ishtihkam_details_line, Ishtihkam_details_polygon, Ishtihkam_details_text
23	Kahriba Bedun Sak Office Application	Autocad-.net Application	ELC_Buildings_kml, ELC_Building
24	Parcel Ifraz Office Application	MapInfo	Parcel_Ifraz
K	General Dept. of Construction Licenses		
25	Building permits application	Oracle	Building permits
26	DEMOLISH_BUILDING application	Oracle	DEMOLISH_BUILDING
27	BUILDING_PENALTY application	Oracle	BUILDING_PENALTY

NO	DEPARTMENT	Type	Related Tables
28	Abandoned_Building application	Oracle	ABND_BUILDING
L	LICENSES DEPT.		
29	Shops Certificate Application	Oracle	Shops, Old_Shops
30	Hajj Housing Licenses application	Oracle	HajLic
M	CLEANING DEPT.		
31	Belag_940 Application	Web Based Application	Belag_940

3.2.3 Existing GIS Applications Flow Chart



3.2.4 Departments Decentralized Data (Unshared)

Departments of municipality that have unshared data list is in Table 4.

Table 4 Decentralized Data

No	Department
1	Regional Planning
2	Irrigation and Garden
3	Storm and Drainage
4	Street Lighting
5	Project
6	Investment

3.2.5 Raster Images

Property, date and resolution of existing raster images are in Table 5.

Table 5 Raster Images

Raster NAME ARB	Raster Name	Property
المجسم الطبوغرافي 1000	combine_ecw	
المصور الفضائي بدقة 1 م	ikonos_all	Ikonos 1 m satellite image
المصور الفضائي بدقة 10 متر	spot_10r	Spot 10 m satellite image
التصوير الفضائي 2004	qb2004	QuickBird Satellite image 2004
التصوير الفضائي 2005	QB2005	QuickBird Satellite image 2005
التصوير الفضائي 2006	Madinah2006ecw	Satellite image 2006
التصوير الفضائي 2009	NEW_QB_2009	QuickBird Satellite image 2009
المصور الجوي 1-50,000	Madinah_50K	Aerial photo
مصور فضائي الحناكية_2015	Al_Hinakiyah_GeoEye_2015	GeoEye Satellite image 2015
مصور فضائي ينبع النخل	Yanbu_al_Nakal	Satellite image
مصور فضائي ينبع	Yanbu	Satellite image
مصور فضائي مهد الذهب	Mehad_Al_Zeheb2009	Satellite image 2009
مصور فضائي بدر_2015	Badr_GeoEye_2015	GeoEye Satellite image 2015
مصور فضائي السويقية	AL_SWAIRQIAH2010	Satellite image 2010
مصور فضائي الجديد	AL_JADIDAH2010	Satellite image 2011
مصور فضائي العشائر	AL_ASIHAR_2010	Satellite image 2012
مصور فضائي العلا	Al_Ullah	Satellite image
التصوير الفضائي 2011	Madinah2011	Satellite image 2011
المصور الجوي للمدينة المنورة - 2012	Madinah_Ortho_Mosaic_All	Aerial photo 2012
التصوير الفضائي 2014-2015	Madinah_2014_2015	Satellite image 2014-2015
Al_Easse2010	Al_Easse2010	
التصوير الفضائي 2015	Madinah_GeoEye_2015	GeoEye Satellite image 2015
مصور فضائي الرايس_2015	Ar_Rayis_GeoEye_2015	GeoEye Satellite image 2015
KSA_WMS_5m_2015	KSA_WMS_5m	

4 PROJECT METHODOLOGY AND EXECUTION

The technical proposal of GTC is provided in this Section, including the methodologies to be used. The foundation of this proposal is our capabilities and experience in Middle East, Saudi Arabia and Africa as far as the tasks of this project are concerned.

GENERAL PRINCIPLES

The project methodology here covers the following activities:

- Production of orthophoto maps,
- Vectorization, georegistration of plans and drawings,
- Development of 3D Geospatial data
- Data conversion,
- Geodatabase and Geoportal establishment
- Quality Assurance / Quality Checking
- Delivery of the products.

The detailed work flow of the project can be seen in Figure 2. The brief introduction of each of the activities above is provided below.

Imagery:

- Orthorectification and mosaicking of imagery

DEM / DSM Compilation:

- Compilation of 1-2m DEMs / DSMs from images
- Compilation of object-based 3D geospatial data
- Preparation of Continuous terrain to the resolution of imagery

Vectorization and Georegistration

- Vectorization for project parcels using orthorectified/scanned imagery
- Verification of inconsistencies from received inputs
- Documentation and Submitting to Client
- Georegistration of plans and drawings using orthorectified imagery
- Data Conversion Specification preparation/editing and Submitting for approval from Client
- Checklist preparation

Data Conversion:

- Parcel line Digitization and Attribution
- Issue Documentation and submitting to client
- Resolved issues updating
- Geodatabase Status updating

Quality Assurance / QC:

- Quality Assurance w.r.t Specification Handbook and Checklist
- Verification of Pending & Resolved issues Vs Related tiles
- Fixing inconsistencies
- Documentation of Inconsistencies
- Updating of database and checklist

Delivery:

- Merging of individual Tiles
- Topology Checking and Cleanup
- Converting Data into SHP file/s
- Shipment Notes preparation
- Known issues documentation
- Uploading into GTC or Client specified FTP

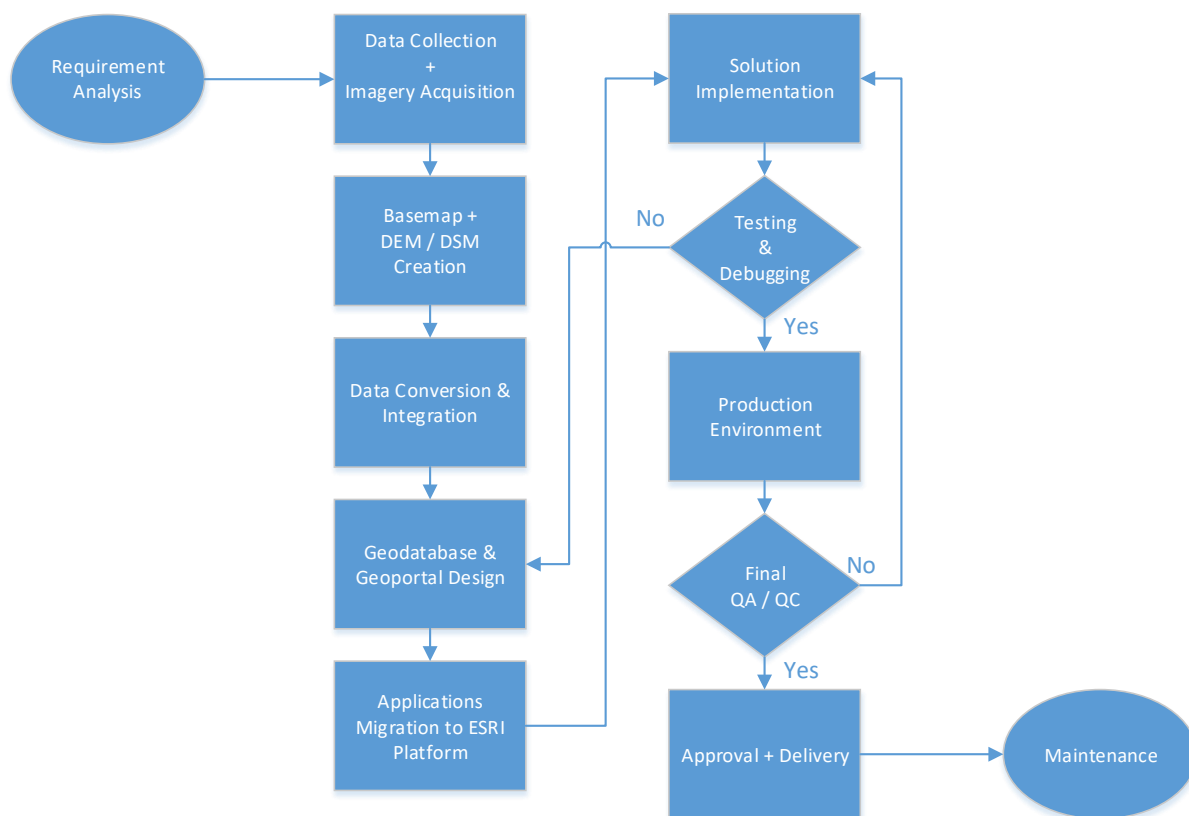


Figure 2 Methodology and Detailed Work Flow

REFERENCE SYSTEMS TO BE USED IN THE PROJECT

This Section addresses the horizontal and vertical reference systems to be used in this project. These reference systems are in conformance with the national systems as established by Ministry of Municipal and Rural Affairs (MOMRA).

National reference systems are generally defined by its datum and projection. Datum is the definition of (i) geodetic control / reference systems by determining the national ellipsoid, its position and orientation with respect to the center of the earth. It is to be noted that projections are the representation of features on the ellipsoid on planar surfaces, (ii) vertical control by determining height surface, usually with reference to geoid surface defined by Mean Sea Level.

Horizontal Reference System

The horizontal reference system to be used in this project is **MOMRA Geodetic Datum 2000 (MTRF-2000)** which is based on the International Terrestrial Reference Frame (ITRF) with ITRF-2000 datum and 2004.0 epoch. It consists of 13 x Geodetic Fiducial Network and 659 x Geodetic Main Networks with average point spacing of 50 km (Figure 3). The GFN and GMN stations have precision to Special Order AA and AB corresponding to 0.01 and 0.1 ppm respectively. The project was completed by Geotech in 2004 for MOMRA. The MTRF-2000 definition is given Table 6. As part of the said project, the national transformation from the old Ain Al Abd datum to the MTRF-2000 datum was also determined.

Table 6 The definition of the National Reference System of Saudi Arabia

Datum	MOMRA Geodetic Datum (SGD2000) based on ITRF2000 Datum
Coordinate Epoch	2004.0
Ellipsoid	Geodetic Reference System 1980 (GRS80)
Semi-major axis (a) Inverse flattening (1/f)	6,378,137.0 meters / 298.257222101
Grid coordinates (Universal Transverse Mercator)	Map Grid of Saudi Geodetic Datum 2000 Latitude of origin: 0° 00' 00" N False Easting: 500,000. m False Northing: 0. m Scale Factor at Central Meridian 0.9996

Here, as projection, GTC will use the Universal Transverse Mercator (UTM), which is nationally used for mapping in Saudi Arabia. Since Saudi Arabia is a vast country, it is covered by 5 UTM zones 36, 37, 38, 39 and 40 as illustrated in Figure 4.

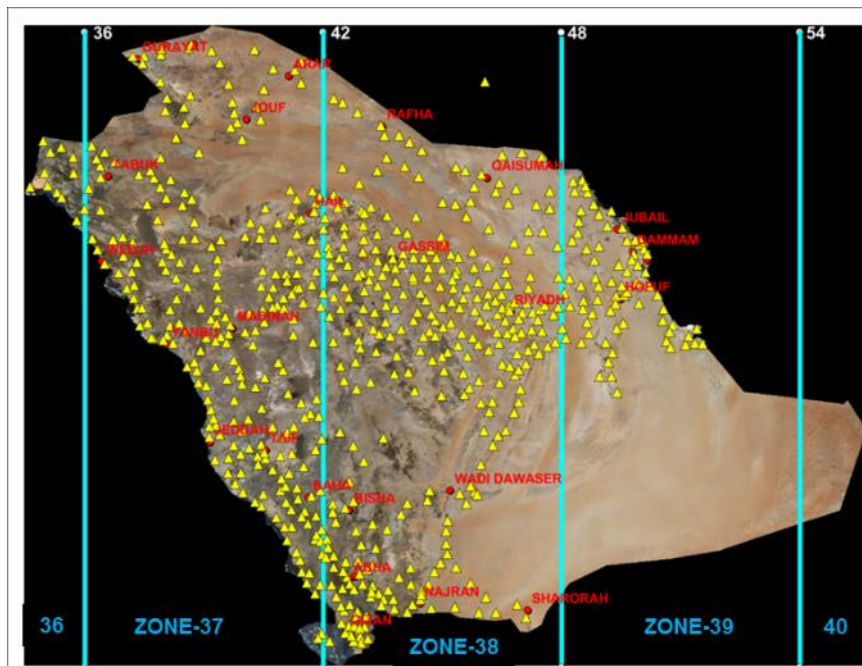


Figure 3 MOMRA GFN and GMN stations together with the UTM Zones

As projection, Saudi Arabia is using Universal Transverse Mercator (UTM) consisting of 5 zones (Zone-36, Zone-37, Zone-38, Zone-39 and Zone-40) as illustrated in Figure 4. Madinah is in Zone-37.

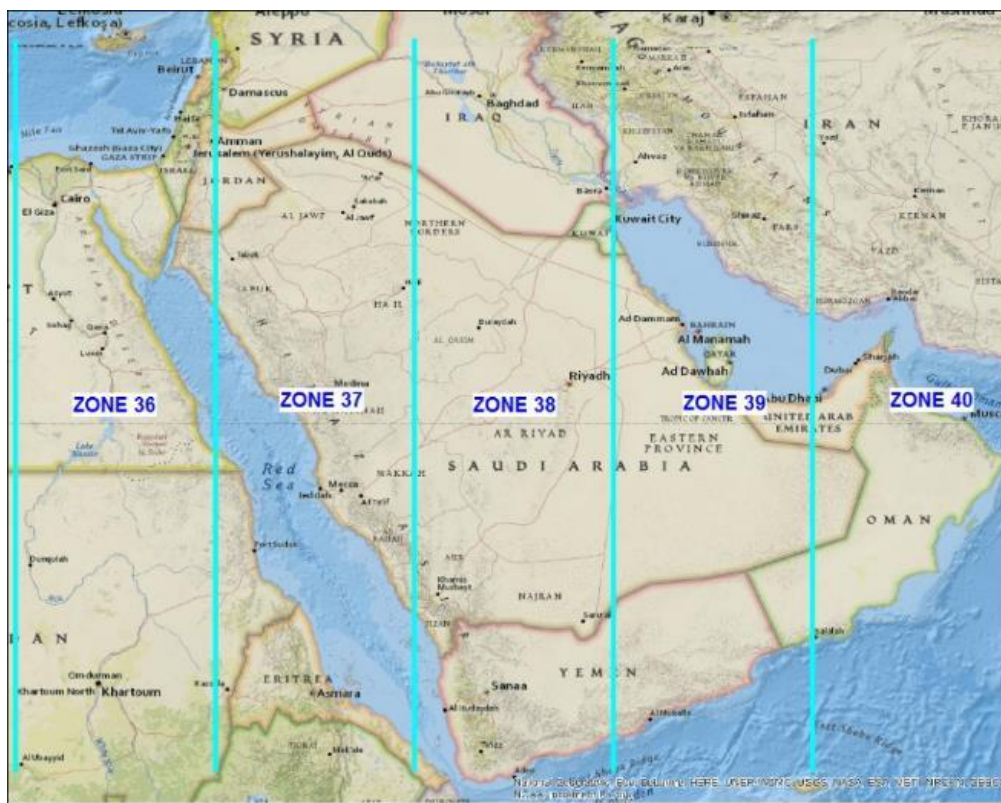


Figure 4 Saudi Arabia and UTM Zones

Vertical Reference System

In late 1960s, the vertical datum for Saudi Arabia was established based on about 1100 benchmarks established with high precision differential leveling and tied to several tide gauges station along the Eastern and the Western coasts. This was designated as Jeddah 1969 Vertical Datum. This vertical datum has been used for all older and some new topographic mapping carried out by the MINISTRY during the 1990s.

More recently, about 1500 km of precision differential leveling has been completed to fill large gaps amongst existing benchmarks and to provide additional benchmarks mainly in and around major population centers in Saudi Arabia. The entire vertical network considered by MOMRA is illustrated in Figure 5.

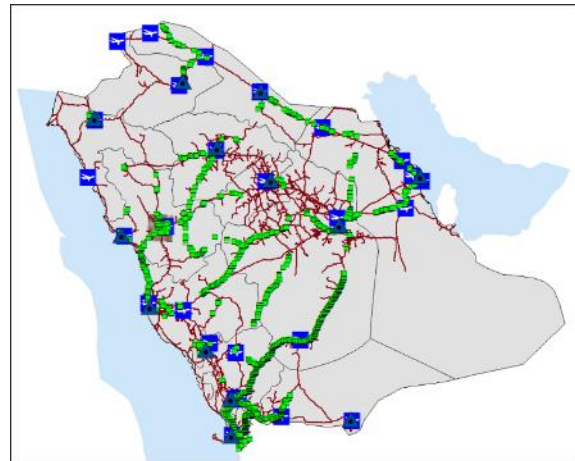


Figure 5 The vertical control network of Saudi Arabia adopted by MOMRA

So, to convert the ellipsoidal height (h) into the orthometric height (H), one needs to know the geoid undulation (N), i.e. geoid height at the desired station (Figure 6).

$$H = h - N$$

The geoid itself can be calculated from diverse types of data. One of the simplest methods is to use GPS/Leveling points, where both the ellipsoidal and orthometric heights are given. From this data, the geoid heights can be calculated using the expression above.

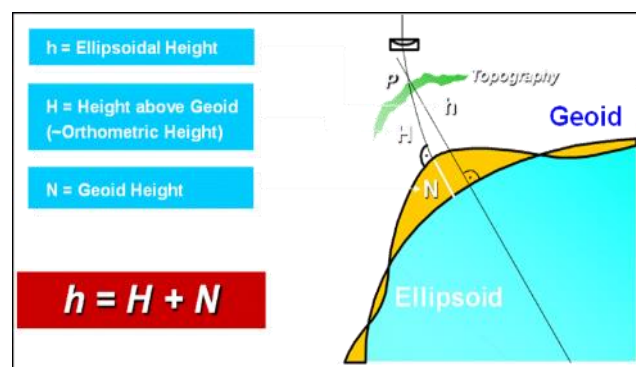


Figure 6 The relation between orthometric, ellipsoidal and geoid heights

The data from old recovered benchmarks and the new benchmarks has been analyzed to refine the EGM96 Geoid Model as well as the more recent EGM2008 Geoid Model for the Kingdom of Saudi Arabia, resulting in the establishment of MOMRA Vertical Datum 2008 (MVD-2008). This has enabled the MINISTRY to use GNSS surveys to precisely establish ellipsoidal heights for new ground control stations and then apply more reliable correction for geoidal heights to derive orthometric height for any newly established control point.

Continuously Operating Reference Stations (CORS) to be Used

The main goal of these CORS is 24-hour RTK operation throughout the Project area. GTC will establish Continuously Operating Reference Stations (CORS) and link them to the existing national CORS of MOMRA and municipalities, which are shown in Figure 7. In the MM project area, we have complete CORS coverage to carry out GPS/GNSS surveys and geodetic positioning.

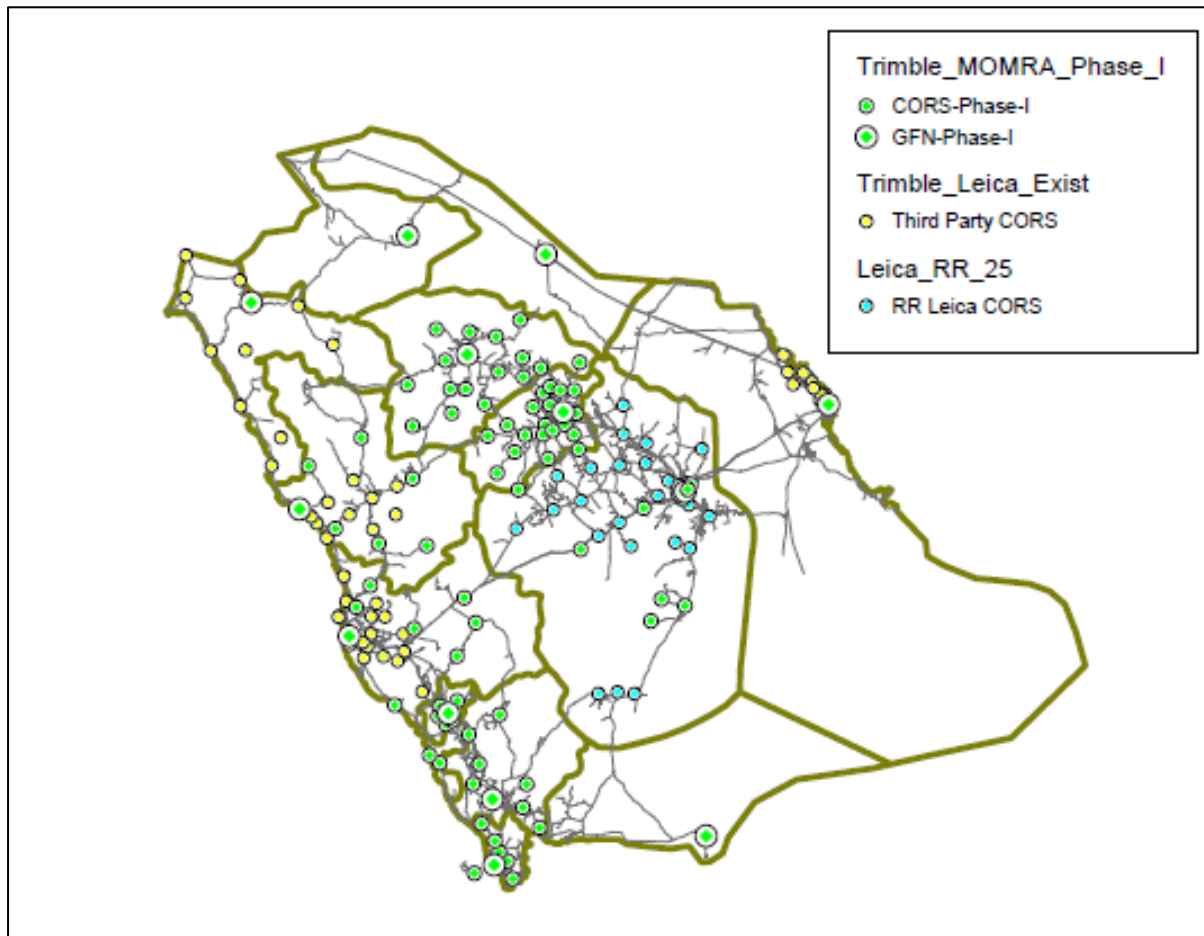


Figure 7 Existing CORS of MOMRA and Others

4.1 Designing all the components of Smart Madinah Municipality

GTC has formed a very strong organization and is carrying out comprehensive study to:

- Design, and develop of all components of project
- Define and develop standards, methodologies, resources and systems to be used in the project for all activities
- Define and develop specifications and standards for web-based land geodatabase

GTC has also prepared this Inception Report addressing

- Introduction
- Scope of project
- Site Visits
- Preliminary Assessments
- The methodologies to be used during the project,
- Consultant Project Team
- Work Time Table

4.1.1 Designing Madinah Geodatabase

Worldwide government agencies like municipalities collect numerous data in different forms, quality and coverage. It is very difficult to use them together without hard efforts. As the data is being changed on daily bases to have the up to date and live transactional data professional approach is required in order to have complete data. To have same level of understanding of both (existing and recommended) databases well-structured and powerful geodatabase is the key for success as well as to achieve geospatial activities and goals of Madinah Municipality. Therefore, GTC will design a comprehensive geodatabase according to National and International standards and formats for all type of geospatial data.

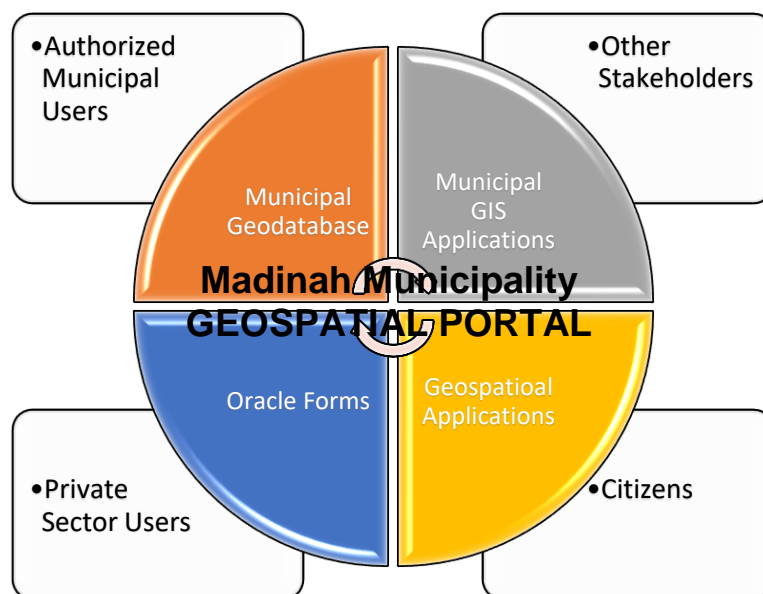


Figure 8 The Architecture of Municipal Geospatial System

4.1.2 Designing Madinah Geoportal

The main goal is to design the central Geoportal of Madinah Municipality based on the principle ONE-STOPSHOP for internal and external users. Therefore, GTC will design a powerful Geoportal according to National and International standards for internal as well as external geospatial data users.



Figure 9 Madinah Geoportal Conceptual Architecture

4.1.3 Designing Capacity Building and Training

A comprehensive study will be carried out in the Municipality to prepare Terms of References (TORs) to be tendered for capacity building to carry out;

- Geospatial data collection, processing, data conversion and integration
- Establishment of the Municipality geodatabase and maintenance
- Establishment of the Municipality geoportal and maintenance
- Development of GIS-LIS applications
- Maintenance and operation

All the above-mentioned processes will be demonstrated via Workshops and on the job training to the selected persons.



Figure 10 Capacity Building and Training

4.1.4 Preparing Specifications and Standards for Geodatabase and Geoportal

As part of the Project, GTC will develop:

- GEODATABASE standards and specifications per national and international formats and practices,
- GEOPORTAL standards and specifications per national and international formats and practices.

4.2 Developing Integrated Smart Municipal Geospatial Database

4.2.1 Data Collection

The geospatial data generates the foundation of any spatially related information system. The major investment of geospatial information systems is the data. Besides, data compilation is very time-consuming process. Therefore, it is very important to collect all the existing data, process them and integrate properly.

In this respect, GTC will carry out the following activities for the collection of geospatial data (maps, images, plans, drawings, etc.):

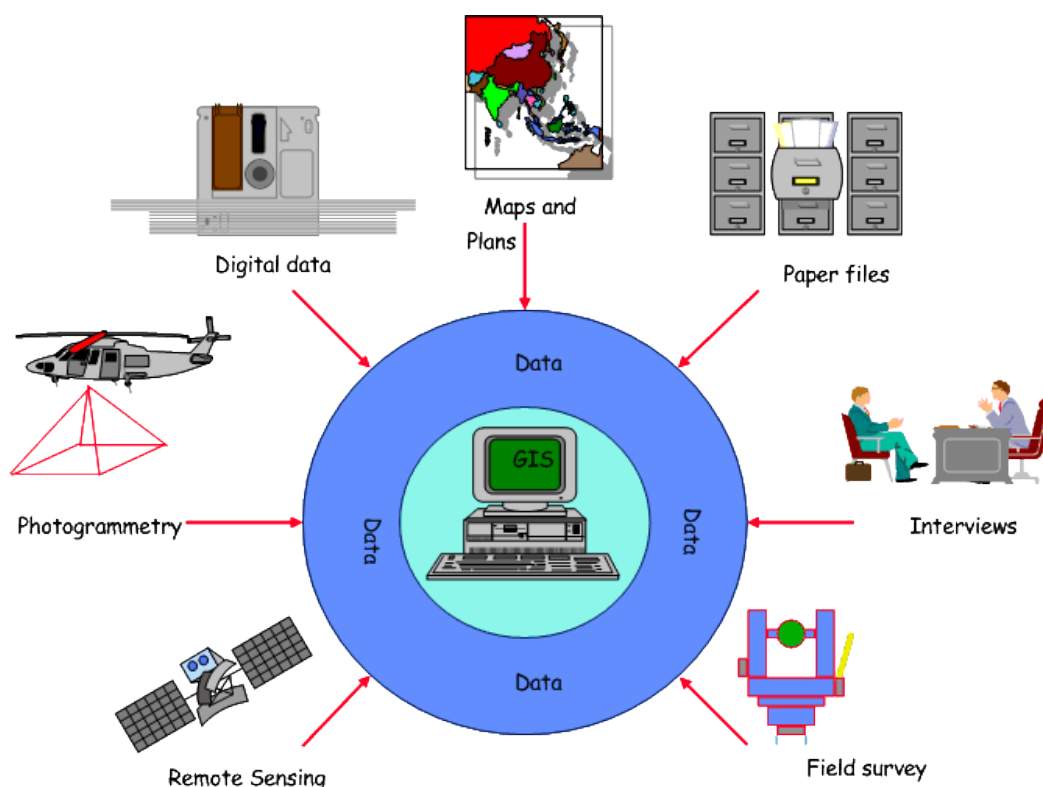


Figure 11 Data Collection

- Collection of geospatial data that are listed in Assessment section of this report Table 2 from Municipality Departments,
- Collection of Geospatial Data from External Sources:
 - Madinah Development Authority

- Madinah Governorate
- Ministry of Municipal and Rural Affairs (MOMRA)
- Ministry of Environment, Water and Agriculture (MEWA) / National Water Company
- SCECO
- Ministry of Transportation
- General Commission for Surveys (GCS)
- Ministry of Interior
- Ministry of Justice
- Others

Fundamental Geospatial Data Themes of the Project to be collected from external sources are in Table 7.

The collected data will be processed, transformed and georegistered in the national system followed by the integration into the Municipality geodatabase.

Table 7 Fundamental Geospatial Data Themes of the Project to be collected

No	Fundamental Geospatial Data Themes	Index	Data Item		Who could supply this information	Data Format	scale	Coverage
1	Administrative Boundaries	1.1	International Boundary	الدولة	Ministry of Municipal and Rural Affairs (MOMRA), Ministry of Interior, GCS	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	All KSA
		1.2	Sea Boundary	الحدود البحرية				All KSA
		1.3	Province Boundary (Region)	المنطقة				All KSA
		1.4	Governorate Boundary	المحافظة				Madinah Governorate
		1.5	Centers Boundary	المركز / الأمانة				Madinah Governorate
		1.6	Municipality Boundary	البلدية				Madinah Governorate
		1.7	Urban Boundary	النطاق العمراني				Madinah Governorate
		1.8	District Boundary	الحي				Madinah Governorate
		1.9	Settlement Locations	مواقع التجمعات السكانية العمرانية				Madinah Governorate
2	Transport	2.1	Road network	الطرق	Ministry of Transportation, Municipalities or Ministry of Municipal and Rural Affairs (MOMRA)	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	All KSA for major networks and details for Madinah Governorate
		2.2	Rail	الخطوط الحديدية	Ministry of Transportation			
		2.3	Air	الجوية	Civil Aviation			
		2.4	Marine	البحرية	Ministry of transportation			
3	Cadastral	3.1	Parcel Boundary	قطع/تقسيم الأراضي	Ministry of Municipal and Rural Affairs (MOMRA), Madinah Municipality	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more	Madinah Governorate

No	Fundamental Geospatial Data Themes	Index	Data Item		Who could supply this information	Data Format	scale	Coverage
							accurate locations and coordinates	
		3.2	Property ownership Boundaries	الملكيات	The COMMITTEE Ministry of Municipal and Rural Affairs (MOMRA)- Justice (Cadastral) Ministry of finance (Public Properties)	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
4	Land Cover	4	Topography data (contains all the other features)		General Commission for Survey (GCS) (25000/50,000) MOMRA <= 25,000	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
5	Land use	5	Land use	استخدامات الأراضي	Ministry of Municipal and Rural Affairs (MOMRA), Madinah Municipality	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	City, County, Region for Madinah Governorate
6	Building	6	Building	المباني / العقار	General Commission for Survey (GCS) Ministry of Municipal and Rural Affairs (MOMRA), Madinah Municipality	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
7	Utility and governmental services	7.1	Water Supply	إمدادات المياه	Ministry of Water; Municipalities; National Water CO.	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
		7.2	Sewage	الصرف الصحي	Ministry of Water; Municipalities	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate

No	Fundamental Geospatial Data Themes	Index	Data Item		Who could supply this information	Data Format	scale	Coverage
		7.3	Power Distribution	توزيع الطاقة الكهربائية	Electricity Co.	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
		7.4	Telecom Distribution	توزيع الاتصالات	Ministry of Communication and IT	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
8	Elevation	8.1	Elevation DEM (Digital Elevation Model)		General Commission for Survey (GCS); Ministry of Municipal and Rural Affairs (MOMRA)	DEM files	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
		8.2	Elevation DSM (Digital Surface Model)		General Commission for Survey (GCS) Ministry of Municipal and Rural Affairs (MOMRA)		To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
9	Hydrology	9	Surface Water		General Commission for Survey (GCS) Saudi Geological Survey, MEWA	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
10	Soil	10	Soil		Ministry of Environmental Water and Agriculture; Saudi Geological Survey	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
11	Natural risk zones	11.1	Earthquake Zone	مناطق الزلازل	Saudi Geological Survey	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate

No	Fundamental Geospatial Data Themes	Index	Data Item		Who could supply this information	Data Format	scale	Coverage
		11.2	Sand Storm Zones	مناطق عواصف رملية	General Authority of Meteorology and Environmental Protection	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
		11.3	Storm Water Zones	مناطق سيول	Saudi Geological Survey, Ministry of Water	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
12	Energy Resources	12	Energy Resources (Petrol, Gas)		Ministry of Energy Industry and Minerals Saudi	shape file, Oracle Spatial	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
13	Mineral Resources	13	Mineral Resources		Saudi Geological Survey	shape file, Oracle Spatial	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
14	Geology	14.1	Geological Model		Saudi Geological Survey	shape file, Oracle Spatial	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
		14.2	Geohydrological Model					
		14.3	Geomorphology					
15	Protected sites	15	Protected sites		Culture and Tourism; Environmental Protection Commission, MEWA	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate
16	Cultural, Historical, Religious sites	16	Cultural, Historical, Religious sites		Ministry of Islamic Affairs and Endowments, General Authority for Tourism and National Heritage	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate

No	Fundamental Geospatial Data Themes	Index	Data Item		Who could supply this information	Data Format	scale	Coverage
17	Flora	17	Flora		Ministry of Environmental Water and Agriculture	shape file, Oracle Spatial, GeoDB	To be defined in accordance with available information. The most suitable scale for more accurate locations and coordinates	Madinah Governorate

Table 8 The major agencies to be considered for existing data collection

Ministry of Municipal and Rural Affairs (MOMRA)	وزارة الشؤون البلدية والقروية
DMTP	وكالة الوزارة لتخطيط المدن
Settlements	مواقع التجمعات السكانية العمرانية
Tourism Plans	المخططات السياحية
Garbage Dump Areas	مواقع مكب أو مرامي النفايات
Specified Municipality Investments	مواقع إستثمارات بلدية محددة
Structural Land Use	استخدامات الأراضي
Structural Roads	شبكة الطرق
Plan Boundary	حدود المخططات
Parcel	قطع الأراضي
Municipality Boundaries	حدود البلديات
Districts	حدود الأحياء السكنية
Road Edge	حواف الطريق
Protected Areas	المناطق المحظورة
Landmarks	المعالم مثل مواقع المحلات والمباني الحكومية
Urban Boundary	النطاق العمراني
Building	المباني / العقار
Property ownership Boundaries	الملكيات
Sewage	شبكة الصرف الصحي
Surveying Department	إدارة المساحة
Governorate Boundary	حدود المحافظات
Province Boundary	حدود المناطق
Topographic Maps for 1K	1K خرائط طبوغرافية
Topographic Maps for 5K	5K خرائط طبوغرافية
Topographic Maps for 10K	10K خرائط طبوغرافية
Topographic Maps for 20K	20K خرائط طبوغرافية
Map Drawings	رسومات خرائط
Utility Lines (Electricity network, water network, etc....)	خطوط الخدمات (شبكة توزيع الكهرباء، شبكة توزيع المياه..إلخ)
Utility Points (Substation, Pump station, etc....)	نقاط الخدمات (محطات فرعية، محطات ضخ...إلخ)
Utility Area (Pump station boundary, distribution point boundary, etc....)	نطاق الخدمات (حدود محطات الضخ، حدود نقاط التوزيع)
Hydrology-Point	طبقة الهيدرولوجيا (موقع الأبار، سدود..إلخ)
Hydrology-Line	خطوط الهيدرولوجيا (وادي، مجرى مياه..إلخ)
Hydrology-Area	حدود الهيدرولوجيا (حدود السدود، حدود البحيرات..إلخ)
Orthophoto	مصورات جوية
Spot6 / Spot7 satellite images	صور أقمار صناعية سبوت 6 / سبوت 7
Sea Boundary	الحدود البحرية
Elevation DEM (Digital Elevation Model)	نماذج الارتفاعات الرقمية
Elevation DSM (Digital Surface Model)	نماذج السطح الرقمية
Ministry of Transport	وزارة الطرق والنقل
Railway Network	خطوط سكة حديد

Future Railway Network	خطوط سكة حديد مستقبلية
Roads Network	شبكة الطرق
Feature Roads Network	شبكة الطرق مستقبلية
Road Boundary	حدود الطرق
Landmarks	المعالم مثل مواقع المحلات والمباني الحكومية
Marine	البحرية
Ministry of Energy, Industry and Mineral Resource	وزارة الطاقة والصناعة والثروة المعدنية
Mineral Resources Distribution	توزيع الثروات المعدنية
Electric Distribution Lines (Existing/Planned)	خطوط الضغط الكهربائي (القائمة / المستقبل)
Petrol Pipelines (Existing/Planned)	خطوط ناقلية لمشتقات البترول (القائمة / المستقبل)
Gas and Oil Exploration Areas (Existing/Planned)	مناطق تنقيب عن النفط والغاز (القائمة / المستقبل)
Industrial Areas (Existing/Planned)	مناطق صناعية (القائمة / المستقبل)
Building Martial Preparation Areas	مواقع الكسارات ومواد البناء
Government Land Use	الإستعمالات والملكيات الحكومية
Lands of Ministry of Energy, Industry and Mineral Resource	أراضي وزارة الطاقة والصناعة والثروة المعدنية
Restricted Areas	المناطق المحظورة
Ministry of Environment, Water and Agriculture	وزارة البيئة والمياه والزراعة
Farms	المزارع
Water Production Well	آبار المياه
Water Distribution Main Lines	خطوط مياه رئيسية
Grazing Areas	منطق رعي
Hydrology-Point	طبقة الهيدورولجيا (موقع الآبار، سدود.. إلخ)
Hydrology-Line	خطوط الهيدورولجيا (وادي، مجرى مياه.. إلخ)
Hydrology-Area	حدود الهيدورولجيا (حدود السدود، حدود البحيرات.. إلخ)
Soil	التربة
Protected Areas	المناطق المحظورة
Sewage	شبكة الصرف الصحي
Flora	النباتية
Ministry of Justice	وزارة العدل
Private Properties	الملكيات الخاصة
Protected Areas	المناطق المحظورة
Saudi Wildlife Authority	الهيئة السعودية للحياة الفطرية
Wildlife Protected Areas	محميات برية
Ministry of Communication and IT	وزارة الاتصالات وتقنية المعلومات
Landline Communication Network	شبكة اتصالات أرضية
Ministry of Defense	وزارة الدفاع
Government Land Use	الإستعمالات والملكيات الحكومية
Restricted Areas	المناطق المحظورة
Ministry of Interior	وزارة الداخلية
Government Land Use	الإستعمالات والملكيات الحكومية
Settlements	مواقع التجمعات السكانية العمرانية
Province Center	عاصمة المنطقة
Governorate Center	عاصمة المحافظة
Centers	المراكز مصنفة إلى فئات
Villages	القرى
National Border Lines of KSA	الحدود الوطنية
Governorate Boundary	حدود المحافظات
Province Boundary	حدود المناطق
Center Boundary	حدود المركز
Restricted Areas	المناطق المحظورة
Aramco	أرامكو
Government Land Use	الإستعمالات والملكيات الحكومية
Restricted Areas	المناطق المحظورة
General Commission for Survey (GCS)	الهيئة العامة للمساحة

Hydrology-Point	طبقة الهيدرولوجيا (موقع الآبار، سدود.. إلخ)
Hydrology-Line	خطوط الهيدرولوجيا (وادي، مجرى مياه.. إلخ)
Hydrology-Area	حدود الهيدرولوجيا (حدود السدود، حدود البحيرات.. إلخ)
Topographic Maps for 50K	50K خرائط طبوغرافية
Topographic Maps for 250K	250K خرائط طبوغرافية
Topographic Maps for 500K	500K خرائط طبوغرافية
Building	المباني / العقار
Elevation DEM (Digital Elevation Model)	نماذج الارتفاعات الرقمية
Surface Water	المسطحات المائية
National Water Company	الشركة الوطنية للمياه
Water Supply	شبكة توزيع المياه
Saudi Electricity Company	الشركة السعودية للكهرباء
Power Distribution	شبكة توزيع الكهرباء
Civil Aviation	الهيئة العامة للطيران المدني
Air Ports & Ways	المطارات، شبكة الملاحة
Saudi Geological Survey	هيئة المساحة الجيولوجيا السعودية
Soil	التربة
Earthquake Zone	مناطق الزلازل
Storm Water Zones	مناطق سيول
Mineral Resources	مناطق توزيع الثروة المعدنية
Geological Model	النماذج الجغرافية
Geohydrological Model	نماذج الهيدرولوجيا
Geomorphology	الجيومورفولوجيا
Surface Water	المسطحات المائية
General Authority of Metrology and Environmental Protection	الهيئة العامة للأرصاد وحماية البيئة
Sand Storm Zones	مناطق عواصف رملية
Protected sites	المناطق المحظورة
Saudi Commission for Tourism & National Heritage	الهيئة العامة للسياحة والتراث الوطني
Protected sites	المناطق المحظورة
Cultural and historical sites	المواقع الثقافية والتاريخية
Madinah Governorate	محافظة العلا
Settlements	مواقع التجمعات السكانية العمرانية
Governorate Boundary	حدود المحافظات
Center Boundary	حدود المركز
Restricted Areas	المناطق المحظورة
Cultural and historical sites	المواقع الثقافية والتاريخية
Government Land Use	الاستعمالات والملكيات الحكومية

4.2.2 Densification/Updating Geodetic Networks & CORS

GTC will carry out the densification of geodetic network and upgrading CORS network in Madinah Municipality region.

Geodetic control originates the foundation / reference for all type of geographic information. It provides the common reference for mapping activities and other geospatial data. The geodetic control points here consist of (i) horizontal control, and (ii) vertical control. They are presented in subsequent sections.

The geodetic network and the CORS network in Madinah will be referenced to the National Geodetic Network and national CORS network of Ministry of Municipal and Rural Affairs (MOMRA).

Madinah Municipality already has an operational CORS network. GTC shall examine and integrate this network to the national CORS of MOMRA defined with reference to the MTRF-2000 datum at epoch 2004.0.

If needed, GTC shall determine the additional CORS sites to be established by the Municipality and integrated by GTC.

The steps of the strengthening of Madinah Geodetic Network and CORS are presented in Figure 12.

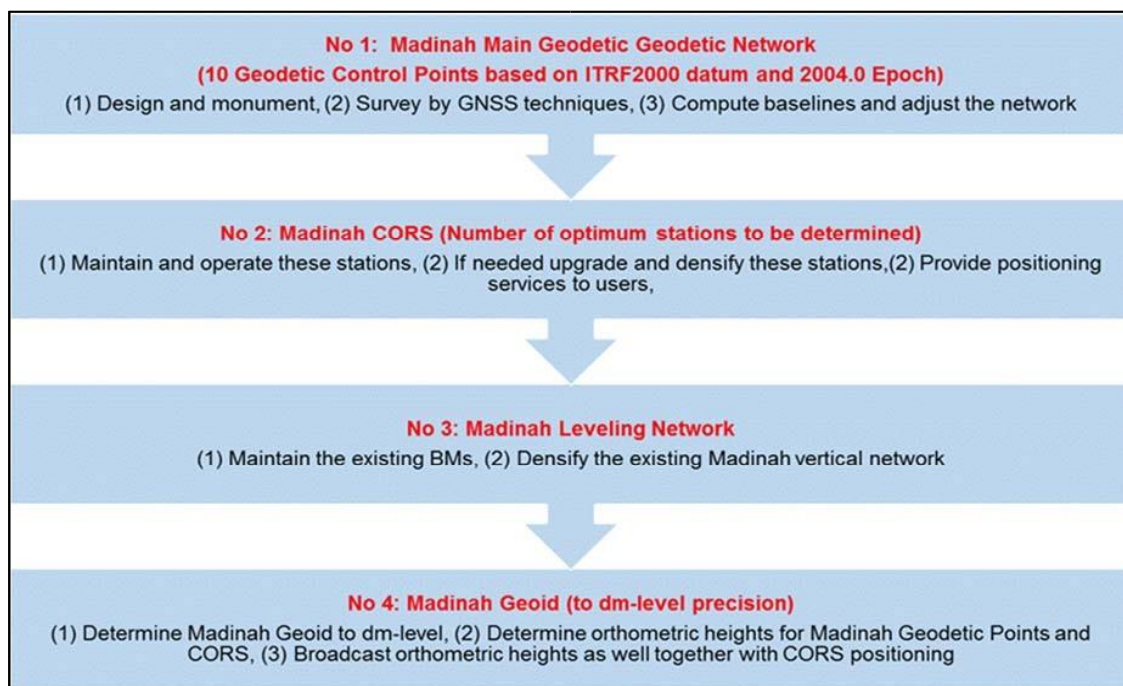


Figure 12 The steps of the strengthening of Madinah Geodetic Network and CORS

4.2.3 Development of Seamless DEMs

GTC will collect Digital Elevation Models (DEMs) from the Municipality, Madinah Development Authority, MOMRA and other agencies. Then, GTC will develop a seamless DEMs using all the available data starting from the highest resolution data. The steps of the development of seamless DEMs are presented in Figure 13.

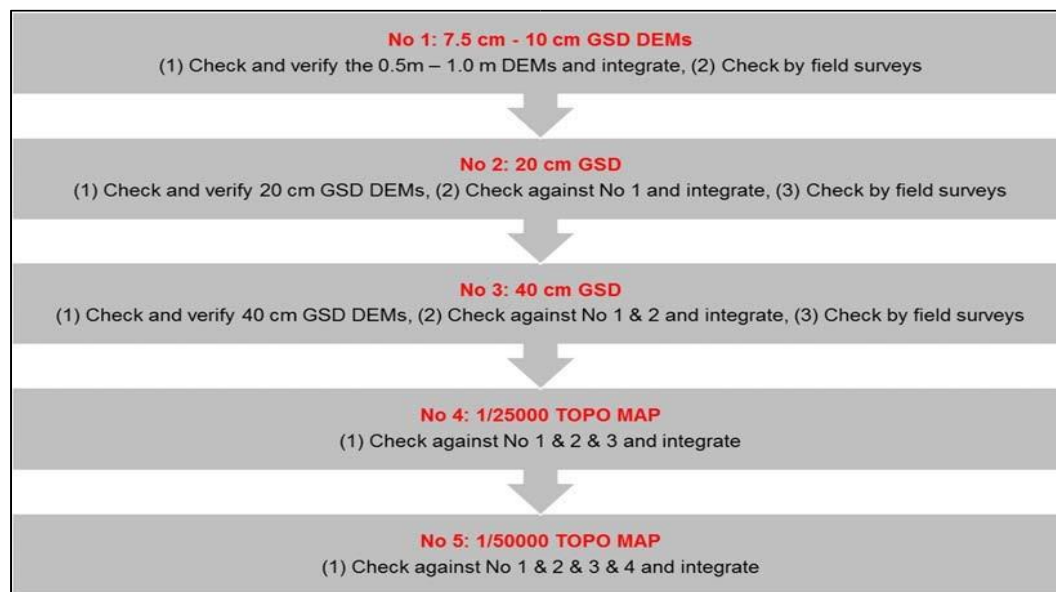


Figure 13 The steps for the development of seamless DEMs

A Bare Earth DTM is required that adequately defines the ground to the required Project accuracy. To collect/edit full DTM data, most commonly used technique is stereo aerial images, first by generating Digital Surface Models (DSMs) and then by filtering of all above-ground features from the finalized Project DSM to retain only bare earth elevations, i.e. DTM.

The finalized DTM Project data will be delivered by the GTC to MM in the following formats:

- DTM gridded data will be delivered as seamless Geographic (Longitude, Latitude) Non- Projected coordinate, ESRI readable raster format data, with a 5-meter pixel size,
- All vector data (including Mass Points & Break lines) used in the production of the DTM, will be delivered as a seamless Geographic (Longitude, Latitude) Non-Projected coordinate, ESRI format Geodatabase,

If there is a notification from MM Inspection & Approval Team about the delivered data, GTC will undergo a correction and re-submission cycle for this Project Deliverable until it is accepted by MM.

4.2.4 Development of Seamless Base Maps

GTC will collect base maps (large scale to small scale) from the Municipality, Madinah Development Authority, MOMRA and other agencies such as GCS. Then, GTC will establish a seamless base map using all the available data starting from the largest scale maps. The steps of the development of seamless base maps are presented in Figure 14.

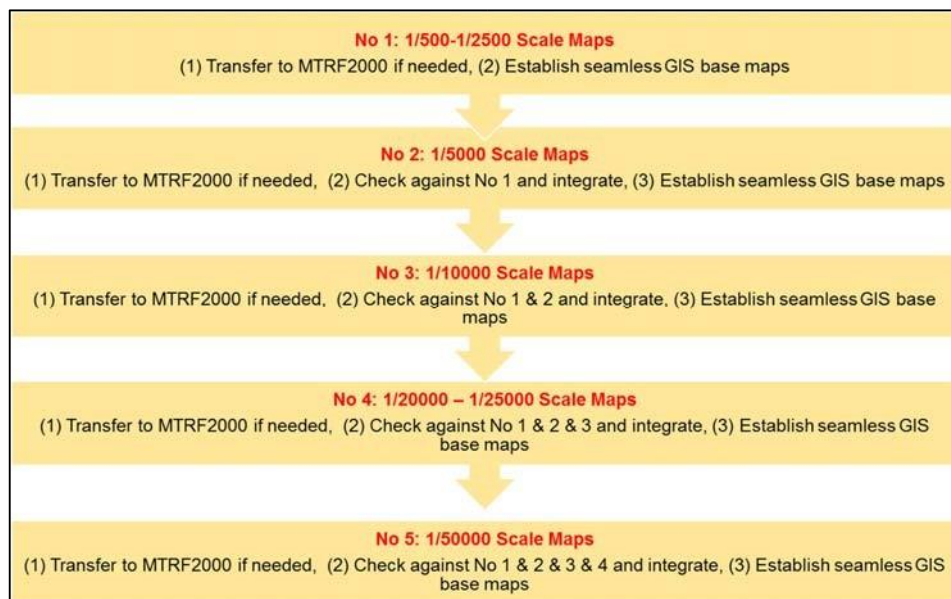


Figure 14 The steps of the development of seamless base maps

4.2.5 Development of Seamless Image Maps

GTC will collect orthophoto and orthorectified (highest resolution to low resolution) images from the Municipality, Madinah Development Authority, MOMRA and other agencies such as GCS. Then, GTC will establish a map using all the available data starting from the highest resolution images. The steps of the development of seamless image maps are presented in Figure 15.

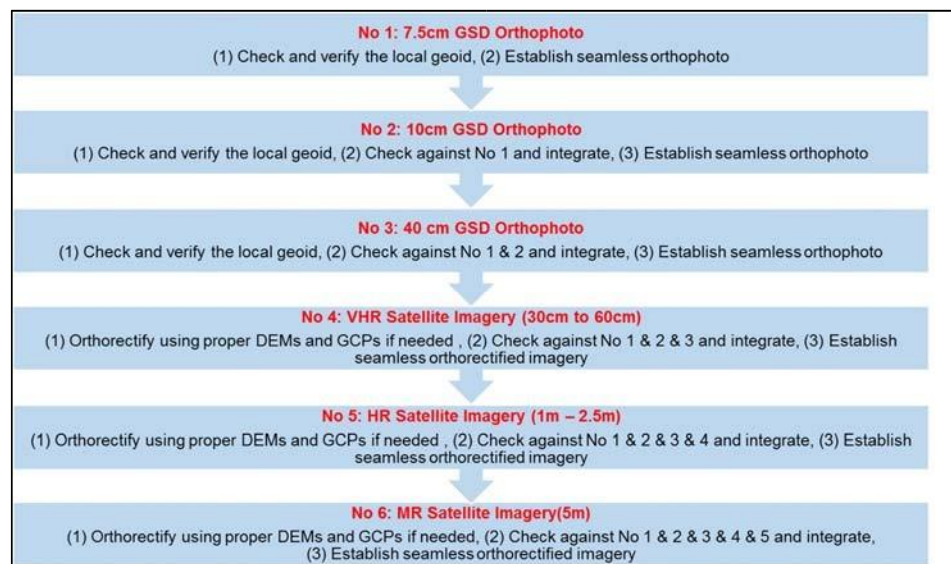


Figure 15 The steps of the development of seamless image maps

4.2.6 Development of Seamless Special Layers & Other Thematic Layers

GTC will collect special and thematic layers (such as master plans, subdivision plans, etc.) belonging to Madinah Municipality region from the Municipality, Madinah Development Authority, MOMRA and other agencies such as GCS, SCECO, NWC, etc. GTC will compile a seamless and rectified municipality layers using all the available data starting from the highest resolution data. The steps of the development of seamless and rectified municipality layers are presented in Figure 16.

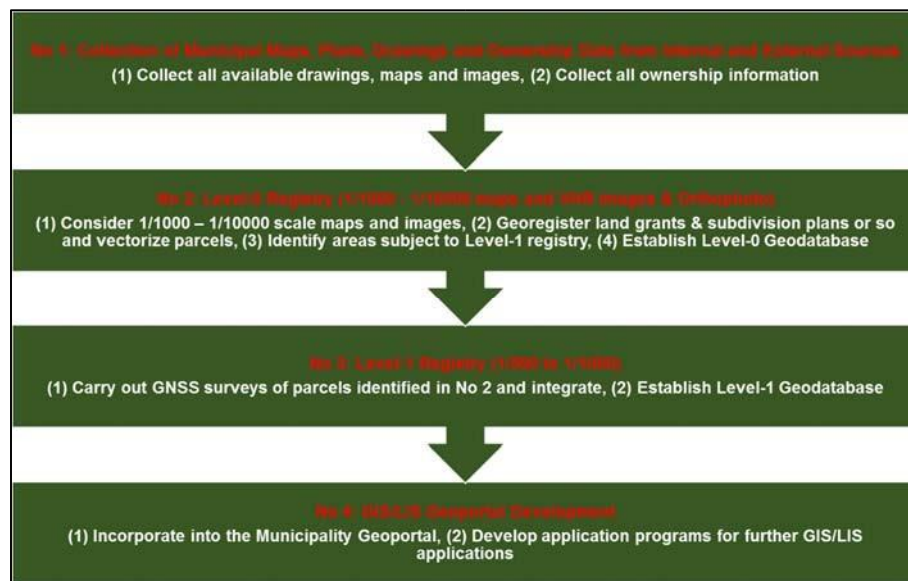


Figure 16 The steps of the development of seamless and rectified municipality layers

All the drawings and plans belonging to existing parcels will be collected from the authorities. Then, GTC will arrange and index all collective schemes and if required make scans for each sheet at resolution of 400 dpi, using technologies that suit digitizing information sources and save it in a digital format.

According to our experience in Saudi Arabia, the existing geospatial data in the Country lack the technical specification and geometric precision, most of them are in CAD format and needs to be converted into the national system with proper coordinates and precision. Therefore, GTC intends to carry out transformation of local coordinates into the national system using any existing large scale base maps or orthophoto. GTC will try to determine 4-5 common points per drawing / plan sheet with coordinates in both systems and then carry out commonly used Helmert or Affine transformation.

In the case that we cannot identify common points on drawings / plans and existing base maps / images, GTC will determine the points to be surveyed by Municipality surveyors based on the national geodetic reference framework and control points established as part of this project.

For terrestrial surveys, the Municipality will use Real Time Kinematic (RTK) surveys of CORS network based on the national / newly established geodetic control points or CORS, in order to achieve the accuracy to cm-level. The surveys will be supplemented by the associated features and attributes, including photographs of each parcel with GPS coordinates.

A neat and legible sketch (such as 297 x 420 mm paper) numbered consecutively starting from 1 will be prepared for the surveyed points / parcels. The sketch will include the project, town, date of survey, sketch number, operator, survey technique, survey length, etc. The height of the instrument and antenna will be recorded.

Following the registration procedures, GTC will digitize all features in vector mode by using their feature codes, symbols and layers and, verify the completeness, accuracy, data quality, consistency of these features and vector data. In vector digitization and data collection step, GTC will classify all features and map details at proper layers. Digitization and data collection will be performed by using well-known CAD / GIS software packages such as MicroStation, ArcMap, etc.

All geodata will be produced in digital form compatible with “ESRI-ArcGIS”.

Parcels and area outlines requiring area fill symbolization will be provided as closed polygons in addition to the bounding features. Feature junctions will be taken part at numerically exact coordinated positions with no overshoots or undershoots allowed in the data. A centroid will be assigned to each parcel digitized by GTC; the position of the centroid will be approximately at the center and, a unique code will be assigned to each centroid using the numbering scheme approved by the MM.

4.2.7 Development of 3D City Models

As part of this Project, GTC will prepare Terms of References (TORs) and supervise the compilation of 3D geospatial data using;

- 7.5cm GSD stereo aerial photography, or
- 5cm GSD aerial UAV / drone photography
- 3D mobile mapping

Then, GTC will develop 3D GIS of Madinah City to dm-level precision and broadcast 3D Madinah City model to users via web (PCs, tablets, mobiles, etc.).

Smart cities offer excellent tools for public and governmental agencies. Smart cities are mostly based on 3D smart modelling of the city. GTC has a cutting-edge geospatial package called CITIGENIUS, which develops 3D modeling, measurement and analysis tools. Citigenius methodology utilizes high resolution intelligent geospatial data for smart cities and it is based on a next generation photorealistic 3D virtual city model. Citigenius is a great tool for developing smart and object-based 3D geospatial data, it incorporates Artificial Intelligence

(AI), High Performance Computing, Simulation Technologies and Computer Graphics, with extensive measurement/editing and analysis tools. Citigenius data sets cover:

- High resolution imagery
- Geometry
- Geospatial semantics
- Artificial intelligence
- Automation and
- Topology

GTC will develop 3D Smart and Object-Based Geospatial Data and Analysis in the primary AOI consisting of:

- DSM: noise removed, and clean DSM derived at the resolution of imagery, i.e. 10cm GSD
- DTM: a DTM model representation of the ground with the same GSD, excluding vegetation, buildings etc., but preserving all the remaining terrain data features
- True Ortho: A true Ortho imagery at urban areas and high elevation changes such as cliffs, etc.
- 3D Buildings: 3D Object-based building models with roof and façade texture generated from the imagery without using any external data source
- Basic Measurement Tools: Coordinates, profiling, cut and fill computations, slope/aspect, contouring, etc.
- Analysis Tools: Renewable energy location determination and analysis, heat islands, flood and water analysis, archeological site management and exploration analysis, infrastructure planning and management, etc.

The proposed solution provides 3D Geographic Information System tools allowing end users to perform innovative evaluation and analysis operations on virtual cities in addition to spatial operations, urban planning and simulations. This solution has the potential to introduce a new path in the field of Photorealistic 3D Virtual and Smart Cities due to its unique and innovative characteristics. With its ability to perform rich spatial analysis, urban planning and simulations, Citigenius serves to meet demands such as: energy efficiency, disaster management, improved quality of life and urban development management.

In this Project, GTC solution will mainly cover the features listed below:

- Basic Features
- Integrated and Green Design

Each of these solutions are presented in subsequent sections. Moreover, extensive effort is spent to visualize the analyses results on web-based globe solutions such as CESIUM.

4.2.7.1 Basic Features of Citigenius

As mentioned above, Smart Cities and touristic sites use realistic virtual city models. It is very important to provide new tools to better explore the potential of this type of data sets. In this respect, Citigenius introduces various new measurement solutions such as vertical area calculation, vertical distance, slope, azimuth, horizontal distance etc. In total, Citigenius offers almost 20 different measurement tools. Basic features also include file operations, editing, geospatial queries and filtering functions that are very typical in GIS tools. However, we tried to extend such features with various cost calculation tools such as cut & fill, irrigation, road construction, tiling, asphalt removal etc. Citigenius uses high-resolution and very precise geospatial data, that is required for accurate cost calculation.

The cut & fill feature can generate very detailed and accurate report as shown in Figure 17. The output presents precise cut and fill volumes, type of cut volume (soil/rock/clay if drilling is available), operational cost etc. Similarly, it is also possible to calculate almost exact costs to construct a new road by utilizing the high-resolution and seamless terrain data.



Figure 17 Cut & Fill Cost Analysis

Citigenius also generates detailed object geometry such as buildings. This type of output lets us to generate many calculations for buildings such as debris cost, thermal insulation cost or ice-load risk assessment. Our future goal is to generate more information regarding the building structure by using façade texture maps. We believe that machine learning techniques accompanied with several heuristics will help us to realize this goal.

In addition, Citigenius introduces a revolutionary approach for rapid 360 degrees high-resolution panoramic image generation. In this approach as a first step dozens of high-resolution planar images are generated from an arbitrary view-point. At the second step these images are distorted and stitched to generate panoramic image as shown in Figure 18. To the best of our knowledge, there is no practical GIS solution that can generate such output in seconds. All these features will be extensively used in Madinah.



Figure 18 Panoramic View (an example from Turkey)

4.2.7.2 Integrated and Green Design

Citigenius offers many more analysis and tools for various purposes. Integrated and green design is a hot topic in the design community. This approach blends various domain-knowledge ranging from architectural to engineering. The idea is to build smart, green and efficient structures to ensure the sustainability of the cities. Citigenius provides easy to use solution for urban designers to help them build smart cities. It incorporates computational fluid dynamics, solar equations, high-performance computing and physics to bridge the gap between the CAD tools and GIS tools regarding building design.

Citigenius has a built-in tool that determines the best orientation considering the parameters given above. Thanks to the enormous processing power provided by graphical processing units. It is possible to perform complicated solutions such as computational fluid dynamics in real time as shown in Figure 19. The same Figure also shows the optimum orientation which starts with larger intervals and goes on with smaller intervals. In this chart the minimum energy demand value gives us the optimum orientation. In this basic sample we determined almost 3% difference between the worst and best orientation considering energy gain, which is very significant considering the amount saved during the life-cycle of the buildings. It is certain that such simple design issues contribute a lot for the sustainability of future cities. In this sense, providing such a practical solution in GIS environment will help us to build green structures easily.



Figure 19 Optimum Orientation of a Building (left) and Optimum Orientation Chart (right)

Such powerful design tools also include very accurate solar energy assessment solution. Shadow effect is also precisely calculated since each new building introduces a shadowing effect to the neighboring area. Thanks to the high-resolution geospatial data and 3D object representation model, Citigenius is designed to provide minute-base detailed report regarding the shadow effect of each structure. The green design tools also address important environmental issues such as building carbon footprint assessment, local micro-climate analysis.

4.2.8 Data Conversion, Integration & Establishment of Municipality Geodatabase

The steps to be followed by GTC for the design of the database and the activities comprising this project component are described below.

1. **Conceptual Geodatabase Design** – GTC team will prepare conceptual geodatabase design. The conceptual model is a simple graphic illustrating the storage containers and items for all datasets.
2. **Logical Geodatabase Design** – GTC will extend the conceptual geodatabase to develop a detailed logical design. The logical geodatabase design is a document created within a software toolset that can be easily exported into a database. The logical design will be presented to the Ministry and selected stakeholders by way of an optional web cast, and feedback from the municipality will be incorporated into the logical design as appropriate.
3. **Source Data Matrix** – GTC will include Source Data Matrix with the database design. This spreadsheet will list the source datasets and specify mappings from the source data to the associated feature classes in the target data model.

GTC will perform all these activities in a well-defined “Spatial Framework” which is coming from similar experiences. Briefly, this spatial framework has well defined steps as discussed below;

- a. Designing GIS data catalogue for geo-database according to national and international standards and formats (projection and datum, layer names and types, attribute column names and types, naming standards, metadata, data dictionary, icon and layer styles, symbolization, optimization and permission methodology etc.)
- b. Analyzing GIS application development and integration phases.
- c. Sizing of software and hardware configurations according to data catalog size and application loads. (Oracle or MS-SQL Server database and ESRI ArcGIS Software, Servers, PCs, Plotters, Scanners, Printers, Network Settings etc.)
 - Assigning adequate number of skilled and experienced staff to project (managers, specialists and operators etc.)
 - Identifying user access permissions to geo-database (department name, database name, layer name, user name, password, read-write rights etc.)
 - Creating edit/update/replication methods for database synchronization (production, test, training, development and backup database at different located centers)

Having several experiences with enterprise level geodatabase establishment, GTC is in a unique position. One of the most recent responsibilities of GTC is with Ministry of Environment, Water and Agriculture. Within this project, GTC has established the complete GIS infrastructure for agricultural development and management purposes for the whole Kingdom.

GTC has valuable experience with enterprise level geodatabase establishment. Two of the most recent responsibilities of GTC are: Ministry of Environment, Water and Agriculture - GTC established a complete GIS and Geoportal for agricultural development and management purposes for the whole Kingdom; PIF - we established a complete GIS and Geoportal for the NEOM project. A sample geodatabase is shown in Figure 20.

Together with geodatabase development, GTC will also develop associated metadata, which is documentation about the digital dataset. This information is valuable to users of spatial data within and outside of the Client. Long after the dataset is created, questions may arise about the automation methodology. A document that details the automation process is useful in answering questions and helps users maintain consistency and integrity of the dataset when updates are performed. Users will rely on metadata to determine how the dataset may be used and its level of accuracy. Metadata will include, but is not limited to the following:

- Reference information of organization and individual(s) who created the dataset and contact information;
- File name and format;
- Date compiled;
- Coordinate system;
- Automation methods (scanning, digitizing, research)
- If rectified by digital orthophotos, the file names, dates, and location of these files;
- Source documents (where housed, quantity, media, scale);
- Notes concerning errata, their location, and how unresolved parcels were handled;
- Positional accuracy;
- Attribute file name and format;
- Attribute fields and their parameters;
- Dates revised (and by whom); and
- Tiling structure

GTC will follow ISO standards in providing the metadata for the geographical and non-geographical data. GTC has already implemented ISO-compliant metadata repository for the Ministry of Interior, Ministry of Agriculture, etc.

A sample database design is provided in Figure 20. The minimum Metadata fields to be contained in the database are provided in Table 9. A sample metadata definition for a layer is also given in Table 10. Final structure of metadata is being developed at the present.

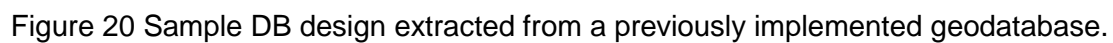



Table 9 Metadata fields to be contained in the database.

Name	Definition	Condition *	Metadata Level	Max Occurrence	Type	Domain
Title	Title for the dataset	M	D	1	Character String	Free Text
Alternative title	Alternative Title for the dataset	O	D	n	Character String	Free Text
Version		O	D	1	Character String	Free Text
Version Date		O	D	1	Date	
Creation Date	When was the dataset first created	M	D	1	Date	
Metadata Language	What language is the metadata in?	M	D	1	Character String	Languages
Data Language	What languages are used in the data?	M	D	n	Character String	Languages
Abstract	Give a brief narrative summary about the content of the dataset	M	D	1	Character String	Free Text
Metadata Author	Name, organization, position, Address, etc.	M	D	1		
Point of Contact	Name, organization, position, Address, etc.		D	n		
Dataset History (Lineage)	Describe how the dataset was created. Processes that were used to create the dataset		D		Character String	Free Text
Themes or Categories	which of the listed themes or categories best describe the content of the dataset	M	D	n	Character String	Topic Category Code List
Maintenance And Update Frequency	How often is the dataset updated	O	D	1	Character String	Maintenance Frequency Code
Date Of Last Update		O	D, F	1	Date	
Date Of Next Update		O	D	1	Date	
Use Restrictions	Limits that affect fitness of use of the data	O	D	n	Character String	Free Text
Legal Restrictions	Limits or legal prerequisites for using the data	O	D	n	Character String	Restriction Code List
Security Restrictions	Handling restrictions imposed on the data for security reasons	O	D	1	Character String	Classification Code List
Scale	Describe the dataset's level of detail by specifying its scale or resolution	O	D	n		
Keywords	Which types are appropriate to the dataset	M	D	n		Keyword Type Code List
Coordinate System	Reference coordinate system name	M	D	1		Auto
Bounding Coordinates	Geographic extent of data	M	D	1		Auto
Data edited by	Name of the data editor	M	F	1	Character String	Editors Name List
Edit type	Type of edit	M	F	1	Character String	Edit Type Code List
Data Source	Source of data	M	F	1	Character String	Data Sources Code List

Where "Condition and Metadata Level" is one of the followings:

M: Mandatory, O: Optional, F: Feature level metadata, D: Dataset level metadata

Table 10 Sample metadata of a layer.

Feature Class Name	COUNTRY	
Title	Country	
Alternative title	Surroundings of KSA	
Version	1.04	
Version Date	2008-04-09	
Creation Date	2006-10-01	Feature Count
Metadata Language	English	26
Data Language	English, Arabic	
Abstract	This layer contains KSA, NEIGHBORING COUNTRIES of KSA and SEA. The information contained/presented within this layer cannot be used as a legal proof/evidence.	
Metadata Author	<the personnel editing/authoring the metadata>	
Point of Contact	<A responsible person from the organization>	
Dataset History (Lineage)	<ul style="list-style-type: none"> - 2006-09-10: Original data has been captured from ESRI World data. - 2006-09-25: National Boundary data changes applied. - 2007-04-30: National Boundary data changes applied. 	
Themes or Categories	Administrative and political boundaries	
Maintenance And Update Frequency	As needed	
Date Of Last Update	2006-10-01	
Date Of Next Update	N/A	
Use Restrictions	The dataset will be available for <PROJECT> scope, without any restrictions.	
Legal Restrictions	Restricted	
Security Restrictions	Unclassified	
Scale	1:1,000,000	
Keywords	Country, Neighbor, Sea	
Coordinate System	Ain_el_Abd_UTM_Zone_38N	
Bounding Coordinates	3796015.012	
	-895408.632	2180617.91
	1175735.448	

Only those which are Dataset level are shown here. Feature level metadata, such as the type of change will be stored in the database and can be retrieved upon request.

A modern geodatabase is the fundamental component of any geo-information, GIS and geoportal. A geodatabase is designed to store, query, and manipulate geographic information and spatial data. It is also known as a spatial database. The geodatabase is the common data storage and management framework for ArcGIS. It combines "geo" (spatial data) with "database" (data repository) to create a central data repository for spatial data storage and management. It allows you to store GIS data in a central location for easy access and management.

As part of this project, GTC will compile seamless and rectified layers mentioned earlier using all the available data starting from the highest resolution data. These layers are also illustrated in Figure 21.

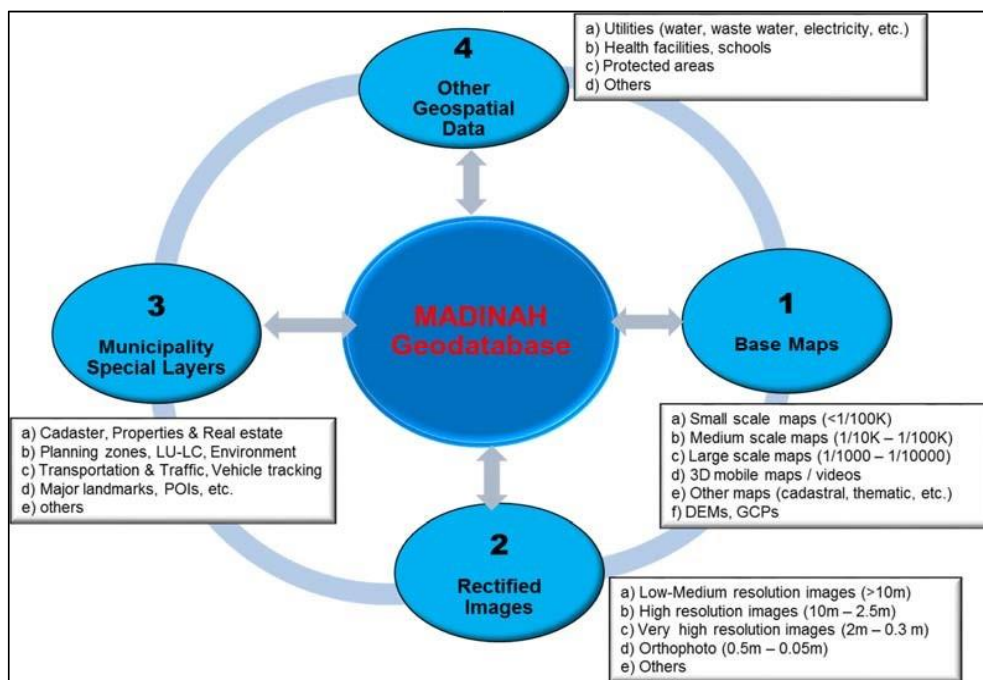


Figure 21 Geospatial Layers of Madinah Geodatabase

4.3 Developing Smart Geoportal

Geoportal helps user to maintain the quality, currentness, and availability of registered resources by providing tools to evaluate new entries, control access to metadata and resources, and integrate the geoportal with other enterprise systems.

Geoportal allows the users to find and access geographic information (geospatial information) and associated geographic services (display, editing, analysis, etc.) via the Internet.

Based on ESRI Platform, GTC will develop powerful Geoportal capable of handling GIS features such as:

- Map navigation
- Bookmarking a specific view
- Layer administration
- Map legend
- Base map selection
- Scanned images gallery
- Raster and vector overlay on map views
- Thematic maps
- Search / query: based on attributes or geographic filters
- Reporting modules
- Printing of selected or pre-defined map documents
- Arabic and English Interface
- Multiple map projections including UTM and geographic Latitude and Longitude

coordinates

- Single Sign ON (SSO) using Microsoft Active Directory (LDAP-Lightweight Directory Access Protocol)
- The existing technology will be modified and expanded as required to fulfill the requirements of the current project.

Amongst others, followings are the key features of GeoPortal GTC will implement.

Base Map

GeoPortal supports the internal and external base map services like following base maps.

- Satellite Map (Internal Cached Base map service)
- Vector Map (Internal Cached Base map service)
- Google Map (Online base map)
- Open Street Map (Online base map)
- ArcGIS Online Base maps (Online base map)

Map Controls

All the standard map controls are available in GeoPortal.

- Navigation Controls (Pan, Zoom Selection, Zoom Max Extend, Zoom Bar, Go Back and Go Forward, Layer Order, Zoom To (X. Y))
- Identify Feature
- Measurement Controls (Line, Area)
- Overview Map
- Vector/Satellite Map Switcher
- Print Maps (User selection, Pre-define Map)
- Legend

Map Layers Control

Geoportal's layer control provides the following features: to list, add, remove and control transparency of layer on the map as shown in Figure 22.



Figure 22 Map Layers Control

Query Functions

As an extra functionality different kind of queries can be done by Query functions. Queries can be based on the attributes or based on spatial features. Also, query can be mixed both attribute and spatial.

By attribute query, user can search the layer information based on layer attributes and result will be listed in a grid view as shown in Figure 23. Result will be integrated with map. If any layer has relational information, it can be showed in a separate window with all details as shown in Figure 24.

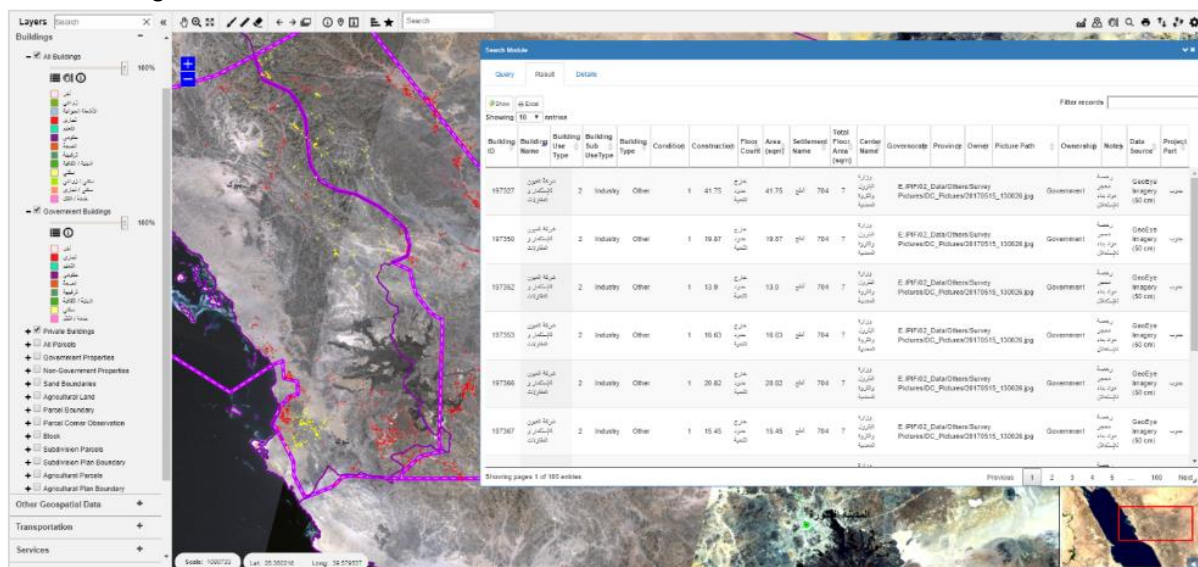


Figure 23 Search Results based on attribute



Figure 24 Feature information of selected record with all related information.

Spatial Query provides the facility to the user to interact with map and search the layer data like user draws polygon and gets data within drawn polygon. Query polygon can be drawn by user or can be used any pre-defined polygons like Region Boundary, Governorate Boundary, etc.

Following are the Sample Spatial Filters;

- Draw Polygon, Rectangle, Square
- Draw Buffer Area
- Map Extent

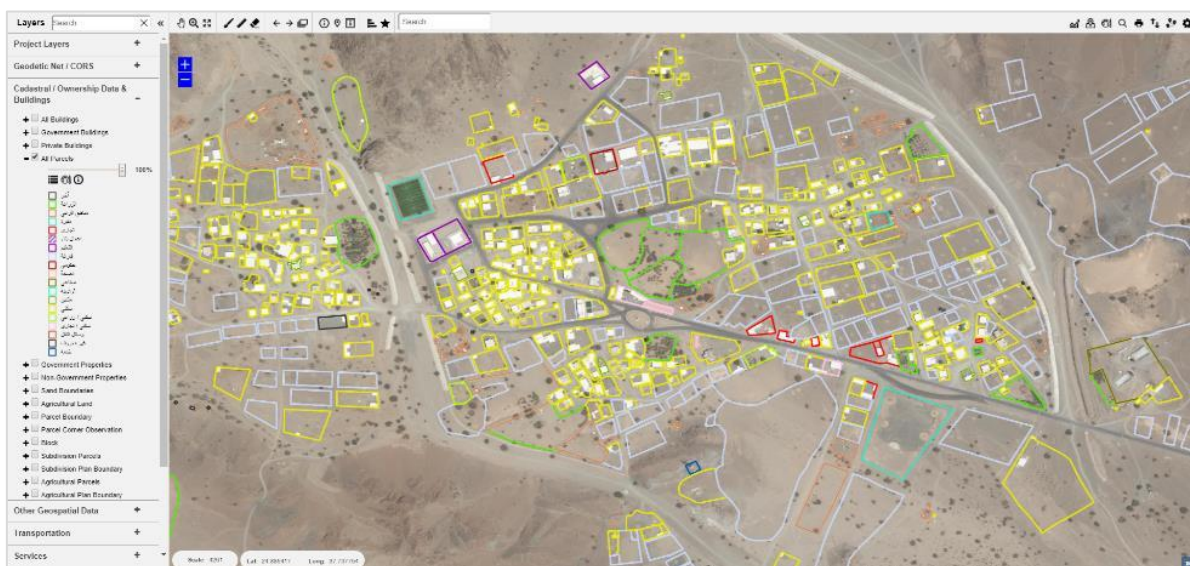


Figure 25 Map Extent Filter

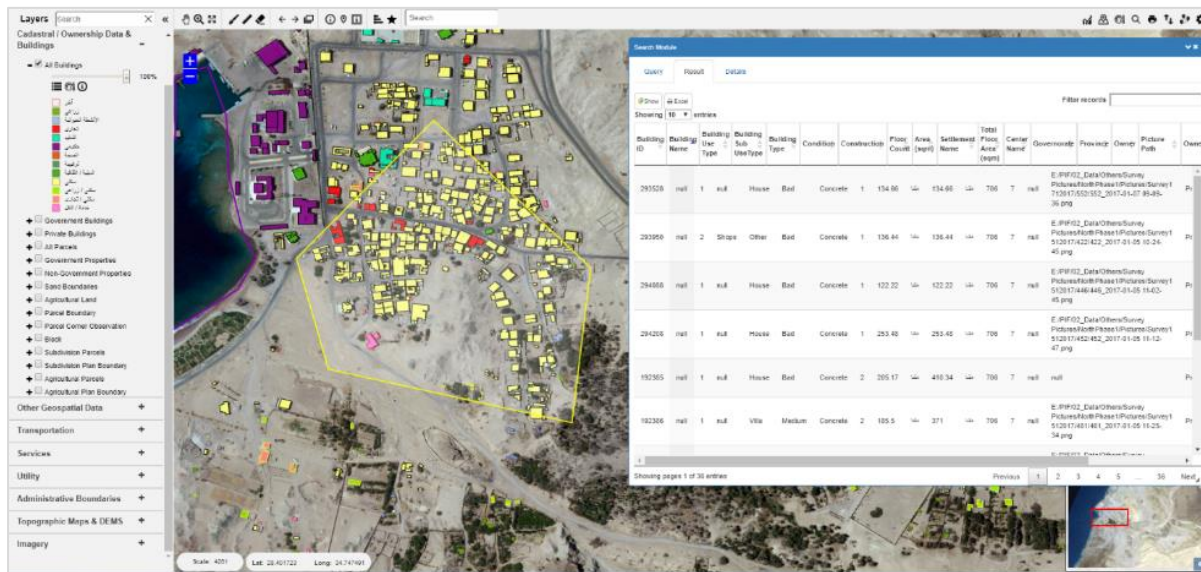


Figure 26 Draw Polygon

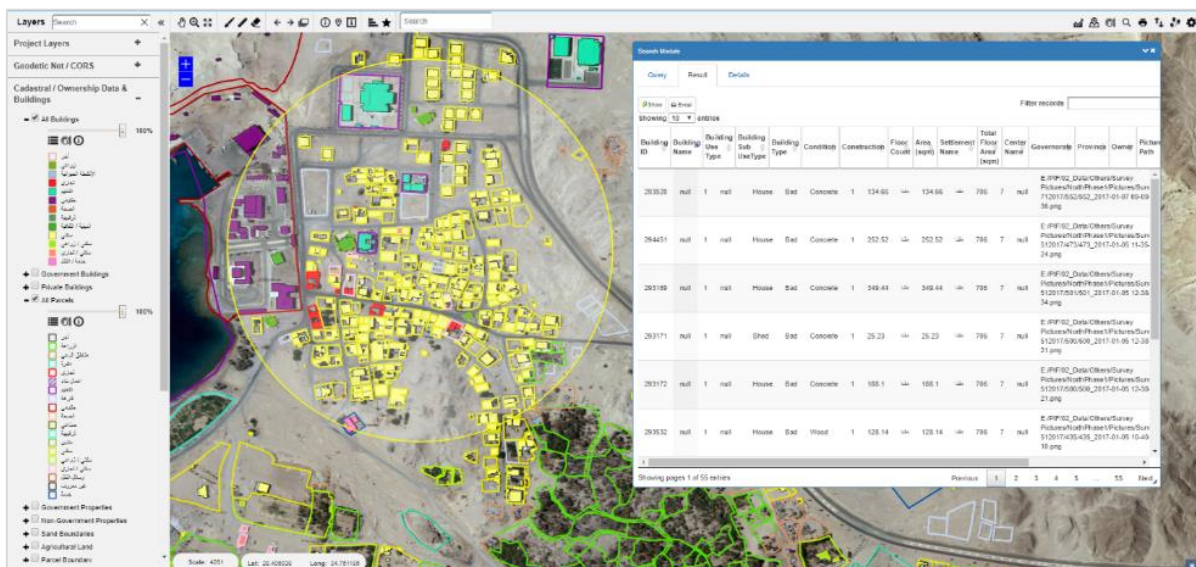


Figure 27 Draw Buffer Area

Search/Print Nearest Geo Elements

By using this component, user can search all the Geo Elements near to provided coordinates within a buffer area. Result will be listed in a grid view and marked on map with distances. Also result will be printed in a predefined format. A sample component and related views have been showed in Figure 28, Figure 29 and Figure 30.

Nearest Geo Element

Nearest Element Criteria

All Buildings

DD

DDM

DMS

UTM

Lat

Longitude

Buffer(KM)

10

☒ Print

☐ Nearest Element

Report Title

Templates

A4 Landscape

Legend Layers

Geodetic Control Points

CORS Sites

Building

Government Buildings

Scale

4261

☒ Map Scale

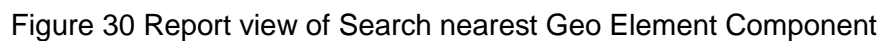
Print

Find

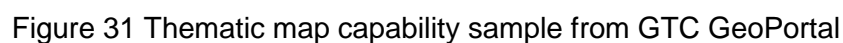
Figure 28 A sample Search nearest Geo Element Component



Figure 29 Map view of Search nearest Geo Element Component



A thematic map shows the spatial distribution of one or more specific data themes for selected geographic areas. The map may be qualitative in nature (e.g., predominant farm types) or quantitative (e.g., percentage population change). The thematic map capability is the part of GeoPortal (shown in Figure 31).



Admin Application

GeoPortal is also equipped with admin application which provides the following functionalities to the administrator

- Authentication features so that only valid users will have access to the system
- Authorization features so that users have access to only parts (Applications, screens, features, attributes, layers, Map Controls etc) of the system that they can use.
- Administration features so that admin can perform CRUD/assignments of all parts for Web Portal
- Logging feature to log all the actions perform by user.
- Role based mechanism to authorize the LDAP or web user

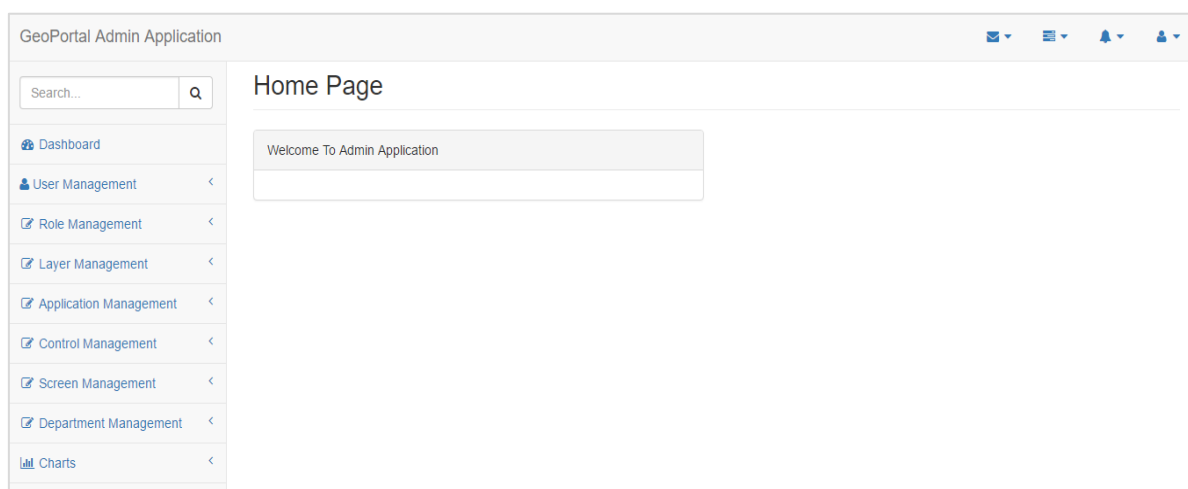


Figure 32 Home Page - Admin Application

The admin application has the following features:

User management

By user management, administrator can create, update, delete user and assign them appropriate role, layer groups and control groups.

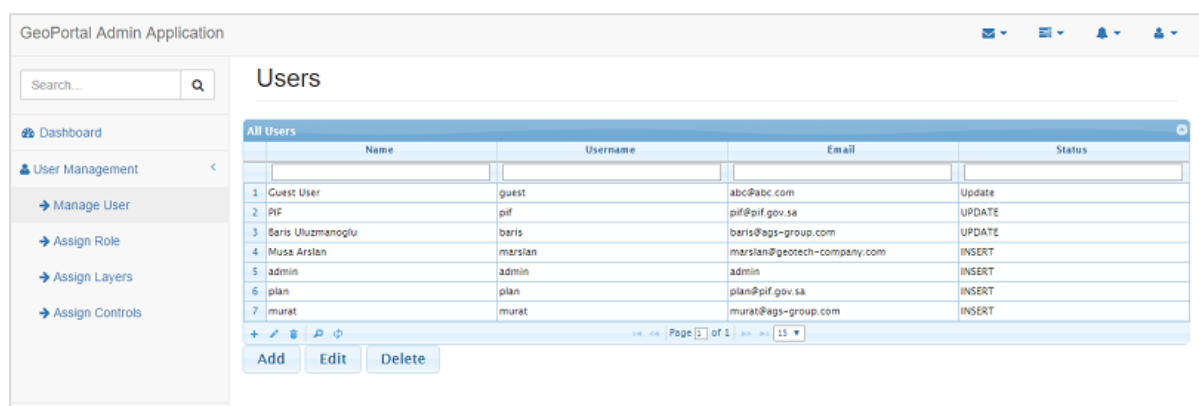


Figure 33 Admin Application - User Management

Role management

By role management, administrator can create, update, delete role to control the access of application, screens and users.

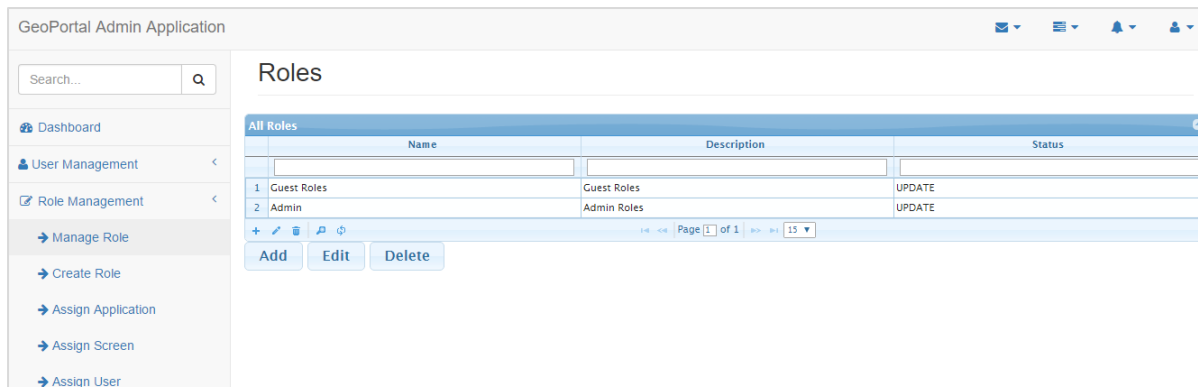


Figure 34 Admin Application - Role Management

Layer management

By layer management, administrator can create, update, delete layer for Geoportal application. Also, administrator can control the access of layers and related attributes.

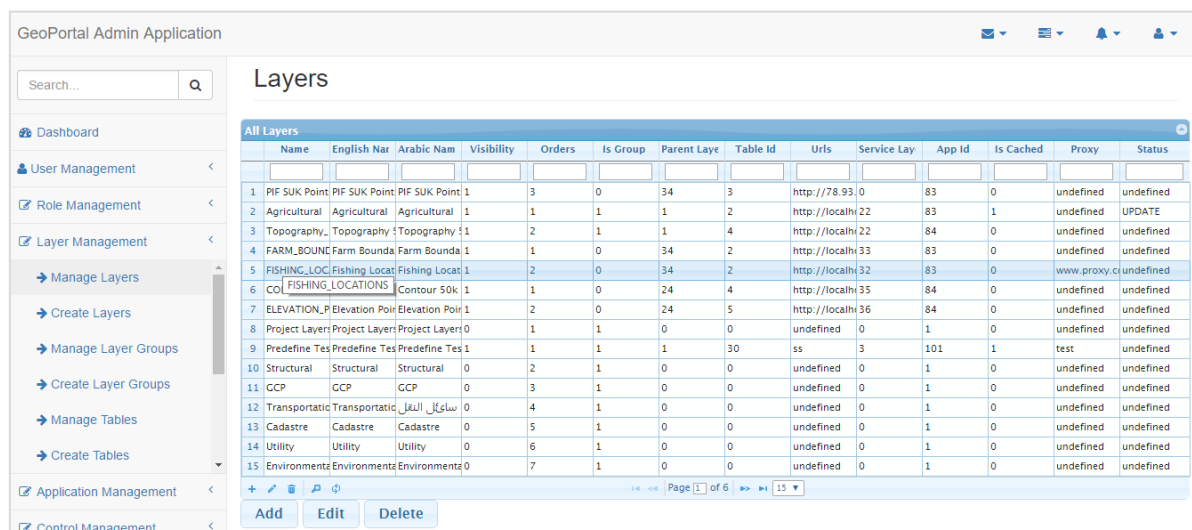


Figure 35 Admin Application - Layer Management

Application management

This feature enables the administrator to create, update, delete application and related configuration. Also, it helps admin to create/update manipulation for localization.

GeoPortal Admin Application

Search...

Dashboard

User Management

Role Management

Layer Management

Application Management

Control Management

Manage Controls

Create Control

Manage Controls Groups

Create Control Groups

Assign Users

Manage Category

Controls

All Controls												
Name	Element Id	Image Url	OnClick	Title	CATEGORY	Type	Status	Assign Pane	View Url	Component	Sub Menu	Class Name
1 Pan	pan	../assets/undefined	Pan	1	Button	UPDATE	false	undefined	panComponent	false	toolBoxMenu	
2 Zoom In	zoomin	../assets/undefined	Zoom In	1	Button	UPDATE	false	undefined	zoomInComp	false	toolBoxMenu	
3 Zoom Out	zoomOut	../assets/undefined	Zoom Out	1	Button	UPDATE	false	undefined	zoomOutComp	false	toolBoxMenu	
4 Full Extent	fullExtent	../assets/undefined	Full Extent	1	Button	UPDATE	false	undefined	fullExtentComp	false	toolBoxMenu	
5 Print	printFeatures	../assets/undefined	Print	1	Button	UPDATE	false	undefined	printCompone	false	toolBoxMenu	
6 Draw	draw	../assets/undefined	Draw	1	Button	UPDATE	false	undefined	drawVectorCo	true	draw_tool	
7 Measure	measure	../assets/undefined	Measure	1	Button	UPDATE	false	undefined	measureComp	true	draw_tool	
8 Remove All Fe	removeAllFeat	../assets/undefined	Remove All Fe	1	Button	UPDATE	false	undefined	removeAllFeat	true	draw_tool	
9 Identify Featur	identifyFeature	../assets/undefined	Identify Featur	1	Button	UPDATE	false	undefined	identifyComp	true	draw_tool	
10 Next History	next_history	../assets/undefined	Next History	1	Button	UPDATE	false	undefined	nextHistoryCo	true	draw_tool	
11 Back History	back_history	../assets/undefined	Back History	1	Button	UPDATE	false	undefined	backHistoryCo	true	draw_tool	
12 Point	point	../assets/undefined	Point	2	Button	INSERT	false	point/point.co	pointCompone	false	point_draw_ve	
13 Line	line	../assets/undefined	Line	2	Button	INSERT	false	line/line.comp	lineComponent	false	line_draw_vect	
14 Polygon	polygon	../assets/undefined	Polygon	2	Button	UPDATE	false	polygon/polyg	polygonCompi	false	polygon_draw	
15 Modify	polygon	../assets/undefined	Modify	2	Button	INSERT	false	modify/modify	modifyCompoi	false	modify_draw	

Page 1 of 2

Add Edit Delete

Figure 36 Admin Application - Application Management

Control management

This feature enables the administrator to create, update, delete control for Geoportal application and also administrator can limit the user control according to the given role

GeoPortal Admin Application

Search...

Dashboard

User Management

Role Management

Layer Management

Application Management

Control Management

Manage Controls

Create Control

Manage Controls Groups

Create Control Groups

Assign Users

Manage Category

Controls

All Controls												
Name	Element Id	Image Url	OnClick	Title	CATEGORY	Type	Status	Assign Pane	View Url	Component	Sub Menu	Class Name
1 Pan	pan	../assets/undefined	Pan	1	Button	UPDATE	false	undefined	panComponent	false	toolBoxMenu	
2 Zoom In	zoomin	../assets/undefined	Zoom In	1	Button	UPDATE	false	undefined	zoomInComp	false	toolBoxMenu	
3 Zoom Out	zoomOut	../assets/undefined	Zoom Out	1	Button	UPDATE	false	undefined	zoomOutComp	false	toolBoxMenu	
4 Full Extent	fullExtent	../assets/undefined	Full Extent	1	Button	UPDATE	false	undefined	fullExtentCom	false	toolBoxMenu	
5 Print	printFeatures	../assets/undefined	Print	1	Button	UPDATE	false	undefined	printCompone	false	toolBoxMenu	
6 Draw	draw	../assets/undefined	Draw	1	Button	UPDATE	false	undefined	drawVectorCo	true	draw_tool	
7 Measure	measure	../assets/undefined	Measure	1	Button	UPDATE	false	undefined	measureComp	true	draw_tool	
8 Remove All Fe	removeAllFeat	../assets/undefined	Remove All Fe	1	Button	UPDATE	false	undefined	removeAllFeat	true	draw_tool	
9 Identify Featur	identifyFeature	../assets/undefined	Identify Featur	1	Button	UPDATE	false	undefined	identifyComp	true	draw_tool	
10 Next History	next_history	../assets/undefined	Next History	1	Button	UPDATE	false	undefined	nextHistoryCo	true	draw_tool	
11 Back History	back_history	../assets/undefined	Back History	1	Button	UPDATE	false	undefined	backHistoryCo	true	draw_tool	
12 Point	point	../assets/undefined	Point	2	Button	INSERT	false	point/point.co	pointCompone	false	point_draw_ve	
13 Line	line	../assets/undefined	Line	2	Button	INSERT	false	line/line.comp	lineComponent	false	line_draw_vect	
14 Polygon	polygon	../assets/undefined	Polygon	2	Button	UPDATE	false	polygon/polyg	polygonCompi	false	polygon_draw	
15 Modify	polygon	../assets/undefined	Modify	2	Button	INSERT	false	modify/modify	modifyCompoi	false	modify_draw	

Page 1 of 2

Add Edit Delete

Figure 37 Admin Application - Control Management

User Activity Management

This feature enables the administrator to monitor the user activities like login, logout, view/update/delete data, control usage etc.

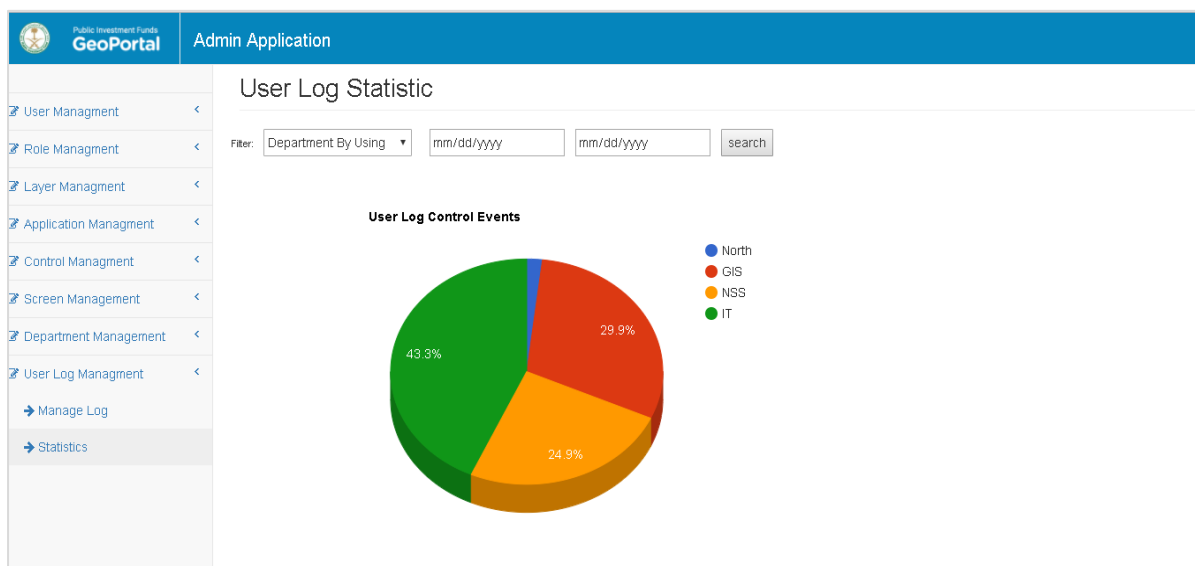


Figure 38 Admin Application - User Activity Management

The idea of sharing data is the most essential element for geographic information infrastructure, data standards and quality. To achieve this; building spatial data infrastructure, sharing and the presentation of the data concepts are available throughout the world. Following the production of data, there are specific standards such as ISO TC/211, INSPIRE and OGC to define rules and procedures of data sharing. It is important to reach the data through a single door/gate-like state of the environment. At this point, the portal architecture and technology are essential to respond to this need. It is important that predefined data can be shared through a unique interface.

Geoportals, in general, provide the general framework required to access geographic information and accessibility criteria via both intra and internet. Per the Open Geospatial Consortium, Geoportal is “a human interface to a collection of online geospatial information resources, including data sets and services”. Geoportals can be considered as “gateways to geographic content and capabilities”.

Geoportals basically work per triple framework composed of Geoportal Core Services, Data Providers and Geoportal Clients as illustrated in Figure 39. Geoportal Core Services provide sustainable internal service flow that links data, spatial service and metadata providers to Geoportal clients. Data, spatial service and metadata providers are responsible for working in accordance with related SDI (Spatial Data Infrastructure) components, metadata standards and sustainable data provision. Clients consume the provided services.

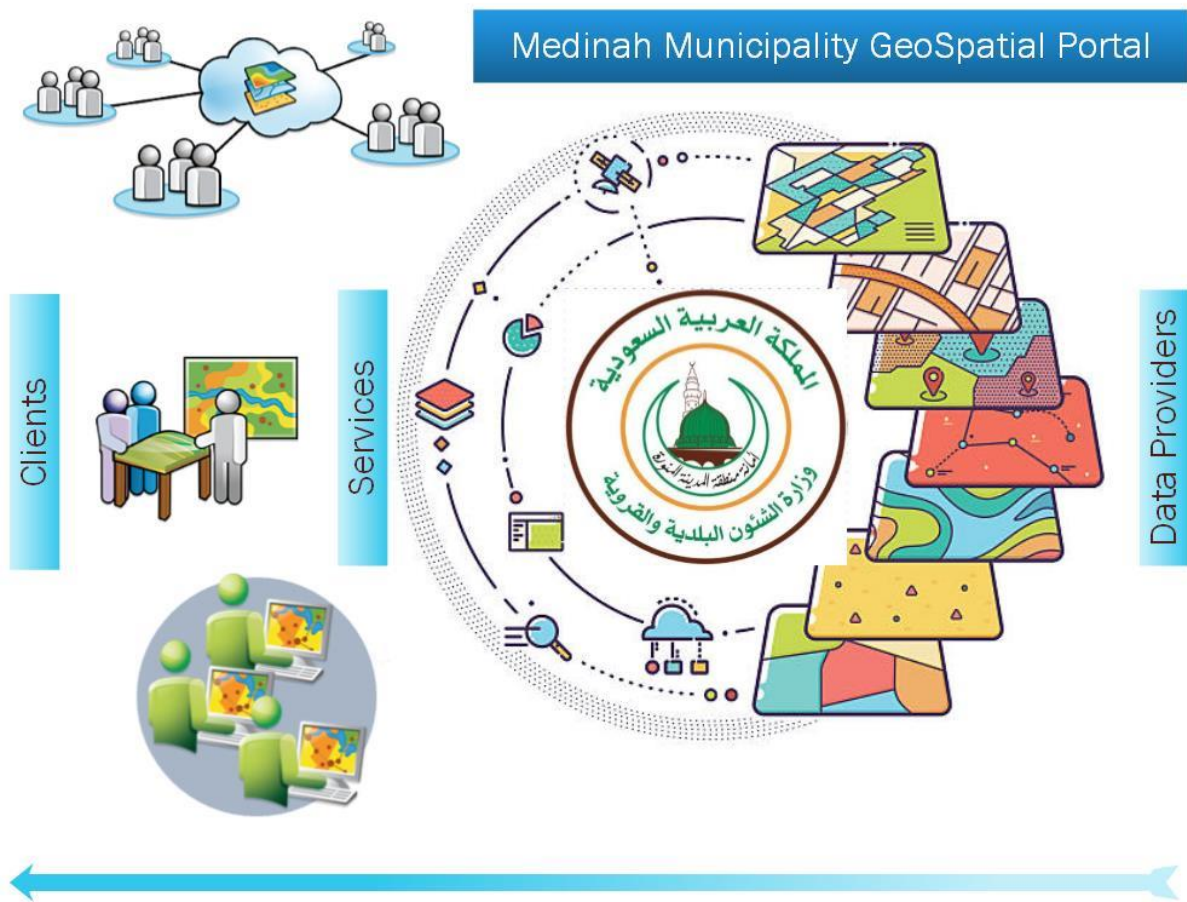


Figure 39 Madinah Municipality - Geospatial Portal Development

Per the OGC Reference Architecture in Figure 40, core structures of the Geoportal is composed of four components that are responsible for different procedure performances via internet infrastructure. These are; Portal Services, Portrayal Services, Catalog Services and Data Services.

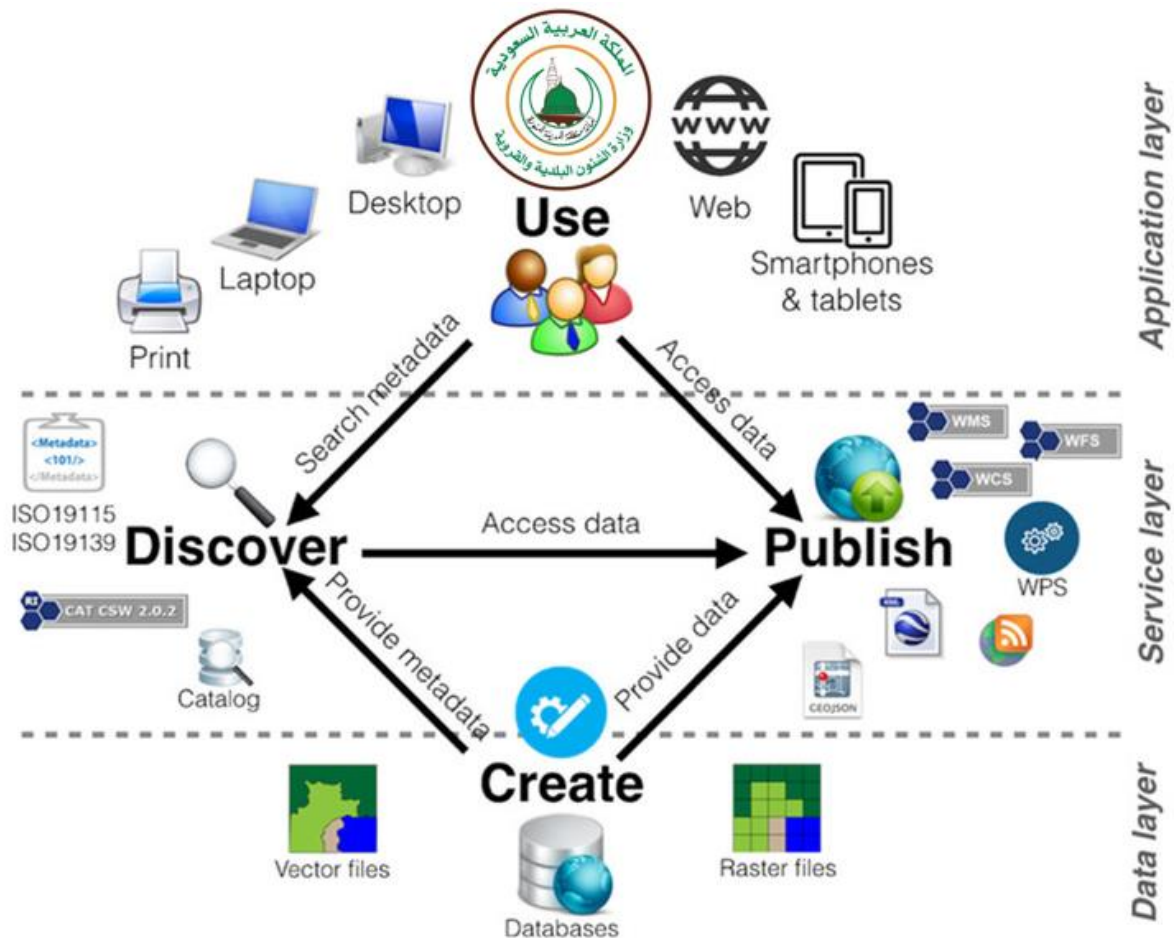


Figure 40 OGC Portal Service Architecture and Service Components

So, with the consideration of the municipality requirements above, GTC will develop Geoportal and applications for Internal and External users of Madinah Municipality mainly consisting of:

- 1) Queries and search (addresses, major landmarks, POIs, etc.)
- 2) Applications for major activities of the Municipality (commercial licenses, building permits, and other applications of spatially working departments, etc.)
- 3) Updating graphical and attribute information by assigning authorizations
- 4) Tendering and purchasing
- 5) Property and License management
- 6) Environmental management
- 7) Analysis and reporting
- 8) Web-based PC, tablet and mobile applications
- 9) Bulk e-mail and mobile SMS messages

In the development of Geoportal, GTC intends to adapt the new ESRI technology called WebGIS. GTC can support in implementing the out of the box product Esri "Portal for ArcGIS" that comes with ArcGIS Enterprise (formerly ArcGIS for Server). Then, GTC developers will develop all the required Apps within Esri WebApp builder formwork.

4.4 Capacity Building and Training

GTC will provide comprehensive on-the-job and formal trainings for the activities of the Project, including:

Geodesy and Map Projections

- Figure of the Earth
- Physical Geodesy
- Geometric Geodesy
- Geodetic Surveys
- Geodetic Control Networks
- Datum Definition (WGS84 – ITRF and SGD-2000) and Datum Transformation

Data Types, Conversion and Integration

- Geodetic Networks
- Topography / DEMs
- Maps
- Images
- Ownership
- Other Geospatial Layers

GNSS Positioning Techniques

- GNSS Overview
- GNSS Observables
- Absolute Positioning
- Relative Positioning
- RTK & CORS Networks

Madinah Geodatabase and Geoportal

- Fundamentals of GIS
- GIS and Municipalities
- Geospatial Database
- Madinah Geodatabase
- Madinah Geoportal

In addition, GTC Consultant will prepare Terms of References (TORs) for

- Formal Education of Municipality Staff Abroad on Geomatics Engineering (Higher Education) and IT
- Training of Municipality Staff on Geomatics Engineering and IT (Abroad and in the Country)

Thus, GTC will support in the items above by providing, building the required training plan according to job roles for this project. GTC will provide certified training instructor Led courses, on the job training & Jumpstart around geospatial technology.

GTC proposes to arrange workshops and to hold a conference during the course of the Project.

4.5 Operation and Maintenance

GTC will successfully carry out the following tasks during the Project:

- a) Operation and Maintenance of geospatial data updating
- b) Operation and Maintenance of Geodatabase
- c) Operation and Maintenance of Geoportal

GTC will operate and maintain geospatial data by regularly updating. Such data is expected to come from the Municipality departments, MOMRA and other mapping agencies.

Similarly, GTC will also operate and maintain the Municipality Geodatabase by incorporating the updated information mentioned above.

Finally, during the Project, GTC will operate and maintain the Municipality Geoportal and applications mentioned above.

5 DELIVERABLES AND PROJECT MANAGEMENT TEAM

5.1 Deliverables

The below are main list of the deliverables required to complete the project. GTC will ensure that the deliverables produced covers the entire Scope of Work set out in the Contract.

Table 11 List of deliverables

Phase	#	Deliverable name	High-level description
1		Designing all the components	Designing a comprehensive Geodatabase, Geoportal, capacity building and training, preparing Geodatabase and Geoportal standards and guidelines.
2		Developing Integrated GeoDatabase	Data collection, densification/updating geodetic network and CORS, development of seamless DEMs, base maps, image maps, Municipality special layers and other thematic layers, 3D city model and conversion, integration and establishment of GeoDatabase.
3		Developing Smart Geoportal (Web Based)	For Municipality Departments (Internal Users) and For External Users & Public.
4		Capacity Building and Training	Formal Education of Municipality Staff Abroad on Geomatics Engineering and IT, Training of Municipality Staff on Geomatics Engineering and IT (Abroad & KSA) and Periodical Workshops and Conferences on Smart Municipality
5		Operation and Maintenance	Operation and Maintenance of geospatial data updating, Geodatabase and Geoportal.

Project Reporting

- Weekly Report: GTC will submit weekly status report containing a cover page of summary followed by the status of each work package on one separate page.
- Monthly Report: GTC will submit monthly status report, is basically the collection of the weekly report during the month. This report will highlight milestone events covering the current and next month period. Monthly progress reports will address:
 - Administration (project organization, meetings, visits, etc.)
 - Activities accomplished during previous periods
 - Activities accomplished during the present period
 - Activities planned for coming periods
 - Project output, deliveries and time table against milestones
 - Issues of concern
 - Annexes
- Report on Collection of Existing Information

- Report on 3D Modeling and Citigenius applications and analysis
- Report on Geodatabase and Geoportal
- Final Report: The final report will be submitted at the end of the project containing:
 - Overview of the project
 - Technical procedures used in completing each task
 - Comments on any problems encountered and the remedial actions taken for their solution and comments how such problems may be avoided in future.
 - Any recommendations for modifying the technical specifications for similar projects in the future.

Meetings

- A complete schedule of meetings to control the project will be provided by GTC. The meeting schedule will include but not limited to the following activities
 - Periodic review progress
 - Periodic update (report, progress, risks, issues, change management, etc.)
- GTC will propose a plan for the listed activities needed to control the project

5.2 Project Management Team

GTC employs leading experts and specialists in all fields of geomatics engineering, ranging from geodetic control, GPS surveys, digital mapping, data conversion, DEM compilation, image processing, programming, to GIS and Geoportal establishment.

GTC has prepared a well-structured organization project management plan to undertake this strategic project in such a short duration. The plan includes the followings:

- Preparing a detailed action plan for the project, which includes all tasks to be performed, delivery dates of major tasks, the Consultant's selected personnel, and the assigned dates for delivering outputs.
- Assigning Project Manager.
- Setting and executing a communication plan between different teams of the project.
- Setting a plan for risk management
- Managing the implementation of project's plan.
- Identifying hazard cases and risks and proposing solutions and procedures for eliminating its negative effects.
- Preparing progress reports for the project

In order to complete the project in efficient, quality and secure manner, GTC has considered a team of qualified and expert staffs having relevant experience. The Key Staff of GTC to be assigned to this project is provided below:

- 1) Project Manager (Eng. Ayhan YAGMUR, over 27 years' experience in Mapping & GIS.)
- 2) Project Coordinator: Dr. Fahri Kartal, over 30 years' experience in Geomatics Engineering)

- 3) Project Coordinator (Dr. Talat EKSIOGLU, over 25 years' experience in spatial database and GIS; Project Manager of very prestigious MOMRA Planning System and PIF NEOM Project)
- 4) 3D Geospatial Data and Citigenius Expert (Dr. Erdal YILMAZ, over 20 years' experience in photogrammetric mapping, computer engineering and software development)
- 5) GIS Consultant / Specialist (Eng. Suleyman Arslan, over 20 years' experience in GIS / Geodatabase)
- 6) GIS Application Developer (Wajid HANIF, over 10 years in GIS software development)
- 7) Geomatics Engineer (Eng. Murat Arslanoglu, over 20 years' experience in geomatics engineering)
- 8) Geomatics Engineering Expert (Dr. Ekrem UCAR, over 25 years' experience in photogrammetric mapping)
- 9) GIS Expert (Eng. Muhammed Yousaf ISMAIL, over 15 years of experience in the field of GIS.)
- 10) GIS Expert (Mr. Mustafa Ahmed Ali Hassan, over ten years of GIS / Remote sensing experiencing.)
- 11) GIS Analyst (Eng. Musa Arslan over 15 years of experience in GIS)
- 12) Data Base Expert. (Mr. Omer Seyfettin KAR, over 30 years of diversified experience in the field of IT and Data bases.

6 WORK PROGRAM

The duration of the project is 36 months starting from the date of contract signing. The time table for the execution of the Project is given in Appendix C.

7 PAYMENTS

With the starting of the project on **15th of July 2018** according to the **Hijri 2/11/1439**, GTC has mobilized project staff, set up of project office and started the activities.

According to Contract and with the consideration of the ongoing expenses, activities and products, first receipt is 5% advance of total project value (Page 18, Clause 12 A). GTC will submit the payments in 5 installments according to Contract. Final payment is 10% of total project value (Contract Document: Page 26 Clause 9.6). Each installment item, its percentage payment and amount in SR and its status is provided in Table 12.

Table 12 Payments and installments

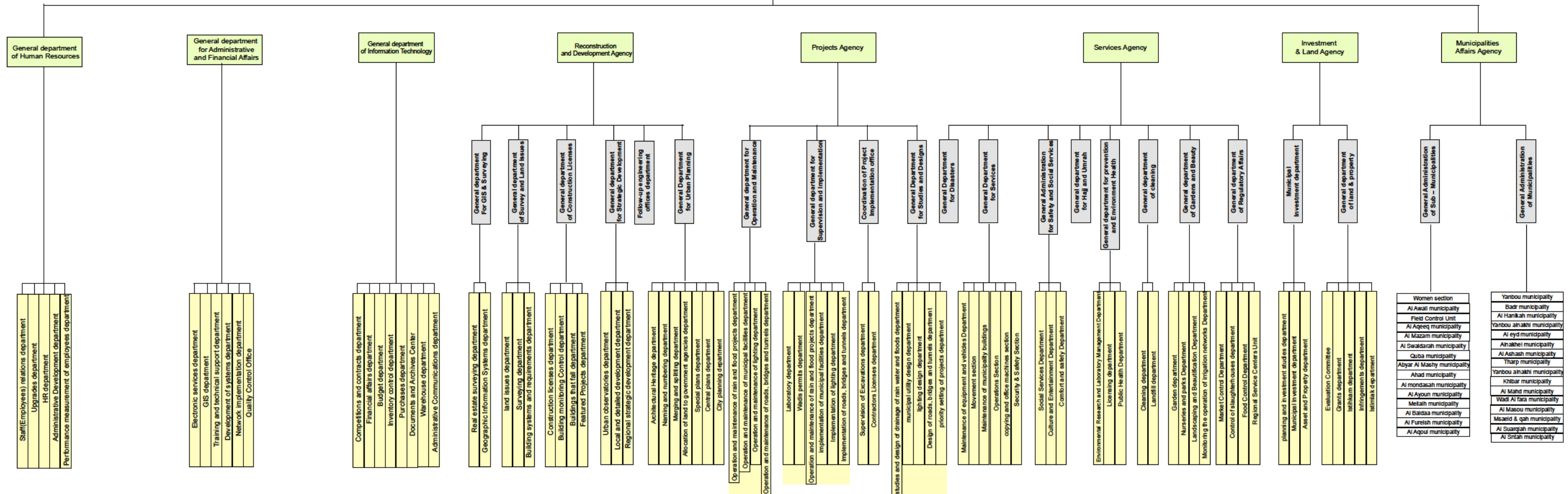
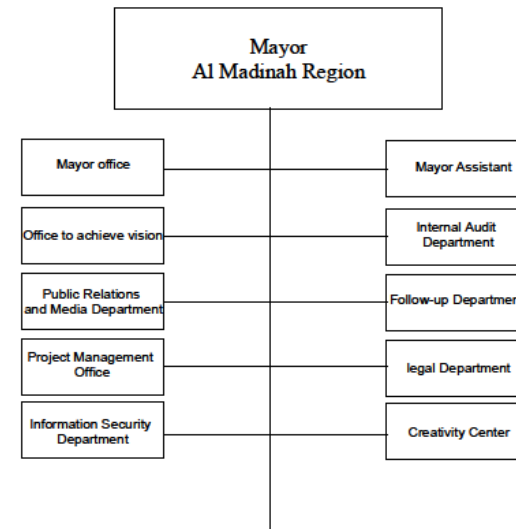
NO	ITEM	%	AMOUNT (SR)	Submit	Payment Status	Remarks
1	First Receipt	5.00%	763,250	To be Submitted		Advance
2	Second Receipt	1.81%	276,250			
3	Third Receipt	43.99%	6,715,000			
4	Fourth Receipt	25.11%	3,833,500			
5	Fifth Receipt	3.56%	544,000			
6	Sixth Receipt	10.52%	1,606,500			
7	Final Payment	10.00%	1,526,500			
Total		100%	15,265,000			

8 APPENDICES

8.1 Appendix A - Organizational Chart



Kingdom of Saudi Arabia
Ministry of Municipal & Rule Affairs
Al Madinah Regional Municipality
Organizational Chart



8.2 Appendix B - Tables and Data Types of Columns

TABLE_NAME	COLUMN_NAME	DATA_TYPE
ABND_BUILDING	BDGLOC	NUMBER
	RPRTYYY	NUMBER
	RPRTNO	NUMBER
	RPRTDAT	VARCHAR2
	B_NO	VARCHAR2
	STRTNO	NUMBER
	DPRTNO	VARCHAR2
	MI_STYLE	VARCHAR2
	MI_PRINX	NUMBER
	GEOLOC	SDO_GEOMETRY
	MODUSR	VARCHAR2
	HEIGHT	NUMBER
AIRPORT_BUILDING_HEIGHTS	MI_PRINX	NUMBER
	GEOLOC	SDO_GEOMETRY
ATM_BANK	BANK_NAME	VARCHAR2
	ATM_TYPE	VARCHAR2
	MI_PRINX	NUMBER
	GEOLOC	SDO_GEOMETRY
BAQI_NEW_PLOT	PLOT_NO	VARCHAR2
	KABIRTYPE	VARCHAR2
	NUM_OF_KABIR	NUMBER
	AREA_OF_PLOT	NUMBER
	LAST_DATE	VARCHAR2
	STATUS	CHAR
	QDATE	VARCHAR2
	MI_STYLE	VARCHAR2
	MI_PRINX	NUMBER
	GEOLOC	SDO_GEOMETRY
	MODUSR	VARCHAR2
BAQI_NEW_POLY	PLOT_NO	VARCHAR2
	KABIR_NO	NUMBER
	REF_NO	NUMBER
	XCOOR	NUMBER
	YCOOR	NUMBER
	LAST_DATE	VARCHAR2
	DIGGING_OK	VARCHAR2
	DEFIN_OK	VARCHAR2
	DIGGING_DATE	VARCHAR2
	STATUS	VARCHAR2
	QDATE	VARCHAR2
	MI_STYLE	VARCHAR2
	MI_PRINX	NUMBER
	GEOLOC	SDO_GEOMETRY
	MODUSR	VARCHAR2



Tables_Columns.xls
x

8.3 Appendix C - Work Program

[illegible]